Macro-Monopoly Dynamics: How Large Firms Shape Aggregate Outcomes*

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Abstract

This paper develops a dynamic general equilibrium model with a macro-monopoly, a firm large enough to affect aggregates, to explore how its profit-maximizing decisions under commitment shape macroeconomic dynamics. Unlike monopolistic competitors, a macro-monopoly internalizes its aggregate influence through five channels: price, wage, interest rate, capital and implementability effects. Counterfactual analysis shows that price and wage effects are the dominant sources of distortion, while capital and implementability channels partially offset them. Under baseline calibration, these channels reduce steady-state output by 5.7% relative to the competitive benchmark, reaching 26.5% under configurations of high market power. We contrast two profit valuation approaches: consumption-based (discounting via the stochastic discount factor) and utility-based (weighting by contemporaneous marginal utility). Consumption-based valuation exhibits "initial-period dependence": raising period-0 consumption lowers initial marginal utility, reducing the discount rate for all future profits and increasing their present value. This generates an additional source of time inconsistency, generating deviations far larger than those from classical time inconsistency alone while reoptimizing.

Keywords: macro-monopoly, dynamic general equilibrium, market power, time inconsistency, Ramsey problem

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1 Introduction

In recent decades, the large corporations with rising market power have reshaped macroeconomic dynamics–for example, Samsung and Hyundai, which are large relative to Korea's economy (Gabaix 2011). Those firms, as well as others, have influence in the aggregate economy (Azar & Vives 2021). Yet this fact stands in stark contrast to the dominant paradigm in macroeconomics, which relies on monopolistic competition frameworks à la (Dixit & Stiglitz 1977, Blanchard & Kiyotaki 1987). In these models, firms may have price-setting power in their product markets but remain passive takers of macroeconomic conditions—treating aggregate prices, interest rates, and marginal utilities as exogenous parameters beyond their control. This disconnect between reality and theoretical modeling leaves critical questions unanswered about how large firms' strategic decisions shape the broader economy.

This paper bridges this gap by developing a dynamic general equilibrium model featuring a "macro-monopoly"—a single firm large enough to influence aggregate output, consumption, and investment through its production decisions. Our analysis pursues two primary objectives: first, to establish a theoretical framework capable of capturing the dynamic interactions between a large firm and the macroeconomy over time; second, to identify and quantify the specific distortions introduced through five channels: price effects operating through market power over both sectors' output, wage effects through both goods and labor market reallocation, interest rate effects through consumption path manipulation, capital effects through resource constraint binding, and implementability effects through household Euler equation impacts. Unlike static models that focus on current outcome, our framework endogenizes the interaction between the firm's intertemporal choices and the aggregate conditions that determine its profitability, which gives us the chance to discuss the transition dynamics and time inconsistency.

It is worth noting that our framework is a stylized model designed to isolate core mechanisms. While in reality, market power affecting aggregate outcomes often takes the form of oligopolies with multiple large firms, we focus on the extreme case of a single monopolist. This simplification allows us to more clearly analyze the fundamental economic forces how a firm's awareness of its influence on aggregate conditions shapes its intertemporal decisions. The insights derived from this monopoly case provide a theoretical foundation for understanding more complex oligopolistic settings.

Constructing such a model presents significant challenges. First, a macro-monopoly inherently operates within a leader-follower structure, creating a dynamic Stackelberg game where the firm's decisions must account for households' and small firms' forward-looking responses. This strategic interaction introduces non-trivial forward-looking constraints that amplify the complexity of incorporating capital accumulation—a cornerstone of long-term firm behavior. As noted, existing models either restrict firms to industrylevel interactions (Gabaix 2011, Baqaee & Farhi 2019, Carvalho & Grassi 2019) or abstract from capital dynamics entirely(Azar & Vives 2021). Our approach explicitly analyzes how profit valuation rules interact with intertemporal decisions when firms recognize their ability to shape economy-wide outcomes.

Second, modeling macro-monopolies raises fundamental questions about objective function specification: how should a firm that understands its ability to alter equilibrium conditions structure its intertemporal profit maximization problem? Unlike smaller firms, macro-monopolies face a unique tension: their production decisions endogenously change the interest rate and discount factors used to value future profits. This paper follows the standard practice in macroeconomics of assuming firms maximize their present discounted value of future cash flows (Lucas 1978, **?**) but departs critically from the literature by relaxing the exogenous discounting assumption. Most macro studies take discount factors unaffected by the firm's own actions, a simplification that overlooks the critical channel through which aggregate consumption changes—driven by the large firm's decisions—alter marginal utilities and thus profit valuations. We explicitly compare two valuation approaches: consumption-based valuation (valuating profits by units of initial-period aggregate consumption) and utility-based valuation (valuating profits by units of utilities), demonstrating how objective function specification fundamentally shapes dynamic behavior.

Our analysis yields three key findings that advance understanding of large-firm macroeconomics. First, through steady-state comparative statics and counterfactual analysis, we show that macro-monopoly power reduces aggregate output by 6% under baseline calibration (corresponding to 24% GDP share), reaching 27% under configurations of high market power (corresponding to 80% GDP share). Counterfactual analysis excluding certain effect reveals that price and wage effects are the dominant sources of welfare losses, while capital and implementability effects paradoxically discipline monopoly power by imposing intertemporal constraints.

Second, we identify a distinctive feature of consumption-based valuation: "initial-period dependence." By increasing period-0 production to raise aggregate consumption, the firm reduces initial marginal utility $U'(c_0)$—the normalization factor converting the total utility value of future profits into units of initial consumption—thereby boosting their present value. This mechanism is absent in subsequent periods under committed plans, creating structural asymmetry where initial allocations systematically differ from other decisions. Both objectives converge to identical steady states, but time paths differ qualitatively during transitions due to this feature. For capital stocks below steady state, consumption-based valuation slows accumulation by reallocating labor toward the monopoly sector at initial period; for stocks above steady state, it accelerates decumulation through the same channel operating in reverse.

Third, we demonstrate that initial-period dependence creates an additional source of time inconsistency-valuation-driven time inconsistency. This mechanism is analogous to the "present bias" in quasi-hyperbolic discounting models, and operates alongside the classical mechanism rooted in forward-looking constraints. When reoptimizing at period 1, consumption-based valuation resets the normalization factor from $U'(c_0)$ to $U'(c_1)$. Numerical analysis quantifies this dual inconsistency: under baseline calibration with low initial capital, reoptimized monopoly labor surges 175% relative to the committed plan, while aggregate consumption rises 32%. In contrast, utility-based valuation—which eliminates this valuation-driven time inconsistency—exhibits deviations below 2%, isolating the contribution of classical inconsistency. This contrast (175% versus 2%) establishes valuation-driven time inconsistency as the quantitatively dominant source of plan revision for firms using consumption-based valuation.

Our work connects with several strands of literature while offering distinct contributions. The literature on time inconsistency(Kydland & Prescott 1977) has primarily focused on policymakers' behavior, with limited applications to firm dynamics. We demonstrate that a macro-monopoly's profit-maximization problem can generate a form of time inconsistency that is structurally akin to the "present bias" found in the hyperbolic discounting literature (Laibson 1997). The shared feature is an asymmetric treatment of the present versus the future within the objective function. However, the source of this asymmetry is fundamentally different. In behavioral models, present bias is typically a primitive assumption about preferences. In our model, the asymmetry arises because the firm's choice in the present have a dual impact: it affects profits and simultaneously establishes the normalization factor, $U'(c_0)$, for valuing the entire future profit stream. From the perspective of any future period, however, the firm's choices only affect profits, as the normalization factor is predetermined. This endows the initial period with a special status, making its consumption level, c_0, the unique benchmark for all subsequent profits—a role not shared by any future period. This asymmetry, rooted in the standard logic of asset pricing rather than psychology, creates a novel mechanism for time inconsistency.

Methodologically, our approach parallels the Ramsey problem literature (Lucas & Stokey 1983), where planners account for . However, while Ramsey analyses focus on social welfare maximization with exogenous policy instruments, we examine profit maximization where the valuation metric—marginal utility—is endogenously determined by the firm's own choices. This shifts analytical focus from optimal fiscal policy design to optimal production plan for large firms.

Methodologically, our approach parallels the Ramsey problem literature (Lucas & Stokey 1983), where a planner optimizes its choices while accounting for the policy effects on household behavior. However, the identity of the planner, the objective, and the choice variables are fundamentally different in our setting. The classical Ramsey planner is a benevolent government or central bank that chooses fiscal policy or monetary policy instruments to maximize social welfare or policy target. In contrast, our planner is a private, profit-maximizing firm, and its choice variables are its own production and labor plans. This re-framing naturally shifts the analytical focus from the design of optimal fiscal policy to the optimal production strategy for a large firm.

The remainder of the paper proceeds as follows. Section 2 outlines the baseline model, including household preferences, competitive firms' problem, the macro-monopoly's problem, Ramsey-style formulation, and the two profit valuation schemes. Section 3 analyzes an analytical special case to underscoring the initial-period dependence mechanism. Section 4 presents steady state comparative statics in the general case, and counterfactual analysis to identify dominant channels. Then we analyze transition dynamics. Section 5 examines time inconsistency by comparing committed versus reoptimized plans, decomposing the dual sources of deviation. Section 6 concludes with implications for regulating policy and macroeconomic modeling of large firms.

2 The Model

We consider a dynamic general equilibrium model with a monopolistic sector large enough to affect aggregate outcomes. The economy consists of a representative household, a continuum of competitive firms in sector 1, and a single monopolistic firm in sector 2. The monopolist recognizes its influence on equilibrium prices, wages, interest rates, and capital accumulation, internalizing these effects when formulating optimal production plans under commitment. We analyze two alternative profit valuation objectives that differ in the unit, and introduce the first-best allocation where both sectors operate competitively as a benchmark.

2.1 Households

A continuum of identical households with measure one maximizes lifetime utility. The representative household's preferences are defined over a composite consumption good c_t, which aggregates sector-specific consumption goods c_{1t} and c_{2t} via a constant elasticity of substitution (CES) function:

$$c_t = \left[\theta c_{1t}^{\frac{\gamma-1}{\gamma}} + (1-\theta) c_{2t}^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} \tag{1}$$

where $\theta \in (0,1)$ governs the relative weight on good 1, and $\gamma > 0$ denotes the elasticity of substitution between the two goods. Period utility takes the constant relative risk aversion form:

$$U(c_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma} \tag{2}$$

where $\sigma > 0$ measures the coefficient of relative risk aversion. The household's lifetime utility is:

$$\sum_{t=0}^{\infty} \beta^t U(c_t) \tag{3}$$

with discount factor $\beta \in (0, 1)$.

The household faces a sequence of budget constraints. In each period t, it allocates income from labor, capital rental, bonds purchased in the previous period, and firm profits to consumption, asset purchases, and new bond holdings:

$$p_{1t}c_{1t} + p_{2t}c_{2t} + p_{1t}a_{t+1} + b_{t+1} = w_t + p_{1t}(1 + \rho_t)a_t + (1 + i_t)b_t + \pi_{1t} + \pi_{2t} \tag{4}$$

where p_{1t} and p_{2t} denote the prices of goods 1 and 2, a_t represents assets (physical capital) purchased in units of good 1, b_t denotes risk-free bond holdings, w_t is the wage, ρ_t is the returns rate of asset, i_t is the risk-free interest rate, and π_{it} represents profits from sector i. We assume only good 1 can be converted one-to-one into physical capital, while good 2 serves purely for consumption. Labor supply is inelastically fixed at one unit per household. The households equally own all firms in the economy, with non-tradable shares ensuring profit distribution but no secondary asset markets beyond capital and bonds. The numeraire in this economy is the composite consumption good c_t, where price for the composite consumption good p_t is 1.

The household's optimization yields standard first-order conditions for consumption allocation and intertemporal choice.

$$\frac{\partial c_t}{\partial c_{1t}} = \frac{p_{1t}}{p_t} \tag{5}$$

$$\frac{\partial c_t}{\partial c_{2t}} = \frac{p_{2t}}{p_t} \tag{6}$$

$$U'(c_t)\frac{\partial c_t}{\partial c_{1t}} = \beta U'(c_{t+1})\frac{\partial c_{t+1}}{\partial c_{1t+1}}(1 + \rho_{t+1}) \tag{7}$$

$$U'(c_t) = \beta(1 + i_{t+1})U'(c_{t+1}) \tag{8}$$

2.2 Competitive Sector

Sector 1 consists of a continuum of identical competitive firms with measure one. Each firm operates a constant elasticity of substitution production technology that combines capital and labor:

$$y_{1t} = A_1[\alpha k_t^{1-\eta} + (1 - \alpha)l_{1t}^{1-\eta}]^{\frac{1}{1-\eta}} \tag{9}$$

where $A_1 > 0$ denotes total factor productivity, k_t is capital employed, l_{1t} is labor employed, $\alpha \in (0,1)$ represents the capital share parameter, and $\eta > 0$ governs the elasticity of substitution between factors. The capital stock depreciates at a constant rate δ each period. Firms rent capital from households at rate r_t and hire labor at wage w_t, taking both factor prices as given.

The representative firm in sector 1 solves a static profit maximization problem each period:

$$\max_{k_t, l_{1t}} \Pi_{1t} = p_{1t} y_{1t} - p_{1t} r_t k_t - w_t l_{1t} \tag{10}$$

Standard first-order conditions yield factor pricing equations that equate marginal products to factor prices:

$$r_t = A_1 \alpha \left[\alpha k_t^{1-\eta} + (1-\alpha) l_{1t}^{1-\eta} \right]^{\frac{\eta}{1-\eta}} k_t^{-\eta} \tag{11}$$

$$w_t = p_{1t} A_1 (1-\alpha) \left[\alpha k_t^{1-\eta} + (1-\alpha) l_{1t}^{1-\eta} \right]^{\frac{\eta}{1-\eta}} l_{1t}^{-\eta} \tag{12}$$

Perfect competition in sector 1 ensures zero economic profits in equilibrium, with all output distributed to capital and labor according to their marginal contributions.

2.3 Market Clearing

The monopolist recognizes that in equilibrium, all markets must clear. The labor market clearing condition is:

$$l_{1t} + l_{2t} = 1 \tag{13}$$

reflecting the fixed unit labor supply. The asset market clears when household asset holdings equal capital employed in sector 1:

$$a_t = k_t \tag{14}$$

The market for goods 1 clears when production equals consumption plus net investment:

$$y_{1t} = c_{1t} + k_{t+1} - (1-\delta) k_t \tag{15}$$

Combine asset market and goods 1 market clearing condition, we have:

$$\rho_t = r_t - \delta \tag{16}$$

The market for goods 2 clears when production equals consumption:

$$y_{2t} = c_{2t} \tag{17}$$

The bond market clears when aggregate bond holdings are zero, as there is no external borrowing or lending:

$$b_t = 0 \tag{18}$$

The profits that households receive equals the firms' profits.

$$\pi_{1t} = \Pi_{1t}, \quad \pi_{2t} = \Pi_{2t}, \tag{19}$$

2.4 Monopoly Sector

Sector 2 consists of a single firm with linear production technology:

$$y_{2t} = A_2 l_{2t} \tag{20}$$

where $A_2 > 0$ denotes labor productivity and l_{2t} represents labor employed in sector 2. The monopolist's profit in period t, measured in units of composite consumption, is:

$$\Pi_{2t} = \frac{p_{2t}}{p_t} y_{2t} - \frac{w_t}{p_t} l_{2t} \tag{21}$$

where p_t is the aggregate price index corresponding to the composite good numeraire, and $p_t = 1$.

The monopolist is managed by a professional manager. We consider that the manager's compensation depends on the market value of the firm, defined as the present value of future profit streams. To maximize this value, the monopolist chooses an optimal production plan, represented by the sequence of labor allocations $\{l_{2t}\}_{t=0}^{\infty}$. The value is calculated using the equilibrium risk-free rate to discount, which is endogenous to the monopolist's decisions through their impact on aggregate consumption paths.

This suggests the following objective for the monopolist:

Objective 1: Consumption-Based Valuation

$$\max_{\{l_{2t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \frac{1}{\prod_{s=0}^{t}(1+i_s)} \Pi_{2t} \tag{22}$$

The monopolist's primitive problem is maximize the objective by choosing production plan $\{l_{2t}\}_{t=0}^{\infty}$, subject to

1. The household's first-order conditions (Equations 5-8).
2. The competitive firms' first-order conditions (Equations 9, 11,12).
3. All market clearing conditions (Equations 13-19).

We consider an alternative scenario where the manager's compensation remains linked to firm value, but shareholders at the initial-period meeting specify that value should be measured in utility units rather than consumption units.

Objective 2: Utility-Based Valuation

$$\max_{\{l_{2t}\}_{t=0}^{\infty}} U'(c_0) \cdot \sum_{t=0}^{\infty} \frac{1}{\prod_{s=0}^{t}(1+i_s)} \Pi_{2t} \tag{23}$$

The constraints are the same.

An equilibrium consists of sequences of allocations $\{c_{1t}, c_{2t}, k_{t+1}, l_{1t}, l_{2t}\}_{t=0}^{\infty}$ and prices $\{p_{1t}, p_{2t}, w_t, r_t, \rho_t, i_t\}_{t=0}^{\infty}$ such that households optimize given prices, competitive firms in sector 1 maximize profits taking prices as given, all markets clear, and the monopolist in sector 2 solves its dynamic optimization problem recognizing the impact of its decisions on equilibrium prices and quantities.

2.5 Ramsey-Style Formulation

The monopolist's problem is inherently a dynamic Stackelberg game. The monopolist acts as a leader, choosing its production plan, while households and competitive firms act as followers, optimizing based on the resulting macroeconomic environment. In the most primitive form, the monopolist would choose a production plan $\{l_{2t}\}_{t=0}^{\infty}$. It must then anticipate the followers' optimal responses (consumption, savings, factor prices) to this plan and the general equilibrium it induces. Solving this problem directly is complex because the monopolist's constraints are determined by the followers' optimal behavior, which itself is a reaction to the monopolist's chosen path.

To avoid this complexity, we adopt the Ramsey approach. Instead of choosing production plan only, we allow the monopolist (the "planner") to choose the final allocations, such as $\{c_{1t}, c_{2t}\}_{t=0}^{\infty}$, directly. However, the planner cannot choose any arbitrary allocation. The chosen path must be implementable—that is, it must be an outcome that rational households and firms would willingly support in a market equilibrium.

The key to ensuring implementability lies in incorporating the household's intertemporal Euler equation. By including the Euler equation as an implementability constraint, we force the monopolist to select only from the set of consumption paths that households would find optimal. This is precisely what grants us the "right" to treat the allocation sequence $\{c_{1t}\}_{t=0}^{\infty}$ as a choice variable for the planner. With the choice variables transformed, equilibrium prices can be substituted out of the problem by expressing them as functions of the chosen allocations. This reformulation is the cornerstone of the Ramsey method, and its validity is established by the following proposition.

Proposition 1 (Equivalence of Ramsey-Style Formulation). *The solution to the Ramsey problem, where the planner chooses the allocations to maximize the monopolist's objective function subject to resource and implementability constraints, is equivalent to* *the equilibrium outcome of the original primitive problem.*

(Proof in Appendix A.2)

The monopolist's problem can now be expressed entirely in terms of allocations. Under Objective 1 (consumption-based valuation):

$$\max_{\{c_{1t},c_{2t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \frac{U'(c_t)}{U'(c_0)} \left(\frac{\partial c_t}{\partial c_{2t}} A_2 l_{2t} + \frac{\partial c_t}{\partial c_{1t}} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t} \right) \tag{24}$$

subject to the household's Euler equation for capital (the implementability constraint):

$$U'(c_t) \frac{\partial c_t}{\partial c_{1t}} = \beta U'(c_{t+1}) \frac{\partial c_{t+1}}{\partial c_{1,t+1}} \left(\frac{\partial y_{1,t+1}}{\partial k_{t+1}} + 1 - \delta \right) \tag{25}$$

and the resource constraint:

$$k_{t+1} = (1-\delta)k_t + y_{1t} - c_{1t} \tag{26}$$

This formulation reveals five distinct channels through which the monopolist internalizes its aggregate impact. The **price effect** appears through $\partial c_t/\partial c_{2t}$, capturing how changes in c_{1t} and c_{2t} affect the relative valuation of good 2 in the composite consumption bundle. The **wage effect** appears through $(\partial c_t/\partial c_{1t})(\partial y_{1t}/\partial l_{2t})$, reflecting how reallocating labor between sectors alters the competitive sector's marginal product of labor and the effect of the relative valuation of good 1 in the composite consumption bundle. The **interest rate effect** operates through the discount factor $\beta^t U'(c_t)/U'(c_0)$, showing how production decisions influence the entire path of stochastic discount factors by shaping the consumption trajectory. The **capital effect** enters through the resource constraint, linking current allocation decisions to future capital stock via sector 1 output. The **implementability effect** appears through the Euler equation constraint, demonstrating how announced future allocations affect current household saving behavior and thus current consumption allocations.

Notably, the normalization by $U'(c_0)$ treats initial-period marginal utility as the fixed measuring stick for intertemporal comparison, following conventional asset pricing where present value calculations anchor at the initial date. However, this formulation creates tension when the firm is large enough to influence aggregate consumption. Decisions in period 0 that increase c_0 reduce $U'(c_0)$, thereby altering the normalization factor that determines how all future profits are valued. This observation motivates an alternative specification that eliminates this structural asymmetry between the initial period and all others. Objective 2 can serve this exact purpose.

Under Objective 2 (utility-based valuation), the formulation differs only in the discount factor weighting:

$$\max_{\{c_{1t},c_{2t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U'(c_t) \left(\frac{\partial c_t}{\partial c_{2t}} A_2 l_{2t} + \frac{\partial c_t}{\partial c_{1t}} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t} \right) \tag{27}$$

subject to the same Euler equation and resource constraints. All five channels remain operative, but the normalization by $U'(c_0)$ is excluded.

2.6 First-Order Conditions and the Five Channels

To make explicit how the five channels operate, we derive the first-order conditions. For clarity, we will use the FOC with respect to c_{1t} as the primary example to illustrate the five channels and the unique normalization effect in Objective 1. The full set of FOCs, including those for c_{2t}, are detailed in Appendix B.

The first-order condition with respect to c_{1t} for $t \geq 1$ reveals the interactions of all five channels:

$$\begin{aligned} &\frac{1}{U'(c_0)} \cdot \Bigg(\underbrace{U''(c_t) \frac{\partial c_t}{\partial c_{1t}} \Pi_{2t}}_{\text{interest rate effect}} + \underbrace{U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t} \partial c_{2t}} A_2 l_{2t}}_{\text{price effect}} + \underbrace{U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t}}_{\text{wage effect}} \Bigg) \\ &- \underbrace{\mu_t}_{\text{capital effect}} - \underbrace{\lambda_t \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right)}_{\text{implementability effect for next period}} \\ &+ \underbrace{\lambda_{t-1} \left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta \right) \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right)}_{\text{implementability effect from previous period}} = 0 \end{aligned} \tag{28}$$

where λ_t is the Lagrange multiplier on the Euler equation at time t and μ_t is the multiplier on the resource constraint.

Each term in this condition corresponds to one of the five channels.

The **price effect** operates through $U'(c_t)(\partial^2 c_t / \partial c_{1t} \partial c_{2t}) A_2 l_{2t}$. This term reflects how changes in c_{1t} affect the marginal contribution of monopoly output c_{2t} to aggregate consumption, which is the relative price. In this CES aggregator, increasing c_{1t} increases the relative price of good 2, and further increases the present value contribution of period-t profits.

The **wage effect** appears through $U'(c_t)(\partial^2 c_t / \partial c_{1t}^2)(\partial y_{1t} / \partial l_{2t}) l_{2t}$. This term captures how changes in c_{1t} affect price of good 1, and interact with the monopolist's labor allocation decision through general equilibrium wage effects. Recall that $\partial y_{1t} / \partial l_{2t} < 0$ because increasing monopoly labor reduces competitive sector output, lowering the marginal product of labor in sector 1. The term $\partial^2 c_t / \partial c_{1t}^2$ is negative, overall the term is positive: increasing c_{1t} increases the present value contribution of period-t profits.

The **interest rate effect** appears through $U''(c_t)(\partial c_t/\partial c_{1t})\Pi_{2t}$, capturing how changes in c_{1t} alter aggregate consumption c_t, which changes marginal utility $U'(c_t)$, and thus the discount factor applied to period-t profits. Since $U'' < 0$, increasing c_{1t} (which raises c_t) reduces marginal utility, lowering the effective discount rate and reducing the present value contribution of period-t profits.

The **capital effect** is the shadow value μ_t on the resource constraint. This multiplier measures the marginal value of relaxing the capital accumulation constraint at time t, representing how changes in c_{1t} affect investment and future capital stock.

The **implementability effect** enters through two terms involving the Lagrange multiplier λ_t on the Euler equation. The term with λ_t reflects how current consumption c_{1t} affects the constraint linking period t to period $t+1$: changes in c_t alter $U'(c_t)$, tightening or loosening the Euler equation. The term with λ_{t-1} captures the corresponding effect from the previous period's Euler equation, which links period $t-1$ to period t.

For period 0, the first-order condition includes an additional term unique to consumption-based valuation:

$$
\begin{aligned}
&\frac{\partial \Pi_{20}}{\partial c_{10}} - \lambda_0 \left(U''(c_0) \left(\frac{\partial c_0}{\partial c_{10}} \right)^2 + U'(c_0) \frac{\partial^2 c_0}{\partial c_{10}^2} \right) - \mu_0 \\
&\underbrace{- \frac{U''(c_0)}{U'(c_0)^2} \frac{\partial c_0}{\partial c_{10}} \sum_{t=1}^{\infty} \beta^t U'(c_t) \Pi_{2t}}_{\text{normalization effect}} = 0
\end{aligned}
\tag{29}
$$

The normalization effect, appearing only in period 0 under Objective 1, creates structural asymmetry between the initial period and all subsequent periods. This term captures how period-0 decisions affect the normalization factor $U'(c_0)$ converting the total utility value of future profits into units of initial consumption. Increasing c_{10} raises aggregate consumption c_0, reducing marginal utility $U'(c_0)$ due to diminishing returns. Since all future profits in the objective function are divided by $U'(c_0)$, a lower normalization factor increases their present value. This effect is absent in periods $t \geq 1$ because $U'(c_0)$ is predetermined from their perspective.

The five channels respect to c_{2t} are the same, except the price and wage effect are in the opposite direction. The corresponding conditions for Objective 2 are similar to above, while lacking the normalization effect. The details are presented in Appendix B.

2.7 First-Best Allocation

To evaluate the consequences of monopoly power and assess the quantitative importance of the five distortion channels, we introduce the first-best allocation as a benchmark. This allocation solves the social planner's problem when both sectors operate competitively, eliminating market power distortions while retaining all production technologies and household preferences.

The social planner maximizes household lifetime utility by choosing paths for sector-1 consumption, and sector-2 labor:

$$\max_{\{c_{1t}, l_{2t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U(c_t) \tag{30}$$

subject to the resource constraint:

$$k_{t+1} = (1-\delta)k_t + y_{1t} - c_{1t} \tag{31}$$

The first-order conditions characterize the efficient allocation.

$$\frac{\partial c_t / \partial c_{2t}}{\partial c_t / \partial c_{1t}} = \frac{A_2}{-\partial y_{1t} / \partial l_{2t}} \tag{32}$$

which equates the marginal rate of substitution between goods 1 and 2 to their marginal rate of transformation. The intertemporal efficiency condition follows from combining the first-order conditions for c_{1t} and k_{t+1}:

$$U'(c_t)\frac{\partial c_t}{\partial c_{1t}} = \beta U'(c_{t+1})\frac{\partial c_{t+1}}{\partial c_{1,t+1}}\left(1-\delta+\frac{\partial y_{1,t+1}}{\partial k_{t+1}}\right) \tag{33}$$

This benchmark allocation satisfies three defining properties. First, intratemporal optimality ensures no reallocation of resources across sectors within any period can raise household utility, as the social marginal benefit of each good equals its social marginal cost. Second, intertemporal optimality ensures the consumption-saving trade-off equates the marginal utility of current consumption to the discounted marginal utility of future consumption enabled by capital accumulation. Third, the absence of markup distortions means labor and capital are compensated at their social marginal products without any wedge created by market power. This benchmark thus provides a clear metric to assess how the monopolist's objectives deviate from Pareto efficiency in subsequent sections.

3 Analytical Characterization: A Special Case

To build intuition and validate our numerical methods, we first solve a special case with analytical solutions. The detailed derivation and formulation for this special case are presented in Appendix C. We impose the following parameter restrictions:

$$\frac{1}{\gamma} = \sigma = \eta \quad \text{and} \quad \delta = 1 \tag{34}$$

Under these conditions, the household's first-order conditions imply that c_{1t} is proportional to y_{1t}:

$$c_{1t} = \left(1 - (\alpha\beta A_1^{1-\sigma})^{\frac{1}{\sigma}}\right) y_{1t} \tag{35}$$

This proportionality dramatically simplifies the monopolist's problem, as the forward-looking constraints effectively disappear from the optimization, making consumption a constant fraction of output regardless of the monopolist's choices. Moreover, this proportionality ensures that any change in the marginal product of labor (MPL) in sector 1, driven by the accumulation of capital, is perfectly offset by a corresponding change in the price of good 1. Therefore, for Objective 2 (utility-based valuation), the time-symmetric nature of the objective function means the monopolist faces an identical static trade-off in every period. This results in a constant optimal labor allocation, $l_{2t} = \bar{l_2}$, for all time periods $t \geq 0$.

In contrast, Objective 1 (consumption-based valuation) exhibits the "initial-period dependence" that is one of the key findings of our analysis. For all periods $t \geq 1$, the optimal labor allocation is the same constant, $l_{2t} = \bar{l_2}$, identical to the solution under Objective 2. This is because from the perspective of any period after $t = 0$, the normalization factor $U'(c_0)$ is a predetermined constant. However, the decision for the initial period, l_{20}, is different. At $t = 0$, the monopolist recognizes that increasing its production (and thus aggregate consumption c_0) reduces the marginal utility $U'(c_0)$. Since all future profits are divided by this term, a lower $U'(c_0)$ inflates their present value. This creates a unique incentive to manipulate initial production, causing l_{20} to deviate from the constant value $\bar{l_2}$.

These distinct behaviors under the two objectives can be formally stated in the following proposition.

Proposition 2 (Initial-Period Dependence in the Special Case). *Under the parameter restrictions $\frac{1}{\gamma} = \sigma = \eta$ and $\delta = 1$, the monopolist's optimal plan exhibits distinct properties based on its objective.*

1. *Under Objective 2 (utility-based), the optimal labor allocation is a constant for all periods, $l_{2t} = \bar{l_2}$, for $t \geq 0$.*

2. *Under Objective 1 (consumption-based), the optimal labor allocation is $l_{2t} = \bar{l_2}$ for all future periods $t \geq 1$, but deviates in the initial period, $l_{20} > \bar{l_2}$.*

This deviation at $t = 0$ under Objective 1 is a direct consequence of initial-period dependence, where the monopolist strategically increases initial production to reduce the normalization factor $U'(c_0)$.

Figure 1 presents the parameter sensitivity. The results first confirms our theoretical predictions that initial-period labor allocation l_{20} for Objective 1 is higher than labor

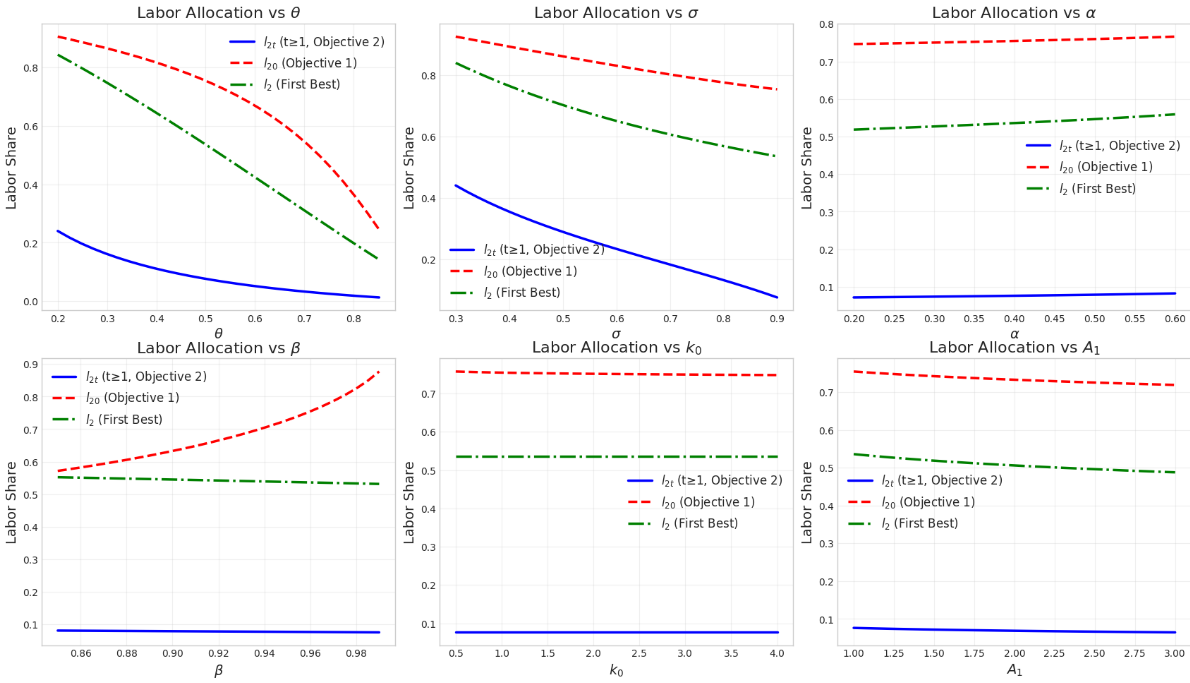

Figure 1: Parameter Sensitivity Analysis: Sector 2 Labor Allocation Across Key Parameters

allocation l_{2t} when $t \geq 1$, on entire parameter space. We also observe that l_{2t} is lower than first best case, showing the existence of distortion.

Figure 2 shows that welfare under Objective 1 is superior than Objective 2. The initial increase of l_{20} allows for a more beneficial initial consumption. However, compare to the first best case, the superior is small.

From figure 3, the capital path is affected by the initial labor decision a lot. Objective 1's incentive to boost initial consumption (by allocating more labor to sector 2) results in slower initial capital accumulation compared to Objective 2, when the initial capital is lower than steady state. When the economy starts with a high capital level, Objective 1 decumulates faster. The temporary dip in capital below its steady state under Objective 1 is an artifact of the complete depreciation assumption ($\delta = 1$) combined with the strong initial consumption motive.

The consumption paths in figure 4 provide direct evidence of the initial period dependence. Objective 1 consistently generates higher initial consumption (c_0) than Objective 2. This is the direct result of the monopolist's incentive to manipulate the normalization factor $U'(c_0)$.

4 General Case: Steady State and Dynamics

The analytical special case in Section 3 provides characterization of the monopolist's behavior under restrictive parameter values, highlighting the normalization effect. We now

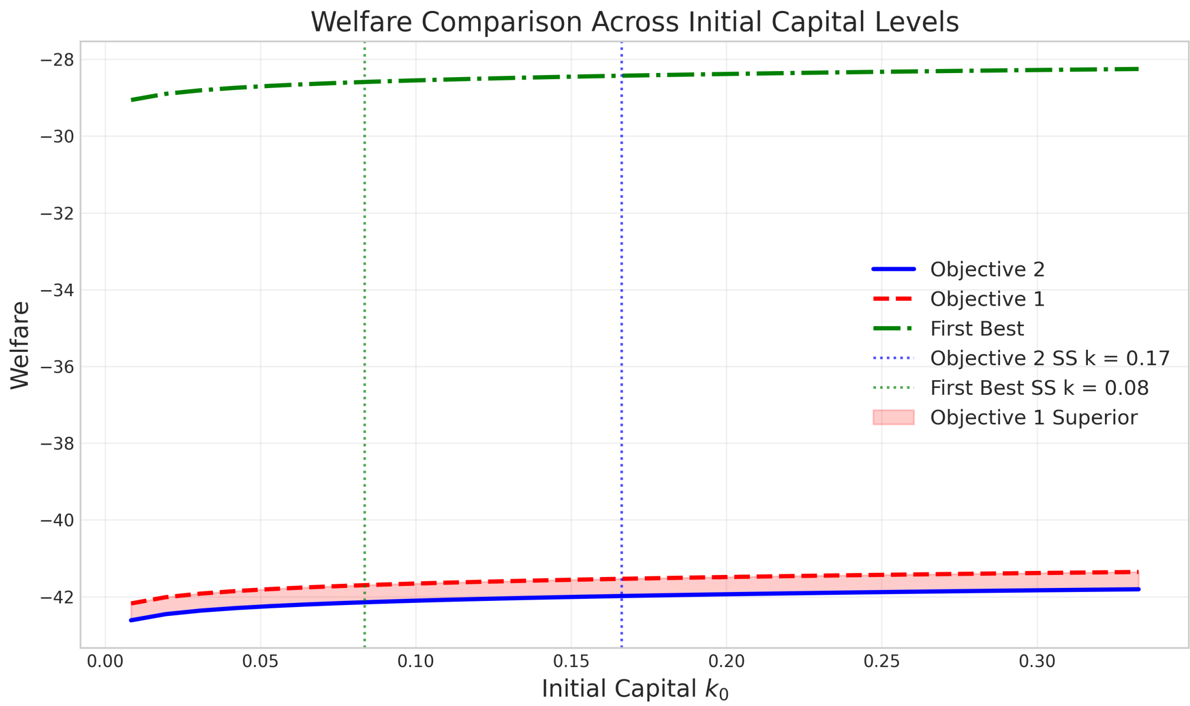

Figure 2: Welfare Comparison: Lifetime Utility Across Initial Capital Levels

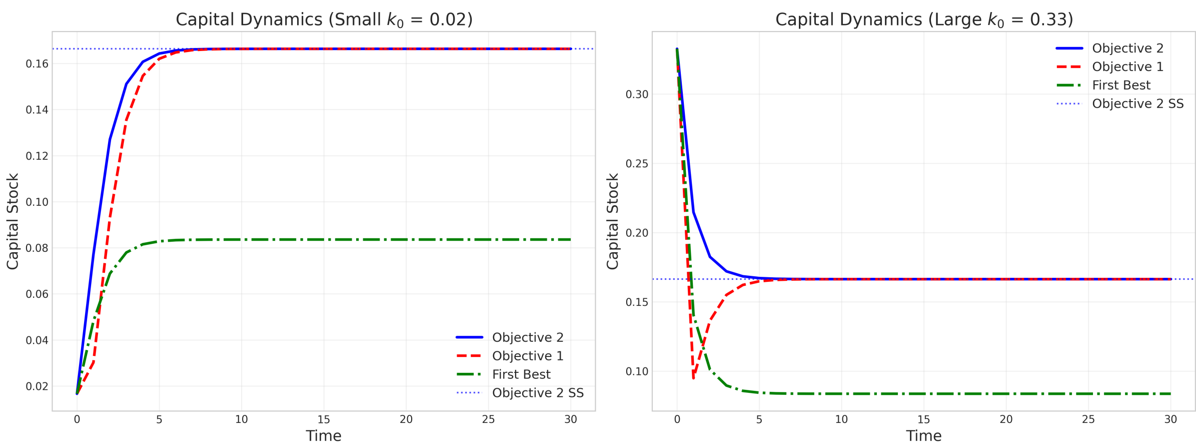

Figure 3: Capital Dynamics: Convergence Paths Under Different Initial Capital Levels

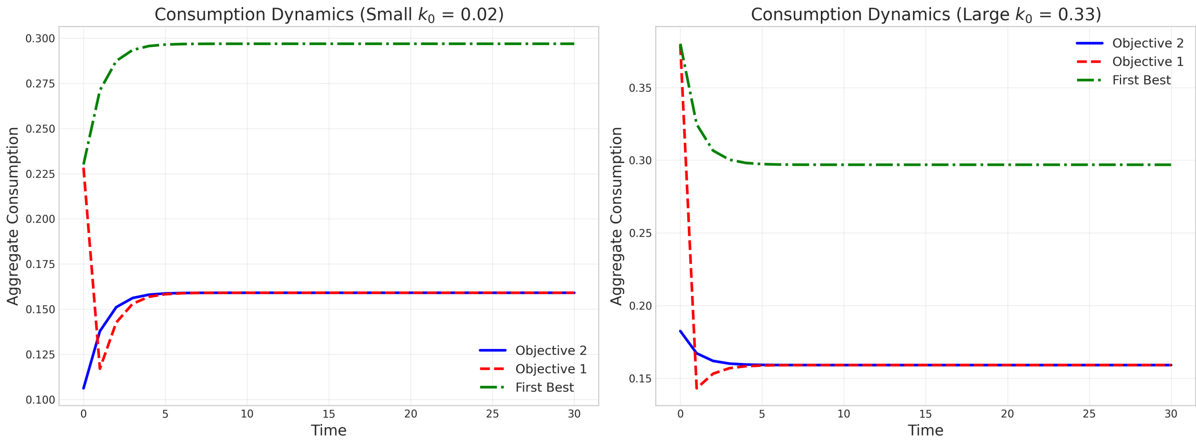

Figure 4: Aggregate Consumption Dynamics.

turn to the general case, where parameters are relaxed for more flexible calibrations. We begin by examining the steady-state properties, before analyzing the transition dynamics.

4.1 Steady-State Comparative Statics

In steady state, all variables are constant, and both objectives yield identical steady-state allocations, which we compare against the first-best benchmark. We compute steady states across variations in the preference weight θ and sector 1 TFP A_1, with other parameters held at the baseline values in Table 1.

Table 1: Baseline Parameter Calibration

Parameter	Value	Source
β (discount factor)	0.96	Kydland and Prescott (1982)
σ (risk aversion)	0.9	Jones (2000)
γ (elast. of subst.)	2.0	Bouakez et al. (2009)
θ (weight on good 1)	0.5	Match 24% of GDP
η (production elast.)	1.06	Antràs (2004)
α (capital share)	0.33	Standard
δ (depreciation)	0.1	King and Rebelo (1999)
A_1, A_2 (TFP)	1.0	Normalization

Figure 5 illustrates that the monopoly's distortions are most severe when its product is highly valued by households (low θ). The monopolist consistently restricts its own output (c_2) and over-accumulates capital (k) relative to the first-best. At the baseline ($\theta = 0.5$), this leads to a 5.7% reduction in total output value. This loss widens to 26.5% in the high-power case ($\theta = 0.15$), where the monopoly good is central to utility, but shrinks to just 0.1% when the good is peripheral ($\theta = 0.85$). The over-accumulation of capital and over-production of good 1 are general equilibrium consequences of the monopolist restricting labor in its own sector.

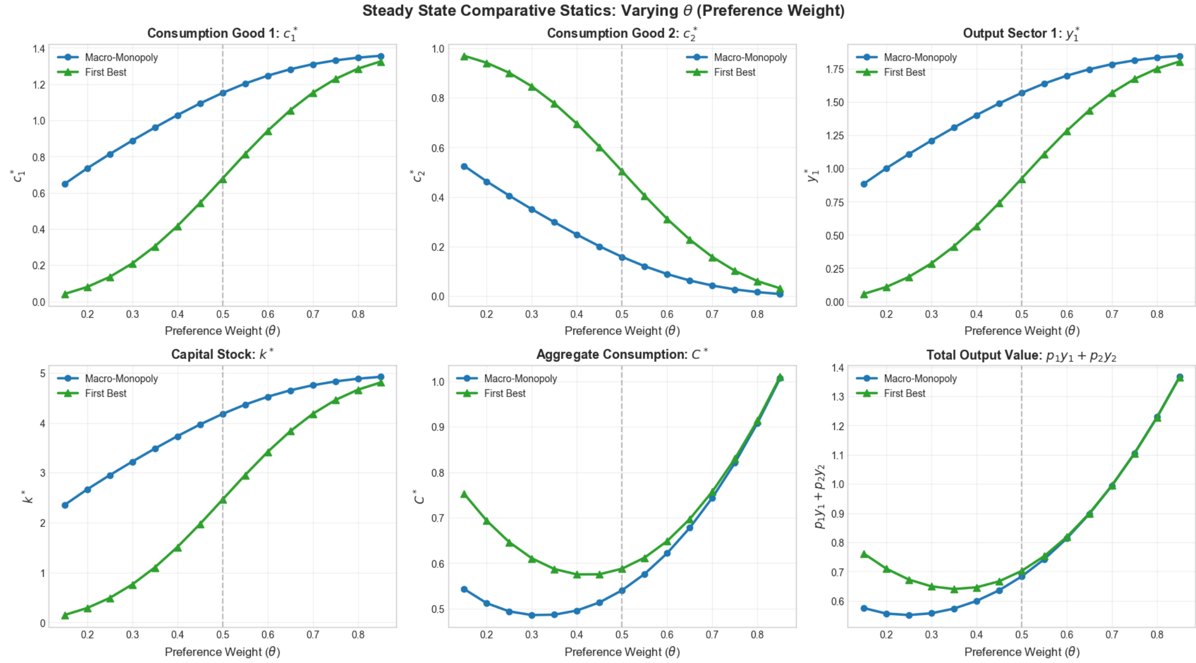

Figure 5: Steady State Comparative Statics: Varying θ (Preference Weight on Good 1). *Each panel shows a different endogenous variable. Blue circles: Macro-Monopoly. Green triangles: First Best. The vertical dashed line marks the baseline* $\theta = 0.5$.

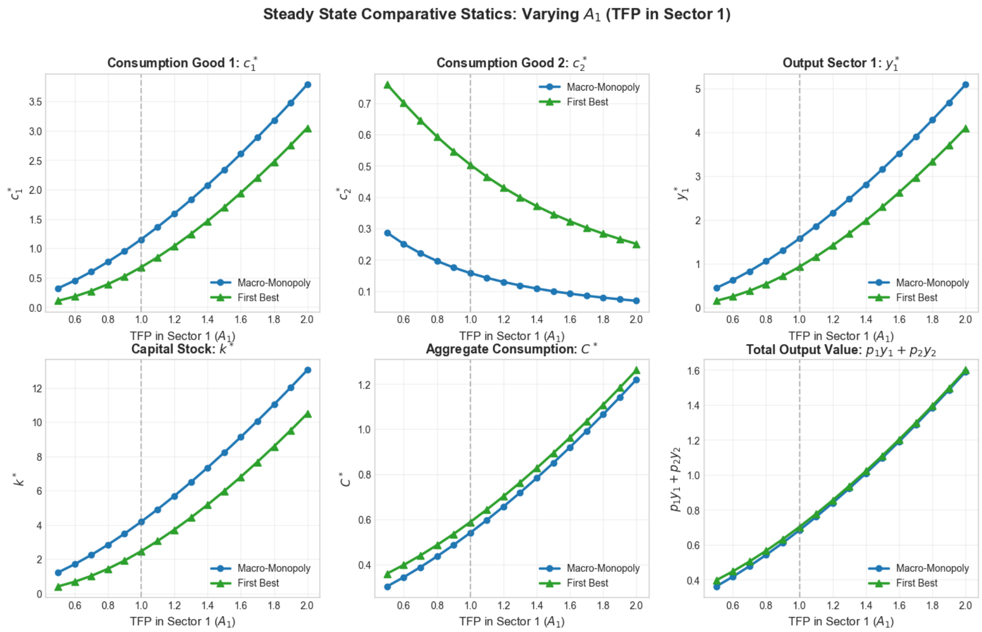

Figure 6: Steady State Comparative Statics: Varying A_1 (TFP in Sector 1). *Panel layout and color scheme are identical to Figure 5. The vertical dashed line marks the baseline* $A_1 = 1.0$.

Figure 6 shows that while higher productivity in the competitive sector (A_1) boosts overall output, it does not eliminate the core monopoly distortion. The monopolist's decision to restrict its output (c_2) remains largely independent of A_1. Consequently, as the competitive sector becomes more productive, the economy becomes increasingly skewed toward overproduction of good 1 and over-accumulation of capital. While the aggregate output loss relative to the first-best shrinks (from 12.2% at $A_1 = 0.5$ to 2.2% at $A_1 = 2.0$) because the economy is richer overall, the fundamental misallocation of resources persists.

These comparative statics exercises consistently point to a specific pattern of distortions, which we summarize in the following remark.

Remark 1 (Key Steady-State Distortions). The steady-state analysis reveals that the macro-monopoly introduces significant distortions relative to the first-best allocation. The distortions induce under-production of the monopoly good c_2, over-accumulation of capital k, and over-production in the competitive sector (c_1). These distortions are most pronounced when the monopoly's product is highly valued by consumers (low θ). The loss relative to the first-best shrinks as the competitive sector become more productive (high A_1).

Having established the nature of the steady-state distortions, we now turn to quantify the contribution of each channel. We conduct a counterfactual exercise where we selectively eliminate individual channels from the monopolist's first-order conditions and recompute the steady-state allocation. Eliminating a channel corresponds to assuming that the monopolist no longer recognizes its influence through that particular margin—the firm ceases to internalize how its decisions affect equilibrium outcomes through that specific mechanism. Operationally, this means setting the associated term in the first-order condition to zero. This excercise isolates the marginal impact of each channel on equilibrium outcomes, allowing us to assess which mechanisms are most responsible for the deviations from the first-best benchmark.

We consider five counterfactual scenarios corresponding to the five channels identified in Section 2: price, wage, interest rate, capital, and implementability effects. In the "**Price Taker**" scenario, we force the monopoly to act as a price taker on its own goods market. The monopolist no longer recognizes that changes in its decisions affect the marginal utility of sector-2 goods and thus the relative price p_2/p. In the "**Wage Taker**" scenario, we force the monopoly to act as a wage taker on labor market. The monopolist ignores how its labor allocation affects the equilibrium wage through general equilibrium spillovers in sector 1. In the "**Interest Rate Taker**" scenario, we force the monopoly to act as an interest rate taker in the economy. The monopolist does not account for how its decisions alter marginal utility of consumption path and thus the discount factor applied to current-period profits. In the "**Next-Period Capital Taker**" scenario, the monopolist fails to recognize that current production and consumption decisions constrain future capital accumulation. In the "**Without Implementability Effect**" scenario, the monopolist ignores the forward-looking Euler equation constraint linking current consumption to future capital returns, while the Euler equation still holds in the equilibrium.

Table 2 reports the steady-state outcomes under each counterfactual scenario at the baseline parameter values, along with the full model (where all five channels operate) and the first-best benchmark. For each scenario, we show the steady-state values of key variables and their percentage deviations from the first-best.

Table 2: Steady-State Outcomes Under Counterfactual Scenarios

	k^{SS}	c_1^{SS}	c_2^{SS}	c^{SS}	Total Output
First Best	1.521	0.533	0.531	0.532	0.608
Full Model	2.700	0.946	0.168	0.478	0.574
(% vs FB)	(77.5%)	(77.5%)	(−68.4%)	(−10.2%)	(−5.7%)
Price Taker	2.042	0.715	0.371	0.529	0.617
(% vs FB)	(34.3%)	(34.3%)	(−30.2%)	(−0.6%)	(1.4%)
Wage Taker	2.333	0.817	0.281	0.514	0.607
(% vs FB)	(53.4%)	(53.4%)	(−47.1%)	(−3.4%)	(−0.2%)
Interest Rate Taker	2.565	0.899	0.210	0.494	0.589
(% vs FB)	(68.6%)	(68.6%)	(−60.6%)	(−7.2%)	(−3.1%)
Next-Period Capital Taker	2.761	0.967	0.149	0.469	0.565
(% vs FB)	(81.5%)	(81.5%)	(−71.9%)	(−11.9%)	(−7.1%)
Without Implementability	2.743	0.961	0.155	0.472	0.568
Effect (% vs FB)	(80.3%)	(80.3%)	(−70.9%)	(−11.3%)	(−6.6%)

The price and wage effects emerge as the dominant sources of distortion. Eliminating the price effect dramatically reduces capital over-accumulation from 77.5 percent above the first-best to only 34.3 percent. Consumption of good 2 rises from 68.4 percent below the first-best to only 30.2 percent below, indicating that much of the monopolist's output restriction is driven by the recognition that limiting supply raises the relative price p_2/p. Total output improves from 5.7 percent below the first-best to 1.4 percent above, suggesting that the price effect is the single most important source of aggregate inefficiency.

The price and wage effects emerge as the dominant sources of distortion. Eliminating the price effect dramatically reduces loss of aggregate consumption from 10.2% to 0.6%. Total output improves from 5.7 percent below the first-best to 1.4 percent above, suggesting that the price effect is the single most important source of aggregate inefficiency.

Eliminating the wage effect also yields substantial improvements, though somewhat smaller than removing the price effect. Aggregate consumption rises from 10.2 percent below the first-best to 3.4 percent below. Total output reaches 0.2 percent below the first-best, nearly achieving efficiency.

It is worth noting that, removing the capital or implementability effects worsens outcomes relative to the full model. Without the capital channel, aggregate consumption decreases to 11.9 percent below the first-best and total output falls to 7.1 percent below the first-best. Without the implementability channel, aggregate consumption decreases to 11.3 percent below the first-best and total output falls to 6.6 percent below the first-best. These counterfactual scenarios demonstrate that the capital and implementability effects partially mitigate the monopolist's distortions by imposing intertemporal constraints that limit the firm's ability to exploit its market power.

The results from this decomposition exercise reveal a crucial hierarchy among the five channels, which we distill in the following remark.

Remark 2 (Dominant vs. Disciplining Channels). The counterfactual exercise reveals that the price and wage effects are the dominant sources of distortion. Eliminating them brings the allocation much closer to the first-best. Conversely, the capital and implementability effects act as disciplining forces; they impose intertemporal constraints that partially mitigate the monopolist's market power. Removing these channels paradoxically worsens the steady-state outcome.

These findings have important policy implications. Regulations targeting the monopolist's price-setting behavior and labor market distortions are likely to be most effective in reducing welfare losses. The price effect can be addressed through markup regulation or price caps that limit the firm's ability to exploit scarcity. The wage effect can be mitigated through labor market policies that reduce the monopolist's influence over equilibrium wages, such as wage subsidies in sector 1 or employment mandates in sector 2. In contrast, interventions aimed at capital accumulation or intertemporal planning may have limited impact or even backfire by removing constraints that currently limit monopoly power. For instance, policies that relax capital accumulation constraints—such as investment subsidies or reduced capital taxation—might paradoxically increase distortions by enabling the monopolist to over-accumulate capital more aggressively without the moderating influence of the resource constraint.

4.2 Dynamics: Numerical Analysis

Having characterized the steady state, we now examine transition dynamics. To do so, we solve it numerically using a finite-horizon approximation. We acknowledge that a recursive solution is viable—for instance, by first solving the model for all periods t 1 and then solving for the initial period t = 0, as we elaborate in the appendix. However, given that our primary goal is to characterize the transition dynamics, the finite-horizon approximation offers a more efficient computational pathway compared to the recursive alternative. We relegate the technical details of our implementation to Appendix D.

We present numerical results for two initial capital levels ($k_0 = 0.5 \cdot k_{SS}$ and $k_0 = 1.5 \cdot k_{SS}$) and contrasting the dynamics under Objective 1 (consumption-based) and Objective 2 (utility-based).

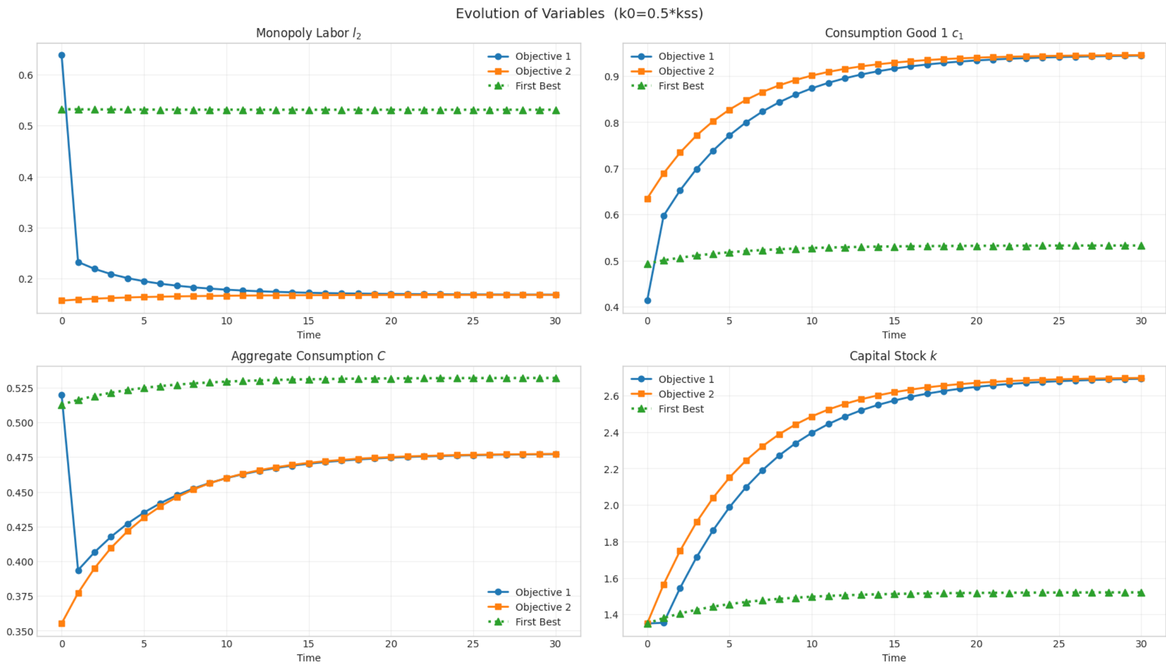

Figure 7: Evolution of Variables (Finite Horizon, $T = 100$, $t = 0$ to 30, $k_0 = 0.5 \cdot k_{SS}$). *Top-left*: Monopoly labor in sector 2 (l_2); *Top-right*: Consumption of good 1 (c_1); *Bottom-left*: Aggregate consumption (C); *Bottom-right*: Capital stock (k). Lines: blue = Objective 1, orange = Objective 2, green = First Best.

Figure 7 illustrates dynamics for an economy starting with low capital ($k_0 = 0.5 \cdot k_{SS}$). Under Objective 1, the monopolist initially allocates more labor to its own sector (l_2) to boost initial consumption c_0, driven by the normalization effect. This slows down initial capital accumulation compared to Objective 2, which allocates more labor to the capital-producing sector 1. As a result, Objective 1's capital path (blue line) lags behind Objective 2's (orange line) in the early periods.

For an economy starting with high capital ($k_0 = 1.5 \cdot k_{SS}$), the incentives reverse (Figure 8). Objective 1 still allocates more labor to sector 2 to manipulate initial consumption, but this now accelerates capital decumulation. By producing less of good 1, the economy invests less, causing the capital stock to fall faster under Objective 1 than under Objective 2. In both cases, the initial-period dependence of Objective 1 creates a distinct dynamic path that differs qualitatively from the time-symmetric Objective 2.This dynamic manifestation of our core mechanism is summarized below.

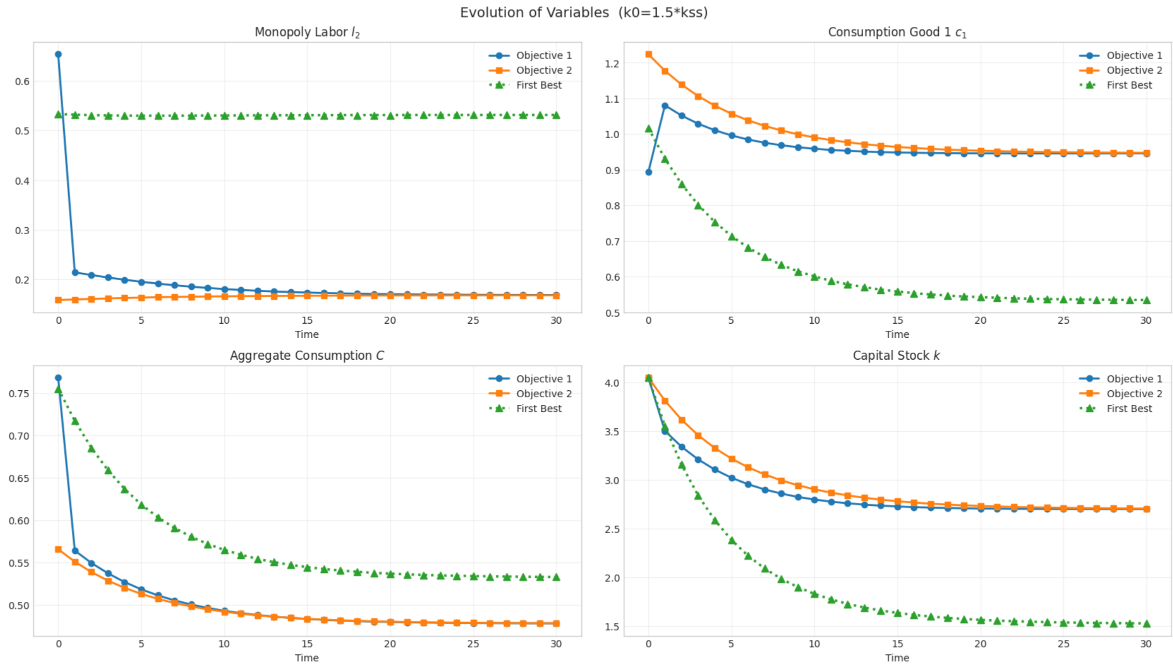

Figure 8: Evolution of Variables (Finite Horizon, $T = 100$, $t = 0$ to 30, $k_0 = 1.5 \cdot k_{SS}$). *Line colors and panel layout are identical to Figure 7.*

Remark 3 (Dynamics of Initial-Period Dependence). While both objectives converge to the same steady state, their paths differ qualitatively in the short run. The initial allocation of Objective 1 is quite unique, creates kinks in the dynamic path, leading to slower capital accumulation when starting from a low capital stock and faster decumulation from a high one. The monopolist tends to increase the initial consumption level c_0 and thus boosts the valuation of all future profits.

This clear difference in the committed paths naturally raises the question of their credibility. If the monopolist has an incentive to manipulate the initial period, will it also have an incentive to deviate later on? We explore this in the next section.

5 Committed Plans vs. Reoptimization

A central question for any leader making decisions under commitment is whether they will adhere to their announced plan. In this section, we explore the monopolist's incentive to deviate from its initial plan by analyzing a one-shot reoptimization at $t = 1$. It is important to clarify the scope of this exercise: we are not computing a fully time-consistent equilibrium (such as a Markov Perfect Equilibrium). Instead, we conduct a thought experiment where the monopolist believes it can still credibly commit to the new plan from $t = 1$ onwards, even though it has just broken its original commitment. This allows us to isolate the sources and magnitude of the temptation to deviate.

We find that the incentive to reoptimize stems from two distinct sources of time inconsistency, with their relevance depending critically on the monopolist's objective function. For detailed derivations of the first-order conditions discussed here, see Appendix E.

The first source is classical time inconsistency, which arises from the strategic interaction with followers under forward-looking constraints. When reoptimizing at $t = 1$, the state variable k_1 is predetermined by past decisions. The monopolist treats past commitments as "bygones" and solves a new problem, leading to different Lagrange multipliers and potentially a different optimal path. This form of inconsistency is present under both objective functions.

The second, novel source is **valuation-driven time inconsistency**, which is unique to Objective 1 (consumption-based valuation). Its effect is behaviorally similar to present bias, but its origin is distinct. The common root of our mechanism and hyperbolic discounting is the asymmetric treatment of the present versus the future in the objective function. In quasi-hyperbolic models, this asymmetry is imposed via a behavioral parameter that specifically discounts all future periods relative to the present. In our model, the asymmetry arises from a standard valuation principle: the present value of future profits is $\sum_{t=0}^{\infty} \beta^t \frac{U'(c_t)}{U'(c_0)} \Pi_{2t}$. Here, the initial period $t = 0$ is structurally unique because its marginal utility $U'(c_0)$ serves as the normalization factor for the entire stream of utility value of future profits. When the firm reoptimizes at $t = 1$, it treats period 1 as the new 'present', causing the valuation benchmark to reset to $U'(c_1)$. This shift in the normalization factor, creates the incentive to deviate. Objective 2, which avoids this normalization, is immune to this effect.

This crucial distinction can be stated formally in the following proposition.

Proposition 3 (Dual Sources of Time Inconsistency). *The two objective functions are subject to different sources of time inconsistency.*

1. *Objective 1 (consumption-based) is subject to both classical time inconsistency, arising from the forward-looking constraints, and valuation-driven time inconsistency. The latter arises because upon reoptimization at period $t = 1$, the valuation benchmark for all future profits resets from the original $U'(c_0)$ to the new $U'(c_1)$.*

2. *Objective 2 (utility-based) is subject only to classical time inconsistency, as its time-symmetric structure is immune to the valuation benchmark reset.*

To quantify the impact of these two sources, we compare the committed plan (formulated at $t = 0$) with the reoptimized plan (formulated at $t = 1$, taking k_1 as given). Both plans are computed under full commitment, using the finite-horizon numerical framework, which approximates the infinite-horizon problem. We analyze an economy starting with low capital ($k_0 = 0.5 \cdot k_{SS}$).

Table 3 and Figure 9 show the dramatic consequences of dual (structural + classical) inconsistency under Objective 1. Upon reoptimization at $t = 1$, monopoly labor (l_2) surges by 175% compared to the committed plan. After comparing with the Objective 2 case later, we will see that this massive deviation is mainly driven by the structural inconsistency: by treating $t = 1$ as the new initial period, the monopolist is incentivized to sharply increase its own production to raise c_1, lower the new normalization factor $U'(c_1)$, and thereby inflate the present value of all subsequent profits. This labor reallocation causes aggregate consumption to jump by 32% and consumption of the competitive good (c_1) to fall by 31%.

Table 3: Time Inconsistency Analysis: Objective 1, $k_0 = 0.5 \cdot k_{SS}$

Variable	Commit	Reopt	Difference	% Diff
l_2	0.232	0.638	0.406	174.95%
c_1	0.597	0.414	−0.183	−30.65%
c	0.394	0.520	0.127	32.19%
k	1.354	1.354	0.000	0.00%

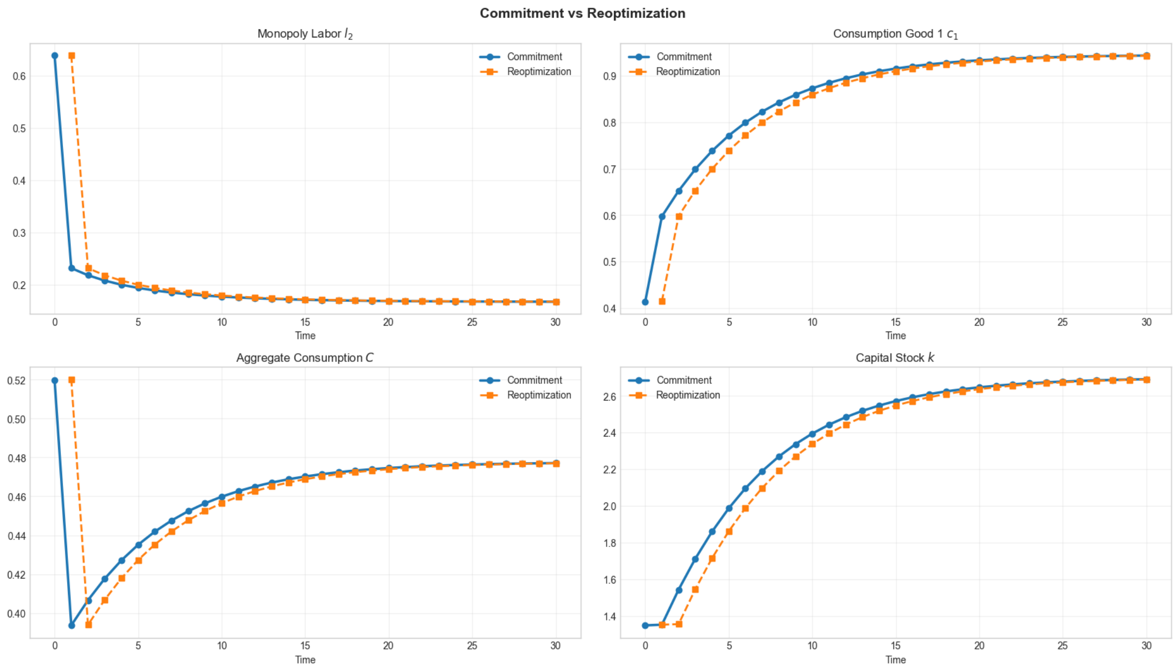

Figure 9: Reoptimization Analysis: Objective 1 (Consumption-Based Valuation). *The figure shows dynamic paths under the committed plan (solid lines) and reoptimized plan at $t = 1$ (dashed lines). Initial capital $k_0 = 0.5 \cdot k_{SS}$.*

In stark contrast, Objective 2 exhibits almost no incentive to reoptimize. As shown in Table 4 and Figure 10, the reoptimized path deviates from the committed plan by less than 2% across all variables. Because Objective 2 is time-symmetric and thus free from valuation-driven time inconsistency, these tiny deviations isolate the pure effect of classical time inconsistency. The near-identical paths demonstrate that, in our framework, the classical channel alone provides a negligible motive for plan revision.

Table 4: Time Inconsistency Analysis: Objective 2, $k_0 = 0.5 \cdot k_{SS}$

Variable	Commit	Reopt	Difference	% Diff
l_2	0.158	0.156	-0.002	-1.52%
c_1	0.689	0.691	0.001	0.20%
c	0.377	0.376	-0.001	-0.36%
k	1.565	1.565	0.000	0.00%

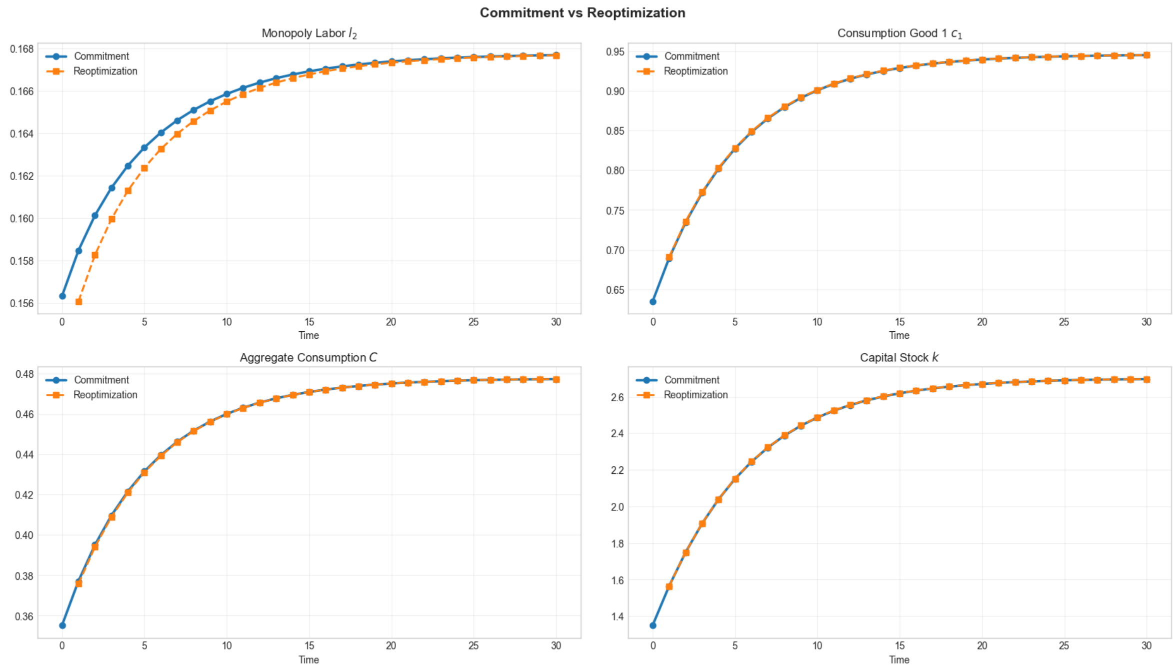

Figure 10: Reoptimization Analysis: Objective 2 (Utility-Based Valuation). *Paths under the committed plan (solid) and reoptimized plan (dashed) are nearly indistinguishable, reflecting only classical inconsistency.*

The comparison—a 175% deviation for Objective 1 versus a <2% deviation for Objective 2—provides a clear quantitative decomposition. This leads to the central finding of our time inconsistency analysis, which we state in our final remark.

Remark 4 (Valuation-Driven Inconsistency is Quantitatively Dominant). Valuation-driven time inconsistency is the overwhelmingly dominant source of plan revision.

This finding suggests that for firms or policymakers large enough to influence aggregates, the credibility of their commitments is fundamentally tied to the internal structure of their objective function, not just to external enforcement mechanisms. An objective with structural time-asymmetries (like consumption-based valuation) may be inherently non-credible, whereas a time-symmetric objective (like utility-based valuation) is far more robust to opportunistic deviations.

6 Conclusion

This paper explores the dynamic decisions of "macro-monopolies"—firms large enough to shape economy-wide equilibrium conditions—under commitment, focusing on two alternative profit objectives: consumption-based valuation, which normalizes future profits by initial-period marginal utility, and utility-based valuation, which weights profits by contemporary marginal utility. Our key findings are threefold.

First, we identify five transmission channels through which macro-monopolies internalize their influence on aggregate conditions: the price effect through market power over both sectors' output, the wage effect through labor demand that shapes economy-wide wages, the interest rate effect through future consumption path, the capital effect through resource constraints linking consumption and investment, and the implementability effect through the representative household's Euler equation. Steady-state analysis reveals that such market structure reduces output by 5.7% under baseline calibration, reaching 26.5% under configurations of high market power. Mechanism decomposition shows that the price and wage channels drive the bulk of welfare losses—eliminating the price effect alone reduces capital over-accumulation from 78% to 34% and narrows the output gap from 6% below first-best to 1% above. The capital and implementability channels partially offset monopoly distortions by imposing intertemporal constraints; removing these channels worsens outcomes, with capital over-accumulation rising to 82% and output falling to 7% below first-best.

Second, consumption-based valuation exhibits "initial-period dependence". Initial decisions strategically alter the valuation of all future profits through manipulation of the normalization factor $U'(c_0)$. By increasing sector-2 labor at $t = 0$ to raise aggregate consumption c_0, the firm reduces $U'(c_0)$ and thereby inflates the present value of all future profits. This normalization effect is absent in all subsequent periods under the committed plan, generating time-asymmetric incentives unique to consumption-based valuation. Finite-horizon analysis demonstrates that both objectives converge to identical steady states, but transition dynamics diverge sharply based on initial conditions: for low initial capital ($k_0 = 0.5 * kss$), consumption-based valuation reallocates labor to sector 2 in period 0, slowing capital accumulation relative to utility-based valuation; for high initial capital ($k_0 = 1.5 * kss$), this pattern reverses, with consumption-based valuation accelerating capital decumulation.

Third, initial-period dependence creates an additional source of time inconsistency distinct from classical inconsistency rooted in forward-looking constraints. When reoptimizing at $t = 1$, the monopolist treats that period as a new "initial period," resetting the normalization factor from $U'(c_0)$ to $U'(c_1)$. Our numerical analysis quantifies this dual inconsistency: under consumption-based valuation with initial capital $k_0 = 0.5 * kss$, reoptimized monopoly labor l_2 surges by 175% relative to the committed plan, while aggregate consumption rises by 32% and consumption of good 1 falls by 31%. In contrast, utility-based valuation exhibits deviations below 2% across all variables, isolating the contribution of classical inconsistency alone. This 175% versus 2% contrast demonstrates that valuation-driven inconsistency dominates classical inconsistency, establishing initial-period dependence as the quantitatively dominant deviation channel.

These findings carry meaningful theoretical and policy implications. Theoretically, we extend the literature on time inconsistency by identifying a novel source rooted in the structure of the objective function rather than forward-looking constraints alone. This demonstrates that for macro-monopolies, "what to maximize" is as critical as "how to maximize"—objective function design can eliminate or amplify intertemporal distortions independently of commitment technology. We also fill a gap in macro-monopoly research by formalizing how profit valuation rules interact with aggregate endogeneity, showing that normalization choices create path-dependent valuation mechanisms absent in small-firm models.

For policy, our results suggest three actionable directions, ordered by their directness. First, the price effect can be addressed through markup regulation or price caps that limit the firm's ability to exploit scarcity in sector 2. The wage effect can be mitigated through labor market policies that reduce the monopolist's influence over equilibrium wages, such as wage subsidies in sector 1 or employment mandates in sector 2. Second, interventions aimed at capital accumulation or intertemporal planning require careful design, as the capital and implementability channels partly discipline monopoly power. Policies that relax capital accumulation constraints—such as investment subsidies or reduced capital taxation—might paradoxically increase distortions by enabling the monopolist to over-accumulate capital more aggressively without the moderating influence of the resource constraint. Third, regulating large firms' objective function design—for instance, mandating utility-based valuation for systemically important corporations—could mitigate structural inconsistency without requiring external commitment devices, though implementation challenges remain substantial.

This study offers an initial attempt to model economies where macro-monopolies internalize their influence on aggregate conditions. In economies dominated by large firms, the traditional separation between firm-level optimization and economy-level aggregation requires reconsideration. Our framework provides one approach to modeling these interdependencies, establishing tractable foundations for subsequent extensions. The finite-horizon framework and analytical special case offer benchmarks for infinite-horizon analysis via numerical methods, while the commitment solution provides a reference point for exploring Markov perfect equilibria where reoptimization occurs each period. The space for alternative formulations remains substantial, inviting further theoretical and quantitative investigation into equilibrium appropriate for settings where firm-level and economy-level variables are fundamentally intertwined.

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A Appendix A: Ramsey Problem Formulation

A.1 Derivation of Equilibrium Prices as Functions of Allocations

To formulate the Ramsey problem, we must express all prices in the monopolist's profit function in terms of the chosen allocations $\{c_{1t}, c_{2t}\}_{t=0}^{\infty}$. This is done by using the first-order conditions of the households and competitive firms.

Relative Prices The relative price of good i in terms of the composite consumption good c_t is given by the marginal rate of substitution from the aggregator function $c_t = C(c_{1t}, c_{2t})$.

$$\frac{p_{1t}}{p_t} = \frac{\partial c_t}{\partial c_{1t}} \quad \text{and} \quad \frac{p_{2t}}{p_t} = \frac{\partial c_t}{\partial c_{2t}} \tag{36}$$

Real Wage The competitive sector (sector 1) hires labor until the marginal product of labor equals the real wage. The wage is paid in units of good 1 and then converted to units of composite consumption. The total labor supply is fixed at $\bar{L}$, so $l_{1t} = \bar{L} - l_{2t}$.

$$\frac{w_t}{p_{1t}} = \frac{\partial y_{1t}}{\partial l_{1t}} \tag{37}$$

Therefore, the real wage in units of the composite good is:

$$\frac{w_t}{p_t} = \frac{p_{1t}}{p_t}\frac{\partial y_{1t}}{\partial l_{1t}} = \frac{\partial c_t}{\partial c_{1t}}\frac{\partial y_{1t}}{\partial l_{1t}} \tag{38}$$

Using the labor market clearing condition, we can express the derivative with respect to l_{2t}:

$$\frac{\partial y_{1t}}{\partial l_{1t}} = -\frac{\partial y_{1t}}{\partial l_{2t}} \tag{39}$$

This gives the wage expression used in the main text's profit function:

$$\frac{w_t}{p_t} = -\frac{\partial c_t}{\partial c_{1t}}\frac{\partial y_{1t}}{\partial l_{2t}} \tag{40}$$

Real Interest Rate The real return on capital, ρ_t, is determined by the marginal product of capital in the competitive sector, net of depreciation δ.

$$\rho_t = r_t - \delta = \frac{\partial y_{1t}}{\partial k_t} - \delta \tag{41}$$

This rate of return is central to the household's intertemporal Euler equation, which forms the implementability constraint.

A.2 Proof of Equivalence (Proposition 1)

The proposition states that the solution of the Ramsey problem is equivalent to the equilibrium of the original Stackelberg game. We prove this by showing that the set of feasible allocations for both problems is identical, and the objective function is the same.

1. **Any Stackelberg equilibrium allocation is a feasible allocation in the Ramsey problem.**
   - In a Stackelberg equilibrium, the monopolist chooses a plan $\{l_{2t}\}_{t=0}^{\infty}$. The followers (households and competitive firms) take the resulting prices and wages as given and optimize.
   - The household's optimization implies that their consumption-savings path $\{c_{1t}, k_{t+1}\}_{t=0}^{\infty}$ must satisfy their budget constraint and their intertemporal Euler equation.
   - By definition, the resulting allocation path $\{c_{1t}, c_{2t}, k_{t+1}\}_{t=0}^{\infty}$ satisfies the economy's resource constraint.
   - Since the household's Euler equation holds in any Stackelberg equilibrium, this allocation path satisfies the implementability constraint of the Ramsey problem.
   - Therefore, any allocation that is an outcome of the Stackelberg game is within the feasible set of the Ramsey problem.

2. **Any feasible allocation in the Ramsey problem is a possible Stackelberg equilibrium allocation.**
   - Consider an allocation path $\{c_{1t}^*, c_{2t}^*\}_{t=0}^{\infty}$ that solves the Ramsey problem.
   - By construction, this path satisfies the resource constraint and the implementability constraint (the household's Euler equation).
   - We can construct a set of supporting prices. Define prices as functions of this allocation path: $p_{1t}/p_t = \partial c_t/\partial c_{1t}$, $w_t/p_t = (p_{1t}/p_t)\partial y_{1t}/\partial l_{1t}$, and a real interest rate consistent with the Euler equation.
   - Given these prices, the allocation path $\{c_{1t}^*, c_{2t}^*\}_{t=0}^{\infty}$ is optimal for the followers. The competitive firms are maximizing profits, and the households are satisfying their Euler equation, which is the sufficient condition for optimality in their dynamic program (given a transversality condition, which is typically assumed).
   - This means that the allocation $\{c_{1t}^*, c_{2t}^*\}_{t=0}^{\infty}$ is *implementable* as a decentralized market equilibrium.

- Therefore, the monopolist *could* have chosen a plan $\{l_{2t}^* = c_{2t}^*/A_2\}_{t=0}^{\infty}$ in the original Stackelberg game, which would have led to this exact equilibrium outcome.

Conclusion Since the feasible sets of allocations for both problems are the same, and the objective function (the present discounted value of the monopolist's profits) is identical in both formulations, the allocation that maximizes the objective in the Ramsey problem must also be the optimal choice for the monopolist in the Stackelberg game. The two problems are therefore equivalent.

B Appendix B: Detailed Derivations of First-Order Conditions

This appendix provides the full derivation of all first-order conditions discussed in Section 2.6. This includes the complete Lagrangian setup, the first-order conditions with respect to monopoly labor l_{2t}, and the full set of conditions for Objective 2.

We formulate the Lagrangian for Objective 1 as:

$$\mathcal{L}_1 = \sum_{t=0}^{\infty} \beta^t \Bigg\{ \frac{U'(c_t)}{U'(c_0)} \Pi_{2t} + \lambda_t \left(\beta U'(c_{t+1}) \frac{\partial c_{t+1}}{\partial c_{1,t+1}} \left(\frac{\partial y_{1,t+1}}{\partial k_{t+1}} + 1 - \delta \right) - U'(c_t) \frac{\partial c_t}{\partial c_{1t}} \right) \\ + \mu_t \left((1-\delta) k_t + y_{1t} - c_{1t} - k_{t+1} \right) \Bigg\} \tag{42}$$

where λ_t is the Lagrange multiplier on the Euler equation at time t and μ_t is the multiplier on the resource constraint.

The first-order condition with respect to c_{1t} for $t \geq 1$ reveals the interactions of all five channels:

$$\frac{1}{U'(c_0)} \cdot \Bigg(\underbrace{U''(c_t) \frac{\partial c_t}{\partial c_{1t}} \Pi_{2t}}_{\text{interest rate effect}} + \underbrace{U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t} \partial c_{2t}} A_2 l_{2t}}_{\text{price effect}} + \underbrace{U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t}}_{\text{wage effect}} \Bigg) \\ - \underbrace{\mu_t}_{\text{capital effect}} - \underbrace{\lambda_t \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right)}_{\text{implementability effect for next period}} \\ + \underbrace{\lambda_{t-1} \left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta \right) \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right)}_{\text{implementability effect from previous period}} = 0 \tag{43}$$

For period 0, the first-order condition includes an additional term unique to consumption-based valuation:

$$\frac{\partial \Pi_{20}}{\partial c_{10}} - \lambda_0 \left(U''(c_0) \left(\frac{\partial c_0}{\partial c_{10}} \right)^2 + U'(c_0) \frac{\partial^2 c_0}{\partial c_{10}^2} \right) - \mu_0 \\ \underbrace{- \frac{U''(c_0)}{U'(c_0)^2} \frac{\partial c_0}{\partial c_{10}} \sum_{t=1}^{\infty} \beta^t U'(c_t) \Pi_{2t}}_{\text{normalization effect}} = 0 \tag{44}$$

For Objective 2 (utility-based valuation), the Lagrangian is:

$$\begin{aligned}\mathcal{L}_2 = \sum_{t=0}^{\infty} \beta^t \Big\{ & U'(c_t)\Pi_{2t} + \lambda_t \left(\beta U'(c_{t+1}) \frac{\partial c_{t+1}}{\partial c_{1,t+1}} \left(\frac{\partial y_{1,t+1}}{\partial k_{t+1}} + 1 - \delta \right) - U'(c_t) \frac{\partial c_t}{\partial c_{1t}} \right) \\ & + \mu_t \left((1-\delta)k_t + y_{1t} - c_{1t} - k_{t+1} \right) \Big\} \end{aligned} \tag{45}$$

The first-order condition with respect to c_{1t} for any $t \geq 0$ is:

$$\begin{aligned} & U''(c_t)\frac{\partial c_t}{\partial c_{1t}}\Pi_{2t} + U'(c_t)\frac{\partial^2 c_t}{\partial c_{1t}\partial c_{2t}} A_2 l_{2t} + U'(c_t)\frac{\partial^2 c_t}{\partial c_{1t}^2}\frac{\partial y_{1t}}{\partial l_{2t}} l_{2t} \\ & - \mu_t - \lambda_t \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right) \\ & + \lambda_{t-1} \left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta \right) \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right) = 0 \end{aligned} \tag{46}$$

with $\lambda_{-1} = 0$. Critically, this condition maintains identical structure across all periods including $t = 0$. All five channels remain operative—price, wage, interest rate, capital, and implementability effects—but the normalization effect is absent. Period 0 receives no special treatment because each period's profit is weighted by its own contemporaneous marginal utility $U'(c_t)$ without being normalized by a fixed initial value $U'(c_0)$.

Similarly, the first-order condition with respect to monopoly labor l_{2t} exhibits same property: all five channels effects decisions dependently. For Objective 1, the condition for $t \geq 1$ is:

$$\begin{aligned} & \frac{1}{U'(c_0)} \left(U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \Pi_{2t} + U'(c_t) \frac{\partial \Pi_{2t}}{\partial l_{2t}} \right) \\ & - \lambda_t \left(U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \frac{\partial c_t}{\partial c_{1t}} + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}\partial c_{2t}} A_2 \right) \\ & + \lambda_{t-1} \left[\left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta \right) \left(U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \frac{\partial c_t}{\partial c_{1t}} + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}\partial c_{2t}} A_2 \right) \right. \\ & \quad \left. + U'(c_t) \frac{\partial c_t}{\partial c_{1t}} \frac{\partial^2 y_{1t}}{\partial k_t \partial l_{2t}} \right] + \mu_t \frac{\partial y_{1t}}{\partial l_{2t}} = 0 \end{aligned} \tag{47}$$

The direction of price and wage effect is just the opposite of c_{1t}. For period 0 under Objective 1, an additional normalization term appears:

$$\begin{aligned} & \frac{\partial \Pi_{20}}{\partial l_{20}} - \lambda_0 \left(U''(c_0) \frac{\partial c_0}{\partial c_{20}} A_2 \frac{\partial c_0}{\partial c_{10}} + U'(c_0) \frac{\partial^2 c_0}{\partial c_{10}\partial c_{20}} A_2 \right) + \mu_0 \frac{\partial y_{10}}{\partial l_{20}} \\ & - \frac{U''(c_0)}{U'(c_0)^2} \frac{\partial c_0}{\partial c_{20}} A_2 \sum_{t=1}^{\infty} \beta^t U'(c_t) \Pi_{2t} = 0 \end{aligned} \tag{48}$$

This normalization effect directly incentivizes the monopolist to increase l_{20} (initial labor allocation to sector 2) to raise c_{20}, thereby increasing aggregate consumption c_0 and reducing the normalization factor $U'(c_0)$. This strategic manipulation of the measuring stick inflates the present value of all future profits at the cost of distorting initial allocation.

Under Objective 2, the first-order condition for l_{2t} maintains time symmetry for all $t \geq 0$:

$$
\begin{aligned}
&U''(c_t)\frac{\partial c_t}{\partial c_{2t}}A_2\Pi_{2t} + U'(c_t)\frac{\partial \Pi_{2t}}{\partial l_{2t}} \\
&- \lambda_t\left(U''(c_t)\frac{\partial c_t}{\partial c_{2t}}A_2\frac{\partial c_t}{\partial c_{1t}} + U'(c_t)\frac{\partial^2 c_t}{\partial c_{1t}\partial c_{2t}}A_2\right) \\
&+ \lambda_{t-1}\left[\left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta\right)\left(U''(c_t)\frac{\partial c_t}{\partial c_{2t}}A_2\frac{\partial c_t}{\partial c_{1t}} + U'(c_t)\frac{\partial^2 c_t}{\partial c_{1t}\partial c_{2t}}A_2\right)\right. \\
&\qquad \left. + U'(c_t)\frac{\partial c_t}{\partial c_{1t}}\frac{\partial^2 y_{1t}}{\partial k_t \partial l_{2t}}\right] + \mu_t\frac{\partial y_{1t}}{\partial l_{2t}} = 0
\end{aligned}
\tag{49}
$$

No additional terms appear at $t = 0$, confirming that Objective 2 treats all periods identically and eliminates the initial-period dependence that characterizes Objective 1.

The five channels identified in the objective function thus manifest distinctly in the first-order conditions. Price effects enter through cross-derivatives of the consumption aggregator. Wage effects appear through price of goods 1 and general equilibrium linkages between labor allocation and competitive sector's marginal product of labor. Interest rate effects operate through the discount factor weighting on current-period profits. Capital effects are embodied in the shadow value of the resource constraint. Implementability effects arise from the Lagrange multipliers on forward-looking Euler equations that link current consumption to future capital returns. Under consumption-based valuation, a sixth effect—the normalization effect—creates asymmetry between period 0 and all subsequent periods, while utility-based valuation maintains structural symmetry across time.

C Appendix C: Derivations for the Analytical Special Case

This appendix details the formulation and solution of the special case discussed in Section 3, where we impose the parameter restrictions $\frac{1}{\gamma} = \sigma = \eta$ and $\delta = 1$. Under these conditions, the household's first-order conditions imply that consumption in sector 1 is proportional to output in sector 1:

$$c_{1t} = \left(1 - (\alpha\beta A_1^{1-\sigma})^{\frac{1}{\sigma}}\right) y_{1t} \tag{50}$$

This proportionality simplifies the monopolist's problem by making the forward-looking implementability constraint non-binding on the choice of labor allocation.

For **Objective 1 (consumption-based valuation)**, the normalized profit maximization problem becomes:

$$\max_{\{l_{2t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \frac{U'(c_t)}{U'(c_0)} \Pi_{2t} \tag{51}$$

where the period profit Π_{2t} can be expressed as:

$$\Pi_{2t} = \frac{\partial c_t}{\partial c_{2t}} A_2 l_{2t} + \frac{\partial c_t}{\partial c_{1t}} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t}$$

Given the specific functional forms and parameter restrictions, this can be written out explicitly. With $U(c_t) = c_t^{1-\sigma}/(1-\sigma)$, so $U'(c_t) = c_t^{-\sigma}$, the problem is:

$$\max_{\{l_{2t}\}} \sum_{t=0}^{\infty} \beta^t \frac{c_t^{-\sigma}}{c_0^{-\sigma}} \left((1-\theta) c_t^{\sigma} (A_2 l_{2t})^{1-\frac{1}{\gamma}} - \theta c_t^{\sigma} c_{1t}^{-\frac{1}{\gamma}} \frac{\partial y_{1t}}{\partial l_{1t}} l_{2t} \right)$$

Substituting the simplified relationships yields the objective function presented in the main text.

For **Objective 2 (utility-based valuation)**, the problem is analogous but without the normalization by $U'(c_0)$:

$$\max_{\{l_{2t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U'(c_t) \Pi_{2t} \tag{52}$$

The key distinction lies in the normalization factor. Under Objective 2, the monopolist's first-order condition with respect to l_{2t} is time-invariant:

$$\begin{aligned} A_2^{1-\sigma}(1-\theta)(1-\sigma)(A_2 l_{2t})^{-\sigma} = \theta A_1^{1-\sigma}(1-\alpha) &\left(1 - (\alpha\beta A_1^{1-\sigma})^{\frac{1}{\sigma}}\right)^{-\sigma} \\ &\times \left[\sigma(1-l_{2t})^{-\sigma-1} l_{2t} + (1-l_{2t})^{-\sigma}\right] \end{aligned} \tag{53}$$

This equation yields a constant labor allocation $l_{2t} = \kappa$ for all t, where κ is the solution.

Under Objective 1, the solution is more complex. For periods $t \geq 1$, the first-order condition is identical to that of Objective 2, yielding the same constant allocation $l_{2t} = \kappa$. However, the period-0 allocation differs due to the normalization effect. The first-order condition for l_{20} is:

$$\frac{\partial \left(U'(c_0)\Pi_{20}\right)}{\partial l_{20}} + \frac{\partial}{\partial l_{20}} \left(\frac{1}{U'(c_0)}\right) \sum_{t=1}^{\infty} \beta^t U'(c_t)\Pi_{2t} = 0 \tag{54}$$

which simplifies to:

$$\frac{\partial \Pi_{20}}{\partial l_{20}} - U'(c_0)^{-2} U''(c_0) \frac{\partial c_0}{\partial l_{20}} \sum_{t=1}^{\infty} \beta^t U'(c_t)\Pi_{2t} = 0 \tag{55}$$

The second term, the normalization effect, captures how the period-0 decision affects the valuation of all future profits by altering $U'(c_0)$. This creates a structural difference between the decision at $t = 0$ and all subsequent periods, illustrating the "initial-period dependence."

D Appendix D: Computational Approach for the General Case

This appendix details the computational strategy for the general case. We first present the recursive formulation of the monopolist's problem to formally characterize its structure. This clarifies why a standard, time-invariant recursive solution is not directly applicable for Objective 1 and allows us to outline the viable, yet computationally intensive, multi-stage recursive alternative. We then introduce the finite-horizon approximation used for our numerical analysis, justifying its selection as a more efficient method for characterizing transition dynamics.

D.1 Recursive Formulation of the Monopoly Problem

We reformulate both objectives in recursive form using the approach of Marcet & Marimon (2019). This allows us to handle the forward-looking implementability constraint via a costate variable and formally distinguishes the structural asymmetry of Objective 1 from the time symmetry of Objective 2.

D.1.1 Objective 1: Consumption-Based Recursive Contracts

For Objective 1, the normalization by $U'(c_0)$ makes the initial period structurally unique. The problem must be split into two parts: a period-0 problem and a continuation problem for $t \geq 1$.

Continuation Problem for $t \geq 1$: The state variables are (k_t, ν_t), but the value function is parameterized by the fixed initial consumption, c_0.

$$V(k, \nu; c_0) = \sup_{\{c_1, l_2\}} \inf_{\lambda \leq 0} \left\{ \frac{U'(c)}{U'(c_0)} \Pi_2 + \nu U'(c) \frac{\partial c}{\partial c_1} \left(\frac{\partial y_1}{\partial k} + 1 - \delta \right) - \lambda U'(c) \frac{\partial c}{\partial c_1} + \beta V(k', \nu'; c_0) \right\} \tag{56}$$

subject to:

$$k' = (1 - \delta)k + y_1 - c_1 \quad \text{(Resource Constraint)} \tag{57}$$

$$\nu' = \lambda \quad \text{(Costate Evolution)} \tag{58}$$

Here, ν_t is the inherited costate variable (the promise from period $t-1$), and λ_t is the new promise made for period $t+1$.

Period-0 Problem: At $t = 0$, the monopolist chooses initial allocations and the initial promise ν_1 to maximize its value, recognizing that its choice of c_0 affects the entire continuation value function $V(\cdot, \cdot; c_0)$.

$$\max_{c_{10}, l_{20}, \nu_1} \left\{ \Pi_{20} - \nu_1 U'(c_0) \frac{\partial c_0}{\partial c_{10}} + \beta V(k_1, \nu_1; c_0) \right\} \tag{59}$$

subject to $k_1 = (1-\delta)k_0 + y_{10} - c_{10}$ and $\nu_0 = 0$. The presence of c_0 as both a choice variable and a parameter of the continuation value function V is the formal representation of the structural time asymmetry.

D.1.2 Objective 2: Standard Recursive Contracts

For Objective 2, the problem is time-symmetric. The state variables are simply (k_t, ν_t).

Value Function for $t \geq 0$:

$$W(k, \nu) = \sup_{\{c_1, l_2\}} \inf_{\lambda \leq 0} \left\{ U'(c)\Pi_2 + \nu U'(c) \frac{\partial c}{\partial c_1} \left(\frac{\partial y_1}{\partial k} + 1 - \delta \right) - \lambda U'(c) \frac{\partial c}{\partial c_1} + \beta W(k', \nu') \right\} \tag{60}$$

subject to the same constraints. The initial condition is $\nu_0 = 0$. This is a standard recursive contract formulation, where the structure of the problem is identical in every period.

D.1.3 Equivalence and Computational Implications

The recursive formulation is fully equivalent to the sequential problem in Appendix B. The costate variable ν_t corresponds to the sequential Lagrange multiplier λ_{t-1}. The key difference is that the recursive approach makes the state-space dependency explicit.

For Objective 1, the dependence of the continuation value V on the endogenous period-0 choice c_0 prevents a solution via a single, time-invariant Bellman equation. As noted in the main text, a recursive solution is nonetheless viable through a two-stage procedure:

1. **Solve the Continuation Problem:** First, one would solve the time-invariant continuation problem for $t \geq 1$ using value function iteration. However, since V depends on c_0, this requires solving for the value function $V(k, \nu)$ for every possible value of c_0 on a discretized grid, or treating c_0 as an additional state variable, which significantly increases dimensionality and computational burden.

2. **Solve the Period-0 Problem:** Second, one would solve the period-0 problem. This involves a search over the initial choice c_0, where for each candidate c_0, the corresponding continuation value $V(k_1, \nu_1; c_0)$ must be retrieved (likely via interpolation) from the family of functions computed in the first stage.

While feasible, this multi-stage approach is computationally intensive and indirect, particularly when the primary goal is to characterize a single transition path from a given initial state, rather than deriving a complete set of stationary policy functions.

D.2 Finite-Horizon Approximation

In light of the multi-stage procedure required for a fully recursive solution and with our focus on characterizing the transition dynamics, we adopt a finite-horizon approximation spanning periods $t = 0, \ldots, T$. This approach provides a more direct and computationally efficient pathway to obtaining the model's equilibrium path.

Instead of iterating on value functions, this method involves solving the system of all first-order conditions for all choice variables $\{c_{1t}, l_{2t}\}_{t=0}^{T}$ and multipliers $\{\lambda_t, \mu_t\}_{t=0}^{T-1}$ **simultaneously**. This turns the problem into finding the root of a single, large system of non-linear equations, given an initial capital stock k_0 and a set of terminal conditions.

We impose two terminal constraints at period T:

$$k_{T+1} = 0 \tag{61}$$

$$\lambda_T = 0 \tag{62}$$

The condition $k_{T+1} = 0$ assumes capital is fully depleted by the horizon's end; for a sufficiently large T, its impact on early-period decisions is negligible. The condition $\lambda_T = 0$ is a natural consequence of the model's structure, as the forward-looking implementability constraint for period T vanishes when there is no period $T + 1$.

This method directly computes the equilibrium path consistent with all intertemporal constraints, providing a reliable approximation of the infinite-horizon dynamics without the need for a complex, nested solution algorithm.

E Appendix E: Derivations for Reoptimization Analysis

This appendix provides the detailed first-order conditions (FOCs) for the committed and reoptimized plans discussed in Section 5, formally illustrating the sources of time inconsistency for both Objective 1 and Objective 2.

E.1 Objective 1: Dual Inconsistency

Committed Plan at $t = 1$: Under the committed plan formulated at $t = 0$, the monopolist adheres to the decisions for $t \geq 1$ derived from the original optimization problem. The objective function is

$$\sum_{s=0}^{\infty} \beta^s \frac{U'(c_s)}{U'(c_0)} \Pi_{2s}$$

. The FOC for l_{21} is given by Equation (37) in Appendix B, which we restate here for clarity:

$$\begin{aligned} &\frac{1}{U'(c_0)} \left(U''(c_1) \frac{\partial c_1}{\partial l_{21}} \Pi_{21} + U'(c_1) \frac{\partial \Pi_{21}}{\partial l_{21}} \right) \\ &- \lambda_1 (\dots) + \lambda_0 (\dots) + \mu_1 \frac{\partial y_{11}}{\partial l_{21}} = 0 \end{aligned} \tag{63}$$

Here, profits at $t = 1$ are scaled by the fixed factor $1/U'(c_0)$, and the multipliers λ_1, μ_1 are consistent with the original plan, linked to the past via λ_0.

Reoptimized Plan at $t = 1$: When reoptimizing at $t = 1$, the monopolist treats it as a new initial period. The objective function becomes

$$\sum_{s=1}^{\infty} \beta^{s-1} \frac{U'(c_s)}{U'(c_1)} \Pi_{2s}$$

. The FOC for l_{21} is now analogous to the FOC for l_{20} in the original problem (Equation 38), but with all indices shifted and c_0 replaced by c_1:

$$\begin{aligned} &\frac{\partial \Pi_{21}}{\partial l_{21}} - \lambda'_0 (\dots) + \mu'_0 \frac{\partial y_{11}}{\partial l_{21}} \\ &\underbrace{- \frac{U''(c_1)}{U'(c_1)^2} \frac{\partial c_1}{\partial l_{21}} \sum_{s=2}^{\infty} \beta^{s-1} U'(c_s) \Pi_{2s}}_{\text{New normalization effect}} = 0 \end{aligned} \tag{64}$$

where λ'_0 and μ'_0 are new multipliers for the reoptimized problem.

Comparing Eq. (63) and (64) reveals the dual inconsistency: 1. Structural Inconsistency: The functional forms are different. The committed FOC has a fixed scaling factor $1/U'(c_0)$, while the reoptimized FOC introduces a new, powerful "normalization effect" term that incentivizes manipulating c_1. 2. Classical Inconsistency: The multipliers are different. The committed plan's λ_1 is tied to λ_0, while the reoptimized plan's λ_0' is independent of the past.

E.2 Objective 2: Only Classical Inconsistency

Committed Plan at $t = 1$: The objective is

$$\sum_{s=0}^{\infty} \beta^s U'(c_s)\Pi_{2s}$$

. The FOC for l_{21} is given by the general time-symmetric condition (Equation 39):

$$U''(c_1)\frac{\partial c_1}{\partial l_{21}}\Pi_{21} + U'(c_1)\frac{\partial \Pi_{21}}{\partial l_{21}} - \lambda_1(\dots) + \lambda_0(\dots) + \mu_1\frac{\partial y_{11}}{\partial l_{21}} = 0 \tag{65}$$

This FOC is structurally identical for any period $t \geq 1$.

Reoptimized Plan at $t = 1$: The reoptimized objective is

$$\sum_{s=1}^{\infty} \beta^s U'(c_s)\Pi_{2s}$$

. Since the problem is time-separable and the objective's structure is time-symmetric, the FOC for l_{21} (the first period of the new problem) takes the same structural form as the FOC for l_{20} in the original problem. It is identical to Eq. (65) except for the multipliers and the absence of the λ_0 term:

$$U''(c_1)\frac{\partial c_1}{\partial l_{21}}\Pi_{21} + U'(c_1)\frac{\partial \Pi_{21}}{\partial l_{21}} - \lambda_0'(\dots) + \mu_0'\frac{\partial y_{11}}{\partial l_{21}} = 0 \tag{66}$$

Comparing Eq. (65) and (66) shows that the only source of deviation is classical inconsistency. The structural terms involving profits and utility are identical. The only difference is that the committed plan's FOC contains a λ_0 term (linking it to the past), while the reoptimized plan's FOC does not, and the new multipliers (λ_0', μ_0') differ from the old ones (λ_1, μ_1). This confirms that Objective 2 is free from structural inconsistency.