

Time Use and Heterogeneous Markups*

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May 31, 2026

Abstract

We enrich standard models of imperfect competition by allowing consumer demand for market goods to depend non-separably on off-market time. Consumers value final consumption experiences that require both market purchases and time, which reshapes demand elasticities through two opposing forces. First, because time is an input, changes in market prices translate only partially into changes in the cost of an experience and second, households can substitute time for market purchases in response to price variation. We show how these forces alter the mapping from markups to welfare by distinguishing between markups and a holistic counterpart that accounts for the time cost of consumption. In a monopolistically competitive environment, firm selection and entry is governed solely by the elasticity of substitution between time use and market purchases, and markup dispersion can be consistent with efficiency when time and market purchases are perfect complements. Extending the analysis to oligopolistic competition, we show that forces that raise markups, like greater market concentration and less competitive conduct, also amplify the gap between the usual and holistic markups.

Keywords: monopolistic competition, markups, efficiency, time use, elasticity of substitution, selection, heterogeneous firms.

*The views stated herein are those of the authors and are not necessarily those of the Federal Reserve Bank of Cleveland or the Board of Governors of the Federal Reserve System. We thank Susanto Basu, Kristian Behrens, David Berger, Jose Berrospide, Mark Bills, Jaroslav Borovicka, Benjamin Bridgman, Fabio Ghironi, Kyle Herkenhoff, Nir Jaimovich, Baris Kaymak, Karen Kopecky, Eunseong Ma, Toshihiko Mukoyama, Guillermo Ordonez, Bruno Pellegrino, Roberto Pinheiro, Guillaume Sublet and James Traina and especially Sergio Ocampo for helpful discussions and comments. We also thank two anonymous referees and an anonymous associate editor for guidance. The paper was previously circulated as “Time Use and the Efficiency of Heterogeneous Markups.”

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1 Introduction

Studies of markups find large heterogeneity across firms.¹ In standard models of imperfect competition with endogenous entry, observed markups are tightly linked to market power and have direct welfare content. For example, in monopolistic competition environments (e.g. [Dhingra and Morrow \(2019\)](#)), heterogeneous markups imply misallocation, while in oligopolistic environments (e.g. [Atkeson and Burstein \(2008\)](#), [De Loecker et al. \(2021\)](#), and [Edmond et al. \(2023\)](#)), markups are also shaped by concentration and conduct. In this paper we revisit the mapping from markups to market power and welfare in an environment in which off-market time enters the consumer’s preferences non-separably in the spirit of [Becker \(1965\)](#). Non-separable time use implies that the usual product-level markup need not coincide with that which accounts for how consumers allocate time across different final consumption experiences. Our results imply that observed markups can misstate both the extent of market power and the welfare consequences of imperfect competition.

In our model, we distinguish between market purchases and final consumption experiences in the following sense. We assume consumers have preferences over varieties of consumption “experiences” that are produced using both market goods and off-market time. We think of these experiences as time-consuming activities such as attending a play or playing video games, in which the market price of the good is not the total price of the associated experience.² For example, attending a play requires both a ticket (a market purchase) and the attendee’s time, which could have been devoted to other experiences or to earning labor income. Because consumers can respond to price changes by adjusting both off-market time and market purchases, demand elasticities (and hence markups) depend on the degree to which off-market time can substitute for market goods. In this way, non-separable time use provides a source of variation in markups beyond that generated by variable elasticities of substitution across experiences.

We first decompose the role of non-separable time use on demand elasticities into two opposing effects. First, the fact that time use serves as an input into final consumption experiences implies that the total price of each experience is relatively

¹See, e.g., [Epifani and Gancia \(2011\)](#), [De Loecker et al. \(2020\)](#), [Peters \(2020\)](#), and [Edmond et al. \(2023\)](#).

²This interpretation is clearest when the time spent consuming a market purchase is a distinct margin rather than a product characteristic fully capitalized into the market price. For products whose main difference is time-saving convenience, such as faster transportation, we view the market object as quality-adjusted and do not attempt to resolve such product-level measurement issues here.

less elastic with respect to the market price. For instance, if the price of a theatre ticket doubles, the total price to the consumer of attending the play less than doubles, because their opportunity cost is unchanged. For a given elasticity of substitution across varieties, non-separable time use therefore reduces the price elasticity of each experience. Second, as the price of a market good rises, consumers could (in principle) choose to substitute market resources for additional time spent consuming, which serves to increase the price elasticity of (market) demand and implies that the net impact of the above two effects is theoretically ambiguous.

To make these forces transparent, we next study a CES monopolistic-competition benchmark that delivers closed-form demand elasticities and clear comparative statics for markups. In this benchmark, complementarities between off-market time and market purchases imply that markups are increasing in firm productivity (i.e., decreasing in marginal cost) and firm size, whereas under substitutability the relationship between productivity and markups can be either positive or negative. In the special cases of unit elasticity of substitution or additive separability between off-market time and market purchases, markups are constant across firms. We then extend the analysis to an oligopolistic-competition environment following [Edmond et al. \(2023\)](#), with a continuum of sectors that each contain finitely many firms. In oligopoly, the same two demand-side forces (price dilution and time-use substitution) shape the elasticity component of pricing, alongside endogenous market shares and firm conduct.

Because time use affects demand elasticities and firm profits, it alters the incentives for firms to enter and operate. Following [Dhingra and Morrow \(2019\)](#), we model firm entry as a two-step process. First, ex-ante identical firms must pay a fixed cost (entry cost) in order to draw a parameter specifying their marginal cost of production. Second, upon learning their marginal cost, firms must pay a second fixed cost (operating cost) in order to produce. In the monopolistic competition setting, there are therefore two quantities related to firm entry: the mass of firms that draw a productivity parameter, and the productivity of the marginal firm, which we refer to as firm “selection.” We study whether the equilibrium values of these quantities are higher or lower than those chosen by a utilitarian planner.³

To facilitate our analysis of allocations under monopolistic competition, we first show that equilibrium allocations solve a certain optimization problem, in which the objective is proportional to the aggregate revenues of all firms and the constraint incorporates the role of time use. We use this insight to show that the analysis of firm selection amounts to comparing the elasticities of two quantities: the first

³When extending the model to oligopolistic competition, we primarily study how markups are impacted by the competition structure and conduct, though the introduction of time-use non-separabilities also affects the equilibrium number of operating firms in a sector by distorting the impact of firm pricing decisions and thus profits.

representing the average *social* value of all varieties, and the second representing the average *private* value of all varieties (i.e., profits). Further, with CES preferences over experiences, we show that firm selection depends solely on the elasticity of substitution between time and market purchases: when market goods and time are substitutes, too few entering firms survive, while when they are complements, too many do. More precisely, in equilibrium, the marginal cost of the marginal firm is (weakly) inefficiently high when off-market time and market purchases are complements and inefficiently low when they are substitutes. However, in the special cases in which off-market time and market purchases are perfect complements or exhibit unit elasticity of substitution, the marginal cost of the marginal firm coincides with the efficient value.

The intuition for the above selection results under monopolistic competition is as follows. When off-market time and market purchases are perfect complements, they are consumed in fixed proportions independently of prices, and so the model is essentially identical to a model with no time use (and relabeled marginal costs), where efficiency is known to obtain with CES preferences.⁴ Outside of this extreme case, when time and market goods are complements, consumers cannot easily substitute time for market goods as costs rise, and so profits are less elastic than social surplus. Conversely, when market goods and time are substitutes, the reverse is true because consumers can more easily substitute time for market purchases, and effectively use their time to compete with firms. This ensures that profits fall more rapidly than social surplus as costs rise and leads to an inefficiently large number of firms that choose not to operate.

We then turn to the aggregate resources devoted to firm entry, and show that the monopolistically competitive equilibrium allocation always devotes (weakly) too few resources to firm entry and product creation, regardless of the structure of the consumption technology. Consumers in this economy do not internalize the fact that their decisions to allocate labor between off-market time and market production affect firms' profits and the incentives to enter. This is an additional margin of adjustment that is not present in models without off-market time. However, the sole exception in terms of efficiency occurs in the case of perfect complements, in which the ratio of off-market time to market purchases is independent of prices and marginal costs. In this case, the mass of firms also coincides with the efficient value, and so the monopolistically competitive equilibrium allocation in this case is first-best.

To interpret this last result and relate to the literature, we distinguish between two different notions of markups. The first is the usual definition of a markup ratio: the price of a good divided by its marginal cost. However, because market goods are only

⁴See, e.g., [Dhingra and Morrow \(2019\)](#).

one input into consumption experiences, we contrast the usual markup ratio with an alternative, “holistic” notion: the ratio of the total price of an experience to its total marginal cost, where both account for the value of the consumer’s time. Equipped with this nomenclature, we believe that the efficiency of the perfect complements case becomes intuitive, because this is the sole situation in which holistic markups (but not the usual markups) are constant across firms.

The results in this paper have several important implications. First, our result that efficiency attains when off-market time and market goods are perfect complements in the consumption technology shows that variable firm-level markups need not, by themselves, imply welfare losses relative to a first-best allocation.⁵ This does not imply a general relationship between markup dispersion and welfare; rather, it shows that the mapping depends on the consumer decision structure generating demand. This is potentially important given that estimates of markup dispersion suggest an increase over the last 40 years.⁶ Second, the fact that holistic markups are always less than the usual markups implies that firm-level markups alone are an incomplete statistic for the welfare-relevant price-cost wedge in this environment. Third, in oligopolistic settings the same wedge between the usual (firm-level) and holistic markups is amplified by the standard forces that raise markups, such as greater market concentration and less competitive conduct. As a result, environments with higher markups are also those in which ignoring time use is most likely to exaggerate the market-power component of observed markups and the associated welfare costs in our model.

Related literature. The seminal contribution to the theory of optimal product variety is [Dixit and Stiglitz \(1977\)](#), who consider an environment with homogeneous firms and endogenous entry and show that the efficiency of the equilibrium depends on whether preferences over varieties exhibit constant or variable elasticities of substitution. The literature emanating from [Dixit and Stiglitz \(1977\)](#) is vast and so we highlight only closely related developments.⁷ [Zhelobodko et al. \(2012\)](#) provide further insight into the variable elasticity of substitution (VES) equilibrium with homogeneous firms and derive general comparative statics. [Dhingra and Morrow \(2019\)](#) extend the analysis of optimal product variety to models with heterogeneous firms, while [Behrens et al. \(2020\)](#) allow for different elasticities between sectors and quantify the welfare losses associated with markups. In these papers time use is inelastic and CES preferences are both necessary and sufficient for markups to be constant and for allocations to be efficient when marginal costs differ across firms. Our results are

⁵In models such as [Peters \(2020\)](#) and [Edmond et al. \(2023\)](#), markup dispersion creates misallocation and ultimately reduces welfare relative to a benchmark with no dispersion.

⁶See, e.g., Figure 3 of [De Loecker et al. \(2020\)](#) and Figure 2 of [Flynn et al. \(2019\)](#).

⁷See the special issue in [Etro \(2017\)](#) for further discussion and historical context.

reminiscent of [Parenti et al. \(2017\)](#), who enrich the problem of the consumer to incorporate uncertainty over love-for-variety, and also show that variable markups can be consistent with efficiency. In these monopolistically competitive environments, markups are governed by demand elasticities implied by preferences.

Our modeling of the consumer problem reflects the fundamental idea first discussed in [Becker \(1965\)](#) and analyzed in depth in [Ghez and Becker \(1974\)](#) that in order to enjoy consumption, consumers must allocate time toward doing so. This is the basis of the “consumption technology” we implement: just like a production technology it takes in intermediate inputs (i.e., goods and services bought on the market) and time to generate an output, which we call “final consumption experience.”⁸ Our approach is motivated by empirical evidence that time use and market purchases (what we sometimes refer to as “market goods/services”) are not separable in preferences.⁹ The literature has recently begun to consider the implications of incorporating non-separable preferences for market purchases and leisure time for outcomes only indirectly related to consumer time use itself. For example, [Boerma and Karabarbounis \(2021\)](#) and [Pretnar \(2025\)](#) use models with non-separabilities between time use and market goods to measure welfare inequality, [Bridgman et al. \(2018b\)](#) and [Bednar and Pretnar \(2026\)](#) study how accounting for time use affects implications for structural change, and [Bridgman \(2016\)](#) studies how in-home productivities for different types of market products have changed over time. We add to these findings by studying the welfare implications of the [Becker \(1965\)](#) model in an economy with monopolistically competitive firms.

Our incorporation of non-separable off-market time into the consumer problem builds on models of monopolistic competition which also allow for elastic labor supply. The literature on monopolistic competition has considered elastic labor, but to the best of our knowledge it has assumed separability from market purchases. [Bilbiie et al. \(2012\)](#) explore how the allocation of labor across sectors and the number of products and producers varies over the business cycle. [Bilbiie et al. \(2019\)](#) consider the role that elastic factors of production (labor and capital) play in amplifying distortions on a dynamic path along which firms may enter and exit. [Boar and Midrigan \(2019\)](#) allow for additively separable consumption of market goods and time, but focus on how markup distortions redistribute income from laborers to entrepreneurs. [De Loecker](#)

⁸In the literature some refer to this process as “home production,” though the term, which seems to have originated with [Gronau \(1977\)](#), tends to have a more narrow interpretation than what [Becker \(1965\)](#) originally theorized. The [Becker \(1965\)](#) approach can be seen in the models of [Greenwood and Hercowitz \(1991\)](#), [Gomme et al. \(2001\)](#), [Greenwood et al. \(2005\)](#), [Ngai and Pissarides \(2008\)](#), and [Bridgman et al. \(2018a\)](#) where home technologies are assumed to take in both time and market select goods (i.e., durables, physical goods, etc.) to yield a home production output.

⁹See, e.g., [Aguiar and Hurst \(2005\)](#), [Aguiar and Hurst \(2007\)](#), [Fang et al. \(2022\)](#) and [Pretnar \(2025\)](#).

et al. (2021) also allow for separable consumption of market goods and off-market time but only include leisure in preferences to quantify how changes to the structure of competition affect the labor supply. Finally, Edmond et al. (2023) disentangle the degree to which markups, misallocation of factors of production, and inefficient entry contribute to welfare costs, and quantify the welfare effects of markups. We add to this literature by considering how the allocation of off-market time affects general equilibrium outcomes in a monopolistically competitive setting.

Finally, we contribute to a related literature studying markups in oligopolistic settings, in which firm-level market shares and strategic interaction shape pricing in addition to the demand elasticities implied by preferences. Atkeson and Burstein (2008) provide a canonical framework linking market structure to variable markups in general equilibrium. De Loecker et al. (2021) quantify how changes in the structure of competition affect markups and labor supply in an environment with separable leisure. We add to this literature with our oligopolistic competition extension, where we consider how firm conduct (choosing prices versus quantities) interacts with the time-use and market goods non-separabilities we introduce to affect inferences regarding markups and market power when there are finitely many firms.¹⁰

2 Monopolistic competition

Our goal is to understand how non-separable time use, and in particular, complementarities between off-market time and market purchases, shapes both equilibrium and efficient outcomes when preferences discipline market power. We therefore start with a generalized, non-parametric model of monopolistic competition (MC), which provides a clean baseline in which pricing and markups are governed by demand elasticities implied by preferences and the consumption technology.¹¹ Section 2.4 then imposes functional forms that deliver closed-form demand elasticities and clear comparative statics for markups, allowing us to study firm selection and aggregate entry in MC transparently. Throughout, we characterize both the decentralized equilibrium

¹⁰The extent to which we introduce a novel new mechanism affecting markup inferences also places our work within a broader literature in which deeper, less salient measures of product quality affect inferences regarding the competitive structure of the economy; the work of Pellegrino (2025), who considers product characteristic and thus quality heterogeneity, comes to mind.

¹¹We begin with MC because, with atomistic firms, market power (as summarized by markups) is entirely pinned down by preference parameters, namely elasticities of substitution. In oligopolistic competition (OC), by contrast, markups depend on both elasticities and endogenous market shares, so firm size matters. We therefore introduce the OC model in Section 3 as an extension of the MC environment in which the extensive margin of entry (and hence the number and sizes of firms) feeds back into pricing.

and the efficient allocation with elastic time use under imperfect competition.¹²

Our setup is as follows. First, consumers buy varieties of goods and services on the market. These varieties are produced by imperfectly competitive firms engaged in monopolistic competition using a linear production technology where labor is the only input. Next, consumers use all of the varieties they purchase on the market in various off-market consumption activities. In doing so they are allocating their resources to an intermediate production step which involves using two inputs — market varieties and off-market time — in order to produce what we call a “final consumption experience.” Consumers ultimately derive utility from this experience, produced by combining time and market goods in the consumption technology. Final consumption experiences cannot be bought and sold, despite the fact that some of the inputs used to make these experiences (i.e., market goods and services) are tradable. [Becker \(1965\)](#) referred to “attending a play” as one of these experiences. While tickets to the play can be bought and sold on the market, a ticket (the market good/service) will yield the consumer no utility unless it is actually used for attendance (as opposed to just sitting unused on one’s desk at home). Attendance, though, requires a consumer’s time as well. Video gaming is a more modern example of a consumption experience: the model of [Aguiar et al. \(2021\)](#) relates market expenditure to time allocation decisions similar to the model we outline. To derive utility from a video-gaming experience, consumers must first buy a game (a software service) and then spend their time playing that game. Simply owning the game (or subscribing to a service that provides access to the game) without actually playing it provides no utility.

The aforementioned examples suggest a model in which consumer demand for market goods depends on both their marginal utility for the final consumption experience and the marginal product of market goods and time in the consumption technology. However, firms have direct control over the price of only one of the consumer inputs (market goods) but not the value of a consumer’s off-market time nor the unit-value (or “price”) of the final consumption experience. This latter value is a weighted sum of the price of market varieties and the value of a consumer’s off-market time. As the following formal model shows, this means that firm pricing rules for market goods will depend on the degree to which such goods are complementary or substitutable with off-market time. The structure of the consumption technology

¹²Most existing work that incorporates elastic time use in models with imperfect competition does so in MC settings: [Bilbiie et al. \(2012\)](#) and [Bilbiie et al. \(2019\)](#) feature variable labor supply and leisure that is separable from the consumption of market goods, while in [Zhelobodko et al. \(2012\)](#) and [Dhingra and Morrow \(2019\)](#) time use is inelastic and does not enter utility. In an oligopolistic setting, [Atkeson and Burstein \(2008\)](#) allow for elastic labor supply but model the leisure–consumption tradeoff at an aggregate level rather than good-by-good as in the [Becker \(1965\)](#) framework.

will thus determine the degree to which firms can price above their marginal cost and therefore ultimately which firms choose to operate.

2.1 Consumers

There exists a unit mass of identical consumers who have preferences over a continuum of final consumption experiences, each of which is indexed by $i \in \mathcal{I} \subseteq \mathbb{R}$:

$$\mathcal{U}(\mathbf{c}) = \int_{\mathcal{I}} u(c_i) di. \quad (2.1)$$

We denote consumption experiences by c_i , where $\mathbf{c} \subset \mathbb{R}_+$ denotes the set, indexed by the set $\mathcal{I}$, of all consumption experiences.¹³ We assume that $\mathcal{I} \subset \mathbb{R}_+$ is compact. As in [Dhingra and Morrow \(2019\)](#), we make the following regularity assumptions on u .¹⁴

Assumption 2.1 (Regularity of u). *The sub-utility function u is strictly increasing, strictly concave, at least four-times differentiable, and such that $u(0) = 0$.*

A consumption experience is defined as the act of combining goods and services purchased on the market with off-market time in order to generate final utility.¹⁵ Consumers produce these experiences using a “production function” h that takes market goods, q_i , and off-market time, n_i , as inputs,

$$c_i := h(q_i, n_i). \quad (2.2)$$

We emphasize that n_i represents the time devoted to the consumption of the i^{th} variety q_i , and not a distinct good produced by the household.¹⁶ We will later show in our parametric exercises how the functional form of h (and specifically, whether q_i and n_i are complements or substitutes) affects both the efficient allocations and the distribution of markups. We adopt the following general assumptions on h .

Assumption 2.2 (Regularity of h). *The function h is strictly increasing, strictly concave, four-times differentiable, and satisfies the Inada conditions $\lim_{x \rightarrow 0^+} h_q(x, n) = \lim_{x \rightarrow 0^+} h_n(q, x) = \infty$ for all $q, n \geq 0$.*

¹³Bold faced fonts will denote sets, so that $c_i \in \mathbf{c}$.

¹⁴While [Dhingra and Morrow \(2019\)](#) strictly focus on a monopolistically competitive environment, our regularity assumptions on u will also apply to our later model extensions to oligopolistic competition.

¹⁵Our experiences are analogous to what [Becker \(1965\)](#), [Aguilar et al. \(2012\)](#), [Aguilar and Hurst \(2013\)](#), and [Aguilar and Hurst \(2016\)](#) refer to as “commodities.”

¹⁶The latter interpretation is closer to [Gronau \(1977\)](#), who sought to expand [Becker \(1965\)](#) to incorporate household production. Our formulation follows [Becker \(1965\)](#), who develops a theory of consumer choice that includes the cost of time on the same footing as the cost of market goods.

Assumption 2.3 (Homogeneity of h). *The function h is homogeneous of degree one.*

Assumption 2.3 is a standard assumption (see, e.g., Aguiar et al. (2012) and Aguiar and Hurst (2016)), and will allow us to interpret our results in terms of the prices of either market goods or final consumption experiences. Because each consumption experience depends on one and only one market variety, we think of $u(c_i)$ as the utility a consumer derives from the utilization of market variety, q_i . This is similar to how u is defined in Dixit and Stiglitz (1977) and Dhingra and Morrow (2019) but with the added complication that utilization of the market variety also requires off-market time. In the video game example, the experience is “playing video games” which requires the game itself, q_i , and time spent playing, n_i . As in standard models of monopolistic competition, consumers exhibit a “love-of-variety,” but it is a love of variety for consumption *experiences* rather than solely market goods and services.

Resource constraints. Each consumer is endowed with $\bar{T}$ units of time that is split between three types of activities: 1) labor devoted to creating firms, $\mathcal{E}$; 2) labor devoted to the production of market goods and services, $\mathcal{L}$; and 3) time devoted to the production of final consumption experiences, $\mathcal{N} := \int_{\mathcal{I}} n_i di$. The consumer’s time-use constraint is the sole resource constraint in the economy and is given by

$$\mathcal{E} + \mathcal{L} + \mathcal{N} \leq \bar{T}. \quad (2.3)$$

Consumers earn labor income, $\mathcal{E} + \mathcal{L}$, on the market, so total expenditure on market goods must satisfy the budget constraint $\int_{\mathcal{I}} p_i q_i di = \mathcal{E} + \mathcal{L}$, where p_i is the price of market good/service q_i and we normalize hourly wages to unity. When combined with the constraints (2.2), (2.3), and the objective (2.1), the problem of the consumer is to choose market varieties $\mathbf{q}$ and off-market time $\mathbf{n}$ to solve the problem

$$\begin{aligned} \max_{\mathbf{q}, \mathbf{n}} \quad & \int_{\mathcal{I}} u(h(q_i, n_i)) di \\ \text{s.t.} \quad & \int_{\mathcal{I}} (p_i q_i + n_i) di = \bar{T}. \end{aligned} \quad (2.4)$$

If λ is the multiplier on the consumer’s budget constraint then the first-order condition with respect to q_i is $u'(h(q_i, n_i))h_q(q_i, n_i) = p_i\lambda$. If $h(q, n) = q$ for all $q, n > 0$, then differentiating the first-order condition with respect to p_i shows that the price elasticity of demand is simply the reciprocal of the elasticity of marginal utility. However, outside of this special case, consumers may choose to adjust their time use in response to a price change, and in so doing affect their marginal utility with respect to the consumption of market goods. To see how this affects the price elasticity of demand, we first note that Assumptions 2.2 and 2.3 imply that for some increasing

function Γ , the optimal choices of the consumer satisfy $n_i/q_i = \Gamma(p_i)$ for all $i \in \mathcal{I}$.¹⁷ The i^{th} term in the budget constraint in (2.4) may be written as $\psi_i c_i = p_i q_i + n_i$, where

$$\psi_i := \psi(p_i) := \frac{p_i + \Gamma(p_i)}{h(1, \Gamma(p_i))} = \min_{x>0} \frac{p_i + x}{h(1, x)} \quad (2.5)$$

can be interpreted as the per-unit cost of a final consumption experience.¹⁸ We call this object the “holistic price” of engaging in a final consumption experience, since it embeds both the price consumers pay for market goods/services and the value of their time. Further, ψ is the marginal cost a household incurs to produce one unit of experience c .¹⁹ The problem (2.4) can therefore be solved by first considering the problem of maximizing $\int_{\mathcal{I}} u(c_i) di$ subject to the constraint $\int_{\mathcal{I}} \psi(p_i) c_i di = \bar{T}$, which is identical to a problem without time use except that the price of a unit of the i^{th} variety is not p_i but instead the holistic price $\psi(p_i)$.

To derive the price elasticity of demand, we write demand for market goods as $q = c \times q/c$ and decompose its price elasticity into the price elasticities of c and q/c separately. Differentiating the first-order condition for c_i gives $\epsilon_c(p_i) = \epsilon_\psi(p_i)/\epsilon_{u'}(c(p_i))$, and applying the envelope theorem to (2.5) gives

$$q(p_i) = c(p_i) \psi'(p_i). \quad (2.6)$$

Combining these two observations then immediately gives the following.

Lemma 2.4 (Demand elasticity). *The price elasticity of demand satisfies*

$$\epsilon_q(p_i) - \frac{1}{\epsilon_{u'}(c(p_i))} = \frac{\epsilon_\psi(p_i) - 1}{\epsilon_{u'}(c(p_i))} + \epsilon_{\psi'}(p_i). \quad (2.7)$$

The expression for the price elasticity of demand in Lemma 2.4 is fundamental to the analysis in this paper and therefore warrants some discussion. As noted above, when final consumption experiences do not depend on time use, the price elasticity of demand is just $\epsilon_{u'}(c(p_i))^{-1}$ since $\psi(p_i) = p_i$ and in such a case is thus unit-elastic in p_i . Lemma 2.4 implies that the difference between the price elasticity of demand

¹⁷Assumption 2.3 implies that the joint choice of q_i and n_i solves $h_q(1, n_i/q_i)/h_n(1, n_i/q_i) = p_i$, and Assumption 2.2 implies that Γ is well-defined and increasing.

¹⁸The function ψ_i is analogous to the π_i function introduced on page 422 of Becker (1965). We write ψ instead of π because the latter is now typically reserved for operating profits.

¹⁹One could also think of ψ as the market price of a unit of c , if c were produced by a firm operating in a perfectly competitive final goods sector. In this interpretation q 's could be thought of as intermediate goods and n 's as labor supplied to the production of c 's by firms operating the technology $h(q, n)$ and then selling c 's to consumers at price ψ . Of course, given there is a unit continuum of c 's, this would also require the assumption of a unit continuum of perfectly competitive final goods sectors.

and this “usual” term is the sum of two distinct economic effects corresponding to the terms of the right-hand side of (2.7).

First, because it is the minimum of affine functions, the function ψ is concave, and so its elasticity cannot exceed unity.²⁰ This bound reflects the fact that market goods are only one input (along with time) into final consumption experiences, which ensures that ψ is inelastic with respect to p_i . For instance, in the theatre example of Becker (1965), if the price of entry were \$30 and the consumer valued the time taken to watch the play at \$100, then a doubling of the ticket price would lead ψ to rise by less than double, from \$130 to \$160.²¹ For a given elasticity of marginal utility, the presence of time use always reduces the price elasticity of final consumption experiences and so the first term on the right-hand side of (2.7) is non-negative.

Second, as the price of a market variety, q , rises, consumers can not only reduce their demand for final consumption experiences, but also adjust the rate at which they use market goods to achieve final consumption experiences. By the envelope condition, we have $q(p_i) = c(p_i)\psi'(p_i)$, and so this second effect is captured by the elasticity $\epsilon_{\psi'}$, which is always non-positive by the concavity of ψ , and therefore opposes the first effect above. For example, in the case of video gaming, where utility depends on both gaming equipment purchased and the time spent playing, as the price of gaming equipment rises, consumers can devote more time to each game, and their willingness to substitute time for market goods is reflected in the elasticity $\epsilon_{\psi'}$.²² For the functional forms in Section 2.4, the terms on the right-hand side of (2.7) simplify in a manner that facilitates comparative statics for markups.

2.2 Firms

For the modeling of firm entry, technology and behavior under monopolistic competition, we deliberately follow [Dhingra and Morrow \(2019\)](#) in order to highlight the novel role played by the presence of off-market time in preferences. There is a continuum of potential firms that can each produce a unique variety of market good/service.²³ Firms are ex-ante identical and must pay a fixed cost f_e in order to draw a marginal cost κ from some distribution G . Upon drawing their marginal cost, the firms must

²⁰By the mean-value theorem and the concavity of ψ , for any $p > 0$ there exists $\underline{p} \in (0, p)$ such that $\psi(p) = \psi(0) + p\psi'(\underline{p}) \geq 0 + p\psi'(p)$, which gives $\epsilon_{\psi}(p) \leq 1$.

²¹This example may be interpreted as one in which the “production technology” is approximately Leontief, assuming that each play requires (roughly) the same amount of time to attend.

²²In the above theatre example this second effect is likely negligible, because utility is presumably not increased by staying in the theatre beyond the completion of the play.

²³When later turning to the oligopolistic market structure, we will distinguish amongst a continuum of sectors where each sector will contain only finitely many firms, but the simple per-firm production structure we describe here will remain the same.

pay an additional fixed cost f in order to produce. Both of the above fixed costs are denominated in units of effective labor and are interpreted as real resource costs associated with setting up a firm. We make the following assumption regarding the distribution of marginal costs.

Assumption 2.5. *The CDF G has a continuous, positive density, denoted g , defined on the set $\mathcal{K}$.*

Entry costs and technology. The mass of firms that pay f_e and draw κ is denoted by M_e . Some fraction of these firms remain in the market and produce, making non-negative profits. We denote this latter mass of firms by $M \leq M_e$. Further, let $\mathcal{K} = [\underline{\kappa}, \bar{\kappa}] \subseteq \mathcal{I}$ denote the set of operating firms. We index firms by their marginal cost κ and refer to this as the firm’s “type.” The output of a firm of type κ that employs ℓ units of effective labor is $y(\kappa, \ell) = \ell/\kappa$, so that κ is the marginal cost of the firm and $1/\kappa$ is the firm’s labor productivity. The labor supply, $\ell(\kappa)$, may vary across firms. In both the efficient and equilibrium allocations defined below, the set of marginal costs of firms that produce is of the form $[\underline{\kappa}, \bar{\kappa}]$ for some $\bar{\kappa} > \underline{\kappa}$. The cutoff value $\bar{\kappa}$ is an equilibrium object determined by the profit-maximizing decisions of firms. We refer to the determination of this value of $\bar{\kappa}$ as firm “selection.”

Assumption 2.6 (Indexing). *The set indexing consumption experiences, $\mathcal{I}$, is identical to the set indexing producers’ marginal costs, $\mathcal{K}$, so each q_i is associated with exactly one firm output, $q(\kappa) := y(\kappa, \ell)$, and each n_i can be written $n(\kappa)$.*

Assumption 2.6 is a natural assumption given that we interpret n_i as the time devoted to the consumption of the i^{th} variety, and the variety is assumed to not exist until the associated firm pays the necessary fixed costs in order to enter and operate.²⁴ We therefore define the market equilibrium and efficient allocations below under Assumption 2.6.²⁵ We can therefore index market purchases and time use by the same variable $\kappa \in [\underline{\kappa}, \bar{\kappa}]$ which indexes the firms.

An entering firm has paid fixed cost f_e to draw a marginal cost κ . It must then pay an additional fixed cost f in order to operate (i.e. produce positive output). The problem of a firm who has paid both fixed costs is then defined as follows.

Definition 2.7 (Firm problem and operating profits under monopolistic competition). Given a multiplier λ on the consumer’s budget constraint and the associated

²⁴This assumption is consistent with the usual approach adopted in monopolistic competition models of endogenous firm variety without time use (see, e.g., [Dhingra and Morrow \(2019\)](#)).

²⁵In Section 2.5 we discuss how Assumption 2.6 may be relaxed to allow for consumers to derive utility from off-market activities not associated with the existence of a good produced by a firm.

demand schedule $q(p; \lambda)$, an operating firm of type κ chooses p to solve

$$\pi(\kappa; \lambda) = \max_{p \geq 0} (p - \kappa)q(p; \lambda) - f. \quad (2.8)$$

The quantity in (2.8) will be referred to as the operating profits of the firm, and we will omit reference to the multiplier λ unless necessary.

We should add a brief clarifying remark about Definition 2.7 which only applies to a firm engaged in choosing prices under monopolistic competition.²⁶ First, note that the additively separable nature of $\mathcal{U}$ and the regularity conditions on h allow us to write demand as solving $u'(h(q_i, n_i))h_q(q_i, n_i) = p_i\lambda$ with $n_i/q_i = \Gamma(p_i)$. Further, note that λ will depend on the resources available for market purchases and thus some aggregate price level characterizing the aggregate value of all market goods/services, $\int_{\mathcal{I}} q_i di$. Call this price level $P(\mathbf{p})$ which depends on the set of all p_i 's and is equivalent to the index referred to as “q” on page 298 of Dixit and Stiglitz (1977). In our model, since q_i and n_i result from non-separable decisions, the structure of $P(\mathbf{p})$ will depend both on the structures of u and h . Yet, from the perspective of an *atomistic* firm with infinitesimally small market share, the choice of p_i will not affect $P(\mathbf{p})$, as discussed in Dixit and Stiglitz (1977), and thus will not affect λ . This implies that, in a monopolistically competitive market structure with additively separable $\mathcal{U}$ and one and only one q_i per c_i , firms take λ as given, and we need not fully characterize demand for q_i in terms of its classic, Marshallian structure (i.e., full dependency of q_i on the own price p_i , the aggregate price index $P(\mathbf{p})$, and total resources $\bar{T}$).

Free entry. With a continuum of potential entrants, free entry drives the expected net profit of an entering firm to zero. That is, the mass of entering firms M_e adjusts until

$$\int_{\underline{\kappa}}^{\bar{\kappa}} \pi(\kappa)G(d\kappa) = f_e. \quad (2.9)$$

Since the left-hand side of (2.9) represents the aggregate operating profits of all active firms (per entering firm), multiplying both sides by M_e gives $M_e \int_{\underline{\kappa}}^{\bar{\kappa}} \pi(\kappa)G(d\kappa) = M_e f_e$. Expanding operating profits using Definition 2.7, this implies

$$M_e \int_{\underline{\kappa}}^{\bar{\kappa}} (p(\kappa) - \kappa)q(\kappa)G(d\kappa) = M_e(f_e + fG(\bar{\kappa})) = \mathcal{E}, \quad (2.10)$$

so that aggregate revenues net of variable production costs exactly equal the aggregate fixed costs $\mathcal{E}$ associated with firm entry and operation. Consequently, ag-

²⁶A similar firm choosing prices under Bertrand or Cournot competition, for example, would face a slightly different demand structure.

aggregate profits are zero and do not appear in the consumer's budget constraint (2.4). This is because, as can be seen by inspecting (2.9) and (2.10), profits equate to fixed entry costs and are fully remunerated to consumers as income from their startup effort, implying the budget constraint can be written $\int_{\underline{\kappa}}^{\bar{\kappa}} p(\kappa)q(\kappa) = \mathcal{E} + \mathcal{L} = M_e \int_{\underline{\kappa}}^{\bar{\kappa}} \pi(\kappa)G(d\kappa) + M_e fG(\bar{\kappa}) + \mathcal{L}$. Thus, $\mathcal{E}$ fully summarizes the degree to which firm-level profits enter the budget constraint. Aggregate profits are zero because they must fully offset startup effort to ensure the aggregate resource constraint holds.

Markups and holistic markups. The markup ratio of a firm of type κ that chooses price p is defined as $m(\kappa, p) := p/\kappa$, and the choice of the firm $p(\kappa)$ solves

$$m(\kappa, p(\kappa)) = 1 - \frac{1}{\epsilon_q(p(\kappa)) + 1}. \quad (2.11)$$

The firm-level markup for a variety is the ratio of the market price to its marginal cost of production. However, market production is not the only resource cost incurred in the production of final consumption experiences, because consumers also devote time to off-market activities. This motivates an alternative markup concept, which we call “holistic markups,” that represents the price of final consumption experiences paid by the consumer divided by its equilibrium marginal resource cost. To this end, for any $\kappa, p \geq \underline{\kappa}$ we define

$$\phi(\kappa, p) := \frac{\kappa + \Gamma(p)}{h(1, \Gamma(p))} \quad (2.12)$$

which represents the real amount of resources expended per unit of final consumption experience associated with a variety κ when the price is p . Comparing ϕ to ψ in (2.5), note that the numerator of (2.12) is the sum of the cost of production incurred by the firm, κ , and $\Gamma(p) = n/q$ which is the amount of off-market time per market good outlayed by the household to generate c . At a numeraire wage rate, the denominator is then $c/q = h(1, \Gamma(p))$, which is the real value of the consumption experience the household received for every unit of market goods.

Definitions of ϕ and ψ lead to a natural extension of the notion of markups. Define the holistic markup ratio $\mu(\kappa, p)$ by

$$\mu(\kappa, p) := \frac{\psi(p)}{\phi(\kappa, p)}. \quad (2.13)$$

Since the per-unit resource cost $\phi(\kappa, p)$ is the combined outlay to the firm, represented by κ , plus what the household must expend to transform q and n into c , the holistic markup ratio is the implicit unit-cost, ψ , faced by the household to produce c divided by the marginal resource cost incurred by society (firm and household) to make c . The object μ thus defines how much the implicit price of c is marked up over the

society-wide marginal resource cost, which embeds the production cost, κ , and the consumer's time cost (per unit of q), $\Gamma(p)$. Thus, the adjective “holistic” is intended to signal that μ is not the firm's own markup over production costs, but a price-cost ratio for the entire consumption experience.

An application of the envelope theorem to (2.5) then gives

$$\phi(\kappa, p) = \psi(p) - \psi'(p)(p - \kappa) \quad (2.14)$$

which gives the following relationship between the above markup notions.

Lemma 2.8. *For all $p, \kappa > 0$, the holistic markup ratio satisfies*

$$\mu(\kappa, p) = \frac{m(\kappa, p)}{\epsilon_\psi(p) + (1 - \epsilon_\psi(p))m(\kappa, p)}. \quad (2.15)$$

Further, when $p \geq \kappa$ we have $1 \leq \mu(\kappa, p) \leq m(\kappa, p)$, with $1 = \mu(\kappa, p) = m(\kappa, p)$ if and only if $\epsilon_\psi(p) = 1$ or $p = \kappa$.

Proof. The expression (2.15) follows from the definition (2.13) and equation (2.14), while the inequality $\mu(\kappa, p) \leq m(\kappa, p)$ follows from the concavity of ψ , because this implies that $\epsilon_\psi(p) \leq 1$. $\square$

Lemma 2.8 shows that the firm-level markup $m(\kappa, p)$ always (weakly) overstates the above holistic equilibrium markup on final consumption experiences, regardless of the preferences over final consumption experiences. This is a direct result of the fact that firms are only able to markup the price for one of the two intermediate inputs (the other input being a household's own time) required by households to produce final consumption experiences. We emphasize that because consumers are identical and the time allocation ratio $n/q = \Gamma(p)$ is uniquely pinned down by the market price, the holistic markup ratio $\mu(\kappa, p)$ is a property of the firm's type and its pricing decision, not of individual consumer behavior. The ratio should therefore be read as a model-implied price-cost wedge for the representative consumption experience. Measuring its analogue in data with heterogeneous households would require information on, or imputation of, the time used with market purchases; that empirical exercise is outside the scope of this paper, but the definition identifies the object such work would need to recover.

2.3 Equilibrium and efficient allocations

We now turn to formal definitions of equilibrium and efficient allocations under MC and the relationship between the two. We denote by M_e the mass of firms that

enter and draw a marginal cost, so that the total effective labor used in production is $\mathcal{L} = M_e \int_{\underline{\kappa}} \ell(\kappa) G(d\kappa)$ and the total entry costs paid by firms are $\mathcal{E} = (f_e + fG(\bar{\kappa}))M_e$. Because consumers are identical and have unit mass and labor is the only input used in firm production, the individual time-use constraint (2.3) is also the aggregate resource constraint. Under Assumption 2.6 total off-market time is given by $\mathcal{N} = M_e \int_{\underline{\kappa}} n(\kappa) G(d\kappa)$ and the aggregate resource constraint may be written

$$M_e \left[\int_{\underline{\kappa}}^{\bar{\kappa}} (\kappa q(\kappa) + n(\kappa) + f) G(d\kappa) + f_e \right] = \bar{T}. \quad (2.16)$$

Given the environment described in Sections 2.1 and 2.2, the following definitions of equilibrium and efficient allocations are standard extensions of their analogues with no off-market time.

Definition 2.9 (Equilibrium). Normalizing market wages to unity, a monopolistically competitive equilibrium consists of a marginal cost cutoff $\bar{\kappa}^*$, a mass of firms M_e^* , market quantities $\mathbf{q}^* = \{q^*(\kappa)\}_{\kappa \in [\underline{\kappa}, \bar{\kappa}^*]}$, off-market time $\mathbf{n}^* = \{n^*(\kappa)\}_{\kappa \in [\underline{\kappa}, \bar{\kappa}^*]}$, market prices $\mathbf{p}^* = \{p^*(\kappa)\}_{\kappa \in [\underline{\kappa}, \bar{\kappa}^*]}$, and a multiplier λ^* such that:

- (i) the cutoff $\bar{\kappa}^*$ satisfies $\pi(\bar{\kappa}^*) = 0$;
- (ii) for all $\kappa \in [\underline{\kappa}, \bar{\kappa}^*]$, a firm of type κ chooses $p^*(\kappa)$ to solve (2.8);
- (iii) given prices $\mathbf{p}^*$ and a multiplier λ^* , $\mathbf{q}^*$ and $\mathbf{n}^*$ solve the consumer problem (2.4);
- (iv) given $\bar{\kappa}^*$ and $\mathbf{q}^*$, the mass of entering firms, M_e^* , ensures that market resources add up to total time on the market, $\mathcal{L}^* + \mathcal{E}^* = M_e^* \left[\int_{\underline{\kappa}}^{\bar{\kappa}^*} (\kappa q^*(\kappa) + f) G(d\kappa) + f_e \right]$.²⁷

Definition 2.10 (Efficient allocation). An efficient allocation consists of a cutoff $\tilde{\kappa}$, a mass of firms $\tilde{M}_e$, market quantities $\tilde{\mathbf{q}} = \{\tilde{q}(\kappa)\}_{\kappa \in [\underline{\kappa}, \tilde{\kappa}]}$, and off-market time $\tilde{\mathbf{n}} = \{\tilde{n}(\kappa)\}_{\kappa \in [\underline{\kappa}, \tilde{\kappa}]}$, that maximizes (2.1) subject to the resource constraint (2.16).

Definition 2.10 defines an efficient allocation in terms of market purchases $\mathbf{q}$ and off-market time $\mathbf{n}$. Using the definition of ψ in (2.5), if $\tilde{\kappa}$, $\tilde{M}_e$ and $\tilde{\mathbf{c}}$ solve the problem

$$\begin{aligned} & \max_{\mathbf{c}, M_e, \bar{\kappa}} M_e \int_{\underline{\kappa}}^{\bar{\kappa}} u(c(\kappa)) G(d\kappa) \\ & M_e \left[\int_{\underline{\kappa}}^{\bar{\kappa}} (\psi(\kappa)c(\kappa) + f) G(d\kappa) + f_e \right] = \bar{T}. \end{aligned} \quad (2.17)$$

²⁷This follows from subtracting aggregate off-market time, $\mathcal{N}^* = M_e^* \int_{\underline{\kappa}}^{\bar{\kappa}^*} n^*(\kappa) G(d\kappa)$, from both sides of the aggregate resource constraint (2.16).

then we obtain an efficient allocation with cutoff $\tilde{\kappa}$ and mass of firms $\tilde{M}_e$ by defining $\tilde{q}(\kappa) = \psi'(\kappa)\tilde{c}(\kappa)$ and $\tilde{n}(\kappa) = (\psi(\kappa) - \psi'(\kappa)\kappa)\tilde{c}(\kappa)$ for all $\kappa \in [\underline{\kappa}, \tilde{\kappa}]$. For brevity, we will sometimes refer to the solution to (2.17) as the efficient allocation, with the understanding that $\tilde{\mathbf{q}}$ and $\tilde{\mathbf{n}}$ are related to $\tilde{\mathbf{c}}$ via the consumption technology $h(.,.)$ in the same manner as we have previously outlined.

In view of Definition 2.9 and Definition 2.10, the relationship between MC equilibrium and efficient allocations is not obvious: the former is defined in terms of prices and quantities that solve optimization problems for firms and consumers and satisfy market-clearing conditions, while the latter is the solution to a single optimization problem. Before turning to our results on markups, selection and the aggregate allocation of resources, we first discuss how we intend to compare these two allocations.

To begin, we recall that in an MC model with inelastic time use, [Dhingra and Morrow \(2019\)](#) show that equilibrium allocations maximize the integral of $qu'(q)$ subject to the aggregate resource constraint, and are therefore efficient for all distributions G if and only if $\epsilon_u(q) = qu'(q)/u(q)$ is constant in q . In our environment, there is an additional reason why equilibrium and efficient allocations can differ, namely, that resource costs are higher in the equilibrium allocation because the consumer's time use depends endogenously on market prices. Proposition 2.11 shows this by proving that equilibrium allocations can be recovered from the solution to an optimization problem. To motivate the form of this problem, note that when λ^* is the multiplier on the consumer's budget constraint, prices must satisfy $p^*(\kappa) = \psi^{-1}(u'(c(\kappa))/\lambda^*)$. The following resource constraint is then stated in terms of the holistic marginal resource cost, $\phi(\kappa, p)$, evaluated at these prices.

Proposition 2.11. *If for some $\lambda^* > 0$, the multiplier in the optimization problem*

$$\begin{aligned} V(\lambda^*) &= \max_{\mathbf{c}, M_e, \bar{\kappa}} M_e \int_{\underline{\kappa}}^{\bar{\kappa}} c(\kappa) u'(c(\kappa)) G(d\kappa) \\ M_e \left[\int_{\underline{\kappa}}^{\bar{\kappa}} (\phi(\kappa, \psi^{-1}(u'(c(\kappa))/\lambda^*))) c(\kappa) + f) G(d\kappa) + f_e \right] &= \bar{T} \end{aligned} \quad (2.18)$$

equals λ^* , then the associated allocation constitutes an MC equilibrium allocation in which for all $\kappa \in [\underline{\kappa}, \bar{\kappa}^*]$, prices are $p^*(\kappa) = \psi^{-1}(u'(c^*(\kappa))/\lambda^*)$, demand for market goods is $q^*(\kappa) = \psi'(p^*(\kappa))c^*(\kappa)$ and off-market time is $n^*(\kappa) = (\psi(p^*(\kappa)) - \psi'(p^*(\kappa))p^*(\kappa))c^*(\kappa)$.

Proof. See Appendix B.1. □

Proposition 2.11 implies that for each $\kappa \in [\underline{\kappa}, \bar{\kappa}^*]$, the equilibrium $c^*(\kappa)$ maximizes

equilibrium surplus, defined as

$$S^*(\kappa, \lambda^*) := \sup_{c>0} cu'(c) - \lambda^* \phi(\kappa, \psi^{-1}(u'(c)/\lambda^*))c, \quad (2.19)$$

while if $\tilde{\lambda}$ is the multiplier on the resource constraint in (2.17), then for each $\kappa \in [\underline{\kappa}, \tilde{\kappa}]$, the efficient $\tilde{c}(\kappa)$ maximizes social surplus, defined as

$$\tilde{S}(\kappa, \tilde{\lambda}) := \sup_{c>0} u(c) - \tilde{\lambda} \psi(\kappa)c. \quad (2.20)$$

The key point in the above is that in both the equilibrium and efficient allocation, the cutoff $\bar{\kappa}$ and mass M_e solve a problem of the form

$$\max_{M_e, \bar{\kappa}} M_e \left[\int_{\underline{\kappa}}^{\bar{\kappa}} S(\kappa, \lambda) G(d\kappa) - \lambda(fG(\bar{\kappa}) + f_e) \right] \quad (2.21)$$

for some $\lambda > 0$ and function S . For the equilibrium allocation, S is defined in (2.19), while in the efficient allocation, S is defined in (2.20). The representation (2.21) shows that both the efficient and equilibrium allocations may be viewed as the outcome of choosing final consumption experiences c , a cutoff value $\bar{\kappa}$, and mass of firms M_e to maximize some notion of surplus minus entry costs per variety and in general differ for two conceptually distinct reasons. First, as emphasized in [Dhingra and Morrow \(2019\)](#), the first term in the efficient surplus is utility, $u(c)$, while the first term in the equilibrium surplus is instead $cu'(c)$, which is proportional to utility only in the special case of CES preferences. Second, and novel to this paper, the resource cost per unit of consumption in the efficient allocation is $\psi(\kappa)$, while the corresponding resource cost in the equilibrium allocation is instead the (endogenous) quantity $\phi(\kappa, \psi^{-1}(u'(c)/\lambda^*)) \geq \psi(\kappa)$.

2.3.1 Firm selection and aggregate profits

The fact that firm entry is a two-step process implies that there are two margins along which we can compare MC equilibrium and efficient allocations: the productivity of the least productive firm that operates and the mass of firms that draw a marginal cost. We refer to the first comparison as the study of firm “selection,” and we address the second comparison by characterizing the aggregate resources devoted to firm entry, $M_e(f_e + fG(\bar{\kappa}))$ (which equals operating profits in equilibrium), in both the efficient and the equilibrium allocations.

Selection. By combining the first-order conditions with respect to $\bar{\kappa}$ and M_e in

the problem (2.21), we see that when an interior solution for $\bar{\kappa}$ exists, it solves

$$\frac{S(\bar{\kappa}, \lambda)}{\int_{\underline{\kappa}}^{\bar{\kappa}} S(\kappa, \lambda) G(d\kappa)} = \frac{f}{fG(\bar{\kappa}) + f_e}. \quad (2.22)$$

In view of equation (2.22), the marginal cost $\bar{\kappa}$ of the least productive operating firm is determined by equating the elasticity of the average surplus per firm, $\int_{\underline{\kappa}}^{\bar{\kappa}} S(\kappa, \lambda) G(d\kappa)$, with the elasticity of the average entry cost per firm, $fG(\bar{\kappa}) + f_e$.

Aggregate resources. If we define $C^*(\kappa, \lambda^*) := \lambda^* \phi(\kappa, \psi^{-1}(u'(c^*(\kappa))/\lambda^*)) c^*(\kappa)$ and $\tilde{C}(\kappa, \tilde{\lambda}) := \tilde{\lambda} \psi(\kappa) \tilde{c}(\kappa)$, then the aggregate resources devoted to firm entry can be obtained by combining the first-order condition for M_e in the problem (2.21) with the resource constraint to obtain

$$M_e(fG(\bar{\kappa}) + f_e) = \frac{\bar{T} \int_{\underline{\kappa}}^{\bar{\kappa}} S(\kappa, \lambda) G(d\kappa)}{\int_{\underline{\kappa}}^{\bar{\kappa}} (1 - 1/\nu(\kappa, \lambda))^{-1} S(\kappa, \lambda) G(d\kappa)}, \quad (2.23)$$

where we write

$$\nu(\kappa, \lambda) = \frac{S(\kappa, \lambda)}{C(\kappa, \lambda)} + 1, \quad (2.24)$$

which represents the extent to which the surplus associated with variety κ exceeds its resource cost, and so may be interpreted as a kind of markup. Indeed, note that by equation (2.19), we have in equilibrium

$$\nu^*(\kappa, \lambda^*) = \mu(\kappa, p^*(\kappa)) \quad (2.25)$$

where $p^*(\kappa) = \psi^{-1}(u'(c^*(\kappa))/\lambda^*)$, and so $\nu^*(\kappa, \lambda^*)$ is the holistic markup (2.13) evaluated at equilibrium prices.

Equations (2.22) and (2.23) govern the cutoff value $\bar{\kappa}$ and the mass of firms M_e in both the equilibrium and efficient allocations. The key point of this section is that the form of these equations is the same across the efficient and equilibrium allocations when the decentralized economy is MC, and so these allocations differ only insofar as the functions S and ν differ. It is also apparent by inspecting the surplus functions that the first terms in these objectives are exactly proportional to each other at every c only when u is CES in c , affirming the result in [Dhingra and Morrow \(2019\)](#). Off-market time use only impacts the outlay/cost component of the surplus objectives in (2.19) and (2.20) via both the marginal resource cost, ϕ , and the per-unit cost of final consumption experience, ψ .

2.4 Parameterized model

In this section we will impose functional forms on the utility function u and the home production function h in order to sharpen the characterizations from the non-parameterized model.

Assumption 2.12 (CES utility). *For some $\rho \in (0, 1)$ we have $u(c) = c^\rho$ for all $c \geq 0$.*

Assumption 2.13 (CES production). *For some $\alpha \in (0, 1)$ and $\xi \in [-\infty, 1]$ we have $h(q, n) = (\alpha q^\xi + (1 - \alpha)n^\xi)^{1/\xi}$ for all $q, n \geq 0$, where for $\xi = -\infty$ we define $h(q, n) = \min\{q, n\}$ and for $\xi = 0$ we define $h(q, n) = q^\alpha n^{1-\alpha}$.*

In Assumption 2.13, α is the weight of market goods in final consumption experience and $(1 - \xi)^{-1}$ is the elasticity of substitution between market goods and off-market time. We refer to $\xi = -\infty$ as the perfect complements (or Leontief) case, and refer to $\xi = 0$ and $\xi = 1$ as the Cobb-Douglas and perfect substitutes cases, respectively. For $\xi \in (-\infty, 0) \cup (0, 1)$, the holistic price function becomes

$$\psi(p) = \frac{p}{\alpha} \left(\alpha + (1 - \alpha) [(1/\alpha - 1)p]^{1/(1-\xi)} \right)^{1-1/\xi} \quad (2.26)$$

while $\psi(p) = p + 1$ for $\xi = -\infty$, $\psi(p) = \alpha^{-\alpha} (1 - \alpha)^{-(1-\alpha)} p^\alpha$ for $\xi = 0$, and $\psi(p) = \min\{p/\alpha, 1/(1 - \alpha)\}$ for $\xi = 1$. In all cases with $\xi < 1$, $\psi(p)$ is strictly increasing in p . Further, we have the following explicit expression for the associated elasticity.

Lemma 2.14 (Holistic price elasticity). *Fix $\alpha \in (0, 1)$ and $\xi < 1$. For $\xi \notin \{-\infty, 0, 1\}$, the elasticity of the holistic price function ψ is*

$$\epsilon_\psi(p) = \frac{1}{1 + (1/\alpha - 1)^{1/(1-\xi)} p^{1/(1-\xi)}}. \quad (2.27)$$

For the boundary cases, $\epsilon_\psi(p) = p/(p + 1)$ when $\xi = -\infty$, $\epsilon_\psi(p) = \alpha$ when $\xi = 0$, and when $\xi = 1$ we have $\epsilon_\psi(p) = 1$ for $p(1/\alpha - 1) \leq 1$ and $\epsilon_\psi(p) = 0$ otherwise.

Moreover, for $p > 0$ the elasticity is monotone in p as follows:

- If $\xi \in [-\infty, 0)$, then $\epsilon_\psi(p)$ is (weakly) increasing in p .
- If $\xi = 0$, then $\epsilon_\psi(p)$ is constant in p .
- If $\xi \in (0, 1)$, then $\epsilon_\psi(p)$ is (weakly) decreasing in p .

Finally, we have $\epsilon_{\psi'}(p) = (\epsilon_\psi(p) - 1)/(1 - \xi)$.

Proof. See Appendix B.2. □

Lemma 2.14 shows that while the holistic price $\psi(p)$ is increasing in p under our maintained assumptions, the monotonicity of the elasticity $\epsilon_\psi(p)$ depends on whether off-market time and market goods are complements ($\xi < 0$) or substitutes ($\xi > 0$). For the above specifications of preferences and technology, the price elasticities of market goods and time use then simplify as follows.²⁸

Lemma 2.15. *Under Assumptions 2.12 and 2.13, the price elasticity of time use is*

$$\epsilon_n^m(p) = \left(\frac{1}{1-\xi} - \frac{1}{1-\rho} \right) \epsilon_\psi(p) \quad (2.28)$$

and the price elasticity of market purchases is

$$\epsilon_q^m(p) = -\frac{1}{1-\rho} + \left(\frac{1}{1-\rho} - \frac{1}{1-\xi} \right) (1 - \epsilon_\psi(p)). \quad (2.29)$$

For $p > 0$, we have $\epsilon_q^m(p) \geq -(1-\rho)^{-1}$ if $\xi \leq \rho$ and $\epsilon_q^m(p) \leq -(1-\rho)^{-1}$ if $\xi \geq \rho$. Further, $\epsilon_n^m(p) \leq 0$ for $\xi \leq \rho$ and $\epsilon_n^m(p) \geq 0$ for $\xi \geq \rho$.

Proof. See Appendix B.2. □

For general u and ψ , Lemma 2.4 shows how the price elasticity of q can be decomposed into the price elasticities of c and q/c , respectively. Lemma 2.15 sharpens this by showing that for the above functional forms, this expression simplifies and becomes affine in the elasticity of ψ . In general, the first-order condition in the firm's problem can be written in terms of the price elasticity of demand using (2.11), and for $\xi \notin \{-\infty, 0, 1\}$ this can be written as $F_m(p; \kappa) = 0$, where

$$\begin{aligned} F_m(p; \kappa) &= \frac{1}{p/k - 1} + 1 + \epsilon_q^m(p) \\ &= \frac{p/\kappa}{p/\kappa - 1} - (1-\rho)^{-1} + ((1-\rho)^{-1} - (1-\xi)^{-1})(1 - \epsilon_\psi(p)). \end{aligned} \quad (2.30)$$

Because the function F is not necessarily monotonic in p , the existence or uniqueness of a solution to the firm's first-order condition is not obvious. Proposition 2.16 below shows that a unique solution always exists and derives comparative statics for different values of ξ . When combined with Lemma 2.14, the expression on the right-hand side of equation (2.30) shows that there are three regions for ξ that govern the comparative statics for markups, because the coefficient of $\epsilon_\psi(p)$ in equation (2.30) is positive if

²⁸The superscript m in the following indicates that these elasticities are for the monopolistically competitive allocation.

and only if $\xi > \rho$, while $\epsilon_\psi(p)$ is increasing if and only if $\xi > 0$. This leads to closed-form expressions for markups when $\xi \in \{-\infty, 0, \rho\}$, and simple comparative statics for all other parameters.

Proposition 2.16. *Under Assumptions 2.12 and 2.13, there exists a unique solution to the firm's first-order condition, and the associated markup ratio $p(\kappa)/\kappa$ is constant in κ when $\xi \in \{0, \rho\}$, decreasing in κ when $\xi \in [-\infty, 0) \cup (\rho, 1)$, and increasing in κ when $\xi \in (0, \rho)$. Further, for $\xi \in \{-\infty, 0, \rho\}$:*

(i) (Leontief) For $\xi = -\infty$ we have $p(\kappa)/\kappa - 1 = (1/\rho - 1)(1 + 1/\kappa)$.

(ii) (Cobb-Douglas) For $\xi = 0$, we have $p(\kappa)/\kappa - 1 = (1/\rho - 1)/\alpha$.

(iii) For $\xi = \rho$, we have $p(\kappa)/\kappa - 1 = 1/\rho - 1$.

The markup ratio weakly exceeds $1/\rho$ if $\xi \leq \rho$, is bounded above by $1/\rho$ when $\xi \geq \rho$, and equals $1/\rho$ when $\xi = \rho$.

Proof. See Appendix B.2. □

We emphasize that Proposition 2.16 characterizes the familiar markup ratio: the price charged by the firm divided by their marginal cost of production. In general, this ratio will differ from both of the markup notions defined in equation (2.24), which pertain to final consumption, and incorporate the value of time in the definition of marginal cost. By Lemma 2.8, we see that in general, the holistic equilibrium markup will be lower than the markup on market goods. For our parameterized model, we may obtain sharper results.

Under Assumption 2.12, we can change variables to $p^* = \psi^{-1}(u'(c^*)/\lambda^*)$ and write the equilibrium surplus as

$$S^*(\kappa, \lambda^*) = \rho^{\frac{1}{1-\rho}} (\lambda^*)^{-\frac{\rho}{1-\rho}} \sup_{p^* > 0} (p^* - \kappa) \psi'(p^*) \psi(p^*)^{-\frac{1}{1-\rho}} \quad (2.31)$$

while for social surplus, we change variables to $\tilde{p} = \psi^{-1}(u(\tilde{c})/[\tilde{\lambda}\tilde{c}])$ to write

$$\tilde{S}(\kappa, \tilde{\lambda}) = \tilde{\lambda}^{-\frac{\rho}{1-\rho}} \sup_{\tilde{p} > 0} (\psi(\tilde{p}) - \psi(\kappa)) \psi(\tilde{p})^{-\frac{1}{1-\rho}}. \quad (2.32)$$

Using the representations (2.31) and (2.32) of the equilibrium and social surplus, we may show the following.

Lemma 2.17. *Under Assumptions 2.12 and 2.13, for all $\kappa \geq \underline{\kappa}$ the equilibrium and efficient quantities of $\nu(\kappa, \lambda)$ described in (2.24) (i.e., the extent to which the surplus*

associated with variety κ exceeds its resource cost) are independent of the multipliers and satisfy $\nu^*(\kappa) \leq 1/\rho = \tilde{\nu}(\kappa)$, with equality only in the case of perfect complements ($\xi = -\infty$).

Proof. The first-order condition for (2.31) implies

$$0 = \frac{p^*}{p^* - \kappa} + \epsilon_{\psi'}(p^*) - \frac{\epsilon_{\psi}(p^*)}{1 - \rho} \quad (2.33)$$

while $\nu^*(\kappa) \leq 1/\rho$ is equivalent to $p^*/(p^* - \kappa) - \epsilon_{\psi}(p^*)/(1 - \rho) \geq 0$, which follows from equation (2.33) and the fact that $\epsilon_{\psi'} \leq 0$ with equality only when $\xi = -\infty$. The identity $\tilde{\nu}(\kappa) = 1/\rho$ then follows directly from the first-order condition for (2.32). $\square$

When combined with equation (2.25), Lemma 2.17 shows that equilibrium holistic markups coincide with the efficient holistic markups only when $\xi = -\infty$. For all interior elasticities of substitution for q and n , efficient holistic markups weakly exceed MC equilibrium holistic markups, despite being weakly less than the MC equilibrium markups for p 's as chosen by firms; this follows from Lemma 2.8.

2.4.1 Selection and aggregate entry

We now turn to the analysis of firm selection for our parameterized model under monopolistic competition. The key parameter governing our results is again the elasticity of substitution between off-market time and demand for market varieties, which is governed by ξ . As shown in Proposition 2.16, this elasticity dictates how markups vary in firm costs. We now show that this parameter also governs the efficiency or inefficiency of firm selection.

To this end, we first recall from equation (2.22) that in both the equilibrium and efficient allocations, the marginal cost $\bar{\kappa}$ of the least productive operating firm is determined by equating the elasticity of the average surplus per firm with the elasticity of the average entry cost per firm. The proof of Proposition 2.18 first proceeds from this observation to show that the characterization of MC equilibrium and efficient selection reduces to comparing the elasticities of the two surplus functions in (2.31) and (2.32). Together with an application of the envelope theorem, this in turn reduces to signing the magnitude of equilibrium markups and gives the following.

Proposition 2.18 (Selection). *The equilibrium $\bar{\kappa}$ is inefficiently high if $\xi \in (-\infty, 0)$, inefficiently low if $\xi \in (0, 1)$, and efficient if $\xi \in \{-\infty, 0\}$.*

Proof. See Appendix B.2. $\square$

We believe that it is intuitive why MC equilibrium selection is efficient in the case of perfect complements. Because the ratio of off-market time to market goods is independent of prices, this case is essentially a disguised version of a model with CES preferences and no off-market time, in which the marginal cost of production for a firm of type κ is now $\psi(\kappa) = \kappa + 1$. To see how this relates to the above algebra, note that in this case $\psi'(\kappa) = 1$ for all κ , and so the equilibrium and social surplus in (2.19) and (2.20) are proportional to one another. This is the sole case in which firms' market power does not distort the ratio n/q away from its efficient value.

Proposition 2.18 shows that as we increase the elasticity of substitution between time and market goods above zero, selection is first too lax (for $\xi < 0$) and then too strict (for $\xi > 0$). To understand why, note that when market goods and off-market time are complements, consumers cannot easily substitute away from market goods by reallocating time, and so equilibrium surplus (profits) declines more slowly than social surplus. High-cost firms can therefore profitably operate despite their inefficiency, as consumers still need to purchase market goods to utilize their time, which leads to (weakly) inefficiently high entry of high-cost firms. Conversely, when market goods and time are substitutes, consumers can more easily respond to high prices by substituting time for market purchases. This heightened elasticity of substitution ensures that as costs rise, profits fall more rapidly than social surplus, and prevents some marginally efficient high-cost firms from operating.

We now study aggregate resources devoted to entry in our parameterized MC model. Recall that the first entry cost, f_e , is paid by all of the entering firms, while the second entry cost, f , is paid only by the fraction $G(\bar{\kappa})$ that choose to operate. The total resources expended in the process of firm creation are then $(f_e + fG(\bar{\kappa}))M_e$. Proposition 2.19 below shows that the equilibrium value of this quantity is always (weakly) below its efficient counterpart, and coincides in one special case.

Proposition 2.19 (Inefficiently low entry). *The total resources devoted to firm entry, $\mathcal{E} = M_e(f_e + fG(\bar{\kappa}))$, are inefficiently low in equilibrium unless off-market time and market goods are perfect complements ($\xi = -\infty$).*

Proof. This is immediate from equation (2.23) and Lemma 2.17. $\square$

Proposition 2.19 shows that outside of the special case of perfect complementarity between off-market time and market goods, the MC equilibrium allocation devotes too few resources to firm creation. Note also that due to the assumption of free entry (and hence zero ex-ante profits), in equilibrium the quantity $M_e(f_e + fG(\bar{\kappa}))$ coincides with the aggregate ex-post operating profits of all active firms. Proposition 2.19 shows that in our model structure these profits are typically “too small” to provide incentives for efficient firm entry. Intuitively, consumers in this economy do

not internalize the fact that their decisions to allocate labor between off-market time and market production affect firms' profits and the incentives to enter. This is an additional economic force that is not present in models without off-market time.

Proposition 2.18 characterizes when the efficient and equilibrium cutoff values of $\bar{\kappa}$ coincide, while Proposition 2.19 characterizes when the efficient and equilibrium values of $(f_e + fG(\bar{\kappa}))M_e$ coincide. Combining these two results, we obtain the following.

Corollary 2.20 (Efficiency). *The MC equilibrium allocation is efficient if and only if off-market time and market goods are perfect complements in the consumption technology.*

The efficiency of the MC equilibrium allocation under perfect complements is particularly noteworthy because Proposition 2.16 shows that the (usual) markups in this case are not constant across firms. An economist who were to observe this heterogeneity would therefore erroneously conclude that welfare losses existed in this environment if they thought the market under study were monopolistically competitive and they ignored the role of off-market time. Note, however, that by Lemma 2.17, in this case the holistic markups are constant across firms. Empirical work seems to suggest an increasing relationship between markups and productivities.²⁹ The above example shows that such variable markups may, indeed, be efficient in certain markets. Further, when combined with Proposition 2.16, Corollary 2.20 shows that when time use is elastically supplied and non-separable with market varieties, the link between markup constancy and efficiency is broken in both directions, in the sense that such constancy is neither necessary nor sufficient for efficiency. For instance, when $\xi = -\infty$, markups are variable across firms and the allocation is efficient, and so clearly constancy of markups is not necessary. On the other hand, when $\xi = \rho$, markups are constant across firms but selection is inefficiently low, and so such constancy is also not sufficient.

2.4.2 Firm-specific comparisons

Proposition 2.19 shows that outside of the case of perfect complements, the total amount of resources devoted to firm entry is inefficiently low in a monopolistically competitive equilibrium. In view of the resource constraint (2.3), this means that the sum of the aggregate resources devoted to production and off-market time are inefficiently high.

It is then natural to ask whether the time use and market purchases associated with a particular variety are “too high” or “too low” from the point of view of the

²⁹See, e.g., [Edmond and Veldkamp \(2009\)](#); [Berry et al. \(2019\)](#); [Peters \(2020\)](#).

planner. In general, it is not possible to compare such quantities for all types of firms because the distributions of firm productivity differ across the efficient and equilibrium allocations. However, in the case of Cobb-Douglas technology, $\xi = 0$, Proposition 2.18 shows that the distribution of firms that operate in the equilibrium and efficient allocations coincide, and we can sharpen the above results.

Proposition 2.21. *When $u(c) \equiv c^\rho$ and $h(q, n) \equiv q^\alpha n^{1-\alpha}$ for some $\rho, \alpha \in (0, 1)$, the ratios of equilibrium consumption, time use and market purchases to their efficient counterparts are constant across firms and satisfy*

$$\frac{n^*}{\bar{n}} = 1 + (1/\rho - 1)/\alpha > \frac{\bar{c}^*}{\bar{c}} = (1 + (1/\rho - 1)/\alpha)^{1-\alpha} > \frac{q^*}{\bar{q}} = 1 \quad (2.34)$$

while $M_e^* < \bar{M}_e$.

Proof. See Appendix B.2. □

Relative to the efficient allocation, the equilibrium number of varieties is lower, the final consumption of each variety is higher, but the market production for each variety is unchanged. Consequently, under a Cobb-Douglas consumption technology, firms are neither “too big” nor “too small,” but there are too few of them in the aggregate, and consumers devote an inefficiently high amount of time to off-market activities. Thus, while market competition forces the right “kind” of firms to operate (i.e., selection is efficient), there are not enough competitors making market products, and consumers are not supplying enough labor toward creating new firms (i.e., $\mathcal{E}$).

2.5 Allowing for leisure

Under Assumption 2.6 all time spent engaged in off-market activities requires the utilization of market varieties in order to generate final consumption experiences. In the modern world this assumption is not overly implausible: there are very few activities we engage in which do not also involve the utilization of a product bought and sold on the market. Even leisure time is usually complemented by the utilization of recreational goods and services:³⁰ 1) walking in the park requires tennis shoes and perhaps a podcast streamed through Bluetooth headphones and paid for via a subscription service; 2) video gaming requires a console or computer, headsets and other gaming equipment, and the game software itself; 3) child care and personal care require a litany of consumer goods, like soaps, oils, wipes, etc.; 4) even socializing with

³⁰Both Aguiar et al. (2021) and Pretnar (2025) show that time spent using recreational goods purchased on the market is a significant fraction of non-work time.

one's family or friends is often done in conjunction with other consumption activities, like eating out or eating at home, sipping coffee or wine, playing games, watching television or movies, etc. Indeed, it is difficult to come up with an example of an activity one engages in which is also not associated with the utilization of a product bought and sold on the market.

To show, however, that Assumption 2.6 is innocuous we relax it here, letting $\mathcal{K}$ be a strict subset of $\mathcal{I}$. We thus consider an economy where there exist $q(\kappa) > 0$ and associated consumption-time allocations $n(\kappa) > 0$ but also $n_i > 0$ where $i \notin \mathcal{K}$. Of course, $q_i = 0$ for $i \notin \mathcal{K}$. This requires us to restrict the set of possible functions h could take on to those which are finite when $q_i = 0$. Assumption 2.22 encodes this.

Assumption 2.22. *Let h be such that $h(0, n_i) > 0$ for $n_i > 0$, so that there exist final consumption experiences, c_i , for which consumers allocate some positive amount of their off-market time but for which no market goods/services are utilized.*

Under Assumption 2.22 and the form of preferences (2.1), we can write utility as the sum of utility from consumption experiences associated with using both market goods and time and consumption experiences associated only with using time, $\mathcal{U}(\mathbf{c}) = \int_{\mathcal{K}} u(c_i) di + \int_{\mathcal{I} \setminus \mathcal{K}} u(c_i) di$, and the budget constraint can be similarly split.

Segmenting the different kinds of experiences in this manner does not change the demand elasticities for market purchases or firms' pricing decisions. Indeed, the leisure bundle would be such that $\forall i, j \in \mathcal{I} \setminus \mathcal{K}$ such that $i \neq j$, $n_i = n_j$, and we could write $\int_{\mathcal{I} \setminus \mathcal{K}} u(c_i) di = \underline{N}$, where $\underline{N}$ is some leisure-utility index. The introduction of additively separated leisure utility thus does not affect the pricing decisions of firms.

2.6 Inferences from demand elasticities

We have characterized efficient and equilibrium allocations in an MC environment in which consumers exhibit love-for-variety and utility depends non-separably on both market purchases and off-market time. In this section, we now relate the findings of this paper to those in the MC literature, in order to highlight the novel role of non-separable time use. Recall that [Dhingra and Morrow \(2019\)](#) consider an MC environment in which utility is independent of time use and exhibits variable elasticities of substitution (VES) across varieties. They show that the equilibrium $\bar{\kappa}$ is inefficiently high when ϵ_u is everywhere decreasing and inefficiently low when ϵ_u is everywhere increasing.³¹ It is then natural to ask how inferences drawn from observed markups differ between our model and [Dhingra and Morrow \(2019\)](#).

To explore this in the simplest possible case, we first suppose that $h(q, n) \equiv q$ and $u(q) = q^\rho - \eta q$ for some $\eta > 0$, at least when restricted to $q < (\eta/\rho)^{-\frac{1}{1-\rho}}$. This

³¹See Proposition 5 on page 213 of [Dhingra and Morrow \(2019\)](#).

functional form is chosen because it is the simplest utility function whose leading term matches the CES preferences from Section 2.4 but whose utility elasticity is decreasing in q , which is the condition under which [Dhingra and Morrow \(2019\)](#) predict inefficiently lax selection. The linear term $-\eta q$ generates exactly the perturbation needed to produce a demand schedule that, as we show below, is observationally equivalent to the Leontief time-use model with pure CES utility, the case in which our model predicts efficiency. The associated utility elasticity is then

$$\epsilon_u(q) = \rho - \frac{(1 - \rho)\eta}{q^{\rho-1} - \eta} \quad (2.35)$$

which is decreasing, and so by the results of [Dhingra and Morrow \(2019\)](#), the equilibrium $\bar{\kappa}$ is inefficiently high. However, the first-order condition rearranges to give the demand schedule $q(p) = (\lambda/\rho)^{-\frac{1}{1-\rho}}(p + \eta/\lambda)^{-\frac{1}{1-\rho}}$, which coincides with the demand schedules in the model of Section 2.4 with $h(q, n) = \min\{q, n\}$, $u(c) = c^\rho$ and $\lambda = \eta$. Consequently, the equilibrium allocation in the latter economy is efficient, while the equilibrium allocation in the former economy is not. In this example, an econometrician who ignored the role of time use and used markups to infer demand elasticities would therefore erroneously believe that there were welfare losses.

To see how this simple example generalizes, note that with inelastic time use, the demand schedule satisfies $u'(\hat{q}(p)) = \lambda p$, where λ is the multiplier on the consumer's budget constraint, and so using the change-of-variables $z = \hat{q}(w)$, we have

$$u(x) = \int_0^x u'(z)dz = \lambda \int_0^x \hat{q}^{-1}(z)dz = -\lambda \int_{\hat{q}^{-1}(x)}^\infty w\hat{q}'(w)dw \quad (2.36)$$

for all $x \geq 0$. For this utility function, the associated elasticity satisfies

$$\epsilon_u(\hat{q}(p)) = \frac{p\hat{q}(p)}{\int_p^\infty (-w\hat{q}'(w))dw} \quad (2.37)$$

and explicit calculation gives the following.

Lemma 2.23. *If $\epsilon_{\hat{q}}$ is decreasing everywhere, then ϵ_u is decreasing everywhere, where u is defined in equation (2.36).*

Proof. See Appendix B.2. □

Lemma 2.23 shows that if we interpreted the markups emerging from the model in Section 2.4 using the results of [Dhingra and Morrow \(2019\)](#), we would conclude that the equilibrium $\bar{\kappa}$ is inefficiently high when $\xi \in [-\infty, 0) \cup (\rho, 1)$, inefficiently low when $\xi \in (0, \rho)$ and efficient if $\xi \in \{0, \rho\}$. Note that this contrasts with our selection

result in Proposition 2.18, which shows that the equilibrium $\bar{\kappa}$ is inefficiently high if $\xi \in (-\infty, 0)$, inefficiently low if $\xi \in (0, 1)$, and efficient if $\xi \in \{-\infty, 0\}$. An econometrician who observed the markups generated by our model but ignored the role of off-market time would erroneously conclude that selection was not strict enough if $\xi \in (\rho, 1)$ (when in fact it is too strict) and erroneously conclude that it is not strict enough if $\xi = -\infty$ (when it is in fact efficient). Consequently, incorporating off-market time as we have done in this paper does not merely change the distribution of markups but also the welfare implications of such markups under monopolistic competition.

3 Oligopolistic competition

In this section we consider a model of oligopolistic competition, while maintaining our unique modeling assumption that off-market time and market purchases are non-separable in preferences as each are used to produce final consumption experiences over which consumers derive ultimate utility. Recall that in the model of Section 2, any firm that pays f has the right to produce a *unique variety* indexed by a set $\mathcal{I}$. We now follow Edmond et al. (2023) and interpret $\mathcal{I}$ as an index of *sectors*, and suppose that when a firm pays the entry cost, they are randomly assigned to a sector.³² Sectors therefore differ in the number of firms, who subsequently produce different varieties and compete in an oligopolistic fashion as we explain below.

Assumption 3.1. *For some probability distribution $\omega := \{\omega_k\}_{k=0}^\infty$, when a mass M_e of firms pays the entry cost f_e , each firm is assigned to sectors indexed by $[0, M_e]$ in such a manner that the number of firms in any sector is distributed according to ω .*

The precise manner (i.e. the distribution ω) in which new firms are assigned to sectors is not essential in what follows. The point is simply that now, since there are finitely many firms in each sector, the number of operating firms will be an important equilibrium object, which is one thing OC adds relative to MC. Note that the monopolistically competitive environment corresponds to the case in which $\omega_1 = 1$ and $\omega_k = 0$ for $k \neq 1$. In this section we invoke Assumption 2.5 (smooth marginal cost distribution) together with Assumptions 2.12 (CES u) and 2.13 (CES h), and the following.

Assumption 3.2. *All firms in a sector draw a common marginal cost, κ_i , from G , and the draws are independent across sectors.*

³²See p. 1632 in Edmond et al. (2023). We index the assignment by an arbitrary probability distribution so that the monopolistically competitive model arises as a special case.

Assumption 3.2 says that sectors are fully characterized by their index $i \in \mathcal{I}$ or the common within-sector cost structure, κ_i . This assumption will allow us to focus on how our unique model structure under oligopolistic competition affects outcomes of first-order concern with regards to market power, namely markups and within-sector entry. It also makes convenient a clean comparison of such outcomes between models where firms engage in different conduct (i.e., choosing prices as in Bertrand competition or choosing quantities as in Cournot competition).

3.1 Consumers and firms

The consumer has preferences represented by $\int_{\mathcal{I}} C_i^\rho di$ for some $\rho \in (0, 1)$, where C_i is a CES aggregate across varieties in sector $i \in \mathcal{I}$: given $\sigma > 1$ and J_i active firms,

$$C_i = \left(J_i^{-1/\sigma} \sum_{j=1}^{J_i} c_{ij}^{1-1/\sigma} \right)^{\frac{1}{1-1/\sigma}} \quad (3.1)$$

where $c_{ij} = h(q_{ij}, n_{ij})$ for some function h satisfying Assumption 2.13. Consumers choose q_{ij} and n_{ij} and face the budget constraint $\int_{\mathcal{I}} \sum_{j=1}^{J_i} (p_{ij} q_{ij} + n_{ij}) di = \bar{T}$.

Definition 3.3. Given sectors $\mathcal{I}$, active firms $\mathbf{J} = \{J_i\}_{i \in \mathcal{I}}$ and prices $\mathbf{p} = \{p_{ij}\}_{(i,j) \in \mathcal{I}\mathbf{J}}$, the consumer problem is to maximize $\int_{\mathcal{I}} C_i^\rho di$ over $\mathbf{q}, \mathbf{n}$ and $\mathbf{C}$ satisfying (3.1) and the budget constraint $\int_{\mathcal{I}} \sum_{j=1}^{J_i} (p_{ij} q_{ij} + n_{ij}) di \leq \bar{T}$, where $c_{ij} = h(q_{ij}, n_{ij})$ is the consumption of variety j in sector i .

We maintain the following assumption adopted in Atkeson and Burstein (2008) and De Loecker et al. (2021), that gives content to the sector concept.

Assumption 3.4. We define $\chi := \sigma - (1 - \rho)^{-1}$ and assume that $\chi > 0$.

Assumption 3.4 is a natural extension of assumptions in Atkeson and Burstein (2008) and De Loecker et al. (2021) but applied to our model. Instead of market goods within a sector being assumed more substitutable with each other than those between sectors, we assume that the *experiences* associated with market goods within a sector are more substitutable than experiences associated with products from other sectors.

Lemma 3.5. Given prices $\mathbf{p}$, the solution to the consumer problem satisfies

$$c_{ij} = \bar{T} \left(\int_{x \in \mathcal{I}} \Psi_x^{-\frac{\rho}{1-\rho}} dx \right)^{-1} \Psi_i(\mathbf{p}_i)^\chi J_i^{-1} \psi(p_{ij})^{-\sigma}$$

where for any $i \in \mathcal{I}$ and $\mathbf{p}_i = \{p_{ij}\}_{j=1}^{J_i}$, $\Psi_i(\mathbf{p}_i) := \left(J_i^{-1} \sum_{j=1}^{J_i} \psi(p_{ij})^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ denotes the holistic price index.

Proof. See Appendix C.2. □

Lemma 3.5 and the envelope condition $q_{ij} = \psi'(p_{ij})c_{ij}$ imply that

$$\begin{aligned} \ln q_{ij}(\mathbf{p}_i) = & \underbrace{\ln \psi'(p_{ij}) - \frac{\ln \psi(p_{ij})}{1-\rho}}_{\text{MC component}} + \underbrace{\chi(\ln \Psi_i(\mathbf{p}_i) - \ln \psi(p_{ij}))}_{\text{OC component}} \\ & + \ln(\bar{T}/J_i) - \ln\left(\int_{x \in \mathcal{I}} \Psi_x^{-\frac{\rho}{1-\rho}} dx\right) \end{aligned} \quad (3.2)$$

for $i \in \mathcal{I}$ and $j = 1, \dots, J_i$, where the last term is constant from the perspective of firms and consumers once firms have chosen to operate. Equation (3.2) makes clear that in OC demand is proportional to the standard monopolistic competition component from Section 2 along with a term that is specific to the oligopolistic competition environment. One can view the system of equations (3.2) as defining $\mathbf{q}$ as a function of $\mathbf{p}$, or $\mathbf{p}$ as a function of $\mathbf{q}$, which leads to the following pair of elasticities.

Definition 3.6. For any $i \in \mathcal{I}, j \in \{1, \dots, J_i\}$ and $\mathbf{p}_{i,-j} = \{p_{ik}\}_{k \neq j}$, we write $\epsilon_{q_{ij}}(p_{ij})$ for the elasticity of the function $p_{ij} \mapsto q_{ij}(p_{ij}; \mathbf{p}_{i,-j})$, and for $\mathbf{q}_{i,-j} = \{q_{ik}\}_{k \neq j}$, we write $\epsilon_{p_{ij}}(q_{ij})$ for the elasticity of the function $q_{ij} \mapsto p_{ij}(q_{ij}; \mathbf{q}_{i,-j})$.

We now study firm behavior and the determination of prices under two different conduct regimes — 1) a Bertrand regime where firms choose prices, internalizing the prices that competitors also choose; 2) a Cournot regime where firms choose quantities, internalizing the quantities chosen by their competitors. In either conduct regime, firms produce with the same technology as in Section 2, $q_{ij} = \ell_{ij}/\kappa_i$, where κ_i is the marginal cost of firms in sector i .

Definition 3.7. Given sectors $\mathcal{I}$ and active firms $\mathbf{J} = \{J_i\}_{i \in \mathcal{I}}$, for the j^{th} firm in the i^{th} sector, the *Bertrand* problem given prices $\mathbf{p}_{i,-j} = \{p_{ik}\}_{k \neq j}$ is

$$\pi_B(\kappa_i) = \max_{p_{ij} \geq 0} (p_{ij} - \kappa_i) q_{ij}(p_{ij}; \mathbf{p}_{i,-j}) - f$$

and the *Cournot* problem given quantities $\mathbf{q}_{i,-j} = \{q_{ik}\}_{k \neq j}$ is

$$\pi_C(\kappa_i) = \max_{q_{ij} \geq 0} (p_{ij}(q_{ij}; \mathbf{q}_{i,-j}) - \kappa_i) q_{ij} - f.$$

We assume that if j firms are active in a sector ex-ante assigned k firms, then each firm is active with probability j/k .

3.2 Equilibrium

We now define our notion of equilibrium. The structure of equilibrium is identical to that in Definition 2.9: consumers optimize, firms maximize profits, and the expected profits of a prospective firm (net of entry costs) is zero.

Expected profits. When the consumer's multiplier is λ , the profits of an operating firm with marginal cost κ in a sector with j operating firms is denoted $\pi_B(\kappa, j; \lambda)$.³³ Under symmetry, we have $\pi_B(\kappa, j; \lambda) = \bar{R}_j(\kappa)(\lambda/\rho)^{-\frac{1}{1-\rho}} - f$, where

$$\bar{R}_j(\kappa) = \left(1 - \frac{\kappa}{p_B(\kappa, j)}\right) \psi(p_B(\kappa, j))^{-\frac{1}{1-\rho}} \epsilon_\psi(p_B(\kappa, j)) j^{-1}. \quad (3.3)$$

The component of revenue over which firms have direct control is $\bar{R}_j(\kappa)$. The other revenue term, $(\lambda/\rho)^{-1/(1-\rho)}$, will not be affected by firm conduct under the assumption that sectors are atomistic. We define $\bar{\kappa}_1(\lambda)$ to be the marginal cost of the least productive firm that operates given the multiplier λ , and for $\bar{\kappa}_1 \geq \underline{\kappa}$ and $j > 1$ define $\bar{\kappa}_j(\bar{\kappa}_1) = \bar{R}_j^{-1}(\bar{R}_1(\bar{\kappa}_1))$. The profit function is then $\pi_B(\kappa, j; \lambda) = (\bar{R}_j(\kappa)/\bar{R}_1(\bar{\kappa}_1(\lambda)) - 1)f$, and so summing over the number of firms, the expected profits of a prospective firm as a function of $\bar{\kappa}_1$ is

$$\Pi_B(\bar{\kappa}_1) = \sum_{k=1}^{\infty} \sum_{j=1}^{\infty} \omega_k I_{j,k}(\bar{\kappa}_1) - f_e \quad (3.4)$$

where $I_{j,k}(\bar{\kappa}_1) := \int_{\bar{\kappa}_{j+1}(\bar{\kappa}_1)}^{\bar{\kappa}_j(\bar{\kappa}_1)} \min\{j/k, 1\} (\bar{R}_{\min\{j,k\}}(\kappa)/\bar{R}_1(\bar{\kappa}_1) - 1) f G(d\kappa)$, and the analogous function when firms compete in a Cournot fashion is denoted by Π_C . We write $J^*(\kappa, k; \lambda) = \max\{j \leq k | (\bar{R}_j(\kappa)/f)^{1-\rho} \geq \lambda/\rho\}$ for the number of active firms in a sector with k firms with marginal cost κ and have the following definition.

Definition 3.8 (Equilibrium). Normalizing wages to unity, a symmetric Bertrand equilibrium with free entry consists of a marginal cost cutoff $\bar{\kappa}_1^*$, a mass of firms M_e^* , prices $\mathbf{p}^* = \{p^*(\kappa, k); \kappa \geq \underline{\kappa}, k \geq 1\}$, market quantities $\mathbf{q}^* = \{q^*(\kappa, k); \kappa \geq \underline{\kappa}, k \geq 1\}$ and off-market time $\mathbf{n}^* = \{n^*(\kappa, k); \kappa \geq \underline{\kappa}, k \geq 1\}$, such that for $\lambda^* := \rho(\bar{R}_1(\bar{\kappa}_1^*)/f)^{1-\rho}$:

- (i) consumer optimality: given M_e^* , active firms $\mathbf{J} := \{J^*(\kappa, k; \lambda^*), \kappa \geq \underline{\kappa}, k \geq 1\}$, and prices $\mathbf{p}^*$, $\mathbf{q}^*$ and $\mathbf{n}^*$ solve the consumer problem;
- (ii) firm optimality: $p^*(\kappa, k) = p_B(\kappa, J^*(\kappa, k; \lambda^*))$ for $\kappa \geq \underline{\kappa}, k \geq 1$; and
- (iii) zero expected profits for entering firms: $\Pi_B(\bar{\kappa}_1^*) = 0$.

³³As with prices described above, we are using subscript B and C to distinguish between objects that arise under Bertrand and Cournot conduct, respectively.

A symmetric Cournot equilibrium with free entry is defined similarly, except that the functions p_B and Π_B in (ii) and (iii) are replaced by p_C and Π_C , respectively.

Note that the free-entry condition in Definition 3.8 pins down $\bar{\kappa}_1^*$ by imposing zero *expected* profits for a prospective entrant, integrating over the distribution of (κ, k) and the assignment/rationing that selects which firms are active. However, free entry does not require that the marginal firm in every sector earn zero *operating* profits ex-post. Indeed, because $J^*(\kappa, k; \lambda^*)$ is integer-valued, it may be that for some (κ, k) profits at $j = J^*$ are positive while profits at $j = J^* + 1$ are negative.

3.3 Analysis

To begin our analysis of the oligopolistically competitive model, note that the first-order condition in the Bertrand problem implies

$$0 = \frac{1}{p_{ij}/\kappa_i - 1} + 1 + \epsilon_{q_{ij}}(p_{ij})$$

and the first-order condition for the Cournot problem rearranges to

$$0 = \frac{1}{p_{ij}(\mathbf{q})/\kappa_i - 1} + 1 + \frac{1}{\epsilon_{p_{ij}}(q_{ij})}.$$

Using these conditions, the Bertrand and Cournot prices in a sector with J active firms and (common) marginal cost κ can be characterized as follows.

Proposition 3.9 (Symmetric oligopoly prices). *In a sector with $J \geq 1$ active firms and common marginal cost κ , the Bertrand price p_B and the Cournot price p_C solve*

$$0 = \frac{p_B/\kappa}{p_B/\kappa - 1} + \epsilon_q^m(p_B) - (1 - J^{-1})\chi\epsilon_\psi(p_B) \quad (3.5)$$

$$0 = \frac{p_C/\kappa}{p_C/\kappa - 1} + \epsilon_q^m(p_C) - (1 - J^{-1})\chi\epsilon_\psi(p_C)W(p_C, J) \quad (3.6)$$

where the function W is given by

$$W(p, J) = 1 - \frac{\chi J^{-1}\epsilon_\psi(p)}{\chi J^{-1}\epsilon_\psi(p) - \epsilon_q^m(p)} \quad (3.7)$$

and satisfies $W(p, J) \in (0, 1)$ and $\lim_{j \rightarrow \infty} W(p, j) = 1$ for all $p > 0$ and $J \geq 1$. Further, p_B and p_C are well-defined, unique and continuous in κ for any J .

Proof. See Appendix C.2. □

Proposition 3.9 shows that changing the market structure from monopolistic to oligopolistic competition allows for the share, $1/J$ (under symmetry), to impact markups, and the differential impact of conduct (Bertrand versus Cournot) is captured by the “wedge” function W given by (3.7).

Recall from Lemma 2.8 that the holistic markup ratio μ satisfies

$$\frac{p/\kappa}{\mu(p, \kappa)} = 1 + (1 - \epsilon_\psi(p))(p/\kappa - 1). \quad (3.8)$$

Equation (3.8) is a markup bias that may be viewed as a measure of the degree to which the firm-level markup exaggerates price distortions in the economy. We now establish comparative statics for this quantity with respect to changes in several economic forces: 1) within-sector elasticity of substitution σ ; 2) market concentration $1/J$; and 3) firm conduct (Bertrand versus Cournot). The following shows that forces that increase markups also tend to increase the mismeasurement of markups.

Proposition 3.10. *For any $J > 1$ and $\sigma > 1/(1 - \rho)$ the markup bias is higher under Cournot conduct than under Bertrand conduct, and for both conduct notions, the markup bias is decreasing in σ and J .*

Proof. See Appendix C.2. □

Section 2.6 showed that in the monopolistic competition environment, an econometrician who ignored the role of time use could make incorrect welfare inferences from observed markups (even with perfect data). We conclude our analysis of the oligopolistically competitive model by showing how inferences regarding preference parameters can be biased if one ignore time use.

To see this as simply as possible, consider the Cobb-Douglas case, $\xi = 0$, in which $\epsilon_\psi(p) = \alpha$ for all p . The Bertrand markups are

$$p_B/\kappa - 1 = \alpha^{-1} \left(\frac{1}{1/\rho - 1} + (1 - J^{-1})\chi \right)^{-1}. \quad (3.9)$$

Now suppose that an econometrician observed an equilibrium allocation (and therefore observed how markups vary by κ and J) but erroneously ignored time use and therefore assumed that $\alpha = 1$. If the econometrician thought that $\alpha = 1$ and observed how markups varied in κ and J , then they would infer that the preferences of the agent were governed by mismeasured $\sigma' \neq \sigma$ and $\rho' \neq \rho$ satisfying

$$\begin{aligned} \frac{1}{1 - \rho'} - \frac{1}{1 - \rho} &= -\frac{\rho}{1 - \rho}(1 - \alpha) < 0 \\ \sigma' - \sigma &= -(\sigma - 1)(1 - \alpha) < 0. \end{aligned}$$

In other words, an econometrician who ignored time use would think that varieties were less substitutable than they really were.

4 Conclusion

This paper has presented a model in which both the dispersion and welfare effects of markups depend upon the extent to which consumers value off-market time. In our model, the usual definition of markups differs from a more holistic definition that incorporates the fact that the price paid by consumers is not the sole economic cost they incur to consume a market good. For the special case of perfect complements between market goods and off-market time, we have shown that heterogeneous markups can be consistent with a first-best allocation.

We have emphasized in this paper that the distribution of markups is not a sufficient statistic for inferring aggregate welfare when market purchases and off-market time enter non-separably into preferences. This non-separability ensures that the price paid to the firm does not represent the true economic price of final consumption experiences. In this approach we have been motivated by the insights of [Becker \(1965\)](#), because this is an enrichment of the consumer problem that is likely familiar to most economists.

However, the above insight is likely applicable to other environments. For instance, suppose that consumers care solely about a single good produced by a competitive sector of final goods producers, and that the technology of these producers is a CES function of a continuum of intermediate varieties. Suppose further that the production of each variety depends non-separably on both labor and the output of monopolistically competitive firms taking labor as their sole input. Then the situation would be similar to that analyzed in this paper, insofar as the markups of the intermediate producers would not represent the extent to which the price of a variety differed from its (total) marginal cost of production.

We believe that our work ought to encourage researchers to continue to consider how accounting for different household decision structures affects inferences regarding efficiency when faced with market structures that allow for prices to exceed marginal costs. We have shown that there exists an economy in which variable markups are indeed efficient. The recent work of [Parenti et al. \(2017\)](#) represents a different enrichment of the standard consumer problem in which efficiency is also consistent with heterogeneous markups. It thus remains for researchers to determine which decision structures themselves are most plausible when assessing what such structures imply for the efficiency of environments in which firms operate with imperfect competition.

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A Notation

In order to aid the reader, in this appendix we list the symbols used in this paper and provide a link to where they are first defined. We use star symbols $*$ for equilibrium quantities (e.g., the efficient level of market purchases from firm κ is $q^*(\kappa)$) and use large tildes for efficient allocations (e.g., the efficient level of market purchases from firm κ is $\tilde{q}(\kappa)$).

- The utility function is denoted by u . The functional form for u adopted in the parameterized model is given in Assumption [2.12](#).
- The home production function is denoted by h . The functional form for h adopted in the parameterized model is given in Assumption [2.13](#).
- The holistic price function ψ is defined in equation [\(2.5\)](#).
- The operating profits of the firm are defined in Definition [2.7](#) and denoted π . These are net of the operating cost but not the entry cost.^{[34](#)}
- The markup ratio (i.e. the usual notion of the markup) is defined in [\(2.11\)](#). We define this for κ (denoting the firm) and an arbitrary p (denoting the price). The equilibrium markup of firm κ is then $m^*(\kappa)$. In this environment, the firm can either be interpreted as choosing prices or quantities. We interpret it as choosing prices.

³⁴Our convention here follows [Dhingra and Morrow \(2019\)](#).

- Terminology regarding markups is not uniform in the literature. For both markup notions, We follow [Hall \(2018\)](#) and refer to p/κ as the “markup ratio,” with the “markup” then defined as $p/\kappa - 1$.
- The function $\phi(\kappa, p)$ represents the resources expended per unit of final consumption of a variety κ when the price is p and is defined in equation [\(2.12\)](#).
- The holistic markup ratio $\mu(\kappa, p)$ is defined in equation [\(2.13\)](#).
- Operating profits any firm in the monopolistically competitive case are denoted by $\pi(\kappa)$. The Bertrand and Cournot analogues are written π_B and π_C , respectively, and the associated aggregate profits net of entry costs are denoted Π_B and Π_C , respectively.

For any function f we write ϵ_f for the associated elasticity,

$$\epsilon_f(x) = \frac{xf'(x)}{f(x)}.$$

Note that in this paper we do not take absolute values for demand elasticities (as is sometimes done), and so such elasticities are negative.

B Monopolistic competition proofs

B.1 General results

Proof of Proposition [2.11](#). Suppose that for some multiplier $\lambda^* > 0$ the quantities $M_e^*, \bar{\kappa}^*$ and $\{c^*(\kappa)\}_{\kappa \in [\underline{\kappa}, \bar{\kappa}^*]}$ solve the problem [\(2.18\)](#) and that the associated multiplier on the constraint equals λ^* . We wish to use these quantities to construct an equilibrium allocation and prices. In so doing we will also show that λ^* is the multiplier on the consumer’s budget constraint.

First, for any $q, \lambda > 0$, denote by $\hat{n}(q, \lambda)$ the time use chosen by the consumer given market purchases q and multiplier λ on the budget constraint, and note that

$$u'(h(q, \hat{n}(q, \lambda)))h_n(q, \hat{n}(q, \lambda)) = \lambda. \tag{B.1}$$

The definition of ϕ in equation [\(2.12\)](#) implies that for any $p, \kappa, q > 0$ we have

$$h(q, q\Gamma(p))\phi(\kappa, p) = \kappa q + q\Gamma(p),$$

and so substituting the price $p = \psi^{-1}(u'(h(q, \hat{n}(q, \lambda))))/\lambda$, we have

$$h(q, \hat{n}(q, \lambda))\phi(\kappa, \psi^{-1}(u'(h(q, \hat{n}(q, \lambda))))/\lambda) = \kappa q + \hat{n}(q, \lambda). \tag{B.2}$$

Now, for any $\kappa \in [\underline{\kappa}, \bar{\kappa}^*]$, by assumption, $c^*(\kappa)$ solves

$$S^*(\kappa, \lambda^*) := \sup_{c>0} cu'(c) - \lambda^* \phi(\kappa, \psi^{-1}(u'(c)/\lambda^*))c, \quad (\text{B.3})$$

which means that the $q^*(\kappa)$ that solves $c^*(\kappa) = h(q^*(\kappa), \hat{n}(q^*(\kappa), \lambda^*))$ also solves

$$S^*(\kappa, \lambda^*) = \max_{q>0} h(q, \hat{n}(q, \lambda^*))u'(h(q, \hat{n}(q, \lambda^*))) - \lambda^*(\kappa q + \hat{n}(q, \lambda^*)). \quad (\text{B.4})$$

Because h exhibits constant returns to scale, we have $h(q, n) = qh_q(q, n) + nh_n(q, n)$ for all $q, n > 0$, and so (B.4) becomes

$$\begin{aligned} S^*(\kappa, \lambda^*) = & \max_{q>0} qh_q(q, \hat{n}(q, \lambda^*))u'(h(q, \hat{n}(q, \lambda^*))) - \lambda^* \kappa q \\ & + (h_n(q, \hat{n}(q, \lambda^*))u'(h(q, \hat{n}(q, \lambda^*))) - \lambda^*)\hat{n}(q, \lambda^*) \end{aligned}$$

and the second term in parentheses vanishes by the definition of $\hat{n}(q, \lambda^*)$. Consequently, for any $\kappa \in [\underline{\kappa}, \bar{\kappa}^*]$, $q^*(\kappa)$ solves $\max_{q>0} p(q; \lambda^*)q - \kappa q$, where $p(\cdot; \lambda^*)$ is the inverse demand function faced by the firm given by

$$p(q; \lambda^*) = \frac{1}{\lambda^*} h_q(q, \hat{n}(q, \lambda^*))u'(h(q, \hat{n}(q, \lambda^*))), \quad (\text{B.5})$$

and so $q^*(\kappa)$ maximizes the operating profits π of the firm defined in Definition 2.7 and $S^*(\kappa, \lambda^*) = \lambda^*(\Pi_B(\kappa) + f)$. It follows that $\bar{\kappa}^*$ and M_e^* solve

$$\lambda^* \max_{M_e, \bar{\kappa}} M_e \left[\int_{\bar{\kappa}}^{\bar{\kappa}} \Pi_B(\kappa) G(d\kappa) - f_e \right]. \quad (\text{B.6})$$

The first-order condition in (B.6) with respect to $\bar{\kappa}$ ensures that the operating profit of the marginal firm is zero, and the first-order condition with respect to M_e ensures that firms obtain zero net profits in expectation, and so the above allocation and prices constitute an equilibrium. $\square$

B.2 Parameterized model

We now record the proofs for all claims pertaining to the parameterized model from Section 2.4. First recall the definition of h , $h(q, n) = (\alpha q^\xi + (1 - \alpha)n^\xi)^{1/\xi}$ and note that the choice of n/q as a function of p is $\Gamma(p) = [(1/\alpha - 1)p]^{\frac{1}{1-\xi}}$. In this case,

$$\psi(p; \alpha, \xi) = \frac{p}{\alpha} \left(\alpha + (1 - \alpha)[(1/\alpha - 1)p]^{\frac{\xi}{1-\xi}} \right)^{1-1/\xi}. \quad (\text{B.7})$$

Lemma B.1. *The derivative of the total cost function in (B.7) is given by*

$$\psi'(p; \alpha, \xi) = \left(\alpha + (1 - \alpha)[(1/\alpha - 1)p]^{\frac{\xi}{1-\xi}} \right)^{-1/\xi}. \quad (\text{B.8})$$

Proof. Explicit calculation gives

$$\begin{aligned} \psi'(p) &= \frac{1}{\alpha} \left(\alpha + (1 - \alpha)[(1/\alpha - 1)p]^{\frac{\xi}{1-\xi}} \right)^{1-1/\xi} \\ &\quad - (1 - \alpha)[(1/\alpha - 1)p]^{\frac{\xi}{1-\xi}} \frac{1}{\alpha} \left(\alpha + (1 - \alpha)[(1/\alpha - 1)p]^{\frac{\xi}{1-\xi}} \right)^{-1/\xi} \end{aligned}$$

which simplifies as claimed. $\square$

Proof of Lemma 2.14. We first treat the interior case $\xi \notin \{-\infty, 0, 1\}$. Using Lemma B.1 and the definition of elasticity,

$$\epsilon_\psi(p) = \frac{p\psi'(p)}{\psi(p)} = \left(\frac{\psi(p)}{p\psi'(p)} \right)^{-1}.$$

A direct simplification gives

$$\frac{\psi(p)}{p\psi'(p)} = 1 + (1/\alpha - 1)^{\frac{1}{1-\xi}} p^{\frac{\xi}{1-\xi}},$$

which yields the stated closed form for $\epsilon_\psi(p)$.

To establish the monotonicity claims, write

$$\epsilon_\psi(p) = \frac{1}{1 + Ap^\beta}, \quad A := (1/\alpha - 1)^{\frac{1}{1-\xi}} > 0, \quad \beta := \frac{\xi}{1-\xi}.$$

Then for $p > 0$,

$$\epsilon'_\psi(p) = -\frac{A\beta p^{\beta-1}}{(1 + Ap^\beta)^2}.$$

Since $1 - \xi > 0$ for $\xi < 1$, the sign of β coincides with the sign of ξ , and hence $\epsilon'_\psi(p)$ has the opposite sign: $\epsilon_\psi(p)$ is increasing in p when $\xi < 0$, constant when $\xi = 0$, and decreasing when $\xi \in (0, 1)$.

For the boundary cases: if $\xi = -\infty$, then $\psi(p) = p + 1$ and so $\epsilon_\psi(p) = p/(p + 1)$ is strictly increasing in p ; if $\xi = 0$ then $\psi(p) \propto p^\alpha$ and so $\epsilon_\psi(p) \equiv \alpha$; if $\xi = 1$ then $\psi(p) = \min\{p/\alpha, 1/(1 - \alpha)\}$ and so $\epsilon_\psi(p)$ equals 1 on the linear branch and 0 on the flat branch.

To derive $\epsilon_{\psi'}(p)$ for $\xi \neq 1$, differentiate the envelope expression in Lemma B.1 to obtain

$$\psi''(p) = -\frac{1}{\xi} \left(\alpha + (1 - \alpha)[(1/\alpha - 1)p]^{\frac{\xi}{1-\xi}} \right)^{-1/\xi-1} \times \frac{\xi p^{-1}}{1 - \xi} (1 - \alpha)[(1/\alpha - 1)p]^{\frac{\xi}{1-\xi}}.$$

Therefore

$$\frac{p\psi''(p)}{\psi'(p)} = -\frac{1}{1-\xi} \left(\frac{(1-\alpha)[(1/\alpha-1)p]^{\frac{\xi}{1-\xi}}}{\alpha + (1-\alpha)[(1/\alpha-1)p]^{\frac{\xi}{1-\xi}}} \right), \quad (\text{B.9})$$

which simplifies to the stated formula $\epsilon_{\psi'}(p) = (\epsilon_{\psi}(p) - 1)/(1 - \xi)$. $\square$

Proof of Lemma 2.15. Using the functional form in Assumption 2.12, this follows immediately by combining Lemma 2.14 with the general expression (2.7). $\square$

Lemma B.2. *For all $p > 0$ we have*

$$\frac{p\epsilon'_{\psi}(p)}{\epsilon_{\psi}(p)} = \frac{\epsilon_{\psi}(p) - 1}{1/\xi - 1}. \quad (\text{B.10})$$

Proof. For any positive differentiable function f , the derivative of its elasticity satisfies

$$p\epsilon'_f(p) = (1 + \epsilon_{f'}(p) - \epsilon_f(p))\epsilon_f(p) \quad (\text{B.11})$$

Using 2.14, $\epsilon_{\psi'}(p) = (\epsilon_{\psi}(p) - 1)/(1 - \xi)$, and applying (B.11) to $f \equiv \psi$ gives the result. $\square$

Proof of Proposition 2.16. The proof proceeds in three steps: first, we establish existence of an optimal price; second, we prove uniqueness; and third, we derive comparative statics.

Step 1. Existence. Consider the firm's revenue as a function of price. This is bounded above by a multiple of $\epsilon_{\psi}(p)\psi(p)^{-\frac{\rho}{1-\rho}}$ and so profits vanish both when the firm equates its price with the marginal cost, $p = \kappa$, and as $p \rightarrow \infty$, because when $\xi \leq 0$, $\lim_{p \rightarrow \infty} \psi(p)^{-\frac{\rho}{1-\rho}} = 0$, and when $\xi > 0$, $\lim_{p \rightarrow \infty} \epsilon_{\psi}(p) = 0$. The optimal price therefore satisfies the firm's first-order condition $F_m(p; \kappa) = 0$ for F given in

$$F_m(p; \kappa) = \frac{1}{p/\kappa - 1} - \frac{1}{1/\rho - 1} + \left(\frac{1}{1/\rho - 1} - \frac{1}{1/\xi - 1} \right) (1 - \epsilon_{\psi}(p)). \quad (\text{B.12})$$

Step 2. Uniqueness.

We establish uniqueness by showing $F'_m(p; \kappa) < 0$ whenever $F_m(p; \kappa) \geq 0$. Consider two cases:

Case 1: If $\xi \in (-\infty, 0) \cup (\rho, 1)$, then $F'_m(p; \kappa) < 0$ everywhere.

Case 2: For $\xi \in (0, \rho)$, combining (B.12) with (B.10) gives

$$pF'_m(p; \kappa) = -\frac{p/\kappa}{(p/\kappa - 1)^2} + \frac{\epsilon_{\psi}(p)}{1/\xi - 1} \left(\frac{1}{1/\rho - 1} - \frac{1}{1/\xi - 1} \right) (1 - \epsilon_{\psi}(p)) \quad (\text{B.13})$$

Note that $F_m(p; \kappa) \geq 0$ is equivalent to:

$$\frac{1}{p/\kappa - 1} \geq \left(\frac{1}{1/\rho - 1} - \frac{1}{1/\xi - 1} \right) \epsilon_{\psi}(p) + \frac{1}{1/\xi - 1} \quad (\text{B.14})$$

and, upon simplification, $F'_m(p; \kappa) < 0$ is equivalent to

$$\frac{\epsilon_\psi(p)}{1/\xi - 1} \left(\frac{1}{1/\rho - 1} - \frac{1}{1/\xi - 1} \right) (1 - \epsilon_\psi(p)) < \left(\frac{1}{p/\kappa - 1} + 1 \right) \frac{1}{p/\kappa - 1}. \quad (\text{B.15})$$

In order to show that (B.14) implies (B.15), it will suffice to note that (B.14) implies that $\frac{1}{p/\kappa - 1} + 1 \geq \left(\frac{1}{1/\rho - 1} - \frac{1}{1/\xi - 1} \right) \epsilon_\psi(p)$, and so (B.15) is implied by

$$\frac{1}{1/\xi - 1} (1 - \epsilon_\psi(p)) < \left(\frac{1}{1/\rho - 1} - \frac{1}{1/\xi - 1} \right) \epsilon_\psi(p) + \frac{1}{1/\xi - 1}$$

which is true because it reduces to $0 < \epsilon_\psi(p)/(1/\rho - 1)$.

Step 3. Comparative Statics. The comparative statics with respect to κ follow from the first-order condition and the monotonicity properties of $\epsilon_\psi(p)$:

- For $\xi \in [-\infty, 0)$: $\epsilon_\psi(p)$ increases in κ
- For $\xi \in (0, 1)$: $\epsilon_\psi(p)$ decreases in κ
- For $\xi = 0$: $\epsilon_\psi(p)$ is constant in κ

This concludes the proof. $\square$

Proof of Proposition 2.18. First note that if $\hat{S}$ and $\bar{S}$ are two smooth, positive functions on $[\underline{\kappa}, \infty)$ satisfying $\epsilon_{\hat{S}}(\kappa) \geq \epsilon_{\bar{S}}(\kappa)$ for all $\kappa \geq \underline{\kappa}$, then $\hat{S}(\kappa)/\bar{S}(\kappa)$ is weakly increasing and so

$$\int_{\underline{\kappa}}^{\bar{\kappa}} \hat{S}(\kappa) G(d\kappa) \leq \int_{\underline{\kappa}}^{\bar{\kappa}} \hat{S}(\kappa) \left(\frac{\bar{S}(\kappa)}{\hat{S}(\kappa)} \frac{\hat{S}(\bar{\kappa})}{\bar{S}(\bar{\kappa})} \right) G(d\kappa) = \frac{\hat{S}(\bar{\kappa})}{\bar{S}(\bar{\kappa})} \int_{\underline{\kappa}}^{\bar{\kappa}} \bar{S}(\kappa) G(d\kappa) \quad (\text{B.16})$$

for all $\bar{\kappa} \geq \underline{\kappa}$. In view of equation (2.22) and the inequality (B.16), it will suffice to show that for all $\kappa \geq \underline{\kappa}$, we have $\epsilon_{S^*}(\kappa) \geq \epsilon_{\tilde{S}}(\kappa)$ if $\xi \leq 0$, $\epsilon_{S^*}(\kappa) \leq \epsilon_{\tilde{S}}(\kappa)$ if $\xi \geq 0$, and equality if $\xi \in \{-\infty, 0\}$. Applying the envelope theorem to expressions (2.31) and (2.32) gives $\epsilon_{S^*}(\kappa) = -(p^*(\kappa)/\kappa - 1)^{-1}$ and $\epsilon_{\tilde{S}}(\kappa) = -\epsilon_\psi(\kappa)(1/\rho - 1)^{-1}$, respectively, and so if $\hat{p}(\kappa) := \kappa(1 + (1/\rho - 1)/\epsilon_\psi(\kappa))$ then $\epsilon_{S^*}(\kappa) \geq \epsilon_{\tilde{S}}(\kappa)$ is equivalent to

$$F_m(\hat{p}(\kappa), \kappa) = \frac{\epsilon_\psi(\kappa) - 1}{1/\rho - 1} + \left(\frac{1}{1/\rho - 1} - \frac{1}{1/\xi - 1} \right) (1 - \epsilon_\psi(\hat{p}(\kappa))) \geq 0.$$

This in turn is equivalent to $H(\kappa) \leq 0$, where

$$H(\kappa) := \frac{1 - \epsilon_\psi(\kappa)}{1 - \epsilon_\psi(\hat{p}(\kappa))} + \frac{1/\rho - 1}{1/\xi - 1} - 1.$$

Using Lemma 2.14, the function $j(p) := (1 - \epsilon_\psi(p))^{-1} - 1$ is concave when $\xi \leq 0$, and so by

considering a linear approximation of $j(\hat{p}(\kappa))$ about κ and simplifying, we have

$$\begin{aligned} H(\kappa) &\leq \frac{(\hat{p}(\kappa) - \kappa)j'(\kappa)}{j(\kappa) + 1} + \frac{1/\rho - 1}{1/\xi - 1} \\ &= -\frac{(\hat{p}(\kappa)/\kappa - 1)}{1/\xi - 1} \epsilon_\psi(\kappa) + \frac{1/\rho - 1}{1/\xi - 1} = 0 \end{aligned} \quad (\text{B.17})$$

with the reverse inequality for $\xi \geq 0$, which gives the results for $\xi \notin \{-\infty, 0\}$. Finally, selection is efficient when $\xi \in \{-\infty, 0\}$ because in these cases the function j is either constant or linear and the inequality (B.17) becomes an equality. $\square$

Proof of Proposition 2.21. Using the fact that $\psi(p) = \bar{\psi}p^\alpha$ for some $\bar{\psi} > 0$, we have $\psi^{-1}(x) = (x/\bar{\psi})^{1/\alpha}$ and so the equilibrium surplus in (2.19) ultimately simplifies to

$$S^*(\kappa, \lambda^*) = \rho\alpha \sup_{c>0} c^\rho - \kappa[\lambda^*\bar{\psi}/\rho]^{1/\alpha} c^{(1-1/\alpha)(\rho-1)+1}$$

while the social surplus in (2.20) simplifies to $\tilde{S}(\kappa, \tilde{\lambda}) = \sup_{c>0} c^\rho - \tilde{\lambda}\bar{\psi}\kappa^\alpha c$. It follows that equilibrium and efficient consumption are $c^*(\kappa) = \bar{c}^*\kappa^{-\frac{\alpha}{1-\rho}}$ and $\tilde{c}(\kappa) = \tilde{c}\kappa^{-\frac{\alpha}{1-\rho}}$, respectively, for some $\bar{c}^*, \tilde{c} > 0$. Proposition 2.16 shows that the equilibrium markup ratio is independent of κ and given by $m = 1 + (1/\rho - 1)/\alpha$, and so equation (2.15) implies that

$$\frac{1}{\mu^*} = 1 + \alpha(1/m - 1) = 1 - \frac{(1-\rho)\alpha}{\rho\alpha + 1 - \rho}. \quad (\text{B.18})$$

Equation (2.23) then implies that the equilibrium and efficient M_e satisfy

$$\begin{aligned} M_e^*(fG(\bar{\kappa}^*) + f_e) &= \bar{T}(1 - 1/\mu^*) \\ \widetilde{M}_e(fG(\tilde{\kappa}) + f_e) &= \bar{T}(1 - \rho) \end{aligned} \quad (\text{B.19})$$

and so combining (B.18), (B.19) with the fact that $\bar{\kappa}^* = \tilde{\kappa}$, we have

$$\frac{M_e^*}{\widetilde{M}_e} = \frac{1 - 1/\mu^*}{1 - \rho} = \frac{1/\rho}{m} < 1. \quad (\text{B.20})$$

Now, the first equation in (B.19) and the resource constraint combine to give

$$M_e^* \int_{\underline{\kappa}}^{\bar{\kappa}} \phi(\kappa, p^*(\kappa)) \bar{c}^* \kappa^{-\frac{\alpha}{1-\rho}} G(d\kappa) = \bar{T}/\mu^*.$$

When combined with the relationship

$$\frac{\phi(\kappa, p^*(\kappa))}{\psi(\kappa)} = \frac{\psi(p^*(\kappa))}{\psi(\kappa)} \times \frac{\phi(\kappa, p^*(\kappa))}{\psi(p^*(\kappa))} = \frac{m^\alpha}{\mu^*},$$

this implies that the equilibrium and equilibrium allocations satisfy

$$\tilde{c} \int_{\underline{\kappa}}^{\bar{\kappa}} \psi(\kappa) \kappa^{-\frac{\alpha}{1-\rho}} G(d\kappa) = \frac{\rho \bar{T}}{\bar{M}_e} = m^{\alpha-1} \bar{c}^* \int_{\underline{\kappa}}^{\bar{\kappa}} \psi(\kappa) \kappa^{-\frac{\alpha}{1-\rho}} G(d\kappa) \quad (\text{B.21})$$

where we used the second equality in (B.20). With Cobb-Douglas technology, equilibrium allocations satisfy $p^* q^* = \alpha \psi(p^*) \bar{c}^*$ and $n^* = (1 - \alpha) \psi(p^*) \bar{c}^*$ and efficient allocations satisfy $\kappa \tilde{q} = \alpha \psi(\kappa) \tilde{c}$ and $\tilde{n} = (1 - \alpha) \psi(\kappa) \tilde{c}$. When combined with (B.21), this gives the result. $\square$

Proof of Lemma 2.23. Because $\hat{q}(p)$ is decreasing in p , the elasticity $\epsilon_u(q)$ will be decreasing in q if and only if $\ln \epsilon_u(\hat{q}(p))$ is increasing in p . We now define $W(p) := p[\ln \epsilon_u(\hat{q}(p))]'$ $\int_p^\infty x \hat{q}'(x) dx$ and note that $W(p) \leq 0$ if and only if $[\ln \epsilon_u(\hat{q}(p))]' \geq 0$. Explicit calculation using (2.37) and $\int_p^\infty [x \hat{q}'(x) + \hat{q}(x) dx] dx = -p \hat{q}(p)$ then gives

$$\begin{aligned} W(p) &= \left(1 + \epsilon_{\hat{q}}(p) + \frac{p^2 \hat{q}'(p)}{\int_p^\infty x \hat{q}'(x) dx} \right) \int_p^\infty x \hat{q}'(x) dx \\ &= (1 + \epsilon_{\hat{q}}(p)) \int_p^\infty x \hat{q}'(x) dx + p^2 \hat{q}'(p) \\ &= -(1 + \epsilon_{\hat{q}}(p)) \int_p^\infty \hat{q}(x) dx - p \hat{q}(p). \end{aligned}$$

Further, we have $W'(p) = -\epsilon'_{\hat{q}}(p) \int_p^\infty \hat{q}(x) dx$ and $\lim_{p \rightarrow \infty} W(p) = 0$, and so $W(p) \leq 0$ for all $p > 0$ if $\epsilon'_{\hat{q}}(p) \leq 0$ for all $p > 0$, which gives the result. $\square$

C Oligopolistic competition proofs

C.1 Sectoral assignment

C.2 Symmetric oligopoly

Proof of Lemma 3.5. The problem in Definition 3.3 may be written

$$\max_{\mathbf{c}} \int_{\mathcal{I}} \left(J_i^{-1/\sigma} \sum_{j=1}^{J_i} c_{ij}^{1-1/\sigma} \right)^{\frac{\rho}{1-1/\sigma}} di \quad \text{s.t.} \quad \int_{\mathcal{I}} \sum_{j=1}^{J_i} \psi(p_{ij}) c_{ij} di \leq \bar{T}.$$

The first-order condition with respect to c_{ij} is then

$$c_{ij}^{-1/\sigma} J_i^{-1/\sigma} \left(J_i^{-1/\sigma} \sum_{k=1}^{J_i} c_{ik}^{1-1/\sigma} \right)^{\frac{\rho}{1-1/\sigma}-1} = (\lambda/\rho) \psi(p_{ij}). \quad (\text{C.1})$$

Multiplying by c_{ij} and summing over j gives $C_i^\rho = (\lambda/\rho) \sum_{j=1}^{J_i} \psi(p_{ij}) c_{ij}$, which combines with (C.1) and raised to $-\sigma$ to give

$$\begin{aligned} c_{ij}^{-1/\sigma} J_i^{-1/\sigma} \left(J_i^{-1/\sigma} \sum_{k=1}^{J_i} c_{ik}^{1-1/\sigma} \right)^{-1} &= \frac{\psi(p_{ij})}{\sum_{j=1}^{J_i} \psi(p_{ij}) c_{ij}} \\ c_{ij} J_i \left(J_i^{-1/\sigma} \sum_{k=1}^{J_i} c_{ik}^{1-1/\sigma} \right)^\sigma &= \left(\sum_{j=1}^{J_i} \psi(p_{ij}) c_{ij} \right)^\sigma \psi(p_{ij})^{-\sigma}. \end{aligned}$$

Multiplying by $\psi(p_{ij})$ and summing over j gives

$$J_i \left(J_i^{-1/\sigma} \sum_{k=1}^{J_i} c_{ik}^{1-1/\sigma} \right)^\sigma = \left(\sum_{j=1}^{J_i} \psi(p_{ij}) c_{ij} \right)^{\sigma-1} \sum_{j=1}^{J_i} \psi(p_{ij})^{1-\sigma}.$$

This gives $\sum_{j=1}^{J_i} \psi(p_{ij}) c_{ij} = \left(J_i^{-1} \sum_{j=1}^{J_i} \psi(p_{ij})^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \left(J_i^{-1/\sigma} \sum_{k=1}^{J_i} c_{ik}^{1-1/\sigma} \right)^{-\frac{1}{1-\sigma}}$ and substituting into the above gives

$$c_{ij} J_i \left(J_i^{-1/\sigma} \sum_{k=1}^{J_i} c_{ik}^{1-1/\sigma} \right)^\sigma = \left(J_i^{-1} \sum_{j=1}^{J_i} \psi(p_{ij})^{1-\sigma} \right)^{\frac{\sigma}{1-\sigma}} \left(J_i^{-1/\sigma} \sum_{k=1}^{J_i} c_{ik}^{1-1/\sigma} \right)^{-\frac{\sigma^2}{1-\sigma}} \psi(p_{ij})^{-\sigma}.$$

Simplifying then gives

$$c_{ij} J_i \left(J_i^{-1/\sigma} \sum_{k=1}^{J_i} c_{ik}^{1-1/\sigma} \right)^{-\frac{1}{1-1/\sigma}} = \left(J_i^{-1} \sum_{j=1}^{J_i} \psi(p_{ij})^{1-\sigma} \right)^{\frac{\sigma}{1-\sigma}} \psi(p_{ij})^{-\sigma}$$

which gives $c_{ij} = J_i^{-1} C_i (\psi(p_{ij})/\Psi_i)^{-\sigma}$. It follows that C_i solves

$$\max_{\mathbf{C}} \int_{\mathcal{I}} C_i^\rho \mathrm{d}i \quad \text{s.t.} \quad \int_{\mathcal{I}} \Psi_i C_i \mathrm{d}i \leq \bar{T}.$$

The first-order condition gives $C_i = (\lambda/\rho)^{-\frac{1}{1-\rho}} \Psi_i^{-\frac{1}{1-\rho}}$ and hence

$$\bar{T} = \int_{\mathcal{I}} \Psi_i C_i \mathrm{d}i = (\lambda/\rho)^{-\frac{1}{1-\rho}} \int_{\mathcal{I}} \Psi_i^{-\frac{1}{1-\rho-1}} \mathrm{d}i.$$

Substitution gives $C_i \int_{\mathcal{I}} \Psi_i^{-\frac{1}{1-\rho-1}} \mathrm{d}i = \bar{T} \Psi_i^{-\frac{1}{1-\rho}}$, which simplifies as claimed. $\square$

In models like [Atkeson and Burstein \(2008\)](#) and [De Loecker et al. \(2020\)](#), which feature nested CES preferences over market products, the market share enters into equilibrium markups via the various elasticities. However, given our model is not nested CES over

market products but rather over *experiences* associated with such products, we now define the “holistic” market share $\tilde{s}_{ij} := \psi(p_{ij})c_{ij} / \sum_{k=1}^{J_i} \psi(p_{ik})c_{ik}$ and note that by Lemma 3.5,

$$\tilde{s}_{ij} = \frac{\psi(p_{ij})^{1-\sigma}}{\sum_{k=1}^{J_i} \psi(p_{ik})^{1-\sigma}}. \quad (\text{C.2})$$

Lemma C.1. *The elasticity of q_{ij} with respect to p_{ij} is*

$$\epsilon_{q_{ij}}(p_{ij}) = \epsilon_q^m(p_{ij}) - \chi(1 - \tilde{s}_{ij})\epsilon_\psi(p_{ij})$$

and the elasticity of p_{ij} with respect to q_{ij} satisfies

$$\frac{1}{\epsilon_{p_{ij}}(q_{ij}(\mathbf{p}_i))} = \epsilon_{q_{ij}}(p_{ij}) - \left(\frac{\chi \sum_{l \neq j} \tilde{s}_{il} \epsilon_\psi(p_{il}) / \epsilon_q^a(p_{il})}{1 + \chi \sum_{l \neq j} \tilde{s}_{il} \epsilon_\psi(p_{il}) / \epsilon_q^a(p_{il})} \right) \chi \tilde{s}_{ij} \epsilon_\psi(p_{ij})$$

where $\epsilon_q^a(p) := \epsilon_{\psi'}(p) - \sigma \epsilon_\psi(p)$. Further, $\epsilon_{q_{ij}}(p_{ij}) \leq \epsilon_{p_{ij}}(q_{ij}(\mathbf{p}_i))^{-1} \leq \epsilon_q^m(p_{ij}) < 0$ for all prices $\mathbf{p}_i$.

Proof. The demand elasticity follows directly from equations (3.2) and (C.2). For the second claim, first note that $\epsilon_q^m(p) = \epsilon_q^a(p) + \chi \epsilon_\psi(p)$ and hence

$$\epsilon_q^a(p) = \epsilon_{q_{ij}}(p_{ij}) - \chi \tilde{s}_{ij} \epsilon_\psi(p_{ij}). \quad (\text{C.3})$$

For any $j = 1, \dots, J_i$, equation (C.2) implies

$$\frac{\partial}{\partial \ln q_{ij}} \ln \left(\sum_{l=1}^{J_i} \psi(p_{il})^{1-\sigma} \right) = (1 - \sigma) \sum_{k=1}^{J_i} \tilde{s}_{ik} \epsilon_\psi(p_{ik}) \frac{q_{ij}}{p_{ik}} \frac{\partial p_{ik}}{\partial q_{ij}}.$$

We differentiate (3.2) with respect to q_{ik} and multiply by q_{ij} to give

$$\begin{aligned} 0 &= -1 + \epsilon_q^a(p_{ij}) \epsilon_{p_{ij}}(q_{ij}) + \chi \sum_{l=1}^{J_i} \tilde{s}_{il} \epsilon_\psi(p_{il}) \epsilon_{p_{il}}(q_{ij}) \\ 0 &= \epsilon_q^a(p_{ik}) \epsilon_{p_{ik}}(q_{ij}) + \chi \sum_{l=1}^{J_i} \tilde{s}_{il} \epsilon_\psi(p_{il}) \epsilon_{p_{il}}(q_{ij}). \end{aligned} \quad (\text{C.4})$$

For all $k \neq j$ we then have $\epsilon_{p_{il}}(q_{ij}) = (\epsilon_q^a(p_{ij}) \epsilon_{p_{ij}}(q_{ij}) - 1) / \epsilon_q^a(p_{il})$. Substituting into the first equation in (C.4) gives

$$1 = (\epsilon_q^a(p_{ij}) + \chi \tilde{s}_{ij} \epsilon_\psi(p_{ij})) \epsilon_{p_{ij}}(q_{ij}) + \chi \sum_{l \neq j} \frac{\tilde{s}_{il} \epsilon_\psi(p_{il})}{\epsilon_q^a(p_{il})} (\epsilon_q^a(p_{ij}) \epsilon_{p_{ij}}(q_{ij}) - 1). \quad (\text{C.5})$$

Simplifying then gives

$$1 + \chi \sum_{l \neq j} \frac{\tilde{s}_{il} \epsilon_\psi(p_{il})}{\epsilon_q^a(p_{il})} = \epsilon_q^a(p_{ij}) \left(1 + \chi \sum_{l=1}^{J_i} \frac{\tilde{s}_{il} \epsilon_\psi(p_{il})}{\epsilon_q^a(p_{il})} \right) \epsilon_{p_{ij}}(q_{ij})$$

which rearranges to give

$$\frac{1}{\epsilon_{p_{ij}}(q_{ij})} = \epsilon_{q_{ij}}(p_{ij}) - \chi \tilde{s}_{ij} \epsilon_\psi(p_{ij}) + \frac{\chi \tilde{s}_{ij} \epsilon_\psi(p_{ij})}{1 + \chi \sum_{l \neq j} \frac{\tilde{s}_{il} \epsilon_\psi(p_{il})}{\epsilon_q^a(p_{il})}}$$

where we used (C.3), which gives the result. $\square$

Lemma C.2. *Define the pair of functions*

$$\begin{aligned} w(\epsilon) &= \frac{(1 - \xi)^{-1} + ((1 - \rho)^{-1} - (1 - \xi)^{-1})\epsilon}{(1 - \xi)^{-1} + ((1 - \rho)^{-1} - (1 - \xi)^{-1} + \chi J^{-1})\epsilon} \\ Z(\epsilon) &= (1 - \xi)^{-1} + ((1 - \rho)^{-1} - (1 - \xi)^{-1})\epsilon + (1 - J^{-1})\chi \epsilon w(\epsilon) \end{aligned} \quad (\text{C.6})$$

for $\epsilon \in (0, 1)$. If $\xi \in (0, 1)$ then for all $\epsilon \in (0, 1)$ we have

$$\frac{\epsilon(1 - \epsilon)}{1/\xi - 1} Z'(\epsilon) < Z(\epsilon)(Z(\epsilon) - 1). \quad (\text{C.7})$$

Proof. First note that $(1 - J^{-1})\chi \epsilon^2 w'(\epsilon) < 0 < (1 - \xi)^{-1} - 1$ if $\xi \in (0, 1)$, and so

$$\epsilon Z'(\epsilon) < Z(\epsilon) - 1. \quad (\text{C.8})$$

To establish the claim it will suffice to show that $(1 - \epsilon)/(1/\xi - 1) < Z(\epsilon)$, which is in turn implied by

$$\frac{1 - \epsilon}{1/\xi - 1} < \frac{1}{1/\xi - 1} + \left(\frac{1}{1/\rho - 1} - \frac{1}{1/\xi - 1} \right) \epsilon$$

which is true because $\epsilon/(1/\rho - 1) > 0$. $\square$

Proof of Proposition 3.9. The proof of the existence and uniqueness of p_B is identical to the proof of Proposition 2.16, with ρ replaced by ρ' satisfying $(1 - \rho')^{-1} = (1 - \rho)^{-1} + (1 - J^{-1})\chi$. For Cournot, existence follows the argument in Proposition 2.16. For uniqueness, we note that $\epsilon_q^m(p) = -(1 - \xi)^{-1} - ((1 - \rho)^{-1} - (1 - \xi)^{-1})\epsilon_\psi(p)$ and write

$$F_C(p; \kappa, J) = \frac{\kappa}{p_C - \kappa} + 1 - Z(\epsilon_\psi(p))$$

for the right-hand side of the first-order condition (3.6), using $W(p, J) = w(\epsilon_\psi(p))$ for w

defined in equation (C.6). This implies that

$$pF'_C(p) = -\frac{p\kappa}{(p-\kappa)^2} - p\epsilon'_\psi(p)Z'(\epsilon_\psi(p)). \quad (\text{C.9})$$

If $\xi < 0$, then $\epsilon'_\psi(p), Z'(\epsilon_\psi(p)) > 0$, and so $F'_C(p) < 0$ everywhere. For $\xi \in (0, 1)$, we will show $F'_C(p; \kappa, J) < 0$ if $F_C(p; \kappa, J) \geq 0$. If $y := \kappa/(p - \kappa)$ then we want to show $y > Z(\epsilon_\psi(p)) - 1$ implies $0 < y(y + 1) + p\epsilon'_\psi(p)Z'(\epsilon_\psi(p))$. It will suffice to show

$$0 < Z(\epsilon_\psi(p))(Z(\epsilon_\psi(p)) - 1) + p\epsilon'_\psi(p)Z'(\epsilon_\psi(p)) \quad (\text{C.10})$$

which, using Lemma B.2, is equivalent to Lemma C.2. The continuity of the pricing functions then follows from the single-crossing result established above and the continuity of the right-hand sides of the first-order conditions in (p, κ) . $\square$

Proof of Proposition 3.10. If $\theta \mapsto p(\theta)$ is a differentiable function, then we have

$$\begin{aligned} \frac{d}{d\theta} \left[\frac{p(\theta)/\kappa}{\mu(p(\theta), \kappa)} \right] &= p'(\theta) \left[(1 - \epsilon_\psi(p(\theta)))/\kappa - \epsilon'_\psi(p(\theta))(p(\theta)/\kappa - 1) \right] \\ &= p'(\theta) \left[1 + (1/\xi - 1)^{-1} \epsilon_\psi(p(\theta))(1 - \kappa/p(\theta)) \right] (1 - \epsilon_\psi(p(\theta)))/\kappa \end{aligned}$$

where we used Lemma B.2. Because $|(1 - \kappa/p)\epsilon_\psi(p)| \leq 1$ for $p \geq \kappa$, it follows that the sign of the change in the markup bias coincides with the sign of $p'(\theta)$. For any fixed κ , a change in a parameter that increases prices (and hence markups) therefore also increases the markup bias. The conclusions then follow from the fact that the right-hand sides of equations (3.5) and (3.6) are decreasing in J and χ , and the fact that $W(p_C, J) \in (0, 1)$ for all $p > 0$ and $J \geq 1$. $\square$