Macro-Monopoly Dynamics: How Large Firms Shape Aggregate Outcomes

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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 channels. Mechanism decomposition shows that price and wage channels 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 a novel source of time inconsistency, generating deviations far larger than those from classical time inconsistency alone while reoptimizing.
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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 and Vives 2021). Yet this fact stands in stark contrast to the dominant paradigm in macroeconomics, which relies on monopolistic competition frameworks à la (Dixit and Stiglitz 1977, Blanchard and 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 evidence in reality and theoretical modeling leaves critical questions unanswered about how large firms' strategic decisions shape the broader economy.

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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 and capital accumulation 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 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 outcomes or industry-level analyses that limit firms' influence to sectoral boundaries, our framework endogenizes the interaction between the firm's intertemporal choices and the aggregate conditions that determine its profitability.

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 industry-level interactions (Gabaix 2011, Baqaee and Farhi 2019, Carvalho and Grassi 2019) or abstract from capital dynamics entirely(Azar and Vives 2021). Our approach explicitly analyzes how profit valuation rules interact with intertemporal capital 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 and investment decisions endogenously change the marginal utilities 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 and Stokey 1983, Blanchard and Kiyotaki 1987) 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 firm's decisions—alter marginal utilities and thus profit valuations. We explicitly compare two valuation approaches: consumption-based valuation (normalizing profits by initial-period marginal utility) and utility-based valuation (using time-varying contemporaneous marginal utilities as weight), 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 mechanism decomposition, we show that macro-monopoly power reduces aggregate output by 6% under baseline calibration, reaching 27% under configurations emphasizing the monopoly sector's economic importance. Decomposing distortions across our five identified channels 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 for all future profits—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 a novel form of time inconsistency distinct from the classical mechanism rooted in forward-looking constraints alone. When reoptimizing at period 1, consumption-based valuation resets the normalization factor from $U'(c_0)$ to $U'(c_1)$, treating the new period as an independent initial condition. 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 structural inconsistency —exhibits deviations below 2%, isolating the contribution of classical inconsistency through changed Lagrange multipliers on implementability constraints. This contrast (175% versus 2%) establishes structural inconsistency as the quantitatively dominant source of plan revision for firms using consumption-normalized objectives.

Our work connects with several strands of literature while offering distinct contributions. The literature on dynamic inconsistency, initiated by (Kydland and Prescott 1977), has primarily focused on policymakers' behavior, with limited applications to firm dynamics. Existing studies either assume commitment to fixed plans or attribute deviations to exogenous shocks, while exceptions like hyperbolic discounting models (Laibson 1997) maintain exogenous preferences. In contrast, our framework introduces endogenously determined valuation mechanisms driven by the firm's impact on aggregate consumption.

Methodologically, our approach parallels the Ramsey problem literature (Lucas and Stokey 1983), where planners account for policy effects on household behavior. 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.

The remainder of the paper proceeds as follows. Section 2 outlines the baseline model, including household preferences, the macro-monopoly's problem with capital accumulation, 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 decomposes mechanisms to identify dominant channels. Then we introduce the finite-horizon formulation to 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.

I. 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.

A. 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.

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

$$U'(c_t) \cdot \frac{\partial c_t}{\partial c_{1t}} = \phi_t p_{1t} \tag{5}$$

$$U'(c_t) \cdot \frac{\partial c_t}{\partial c_{2t}} = \phi_t p_{2t} \tag{6}$$

$$p_{1t}\phi_t = \beta p_{1,t+1}(1 + \rho_{t+1})\phi_{t+1} \tag{7}$$

$$\phi_t = \beta(1 + i_{t+1})\phi_{t+1} \tag{8}$$

where ϕ_t is the Lagrangian multiplier of budget constraint.

B. 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. 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.

C. Monopoly Sector

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

$$y_{2t} = A_2 l_{2t} \tag{13}$$

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:

$$\Pi_{2t} = \frac{p_{2t}}{p_t}y_{2t} - \frac{w_t}{p_t}l_{2t} \tag{14}$$

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 using the equilibrium risk free rate to discount. This discount factor 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

$$\max_{\{l_{2t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \frac{1}{\prod_{s=0}^{t}(1+i_s)} \Pi_{2t} \tag{15}$$

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

$$U'(c_0) \cdot \sum_{t=0}^{\infty} \frac{1}{\prod_{s=0}^{t}(1+i_s)} \Pi_{2t} \tag{16}$$

D. Market Clearing

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

$$l_{1t} + l_{2t} = 1 \tag{17}$$

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

$$a_t = k_t \tag{18}$$

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

$$y_{1t} = c_{1t} + k_{t+1} - (1-\delta)k_t \tag{19}$$

The market for good 2 clears when production equals consumption:

$$y_{2t} = c_{2t} \tag{20}$$

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

$$b_t = 0 \tag{21}$$

The profits that households receive equals the firms' profits.

$$\pi_{1t} = \Pi_{1t}, \quad \pi_{2t} = \Pi_{2t}, \tag{22}$$

An equilibrium consists of sequences of allocations $\{c_{1t}, c_{2t}, k_{t+1}, l_{1t}, l_{2t}\}_{t=0}^{\infty}$ and prices $\{p_{1t}, p_{2t}, w_t, r_t, i_t\}_{t=0}^{\infty}$ 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.

E. Ramsey-Style Formulation

Following the approach in Ramsey problems where policymakers account for private-sector responses to policy instruments (Lucas and Stokey 1983), we reformulate the monopolist's problem by substituting out equilibrium prices using households' and competitive firms' first-order conditions. This transformation makes explicit how the monopolist's choices directly shape allocations rather than indirectly through prices.

From the household's intratemporal first-order conditions and the composite consumption structure, we obtain:

$$\frac{p_{2t}}{p_t} = \frac{\partial c_t}{\partial c_{2t}} \tag{23}$$

$$\frac{p_{1t}}{p_t} = \frac{\partial c_t}{\partial c_{1t}} \tag{24}$$

From competitive sector factor pricing and labor market clearing (which implies $l_{1t} = 1 - l_{2t}$), the wage in units of composite consumption is:

$$\frac{w_t}{p_t} = \frac{\partial c_t}{\partial c_{1t}} \frac{\partial y_{1t}}{\partial l_{1t}} = -\frac{\partial c_t}{\partial c_{1t}} \frac{\partial y_{1t}}{\partial l_{2t}} \tag{25}$$

where the second equality uses $\partial l_{1t}/\partial l_{2t} = -1$. From assets market clearing, return rate is

$$\rho_t = r_t - \delta = \frac{y_{1t}}{k_t} - \delta \tag{26}$$

where $\delta \in (0, 1)$ is the depreciation rate. From the bond market Euler equation:

$$\prod_{s=0}^{t} (1 + i_s) = \frac{1}{\beta^t} \frac{U'(c_0)}{U'(c_t)} \tag{27}$$

Substituting these expressions into the monopolist's period-t profit measured in composite consumption units:

$$\Pi_{2t} = \frac{p_{2t}}{p_t} A_2 l_{2t} - \frac{w_t}{p_t} l_{2t} \tag{28}$$
$$= \frac{\partial c_t}{\partial c_{2t}} A_2 l_{2t} + \frac{\partial c_t}{\partial c_{1t}} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t}$$

Note that the wage term enters with a positive sign because $\partial y_{1t}/\partial l_{2t} < 0$.

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

$$\max_{\{l_{2t}, c_{1t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \frac{U'(c_t)}{U'(c_0)} \left(\frac{\partial c_t}{\partial c_{2t}} A_2 l_{2t} + \frac{\partial c_t}{\partial c_{1t}} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t} \right) \tag{29}$$

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

$$U'(c_t) \frac{\partial c_t}{\partial c_{1t}} = \beta U'(c_{t+1}) \frac{\partial c_{t+1}}{\partial c_{1,t+1}} \left(\frac{\partial y_{1,t+1}}{\partial k_{t+1}} + 1 - \delta \right) \tag{30}$$

and the resource constraint:

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

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 l_{2t}(monopoly decisions) 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 consumption and labor allocation decisions to future capital stock via sector-1 output. The *implementability effect* appears through the Euler equation constraint, demonstrating how announced future production plans 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:

$$\max_{\{l_{2t},c_{1t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U'(c_t) \left(\frac{\partial c_t}{\partial c_{2t}} A_2 l_{2t} + \frac{\partial c_t}{\partial c_{1t}} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t} \right) \tag{32}$$

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

F. First-Order Conditions and the Five Channels

To make explicit how the five channels operate, we derive the first-order conditions with c_1 and l_2 for both objectives. These conditions reveal the distinct roles of price, wage, interest rate, capital, and implementability effects in shaping the monopolist's optimal plan.

We formulate the Lagrangian for Objective 1 as:

(33)

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

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 Euler equation constraint at time t links period t to period $t+1$, hence it appears with multiplier λ_t in both the period-t and period-$(t-1)$ terms when we differentiate with respect to $c_{1,t}$ or.

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

$$\begin{aligned} &\frac{1}{U'(c_0)} \cdot \Bigg(\underbrace{U''(c_t) \frac{\partial c_t}{\partial c_{1t}} \Pi_{2t}}_{\text{interest rate effect}} + \underbrace{U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t} \partial c_{2t}} A_2 l_{2t}}_{\text{price effect}} + \underbrace{U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t}}_{\text{wage effect}} \Bigg) \\ &- \underbrace{\mu_t}_{\text{capital effect}} - \underbrace{\lambda_t \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right)}_{\text{implementability effect for next period}} \\ &+ \underbrace{\lambda_{t-1} \left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta \right) \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right)}_{\text{implementability effect from previous period}} = 0 \end{aligned} \tag{34}$$

Each term in this condition corresponds to one of the five channels. 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 price effect operates through $U'(c_t)(\partial^2 c_t/\partial c_{1t}\partial c_{2t})A_2 l_{2t}$. This cross-derivative 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 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:

$$\begin{aligned}&\frac{\partial \Pi_{20}}{\partial c_{10}} - \lambda_0 \left(U''(c_0)\left(\frac{\partial c_0}{\partial c_{10}}\right)^2 + U'(c_0)\frac{\partial^2 c_0}{\partial c_{10}^2}\right) - \mu_0 \\ &\underbrace{-\frac{U''(c_0)}{U'(c_0)^2}\frac{\partial c_0}{\partial c_{10}}\sum_{t=1}^{\infty}\beta^t U'(c_t)\Pi_{2t}}_{\text{normalization effect}} = 0\end{aligned} \tag{35}$$

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 measuring stick $U'(c_0)$ used to normalize all future profits. 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.

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

$$\mathcal{L}_2 = \sum_{t=0}^{\infty} \beta^t \Big\{ U'(c_t)\Pi_{2t} + \lambda_t \left(\beta U'(c_{t+1}) \frac{\partial c_{t+1}}{\partial c_{1,t+1}} \left(\frac{\partial y_{1,t+1}}{\partial k_{t+1}} + 1 - \delta \right) - U'(c_t) \frac{\partial c_t}{\partial c_{1t}} \right) + \mu_t \left((1-\delta)k_t + y_{1t} - c_{1t} - k_{t+1} \right) \Big\} \tag{36}$$

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

$$\begin{aligned} & U''(c_t) \frac{\partial c_t}{\partial c_{1t}} \Pi_{2t} + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t} \partial c_{2t}} A_2 l_{2t} + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \frac{\partial y_{1t}}{\partial l_{2t}} l_{2t} \\ & - \mu_t - \lambda_t \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right) \\ & + \lambda_{t-1} \left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta \right) \left(U''(c_t) \left(\frac{\partial c_t}{\partial c_{1t}} \right)^2 + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t}^2} \right) = 0 \end{aligned} \tag{37}$$

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:

$$\begin{aligned} & \frac{1}{U'(c_0)} \left(U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \Pi_{2t} + U'(c_t) \frac{\partial \Pi_{2t}}{\partial l_{2t}} \right) \\ & - \lambda_t \left(U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \frac{\partial c_t}{\partial c_{1t}} + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t} \partial c_{2t}} A_2 \right) \\ & + \lambda_{t-1} \left[\left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta \right) \left(U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \frac{\partial c_t}{\partial c_{1t}} + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t} \partial c_{2t}} A_2 \right) \right. \\ & \qquad \left. + U'(c_t) \frac{\partial c_t}{\partial c_{1t}} \frac{\partial^2 y_{1t}}{\partial k_t \partial l_{2t}} \right] + \mu_t \frac{\partial y_{1t}}{\partial l_{2t}} = 0 \end{aligned} \tag{38}$$

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:

$$
\begin{aligned}
&\frac{\partial \Pi_{20}}{\partial l_{20}} - \lambda_0 \left(U''(c_0) \frac{\partial c_0}{\partial c_{20}} A_2 \frac{\partial c_0}{\partial c_{10}} + U'(c_0) \frac{\partial^2 c_0}{\partial c_{10} \partial c_{20}} A_2 \right) + \mu_0 \frac{\partial y_{10}}{\partial l_{20}} \\
&- \frac{U''(c_0)}{U'(c_0)^2} \frac{\partial c_0}{\partial c_{20}} A_2 \sum_{t=1}^{\infty} \beta^t U'(c_t) \Pi_{2t} = 0
\end{aligned} \tag{39}
$$

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 $t \geq 0$:

$$
\begin{aligned}
&U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \Pi_{2t} + U'(c_t) \frac{\partial \Pi_{2t}}{\partial l_{2t}} \\
&- \lambda_t \left(U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \frac{\partial c_t}{\partial c_{1t}} + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t} \partial c_{2t}} A_2 \right) \\
&+ \lambda_{t-1} \left[\left(\frac{\partial y_{1t}}{\partial k_t} + 1 - \delta \right) \left(U''(c_t) \frac{\partial c_t}{\partial c_{2t}} A_2 \frac{\partial c_t}{\partial c_{1t}} + U'(c_t) \frac{\partial^2 c_t}{\partial c_{1t} \partial c_{2t}} A_2 \right) \right. \\
&\qquad \left. + U'(c_t) \frac{\partial c_t}{\partial c_{1t}} \frac{\partial^2 y_{1t}}{\partial k_t \partial l_{2t}} \right] + \mu_t \frac{\partial y_{1t}}{\partial l_{2t}} = 0
\end{aligned} \tag{40}
$$

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.

G. *First-Best Allocation*

To evaluate the welfare 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 labo:

$$\max_{\{c_{1t}, l_{2t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U(c_t) \tag{41}$$

subject to the resource constraint:

$$k_{t+1} = (1-\delta)k_t + y_{1t} - c_{1t} \tag{42}$$

and the production technologies:

$$y_{1t} = A_1 \left[\alpha k_t^{1-\eta} + (1-\alpha)(1-l_{2t})^{1-\eta}\right]^{\frac{1}{1-\eta}}, \quad c_{2t} = A_2 l_{2t} \tag{43}$$

where aggregate consumption c_t is defined by the CES aggregator in equation (1).

The Lagrangian for this problem is:

$$\mathcal{L}^{FB} = \sum_{t=0}^{\infty} \beta^t \left\{U(c_t) + \mu_t^{FB}\left[(1-\delta)k_t + y_{1t} - c_{1t} - k_{t+1}\right]\right\} \tag{44}$$

The first-order conditions characterize the efficient allocation. For c_{1t}:

$$U'(c_t)\frac{\partial c_t}{\partial c_{1t}} = \mu_t^{FB} \tag{45}$$

For l_{2t}:

$$U'(c_t)\frac{\partial c_t}{\partial c_{2t}} A_2 = \mu_t^{FB}\frac{\partial y_{1t}}{\partial l_{1t}} \tag{46}$$

where we use $\partial l_{1t}/\partial l_{2t} = -1$ and $\partial y_{1t}/\partial l_{1t} = -\partial y_{1t}/\partial l_{2t}$.

For k_{t+1}:

$$\mu_t^{FB} = \beta\mu_{t+1}^{FB}\left(1 - \delta + \frac{\partial y_{1,t+1}}{\partial k_{t+1}}\right) \tag{47}$$

Combining these conditions yields the intratemporal efficiency condition:

$$\frac{\partial c_t/\partial c_{2t}}{\partial c_t/\partial c_{1t}} = \frac{A_2}{-\partial y_{1t}/\partial l_{2t}} \tag{48}$$

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}:

$$U'(c_t)\frac{\partial c_t}{\partial c_{1t}} = \beta U'(c_{t+1})\frac{\partial c_{t+1}}{\partial c_{1,t+1}}\left(1-\delta+\frac{\partial y_{1,t+1}}{\partial k_{t+1}}\right) \tag{49}$$

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.

II. Analytical Characterization: A Special Case

To build intuition and validate our numerical methods, we first solve a special case with analytical solutions. We impose the following parameter restrictions:

$$\frac{1}{\gamma} = \sigma = \eta \quad \text{and} \quad \delta = 1 \tag{50}$$

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

$$c_{1t} = \left(1-(\alpha\beta A_1^{1-\sigma})^{\frac{1}{\sigma}}\right) y_{1t} \tag{51}$$

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.

For Objective 1 (consumption-based valuation with initial-period dependence), the normalized profit maximization problem becomes:

$$\max_{\{l_{2t}\}} \sum_{t=0}^{\infty} \beta^t \frac{c_t^{-\sigma}}{c_0^{-\sigma}} \Bigg(c_t^{\sigma}(1-\theta)(A_2 l_{2t})^{-\sigma}\cdot A_2 l_{2t}$$
$$- c_t^{\sigma}\theta\cdot A_1^{1-\sigma}(1-\alpha)\left(1-\left(\alpha\beta A_1^{1-\sigma}\right)^{\frac{1}{\sigma}}\right)^{-\sigma}\cdot(1-l_{2t})^{-\sigma} l_{2t}\Bigg)$$

subject to the capital accumulation constraint:

$$k_{t+1} = y_{1t} - c_{1t}$$

For Objective 2 (utility-based valuation with time symmetry), the problem is:

$$\max_{\{l_{2t}\}} \sum_{t=0}^{\infty} \beta^t c_t^{-\sigma} \Bigg(c_t^{\sigma}(1-\theta)(A_2 l_{2t})^{-\sigma} \cdot A_2 l_{2t}$$
$$- c_t^{\sigma}\theta \cdot A_1^{1-\sigma}(1-\alpha) \left(1 - \left(\alpha\beta A_1^{1-\sigma}\right)^{\frac{1}{\sigma}}\right)^{-\sigma} \cdot (1-l_{2t})^{-\sigma} l_{2t} \Bigg)$$

The key distinction lies in the normalization factor: Objective 1 scales all future profits by $1/c_0^{-\sigma}$, creating a structural link between period-0 decisions and the valuation of all subsequent profits, while Objective 2 maintains symmetric weighting across periods through contemporary marginal utility $c_t^{-\sigma}$.

Under Objective 2, the monopolist's first-order condition for l_{2t} becomes:

$$\begin{aligned} A_2^{1-\sigma}(1-\theta)(1-\sigma)(A_2 l_{2t})^{-\sigma} = \theta A_1^{1-\sigma}(1-\alpha) \left(1 - (\alpha\beta A_1^{1-\sigma})^{\frac{1}{\sigma}}\right)^{-\sigma} \\ \times \left[\sigma(1-l_{2t})^{-\sigma-1} l_{2t} + (1-l_{2t})^{-\sigma}\right] \end{aligned} \tag{52}$$

This yields a constant labor allocation $l_{2t} = \kappa$ for all t, where κ solves the above equation. The time-invariant solution reflects the fact that, with the forward-looking constraint neutralized by our parameter choices, the monopolist faces an identical static trade-off in each period.

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

$$\frac{\partial \Pi_{20}}{\partial l_{20}} - U'(c_0)^{-2} U''(c_0) \frac{\partial c_0}{\partial c_{20}} A_2 \sum_{t=1}^{\infty} \beta^t U'(c_t) \Pi_{2t} = 0 \tag{53}$$

The additional term reflects how the period-0 decision affects the normalization factor $U'(c_0)$, which then influences the valuation of all future profits. This creates a structural difference between period 0 and all subsequent periods, illustrating the "initial-period dependence" mentioned in our title.

The monopolist faces a trade-off in period 0: increasing l_{20} reduce current profit Π_{20} with higher consumption c_0 (through increased c_{20}). However, higher c_0 reduces $U'(c_0)$, which increase the normalized value of all future profits. This effect is absent in later periods, where $U'(c_0)$ is predetermined. The optimal l_{20} thus differs from the constant value κ, with the magnitude of deviation depending on parameter values and the relative importance of current versus future profits.

This analytical case demonstrates that even in the absence of traditional time-inconsistency issues (which our parameter restrictions eliminate), Objective 1 creates an inherent asymmetry between the initial period and all subsequent periods. This asymmetry arises purely from the normalization choice.

We now present results from the analytical special case, focusing on four critical dimensions: parameter sensitivity of labor allocations, welfare comparisons, capital dynamics, and consumption dynamics. The baseline parameters employed in this section (Section 3) are calibrated following standard macroeconomic conventions, with key parameter values and their respective literature references—where applicable—summarized in Table 1 of Section 4 for comprehensive reference.

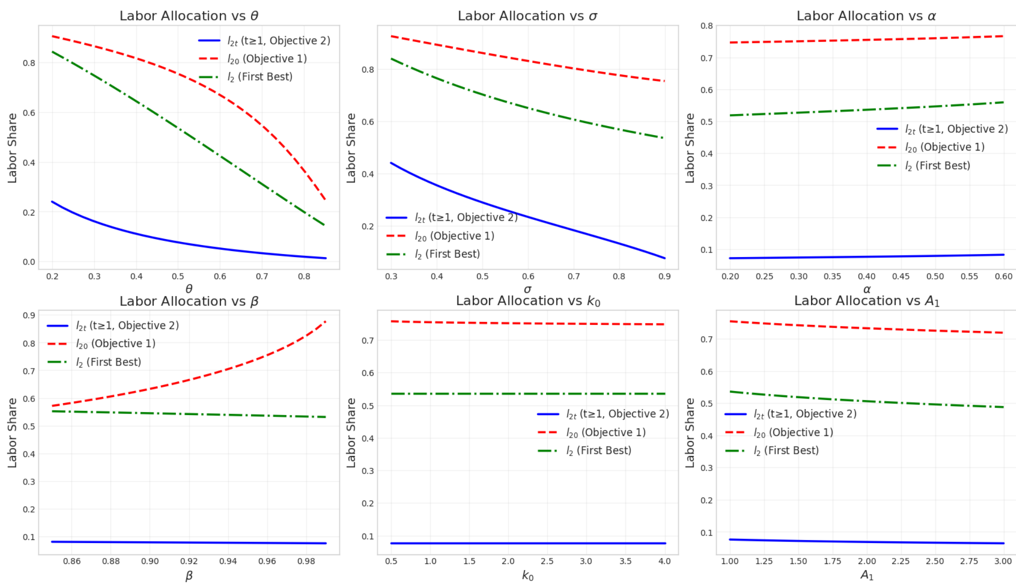

FIGURE 1. PARAMETER SENSITIVITY ANALYSIS: SECTOR 2 LABOR ALLOCATION ACROSS KEY PARAMETERS

Figure 1 displays the labor share in sector 2 across variations in six key parameters: θ, σ, α, β, k_0, and A_1. The horizontal axes measure the respective parameter values, while the vertical axis measures the labor share in sector 2. Three distinct allocations are plotted. The red dashed line represents the initial-period labor allocation under Objective 1 (l_{20}), denoted l_{20}^{Obj1}. The blue solid line represents the labor allocation under Objective 1 when $t \geq 1$, which is also the time-invariant labor allocation under Objective 2 (l_{2t} for $t \geq 0$), denoted l_{2t}^{Obj2}.The green dash-dot line represents the first-best labor allocation, denoted l_2^{FB}.

Across all parameters, l_{2t}^{Obj2} remains constant with respect to k_0, confirming its time-invariant nature under the special case assumptions. In contrast, l_{20}^{Obj1} exhibits systematic deviations from l_{2t}^{Obj2} due to the normalization effect, with the magnitude of deviation depending on the specific parameter.

Figure 2 compares welfare levels across initial capital stocks k_0. The horizontal axis measures initial capital, while the vertical axis measures discounted lifetime utility. Three welfare series are presented. The red dashed line represents welfare

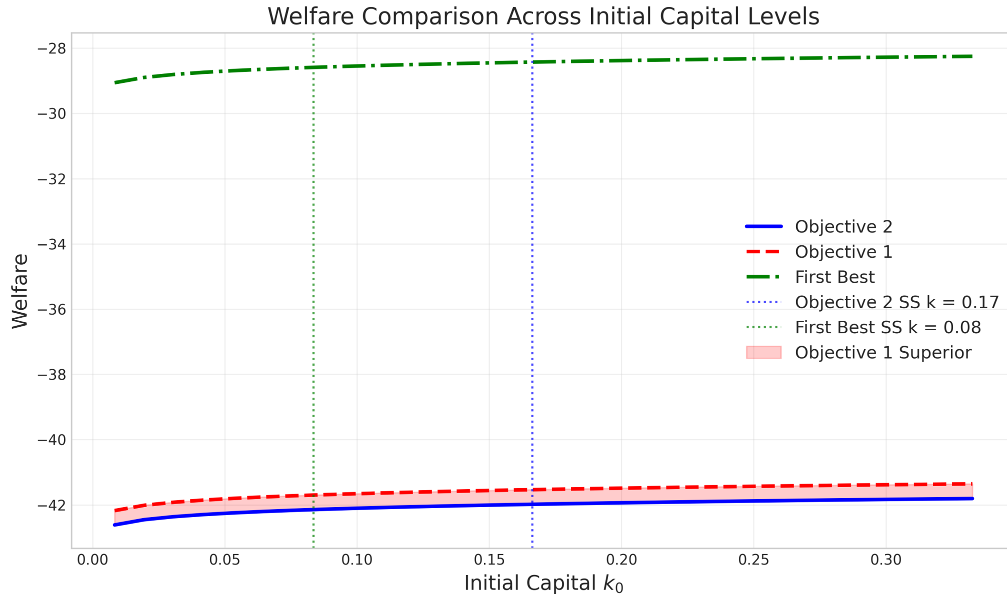

FIGURE 2. WELFARE COMPARISON: LIFETIME UTILITY ACROSS INITIAL CAPITAL LEVELS

under Objective 1 $\mathcal{W}^{\text{Obj1}}$). The blue solid line represents welfare under Objective 2 ($\mathcal{W}^{\text{Obj2}}$). The green dash-dot line represents first-best welfare ($\mathcal{W}^{\text{FB}}$).

Vertical dotted lines mark the steady-state capital levels for Objective 1 and 2 ($k^{\text{SS}}_{\text{Obj12}}$) and the first best ($k^{\text{SS}}_{\text{FB}}$). The shaded region indicates where $\mathcal{W}^{\text{Obj1}}$ exceeds $\mathcal{W}^{\text{Obj2}}$.

The figure reveals that first-best welfare dominates across all initial conditions, as expected given the absence of monopoly distortions. More importantly, $\mathcal{W}^{\text{Obj1}}$ outperforms $\mathcal{W}^{\text{Obj2}}$.

Figure 3 illustrates capital accumulation paths under two initial conditions: a small initial capital stock ($k_0 < k^{\text{SS}}_{\text{Obj2}}$, left panel) and a large initial capital stock ($k_0 > k^{\text{SS}}_{\text{Obj2}}$, right panel). The horizontal axis measures time periods, while the vertical axis measures the capital stock. The red dashed line represents capital dynamics under Objective 1 (k_t^{Obj1}). The blue solid line represents capital dynamics under Objective 2 (k_t^{Obj2}). The green dash-dot line represents capital dynamics under the first best (k_t^{FB}). The blue dotted horizontal line marks $k^{\text{SS}}_{\text{Obj12}}$.

For small initial capital, k_t^{Obj2} accumulates faster than k_t^{Obj1} because $l_{20}^{\text{Obj2}} < l_{20}^{\text{Obj1}}$ employs labor toward sector 1, increasing current output in sector 1. This reflects Objective 1's initial-period emphasis on currentd aggragate consumption enabled by the normalization effect. For large initial capital, k_t^{Obj1} decumulates more aggresively than k_t^{Obj2} as l_{20}^{Obj1} shifts labor toward sector 2, supporting higher current aggregate consumption. An important observation is that un-

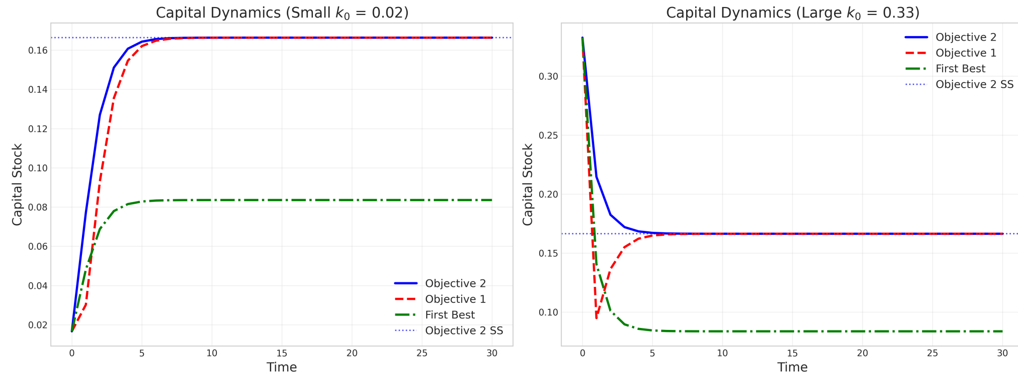

FIGURE 3. CAPITAL DYNAMICS: CONVERGENCE PATHS UNDER DIFFERENT INITIAL CAPITAL LEVELS

der Objective 1, capital initially declines below the steady state before converging back upward. This pattern arises directly from our special case assumption of complete depreciation ($\delta = 1$), all capital must be rebuilt each period from scratch, making capital accumulation purely a function of current output and consumption decisions. The monopolist's initial-period dependence effect encourages higher period-0 consumption, which—combined with complete depreciation—drives capital temporarily below its steady-state level. In both cases, k_t^{FB} converges to a lower steady state than $k_{\mathrm{Obj2}}^{\mathrm{SS}}$, reflecting the first best's balance between 2 goods consumption.

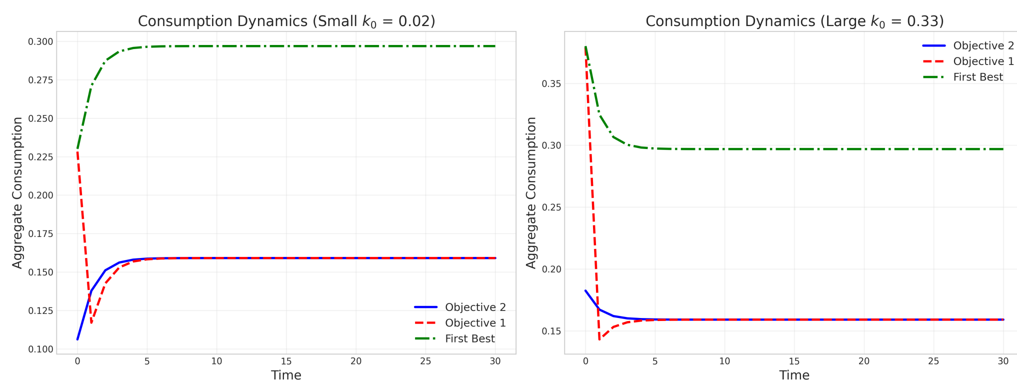

FIGURE 4. AGGREGATE CONSUMPTION DYNAMICS.

Figure 4 complements Figure 3 by showing aggregate consumption dynamics under the same initial conditions. The horizontal axis measures time periods, while the vertical axis measures aggregate consumption c_t. The series plotted correspond to those in Figure 3.

For small initial capital, consumption under Objective 2 starts lower than under Objective 1 due to normalization effect. For large initial capital, the pattern remains: Objective 1 yields higher initial consumption due to its labor reallocation toward sector 2, with convergence to the same steady state as Objective 2. The first best reaches higher consumption than both objectives throughout the transition, reflecting its freedom from monopoly distortions.

Notably, the initial consumption gap between the two objectives arises purely from their differing labor allocations in period 0, underscoring how normalization-induced differences in initial decisions propagate through the entire dynamic path.

III. General Case: Steady State and Dynamics

The analytical special case in Section 3 provides analytical characterization of the monopolist's behavior under restrictive parameter values, underlining the normalization effect and demonstrating how initial-period dependence shapes dynamics. We now turn to the general case, where the parameter restrictions are relaxed to allow for more flexible calibrations. We begin by examining the steady-state properties of the general model, before addressing the computational challenges posed by the finite-horizon formulation required for dynamics.

A. Steady-State Comparative Statics

In steady state, all variables converge to constant values over time, and the distinction between Objective 1 and Objective 2 disappears. When the economy reaches the steady state, the normalization factor $U'(c_0)$ in Objective 1 has been predetermined, causing the first-order conditions for the two objectives to coincide. Consequently, both objectives yield identical steady-state allocations, which we compare against the first-best benchmark.

We compute steady-state allocations across variations in two key parameters: the preference weight θ and sector-1 total factor productivity A_1. Throughout this analysis, we hold other parameters at the baseline values listed in Table 1: $\beta = 0.96$, $\sigma = 0.9$, $\gamma = 2.0$, $\theta = 0.5$, $\eta = 1.06$, $\alpha = 0.33$, $\delta = 0.1$, and $A_1 = A_2 = 1.0$.

Varying Preference Weight

Figure 5 displays steady-state outcomes as the preference weight θ varies from 0.15 to 0.85. This parameter governs the relative importance of good 1 in the consumption aggregator, with higher θ indicating stronger household preference for the competitive sector's output. Blue circles represent the monopoly steady state, while green triangles represent the first-best allocation. A vertical dashed line marks the baseline $\theta = 0.5$.

The monopoly consistently under-produces good 2 relative to the first-best across the entire parameter space. At the baseline $\theta = 0.5$, the monopoly's $c_2^{SS} = 0.168$ is 68.4 percent below the first-best value of $c_2^{SS} = 0.531$. This severe

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

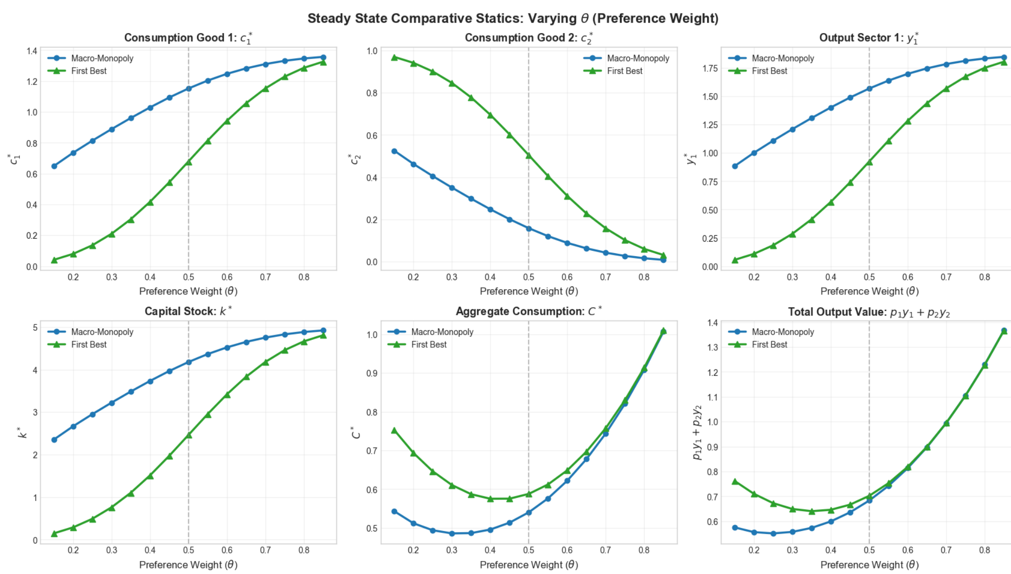

Figure 5. Steady State Comparative Statics: Varying θ (Preference Weight on Good 1). *Panel layout and color scheme identical to Figure 6.* The vertical dashed line marks the baseline $\theta = 0.5$.

output restriction is the direct manifestation of monopoly power. The distortion is most pronounced when the monopoly sector is central to household consumption. At the high market power configuration $\theta = 0.15$ (where the monopoly accounts for around 80% of total output), the monopoly's $c_2^{SS} = 0.531$ is 45.5 percent below the first-best value of $c_2^{SS} = 0.973$. The monopolist exploits strong demand for its product by restricting sector-2 labor allocation. As θ increases to the low market power configuration $\theta = 0.85$, where households prefer the competitive sector's output, the gap widens to 74.7 percent, with the monopoly's $c_2^{SS} = 0.009$ compared to the first-best $c_2^{SS} = 0.034$. When the monopoly sector becomes less important to household utility, the firm faces weaker demand for good 2 and responds by severely restricting production, though the absolute levels are smaller in both regimes.

Conversely, consumption of good 1 is over-produced relative to the first-best, reflecting the reallocation of labor away from the restricted sector 2. At the baseline $\theta = 0.5$, the monopoly's $c_1^{SS} = 0.946$ exceeds the first-best $c_1^{SS} = 0.533$ by 77.5 percent. This over-supply arises from a general equilibrium effect operating through the labor market: by restricting labor allocation to sector 2 to maintain markup power, the monopoly increases labor supply to sector 1, which raises output in that sector. The distortion exhibits similar magnitudes across the parameter space. At $\theta = 0.15$, good 1 is over-produced even more, with the monopoly's $c_1^{SS} = 0.533$ compared to the first-best $c_1^{SS} = 0.030$. At $\theta = 0.85$, the over-production narrows to 2.6 percent, with the monopoly's $c_1^{SS} = 1.127$ compared to the first-best $c_1^{SS} = 1.098$. The convergence at high θ reflects that when households strongly prefer good 1, both the monopoly and first-best allocations concentrate resources in sector 1.

The net effect on aggregate consumption c^{SS} quantifies the welfare loss. At the baseline $\theta = 0.5$, the monopoly's $c^{SS} = 0.478$ is 10.2 percent below the first-best value of $c^{SS} = 0.532$. The over-supply of good 1 does not compensate for the deficit in good 2 in terms of household utility. This gap varies substantially with the monopoly sector's importance. At $\theta = 0.15$ in the high market power configuration, aggregate consumption under the monopoly is 29.0 percent below the first-best. As θ increases to 0.85 in the low market power configuration, the gap narrows to 0.5 percent. When the monopoly produces a good that households value highly, the firm can extract large rents by restricting output, leading to severe welfare losses. When the monopoly's good is less valued, the distortion is confined to a smaller segment of the economy and the aggregate loss is correspondingly modest.

The monopoly consistently over-accumulates capital relative to the first-best. At the baseline $\theta = 0.5$, the monopoly's steady-state capital stock $k^{SS} = 2.700$ exceeds the first-best value of $k^{SS} = 1.521$ by 77.5 percent. This pattern holds across all values of θ, with the percentage gap reaching 1654 percent at $\theta = 0.15$ and narrowing to 2.6 percent at $\theta = 0.85$. The over-accumulation results from the artificially elevated return to capital in sector 1 induced by excessive labor allocation to that sector.

Total output value, measured as $p_1 y_1^{SS} + p_2 y_2^{SS}$ where prices reflect marginal utilities in equilibrium, exhibits a similar pattern to aggregate consumption. At the baseline, total output under the monopoly is 5.7 percent below the first-best. This loss reaches 26.5 percent at $\theta = 0.15$ and declines to 0.1 percent at $\theta = 0.85$.

Varying Sector-1 Productivity

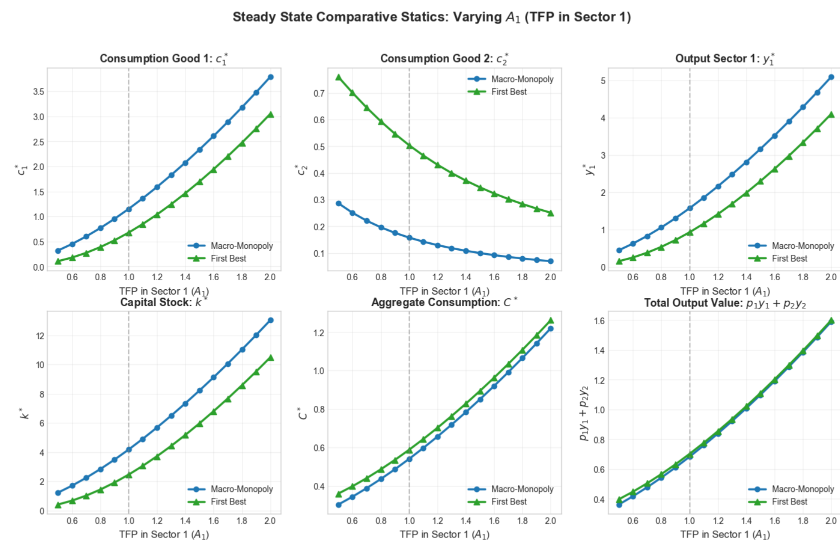

Figure 6. Steady State Comparative Statics: Varying A_1 (TFP in Sector 1). *Each panel shows a different endogenous variable*: capital stock k^*, consumption good 1 c_1^*, consumption good 2 c_2^*, aggregate consumption C^*, sector-1 output y_1^*, and total output value $p_1y_1 + p_2y_2$. Blue circles: Macro-Monopoly. Green triangles: First Best. The vertical dashed line marks the baseline $A_1 = 1.0$.

Figure 6 displays steady-state outcomes as sector-1 total factor productivity A_1 varies from 0.5 to 2.0, holding θ at the baseline value of 0.5. Changes in A_1 shift the relative productivity of the competitive sector compared to monopolistic sector and thereby affecting the economy's aggregate productive capacity.

Consumption of good 1 diverges sharply across regimes as A_1 varies. Under the monopoly, c_1^{SS} rises steeply with A_1, reflecting both higher sector-1 output due to increased productivity and reduced sector-2 production due to the monopolist's labor restriction. At the baseline $A_1 = 1.0$, the monopoly's $c_1^{SS} = 0.946$ exceeds the first-best value of $c_1^{SS} = 0.533$ by 77.5 percent. At $A_1 = 2.0$, the monopoly's $c_1^{SS} = 2.825$ exceeds the first-best value of $c_1^{SS} = 2.178$ by 29.8 percent. At

$A_1 = 0.5$, the over-production reaches 198 percent, with the monopoly's $c_1^{SS} = 0.296$ compared to the first-best $c_1^{SS} = 0.099$. In contrast, the first-best c_1^{SS} rises more gradually with A_1 because the social planner balances the outputs of both sectors to equate the marginal rate of substitution between goods 1 and 2 to their marginal rate of transformation.

Variations in A_1 have little effect on consumption of good 2 under the monopoly, which is linear to the monopolist's optimal labor allocation l_2^{SS}. At the baseline $A_1 = 1.0$, the monopoly's $c_2^{SS} = 0.168$ is 68.4 percent below the first-best value of $c_2^{SS} = 0.531$. This gap ranges from 62.7 percent at $A_1 = 0.5$ to 72.0 percent at $A_1 = 2.0$. This stability indicates that the monopolist's output restriction strategy is largely independent of competitive sector productivity.

The aggregate welfare loss remains relatively modest across the range of A_1 values. At the baseline $A_1 = 1.0$, the monopoly's $c^{SS} = 0.478$ is 10.2 percent below the first-best value of $c^{SS} = 0.532$. This loss reaches 17.7 percent at $A_1 = 0.5$ and narrows to 4.8 percent at $A_1 = 2.0$. The pattern reflects that higher sector-1 productivity mitigates the welfare loss by increasing total output, partially offsetting the monopolist's restriction of sector-2 production.

Capital accumulation responds strongly to sector-1 productivity. At the baseline $A_1 = 1.0$, the monopoly's $k^{SS} = 2.700$ exceeds the first-best value of $k^{SS} = 1.521$ by 77.5 percent. At $A_1 = 2.0$, the gap widens to 29.8 percent, with the monopoly's $k^{SS} = 7.670$ compared to the first-best $k^{SS} = 5.912$. At $A_1 = 0.5$, the gap reaches 198 percent, with the monopoly's $k^{SS} = 0.887$ compared to the first-best $k^{SS} = 0.297$. However, these variations are relatively modest compared to the impact of changing θ, indicating that the monopoly's distortions are driven primarily by market power rather than by the absolute productivity levels in either sector.

Total output value varies proportionally with A_1 under both regimes. At the baseline $A_1 = 1.0$, total output under the monopoly is 5.7 percent below the first-best. This loss reaches 12.2 percent at $A_1 = 0.5$ and narrows to 2.2 percent at $A_1 = 2.0$.

Mechanism Decomposition: Isolating the Five Channels

To quantify the contribution of each channel to the monopoly's distortions, 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 decomposition 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 "No Price" scenario, 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 "No Wage" scenario, the monopolist ignores how its labor allocation affects the equilibrium wage through general equilibrium spillovers in sector 1. In the "No Interest Rate" scenario, 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 "No Capital" scenario, the monopolist fails to recognize that current production and consumption decisions constrain future capital accumulation. In the "No Implementability" scenario, the monopolist ignores the forward-looking Euler equation constraint linking current consumption to future capital returns.

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—Mechanism Decomposition: 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%)
No Price	2.042	0.715	0.371	0.529	0.617
(% vs. FB)	(34.3%)	(34.3%)	(−30.2%)	(−0.6%)	(1.4%)
No Wage	2.333	0.817	0.281	0.514	0.607
(% vs. FB)	(53.4%)	(53.4%)	(−47.1%)	(−3.4%)	(−0.2%)
No Interest Rate	2.565	0.899	0.210	0.494	0.589
(% vs. FB)	(68.6%)	(68.6%)	(−60.6%)	(−7.2%)	(−3.1%)
No Capital	2.761	0.967	0.149	0.469	0.565
(% vs. FB)	(81.5%)	(81.5%)	(−71.9%)	(−11.9%)	(−7.1%)
No Implementability	2.743	0.961	0.155	0.472	0.568
(% 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.

Eliminating the wage effect also yields substantial improvements, though somewhat smaller than removing the price effect. Capital over-accumulation falls to 53.4 percent above the first-best, and consumption of good 2 rises to 47.1 percent below the first-best. Total output reaches 0.2 percent below the first-best, nearly achieving efficiency. The wage effect operates through the monopolist's recognition that reallocating labor to sector 2 reduces labor supply to sector 1, lowering the equilibrium wage and thus the marginal cost of employing labor in the monopoly sector. By internalizing this general equilibrium spillover, the monopolist has an additional incentive to restrict sector-2 employment beyond what the price effect alone would justify.

It is worth noting that, removing the capital or implementability effects worsens outcomes relative to the full model. Without the capital channel, steady-state capital rises to 81.5 percent above the first-best and total output falls to 7.1 percent below the first-best. Without the implementability channel, capital rises to 80.3 percent above 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 interest rate effect has a more modest impact. Eliminating this channel reduces capital over-accumulation to 68.6 percent above the first-best and improves total output to 3.1 percent below the first-best. This channel captures how current consumption affects marginal utility and thus the discount factor applied to current-period profits. The relatively small impact suggests that intertemporal distortions—manipulating the valuation of current versus future profits through consumption choices—are less quantitatively important than intratemporal distortions operating through prices and wages.

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.

B. Finite-Horizon Formulation and Dynamics

Having characterized the steady-state properties of the general model, we now examine the dynamics from an arbitrary initial capital stock to the long-run equilibrium. Unlike the steady state, transition paths differ qualitatively between Objective 1 and Objective 2 due to the normalization factor $U'(c_0)$ in Objective 1, which creates different weights on flow utility across periods.

In infinite horizon, dynamic programming (DP) is the workhorse for solving intertemporal optimization problems, as it leverages recursive structure: the optimal decision at time t depends only on a finite set of state variables that summarize all information relevant to the future. For our macro-monopoly problem, however, forward-looking constraints—specifically the household's Euler equation, which links marginal utility and capital accumulation across all periods—break this recursive structure. The monopolist's choice of l_{2t} or k_{t+1} affects not just current profits, but also the entire path of consumption $\{c_s\}_{s=t}^{\infty}$, which in turn shapes the valuation of future profits (via $U'(c_s)$ for all $s > t$). This interdependence means no finite set of state variables can fully capture the future implications of current decisions, as the state space would need to include the entire future path of consumption—a requirement that violates DP's recursive premise.

Compounding this issue is the "initial-period dependence" of Objective 1. For recursive contracts—an alternative framework that uses co-state variables to handle forward-looking constraints—consistency requires that the co-state variable captures all intertemporal trade-offs uniformly across periods(Marcet and Marimon 2019). Under Objective 1, however, the normalization factor $U'(c_0)$ introduces a structural asymmetry: decisions in period 0 affect the valuation of all future profits, while decisions in $t \geq 1$ do not influence the valuation of profits before t. This non-stationary valuation rule means the co-state variable cannot fully encapsulate the trade-offs, as it would need to separately track the initial-period normalization effect alongside standard intertemporal constraints. No existing infinite-horizon method adequately resolves this tension, as recursive contracts and DP both rely on time-invariant state or co-state spaces—properties violated by Objective 1's initial-period dependence.

Given these challenges, we adopt a finite-horizon model spanning periods $t = 0$ to $t = T$, where T denotes the terminal period. This formulation retains the general case's intertemporal dynamics—including forward-looking constraints and the two profit objectives—while avoiding the infinite-horizon's computational challenges. The finite horizon imposes well-defined terminal conditions that close the model, making numerical solution feasible.

We maintain all core features of the model from Section 2—household preferences, firm technologies, market clearing, and the two profit objectives—but restrict the time horizon to $t = 0, 1, ..., T$. The only adjustments are to terminal constraints, which simplify the computation of the solution by eliminating undefined future obligations beyond T.

At the terminal period T, there are no future periods to consider, so two key constraints apply:

$$k_{T+1} = 0 \tag{54}$$

$$\lambda_T = 0 \tag{55}$$

The first condition, $k_{T+1} = 0$, states that capital is fully depleted by the end of the horizon. With no period $T + 1$ to use or accumulate capital, the monopolist has no incentive to retain capital beyond T, and the resource constraint at T simplifies to $k_T + y_{1T} = c_{1T}$ (since $k_{T+1} = 0$). The second condition, $\lambda_T = 0$, sets the Lagrange multiplier on the household's Euler equation to zero at T. Recall from Section 2 that λ_t enforces the Euler equation's link between period t and $t+1$; at T, there is no $t+1$, so this constraint vanishes, and its multiplier becomes irrelevant.

These boundary conditions that anchor the solution: starting from the initial capital k_0, we solve the system of FOCs simultaneously from $t = 0$ to $t = T$, ensuring consistency with both intertemporal constraints and terminal depletion of capital.

The finite-horizon formulation thus retains the general case's economic mechanisms—including the tension between the two profit objectives and the monopolist's influence on aggregate intertemporal dynamics—while overcoming the technical barriers of infinite-horizon methods.

We present numerical results focusing on two initial capital levels ($k_0 = 0.5 * kss$ and $k_0 = 1.5 * kss$) and contrasting dynamics under Objectives 1 (consumption-based valuation) and 2 (utility-based valuation)

Figure 7 illustrates dynamics for $k_0 = 0.5 * kss$, showing the evolution from period 0 to 30. In the top-left panel (monopoly labor l_2), Objective 1 (blue line) features a sharp initial decline: l_2 falls from 0.639 to 0.232 within the first period, then gradually stabilizes. Objective 2 (orange line) increases slightly, while the First Best (green line) almost anchors at $l_2 \approx 0.532$. This divergence arises because Objective 1's initial-period normalization effect incentivizes reallocating labor to boost first-period aggregate consumption. The First Best optimally balances labor across sectors to maximize social welfare.

In the top-right panel (consumption of good 1 c_1), Objective 2's c_1 rises most rapidly, from 0.635 reaching to 0.940 by $t = 20$, while Objective 1's c_1 lags slightly (from 0.416 reaching 0.934) and the First Best's c_1 slightly increase from 0.494 (to 0.532). The difference stems from Objective 2's labor allocation favoring sector 1 production early on, while Objective 1's initial labor shift to sector 2 temporarily reduces c_1 before increasing it over time as capital accumulates.

The bottom-left panel (aggregate consumption C) shows Objective 2's C rising from 0.355 to 0.477, Objective 1's C climbing from 0.394 to the same 0.477, except 0.520 at $t = 0$, and the First Best's C increases from 0.513 to 0.532.

Finally, the bottom-right panel (capital stock k) shows both objectives accu-

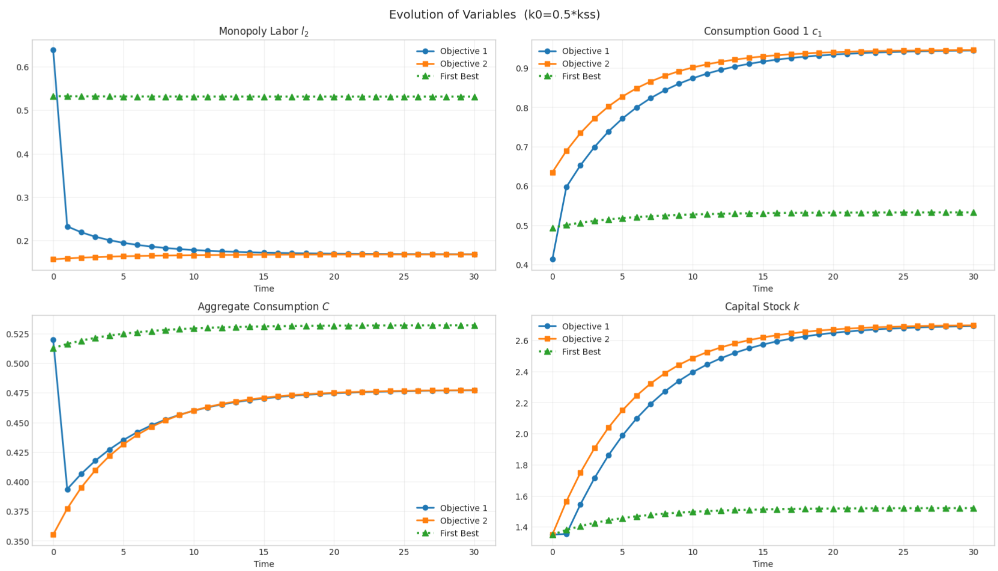

FIGURE 7. EVOLUTION OF VARIABLES (FINITE HORIZON, $T = 100$, $t = 0$ TO 30, $k_0 = 0.5 * kss$). *Top-left*: MONOPOLY LABOR IN SECTOR 2 (l_2); *Top-right*: CONSUMPTION OF GOOD 1 (c_1); *Bottom-left*: AGGREGATE CONSUMPTION (C); *Bottom-right*: CAPITAL STOCK (k). LINES: BLUE = OBJECTIVE 1, ORANGE = OBJECTIVE 2, GREEN = FIRST BEST.

mulating capital: Objective 2's k rises more rapidly, from 1.350 to 2.696, and Objective 1's k rises to 2.691. The First Best's k increases to 1.520.

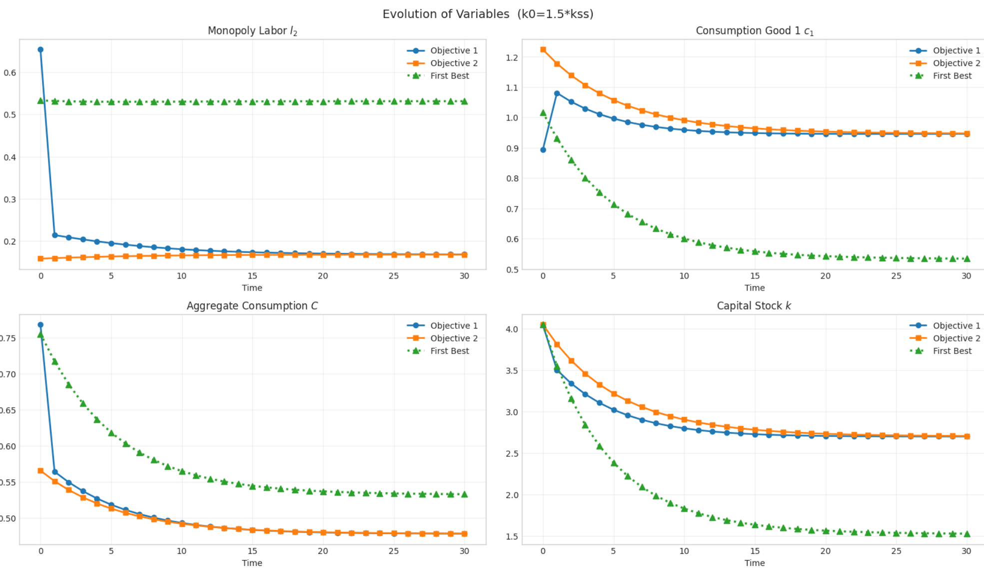

FIGURE 8. EVOLUTION OF VARIABLES (FINITE HORIZON, $T = 100$, $t = 0$ TO 30, $k_0 = 1.5 * kss$).

For $k_0 = 1.5 * kss$ (Figure 8), dynamics reverse in key respects. In the top-right panel (c_1), both objectives' c_1 decline—Objective 1's c_1 falls from 1.080 to 0.946 except at initial period it is 0.893, and Objective 1's c_1 falls from 1.224 to 0.947—while the First Best's c_1 plummets from 1.017 to 0.534. This occurs because $k_0 = 1.5 * kss$ exceeds the First Best steady-state capital more.

The bottom-left panel (C) shows Objective 1's C falling from 0.769 to 0.478, Objective 2's C falling from 0.566 to 0.478, and the First Best's C falling from 0.756 to 0.533. The bottom-right panel (k) confirms capital depletion: Objective 1's k falls from 4.051 to 2.700, Objective 2's k falls to 2.705, and the First Best's k falls to 1.527.

IV. Committed Plans vs. Reoptimization

We define two scenarios for periods $t = 1$. First is the committed Plan. The monopolist adheres to the optimal plan formulated at $t = 0$, which specifies decisions $\{l_{2s}, c_{1s}\}_{s=0}^{\infty}$ (derived in Section 2.3). For $s = 1$, this plan is governed by the FOCs for $t > 0$ (e.g., Equations 33 and 37 for Objective 1). Second is reoptimization at $t = 1$. At $t = 1$, the monopolist treats $t = 1$ as the "new initial period" and solves a new optimization problem, taking k_1 (predetermined by the $t = 0$ decision) as the initial capital. Specifically, for Objective 1, the normalization factor shifts from $U'(c_0)$ (at $t = 0$) to $U'(c_1)$ (at $t = 1$). We analyze and compare these two scenarios below.

A. *Objective 1: Dual Inconsistency-Structural and Classical*

Recall that Objective 1 (consumption-based valuation) at $t = 0$ maximizes the normalized present value of profits, with the normalization factor anchored to $U'(c_0)$:

$$\max_{\{l_{2s}, c_{1s}\}_{s=0}^{\infty}} \sum_{s=0}^{\infty} \beta^s \frac{U'(c_s)}{U'(c_0)} \Pi_{2s}$$

Under commitment, the FOC for l_{21} (period $t = 1$, derived from Equation 37) is: (56)

$$\begin{aligned}
&\frac{1}{U'(c_0)} \cdot \left(U''(c_1) \frac{\partial c_1}{\partial l_{21}} \Pi_{21} + U'(c_1) \frac{\partial \Pi_{21}}{\partial l_{21}} \right) \\
&- \lambda_1 \cdot \left(U''(c_1) \frac{\partial c_1}{\partial l_{21}} \frac{\partial c_1}{\partial c_{11}} + U'(c_1) \frac{\partial^2 c_1}{\partial c_{11} \partial l_{21}} \right) \\
&+ \lambda_0 \left[\left(\frac{\partial y_{11}}{\partial k_1} + 1 - \delta \right) \left(U''(c_1) \frac{\partial c_1}{\partial l_{21}} \frac{\partial c_1}{\partial c_{11}} + U'(c_1) \frac{\partial^2 c_1}{\partial c_{11} \partial l_{21}} \right) + U'(c_1) \frac{\partial c_1}{\partial c_{11}} \frac{\partial^2 y_{11}}{\partial k_1 \partial l_{21}} \right] \\
&+ \mu_1 \frac{\partial y_{11}}{\partial l_{21}} = 0
\end{aligned}$$

Here, all future profits (for $s \geq 1$) are scaled by $1/U'(c_0)$, and the Lagrange multipliers λ_1, μ_1 are consistent with the $t = 0$ committed plan.

Next, we show the reoptimization at $t = 1$ for Objective 1. At $t = 1$, the monopolist resets the optimization problem with $t = 1$ as the new initial period. The new objective function replaces the normalization factor $U'(c_0)$ with $U'(c_1)$ (since c_1 is now the "initial consumption" of the reoptimized plan) and starts the sum from $s = 1$:

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

(The discount factor becomes β^{s-1} to maintain the same intertemporal weighting: β^{s-1} for $s = 1$ is equivalent to β^s for $s = 0$ in the original problem.)

The Lagrangian for this reoptimized problem is:

$$\begin{aligned}
\sum_{s=1}^{\infty} \beta^{s-1} \Bigg\{ \frac{U'(c_s)}{U'(c_1)} \Pi_{2s} + \lambda'_{s-1} \left(\beta U'(c_{s+1}) \frac{\partial c_{s+1}}{\partial c_{1,s+1}} \left(\frac{\partial y_{1,s+1}}{\partial k_{s+1}} + 1 - \delta \right) - U'(c_s) \frac{\partial c_s}{\partial c_{1s}} \right) \\
+ \mu'_{s-1} \left((1 - \delta) k_s + y_{1s} - c_{1s} - k_{s+1} \right) \Bigg\}
\end{aligned}$$

where λ'_{s-1} and μ'_{s-1} are new Lagrange multipliers (distinct from the committed plan's λ_s, μ_s) to enforce the Euler equation and resource constraint starting at

$s = 1$.

For l_{21} (the first period of the reoptimized plan, corresponding to $s = 1$), the FOC is analogous to the original problem's l_{20} (Equation 38, the initial period's FOC) but with c_1 as the new initial consumption:

$$\begin{aligned}
&\underbrace{\frac{\partial \Pi_{21}}{\partial l_{21}}}_{Direct\ profit\ effect} \\
&- \lambda_0' \cdot \left(U''(c_1) \frac{\partial c_1}{\partial l_{21}} \frac{\partial c_1}{\partial c_{11}} + U'(c_1) \frac{\partial^2 c_1}{\partial c_{11} \partial l_{21}} \right) + \mu_0' \frac{\partial y_{11}}{\partial l_{21}} \\
&\underbrace{-U'(c_1)^{-2} U''(c_1) \frac{\partial c_1}{\partial l_{21}} \sum_{s=2}^{\infty} \beta^{s-1} U'(c_s) \Pi_{2s}}_{New\ normalization\ effect\ (unique\ to\ reoptimized\ initial\ period)} = 0
\end{aligned} \tag{57}$$

Comparing Equations (56) and (57) reveals two sources of deviation—reflecting dual inconsistency:

One is structural inconsistency from normalization shift. The committed plan scales $t = 1$ profits by $1/U'(c_0)$ (a fixed factor from $t = 0$), while the reoptimized plan treats $t = 1$ as the initial period: it eliminates the $1/U'(c_0)$ scaling and introduces a new normalization effect (the last term in Equation (57)), which depends on $U'(c_1)$ and future profits from $s \geq 2$. This shift occurs because the "measuring stick" for profit valuation changes with the initial period: at $t = 0$, all profits are valued relative to c_0; at $t = 1$, they are valued relative to c_1. This is not a result of predetermined variables (e.g., k_1) but of the objective function's inherent dependence on the initial period's marginal utility—a structural feature unique to Objective 1.

Another is classical time inconsistency from the strategic interaction between the monopoly and followers. In the committed plan, λ_1 and μ_1 are linked to λ_0 (the Euler equation multiplier from $t = 0$), reflecting the intertemporal consistency of the $t = 0$ plan. In the reoptimized plan, λ_0' and μ_0' are reset to enforce constraints starting at $t = 1$, ignoring the prior multiplier λ_0. This is the classical "bygones are bygones" effect.

B. *Objective 2: Only Classical Time Inconsistency*

Objective 2 (utility-based valuation) at $t = 0$ maximizes the time-symmetric sum of utility-weighted profits (Equation 19):

$$\max_{\{l_{2s}, c_{1s}\}_{s=0}^{\infty}} \sum_{s=0}^{\infty} \beta^s U'(c_s) \Pi_{2s}$$

Its committed FOC for l_{21} (derived from Section 2.3's Objective 2 FOC for $t > 0$) is:
(58)

$$
\begin{aligned}
&U''(c_1)\frac{\partial c_1}{\partial l_{21}}\Pi_{21} + U'(c_1)\frac{\partial \Pi_{21}}{\partial l_{21}} \\
&- \lambda_1 \cdot \left(U''(c_1)\frac{\partial c_1}{\partial l_{21}}\frac{\partial c_1}{\partial c_{11}} + U'(c_1)\frac{\partial^2 c_1}{\partial c_{11}\partial l_{21}} \right) \\
&+ \lambda_0 \left[\left(\frac{\partial y_{11}}{\partial k_1} + 1 - \delta \right) \left(U''(c_1)\frac{\partial c_1}{\partial l_{21}}\frac{\partial c_1}{\partial c_{11}} + U'(c_1)\frac{\partial^2 c_1}{\partial c_{11}\partial l_{21}} \right) + U'(c_1)\frac{\partial c_1}{\partial c_{11}}\frac{\partial^2 y_{11}}{\partial k_1 \partial l_{21}} \right] \\
&+ \mu_1 \frac{\partial y_{11}}{\partial l_{21}} = 0
\end{aligned}
$$

Notably, there is no normalization factor (unlike Objective 1), so the FOC is time-symmetric across s.

At $t = 1$, the reoptimized objective function simply starts the sum from $s = 1$ (no normalization shift, as utility weighting is time-symmetric):

$$
\max_{\{l_{2s}, c_{1s}\}_{s=1}^{\infty}} \sum_{s=1}^{\infty} \beta^s U'(c_s)\Pi_{2s}
$$

The Lagrangian retains the same form as the committed plan but excludes $s = 0$ terms, and the FOC for l_{21} is:

$$
\begin{aligned}
&U''(c_1)\frac{\partial c_1}{\partial c_{21}}A_2\Pi_{21} + U'(c_1)\frac{\partial \Pi_{21}}{\partial l_{21}} \\
&- \lambda_0' \cdot \left(U''(c_1)\frac{\partial c_1}{\partial c_{21}}A_2\frac{\partial c_1}{\partial c_{11}} + U'(c_1)\frac{\partial^2 c_1}{\partial c_{11}\partial c_{21}}A_2 \right) \qquad (59) \\
&+ \mu_0' \frac{\partial y_{11}}{\partial l_{21}} = 0
\end{aligned}
$$

Comparing Equations (58) and (59) shows that the only deviation comes from classical time inconsistency. The committed plan includes λ_0 (the Euler equation multiplier from $t = 0$), linking $t = 1$'s decision to $t = 0$'s trade-offs. The reoptimized plan resets λ_0' and μ_0', ignoring λ_0, because k_1 is now predetermined (bygones are bygones). Meanwhile, there is no structural inconsistency: the utility-weighted profit term $(U'(c_s)\Pi_{2s})$ is identical across periods, so the "valuation rule" for profits does not change when $t = 1$ becomes the new initial period. The objective function's time symmetry eliminates the normalization-driven shift that characterized Objective 1.

C. *Quantifying the Dual Inconsistency: Numerical Evidence*

To quantify the magnitude of time inconsistency under both objectives, we compare the committed plan (formulated at $t = 0$) with the reoptimized plan (formulated at $t = 1$, taking k_1 as given) for initial capital $k_0 = 0.5 * kss$. We focus on four key variables at $t = 1$: monopoly labor l_2, consumption good 1 c_1, aggregate consumption c, and capital k.

Objective 1: Large Deviations from Dual Inconsistency

Table 3 presents results for Objective 1 (consumption-based valuation).

TABLE 3—TIME INCONSISTENCY ANALYSIS: OBJECTIVE 1, $k_0 = 0.5 * kss$

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%

The results for Objective 1 reveal substantial deviations between the committed and reoptimized plans. At $t = 1$, the reoptimized monopoly labor $l_2 = 0.638$ is 174.95% higher than the committed value of 0.232. This dramatic shift arises from the structural inconsistency identified previously: when reoptimizing at $t = 1$, the firm treats that period as the new "initial period," introducing a normalization effect that incentivizes higher sector-2 production to lower $U'(c_1)$ and boost the present value of future profits. Under the committed plan, no such effect exists at $t = 1$ (only at $t = 0$), so l_2 remains low to maintain markups without normalization-driven adjustments.

This labor reallocation cascades into other variables. Aggregate consumption $c = 0.520$ under reoptimization is 32.19% higher than the committed $c = 0.394$, reflecting increased sector-2 output ($c_2 = A_2 l_2$) from the surge in l_2. Conversely, consumption good 1 falls by 30.65% (from 0.597 to 0.414), as labor shifts away from sector 1 reduce y_1 and thus c_{11} (via the resource constraint).

Importantly, capital k is identical across plans ($k_1 = 1.354$), as it is predetermined by the $t = 0$ decision—confirming that deviations arise purely from re-solving the optimization problem, not from changes in initial conditions.

Figure 9 displays the dynamic paths of l_{2t}, c_{1t}, c_t, and k_t under both the committed plan (formulated at $t = 0$) and the reoptimized plan (formulated at $t = 1$). The substantial gap between the two trajectories persists across multiple periods, underscoring that structural inconsistency affects not just period 1 but the entire post-reoptimization trajectory, as the new normalization factor ($U'(c_1)$) shapes the valuation of all $t \geq 1$ profits.

Objective 2: Minimal Deviations from Classical Inconsistency Alone

Table 4 presents results for Objective 2 (utility-based valuation).

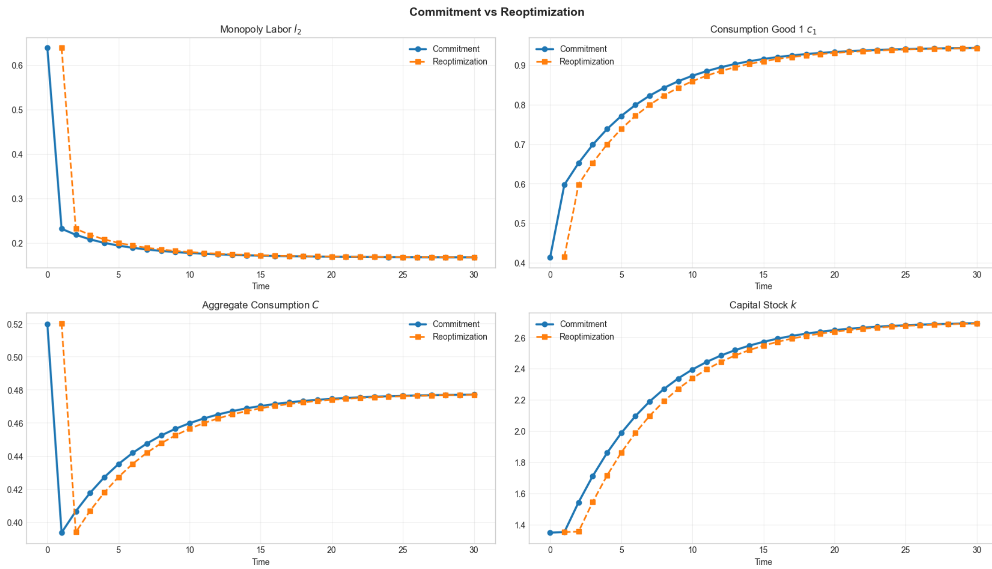

FIGURE 9. REOPTIMIZATION ANALYSIS: OBJECTIVE 1 (CONSUMPTION-BASED VALUATION). *The figure shows dynamic paths of monopoly labor l_{2t}, consumption good 1 c_{1t}, aggregate consumption c_t, and capital k_t under the committed plan (solid lines) and reoptimized plan at $t = 1$ (dashed lines). Initial capital $k_0 = 0.5 * kss$.*

TABLE 4—TIME INCONSISTENCY ANALYSIS: OBJECTIVE 2, $k_0 = 0.5 * kss$

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%

Under Objective 2, deviations are negligible: at $t = 1$, all variables differ by less than 1.6%. This is because Objective 2 lacks structural inconsistency—it eliminates normalization-driven incentives to deviate. The small observed deviations ($\sim$1%) reflect classical time inconsistency: the reoptimized plan's Lagrange multipliers (λ_0', μ_0') differ from the committed plan's (λ_1, μ_1), as the firm ignores past constraints ("bygones are bygones"). However, these deviations are second-order compared to Objective 1's 30–175% divergences.

Figure 10 displays the corresponding dynamic paths under Objective 2. The committed and reoptimized trajectories are virtually indistinguishable, confirming that classical inconsistency alone generates minimal quantitative effects.

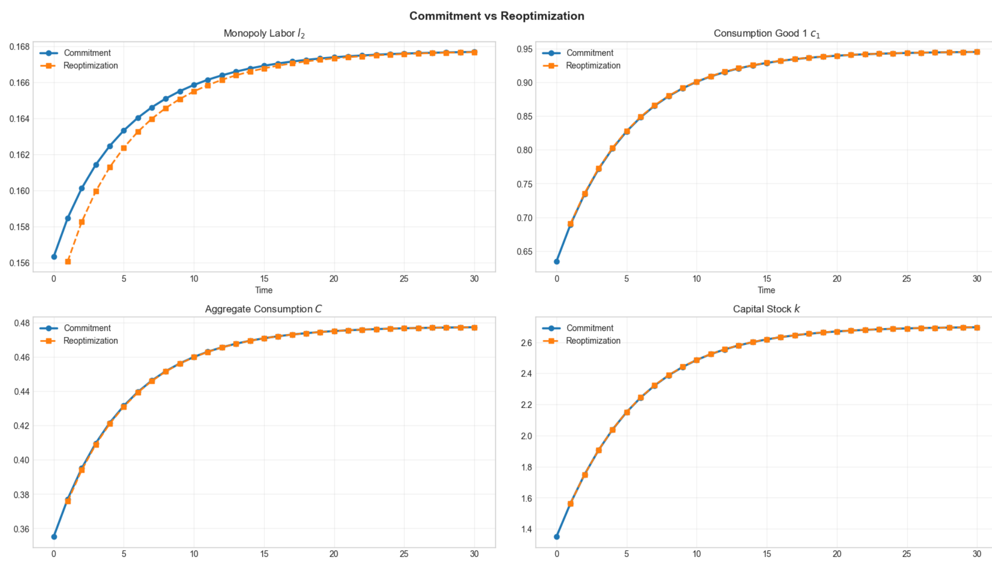

FIGURE 10. REOPTIMIZATION ANALYSIS: OBJECTIVE 2 (UTILITY-BASED VALUATION). *The figure shows dynamic paths of monopoly labor l_{2t}, consumption good 1 c_{1t}, aggregate consumption c_t, and capital k_t under the committed plan (solid lines) and reoptimized plan at $t = 1$ (dashed lines). Initial capital $k_0 = 0.5 * kss$. As expected, deviations are much smaller than under Objective 1, reflecting only classical inconsistency.*

Comparing Tables 3 and 4 quantifies the dual sources of inconsistency. The 174.95% surge in l_{21} under Objective 1 far exceeds Objective 2's 1.52% deviation, attributing the bulk of inconsistency to the structural inconsistency caused by normalization shift. Objective 2's $\sim$1% deviations isolate the contribution of forward-looking constraints alone, absent structural asymmetry.

This decomposition clarifies that consumption-based valuation (Objective 1) introduces a fundamentally different—and quantitatively dominant—source of time inconsistency relative to the classical mechanism. For large firms using market-based profit metrics, this structural inconsistency may explain observed patterns of plan revision that cannot be attributed solely to changing economic conditions (the classical channel).

D. Theoretical Implications: A New Source of Inconsistency

The contrast between the two objectives reveals a critical theoretical contribution: inconsistency in large firms' decisions arises not only from forward-looking constraints (classical) but also from the structural design of the objective function (via normalization choices). This expands our understanding of why leaders (e.g., macro-monopolists, policymakers) may deviate from committed plans: objective function design matters for commitment feasibility. Objective 2's time symmetry reduces the incentive to reoptimize: the only incentive of deviation comes from classical constraints, which can be mitigated by commitment mechanisms (e.g., long-term contracts). Objective 1's structural inconsistency, however, creates an inherent tension: the monopolist would still face a mismatch between the original normalization ($U'(c_0)$) and the new normalization ($U'(c_1)$) as time passes. This suggests that for large firms influencing macro aggregates, utility-based valuation (Objective 2) may be more robust to reoptimization than consumption-based valuation (Objective 1).

In practice, large corporations (e.g., tech giants, energy firms) often revise long-term plans. Our analysis implies that these revisions may reflect not just changing market conditions (classical constraints) but also a shift in how the firm values future profits—e.g., redefining "success" from initial-period shareholder value (Objective 1) to ongoing customer welfare or utility (Objective 2). This provides a new lens to interpret corporate strategy revisions.

The structural inconsistency identified here is a novel source of reoptimization incentive, showing that leaders' deviation motives extend beyond "bygones are bygones" to include inherent changes in the objective function itself. This insight enriches the literature on time inconsistency and provides guidance for designing robust objectives for large firms influencing macroeconomic outcomes.

V. 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", whereby 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 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 structural 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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