BUSINESS DYNAMISM WITH ENDOGENOUS MARKUP

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This paper investigates the effects of changes in entry costs on the distribution of markups, employing a firm dynamics model featuring a nested Constant Elasticity of Substitution (CES) product demand and an endogenous market structure with mixed monopolistic-duopolistic competition. Firms decide between innovation and imitation upon entry and adjust employment in response to productivity shocks. The model is calibrated to the U.S. economy and is utilized to examine the repercussions of reduced entry barriers on the distribution of markups. This exploration opens the door to the possibility of an unconventional outcome, wherein lower entry costs may paradoxically lead to higher markups, contingent upon two pivotal conditions: the presence of transitions between different market structures and the perfect forecast capability of entrants.

KEYWORDS: Business Dynamism, Entry Costs, Markup Distribution.

1. INTRODUCTION

The declining business dynamism manifests as a discernible deceleration or reduction in traditional indicators of economic vibrancy over time. This decline, demonstrated by reduced entry rates (Hathaway and Litan (2014); Criscuolo et al. (2014); Decker et al. (2014b);Calvino et al. (2020); Cerdeiro and Ruane (2022)), heightened profit share, markup, and market concentration (Diez et al. (2018); Akcigit et al. (2020); Goldschlag and Miranda (2020)), and stagnant job reallocation (Haltiwanger et al. (2014); Hathaway and Litan (2014); Decker et al. (2014a); Calvino et al. (2020)) is apparent worldwide, substantiated by extensive empirical investigations across various nations (Diez et al. (2018)), including comprehensive studies spanning regions such as the United States (Hathaway and Litan (2014); Calvino et al. (2020); Decker et al. (2014a,b, 2016a,b, 2017, 2020)), Europe (Calvino et al. (2020); Geurts and Van Biesebroeck (2016); Bijnens and Konings (2020); Biondi et al. (2023)), or China (Cerdeiro and Ruane (2022)) throughout the past decades.

Understanding this trend holds paramount importance for policymakers, economists, and business leaders dedicated to surmounting obstacles to economic growth and cultivating a more dynamic and resilient business environment. Consequently, unraveling the complexities of declining business dynamism has evolved into a central inquiry within industry organization and macroeconomics. Amid various explanatory frameworks, the escalation of entry costs, a direct deduction from canonical Hopenhayn (Hopenhayn (1992)) framework with the nested-CES structure, is widely accepted. Consequently, much scholarly attention has been directed towards establishing the nexus between elevated entry costs and the performance of business dynamism (e.g., Dent et al. (2016) and Alon et al. (2018)). Nonetheless, in recognizing the complexity of the economic system, particularly the simultaneous presence of numerous positive-negative feedback mechanisms - the influential channels are as intricate as a spider's web, with causal relationships weaving through multiple interconnected paths - a simplistic attribution of declining business dynamism to higher entry costs may be incomplete. Indeed, alternative possibilities warrant consideration, such as scenarios where entry costs have actually decreased, or, even more nuanced, instances where entry costs have declined within specific sectors but increased in others.

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Therefore, this paper endeavors to elucidate, through theoretical modeling, the aforementioned prospect: that reduced entry costs may paradoxically lead to heightened markups, thus contributing to the phenomenon of declining business dynamism. Furthermore, this paper emphasizes two conditions contributing to this outcome: the transition between distinct market structures (monopolistic and duopolistic markets below) and the perfect foresight of entrants regarding the equilibrium.

To fulfill this objective, the present investigation initiates by constructing a model firmly grounded in the endogenous markup framework (see Atkeson and Burstein (2008b)). This theoretical framework describes an economy over an infinite time horizon with a discrete time setting. On the household side, a representative household supplies labor and consumes final goods to maximize utility. On the firm side, a constant elasticity of substitution (CES) framework amalgamates goods sourced from diverse industries (markets) into the final goods sector. Notably, the model accommodates both monopolistic and duopolistic markets. Within duopolistic markets, firms engage in Cournot competition, whereas monopolistic markets are characterized by a sole player reaping monopolistic profits. At the end of each period, an exogenous exit process unfolds, precipitating the disappearance of proportionate monopolistic markets and the transformation of duopolistic markets into monopolistic ones. Entrants face a pivotal decision: either pay an innovation entry cost to establish new monopolistic markets and operate as monopolists or pay a reduced imitation entry cost to enter randomly selected monopolistic markets and engage in Cournot competition with incumbents. This entry and exit framework constitutes the innovative cornerstone of this model, accentuating the dynamic interplay of market configurations, thereby affording firms the fluid ability to transition between monopolistic and duopolistic states over time. It is precisely this fluid transition between market structures that obfuscates the once straightforward relationship between markup and entry costs. The entry cost of duopolistic markets no longer solely influences the value of becoming duopolists but also indirectly impacts the profitability of opting to become monopolists. This dynamic interplay renders it conceivable for entry costs to decline while markups ascend. Certainly, as mentioned earlier, the transition between different market structures presents the possibility of lower entry costs of duopolistic markets resulting in higher markups. However, the canonical outcome, where markups decrease, remains a possibility. In fact, the positive feedback mechanism generated by this model may lead to a scenario where decreased entry costs of duopolistic markets drive all monopolistic markets to extinction, thereby causing markups to decrease. This equilibrium point lies beyond the boundaries explicable by this model but can be logically analysed. What enables the unconventional equilibrium to materialize? It is the perfect forecast of entrants, which constitutes the second condition.

Following the attainment of the model's solutions and the derivation of equilibrium conditions, the calibration of parameters ensues, inferring the values of key variables, notably entry costs. Subsequently, counterfactual experiments are undertaken, entailing incremental adjustments - both upwards and downwards - of entry costs by one percentage point, aimed at unraveling their repercussions: alterations in the proportion of duopolistic markets, shifts in the distribution of markups, and fluctuations in the total number of industries within the novel steady-state equilibrium.

The employment of these specific parameters yields novel and intriguing findings. Particularly noteworthy is the unexpected outcome stemming from a reduction in the entry costs of duopolistic markets by one percentage point (from 44.64 to 44.19), while maintaining the entry costs of monopolistic markets at the same level. Contrary to conventional expectations based on canonical models, this adjustment leads to a significant increase in the expected markup (from 28.00% to 29.91%). This augmentation primarily arises from the decrease in the proportion of duopolistic markets (from 55.65% to 35.98%), with a minor contribution from the heightened average markup in duopolistic markets, where firms are more evenly matched under the reduced proportion.

But what drives the decline in the proportion of duopolistic markets? The underlying mechanism is as follows: Lower entry costs of duopolistic markets spur more firm, driving up labor demand and subsequently increasing the wage level. Given that monopolists enjoy larger markups, the higher wage level translates into a higher equilibrium price and reduced quantities, leading to a significant decline in the values of monopolists. From the standpoint of monopolists, maintaining the entry costs of monopolistic markets entails operating in an environment where competition is less intense, the likelihood of participating duopolistic competition is diminished, and the duration of staying as duopolists is curtailed. Achieving this necessitates a lower proportion of duopolistic markets. From the perspective of entrants, a lower proportion of duopolistic markets makes the choice of becoming monopolists more distinguishable from that of becoming duopolists. This compensates for and amplifies the decrease in value differences between monopolists and duopolists, aligning with the cost premium of innovations.

The subsequent subsection presents a comprehensive literature review, providing an overview of the existing body of research in the field. Section 2 outlines the model, presenting its components and structure. The solution and equilibrium conditions are elaborated in Sections 3 and 4, respectively, shedding light on the model's dynamic behavior. Section 5 is devoted to the calibration process. Subsequently, Section 6 presents the obtained results and delves into the underlying mechanisms that drive these outcomes, offering valuable insights into the model's implications. Finally, Section 7 encapsulates the findings and provides concluding remarks.

1.1. *Related Literature*

Numerous studies, spanning national-level analyses (Hathaway and Litan (2014); Criscuolo et al. (2014); Geurts and Van Biesebroeck (2016); Diez et al. (2018); Calvino et al. (2020); Decker et al. (2014a,b, 2016a,b, 2017, 2020); Bijnens and Konings (2020); Cerdeiro and Ruane (2022); Biondi et al. (2023)) and industry-level investigations (Goldschlag and Miranda (2020)), have extensively scrutinized the phenomenon of declining business dynamism. Amidst diverse phenomena, several patterns emerge as recurring characteristics of declining business dynamism. Foremost among these is the persistent decline in the entry rate of new firms, witnessed not only in the USA (Hathaway and Litan (2014);Calvino et al. (2020)) but also in China (Cerdeiro and Ruane (2022)), Turkey (Akcigit et al. (2020)), Belgium (Bijnens and Konings (2020)), and other European or OECD nations (Criscuolo et al. (2014); Diez et al. (2018); Biondi et al. (2023)). This decline, coupled with a relatively stable (Calvino et al. (2020)) or slightly increasing exit rate (Akcigit et al. (2020)), sets the stage for the second characteristic: heightened average markup and market concentration, evident across diverse industries such as manufacturing, services, retail, information, digital-intensive, and high-technical sectors (Calvino et al. (2020)). The gradual shift of activities towards older and larger firms or the upper tail of the markup distribution underlies this increase (Diez et al. (2018); Goldschlag and Miranda (2020); De Loecker et al. (2021)). Autor et al. (2020) take a more assertive stance, attributing the increase to top firms in each industry and coining the phenomenon 'superstar effects' to explain the declining labor share. The higher markup and market concentration in goods markets reverberate in the linked labor market, manifesting as the third characteristic: lower job reallocation (Akcigit et al. (2020); Calvino et al. (2020); Biondi et al. (2023)). Additionally, the capital market mirrors declining business dynamism through a more skewed return to capital distribution (Furman and Orszag (2018)), positive abnormal stock returns, and more profitable M&A deals for firms in concentrated industries (Grullon et al. (2019)), as well as diminished capital reallocation to high marginal product of capital firms and young firms (Cerdeiro and Ruane (2022)). Lastly, lower entrepreneurship rates (Haltiwanger et al. (2014)), stagnant productivity of frontier firms, and unaltered lists of frontier firms (Akcigit et al. (2020)), alongside an eliminated skewness of growth in businesses (Decker et al. (2014a)), encapsulate the characteristics of declining business dynamism.

Amidst robust evidence affirming the existence of declining business dynamism, scholarly inquiries turn to explicating this phenomenon, employing both theoretical frameworks and empirical analyses. Various factors contribute to the decline in business dynamism. Demographic shifts, globalization & technological advancements, and variations in characteristics and strategic behaviors between large and small firms collectively shape the landscape, but the spotlight remains on the ramifications of heightened entry barriers, which stand out as the focal point of inquiry in this paper.

Two widely explored demographic factors contributing to this trend are population aging and an increased share of educated and experienced labor. In essence, both older and educated labor accrue benefits to incumbents by complementing capital more effectively (Ignaszak (2020); Eeckhout et al. (2017)) and dampening the incentive to initiate entrepreneurial ventures (Peters (2020)). Furthermore, such workers exhibit lower job mobility (Fallick et al. (2010); Engbom and Moser (2017)), resulting in reduced dynamism in the labor market.

Globalization and technological advancements constitute additional factors. These developments empower large firms to allocate and adjust resources more adeptly when facing economic shocks, enhancing their survival capabilities while suppressing new market entries (Tang et al. (2020)). In contrast, small and young firms contend with more constraints and negative shocks. Credit concentration, denoting that small and young firms encounter tighter credit constraints both outside and during recessions (Davis and Haltiwanger (2019); Akcigit et al. (2020); Calvino et al. (2020)), provides insights from the financial market perspective. Housing market downturns, resulting in decreased shares for young firms, operate through wealth, liquidity, collateral, credit supply, and consumption demand channels (Davis and Haltiwanger (2019)). Additionally, small and young firms exhibit fewer political connections and resources (Akcigit et al. (2023)).

Beyond these inherent distinctions between large and small firms, their strategic behaviors exacerbate the dynamism decline. Such actions encompass leaders building patent moats to impede knowledge diffusion (Akcigit et al. (2020), Akcigit and Ates (2021)), strategic merger and acquisition deals (Cunningham et al. (2021)), and investments in intangible capital, reducing marginal costs and elevating fixed costs (De Ridder (2019)). Finally, elevated entry costs, encompassing tangible aspects like capital and labor investments and intangible elements such as regulatory barriers, judicial efficiency, bankruptcy regulations, and reduced innovation support (Calvino et al. (2020)), further diminish dynamism by curbing startup rates. The ramifications are multifaceted. Firstly, entrants exhibit an 'up-or-out' characteristic (Criscuolo et al. (2014)), reflecting both lower survival rates of entrants and accelerated development among survivors. Consequently, the job creation and reallocation of potential startups diminishes with fewer new ventures due to higher entry costs. Secondly, Alon et al. (2018) demonstrate that the relationship between firm age and productivity growth is downward sloping and convex, with diminishing magnitudes. Reduced entry rates stifle selection and reallocation effects from young firms, resulting in lower productivity growth. Thirdly, diminished startups lead to lower entrepreneurship rates (Dent et al. (2016)). Simultaneously, a shift towards "subsistence" entrepreneurs (e.g., "Mom and Pop" stores) rather than "transformational" entrepreneurs (e.g., large chain retailers) post-2000 further depresses entrepreneurship rates (Decker et al. (2014a)). Lastly, a lower entry rate itself contributes to heightened market concentration (Gutiérrez et al. (2021)).

However, as highlighted in the introduction, prevailing research endeavors aimed at establishing relationships between entry costs and declining business dynamism predominantly concentrate on the escalation of entry costs, overlooking the potential scenario where the phenomenon could stem from reduced entry costs. For instance, while studies such as Akcigit et al. (2020), Akcigit and Ates (2021) posit explanations grounded in diminished knowledge diffusion (i.e., heightened entry costs for followers), Baslandze (2016) observes enhanced knowledge diffusion (i.e., diminished entry costs). These deliberations concerning the pace of knowledge diffusion and the resultant decline in business dynamism underscore the imperative of exploring the possibility that reduced entry costs could be driving the observed phenomenon. This is the focus of my paper.

From a methodological standpoint, among various models aimed at elucidating the enigma of declining business dynamism, Hopenhayn (1992) laid the foundational groundwork for scrutinizing firm dynamism, providing a fundamental framework that underpins my own model. Atkeson and Burstein (2008b) enriched their nested-CES model with endogenous markup, shedding light on the intricate interplay between pricing-to-market, trade costs, and international relative prices. This framework has since served as the cornerstone for numerous subsequent research endeavors, including my paper. De Loecker et al. (2021) delved into the role of market concentration in elucidating the decline in business dynamism, while Berger et al. (2022) probed into the impact of oligopsony in the labor market. Gutiérrez et al. (2021) directed their attention to the escalation of entry costs as a potential explanatory factor. Infusing the concept of endogenous markup into the Schumpeterian framework, Peters and Walsh (2019) and Peters (2020) conducted analyses spanning three types of innovations: own-innovation, creative destruction, and variety gains. Conversely, Akcigit et al. (2020) and Akcigit and Ates (2023) posited a hypothesis suggesting that a diminished effective knowledge diffusion might elucidate the observed decline in business dynamism. Additionally, Akcigit et al. (2020) broadened their explanatory scope to include credit concentration, delving into the intricate relationship between innovation decisions and innovation capabilities. Significantly, Aghion et al. (2023) directed their focus towards firm expansion, employing a similar framework to scrutinize the effects of information technology (IT) on firm dynamism. By assimilating insights from these prominent works, this paper contributes to the ongoing discourse surrounding the factors that underlie the decline in business dynamism, with a particular focus on an often overlooked aspect: the impact of declining entry costs.

2. MODEL

The model presented herein serves as a natural extension of Hopenhayn's seminal contributions to firm dynamics analysis (Hopenhayn (1992), Hopenhayn and Rogerson (1993)). In this shared lineage, both models employ a representative household and focus primarily on the intricate dynamics governing firm entry and employment dynamics in the presence of adjustment costs. My model sets itself apart through several discernible modifications and innovative augmentations. First and foremost, I enrich Hopenhayn's framework by introducing two distinct market structures: duopolistic and monopolistic, forming the bedrock for in-depth endogenous markup analysis. Furthermore, my model empowers firms to make nuanced strategic decisions beyond mere market entry, differentiating between becoming monopolists or opting for engaging in duopolistic competition. At last, my model aims to analyze a steady-state equilibrium where all aggregate quantities are constant (e.g., productivity distribution or number of industries).

2.1. *Household*

The model integrates a representative household, serving as the proprietors of all firms, contributing labor, and deriving utility from the consumption of goods. The utility derived hinges on various factors, encompassing the discount factor β, aggregate consumption C_t, labor supply L_t, and its corresponding marginal disutility a. Expressed formally, it takes the following mathematical form.

$$U(C,L) = \sum_{t=0}^{\infty} \beta^t [\log C_t - aL_t] \tag{1}$$

Here, the logarithmic form implies a unit inter-temporal elasticity of substitution.

The aggregate consumption C_t constitutes a consumption bundle embracing categories c_{jt} from N industries (j ranging from 0 to N). This bundle follows a constant elasticity of substitution (CES) structure with an elasticity denoted as θ.

$$C_t = \left[\int_0^N c_{jt}^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}} \tag{2}$$

Here I make a convention that I will interchangeably use "industry" and "market." When I emphasize products, I use "industry," whereas when I emphasize competition among firms, I use "market."

Within the N distinct industries (j), the household encounters various subdivisions, each labeled $i = 1, 2, \cdots, M_j$. This household appraises subdivisions within each category with a constant elasticity of substitution denoted as η. This shapes the consumption pattern within industry j, dependent on the consumption of subdivision i within that category during period t.

$$c_{jt} = \left[\sum_{i=1}^{M_j} c_{ijt}^{\frac{\eta-1}{\eta}} dj \right]^{\frac{\eta}{\eta-1}}$$

Typically, products of the same industry tend to have higher substitution rates. Therefore, I assume that $\eta > \theta$ and focus on the case where η equals infinity for simplicity. In such a case, goods within the same industry perfectly substitute, resulting in a linear aggregation form of industry-level goods.

$$c_{jt} = \sum_{i=1}^{M_j} c_{ijt} \tag{3}$$

In the following sections, M_j takes on a value of either 1 or 2 for simplicity, indicating two types of markets: the monopolistic and the duopolistic markets. Furthermore, I assume the proportion of duopolistic market to be λ, whose value is endogenously determined by the decisions of entrants. Whenever the market is duopolistic, i.e., $M_j = 2$, firm i engages in Cournot-quantity competition with firm $-i$ to determine the optimal quantity c_{ijt}.

The household faces a budget constraint each period. Total expenditure, calculated by multiplying the aggregate price index $P_t(p_{jt})$ with C_t, must equal total income, comprising profits Π_t and wage returns from supplying labor to firms at wage rate w_t.

$$P_t \cdot C_t = \int_{j=0}^{N} p_{jt} c_{jt} dj = \Pi_t + w_t L_t \tag{4}$$

For computational simplicity, the aggregate price index is normalized to 1, serving as the numeraire.

2.2. *Markets*

Each of the N distinct categories is exclusively manufactured within a sole industry. The quantity of industries, denoted by N, is inherently ascertained by the horizontal innovations and exits of monopolists, explicated comprehensively in the subsequent Exit and Entry section. Each individual firm is confined to the production of its specific subdivision within each industry, devoid of diversification entry or M&A activities.

2.3. *Production*

In period t, with productivity level z_{ijt}, firm i in the j-th industry hires l_{ijt} labor and applies a diminishing return to scale production technology.

$$y_{ijt} \equiv f(z_{ijt}, l_{ijt}) = z_{ijt} l_{ijt}^{\gamma} \tag{5}$$

Here, γ represents the decreasing return to scale (DRS) parameter. Each firm's productivity is subject to idiosyncratic random fluctuations determined by an AR(1) process.

$$\log z_t = \rho \log z_{t-1} + \epsilon_t, \quad \epsilon_t \sim N(0, \sigma^2) \tag{6}$$

Here, $\rho \in (0,1)$ captures the degree of persistence in productivity and the disturbance term ϵ_t follows a normal distribution with standard deviation σ. Due to the homogeneity of goods within each industry, firm i sells its products in period t at a unified price denoted as p_{jt}. Simultaneously, it compensates its workforce with the wage w_t. The remaining amount constitutes its profits, which contributes to the total income of households.

$$\pi_{ijt} = p_{jt}(y_{ijt}, y_{-ijt}) y_{ijt} - w_t l_{ijt} \tag{7}$$

In the realm of this model, the price of good j during period t, denoted as $p_{jt}(\cdot)$, emerges as a function intricately tied to the quantities of goods produced by firms operating within industry j. This functional relationship can be summarized in the general form from combining Equations (14) and (17) shown below.

$$p_{jt} = \frac{\theta}{\theta - \dfrac{y_{ijt}}{y_{ijt} + y_{-ijt}}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} y_{ijt}^{\frac{1}{\gamma}-1}$$

Within duopolistic markets, both y_{ijt} and y_{-ijt} manifest as positive quantities. Conversely, in monopolistic markets, y_{-ijt} takes on a value of zero.

2.4. *Exit and Entry*

Enterprises, perpetually cycling through births and dissolutions, undergo a recurring process. At the onset of each period, an exogenous fraction, denoted as δ, of markets experiences exits. In the event of an exit occurring in a monopolistic market, the monopolist vanishes. Conversely, if an exit transpires within a duopolistic market, one of the duopolists exits while the other remains. Consequently, the number of surviving duopolistic markets becomes $\lambda(1-\delta)N$. The remaining markets, amounting to $[(1-\lambda)(1-\delta)+\lambda\delta]N$, comprise monopolistic markets. Specifically, among these monopolistic markets, $(1-\lambda)(1-\delta)N$ were already monopolistic markets before the shock, while $\lambda\delta N$ were previously duopolistic markets. It is crucial to note that, given the absence of operating costs in this model, the outlined exogenous exit mechanism is the sole possibility for firms to exit.

The preceding settings implicitly suggest that monopolists have a higher exit rate (δ) compared to duopolists ($\frac{1}{2}\delta$), which may appear anomalous. Although no explicit empirical evidence can either prove or falsify this hypothesis, certain indirect indications lend support to this assumption. First, while both monopolists and duopolists face challenges in exiting, monopolists encounter the risk of antitrust lawsuits, heightening their probability of exit. Second, strategically maintaining competitors in the arena, to some extent, benefits duopolists. This not only shields duopolists from antitrust lawsuits but also ensures the safety of the supply chain. A notable example is cited in Acemoglu et al. (2012):

> Appearing before the Senate Banking Committee in November 2008, Alan R. Mulaly, the chief executive of Ford, requested emergency government support for General Motors and Chrysler, Ford's traditional rivals. Mulaly argued that, given the significant overlap in the suppliers and dealers of the three automakers, the collapse of either GM or Chrysler would have a ripple effect across the industry, leading to severe disruption of Ford's production operations within days, if not hours.

Following the exit process, new enterprises emerge armed with information on the productivity distributions of monopolistic and duopolistic markets at the end of the period. This shared knowledge enables entrants to calculate expected values, assuming the role of a monopolist denoted by $\mathbb{E}_z V_1(z)$ and as a duopolist competing with a rival whose productivity is z_- represented as $\mathbb{E}_z \mathbb{E}_{z_-} V_2(z, z_-)$.

Faced with three pivotal choices - remaining inactive, assuming the role of an innovator, or adopting the stance of an imitator - new entrants make simultaneous decisions. They opt against staying inactive as long as the expected values ($\mathbb{E}_z V_1(z)$ and $\mathbb{E}_z \mathbb{E}_{z_-} V_2(z, z_-)$) are positive due to the absence of operating costs. For entrants choosing to innovate, a fixed sunk entry cost of $\mathcal{C}_M$ in aggregate consumption goods must be borne, establishing them as monopolists. Conversely, imitators incur a commonly known, fixed, sunk entry cost of $\mathcal{C}_D$ in aggregate consumption goods, entering a randomly selected monopolistic market, engaging in Cournot competition with the incumbent. Given the assumed limited capacity of markets, entrants are precluded from entering a duopolistic market. Entrants, when faced with the pivotal choice between innovation and imitation, strictly prefer innovation if and only if $\mathcal{C}_M - \mathcal{C}_D < \mathbb{E}_z V_1(z) - \mathbb{E}_z \mathbb{E}_{z_-} V_2(z, z-)$. After choosing the market to enter, new entrants draw their initial productivity z_0 from a distribution with cumulative productivity density $H(\cdot)$.

It is noteworthy that, in addition to the aforementioned entry process, there exists another entry process setting in the literature. The main difference between the two lies in the information set available to entrants when making decisions. This model assumes that entrants can forecast the eventual distribution perfectly. In this alternative setup, firms do not make decisions simultaneously over a certain period but rather sequentially. Moreover, productivity distributions, as well as firm values determined by these distributions, depend on the decisions of all entrants and unfold sequentially. As a result, entrants do not base their decisions on a forecast of the eventual distributions but instead rely on the distributions before them. Consequently, I propose that new entrants sequentially make choices within the same period. Furthermore, productivity distributions undergo real-time updates for entrants and do not undergo abrupt shifts to avoid the possibility of multiple equilibrium oscillations. The different information sets resulting from these two setups determine whether a canonical or unconventional equilibrium will be achieved. For a detailed analysis, please refer to the discussion section.

3. SOLUTIONS

3.1. *The Household's Optimal Decisions*

The household aims to maximize the utility subject to the budget constraint. The first-order conditions with respect to labor supply can be expressed as follows.

$$C_t = \frac{1}{a} w_t \tag{8}$$

Naturally, an increase in the wage level leads to a corresponding increase in consumption.

The demands for products in each industry are determined by the Dixit-Stiglitz framework, which assumes that the representative household faces a trade-off between the variety of goods available and the price. Specifically, the price p_{jt} in the j-th industry during period t affects demand according to the inverse demand function.

$$c_{jt} = (p_{jt})^{-\theta} C_t \tag{9}$$

Higher prices and higher elasticity of substitution both decrease demand by making products less attractive relative to their competitors.

The aggregate price level, which influences the household's budget constraint, is determined by the CES aggregator of prices across all markets.

$$1 \equiv P_t = \left(\int_0^1 p_{jt}^{1-\theta} dj \right)^{\frac{1}{1-\theta}} \tag{10}$$

3.2. *Firms' Production and Pricing Decisions*

Firms know the demand for goods in their categories clearly and arrange their production based on the corresponding demand.

$$y_{jt} = c_{jt} \quad \forall j \in (0, N), \forall t \tag{11}$$

Within each market, firms strive to determine the optimal quantity to produce. Monopolist i in market j attempts to achieve this goal by maximizing its profits in period t.

$$\pi_{ijt} = p_{jt} y_{ijt} - w_t l_{ijt} = p_{jt} y_{jt} - w_t l_{ijt} = C_t^{\frac{1}{\theta}} y_{jt}^{\frac{\theta-1}{\theta}} - w_t z_{ijt}^{-\frac{1}{\gamma}} y_{jt}^{\frac{1}{\gamma}} \tag{12}$$

To derive the above equality, it is essential to utilize Equations (5), (9), and (11). By setting the first-order conditions, the monopolist is able to establish the optimal quantity in the following manner.

$$y_{ijt} \equiv y_{jt} = \left[\left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} \right)^{-\theta} C_t \right]^{\frac{\gamma}{\gamma+\theta-\theta\gamma}} = \left[\left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} \right)^{-\theta} \frac{w_t}{a} \right]^{\frac{\gamma}{\gamma+\theta-\theta\gamma}} \tag{13}$$

Correspondingly, the pricing equation is as follows.

$$p_{jt} = \frac{\theta}{\theta - 1} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} y_{jt}^{\frac{1}{\gamma}-1} = \frac{\theta}{\theta - 1} \mathrm{mc}_{ijt} \tag{14}$$

where the price in the j-th market is determined by the markup $\frac{\theta}{\theta-1}$ over marginal cost mc_{ijt}. Lower elasticity of substitution leads to higher markup and profits. Consequently, the monopolist calculates profits as follows.

$$\pi_1(z_{ijt}, w_t) = \left(\frac{\theta}{\theta-1}\frac{1}{\gamma} - 1\right)\left(\frac{\theta}{\theta-1}\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}} w_t^{\frac{\xi-(\theta-1)}{\xi}} z_{ijt}^{\frac{\theta-1}{\xi}} a^{-\frac{1}{\xi}} \tag{15}$$

Here, I set ξ as $\gamma + \theta - \theta\gamma$ for simplicity.

Consider now the first-order conditions that the duopolist must satisfy. Taking the derivative with respect to quantity y_{ijt} in Equation (7) leads to the following equation.

$$\frac{\partial \pi_{ijt}}{\partial y_{ijt}} = C_t^{\frac{1}{\theta}} \left\{ (y_{ijt} + y_{-ijt})^{-\frac{1}{\theta}} - \frac{1}{\theta}(y_{ijt} + y_{-ijt})^{-\frac{1}{\theta}-1} y_{ijt} \right\} - \frac{1}{\gamma} w_t \cdot z_{ijt}^{\frac{-1}{\gamma}} y_{ijt}^{\frac{1}{\gamma}-1} = 0$$

where y_{-ijt} denotes the quantity produced by the competitor. Note that the first term on the right-hand side, the marginal revenue, directly includes the influence of the competitor, while the second term captures the marginal production cost, which indirectly associates with competitor's behaviors. Similarly, the competitor's optimal quantity decision satisfies the following first-order condition.

$$\frac{\partial \pi_{-ijt}}{\partial y_{-ijt}} = C_t^{\frac{1}{\theta}} \left\{ (y_{ijt} + y_{-ijt})^{-\frac{1}{\theta}} - \frac{1}{\theta}(y_{ijt} + y_{-ijt})^{-\frac{1}{\theta}-1} y_{-ijt} \right\} - \frac{1}{\gamma} w_t \cdot z_{-ijt}^{\frac{-1}{\gamma}} y_{-ijt}^{\frac{1}{\gamma}-1} = 0$$

The optimal quantity decisions of duopolists are intertwined, as reflected in the interdependence of their first-order conditions. This interconnectivity adds a layer of complexity to the analysis, setting duopolists apart from monopolists whose optimal decisions are unaffected by the actions of competitors.

The perfect substitution leads to the identical pricing, i.e., $p_{ijt} = p_{jt} = p_{-ijt}$. The market share of the firms is determined by the ratio of their product quantities.

$$s_{ijt} = \frac{y_{ijt}}{y_{ijt} + y_{-ijt}} = \frac{y_{ijt}}{y_{jt}}$$

Incorporating the formula of the optimal quantities, the market share in terms of both firms' productivity implicitly defined as follows. The assumption that $\gamma < 1$ guarantees that the market shares are well defined, i.e., $s_{ijt} \in (0,1)$ for all i, j, and t.

$$\frac{z_{ijt}}{z_{-ijt}} = \left(\frac{\theta - s_{ijt}}{\theta - 1 + s_{ijt}}\right)^{-\gamma} \left(\frac{s_{ijt}}{1 - s_{ijt}}\right)^{1-\gamma} \tag{16}$$

After computing the optimal quantities and the resulting market share, Equation (17) presents the price that the duopolist will charge.

$$p_{jt} = \frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} y_{ijt}^{\frac{1}{\gamma}-1} = \frac{\theta}{\theta - s_{ijt}} \mathrm{mc}_{ijt} \tag{17}$$

To sum up, the optimal production levels are as follows.

$$y_{ijt} = s_{ijt} \left[\left(\frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} \right)^{-\theta} C_t \right]^{\frac{\gamma}{\gamma+\theta-\theta\gamma}}$$

$$= s_{ijt}\left[\left(\frac{\theta}{\theta - s_{ijt}}\frac{1}{\gamma}w_t z_{ijt}^{-\frac{1}{\gamma}}\right)^{-\theta}\frac{w_t}{a}\right]^{\frac{\gamma}{\gamma+\theta-\theta\gamma}} \tag{18}$$

Correspondingly, the profits are as follows.

$$\pi_2(z_{ijt}, z_{-ijt}, w_t) = s_{ijt}^{\frac{1}{\gamma}}\left(\frac{\theta}{\theta - s_{ijt}}\frac{1}{\gamma} - 1\right)\left(\frac{\theta}{\theta - s_{ijt}}\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}} w_t^{\frac{\xi-(\theta-1)}{\xi}} z_{ijt}^{\frac{\theta-1}{\xi}} a^{-\frac{1}{\xi}} \tag{19}$$

With the calculations provided above, let me briefly analyze the focal point of this paper: the markup distribution. Based on the model assumptions, the cumulative probability function (CDF) of this distribution comprises two components: a smooth function on $(0, \frac{\theta}{\theta-1})$ and a jump at $\frac{\theta}{\theta-1}$. The former delineates the distribution of markups in duopolistic markets, directly shaped by the gaps in market share between duopolists, and indirectly affected by disparities in their productivity levels. The latter part embodies the unified markup of monopolistic markets: $\frac{\theta}{\theta-1}$, generating a mass at the right end of the distribution. It's worth noting that the smaller the proportion of duopolistic markets, the larger the mass and jump become.

4. EQUILIBRIUM

The analysis of the steady-state equilibrium commences with an examination of market compositions, laying the foundation for the subsequent formulation of the law of motion for productivity distributions and value functions. Finally, a comprehensive summary presents all the essential conditions to define an equilibrium.

4.1. *Compositions of Markets*

In the steady-state equilibrium, there exist N markets with a proportion of λ being duopolistic markets. Equivalently, there are $(1-\lambda)N$ monopolists and $2\lambda N$ duopolists.

During the exit process, $(1-\lambda)\delta N$ monopolists and $\lambda\delta N$ duopolists exit, leaving behind $(1-\lambda)(1-\delta)N$ 'old' monopolists, $\lambda\delta N$ 'new' monopolists, and $2\lambda(1-\delta)N$ duopolists (two duopolists in each duopolistic market). This implies that δN firms cease to exist, creating room for δN entrants. The productivity levels of firms in these surviving markets undergo a transition defined by the AR(1) process mentioned earlier, prior to the entry of new firms. Among the δN entrants, $(1-\lambda)\delta N$ choose to innovate and establish monopolistic markets, while $\lambda\delta N$ entrants opt to imitate and compete with the existing monopolists, giving rise to new duopolistic markets. Since entrants select markets randomly, a proportion of $\frac{(1-\lambda)(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta}$ 'new' duopolistic markets are composed of a monopolist in the previous period and an entrant, while a proportion of $\frac{(\lambda\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta}$ are made up of a duopolist in the past and an entrant.

At the beginning of the subsequent period, there are still N markets, out of which λN are duopolistic markets. Among these duopolistic markets, a proportion of $1-\delta$ represents the 'old' ones, $\frac{\lambda\delta^2}{(1-\lambda)(1-\delta)+\lambda\delta}$ are the new ones formed by a combination of 'old' duopolists and entrants, and $\frac{(1-\lambda)(1-\delta)\delta}{(1-\lambda)(1-\delta)+\lambda\delta}$ are the new ones formed by monopolists and entrants. As for the monopolists, a ratio of δ represent the upstarts, $\frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta}$ are the old nobles, and $\frac{(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta}$ are survivors of one-on-one competition.

4.2. *Steady-state Productivity Distributions*

The probability density (PDF) of monopolistic markets in the next period, $g'_M(z')$, is a weighted average of three PDFs. The first is the PDF of entrants' productivity, $h(z')$. The corresponding weight is δ since $\delta(1-\lambda)N$ monopolists out of the total $(1-\lambda)N$ monopolists are entrants. The second is the PDF of monopolists after the transition. The transition matrix (Markov Kernel), $\Gamma(z'|z)$, comes from the Markov process equivalent to the AR(1) process above. Since $\frac{(1-\lambda)^2(1-\delta)^2 N}{(1-\lambda)(1-\delta)+\lambda\delta}$ monopolists out of the total monopolists are monopolists in the last period, the corresponding weight is $\frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta}$. The last is the PDF of post-transition productivity of monopolists who were duopolists before the exit, $\int_z \Gamma(z'|z)g_D(z)dz$. Here, $g_D(z)$ indicates that, before the transition, the productivity of these former duopolists follows the marginal distribution of duopolistic markets' productivity. There are $\frac{(1-\lambda)(1-\delta)\lambda\delta N}{(1-\lambda)(1-\delta)+\lambda\delta}$ former duopolists in total, causing the corresponding weight $\frac{(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta}$. To sum up, the productivity distribution of monopolistic markets in the next period is as follows.

$$\begin{aligned} g_M(z') = g'_M(z') =& \delta h(z') + \\ & \frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta} \int_z \Gamma(z'|z) g_M(z)dz + \\ & \frac{(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta} \int_z \Gamma(z'|z) g_D(z)dz \end{aligned} \tag{20}$$

The first equation above emphasizes the property of the steady state: distributions in consecutive periods are identical.

Having established the dynamics of productivity distribution in monopolistic markets, I now shift the focus to duopolistic markets. The joint PDF in the next period with the first firm's productivity as z' and its competitor' as z'_- is a product of marginal PDF, $g'_D(z') \cdot g'_D(z'_-)$, which has three compositions. First, both firms were duopolists in the last period and their productivity z', and z'_- come from the transition. In this situation, $\int_z \Gamma(z'|z)g_D(z)dz$ and $\int_{z_-} \Gamma(z'_-|z_-)g_D(z_-)dz_-$ are marginal distributions after the transition and their product is the joint PDF after the transition. The weight $1-\delta = \frac{(1-\delta)\lambda N}{\lambda N}$ comes from the proportion of such cases. Second, one firm is a monopolist and the other is an entrant. Such cases occupy $\frac{(1-\lambda)(1-\delta)\delta}{(1-\lambda)(1-\delta)+\lambda\delta}$ proportion. Among them, half cases are composed of a monopolist whose productivity follows the productivity density in monopolistic markets after the transition $\int_z \Gamma(z'|z)g_M(z)dz$, and an entrant whose productivity comes from $h(z'_-)$. Similarly, the other half cases are made up of a monopolist whose productivity follows $\int_{z_-} \Gamma(z'_-|z_-)g_M(z_-)dz_-$ and an entrant whose productivity follows $h(z')$. The third composition is similar to the second one. The only difference is that, the incumbent is a duopolist before rather than a monopolist. Since there are $\frac{\lambda^2\delta^2 N}{(1-\lambda)(1-\delta)+\lambda\delta}$ markets who have such combinations, the corresponding weight is $\frac{\lambda\delta^2}{(1-\lambda)(1-\delta)+\lambda\delta}$. Consequently, the joint PDF of duopolistic markets' productivity is as follows.

$$\begin{aligned} g_D(z') \cdot g_D(z'_-) =& g'_D(z') \cdot g'_D(z'_-) \\ =& (1-\delta) \left(\int_z \Gamma(z'|z) g_D(z)dz \right) \cdot \left(\int_{z_-} \Gamma(z'_-|z_-) g_D(z_-)dz_- \right) + \end{aligned}$$

$$\frac{1}{2}\frac{(1-\lambda)(1-\delta)\delta}{(1-\lambda)(1-\delta)+\lambda\delta}\left[\left(\int_z \Gamma(z'|z)g_M(z)dz\right)\cdot h(z'_-)\right]+$$
$$\frac{1}{2}\frac{(1-\lambda)(1-\delta)\delta}{(1-\lambda)(1-\delta)+\lambda\delta}\left[h(z')\cdot\left(\int_{z_-} \Gamma(z'_-|z_-)g_M(z_-)dz_-\right)\right]+$$
$$\frac{1}{2}\frac{\lambda\delta^2}{(1-\lambda)(1-\delta)+\lambda\delta}\left[\left(\int_z \Gamma(z'|z)g_D(z)dz\right)\cdot h(z'_-)\right]+$$
$$\frac{1}{2}\frac{\lambda\delta^2}{(1-\lambda)(1-\delta)+\lambda\delta}\left[h(z')\cdot\left(\int_{z_-} \Gamma(z'_-|z_-)g_D(z_-)dz_-\right)\right] \tag{21}$$

4.3. *Value Functions*

When undergoing an exit shock, a monopolist exits with probability δ and has zero value. Meanwhile, it survives with probability $1-\delta$ and experiences the transition of productivity. The probability that this monopolist has productivity z' is $(1-\delta)\Gamma(z'|z)$. After the entry process, this monopolist stays monopoly with probability $\frac{(1-\lambda)^2(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta}$, having the corresponding value $V_1(z')$ with probability $\frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta}\Gamma(z'|z)$. Alternatively, it becomes a duopolist with probability $\frac{(1-\lambda)(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta}$, combined with an entrant with productivity z' with probability $h(z')$(i.e., the PDF of CDF $H(z')$), and has the corresponding value $V_2(z', z'_-)$ with probability $\frac{(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta}\Gamma(z'|z)h(z'_-)$. To sum up, the monopolists' values are as follows.

$$V_1(z) = \pi_1(z,w) + \beta\left\{\delta\cdot 0 + \frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta}\int_{z'=0}^{\infty}\Gamma(z'|z)V_1(z')dz' + \right.$$
$$\left.\frac{(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta}\int_{z'=0}^{\infty}\Gamma(z'|z)\int_{z'_-=0}^{\infty}h(z'_-)V_2(z',z'_-)d(z'_-)dz'\right\} \tag{22}$$

Constructing the values of duopolists follows a similar analysis process. The firm's value today equals to the sum of the profit today and discounted expected value tomorrow. There are four potential outcomes. First, the duopolist exits with probability $\frac{\delta}{2}$ and gets zero value. Second, it stays with its original competitors and experience the transition together.The probability that its own productivity becomes z' and its competitor's becomes z'_- tomorrow is $(1-\delta)\Gamma(z'|z)\Gamma(z'_-|z_-)$. Third, it becomes a monopolist with productivity z'. The corresponding probability is $\frac{1}{2}\frac{(1-\lambda)(1-\delta)\delta}{(1-\lambda)(1-\delta)+\lambda\delta}\Gamma(z'|z)$. Last, after exiting process, transition, and entry, this duopolist needs to compete with a new competitor with productivity z'_-. The weight of this situation is $\frac{1}{2}\frac{\lambda\delta^2}{(1-\lambda)(1-\delta)+\lambda\delta}\Gamma(z'|z)h(z'_-)$.

$$V_2(z,z_-) = \pi_2(z',z'_-,w) + \beta\left\{\frac{\delta}{2}\cdot 0 + \right.$$
$$(1-\delta)\int_{z'=0}^{\infty}\Gamma(z'|z)\int_{z'_-=0}^{\infty}\Gamma(z'_-|z_-)V_2(z',z'_-)d(z'_-)dz' +$$
$$\frac{1}{2}\frac{(1-\lambda)(1-\delta)\delta}{(1-\lambda)(1-\delta)+\lambda\delta}\int_{z'=0}^{\infty}\Gamma(z'|z)V_1(z')dz' +$$

$$\frac{1}{2}\frac{\lambda\delta^2}{(1-\lambda)(1-\delta)+\lambda\delta}\int_{z'_-=0}^{\infty}h(z'_-)\int_{z'=0}^{\infty}\Gamma(z'|z)V_2(z',z'_-)dz'd(z'_-)\Bigg\} \tag{23}$$

4.4. *Summary of Equilibrium Conditions*

In steady-state equilibrium, the following conditions are met.

The household maximizes its utility represented by Equation (1) by optimally allocating the consumption and labor supply under the budget constraint(4). Firms choose their optimal labor demand and the supply of goods to maximize their values following the rules embodied by Equations (13) and (18).

Meanwhile, the productivity distributions in monopolistic and duopolistic markets represented by Equations (20) and (21), are stationary, ensuring that

$$g'_M(z)=g_M(z), \quad g'_J(z,z_-)\equiv g'_D(z)g'_D(z_-)=g_D(z)g_D(z_-)\equiv g_J(z,z_-) \tag{24}$$

hold for all z and z_-, or equivalently,

$$G'_M(z)=G_M(z), \quad G'_J(z,z_-)=G_J(z,z_-), \,\forall z,z_- \tag{25}$$

Here $g_M(\cdot)$ and $g'_M(\cdot)$, $g_D(\cdot)$ and $g'_D(\cdot)$, and $g_J(\cdot,\cdot)$ and $g'_J(\cdot,\cdot)$ are PDFs of monopolists' productivity, marginal and joint PDF of duopolists' productivity. $G_M(\cdot)$, $G_D(\cdot)$, and $G_J(\cdot,\cdot)$ are corresponding CDFs.

The number of the markets N and the proportion of the duopolistic markets λ are constant.

In the labor market, the equilibrium condition is met when the aggregate labor demand equals the aggregate labor supply, clearing this market. Given the positive yet indeterminate profits of firms each period, I normalize the labor supply to $\frac{1}{a}+\epsilon$, where ϵ represents an infinitesimal value.

$$\begin{aligned}\frac{1}{a}+\epsilon = N\cdot\left(\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}}\left(\frac{1}{a}\right)^{\frac{1}{\xi}}w^{\frac{1-\theta}{\xi}}\Bigg\{(1-\lambda)\left(\frac{\theta}{\theta-1}\right)^{-\frac{\theta}{\xi}}\int_{z=0}^{\infty}z^{\frac{1}{\gamma}(\frac{\theta}{\xi}-1)}dG_M(z)\\ +\lambda\iint_{z=0,z'=0}z^{\frac{1}{\gamma}(\frac{\theta}{\xi}-1)}\left(\frac{\theta}{\theta-s}\right)^{-\frac{\theta}{\xi}}s^{\frac{1}{\gamma}}+z_-^{\frac{1}{\gamma}(\frac{\theta}{\xi}-1)}\left(\frac{\theta}{\theta-s_-}\right)^{-\frac{\theta}{\xi}}s_-^{\frac{1}{\gamma}}dG_J(z,z_-)\Bigg\}\end{aligned} \tag{26}$$

Meanwhile, the supply equals to the demand for the goods, clearing the goods market.

$$c_{ij}=y_{ij}, \quad \forall i,j \tag{27}$$

At last, the free entry equals the expected values to entry costs, in both monopolistic and duopolistic markets.

$$\begin{aligned}\mathcal{C}_M &= \mathbb{E}_z V_1(z)=\int_z V_1(z)h(z)dz\\ \mathcal{C}_D &= \mathbb{E}_z\mathbb{E}_{z_-}V_2(z,z_-)=\int_z h(z)\int_{z_-}g_M(z_-)V_2(z,z_-)d(z_-)dz\end{aligned} \tag{28}$$

As delineated in the entry and exit section, the economic system portrayed by my model exhibits at least two equilibrium points. One is the unconventional equilibrium, detailed below, while the other is the canonical equilibrium where the proportion of monopolistic markets dwindles to zero. While the latter equilibrium exists, it lies beyond the explanatory scope of my model, as it violates the setting of my model. Elaboration on the intricacies of information flow encountered by entrants to determine which equilibrium will manifest is beyond the purview of this paper. Therefore, subsequent analysis primarily focuses on the equilibrium with positive entries for both imitation and innovation.

5. CALIBRATION

In this section, it is essential to distinguish among three types of variables for clarity. In the illustrations below, I denote parameters or variables in the model as x, those in the calibration as $\hat{x}$, and those in the data as $\tilde{x}$.

To calibrate the model, nine parameters need to be determined: $\beta, a, \delta, \gamma, \rho, \sigma, \theta, \mathcal{C}_M, \mathcal{C}_D$. Among these parameters, the first three are derived from external data sources. The discount rate β, the disutility a, and the exit rate δ align with the annual interest rates, the average working hours per year and labor share, and firm exit rates from the Business Dynamic Statistics (BDS) dataset, respectively. The subsequent four parameters are calibrated based on moments or estimates obtained from previous research studies. The persistence and standard error of the productivity process ρ and σ target the correlation of log sales of publicly traded manufacturing firms in subsequent periods in Bottazzi and Secchi (2003). Additionally, the elasticity of substitution θ is directly sourced from Broda and Weinstein (2006) while the decreasing return to scale on labor γ is extracted from Burnside et al. (1995). The remaining parameters - the entry costs $\mathcal{C}_M$ and $\mathcal{C}_D$ - are chosen to respectively pin down the values of w and λ, aligning with the expenditure data and the average markup. It is important to note that one period in the model corresponds to one year. Before introducing the details, it is worth mentioning that, all calibrations stand on the normalization with the price index P set at 1.

The results of calibration are shown in Table I. Followings are detailed illustrations.

Subjective Discount Rate In this model, the representative household does not save in the steady state, implying that $\hat{\beta} = \frac{1}{1+\tilde{r}}$, where $\tilde{r}$ represents the annual risk-free interest rate. To calibrate this parameter, I utilize data on the average USA government 1-year treasury rate observed from 1980 to 2000, serving as a proxy for the risk-free rate. The mean rate over this period is 8.605%, leading to a calibrated value of $\hat{\beta} = 0.92$.

Disutility of Labor Supply By employing the first-order condition of the household's optimization problem, a relationship between the disutility and other variables is as follows.

$$a = \frac{w}{\Pi + wL}$$

$$aL = \frac{wL}{\Pi + wL}$$

Hence, the disutility is the product of the inverse of working hours and labor share.

$$\hat{a} = \frac{\widetilde{\text{Labor Share}}}{\tilde{L}}$$

Data on the average annual hours worked by an individual in the USA from 1980 to 2000 shows approximate 1800 total working hours (34.3 hours per week). Meanwhile, the labor compensation in GDP data for the USA indicates an average labor share of 61.4% from 1980 to 2000. Utilizing this information, the estimation of $\frac{1}{3000}$ is obtained, with $\frac{1}{\text{hour}}$ as the unit.

Decreasing Return to Scale Parameter on Labor The decreasing return to scale parameter on labor, denoted as γ, is equivalent to the aggregate return to scale in my model.

$$\text{Aggregate}\,\widehat{\text{Return}}\text{ to Scale} \equiv \frac{AC}{MC} = \frac{wL/y}{\dfrac{1}{\gamma} w z^{-\frac{1}{\gamma}} y^{\frac{1}{\gamma}-1}} = \gamma$$

Various research studies, drawing from diverse datasets, offer different estimations or calibrations of the aggregate return to scale based on various assumptions or model settings. In firm dynamism literature in which labor is the only production input, researchers commonly employ a linear production function, setting γ to 1 (Peters and Walsh (2019), Peters (2020), De Loecker et al. (2021)). Conversely, in those firm dynamism models in which both capital and labor are inputs, values around 0.6 are assigned to γ (Gutiérrez et al. (2021), Di Nola et al. (2023)). Empirical studies aiming to estimate the aggregate return to scale provide estimations ranging between 0.8 and 1.3 (Burnside et al. (1995), Ahmad et al. (2019), Kariel and Savagar (2022), Ruzic and Ho (2023)). In this context, I adopt the result of 0.8 from Burnside et al. (1995), whose estimations are derived from US 2-digit SIC quarterly manufacturing data spanning from 1972 to 1992.

Exit Rate The BDS dataset contains annual exit rates for firms in each state of the USA between 1980 and 2020. By calculating the average of the data from 1980 to 2001, I arrived at an annual exit rate of 8.99%. This rate differs from the 0.055 reported in Lee and Mukoyama (2018) using Longitudinal Business Database and the 0.048 provided in Peters and Walsh (2019) using Annual Survey of Manufactures data. However, it aligns closely with the 0.09 estimated by Gutiérrez et al. (2021) based on the Compustat firms dataset. These results suggest that the exit rate found in the BDS dataset is reasonable and reflective of the dynamics in the economy.

Elasticity of Substitution in Global Markets The majority of authors who have employed the nested-CES model tend to set the elasticity of substitution between industries within a range of 1 to 1.01. (Atkeson and Burstein (2008a), Jaimovich and Floetotto (2008), Lewis and Poilly (2012), Savagar (2021)) However, such choices often result in a relatively high markup. In this paper, I adopt the value of 4, which was estimated by Broda and Weinstein (2006) based on data from Standard International Trade Classification (SITC-3) industries between 1990 and 2001. This selection provides a more suitable representation of the economic dynamics and leads to more realistic markup levels.

Persistence and Standard Error of Productivity Process Several methods to estimate the auto-correlation and standard error of productivity shocks exist. One approach involves using Total Factor Productivity (TFP) data and approximating the productivity process through Solow residuals. Studies have reported auto-correlation values ranging from 0.90 (De Loecker et al. (2021)) to 0.979 (Savagar (2021)), with corresponding standard errors of innovations around 0.1497. Another method involves examining changes in employment and using the resulting data to estimate a persistence value of 0.97 and a standard error of 0.11 (Lee and Mukoyama (2018)).

In this paper, I use moment conditions from Bottazzi and Secchi (2003) to determine the values of ρ and σ. Bottazzi and Secchi estimated an AR(1) process on the normalized log sales of publicly traded manufacturing firms between 1982 and 2001. Their analysis resulted in an estimate of $Corr(\log \widetilde{sale}_t, \log \widetilde{sale}_{t-1}) \approx 0.9506$ for ρ. Additionally, they fitted a Laplacian distribution with a variance of approximately 2×0.7293^2 to the growth rate of firm sizes. Using these moments, I construct the following conditions for calibration and include further details in Appendix C.

$$\hat{\rho} = Corr(\log \widetilde{sale}_t, \log \widetilde{sale}_{t-1}) \approx 0.9506 \tag{29}$$

$$\hat{\sigma^2}(\hat{\theta}, \hat{\gamma}, \hat{\rho}) = \frac{1+\hat{\rho}}{2\Phi_1^2(\tilde{\theta}, \tilde{\gamma})} Var(\widetilde{g_t^{sale}}) \approx 0.087^2 \tag{30}$$

Here $\widetilde{sale}_t$ and $\widetilde{g_t^{sale}}$ are sales of firms and growth rate of firm sales in Bottazzi and Secchi (2003).

Entry Costs In this model, I determine the values of entry costs $\mathcal{C}_M$ and $\mathcal{C}_D$ based on the proportion of duopolistic markets and wage levels.

The value of the proportion of duopolistic markets, λ, relies on the expected markup of 28%, as estimated by Christopoulou and Vermeulen (2008) using data from the manufacturing and construction sectors in the USA between 1981 and 2004. I solve the following equation to find the appropriate value of λ.

$$\begin{aligned} \mathbb{E}(\widehat{\text{markup}}) = \hat{\lambda}\frac{\hat{\theta}}{\hat{\theta}-1} + (1-\hat{\lambda}) \iint_{z,z_-} \Bigg[& \frac{\hat{\theta} \cdot s(z, z_-; \hat{\theta})}{\hat{\theta} - s(z, z_-; \hat{\theta})} \\ & + \frac{\hat{\theta} \cdot (1 - s(z, z_-; \hat{\theta}))}{\hat{\theta} - (1 - s(z, z_-; \hat{\theta}))} \Bigg] dG_J(z, z_-; \hat{\rho}, \hat{\sigma}, \hat{\lambda}, \hat{\delta}) \end{aligned} \tag{31}$$

The resulting proportion is $\hat{\lambda} = 0.5565$.

Simultaneously, the connection between wages and annual aggregate expenditures is articulated through the first-order condition of the household:

$$\hat{w} = \hat{a} \cdot \tilde{C}$$

In practice, households in the US spent an average of 30000 dollars per person per year between 1984 and 2000 (in 1982 U.S. dollars). Integrating this data with the estimate of $\hat{a}$ yields a target wage value of $\hat{w} = 10$, signifying that one hour of work generates 10 dollars in household income.

Using the determined wage level, I derived the corresponding entry costs. Specifically, I identify that the entry costs for innovators and imitators are $\hat{\mathcal{C}}_M = 45.20$ and $\hat{\mathcal{C}}_D = 44.64$, respectively. These values can be interpreted as follows: firms' entry costs amount to approximately 45.20 and 44.64 units of consumption goods, representing arbitrary dollar values based on different scales of the price index.

Initial Productivity Distribution Finally, it is imperative to elucidate the form of the initial productivity distribution, denoted as $H(\cdot)$. In the literature, diverse settings exist for such a distribution. The ergodic distribution of the Markov process is a viable option under the assumption that the entry and exit processes do not influence the shape of the productivity distribution. Alternately, log-normal or exponential distributions are also contenders, given that the actual productivity distribution tends to be right-skewed with a fat tail. In this paper, I propose setting

TABLE I

CALIBRATION RESULTS

Parameter	Value	Target/Explanation/Moments
$\hat{\beta}$	0.920	USA 1-year treasury rate from 1980 to 2000
$\hat{a}$	$\frac{1}{3000}$	USA average weekly working hours and labor share from 1980 to 2000
$\hat{\gamma}$	0.800	Aggregate scale of return from , Burnside et al. (1995)
$\hat{\delta}$	0.090	BDS annual firm exit rate from 1980 to 2020
$\hat{\theta}$	4.000	Broda and Weinstein (2006)
$\hat{\rho}$	0.951	Fit the auto-correlation of log sales in Bottazzi and Secchi (2003)
$\hat{\sigma}$	0.087	Fit the variance of the growth rate's distribution in Bottazzi and Secchi (2003)
$\hat{\lambda}$	0.5565	Fit the expected markup in Christopoulou and Vermeulen (2008)
$\hat{C}_M$,	45.20	USA average annual consumer expenditures from 1990 to 2001
$\hat{C}_D$	44.64	USA average annual consumer expenditures from 1990 to 2001

Note: Calibration results, details are in the context.

$H(\cdot)$ as a uniform distribution spanning ± 5 standard errors around the mean of the ergodic distribution of the Markov process.

6. QUANTITATIVE ANALYSIS

6.1. *Results*

In this subsection, I undertake a counterfactual experiment to scrutinize the ramifications of a one-percentage-point reduction in the entry costs of duopolistic markets. Specifically, I juxtapose the equilibrium wages, proportions of duopolistic markets, value functions, and productivity distributions before and after this alteration. This endeavor aims to underscore the possibility that a reduction in entry costs, as mentioned in the introduction, can result in an increased average markup. Meanwhile, I show similar counterfactual experiments, namely, the decrease of one percentage point in the entry costs of monopolistic markets and the increase of one percentage point in the entry costs of duopolistic markets, in the appendix. Subsequently, in the ensuing subsection, I delve into the intricate interplay among value functions, productivity distributions, and shifts in wages and market proportions, aiming to unveil the underlying mechanisms driving these transformations. A discussion based on different information settings mentioned above marks the concluding phase of this section

6.1.1. *Results Before the Shock*

Value Functions Figure 1 delineates the value function of monopolists across diverse productivity levels, showcasing a nuanced pattern. At low productivity levels, monopolists encounter diminished profits in the current period alongside diminished values for their potential future roles, be it as monopolists or duopolists. This diminished future value stems from two primary factors: first, the likelihood of persistently low productivity levels due to the inertia of productivity trends; and second, the resulting low profits arising from both reduced market share (in the duopolistic scenario) and low efficiency (in both duopolistic and monopolistic settings). However, as productivity levels escalate, monopolists observe a notable increase in profits in all periods. This upward trend results in a corresponding increase in their value functions, highlighting a clear and monotonic increasing relationship between value and productivity for monopolists.

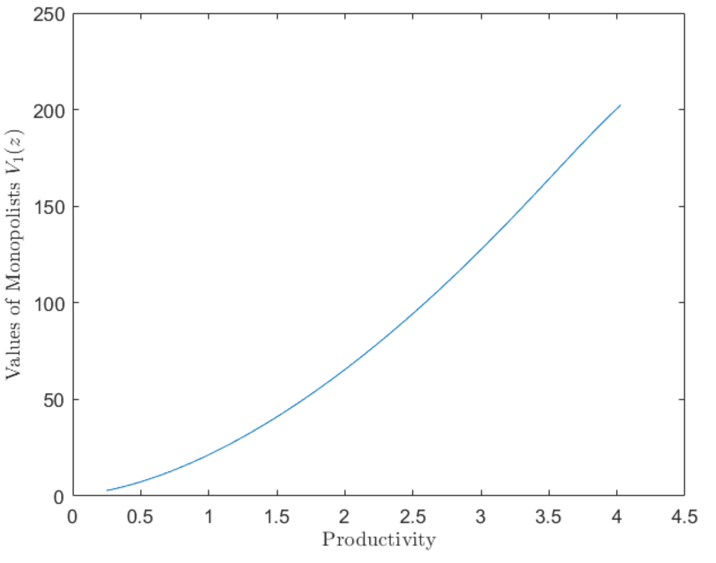

FIGURE 1.—Pre-Shock Monopolists' Values: The x-axis represents the productivity of monopolists, and the y-axis indicates their corresponding values.

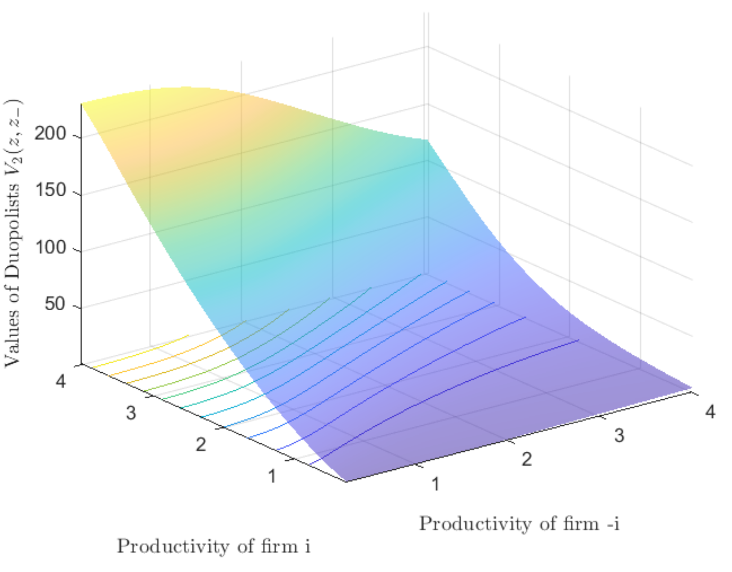

FIGURE 2.—Pre-Shock Duopolists' Values: The x-axis measures the productivity of Duopolist i, while the y-axis gives the productivity of its competitor (firm -i). The z-axis provides the corresponding values of firm i. The curves on the x-y plane represent contours of duopolist i's values.

Transitioning to Figure 2, the focus shifts to the value functions of duopolists across varying productivity levels, considering competitors with different productivity levels. Here, the values of a duopolist, denoted as i, rise with its productivity given the productivity level of its competi-

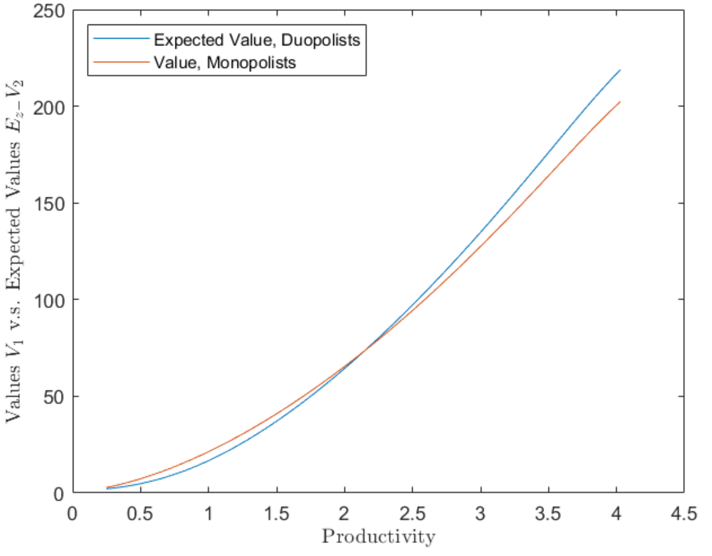

FIGURE 3.—Pre-Shock $V_1(z)$ vs. $\mathbb{E}_{z_-} V_2(z, z_-)$: The x-axis represents the productivity levels, and the y-axis shows the corresponding values. The red curve illustrates the values of monopolists, while the blue curve depicts the expected value of duopolists, i.e., $\mathbb{E}_{z_-} V_2(z, z_-) = \int V_2(z, z_-) dG_M(z_-)$.

tor. This trend mirrors the observations made for monopolists, as both share similar underlying reasons. Meanwhile, when a duopolist faces a competitor boasting higher productivity, its value experiences a monotonic decrease. This decline stems from lower profits due to reduced market shares in the face of a more productive competitor.

In Figure 3, a comparative analysis unfolds, juxtaposing the values associated with being a monopolist against the expected values from functioning as a duopolist with identical productivity levels. Here, the expectation $\mathbb{E}_{z_-} V_2(z, z_-) = \int V_2(z, z_-) dG_M(z_-)$ employs the productivity distribution of monopolistic markets as weights because it is the values associated with becoming a monopolist and those derived from entering an existing monopolistic market and engaging in competition guide entrants' decisions. A seemingly peculiar phenomenon is that firms with high productivity consistently attain more substantial values when operating as duopolists compared to their counterparts with low productivity. The underlying rationale is straightforward: although monopolists enjoy the advantage of avoiding market sharing and generating higher profits per period, they concurrently grapple with a heightened exit rate δ, resulting in a shorter anticipated lifespan. Consequently, firms must carefully weigh the benefits of "excess profits" in a monopolistic role against the drawback of a shorter expected lifespan. Given that higher productivity corresponds to more substantial losses arising from shorter lifespans, firms with superior productivity achieve heightened values when choosing to function as duopolists. If I equate the exit rate of monopolists to $\frac{\delta}{2}$, matching that of duopolists, the (relative) positions of monopolists' value functions and duopolists' expected value functions exhibit a typical pattern. However, this adjustment does not alter the outcome of my conclusion.

Equilibrium Distributions of Productivity In Figure 4, I depict the probability density functions showcasing the distribution of monopolists' productivity and the marginal distribution of duopolists' productivity. These distributions manifest two distinct characteristics. Firstly, both

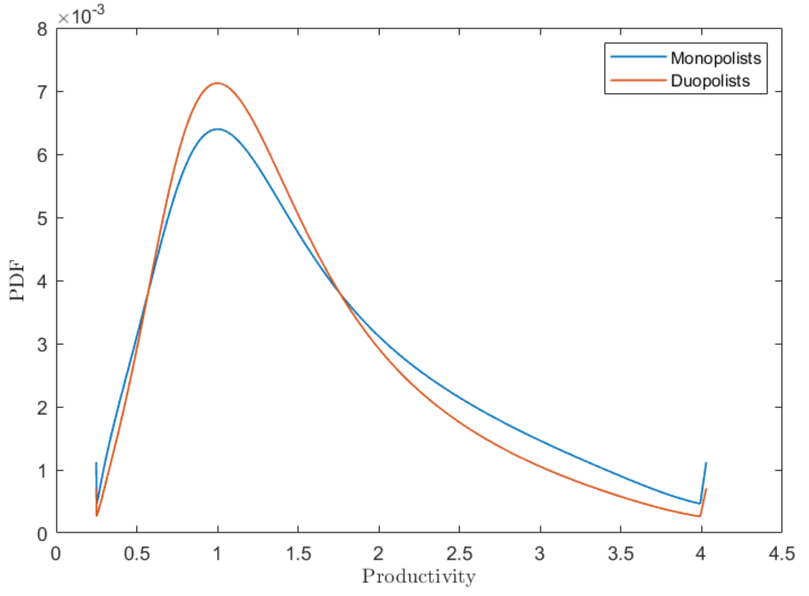

FIGURE 4.—Pre-Shock Productivity Distributions: The x-axis displays productivity levels, and the y-axis represents the probability density. The blue curve represents the probability density function (PDF) of monopolists' productivity, while the red curve illustrates the marginal PDF of duopolists' productivity.

distributions reveal a right-skewed pattern, stemming from the equilibrium distributions being a composite of the ergodic distribution of productivity which follows a log-normal distribution, and the uniform distribution which inherently possesses zero skewness. Secondly, the distribution of monopolists' productivity exhibits fatter tails when juxtaposed with the marginal distribution of duopolists' productivity. This occurrence is a direct consequence of the disparate exit rates between monopolists and duopolists. Given the lower exit rate faced by duopolists, their productivity distribution assigns less weight to the uniform distribution, resulting in a more centralized distribution.

6.1.2. *Results After the Shock*

Following an exogenous shock that reduces the entry costs of duopolistic markets by one percentage point (from 44.64 to 44.19), the model produces unexpected outcomes contrary to canonical models. Instead of an increase in the proportion of duopolistic markets and a decrease in the expected markup, the proportion of duopolistic markets (λ) experiences a decline from 55.65% to 35.98%, leading to an uptick in the expected markup from 28.00% to 29.91%. This surge in the expected markup primarily results from the expansion of monopolistic markets, akin to the 'superstar' effect (Autor et al. (2020)), while the expected markup in duopolistic markets only experiences a marginal increase (from 23.75% to 23.81%).

As anticipated, the equilibrium wage increases from 10 to 10.1887, and the number of markets rises from 3050 to 3163. These findings align with the expectations set by canonical models.

6.2. *Mechanism*

In this subsection, I delve into the interpretation of the findings obtained. Subsequently, I establish relationships between the wage (w) and the proportion of duopolistic markets (λ) with the values of monopolists ($V_1(z)$), the expected values of duopolists ($\mathbb{E}_{z\_}V_2(z,z_-)$), and the expected value differences ($\mathbb{E}_z[V_1(z) - \mathbb{E}_{z\_}V_2(z,z_-)]$). Illustrated in Figure 5, I commence by elucidating the effect of entry costs of duopolistic markets on expected value differences via wage. Subsequently, I establish the relationship between expected value differences and the proportion of duopolistic markets, λ. Armed with these foundations, I expound upon the mechanism causing the decrease in the proportion of duopolistic markets λ after the shock. Lastly, I elucidate the influences of λ on the markup. In the appendix, I provide another perspective on illustrating the decisions of entrants given the higher wage and proportion of duopolistic markets, focusing on excess profits.

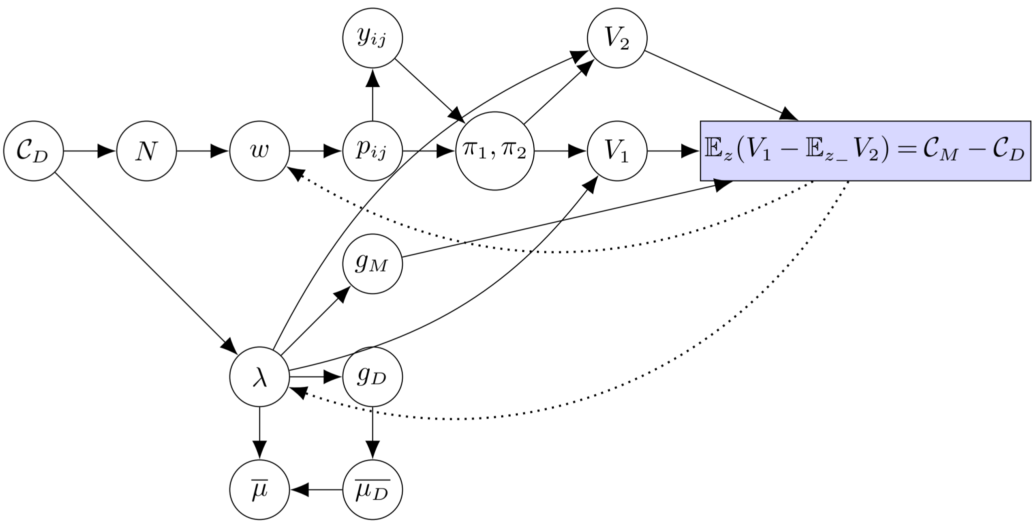

FIGURE 5.—Causality Graph: The diagram illustrates the interplay among key factors in my model. $\mathcal{C}_D$ represents the entry costs of duopolistic markets, while N denotes the number of industries or markets. w signifies the equilibrium wage rate, and p_{ij} and y_{ij} symbolize the prices and quantities of products from firm i in industry/market j. π_1 and π_2 represent monopolistic and duopolistic profits, respectively, while V_1 and V_2 denote the values of monopolists and duopolists. The expression $\mathbb{E}_z(V_1 - \mathbb{E}_{z\_}V_2) = \mathcal{C}_M - \mathcal{C}_D$ illustrates the free entry condition, which determines the values of variables I focus on. λ indicates the proportion of duopolistic markets, and g_M, g_D represent the distribution and the marginal distribution of productivity in monopolistic and duopolistic markets. $\overline{\mu_D}$ and $\overline{\mu}$ correspond to the average markup of the economy and duopolistic markets, respectively. Curved arrows indicate the direction of influence among variables, while dashed arrows highlight the key variables balanced by the free entry condition.

6.2.1. *Effects of Duopolistic Market Entry Costs on Expected Value Differences via Wage*

The exploration of this mechanism begins by establishing the connections among the entry costs of duopolistic markets $\mathcal{C}_D$, the equilibrium wage (w), and the values of monopolists ($V_1(z)$) and expected values of duopolists ($\mathbb{E}_{z\_}V_2(z,z-)$) encountered by incumbents, aiming to illustrate the pathway through which reduced entry costs influence the equilibrium wage and subsequently the values, as well as the expected difference between $V_1(z)$ and $\mathbb{E}_{z\_}V_2(z,z-)$ faced by entrants.

The mechanism driving the wage increase is straightforward: by lowering the entry cost of being duopolists, more firms persist in the markets in equilibrium. This surge in firm presence amplifies the demand for labor, consequently elevating the wage level from 10 to 10.1887.

As shown in Figure F.5, elevated wage levels contribute to lower values for monopolists ($V_1(z)$) and expected values of duopolists faced by incumbents ($\mathbb{E}_{z_-} V_2(z, z_-)$). This outcome is from higher wages providing greater profits per good through markup, while simultaneously diminishing the quantity of goods sold. In general, the profits of monopolists and duopolists decrease, resulting in lower values.

Given that entrants base their decisions on the expected disparities between values of monopolists ($V_1(z)$) and expected values of duopolists faced by incumbents ($\mathbb{E}_{z_-} V_2(z, z_-)$), in Figure 6, I present the discrepancies ($V_1(z) - \mathbb{E}_{z_-} V_2(z, z_-)$) encountered by entrants with varying productivity under different wage levels (w), with λ fixed at 0.5565. Consistent with the preceding analysis, these differences exhibit positivity at low productivity levels and negativity at high productivity levels. More importantly, a higher wage level diminishes the differences at low productivity levels, but increases the differences at high productivity levels.

The mechanism underlying Figure 6 is quite clear: Compared to duopolists with the same productivity level, a higher wage leads monopolists to set higher prices, thus obtaining higher profits while keeping the quantity sold unchanged. However, the higher prices reduce demand, putting pressure on profits. As monopolists, they must bear the full burden of this demand decrease, unlike duopolists who only share part of the quantity loss. In fact, the elasticity of substitution in the model setup precisely results in a combined effect of lower profits. Therefore, profit differences ($\pi_1(z) - \mathbb{E}_{z_-} \pi_2(z, z_-)$) between monopolists and duopolists with the same productivity decrease as the wage rises. However, when firms have high or low productivity, the decrease is much less pronounced compared to those with middle productivity.This occurs because higher productivity leads duopolists to experience more significant demand losses owing to their elevated market share, while lower productivity restricts the extent to which values can decrease.

$$
\begin{aligned}
d(\pi_1(z) - \mathbb{E}_{z_-} \pi_2(z, z_-)) = \frac{\xi - (\theta - 1)}{\xi} w_t^{\frac{1-\theta}{\xi}} z^{\frac{\theta-1}{\xi}} a^{-\frac{1}{\xi}} \\
\left[\left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} - 1 \right) \left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} \right)^{-\frac{\theta}{\xi}} - \mathbb{E}_{z_-} \left(\underbrace{s^{\frac{1}{\gamma}} \left(\frac{\theta}{\theta - s} \frac{1}{\gamma} - 1 \right) \left(\frac{\theta}{\theta - s} \frac{1}{\gamma} \right)^{-\frac{\theta}{\xi}}}_{F(s)} \right) \right] \cdot dw
\end{aligned}
\tag{32}
$$

In mathematical terms, $d(\pi_1(z) - \mathbb{E}_{z-}\pi_2(z, z-))/dw$ is negative due to the negativity of $\frac{\xi-(\theta-1)}{\xi}$. However, the extent of the decrease hinges on two factors: $z^{\frac{\theta-1}{\xi}}$, amplifying the profit gains from higher prices, and the term within the brackets in the second line, signifying the severity of quantity loss. Given that the function $F(s)$ in Equation (32) exhibits monotonic increase, it follows that higher productivity (i.e., a higher market share s) results in a reduced decline in quantity loss.

However, this is just one part of the story, and this part alone cannot explain why in the high productivity region, the value differences $V_1(z) - \mathbb{E}z{-}V_2(z, z_-)$ instead rise (i.e., meaning the decrease in the value of monopolists is smaller than that of the expected values of duopolists). The reason why high-productivity firms prefer to be duopolists, as discussed earlier, is once again at play. The relatively shorter lifespan of monopolists, compounded by the

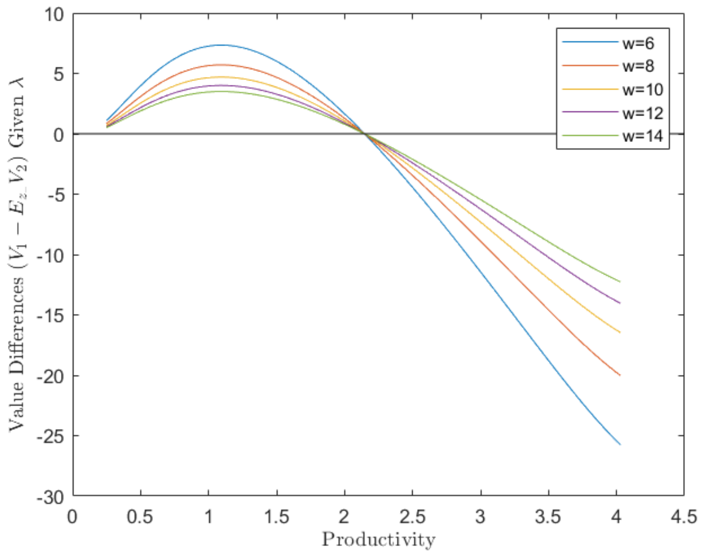

FIGURE 6.—Value differences at Constant λ Across Different Wage Levels: The x-axis represents productivity levels, while the y-axis displays corresponding value differences. The graph illustrates differences between monopolistic and expected duopolistic values with λ held constant, presenting diverse scenarios based on varying wage levels.

high wage causing a decrease in profits in each period, diminishes the disadvantage of monopolists, thereby causing the value differences to rise rather than fall.

Now, I reach the last step of induction. Since entrants do not concern themselves with the values of monopolists or the expected values of duopolists, nor with the difference between them. What matters to them is the expected value differences. In Figure 7, I illustrate the negative correlation between wage and expected value differences given a certain proportion of duopolistic markets λ. Thus, the value differences decrease as the wage increases on average.

6.2.2. *Relationship between Expected Value Difference and the Proportion of Duopolistic Markets* λ

While I have demonstrated the impact of reduced entry costs of duopolistic markets on diminishing expected value differences due to the higher wage, elucidating the equilibrium proportion of duopolistic markets λ requires establishing the relationship between the proportion and the expected value differences.

First, I analyse how the higher proportion λ decreases the values of monopolists and the expected values of duopolists faced by incumbents. Initially, the proportion λ significantly impacts the transition probabilities among monopolistic, duopolistic, and market exit states.

$$
\begin{array}{c} \\ \text{Monopolist(M)} \\ \text{Duopolist(D)} \end{array}
\begin{array}{c}
\begin{array}{ccc} \text{Monopolist(M)} & \text{Duopolist(D)} & \text{Exit(E)} \end{array} \\
\begin{pmatrix}
\frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta} & \frac{\lambda\delta(1-\delta)}{(1-\lambda)(1-\delta)+\lambda\delta} & \delta \\
\frac{\delta(1-\lambda)(1-\delta)}{2[(1-\lambda)(1-\delta)+\lambda\delta]} & 1-\delta+\frac{\lambda\delta^2}{2[(1-\lambda)(1-\delta)+\lambda\delta]} & \frac{\delta}{2}
\end{pmatrix}
\end{array}
$$

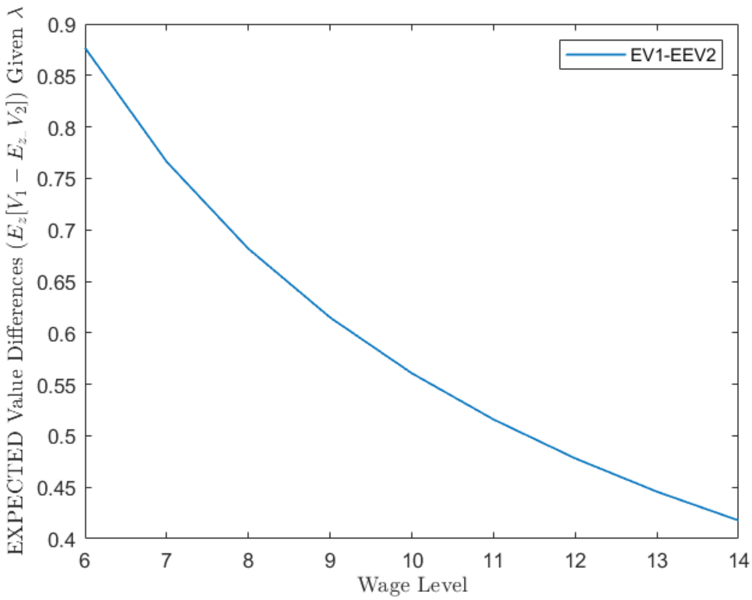

FIGURE 7.—Expected Value Differences Across Varied Wage Levels with a Fixed λ ($\lambda = 0.5565$): The graph illustrates the expected value differences under different wage conditions while maintaining a constant λ value. The x-axis is wage levels and the y-axix is expected value differences

As λ increases, the likelihood of persisting as a monopolist diminishes, evidenced by the derivative $\frac{d}{d\lambda}P(\mathrm{M}|\mathrm{M}) = \frac{-\delta(1-\delta)^2}{[(1-\lambda)(1-\delta)+\lambda\delta]^2} < 0$. Simultaneously, the probability of transitioning from a monopolist to a duopolist intensifies, as expressed by $\frac{d}{d\lambda}P(\mathrm{D}|\mathrm{M}) = \frac{\delta(1-\delta)^2}{[(1-\lambda)(1-\delta)+\lambda\delta]^2} > 0$. Additionally, a duopolist is less prone to revert to a monopolist with increasing λ ($\frac{d}{d\lambda}P(\mathrm{M}|\mathrm{D}) = \frac{-\delta^2(1-\delta)}{2[(1-\lambda)(1-\delta)+\lambda\delta]^2} < 0$), but more likely to sustain its duopolistic status ($\frac{d}{d\lambda}P(\mathrm{D}|\mathrm{D}) = \frac{\delta^2(1-\delta)}{2[(1-\lambda)(1-\delta)+\lambda\delta]^2} > 0$). Consequently, to monopolists, higher λ means they have a higher probability to become duopolists and they stay as duopolists for longer periods during their lifespans. Combining with lower values as duopolists generates lower values of monopolists. To duopolists, except that they stay as monopolists shorter in their life, a higher proportion means they meet entrants as their competitors with a higher probability. While entrants have higher productivity on average since the initial productivity distribution is more left-skewed. So they expect lower profits under higher λ on average, resulting in diminished values given their competitors' productivity levels. What about the expected values of duopolists? Here, I must also consider the productivity distribution of monopolists. Furthermore, an increase in λ leads to a productivity distribution among monopolists characterized by a thinner tail and greater left-skewness, as depicted in Figure F.7. This implies that when entrants compute the expected values of duopolists, they assign higher weight to scenarios with lower productivity. Meanwhile, the decline in the value of low-productivity firms is relatively mild. This is evident because the values of low-productivity firms are inherently low, thus the decline is relatively limited. Therefore, a higher λ attenuates the decrease in the expected values of duopolists through more left-skewed productivity distribution of monopolists.

Now, focusing on Figure 8, I show the variations in value differences for different λ values, while keeping the equilibrium wage constant at the pre-shock level, $w = 10$. The graph depicts a pattern akin to that shown in Figure 6. The mechanism behind Figure 8 can be summarized as follows. A higher proportion of duopolistic market λ makes monopolists and duopolists more 'similar' to each other, meaning that initially, firms that start as monopolists have a greater proportion of their lifespan spent as duopolists. From the perspective of the value function, this translates to an increased weights on the $V_2(z, z-)$ term. Consequently, this reduces the absolute magnitude of the value differences.

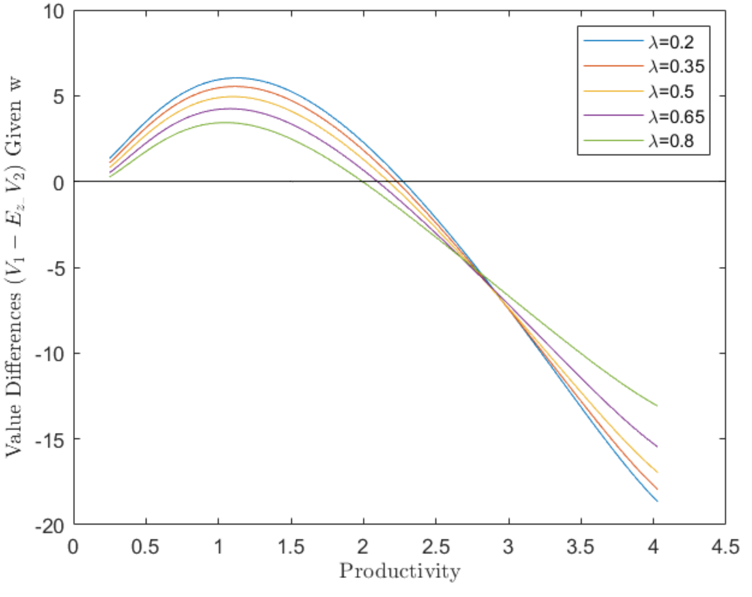

FIGURE 8.—Value differences at Constant Wage Across Different λ Levels: The x-axis represents productivity levels, while the y-axis displays corresponding value differences. The graph illustrates differences between monopolistic and expected duopolistic values with wage held constant, presenting diverse scenarios based on varying λ levels.

Again, entrants care about the expected value differences. Figure 9 demonstrates a diminishing trend in expected value differences with increasing proportion levels. This trend implies that while the higher proportion of duopolistic markets decreases both the values of monopolists and the expected values of duopolists across all productivity levels, its impact on monopolists is more significant on average.

6.2.3. *Mechanism Causing the Decrease of the Proportion of Duopolistic Markets λ After Shock*

Building upon the preceding analysis on influence of the equilibrium wage w and the proportion of duopolistic markets λ on the expected values of monopolists and duopolists faced by entrants, I elucidate the reduction in the equilibrium proportion of duopolistic markets in this section.

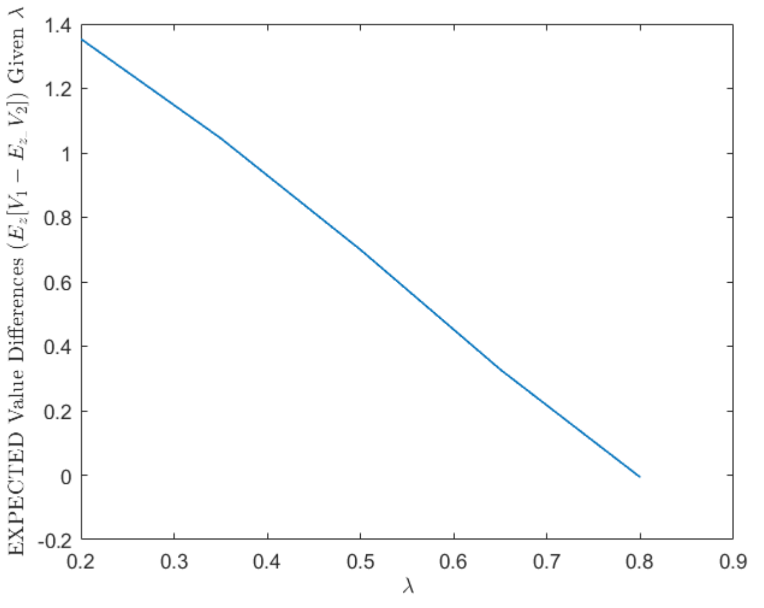

FIGURE 9.—Expected Value Differences Across Varied λ Levels with a Fixed Wage Level ($w = 10$): The graph illustrates the anticipated disparities in value differences under different λs while maintaining a constant wage value. The x-axis is λ and the y-axix is expected value differences s given the same

To see the alterations in λ, I present the expected values of monopolists ($\mathbb{E}_z V_1(z) \equiv \int V_1(z) dH(z)$) and duopolists ($\mathbb{E}_z \mathbb{E}_{z\_} V_2(z, z_-) \equiv \int \mathbb{E}_{z\_} V_2(z, z_-) dH(z)$) faced by entrants below in Figure 10.

Since both the expected values of monopolists and duopolists faced by entrants decrease with an increase in the equilibrium wage w, in both panels, the red curves, representing the post-shock expectations $\mathbb{E}_z V_1(z)$ and $\mathbb{E}_z \mathbb{E}_{z\_} V_2(z, z_-)$, are lower than the blue ones, denoting pre-shock expectations. Meanwhile, since the same negative relationships hold between expected values and the proportion of duopolistic market λ, all curves exhibit a downward trend. Moreover, given that expected value differences diminish with growing wages and the proportion, the absolute slopes of expected values of monopolists (the slopes of curves in the upper pannel) are larger than those of expected values of duopolists (the slopes of curves in the lower pannel). Additionally, the differences between expected values of monopolists at different proportion levels are more substantial than the differences between expected values of duopolists.

Examining the characteristics of the curves in Figure 10, the decline in the equilibrium proportion λ is evident. A higher equilibrium wage propels expected values of monopolists downward, intersecting with the new curve at a lower λ level while maintaining the same monopolistic entry cost line. Similarly, the heightened wage level results in a more modest fall in expected duopolistic values' expectations, allowing the same proportion level to accommodate a reduced duopolistic entry cost.

From the perspective of monopolists, the augmented wage, driven by lower duopolistic entry costs, diminishes their profits by reducing the quantities they sell. Only the decreased competition due to a lower probability of encountering a competitor, attributed to the reduced proportion, can compensate them and uphold the monopolistic entry cost.

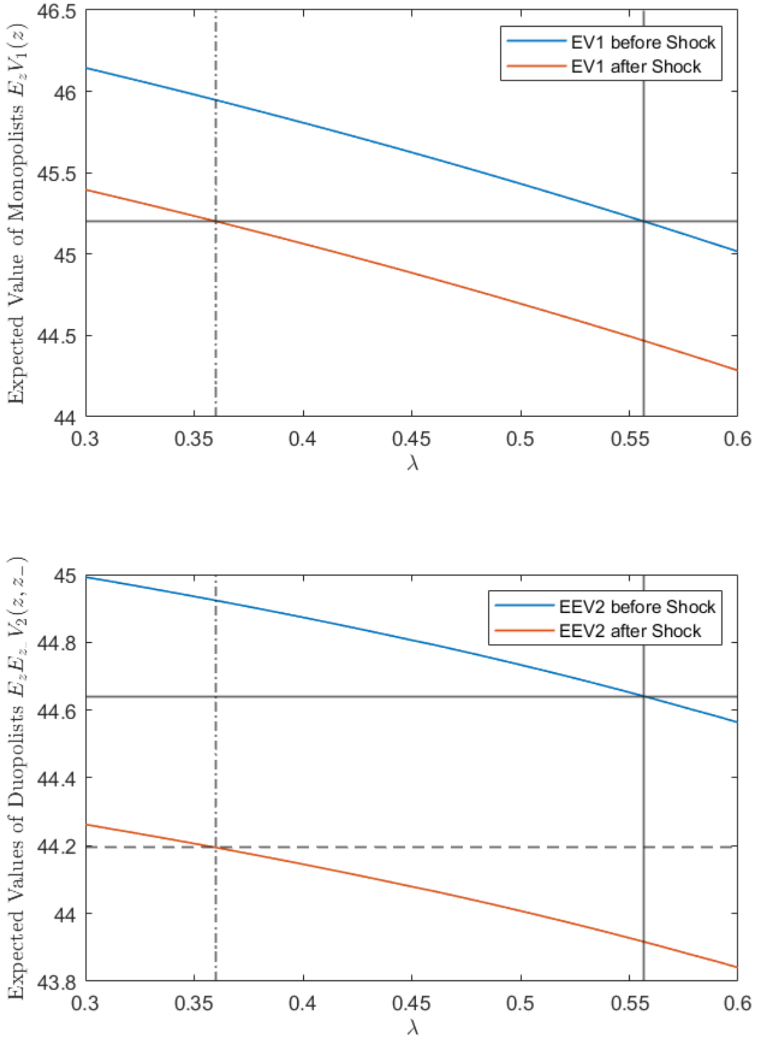

FIGURE 10.—Expected Monopolistic and Duopolistic Values With Respect to Different Proportions (λ) and Wage Levels Before and After the Shock: The upper panel displays blue and red curves representing expected monopolistic values $\int V_1(z)dH(z)$ before and after the shock, while the lower panel features blue and red curves representing expected duopolistic values' expectations $\int \mathbb{E}_{z-} V_2(z, z_-)dH(z)$ before and after the shock. The grey horizontal line in both panels represents entry costs before the shock, while the grey dashed horizontal line signifies the new entry costs for duopolists. The grey and grey dashed vertical lines in both panels indicate the proportion of duopolistic markets before and after the shock.

From the perspective of entrants, the heightened wage induces lower expected value differences, tantamount to more substantial declines in expected values of monopolists compared to expected values of duopolists. Coupled with the increased cost premium, achieving equilibrium demands a lower proportion to generate higher expected value differences and offset losses for monopolists.

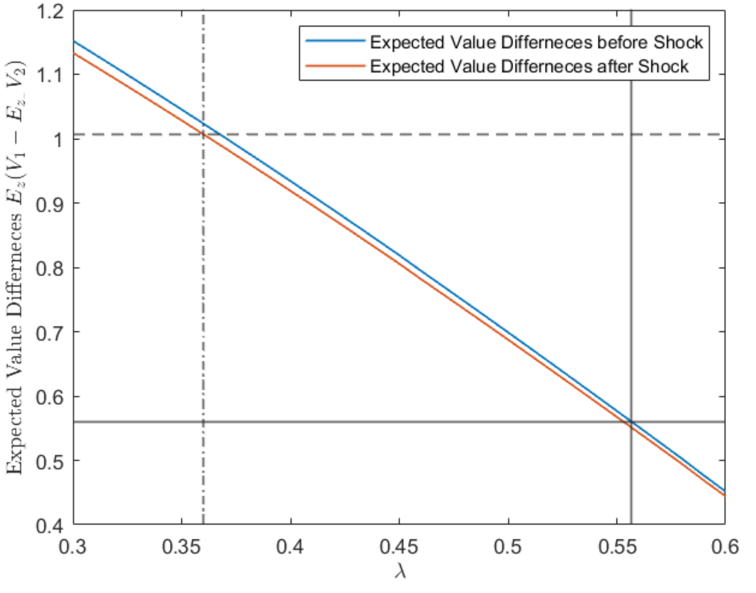

FIGURE 11.—Expected Value Difference Before and After Shock: The blue and red curves in the graph represent expected value differences before and after the shock. The grey and grey dashed horizontal lines indicate cost premia before and after the shock, while the grey and grey dashed vertical lines represent λ values before and after the shock.

6.2.4. *Influences of λ on the Markup*

Now, it's time to delve into the influence of λ on the marginal productivity distribution g_D, as well as the average markup of the economy $\overline{\mu}$ and duopolistic markets $\overline{\mu}_D$. The resulting lower λ increases the expected markup through two opposing channels. First, a lower λ implies higher weights on the markup of monopolistic markets when calculating the expected markup. Given that monopolists have a higher markup than any duopolist, this decrease in λ causes a higher expected markup. Second, a lower λ increases the expected markup within duopolistic markets (from 23.75% to 23.81%) by polarizing the productivity of duopolists. A pair of competitors with high and low productivity enjoys a higher markup compared to a pair of firms with similar productivity, as $\frac{\theta}{\theta - s}$ reaches its minimum when $s = 0.5$. As illustrated in Figure 12, a lower λ generally leads to a more polarized market share, resulting in a higher expected markup in duopolistic markets.

6.2.5. *Discussion*

In the preceding sections, I have provided an explanation of the equilibrium and its underlying mechanism. The discussion here aims to briefly analyze the implications if entrants do not have perfect foresight of the eventual distribution. In such a scenario, lower entry costs of duopolistic markets would lead to the extinction of monopolistic markets and a reduction in markup. The discussion is divided into two parts. Firstly, I focus on elucidating how

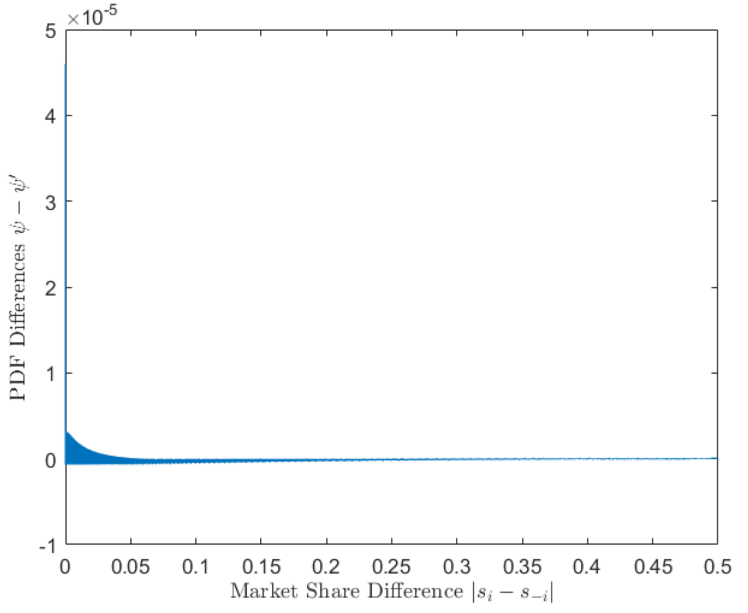

FIGURE 12.—Changes in Distribution of Market Share Differences: The graph illustrates the differences between PDFs of absolute market share differences before and after the shock. Assuming the PDF is denoted as ψ, the graph represents $\psi(|s_i - s_{-i}|) - \psi'(|s_i - s_{-i}|)$, where the prime symbol indicates the PDF after the shock.

the positive feedback mechanism causing the disappearance of monopolistic markets operates. Secondly, given that the canonical equilibrium lies beyond the explanatory boundaries of my model, which causes direct analysis impossible, I employ logical contradiction to demonstrate that the proportion of duopolistic markets is 1.

After the entry costs of duopolistic markets decrease, as mentioned above, an increase in labor demand leads to a rise in the wage. This increase results in a decrease in value differences, making innovation a sub-optimal choice, thus prompting entrants to prefer being duopolists. Consequently, the proportion of duopolistic markets increases, further lowering value differences. Since the transformation of the wage and the proportion of duopolistic markets is continuous, the choices of entrants remain stable: imitation and becoming duopolists until monopolistic markets completely disappear.

Is it possible for the proportion of duopolistic markets to be less than 1? Since entrants would not choose to become monopolists when they could potentially become duopolists, the number of monopolistic markets decreases continuously with the occurrence of exits until it reaches zero. Before monopolists disappear, there is no steady-state equilibrium. Would entrants then choose to become monopolists? This requires that the value differences be greater than before the shock, meaning that the wage must be lower than before. However, as shown in Figure 5, the path influencing the wage is straightforward, so a decrease in the wage can only occur when entry costs rise. Therefore, the proportion of duopolistic markets must be 1.

7. CONCLUSION

In this paper, I have developed a nested-CES model based on the Hopenhayn framework to shed light on the declining business dynamism observed in recent times. In contrast to the conventional wisdom, my model presents a novel explanation in the form of a decrease in entry costs. To support this finding, I have delved into the decomposition of values and the underlying mechanisms.

The significant departure from canonical models in my framework lies in two aspects. Firstly, monopolistic and duopolistic markets can transition between each other, thereby causing the entry costs of each market to no longer solely affect its own market, introducing more positive and negative feedback pathways. Secondly, entrants in this study possess perfect forecasting abilities, enabling the realization of this unconventional equilibrium point that the model is concerned with.

Through extensive analysis, I found that lower entry costs for duopolistic markets result in a decrease in the proportion of duopolistic markets (λ) and an increase in the wage level (w), contrary to conventional expectations. Additionally, this reduction in entry costs leads to a higher expected markup. The mechanisms behind these results have been carefully explored and outlined.

While this paper provides important insights into the declining business dynamism, there remains scope for further research, especially more directed and grounded empirical evidence. Understanding the nuances of these factors can offer a deeper understanding of the underlying dynamics affecting business dynamics and market structures in modern economies.

APPENDIX A: DERIVATIVES

A.1. *The Optimization Problems*

The Optimization Problems of Households The household maximizes its utility when facing the budget constraint.

$$\max_{\{C_t, c_{jt}, L_t\}} U(C_t, L_t) = \sum_{t=0}^{\infty} \beta^t [\log C_t - aL_t]$$

$$s.t.\ C_t = \left[\int_0^N c_{jt}^{\frac{\theta-1}{\theta}} dj\right]^{\frac{\theta}{\theta-1}}$$

$$1 \times C_t = \int_0^N p_{jt} c_{jt} dj = \Pi_t w_t L_t$$

The corresponding Lagrange Equation with Lagrange Multipliers Φ_1, Φ_2, and Φ_3 is as follows.

$$\mathcal{L} = \log C_t - aL_t + \Phi_1 \left\{C_t - \left[\int_0^N c_{jt}^{\frac{\theta-1}{\theta}} dj\right]^{\frac{\theta}{\theta-1}}\right\} + \Phi_2 \left\{C_t - \int_0^N p_{jt} c_{jt} dj\right\}$$
$$+ \Phi_3\{C_t - w_t L_t - \Pi_t\}$$

By solving the F.O.Cs with respect to C_t, c_{jt}, L_t, and multipliers, I get the following solutions.

$$C_t = \frac{1}{a} w_t \tag{33}$$

$$c_{jt} = p_{jt}^{-\theta} C_t \tag{34}$$

The Optimization Problems of Monopolists By definition, the marginal cost faced by any firms during any period is as follows.

$$\text{mc} = \frac{w \cdot dl}{dy} = \frac{w \cdot dl}{\gamma z l^{\gamma-1} dl} = \frac{1}{\gamma}\frac{w}{z} l^{1-\gamma} = \frac{1}{\gamma}\frac{w}{z} z^{1-\frac{1}{\gamma}} y^{\frac{1}{\gamma}-1}$$

A monopolist optimizes its profit by determining the optimal level of production, which is equivalent to determining its labor demand.

$$\max_{y_{jt}} \pi_1(y_{jt}; z_{ijt}, C_t(w_t)) = p_{jt} y_{jt} - w_t l_{ijt} \tag{35}$$

$$s.t.\ y_{jt} = z_{ijt} l_{ijt}^{\gamma} \tag{36}$$

$$y_{jt} = c_{jt} \tag{37}$$

By plugging in Equation (34) and the production function (36), I rewrite the profits into the equation below.

$$\pi_1(y_{jt}; z_{ijt}, C_t) = p_{jt}(y_{jt}, C_t) y_{jt} - w_t z_{ijt}^{-\frac{1}{\gamma}} y_{jt}^{\frac{1}{\gamma}}$$

The corresponding F.O.C is given by the following formula.

$$\frac{d\pi_1}{dy_{jt}} = p_{jt} - \frac{1}{\theta} C_t^{\frac{1}{\theta}} y_{jt}^{-\frac{1}{\theta}} - \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} y_{jt}^{\frac{1}{\gamma}-1}$$

$$= p_{jt} - \frac{1}{\theta} p_{jt} - \text{mc}_{ijt} = 0$$

Consequently, the pricing by monopolists is as follows.

$$p_{jt} = \frac{\theta}{\theta - 1} \text{mc}_{ijt}$$

Correspondingly, the optimal production is stated below,

$$\begin{aligned}
y_{jt} &= \left(\frac{\theta}{\theta - 1} \text{mc}_{ijt} \right)^{-\theta} C_t \\
&= \left(\frac{\theta}{\theta - 1} \right)^{-\theta} \left(\frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} \right)^{-\theta} y_{jt}^{\theta - \frac{\theta}{\gamma}} C_t \\
&= \left[\left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} \right)^{-\theta} C_t \right]^{\frac{\gamma}{\gamma + \theta - \theta\gamma}} \qquad (38)
\end{aligned}$$

and monopolists have the following profits.

$$\begin{aligned}
\pi_1(y_{jt}; z_{ijt}, C_t(w_t)) &= \frac{\theta}{\theta - 1} \text{mc}_{ijt} y_{jt} - w_t z_{ijt}^{-\frac{1}{\gamma}} y_{jt}^{\frac{1}{\gamma}} \\
&= \frac{\theta}{\theta - 1} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} y_{jt}^{\frac{1}{\gamma}} - w_t z_{ijt}^{-\frac{1}{\gamma}} y_{jt}^{\frac{1}{\gamma}} \\
&= \left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} - 1 \right) w_t z_{ijt}^{-\frac{1}{\gamma}} \left[\left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} \right)^{-\theta} \frac{w_t}{a} \right]^{\frac{1}{\gamma + \theta - \theta\gamma}} \\
&= \left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} - 1 \right) \left(\frac{\theta}{\theta - 1} \frac{1}{\gamma} \right)^{-\frac{\theta}{\xi}} w_t^{\frac{\xi - (\theta - 1)}{\xi}} z_{ijt}^{\frac{\theta - 1}{\xi}} a^{-\frac{1}{\xi}}
\end{aligned}$$

The Optimization Problems of Duopolists The duopolist maximizes its profit by determining the optimal production quantity y_{ijt}, considering its own productivity z_{ijt}, its competitor's quantity choice y_{-ijt}, and the price p_{jt}.

$$\begin{aligned}
&\max_{y_{ijt}} \pi_2(y_{ijt}; z_{ijt}, y_{-ijt}, C_t) = p_{jt} y_{ijt} - w_t l_{ijt} \\
&s.t.\ y_{ijt} = z_{ijt} l_{ijt}^{\gamma}
\end{aligned}$$

Assuming the market share of firm i is denoted as $s_{ijt} \equiv \frac{y_{ijt}}{y_{jt}}$, and following the process described above, the first-order condition (F.O.C) can be expressed as follows.

$$\begin{aligned}
\frac{d\pi_2}{dy_{ijt}} &= p_{jt} - \frac{1}{\theta} C_t^{\frac{1}{\theta}} y_{jt}^{-\frac{1}{\theta}} \left(\frac{y_{ijt}}{y_{jt}} \right) - \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} y_{ijt}^{\frac{1}{\gamma} - 1} \\
&= p_{jt} - \frac{s_{ijt}}{\theta} p_{jt} - \text{mc}_{ijt} = 0
\end{aligned}$$

which gives out the relationship between the price p_{jt} and the marginal cost mc_{ijt}.

$$p_{jt} = \frac{\theta}{\theta - s_{ijt}} \mathrm{mc}_{ijt} = \frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} y_{ijt}^{\frac{1}{\gamma}-1} = \frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} s_{ijt}^{\frac{1}{\gamma}-1} y_{jt}^{\frac{1}{\gamma}-1}$$

From the perspective of its competitor, the relationship is as follows.

$$p_{jt} = \frac{\theta}{\theta - s_{-ijt}} \mathrm{mc}_{-ijt} = \frac{\theta}{\theta - 1 + s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} (1 - s_{ijt})^{\frac{1}{\gamma}-1} y_{jt}^{\frac{1}{\gamma}-1}$$

Combining the two equations above, I get the implicit equation of $s_{ijt}(z_{ijt}, z_{-ijt})$.

$$\begin{aligned}
\frac{z_{ijt}^{-\frac{1}{\gamma}} y_{ijt}^{\frac{1}{\gamma}-1}}{\theta - s_{ijt}} &= \frac{z_{ijt}^{-\frac{1}{\gamma}} y_{ijt}^{\frac{1}{\gamma}-1}}{\theta - s_{ijt}} \\
\left(\frac{z_{ijt}}{z_{-ijt}}\right)^{-\frac{1}{\gamma}} &= \frac{\theta - s_{ijt}}{\theta - 1 + s_{ijt}} \left(\frac{s_{ijt}}{1 - s_{ijt}}\right)^{1-\frac{1}{\gamma}} \\
\frac{z_{ijt}}{z_{-ijt}} &= \left(\frac{\theta - s_{ijt}}{\theta - 1 + s_{ijt}}\right)^{-\gamma} \left(\frac{s_{ijt}}{1 - s_{ijt}}\right)^{1-\gamma} \qquad (39)
\end{aligned}$$

Similar to Equation (38), the production of this duopolists' market is as follows.

$$y_{jt} = \left[\left(\frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}}\right)^{-\theta} C_t\right]^{\frac{\gamma}{\gamma + \theta - \theta\gamma}}$$

while the corresponding choice of firm i is

$$y_{ijt} = s_{ijt} \left[\left(\frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}}\right)^{-\theta} C_t\right]^{\frac{\gamma}{\gamma + \theta - \theta\gamma}} \qquad (40)$$

and the profits are shown.

$$\begin{aligned}
\pi_2(y_{ijt}; z_{ijt}, z_{-ijt}, C_t(w_t)) &= \frac{\theta}{\theta - s_{ijt}} \mathrm{mc}_{ijt} y_{ijt} - w_t z_{ijt}^{-\frac{1}{\gamma}} y_{jt}^{\frac{1}{\gamma}} \\
&= \frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}} y_{ijt}^{\frac{1}{\gamma}} - w_t z_{ijt}^{-\frac{1}{\gamma}} y_{ijt}^{\frac{1}{\gamma}} \\
&= \left(\frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} - 1\right) w_t z_{ijt}^{-\frac{1}{\gamma}} \left[\left(\frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} w_t z_{ijt}^{-\frac{1}{\gamma}}\right)^{-\theta} \frac{w_t}{a}\right]^{\frac{1}{\gamma + \theta - \theta\gamma}} \\
&= s_{ijt}^{\frac{1}{\gamma}} \left(\frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma} - 1\right) \left(\frac{\theta}{\theta - s_{ijt}} \frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}} w_t^{\frac{\xi - (\theta - 1)}{\xi}} z_{ijt}^{\frac{\theta - 1}{\xi}} a^{-\frac{1}{\xi}}
\end{aligned}$$

A.2. *Aggregate Labor Demand*

The aggregate labor demand equals to the aggregate labor supply, clearing the labor market.

$$\frac{1}{a}+\epsilon \equiv L_t^S = L_t^D = N\cdot \Bigg\{(1-\lambda)\int_{z=0}^{\infty}\left(\frac{y_M(z)}{z}\right)^{\frac{1}{\gamma}} dG_M(z) + \lambda \iint_{z=0,z'=0}\left(\frac{y_D(z,z_-)}{z}\right)^{\frac{1}{\gamma}} + \left(\frac{y_D(z_-,z)}{z_-}\right)^{\frac{1}{\gamma}} dG_J(z,z_-)\Bigg\}$$

The value of y_M comes from Equation (38).

$$\begin{aligned}\left(\frac{y_M(z)}{z}\right)^{\frac{1}{\gamma}} &= z^{-\frac{1}{\gamma}}\left[\left(\frac{\theta}{\theta-1}\frac{1}{\gamma}wz^{-\frac{1}{\gamma}}\right)^{-\theta}\frac{w}{a}\right]^{\frac{1}{\gamma+\theta-\theta\gamma}} \\ &= \left(\frac{\theta}{\theta-1}\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}}\left(\frac{1}{a}\right)^{\frac{1}{\xi}} w^{\frac{1-\theta}{\xi}} z^{\frac{1}{\gamma}\left(\frac{\theta}{\xi}-1\right)}\end{aligned}$$

Here, $\xi=\gamma+\theta-\theta\gamma$

The value of $y_D(z,z_-)$ comes from Equation (40).

$$\begin{aligned}\left(\frac{y_D(z,z_-)}{z}\right)^{\frac{1}{\gamma}} &= z^{-\frac{1}{\gamma}}s^{\frac{1}{\gamma}}\left[\left(\frac{\theta}{\theta-s}\frac{1}{\gamma}w_t z^{-\frac{1}{\gamma}}\right)^{-\theta}\frac{w}{a}\right]^{\frac{1}{\gamma+\theta-\theta\gamma}} \\ &= \left(\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}}\left(\frac{1}{a}\right)^{\frac{1}{\xi}} w^{\frac{1-\theta}{\xi}} z^{\frac{1}{\gamma}\left(\frac{\theta}{\xi}-1\right)}\left(\frac{\theta}{\theta-s}\right)^{-\frac{\theta}{\xi}} s^{\frac{1}{\gamma}}\end{aligned}$$

Similarly, the value of $\left(\frac{y_D(z_-,z)}{z_-}\right)^{\frac{1}{\gamma}}$ exhibits the following form.

$$\begin{aligned}\left(\frac{y_D(z_-,z)}{z_-}\right)^{\frac{1}{\gamma}} &= z_-^{-\frac{1}{\gamma}}s_-^{\frac{1}{\gamma}}\left[\left(\frac{\theta}{\theta-s_-}\frac{1}{\gamma}w_t z_-^{-\frac{1}{\gamma}}\right)^{-\theta}\frac{w}{a}\right]^{\frac{1}{\gamma+\theta-\theta\gamma}} \\ &= \left(\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}}\left(\frac{1}{a}\right)^{\frac{1}{\xi}} w^{\frac{1-\theta}{\xi}} z_-^{\frac{1}{\gamma}\left(\frac{\theta}{\xi}-1\right)}\left(\frac{\theta}{\theta-s_-}\right)^{-\frac{\theta}{\xi}} s_-^{\frac{1}{\gamma}}\end{aligned}$$

Combining the results above, I get the labor market clearing condition which solves the value of N, the number of markets.

$$\begin{aligned}\frac{1}{a} = N\cdot\Bigg\{&(1-\lambda)\int_{z=0}^{\infty}\left\{\left(\frac{\theta}{\theta-1}\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}}\left(\frac{1}{a}\right)^{\frac{1}{\xi}} w^{\frac{1-\theta}{\xi}} z^{\frac{1}{\gamma}\left(\frac{\theta}{\xi}-1\right)}\right\} dG_M(z) \\ &+\lambda\iint_{z,z'}\left(\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}}\left(\frac{1}{a}\right)^{\frac{1}{\xi}} w^{\frac{1-\theta}{\xi}} \\ &\left\{z^{\frac{1}{\gamma}\left(\frac{\theta}{\xi}-1\right)}\left(\frac{\theta}{\theta-s}\right)^{-\frac{\theta}{\xi}} s^{\frac{1}{\gamma}} + z_-^{\frac{1}{\gamma}\left(\frac{\theta}{\xi}-1\right)}\left(\frac{\theta}{\theta-s_-}\right)^{-\frac{\theta}{\xi}} s_-^{\frac{1}{\gamma}}\right\} dG_J(z,z_-)\Bigg\}\end{aligned}$$

$$
= N \cdot \left(\frac{1}{\gamma}\right)^{-\frac{\theta}{\xi}} \left(\frac{1}{a}\right)^{\frac{1}{\xi}} w^{\frac{1-\theta}{\xi}} \left\{ (1-\lambda) \left(\frac{\theta}{\theta-1}\right)^{-\frac{\theta}{\xi}} \int_{z=0}^{\infty} z^{\frac{1}{\gamma}(\frac{\theta}{\xi}-1)} dG_M(z) \right.
$$

$$
\left. + \lambda \iint_{z,z'} z^{\frac{1}{\gamma}(\frac{\theta}{\xi}-1)} \left(\frac{\theta}{\theta-s}\right)^{-\frac{\theta}{\xi}} s^{\frac{1}{\gamma}} + z_-^{\frac{1}{\gamma}(\frac{\theta}{\xi}-1)} \left(\frac{\theta}{\theta-s_-}\right)^{-\frac{\theta}{\xi}} s_-^{\frac{1}{\gamma}} dG_J(z, z_-) \right\} \tag{41}
$$

APPENDIX B: NUMERICAL SOLUTIONS

B.1. *Overview*

Algorithm 1 Numerical Solution of this Model

Require: parameters

Ensure: Value Functions V_1, V_2, steady-state distribution $G_M(z), G_D(z)$, Number of markets N, proportion of duopolistic markets λ, the equilibrium wage level w.

1: Initialize the parameters
2: Guess the value of wage w and the proportion of duopolistic markets λ
3: Given the guess of w and λ, by iterating the value functions (Equations (22) and (23)), get $\{V_1|\lambda, w\}$, $\{V_2|\lambda, w\}$
4: Given the value of λ, by solving the discretization form of steady-state productivity distributions equation (Equation (24)), get the steady-state productivity distributions $G_M(z)$ and $G_D(z)$
5: Adjust the guess of w and λ until entry conditions (Equation (28)) meet.
6: Use the labor market clearing condition (Equation (26)) to pin down the value N

B.2. *Steady-State Productivity Distributions*

The technology to solve the steady-state PDFs in this paper is as follows. First, equalize $g'_M(\cdot)$ to $g_M(\cdot)$ and $g'_D(\cdot)g'_D(\cdot)$ to $g_D(\cdot)g_D(\cdot)$. Second, transfer the Equations (20) and (21) into matrix forms. Third, solve the discretized equations.

The transition of Equation (20) is as below:

$$
\begin{aligned}
\mathbf{g_M} &= \delta \mathbf{h} + \frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta} \cdot \mathbf{\Gamma}^T \cdot \mathbf{g_M} \\
&\quad + \frac{(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta} \cdot \mathbf{\Gamma}^T \cdot \mathbf{g_D} \\
\left\{ \mathbf{I} - \frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta} \mathbf{\Gamma}^T \right\} \mathbf{g_M} &= \delta \mathbf{h} + \frac{(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta} \cdot \mathbf{\Gamma}^T \cdot \mathbf{g_D} \\
\mathbf{g_M} &= \left\{ \mathbf{I} - \frac{(1-\lambda)(1-\delta)^2}{(1-\lambda)(1-\delta)+\lambda\delta} \mathbf{\Gamma}^T \right\}^{-1} \\
&\quad \cdot \left\{ \delta \mathbf{h} + \frac{(1-\delta)\lambda\delta}{(1-\lambda)(1-\delta)+\lambda\delta} \cdot \mathbf{\Gamma}^T \cdot \mathbf{g_D} \right\}
\end{aligned} \tag{42}
$$

The bold fonts in this equation are K-dimensional vectors or K^2-dimensional matrices corresponding to those variables in Equation (20). Since I apply column vectors as default in this paper, $\mathbf{\Gamma}^T \cdot \mathbf{g_M}$ represents the evolution of PDF.

Similarly, the transition of Equation (21) is:

$$\begin{aligned}
\tilde{\mathbf{g}}_\mathbf{D} \cdot \tilde{\mathbf{g}}_\mathbf{D}^T =& (1-\delta)\left(\mathbf{\Gamma}^T \cdot \mathbf{g_D}\right) \cdot \left(\mathbf{\Gamma}^T \cdot \mathbf{g_D}\right)^T + \\
& \frac{1}{2}\frac{(1-\lambda)(1-\delta)\delta}{(1-\lambda)(1-\delta)+\lambda\delta}[(\mathbf{\Gamma}^T \cdot \mathbf{g_M}) \cdot \mathbf{h}^T + \mathbf{h} \cdot (\mathbf{\Gamma}^T \cdot \mathbf{g_M})^T] + \\
& \frac{1}{2}\frac{\lambda\delta^2}{(1-\lambda)(1-\delta)+\lambda\delta}[(\mathbf{\Gamma}^T \cdot \mathbf{g_D}) \cdot \mathbf{h}^T + \mathbf{h} \cdot (\mathbf{\Gamma}^T \cdot \mathbf{g_D})^T] \\
\tilde{\mathbf{g}}_\mathbf{D} \cdot \tilde{\mathbf{g}}_\mathbf{D}^T =& (1-\delta)\mathbf{\Gamma}^T \cdot \mathbf{g_D} \cdot \mathbf{g_D}^T \cdot \mathbf{\Gamma} + \\
& \frac{1}{2}\frac{(1-\lambda)(1-\delta)\delta}{(1-\lambda)(1-\delta)+\lambda\delta}[\mathbf{\Gamma}^T \cdot \mathbf{g_M} \cdot \mathbf{h}^T + \mathbf{h} \cdot \mathbf{g_M}^T \cdot \mathbf{\Gamma}] + \\
& \frac{1}{2}\frac{\lambda\delta^2}{(1-\lambda)(1-\delta)+\lambda\delta}[\mathbf{\Gamma}^T \cdot \mathbf{g_D} \cdot \mathbf{h}^T + \mathbf{h} \cdot \mathbf{g_D}^T \cdot \mathbf{\Gamma}]
\end{aligned} \tag{43}$$

Here, $\mathbf{g_D} \cdot \mathbf{g_D}^T$ is the outer product of marginal PDF in this period and $\tilde{\mathbf{g}}_\mathbf{D} \cdot \tilde{\mathbf{g}}_\mathbf{D}^T$ is the outer product in the next period. Equation (42) links the PDF of monopolists' productivity and marginal PDF of duopolists' productivity. Equation (43) provides the way to solve $\tilde{\mathbf{g}}_\mathbf{D}$ recursively.

APPENDIX C: MOMENT CONDITIONS

This section presents the moment estimates used to internally calibrate the three key parameters in the model: the persistence (ρ) and standard error (σ) of the productivity process, and the proportion of duopolistic markets (λ).

C.1. *The persistence ρ*

Based on the aforementioned calculations, the sales of monopolist i in market j during period t can be expressed as follows.

$$sale_{ijt} \equiv p_{jt} y_{ijt} = \left(\frac{\theta}{\theta-1}\frac{1}{\gamma}w_t\right)^{\frac{\gamma(1-\theta)}{\gamma+\theta-\theta\gamma}} Y_t^{\frac{1}{\gamma+\theta-\theta\gamma}} z_{ijt}^{\frac{\theta-1}{\gamma+\theta-\theta\gamma}}$$

Furthermore, the AR(1) process of productivity applies to all firms, causing only the period number to influence the calculations below. Meanwhile, in the steady-state equilibrium, both the wage and aggregate outputs remain constant. Therefore, I can succinctly express the firm-level sales.

$$sale_t = \Phi_0 z_t^{\Phi_1}$$

In this context, Φ_0 is defined as $\left(\frac{\theta}{\theta-1}\frac{1}{\gamma}w_t\right)^{\frac{\gamma(1-\theta)}{\gamma+\theta-\theta\gamma}} Y_t^{\frac{1}{\gamma+\theta-\theta\gamma}}$ which remains constant across all periods. Additionally, Φ_1 is given by $\frac{\theta-1}{\gamma+\theta-\theta\gamma}$.

Similarly, the firm-level sales during period $t-1$ can be written as follows.

$$sale_{t-1} = \Phi_0 z_{t-1}^{\Phi_1}$$

Given the logarithmic representation of productivity, I proceed to transform the equations of sales into logarithmic form.

$$\log sale_t = \log \Phi_0 + \Phi_1 \log z_t = \log \Phi_0 + \Phi_1(\rho \log z_{t-1} + \epsilon_t)$$
$$\log sale_{t-1} = \log \Phi_0 + \Phi_1 \log z_{t-1}$$

Theoretically, the value of ρ equals the auto-correlation of sales $\{sale_t\}_{t=1}$

$$\begin{aligned}
Corr(\log sale_t, \log sale_{t-1}) &= \frac{Cov(\log sale_t, \log sale_{t-1})}{Var(\log sale_t)} \\
&= \frac{\mathbb{E}[(\log sale_t - \mathbb{E}\log sale_t)\cdot(\log sale_{t-1} - \mathbb{E}\log sale_{t-1})]}{\mathbb{E}[(\log sale_t - \mathbb{E}\log sale_t)\cdot(\log sale_t - \mathbb{E}\log sale_t)]} \\
&= \frac{\mathbb{E}[\Phi_1^2(\rho \log^2 z_{t-1} + \epsilon_t \log z_{t-1})]}{\mathbb{E}[\Phi_1^2 \log^2 z_{t-1}]} \\
&= \frac{\Phi_1^2 \rho \mathbb{E} \log^2 z_{t-1}}{\Phi_1^2 \mathbb{E} \log^2 z_{t-1}} \\
&= \rho
\end{aligned}$$

Thus, the moment condition for estimating the parameter ρ can be expressed as follows.

$$\hat{\rho} = Corr(\log \widetilde{sale}_t, \log \widetilde{sale}_{t-1}) \tag{44}$$

where $\{\widetilde{sale}_t\}_{t=1}$ represents the firm-level sales data.

C.2. *The standard error σ*

I utilize the growth rate of sales, which is dimensionless, to estimate the standard error of the productivity process, denoted as σ. The growth rate has the following formula.

$$\begin{aligned}
g_t^{sales} &= \log(sale_t) - \log(sale_{t-1}) \\
&= (\rho - 1)\Phi_1 \log(z_{t-1}) + \Phi_1 \epsilon_t
\end{aligned}$$

Thus, the variance of the growth rate of sales can be presented as follows.

$$Var(g_t^{sale}) = \Phi_1^2(Var(\log z_{t-1}) + \sigma^2) = \Phi_1^2 \frac{2}{1+\rho}\sigma^2$$

Consequently, the moment condition for estimating σ can be formulated.

$$\hat{\sigma^2}(\hat{\theta}, \hat{\gamma}, \hat{\rho}) = \frac{1+\hat{\rho}}{2\Phi_1^2(\tilde{\theta}, \tilde{\gamma})} Var(\widetilde{g_t^{sale}}) \tag{45}$$

C.3. *The proportion of the duopolistic markets λ*

This parameter is intricately intertwined with the expecation of the markup distribution.

$$\mathbb{E}(\text{markup}) = \lambda \frac{\theta}{\theta - 1}$$

$$+(1-\lambda)\iint_{z,z_-}\left[\frac{\theta\cdot s(z,z_-)}{\theta-s(z,z_-)}+\frac{\theta\cdot(1-s(z,z_-))}{\theta-(1-s(z,z_-))}\right]dG^J(z,z_-)$$

The expected markup is determined by the weighted average of the average markup in monopoly and duopolistic markets, taking into account the proportions of these markets. All monopolists possess a markup of $\frac{\theta}{\theta-1}$. Within each duopolistic market, a duopolist with productivity z and its competitor with productivity z_- have markups of $\frac{\theta}{\theta-s(z,z_-)}$ and $\frac{\theta}{\theta-(1-s(z,z_-))}$, respectively. The aggregate markup of a duopolistic market, commonly employed in empirical research, is given by the weighted sum of both firms' markups, with market shares serving as the weights: $\frac{\theta\cdot s(z,z_-)}{\theta-s(z,z_-)}+\frac{\theta\cdot(1-s(z,z_-))}{\theta-(1-s(z,z_-))}$. To obtain the aggregate expected markup of duopolistic markets, I take the expectation with respect to the joint distribution of productivity $G^J(z,z_-)$. The variance formula follows the same logical framework.

In light of the expressions provided above, I express the moment condition in terms of markup distribution data $\widetilde{\text{markup}}$ and other relevant parameters.

$$\mathbb{E}(\widetilde{\text{markup}})=\hat{\lambda}\frac{\hat{\theta}}{\hat{\theta}-1}+(1-\hat{\lambda})\iint_{z,z_-}\left[\frac{\hat{\theta}\cdot s(z,z_-;\hat{\theta})}{\hat{\theta}-s(z,z_-;\hat{\theta})}\right.$$
$$\left.+\frac{\hat{\theta}\cdot(1-s(z,z_-;\hat{\theta}))}{\hat{\theta}-(1-s(z,z_-;\hat{\theta}))}\right]dG^J(z,z_-;\hat{\rho},\hat{\sigma},\hat{\lambda},\hat{\delta}) \tag{46}$$

APPENDIX D: AN ALTERNATIVE EXPLANATION BASED ON EXCESS PROFITS

In this appendix, I endeavor to adopt the perspective of entrants to establish the relationship between higher wages and the proportion of duopolistic markets with the expected value differences by analyzing the excess profits associated with choosing to be monopolists.

Image that an entrant is confronted with a decision akin to determining whether to incur a cost premium, denoted as $\mathcal{C}_M-\mathcal{C}_D$. Opting to pay this premium results in entry as a monopolist, while refraining leads to entry as a duopolist. At this point, two parallel universes emerge, let's call them the monopolistic universe and the duopolistic universe, encompassing productivity paths experienced by the entrant and its duality. Everything in these two universes is identical. Without considering exit, the benefits of choosing to be a monopolist primarily stem from the excess profits $\pi_1(z_t)-\mathbb{E}_{z_{-,t}\sim g_t}\pi_2(z_t,z_{-,t})$ each period. These excess profits persist until other entrants enter the monopolistic market or until the entrant's duality becomes a monopolist in the duopolistic universe, let's assume for a period of length $\mathbb{E}T$. Now, let's consider exit. As a monopolist, exiting incurs losses (i.e.,LE below) equivalent to the product of the earnings as a duopolist each period and the excess duration of duopolist survival. Of course, there is also the possibility of the duopolist exiting before the monopolist, in which case the entrant would receive exit benefits (i.e.,BE below), equal to the product of the earnings as a monopolist each period and the excess duration of monopolist survival. An approximate decomposition of value differences is outlined below.

$$V_1(z)-\mathbb{E}_{z_-}V_2(z,z_-)\sim\sum_{t=1}^{\mathbb{E}T}(\pi_1(z_t)-\mathbb{E}_{z_{-,t}\sim g_t}\pi_2(z_t,z_{-,t}))-\text{LE}+\text{BE} \tag{47}$$

The equation presented here serves merely as an approximation. The focus lies in the positive correlation between the left and right sides of the equation, hence I have employed the symbol $\sim$. As mentioned above, the first term encapsulates the total excess profits attained by the entrant during its tenure as a monopolist before the convergence of the two universes. On average, there exist $\mathbb{E}T$ periods during which the entrant reaps extra profits as a monopolist. In any given period t, the extra profits are $\pi_1(z_t) - \mathbb{E}_{z_{-,t}\sim g_t}\pi_2(z_t, z_{-,t})$. Here z_t and $z_{-,t}$ are the productivity of the entrant and its hypothetical competitor in period t. When $t = 1$, z_1 represents the initial productivity of the entrant, while $z_{-,1}$ embodies the productivity following the productivity distribution of monopolists, g_M. The entrant compares its monopolist profits with expected duopolistic profits, calculated concerning the probability density g_t. When $t = 1$, $g_t = g_M$ since the productivity of imaginary competitors follows g_M. During period t, the density is $\Pi_{\tau=1}^{t-1}\Gamma(z_{\tau+1}|z_\tau)\Gamma(z_{-,\tau+1}|z_{-,\tau})g_M$.

The second term, denoted as LE, signifies the loss from exit.

$$\text{LE} \sim \sum_{t=1}^{\mathbb{E}T_L} \mathbb{E}_{z_{-,t}\sim g_t}\pi_2(z_t, z_{-,t}) \tag{48}$$

As the monopolist faces a higher exit rate, its expected survival periods are shorter than both $\mathbb{E}T$ and the survival periods of the duopolist. In the equation above, I label the length of excess survival periods as $\mathbb{E}T_L$. Upon exit, this monopolist garners zero profits, incurring a loss each period. This loss equals $\mathbb{E}_{z_{-,t}\sim g_t}\pi_2(z_t, z_{-,t})$ equivalent to the profits as a duopolist. Consequently, the LE is explicitly influenced by $\pi_2(z_t, z_{-,t})$. However, it is also implicitly influenced by $\mathbb{E}T$.

Similarly, the third term, denoted as BE, signifies the benefits from (duality's) exit.

$$\text{BE} \sim \sum_{t=1}^{\mathbb{E}T_B} \pi_1(z_t) \tag{49}$$

Here $\mathbb{E}T_B$ is the excess survival period of the monopolist.

In the context of the decomposed value differences, the impact of w and the proportion of duopolistic markets λ can be analyzed. Without affecting $\mathbb{E}T$ and g_t, a higher wage decreases the extra profits as analyzed in the context. Now, the illustration of Figure 6 is straightforward. A higher wage reduces the extra profits in each period while keeping $\mathbb{E}T$ and g_t constant. The first term in Equation (47) becomes smaller. Meanwhile, since $\mathbb{E}_{z_{-,t}\sim g_t}\pi_2(z_t, z_{-,t})$ also decreases in all periods, the loss of exit also decreases. However, the benefits of exit decreases for lower $\pi_1(z_t)$ in each excess survival period. Consequently, entrants with lower productivity exhibit lower value differences, as the reduction in the extra profits and benefits of exit dominate the decrease in the loss of exit. Conversely, entrants whose productivity lies in the high region or the region where the value differences are negative experience an augmentation, as the decrease in the loss of exit takes precedence.

Now, shifting our focus to λ, an increased λ reduces the overall excess profits due to a shorter period monopolized $\mathbb{E}T$ and decreased extra profits. Simultaneously, it decreases the benefits of exits by shortening the excess survival period $\mathbb{E}T_B$ and reducing monopolistic profits $\pi_1(z_t)$. However, it may elevate the loss of exit due to larger $\mathbb{E}_{z_{-,t}\sim g_t}\pi_2(z_t, z_{-,t})$ resulting from weaker imaginary competitors, yet may mitigate this loss through a reduced probability of exit caused by a shorter $\mathbb{E}T$. When the entrant has low productivity, its diminished value differences stem from both reduced extra profits and increased loss of exit. Conversely, for entrants with higher productivity, the dominant effect contributes to a decrease in loss.

TABLE E.I

COUNTERFACTUAL EXPERIMENTS RESULTS: INCREASE OF THE ENTRY COSTS OF DUOPOLISTIC MARKETS

$\mathcal{C}'_D$	Wage w	Proportion λ	Number of Markets N	Average Markup $\overline{\mu}$	Average Duopolists' Markup $\overline{\mu}_D$
45.0876	9.7863	0.7403	2926	26.18%	23.67%

Note: Counterfactual experiments results: 1 percentage increase of entry costs of duopolistic markets

TABLE E.II

COUNTERFACTUAL EXPERIMENTS RESULTS: DECREASE OF ENTRY COSTS OF MONOPOLISTIC MARKETS

$\mathcal{C}'_M$	Wage w	Proportion λ	Number of Markets N	Average Markup $\overline{\mu}$	Average Duopolists' Markup $\overline{\mu}_D$
44.7499	9.8967	0.7424	2926	26.44%	23.67%

Note: Counterfactual experiments results: 1 percentage decrease of entry costs of monopolistic markets

APPENDIX E: OTHER COUNTERFACTUAL EXPERIMENTS

In this appendix, I present the outcomes of two additional counterfactual experiments, namely, a one percentage increase in the entry costs of duopolistic markets and a one percentage decrease in the entry costs of monopolistic markets. Given that the obtained results align with the inferences drawn in the main text regarding the mechanism, I simply list the outcomes in the tables below.

As presented in Table E.I, when the entry costs of duopolistic markets rise from 44.6412 to 45.0876, the number of markets declines from 3050 to 2926. Consequently, the equilibrium wage decreases from 10 to 9.7863, while the proportion of duopolistic markets escalates from 55.65% to 74.03%. This shift results in a decrease in the average markup of the economy from 28% to 26.18%.

A one percentage increase in the entry costs of monopolistic markets yields similar outcomes. The number of markets also decreases, from 3050 to 2926. Meanwhile, the equilibrium wage decreases from 10 to 9.8967, and the proportion increases to 74.24%. Consequently, the after-shock average markup of the economy decreases to 26.44%.

APPENDIX F: GRAPHS

In this appendix, I show graphs not shown in context.

REFERENCES

ACEMOGLU, DARON, VASCO M CARVALHO, ASUMAN OZDAGLAR, AND ALIREZA TAHBAZ-SALEHI (2012): "The network origins of aggregate fluctuations," *Econometrica*, 80 (5), 1977–2016. []

AGHION, PHILIPPE, ANTONIN BERGEAUD, TIMO BOPPART, PETER J KLENOW, AND HUIYU LI (2023): "A theory of falling growth and rising rents," *Review of Economic Studies*, 90 (6), 2675–2702. []

AHMAD, MUMTAZ, JOHN FERNALD, HASHMAT KHAN, ET AL. (2019): "Returns to Scale in US Production, Redux," Tech. rep., Carleton University, Department of Economics. []

AKCIGIT, UFUK, YUSUF EMRE AKGUNDUZ, SEYIT MUMIN CILASUN, ELIF OZCAN-TOK, AND FATIH YILMAZ (2020): "Facts on business dynamism in Turkey," *European Economic Review*, 128, 103490. []

AKCIGIT, UFUK AND SINA T ATES (2021): "Ten facts on declining business dynamism and lessons from endogenous growth theory," *American Economic Journal: Macroeconomics*, 13 (1), 257–298. []

——— (2023): "What happened to US business dynamism?" *Journal of Political Economy*, 131 (8), 2059–2124. []

AKCIGIT, UFUK, SALOMÉ BASLANDZE, AND FRANCESCA LOTTI (2023): "Connecting to power: political connections, innovation, and firm dynamics," *Econometrica*, 91 (2), 529–564. []

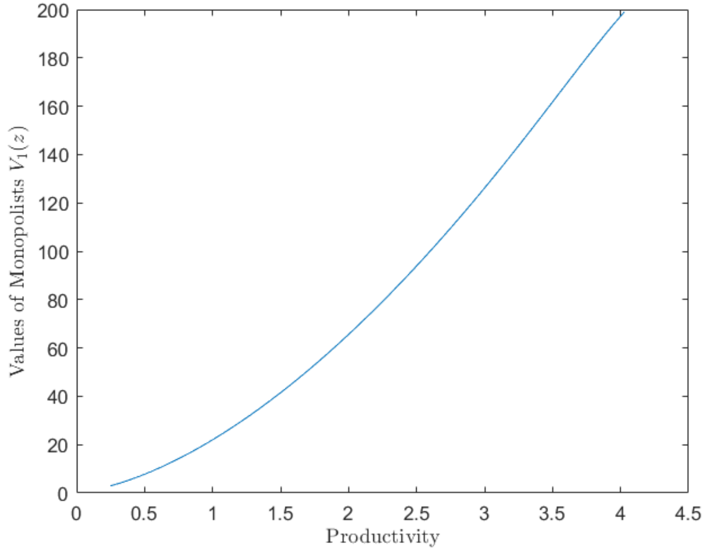

FIGURE F.1.—Monopolists' Values After Shock: The x-axis represents the productivity of monopolists, and the y-axis indicates their corresponding values.

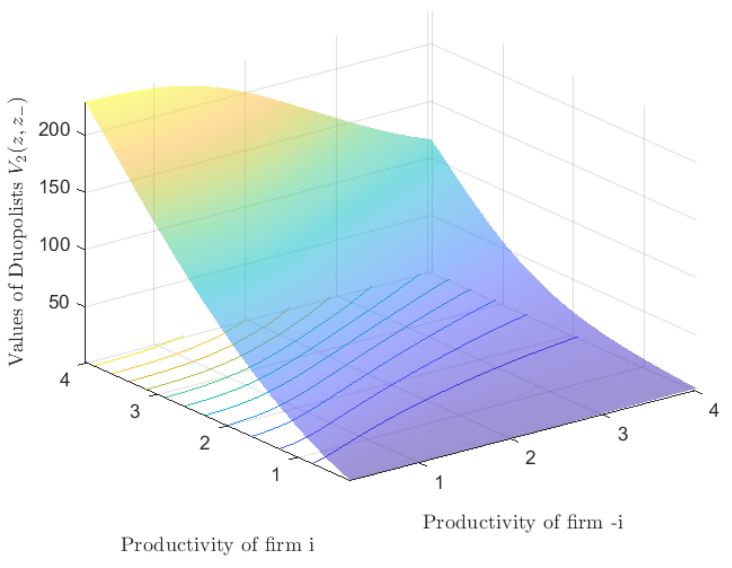

FIGURE F.2.—Duopolists' Values After the Shock: The x-axis measures the productivity of Duopolist i, while the y-axis gives the productivity of its competitor (firm -i). The z-axis provides the corresponding values of firm i. The curves on the x-y plane represent contours of duopolist's values.

ALON, TITAN, DAVID BERGER, ROBERT DENT, AND BENJAMIN PUGSLEY (2018): "Older and slower: The startup deficits lasting effects on aggregate productivity growth," *Journal of Monetary Economics*, 93, 68–85. []

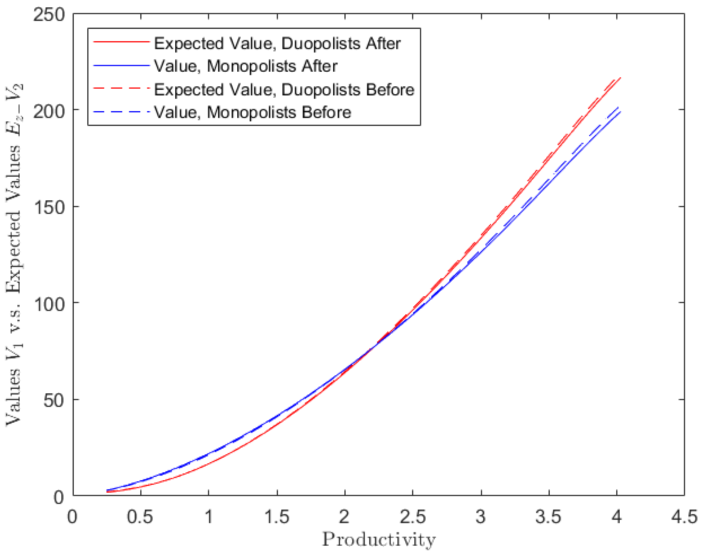

FIGURE F.3.—Before and After Shock $V_1(z)$ vs. $\mathbb{E}_{z_-}V_2(z)$: The x-axis represents productivity levels, and the y-axis displays corresponding values. The red and red dash curves depict the values of monopolists before and after the shock, while the blue and blue dash curves represent the expected value of duopolists before and after the shock, denoted as $\mathbb{E}_{z_-}V_2(z,z_-) = \int V_2(z,z_-)dG_M(z_-)$.

ATKESON, ANDREW AND ARIEL BURSTEIN (2008a): "Pricing-to-market, trade costs, and international relative prices," *American Economic Review*, 98 (5), 1998–2031. []

——— (2008b): "Trade costs, pricing to market, and international relative prices," *American Economic Review*, 98 (5), 1998–2031. []

AUTOR, DAVID, DAVID DORN, LAWRENCE F KATZ, CHRISTINA PATTERSON, AND JOHN VAN REENEN (2020): "The fall of the labor share and the rise of superstar firms," *The Quarterly Journal of Economics*, 135 (2), 645–709. []

BASLANDZE, SALOME (2016): "The role of the it revolution in knowledge diffusion, innovation and reallocation," in *2016 Meeting Papers*, Society for Economic Dynamics, vol. 1509. []

BERGER, DAVID, KYLE HERKENHOFF, AND SIMON MONGEY (2022): "Labor market power," *American Economic Review*, 112 (4), 1147–1193. []

BIJNENS, GERT AND JOZEF KONINGS (2020): "Declining business dynamism in Belgium," *Small Business Economics*, 54, 1201–1239. []

BIONDI, FILIPPO, SERGIO INFERRERA, MATTHIAS MERTENS, AND JAVIER MIRANDA (2023): "Declining business dynamism in Europe: The role of shocks, market power, and technology," Tech. rep., IWH Discussion Papers. []

BOTTAZZI, GIULIO AND ANGELO SECCHI (2003): "Common properties and sectoral specificities in the dynamics of US manufacturing companies," *Review of Industrial Organization*, 23, 217–232. []

BRODA, CHRISTIAN AND DAVID E WEINSTEIN (2006): "Globalization and the Gains from Variety," *The Quarterly journal of economics*, 121 (2), 541–585. []

BURNSIDE, CRAIG, MARTIN EICHENBAUM, AND SERGIO REBELO (1995): "Capital utilization and returns to scale," *NBER macroeconomics annual*, 10, 67–110. []

CALVINO, FLAVIO, CHIARA CRISCUOLO, AND RUDY VERLHAC (2020): "Declining business dynamism," *OECD Science, Technology and Industry Policy Papers*. []

CERDEIRO, DIEGO A AND CIAN RUANE (2022): *China's Declining Business Dynamism*, International Monetary Fund. []

CHRISTOPOULOU, R AND P VERMEULEN (2008): "Markups in the Euro Area and the US over the Period 1981–2004, European Central Bank," Tech. rep., Working Paper. []

CRISCUOLO, CHIARA, PETER N GAL, AND CARLO MENON (2014): "The dynamics of employment growth: New evidence from 18 countries," . []

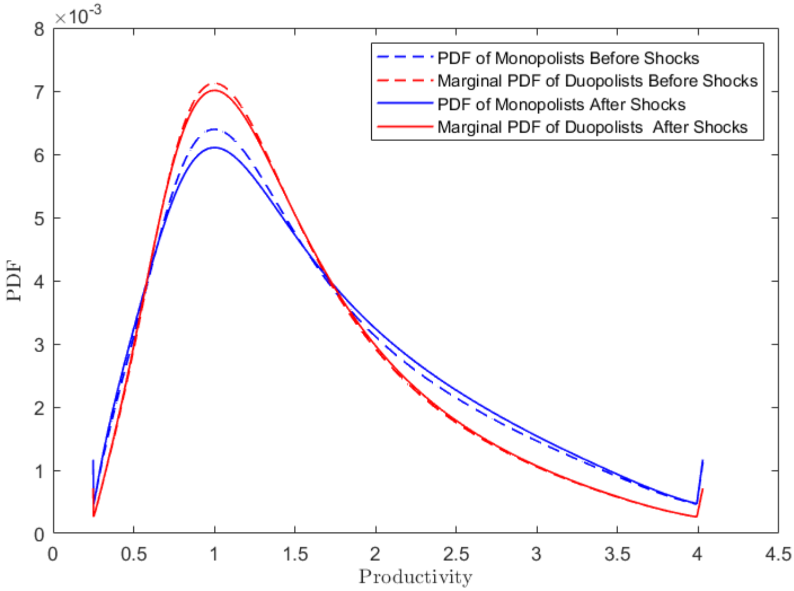

FIGURE F.4.—Before and After the Shock Distribution of Monopolistic Productivity and Marginal Distribution of Duopolistic Productivity: The x-axis displays productivity levels, and the y-axis represents probability density. The blue dash and blue curve represent the probability density function (PDF) of monopolists' productivity before and after the shock, while the red dash and red curves illustrate the marginal PDFs of duopolists' productivity before and after the shock.

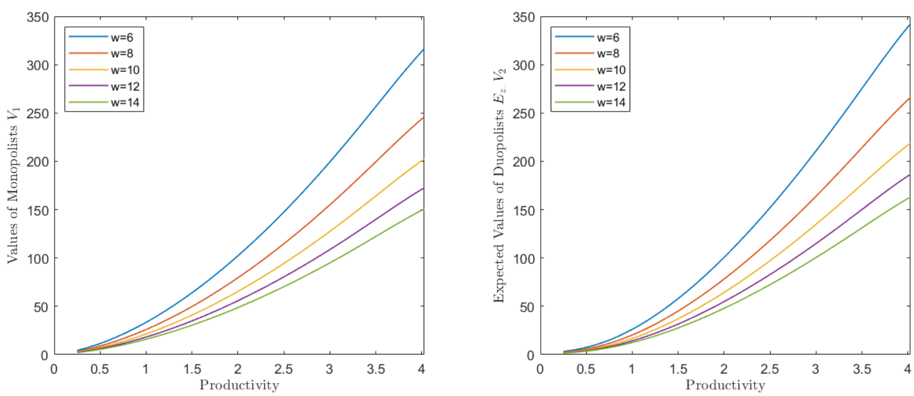

FIGURE F.5.—Monopolistic and Expected Duopolistic Values at Constant λ Across Varying Wage Levels: The x-axis indicates productivity levels, and the y-axis presents corresponding values. This graph compares the values of monopolists and the expected values of duopolists at a consistent λ while varying wage levels.

CUNNINGHAM, COLLEEN, FLORIAN EDERER, AND SONG MA (2021): "Killer acquisitions," *Journal of Political Economy*, 129 (3), 649–702. []

DAVIS, STEVEN J AND JOHN C HALTIWANGER (2019): "Dynamism diminished: The role of housing markets and credit conditions," Tech. rep., National Bureau of Economic Research. []

DE LOECKER, JAN, JAN EECKHOUT, AND SIMON MONGEY (2021): "Quantifying market power and business dynamism in the macroeconomy," Tech. rep., National Bureau of Economic Research. []

DE RIDDER, MAARTEN (2019): "Market power and innovation in the intangible economy," . []

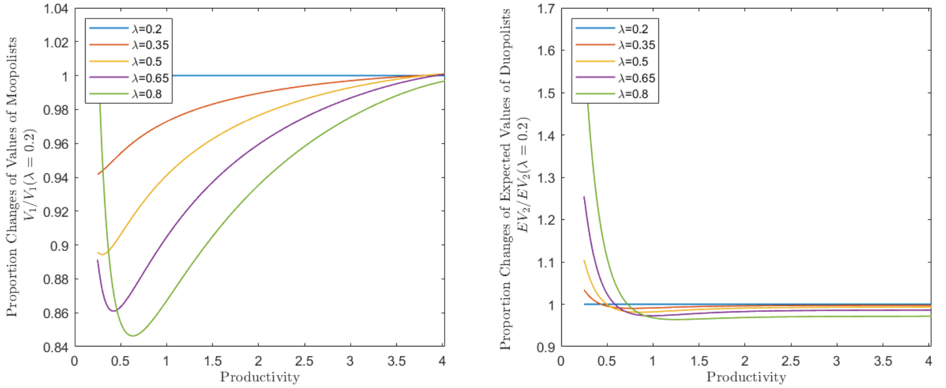

FIGURE F.6.—Proportion of Value Changes of Monopolists and Expected Values Changes of Duopolists at Constant Wage Level Across Varying λ: The x-axis represents productivity levels, while the y-axis displays corresponding value percentage changes. The benchmarks are the values when $\lambda = 0.2$. This graph compares the values of monopolists and the expected values of duopolists at a consistent wage level while varying λ.

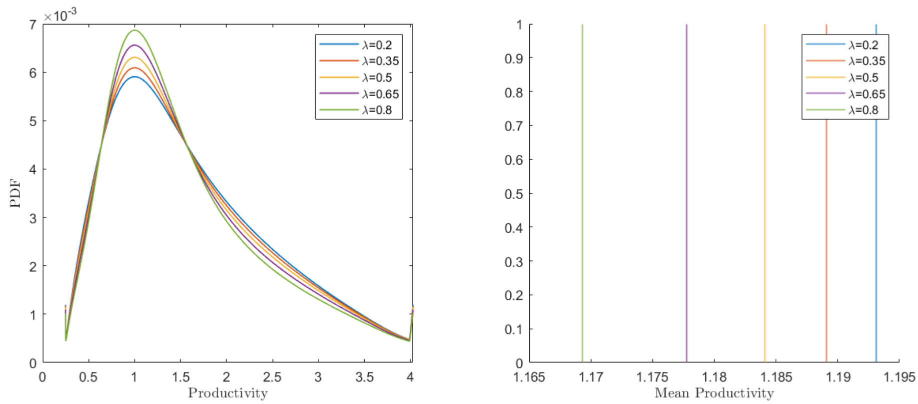

FIGURE F.7.—Divergent Productivity Distributions in Monopolistic Markets Under Various λ Values with a Consistent Wage Level: The left panel displays distinct Probability Density Functions (PDFs), while the right panel showcases the corresponding expectations of the distributions depicted in the left panel. All scenarios maintain a constant wage level.

DECKER, RYAN, JOHN HALTIWANGER, RON JARMIN, AND JAVIER MIRANDA (2014a): "The role of entrepreneurship in US job creation and economic dynamism," *Journal of Economic Perspectives*, 28 (3), 3–24. []

——— (2014b): "The secular decline in business dynamism in the US," *Unpublished draft, University of Maryland*, 3. []

DECKER, RYAN A, JOHN HALTIWANGER, RON S JARMIN, AND JAVIER MIRANDA (2016a): "Declining business dynamism: Implications for productivity," *Brookings Institution, Hutchins Center Working Paper*. []

——— (2016b): "Where has all the skewness gone? The decline in high-growth (young) firms in the US," *European Economic Review*, 86, 4–23. []

——— (2017): "Declining dynamism, allocative efficiency, and the productivity slowdown," *American Economic Review*, 107 (5), 322–326. []

——— (2020): "Changing business dynamism and productivity: Shocks versus responsiveness," *American Economic Review*, 110 (12), 3952–3990. []

DENT, ROBERT C, FATIH KARAHAN, BENJAMIN PUGSLEY, AND AYŞEGÜL ŞAHIN (2016): "The role of startups in structural transformation," *American Economic Review*, 106 (5), 219–223. []

DI NOLA, ALESSANDRO, LEO KAAS, AND HAOMIN WANG (2023): "Rescue policies for small businesses in the COVID-19 recession," *Review of economic dynamics*, 51, 579–603. []

DIEZ, MR FEDERICO, MR DANIEL LEIGH, AND SUCHANAN TAMBUNLERTCHAI (2018): *Global market power and its macroeconomic implications*, International Monetary Fund. []

EECKHOUT, JAN, XI WENG, ET AL. (2017): "The technological origins of the decline in labor market dynamism," *International Economic Review*, 58 (3), 727–750. []

ENGBOM, NIKLAS AND CHRISTIAN MOSER (2017): "Returns to education through access to higher-paying firms: Evidence from US matched employer-employee data," *American Economic Review*, 107 (5), 374–378. []

FALLICK, BRUCE, CHARLES FLEISCHMAN, AND JONATHAN PINGLE (2010): "The effect of population aging on the aggregate labor market," in *Labor in the New Economy*, University of Chicago Press, 377–417. []

FURMAN, JASON AND PETER ORSZAG (2018): "A firm-level perspective on the role of rents in the rise in inequality," in *Toward a just society: Joseph stiglitz and twenty-first century economics*, Columbia University Press, 19–47. []

GEURTS, KAREN AND JOHANNES VAN BIESEBROECK (2016): "Firm creation and post-entry dynamics of de novo entrants," *International Journal of Industrial Organization*, 49, 59–104. []

GOLDSCHLAG, NATHAN AND JAVIER MIRANDA (2020): "Business dynamics statistics of High Tech industries," *Journal of Economics & Management Strategy*, 29 (1), 3–30. []

GRULLON, GUSTAVO, YELENA LARKIN, AND RONI MICHAELY (2019): "Are US industries becoming more concentrated?" *Review of Finance*, 23 (4), 697–743. []

GUTIÉRREZ, GERMÁN, CALLUM JONES, AND THOMAS PHILIPPON (2021): "Entry costs and aggregate dynamics," *Journal of Monetary Economics*, 124, S77–S91. []

HALTIWANGER, JOHN, IAN HATHAWAY, AND JAVIER MIRANDA (2014): "Declining business dynamism in the US high-technology sector," *Available at SSRN 2397310*. []

HATHAWAY, IAN AND ROBERT E LITAN (2014): "Declining business dynamism in the United States: A look at states and metros," *Brookings institution*, 2. []

HOPENHAYN, HUGO AND RICHARD ROGERSON (1993): "Job turnover and policy evaluation: A general equilibrium analysis," *Journal of political Economy*, 101 (5), 915–938. []

HOPENHAYN, HUGO A (1992): "Entry, exit, and firm dynamics in long run equilibrium," *Econometrica: Journal of the Econometric Society*, 1127–1150. []

IGNASZAK, MAREK (2020): "Composition of labor supply and business dynamism," Tech. rep., Working paper. []

JAIMOVICH, NIR AND MAX FLOETOTTO (2008): "Firm dynamics, markup variations, and the business cycle," *Journal of monetary Economics*, 55 (7), 1238–1252. []

KARIEL, JOEL AND ANTHONY SAVAGAR (2022): "Returns to Scale and Productivity," . []

LEE, YOONSOO AND TOSHIHIKO MUKOYAMA (2018): "A model of entry, exit, and plant-level dynamics over the business cycle," *Journal of Economic Dynamics and Control*, 96, 1–25. []

LEWIS, VIVIEN AND CÉLINE POILLY (2012): "Firm entry, markups and the monetary transmission mechanism," *Journal of Monetary Economics*, 59 (7), 670–685. []

PETERS, MICHAEL (2020): "Heterogeneous markups, growth, and endogenous misallocation," *Econometrica*, 88 (5), 2037–2073. []

PETERS, MICHAEL AND CONOR WALSH (2019): "Declining dynamism, increasing markups and missing growth: The role of the labor force," *Increasing Markups and Missing Growth: The Role of the Labor Force (November 6, 2019)*. []

RUZIC, DIMITRIJE AND SUI-JADE HO (2023): "Returns to Scale, Productivity, Measurement, and Trends in US Manufacturing Misallocation," *Review of Economics and Statistics*, 105 (5), 1287–1303. []

SAVAGAR, ANTHONY (2021): "Measured productivity with endogenous markups and economic profits," *Journal of Economic Dynamics and Control*, 133, 104232. []

TANG, JIANMIN, WEIMIN WANG, AND ZHIHAO YU (2020): "Globalisation, ICT investment and firm dynamism," *Transnational Corporations Review*, 12 (2), 193–202. []