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A Search-Based Theory of Mergers and Acquisitions

Flavien Moreau; Semih Üslü

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Author's E-Mail Address:	semihuslu@jhu.edu; fmoreau@imf.org

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WORKING PAPERS

A Search-Based Theory of Mergers and Acquisitions

Prepared by Flavien Moreau and Semih Üslü

A Search-Based Theory of Mergers and Acquisitions *

Flavien Moreau[†] ⓡ Semih Üslü[‡]

October 14, 2025

Abstract

We develop a search-based theory of mergers and acquisitions with heterogeneous firms and endogenous search complementarities. We use this model to understand how merger incentives and the firm size distribution interact. In equilibrium, search costs and entry rates determine search intensities and shape the distribution of market power. We derive the law of motion of the firm size distribution, provide closed-form solutions, and solve for endogenous search efforts. Finally, we derive the aggregate welfare function and show how our framework can be used to simulate the impact of various antitrust policies. In particular, antitrust policy can have large effects on welfare due to the existence of multiple equilibria.

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*We thank Petia Topalova for helpful feedback. The use of ⓡ signals that the authors' names have been randomized using a uniform distribution, following Ray ⓡ Robson (2018). The views expressed in this paper are those of the authors and do not necessarily represent the views of the IMF, its Executive Board, nor IMF management.

[†]International Monetary Fund, fmoreau@imf.org

[‡]Johns Hopkins University, semihuslu@jhu.edu

"A successful search program combines methodical hard work with occasional instances of pure luck; that is, 'being in the right place at the right time.' But luck in the M&A business isn't just happenstance. Being in the right place at the right time is the result of considerable effort."

— Jeffrey C. Hooke, M&A: A Practical Guide to Doing the Deal (2015, p. 47)

1 Introduction

Acquisitions have become an increasingly common exit strategy for start-up companies backed by Venture Capital (VC) firms (Figure 1). When made by large incumbents, these acquisitions mechanically generate an increase in business concentration – at least momentarily –. This increase in concentration has raised concerns about increased market power, prompting regulators to reconsider whether merger control policies should be strengthened. In particular, both the United States and the United Kingdom have recently updated their merger guidelines, with a view to better control the risks generated by such large-scale acquisitions.[1] Yet, we still do not have a firm understanding of the welfare implications of these policies. In particular, both theory and empirics have not shed sufficient light on the link between firm dynamics, the search for mergers and acquisition, and the subsequent evolution of market power.

Studies of mergers and acquisitions (M&A) have traditionally taken a partial equilibrium and static perspective, and are therefore often silent on the broader implications that M&A activities and antitrust policies to regulate them can have. Searching for M&A is a costly activity whose returns depend on the distribution of available prospects and the evolution of market power that shapes the distribution of profits. In turn, both of these objects are affected by the intensity of M&A activity. To shed light on the implications of M&A activity, it is therefore important to pay close attention to how search intensity responds endogenously to the distribution of firms and how in turn the latter is shaped by M&A transactions.

[1] See for instance the former FTC declarations on start-ups https://techcrunch.com/2024/06/15/ftc-chair-lina-khan-on-startups-scaling-and-innovations-in-potential-law-breaking/ for the United States and the new merger control guidelines issued in the United Kingdom https://www.skadden.com/insights/publications/2024/05/uk-revamps-merger-control

In this paper, we develop a continuous-time frictional goods market framework to study the dynamic implications of M&A and their market-wide implications for the evolution of the distribution of market power. We do so by building on the New Monetarist (Choi and Rocheteau, 2021). In particular, our modeling of the real economy and market power borrows key elements from the canonical game-theoretic models of decentralized markets with bargaining of Rubinstein and Wolinsky (1985) and features a rent-seeking channel as in Choi and Rocheteau (2024). Mergers and acquisitions in our search and bargaining framework is a dynamic process and leads to an evolving distribution of firms, whose behavior is reminiscent of the information percolation mechanisms studied in Duffie, Giroux and Manso (2010) and Duffie (2011).

Our first contribution, taking search intensity as given, is to derive analytical expressions characterizing the merger dynamics. We solve for the Kolmogorov Forward Equation and use the characteristic function to describe the moments of the firm distribution. Both the first and second moment are strictly increasing in the search intensity and the amount of synergies created by M&A transactions. We then solve for the firms' equilibrium value function, where, importantly, markups arise endogenously from bilateral bargaining between firms and their customers. The presence of markups, in turn, generates firms' endogenous incentive to search for M&A partners. As our model yields closed-form solutions for firms' value functions, the equilibrium distribution of firms' product quality, and the endogenous M&A search intensity, the analysis is both tractable and transparent. Firm profits arising from markups incentivize the firms to search for M&A partners, which in turn enhances the product quality distribution. By using parametric examples, we demonstrate that, when the product quality distribution is better (in the sense of first-order stochastic dominance), consumers are on net better off even though they end up paying a larger markup for firms' products.

Next, we delve into the details of how firms respond endogenously to merger opportunities by choosing their search intensity optimally. In particular, we show that multiple equilibria can arise under certain conditions. In particular, a low search-intensity equilibrium can coexist with a high search-intensity equilibrium. While the low-intensity equilibrium is stable, the other is not and vanishes when search costs reach a certain threshold. We then study the endogenous changes in market structures associated with either equilibria with numerical simulations. The higher-intensity equilibrium leads to higher welfare. Because the markup heterogeneity generated by the bilateral bargaining protocol tends to be smaller than the variance in quality that grows with M&A activity, market concentration is humped-shaped and can be lower in the higher-intensity equilibrium. Finally, we provide comparative statics and show

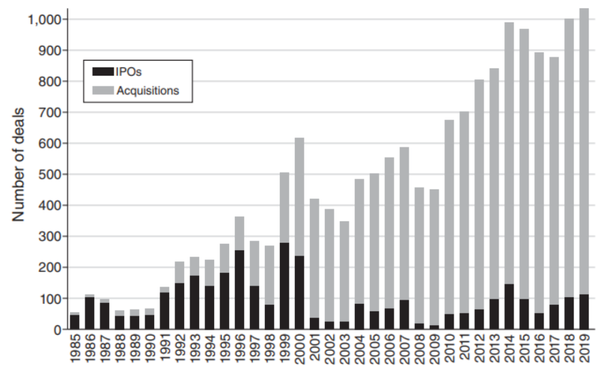


Figure 1: Number of Deals of VC-backed start-ups

Source: National Venture Capital Association, cited in Ederer and Pellegrino (2023)

that affecting the cost structure of the economy, either the search costs, the operating costs, or the rent-seeking costs, have similar effects on the equilibrium search intensities. But while they naturally depress the low-intensity equilibrium, they can, counter-intuitively, have a positive impact on the high-intensity equilibrium, and therefore welfare.

Related Literature Our search-theoretic approach to market power provides an alternative lens to the extensive analyses of horizontal merger policy that focus on the classic trade-off between the potential efficiency gains and the increased market power using static frameworks (Williamson, 1968). Merger approval rules have been the focus of a small and recent theoretical literature started by Besanko and Spulber (1993). Other recent papers in this literature include Neven, Röller and Jullien (2005), Nocke and Whinston (2010), and Ottaviani and Sotcrensen (2011). More recently, Nocke and Whinston (2013) demonstrate that competition authorities should impose "a tougher standard on mergers involving larger merger partners (in terms of their pre-merger market share)". In this paper we show how merger standards interact with the merger dynamics to shape the firm size distribution.

However, there is limited causal evidence regarding the macroeconomic impact of merger policies due to the difficulty in existing frameworks to tie policies with the evolution of the distribution of market power.[2]. Guadalupe, Rappoport, Salanié and

[2]Similarly, aggregate implications of antitrust policies against cartelization and collusion between firms are not well-known. Using a quantitiative framework that accounts for the misallocation costs of collusion, Moreau and Panon (2023) find potentially important costs of competition distortions from cartelization.

Thomas (2021) propose a static assignment model of mergers and acquisitions and study complementarities between targets and acquirers. Closer to our paper, David (2021) proposes a theory of M&A where search happens exogenously and firms do not have markups, therefore preventing to study the potentially anti-competitive impact of mergers. Chan and Qi (2025) and Cavenaile, Celik and Tian (2021) build on this framework and add Schumpeterian innovation. Our key contribution relative to this literature is to endogenize search intensity and provide analytical expressions linking search intensities with market structure in equilibrium.

Second, our search-theoretic micro-foundations for market power and mergers draw on the canonical sequential bargaining approach of Rubinstein and Wolinsky (1985), recently used in the New Monetarist literature (Choi and Rocheteau, 2024). While Choi and Rocheteau (2024) takes the product quality distribution as given, we make it endogenous by introducing M&A search dynamics. These search motives in turn generate an endogenous firm size distribution whose dynamic properties are reminiscent of the information percolation mechanism studied in Duffie, Giroux and Manso (2010) and Duffie (2011). These two features of our framework allow us to provide a micro-foundation for heterogeneous markups that are shaped by endogenous merger dynamics.

Finally, our paper is related to an expanding macroeconomic literature studying market concentration and business dynamism. Business concentration is growing in the United States and many European economies, with the dominant firms in many sectors commanding ever-increasing market shares (De Loecker, Eeckhout and Unger, 2019; Diez et al., 2018). Increased concentration has prompted concerns about a decrease in competition, as measured by declining entry rates and increasing markups. Several hypotheses have been put forward to explain this rise in concentration. Jovanovic and Rousseau (2002) and Jovanovic and Rousseau (2008) use a Q-theory to study the reallocative effect of merger waves. Grullon et al. (2015) and Gutiérrez and Philippon (2017) highlight that the joint rise of markups and concentration in the U.S. has coincided with a relaxation of antitrust standards. Our findings are consistent with these stylized facts and support this view by characterizing this channel in a general equilibrium model.

2 A Search-Based Model

This section develops our model and presents the main theoretical results. We proceed in several steps. We first characterize the equilibrium distribution of firm size and the firms' value function for a given exogenous search intensity. We then endogenize search intensity decisions and show how M&A activity responds to deep parameters and anti-trust policy.

2.1 Equilibrium Mergers and Acquisitions Dynamics with Heterogeneous Firms

Time is continuous and runs forever, $t \in [0, \infty)$. There are a unit-mass continuum of target firms/entrepreneurs/sellers that produce products of heterogeneous quality, ε. At $t = 0$, the cross-sectional distribution of ε admits a probability density function (pdf) $g : \mathcal{E} = [\varepsilon_l, \varepsilon_h] \to \mathbb{R}$. Target firms in the economy are subject to an overlapping generations structure as follows. At a Poisson rate $\eta > 0$, a target firm dies and is immediately replaced with a new-born target firm whose product quality comes from the same pdf $g(\cdot)$. At a Poisson rate $\lambda > 0$, a target firm is matched with another target firm to negotiate an M&A (mergers-and-acquisitions) deal. These "death" and "matching" shocks are independent from each other and i.i.d. in the cross section of firms. We follow the finance search literature (Üslü, 2019; Farboodi et al., 2018) in assuming that, following a matching shock, a Pareto-optimal bargaining procedure with symmetric bargaining powers immediately results in a deal.

We describe and characterize the target firms' continuation utilities and surplus from M&A deals in the next section. Here we take as given the result of the M&A: An M&A between two target firms with initial product qualities of ε' and ε'' results in one target firm ending up with a product quality of $A + \varepsilon' + \varepsilon''$, where $A \geq 0$ reflects the synergy benefit of M&As, and the other target firm ending up with a new product quality from the pdf g.[3] The endogenous pdf of product quality, ε, that we name $f(\cdot)$,

[3]We assume, in the next section, that the realization of this new product quality from the pdf g occurs after the M&A goes through. Thus, negotiations take place by considering the expected value of this new product quality. Combined with the symmetric bargaining power that allows for an appropriate split of the gains from the M&A, target firms are indifferent between ending up with quality $A + \varepsilon + \varepsilon'$ or with a new product quality from the pdf g.

hence, evolves according to the following Kolmogorov Forward Equation (KFE):

$$\dot{f}(\varepsilon) = -\underbrace{(\eta+\lambda) f(\varepsilon)}_{exit} + \underbrace{\left(\eta+\frac{\lambda}{2}\right) g(\varepsilon)}_{entry} + \underbrace{\frac{\lambda}{2}\int_{-\infty}^{\infty} f(\varepsilon') f(\varepsilon - A - \varepsilon')\, d\varepsilon'}_{mergers}. \tag{1}$$

The first term on the RHS of (1) captures the exit of firms with product quality ε due to death and M&As. The second term captures the entry of firms with product quality ε due to death and M&As. Note that $\lambda/2$ reflects the fact that M&As occur at rate λ and in each M&A one of the firms adopts a new product quality from the pdf g. The third term of (1) captures the entry of firms with synergy benefit following M&As. More specifically, any firm with product quality ε' may end up with the post-M&A product quality ε, conditional on meeting a firm with initial product quality of $\varepsilon - A - \varepsilon'$. These continuum of possibilities are behind the convolution integral in the last term. Since the convolution integral complicates the computation of the pdf, we will make use of the characteristic function (Lukacs, 1970, p. 5):

$$\hat{f}(z) = \int_{-\infty}^{\infty} e^{iz\varepsilon} f(\varepsilon)\, d\varepsilon.$$

Using the characteristic function allows to solve the KFE in closed form. We have the following proposition.

Proposition 1 (Steady state solution)**.** *Let $\hat{f}(\cdot)$ be the characteristic function of the endogenous distribution of product quality. Then, $\hat{f}(\cdot)$ satisfies the following KFE:*

$$\dot{\hat{f}}(z) = -(\eta+\lambda)\hat{f}(z) + \left(\eta+\frac{\lambda}{2}\right)\hat{g}(z) + \frac{\lambda}{2} e^{iAz}\left(\hat{f}(z)\right)^2. \tag{2}$$

At steady state, the characteristic function admits the following explicit expression:

$$\hat{f}(z) = \frac{\eta+\lambda-\sqrt{(\eta+\lambda)^2 - 2\lambda e^{iAz}\left(\eta+\frac{\lambda}{2}\right)\hat{g}(z)}}{\lambda e^{iAz}}. \tag{3}$$

As there is a one-to-one correspondence between the characteristic function $\hat{f}$ and the cumulative distribution function, we conclude that the KFE admits a unique solution, f, such that

$$f(\varepsilon) = \frac{1}{2\pi}\int_{-\infty}^{\infty} e^{-i\varepsilon z}\hat{f}(z)\, dz.$$

Furthermore, the characteristic function can be used to provide analytical expressions for all the moments of the solution. These analytical expressions allow us to study how deep parameters shape the steady state distribution of firms. In particular, we have the following comparative statics:

Proposition 2 (Moments of the steady state distribution)**.** *At the steady state, the first two moments of the firms' product quality distribution are i) strictly increasing in the matching rate, λ, and, ii) in the amount of synergies, A.*

For $n \geq 0$, the $n-th$ moment of the stationary distribution admits the following recursive representation

$$\mathbb{E}_f\left[\varepsilon^n\right] = \frac{1}{\eta}\left(\eta + \frac{\lambda}{2}\right)\mathbb{E}_g\left[\varepsilon^n\right] + \frac{1}{\eta}\frac{\lambda}{2}\sum_{l=0}^{n-1}\sum_{m=0}^{\min\{n-l,n-1\}}\binom{n}{n-l-m,l,m}A^{n-l-m}\mathbb{E}_f\left[\varepsilon^l\right]\mathbb{E}_f\left[\varepsilon^m\right]$$

and, in particular, the first two moments of the target firms' product quality distribution are

$$\mathbb{E}_f\left[\varepsilon\right] = \frac{1}{\eta}\left[\left(\eta + \frac{\lambda}{2}\right)\mathbb{E}_g\left[\varepsilon\right] + \frac{\lambda}{2}A\right] \tag{4}$$

and

$$\mathbb{E}_f\left[\varepsilon^2\right] = \frac{1}{\eta^3}\left[\eta^2\left\{\left(\eta + \frac{\lambda}{2}\right)\mathbb{E}_g\left[\varepsilon^2\right] - \frac{\lambda}{2}A^2\right\} + \lambda\left(\eta + \frac{\lambda}{2}\right)^2\left(\mathbb{E}_g\left[\varepsilon\right] + A\right)^2\right], \tag{5}$$

respectively.

2.2 A Frictional Goods Market with Market Power

In this section, we present the trading side of our model economy. We borrow many of the model assumptions from Rubinstein and Wolinsky (1985) and Choi and Rocheteau (2024)[4]. However, we endogenize the product quality distribution by introducing M&A dynamics, while Choi and Rocheteau (2024) present a model of market power by taking as given the firms' product quality distribution.

Environment There are two types of goods in the economy. First, there is a continuum of products whose qualities are seller-specific. These perishable products are produced by sellers on the spot in bilateral meetings with buyers. Second, there is also a homogeneous perishable good, called *numéraire*, that all agents produce and consume.

[4] See Section 3.2 and 6 of Choi and Rocheteau (2024).

At any point in time, there is a flow, $\omega > 0$, of homogeneous buyers into the economy. At rate $\alpha > 0$, a buyer is matched with a seller picked randomly and uniformly from the pool of all sellers. Upon meeting, the buyer and the seller engage in Kalai bargaining to determine how much of its product the seller will produce on the spot and how much numéraire will be transferred from the buyer to the seller. After meeting a seller, the buyer exits the economy regardless of the outcome of the bargaining. That is, trading is an option, and not a requirement, for a pair of buyer and seller, as is typical in these bilateral trade models.

Bilateral bargaining In a meeting in which the seller produces y units of its product of quality ε and sells it to the buyer at a per-unit price of p, the buyer's surplus is $\varepsilon u(y) - py$ and the seller's surplus is $py - c(y)$. Note that, *ceteris paribus*, these specifications imply a higher consumer surplus from a higher quality product, but firms bear the same cost of production.

We assume that the terms of trade (y, p) are determined by the proportional Kalai bargaining:

$$\max_{y,p} \varepsilon u(y) - py$$

s.t.

$$py - c(y) = \theta(\varepsilon u(y) - py),$$

where $\theta \in [0, \infty)$ is the seller's relative bargaining power (Kalai, 1977). Importantly, θ will be endogenously determined by a seller's rent-seeking activities (see Equation (10)), and this mechanism is what generates an endogenous distribution of market power in our model as in Choi and Rocheteau (2024). For now, taking the bargaining power, θ, as given, the interior solution of the bargaining is as follows:

$$\varepsilon u'(y^*) = c'(y^*) \quad \text{and} \quad p = \frac{\theta}{\theta+1}\frac{\varepsilon u(y^*)}{y^*} + \frac{1}{\theta+1}\frac{c(y^*)}{y^*}.$$

Hence, the bargaining solution leads to a buyer's surplus of $\frac{1}{\theta+1}(\varepsilon u(y^*) - c(y^*))$, while the seller's surplus is $\frac{\theta}{\theta+1}(\varepsilon u(y^*) - c(y^*))$. To be able to derive sellers' continuation utility in closed form, in what follows, we further assume that $u(y) = \sqrt{y}$ and that $c(y) = c_0 y$ for some $c_0 > 0$.

Market power With our functional form assumptions on the buyer's utility and the seller's cost, a meeting between the seller of ε-quality product and a buyer results in the exchange of $y^* = \frac{\varepsilon^2}{4c_0^2}$ units of the product for $p = \left(\frac{\theta(\varepsilon)}{\theta(\varepsilon)+1} + 1\right) c_0$ units of numérarire per unit, where we emphasize the dependence of $\theta(\varepsilon)$ on ε. The precise relation between the two will become clear shortly when we define and solve the seller's problem below.

Now we illustrate how this model generates various measures of market power by taking an arbitrary function $\theta(\varepsilon)$. At the firm-level, a most common measure of market power is to look at the markup. In our economy, the markup of the seller of product ε is

$$\mu(\varepsilon) \equiv \frac{p}{c'(y^*)} - 1 = \frac{\theta(\varepsilon)}{\theta(\varepsilon) + 1}.$$

From a market-wide perspective, a common measure of market power is the Herfindahl-Hirschman Index (HHI), defined as follows

$$HHI \equiv \int [s(\varepsilon)]^2 \, dF(\varepsilon), \tag{6}$$

where $s(\varepsilon)$ is the market share of the firm with product quality ε and equal to

$$s(\varepsilon) \equiv \frac{p(\varepsilon)\, y^*(\varepsilon)}{\int p(\varepsilon')\, y^*(\varepsilon')\, dF(\varepsilon')} = \frac{[\mu(\varepsilon) + 1]\, \varepsilon^2}{\int [\mu(\varepsilon') + 1]\, (\varepsilon')^2\, dF(\varepsilon')}. \tag{7}$$

Hence, both firms' markups and the market HHI will be determined once we solve for the endogenous bargaining power $\theta(\varepsilon)$.

Seller's problem Now we are ready to describe the sellers' continuation utility. By assuming that sellers discount the future at rate $\rho > 0$, an application of the Bellman's principle of optimality implies that the continuation utility of a seller of product quality ε at steady state satisfies

$$\begin{aligned} \rho V(\varepsilon) = \max_{\theta \in [0,\infty)} \Bigg\{ & \underbrace{-v(\theta)}_{\text{rent-seeking cost}} + \underbrace{\alpha \frac{\omega}{\alpha} \frac{\theta}{\theta + 1} \left(\varepsilon u(y^*) - c(y^*)\right)}_{\text{flow value of trading}} - \underbrace{\eta V(\varepsilon)}_{exit} \\ & \underbrace{+ \tilde{\lambda} \int \int \frac{1}{2} \left[V\left(\varepsilon' + \varepsilon + A\right) + V\left(\varepsilon''\right) - V(\varepsilon) - V\left(\varepsilon'\right)\right] dF\left(\varepsilon'\right) dG\left(\varepsilon''\right) \Bigg\}}_{\text{flow value of an M\&A deal}} \end{aligned} \tag{8}$$

subject to

$$\varepsilon u'(y^*) = c'(y^*).$$

The first term on the RHS of (8) is the flow cost of rent-seeking activities that support a seller bargaining power of θ. The second term is the flow value of gains from trade, which is equal to the Poisson rate of meeting a buyer (α) times the steady-state mass of buyers (ω/α) times the seller's bargaining share ($\frac{\theta}{\theta+1}$) times the joint surplus of a trade between a buyer and the seller of product quality ε. The third term is the flow value of a death shock that arrives with the Poisson rate of η. The second line is the flow value of an M&A deal, which is equal to the the Poisson rate of the arrival of an M&A deal ($\tilde{\lambda}$) times the symmetric bargaining share ($1/2$) times the joint surplus of an M&A deal between the seller of quality ε and another seller of quality ε' that is picked randomly and uniformly from the steady-state distribution of sellers F. Upon meeting, these two sellers bargain over an acquisition price anticipating that one firm will leave the table with a certain product quality of $\varepsilon + \varepsilon' + A$ and the other an uncertain product quality of ε'' that comes from the distribution G. The acquisition price of

$$P\left(\varepsilon', \varepsilon\right) = \frac{1}{2} \int \left[V\left(\varepsilon' + \varepsilon + A\right) - V\left(\varepsilon''\right) + V\left(\varepsilon\right) - V\left(\varepsilon'\right)\right] dG\left(\varepsilon''\right)$$

convinces the firm of initial quality ε' to acquire the firm of initial quality ε by leaving both firms with same expected surplus of

$$V\left(\varepsilon' + \varepsilon + A\right) - V\left(\varepsilon'\right) - P\left(\varepsilon', \varepsilon\right) = V\left(\varepsilon' + \varepsilon + A\right) - V\left(\varepsilon\right) + P\left(\varepsilon', \varepsilon\right),$$

which is equal to the surplus stated in the second line of (8). Similarly, the acquisition price of

$$P\left(\varepsilon, \varepsilon'\right) = \frac{1}{2} \int \left[V\left(\varepsilon' + \varepsilon + A\right) - V\left(\varepsilon''\right) - V\left(\varepsilon\right) + V\left(\varepsilon'\right)\right] dG\left(\varepsilon''\right)$$

convinces the firm of initial quality ε to acquire the firm of initial quality ε' by leaving both firms with same expected surplus of

$$V\left(\varepsilon' + \varepsilon + A\right) - V\left(\varepsilon'\right) + P\left(\varepsilon, \varepsilon'\right) = V\left(\varepsilon' + \varepsilon + A\right) - V\left(\varepsilon\right) - P\left(\varepsilon, \varepsilon'\right),$$

which is equal to the surplus stated in the second line of (8). Hence, in writing the sellers' HJB equation (8) we do not need to distinguish between cases in which the firm is an acquirer versus a target firm thanks to our specific M&A protocol with ex-ante symmetric bargaining.

With our maintained assumptions $u\left(y\right) = \sqrt{y}$ and $c\left(y\right) = c_0 y$ and by assuming a linear rent-seeking cost $v\left(\mu\right) = v_0\theta$ for some $v_0 > 0$, (8) becomes

$$\begin{aligned}\left(\rho + \eta\right) V\left(\varepsilon\right) = \max_{\theta \in [0,\infty)} \Bigg\{ & - v_0\theta + \omega \frac{\theta}{\theta + 1} \frac{\varepsilon^2}{4c_0} \\ & + \tilde{\lambda} \int \int \frac{1}{2} \left[V\left(\varepsilon' + \varepsilon + A\right) + V\left(\varepsilon''\right) - V\left(\varepsilon\right) - V\left(\varepsilon'\right)\right] dF\left(\varepsilon'\right) dG\left(\varepsilon''\right) \Bigg\}. \end{aligned} \quad (9)$$

Then, provided that ε is sufficiently large, the sellers' first-order condition implies that the endogenous bargaining power for firms of type ε is

$$\theta(\varepsilon) = \sqrt{\frac{\omega}{4c_0 v_0}\varepsilon} - 1, \tag{10}$$

which, in turn, implies a seller's endogenous markup of

$$\mu(\varepsilon) = \frac{\theta(\varepsilon)}{\theta(\varepsilon)+1} = \frac{\sqrt{\frac{\omega}{4c_0 v_0}\varepsilon} - 1}{\sqrt{\frac{\omega}{4c_0 v_0}\varepsilon}}. \tag{11}$$

We therefore have the following proposition characterizing market power in the steady state.

Proposition 3 (Steady-state Markups and Market Concentration)**.** *At the steady state, the endogenous markups, market shares, and market concentrations are*

$$\mu(\varepsilon) = 1 - \frac{1}{\varepsilon}\sqrt{\frac{4c_0 v_0}{\omega}},$$

$$s(\varepsilon) = \frac{2\varepsilon^2 - \sqrt{\frac{4c_0 v_0}{\omega}}\varepsilon}{2\mathbb{E}_f[\varepsilon^2] - \sqrt{\frac{4c_0 v_0}{\omega}}\mathbb{E}_f[\varepsilon]}, \text{ and}$$

$$HHI = \frac{4\mathbb{E}_f[\varepsilon^4] - 4\sqrt{\frac{4c_0 v_0}{\omega}}\mathbb{E}_f[\varepsilon^3] + \frac{4c_0 v_0}{\omega}\mathbb{E}_f[\varepsilon^2]}{\left(2\mathbb{E}_f[\varepsilon^2] - \sqrt{\frac{4c_0 v_0}{\omega}}\mathbb{E}_f[\varepsilon]\right)^2},$$

respectively.

This proposition provides us with intuitive comparative statics. In the cross section of firms, those with higher product quality are able to charge a higher markup to buyers. This is because of endogenous rent seeking: a seller of high quality product generates a large trade surplus, and so, she has incentive to devote resources to rent seeking to be able to have a large bargaining share. In addition, the overall level of markups is larger in an economy with frequent arrival of buyers, low cost of rent seeking, and low marginal cost of production. In all of these cases, the expected trade surplus is large and sellers want to capture a large share of that large "pie."

We now solve for the equilibrium value function. Using (11), (9) becomes

$$\begin{aligned}(\rho+\eta)V(\varepsilon) &= \left(\sqrt{\frac{\omega}{4c_0}}\varepsilon - \sqrt{v_0}\right)^2 \\ &+ \tilde{\lambda}\int\int \frac{1}{2}\left[V(\varepsilon'+\varepsilon+A) + V(\varepsilon'') - V(\varepsilon) - V(\varepsilon')\right] dF(\varepsilon')\, dG(\varepsilon'').\end{aligned} \tag{12}$$

The unique quadratic solution of (12) for a given market-wide search intensity $\tilde{\lambda}$ is obtained by conjecturing a quadratic solution for V and matching the coefficients.

Proposition 4 (Equilibrium value function)**.** *Let $K = \sqrt{\frac{\omega}{c_0}}$. Assume the supports of the distributions F and G are bounded below such that all $\varepsilon \geq \frac{2\sqrt{v_0}}{K}$. Then, the unique quadratic solution to the sellers' HJB equation* (9) *is*

$$V(\varepsilon) = V_0 + \frac{K}{4(\rho+\eta)}\left[\left(-4\sqrt{v_0} + \frac{\tilde{\lambda}}{\rho+\eta}K\mathbb{E}_f[\varepsilon + A]\right)\varepsilon + K\varepsilon^2\right], \tag{13}$$

where

$$(\rho+\eta)V_0 = v_0 + \frac{\tilde{\lambda}}{8(\rho+\eta)}K\Bigg[-4\sqrt{v_0}\mathbb{E}_g[\varepsilon + A] + \frac{\tilde{\lambda}}{\rho+\eta}K\mathbb{E}_f[\varepsilon + A]\,\mathbb{E}_g[\varepsilon + A] + K\mathbb{E}_g\left[\varepsilon^2\right] + KA\left(2\mathbb{E}_f[\varepsilon] + A\right)\Bigg].$$

The main benefit of Proposition 4 is that it provides a clear analytical characterization of the dynamic value for a seller of sustaining a particular M&A effort level $\tilde{\lambda}$.

2.3 Endogenous M&A Efforts

We now endogenize a seller's choice of $\tilde{\lambda}$ by taking as given the cross-sectional average of firms' product quality, $\mathbb{E}_f[\varepsilon]$, which itself depends on the aggregate M&A effort level, λ, of other firms as given by Corollary 2.

More precisely, we now allow entrant sellers to commit to a level of M&A efforts, $\tilde{\lambda}$, before the realization of their individual state ε, which realizes randomly from the exogenous distribution G. This is in the spirit of the endogenous-search-intensity over-the-counter (OTC) trading models, e.g., Farboodi, Jarosch and Shimer (2018) and Üslü and Weill (2022). Subsequently, the seller pays a flow cost $\chi(\tilde{\lambda})$ resulting from her M&A efforts, where $\chi : \mathbb{R}_+ \to \mathbb{R}$ is twice continuously differentiable and strictly increasing. This translates into the following optimization problem:

$$\max_{\tilde{\lambda}\in[0,\bar{\lambda}]} (\rho+\eta)\,\mathbb{E}_g[V(\varepsilon)] - \chi(\tilde{\lambda})$$

subject to (13). To be able to solve for the equilibrium search intensity in closed form, we assume quadratic search costs, namely $\chi(\tilde{\lambda}) = \frac{1}{2}\chi_0\tilde{\lambda}^2$. Then, by using Equation (4) and (13), one can write the first-order condition and second-order condition for an

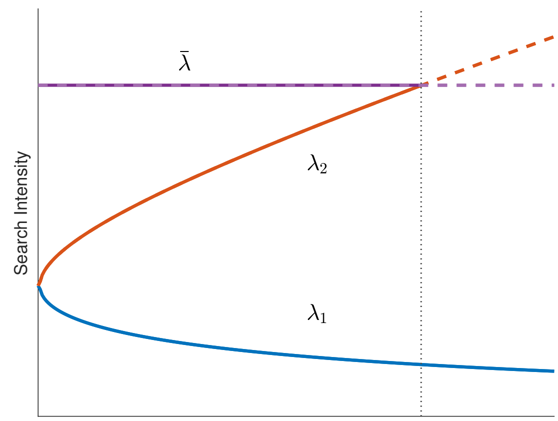


Figure 2: Equilibrium Search Intensities

Note: Solid lines indicate equilibria. In the region to the left hand side of the vertical line, three equilibria coexist.

interior solution:

$$\tilde{\lambda} = \left[\left(1+\frac{\lambda}{2\eta}\right)\mathbb{E}_g\left[\varepsilon+2A\right]\mathbb{E}_g\left[\varepsilon\right] - \frac{2\sqrt{v_0}}{K}\mathbb{E}_g\left[\varepsilon+A\right] + \frac{1}{2}\mathbb{E}_g\left[\varepsilon^2\right] + \frac{1}{2}\left(1+\frac{\lambda}{\eta}\right)A^2\right]$$
$$\times\left[\frac{4\left(\rho+\eta\right)}{K^2}\chi_0 - \frac{1}{\rho+\eta}\left(1+\frac{\lambda}{2\eta}\right)\left(\mathbb{E}_g\left[\varepsilon+A\right]\right)^2\right]^{-1} \quad (14)$$

and

$$\chi_0 > \frac{K^2}{4\left(\rho+\eta\right)^2}\left(1+\frac{\lambda}{2\eta}\right)\left(\mathbb{E}_g\left[\varepsilon+A\right]\right)^2,$$

respectively. Note that the second-order condition also guarantees that the denominator in the RHS of the first-order condition (14) is positive.

Because the second-order condition is independent of $\tilde{\lambda}$, the objective function is globally concave when it is satisfied. Hence, we have an interior solution if the first-order condition (14) generates a $\tilde{\lambda}$ which belongs to $(0, \bar{\lambda})$. But if the first-order condition implies $\tilde{\lambda} \leq 0$, the firm actually chooses $\tilde{\lambda} = 0$. Similarly, if the first-order condition implies $\tilde{\lambda} \geq \bar{\lambda}$, the firm actually chooses $\tilde{\lambda} = \bar{\lambda}$. Finally, when the second-order condition fails, the maximum obtains at a corner as well.

Assuming an interior solution, the first-order condition (14) is also the sellers' best-response function in choosing their M&A search efforts. This reveals that the game among the entrant sellers is a game with strategic complementarity in actions. The intuition is clear: Equation (4) shows that the cross-sectional average of firms' product quality is an increasing function of the aggregate M&A intensity. And naturally, when the cross-sectional average of firms' product quality is higher, an entrant's marginal benefit from increasing her own M&A intensity is higher, which makes $\tilde{\lambda}(\cdot)$ an increasing function of λ in (14) resulting in the mentioned strategic complementarity. Note that this is different from the game among entrant investors in the models of Farboodi, Jarosch and Shimer (2018) and Üslü and Weill (2022), which exhibit strategic substitutability. The reason is that in those models, when aggregate search intensity is higher, the equilibrium level of misallocation is lower, which lowers the gains from trade, and in turn, lowers the marginal benefit of choosing a higher search intensity. While this situation generates unique equilibrium in those search-based OTC trading environments, our model with strategic complementarity shows that search-based M&A environments are prone to multiple equilibria.

Proposition 5 (Equilibrium search intensities)**.** *Assume $\chi\left(\tilde{\lambda}\right) = \frac{1}{2}\chi_0\tilde{\lambda}^2$ for sufficiently high $\chi_0 > 0$ such that $\Delta > 0$, where*

$$\Delta \equiv \left[\frac{\rho+3\eta}{2} - \frac{4\eta\left(\rho+\eta\right)^2}{K^2\left(\mathbb{E}_g\left[\varepsilon+A\right]\right)^2}\chi_0\right]^2 - 2\eta\left(\rho+\eta\right)\left[1+\frac{\frac{1}{2}\left(\mathbb{E}_g\left[\varepsilon^2\right]-A^2\right)-\frac{2\sqrt{v_0}}{K}\mathbb{E}_g\left[\varepsilon+A\right]}{\left(\mathbb{E}_g\left[\varepsilon+A\right]\right)^2}\right].$$

Let

$$\lambda_1 = \max\left\{0, \frac{4\eta\left(\rho+\eta\right)^2}{K^2\left(\mathbb{E}_g\left[\varepsilon+A\right]\right)^2}\chi_0 - \frac{\rho+3\eta}{2} - \sqrt{\Delta}\right\}$$

and

$$\lambda_2 = \frac{4\eta\left(\rho+\eta\right)^2}{K^2\left(\mathbb{E}_g\left[\varepsilon+A\right]\right)^2}\chi_0 - \frac{\rho+3\eta}{2} + \sqrt{\Delta}.$$

Then, if $0 \le \bar{\lambda} < \lambda_2$, there exists a unique symmetric equilibrium with the M&A intensity $\lambda^* = \min\left\{\lambda_1, \bar{\lambda}\right\}$. If $\bar{\lambda} = \lambda_2$, there exist two symmetric equilibria with the M&A intensities $\lambda^* \in \left\{\lambda_1, \lambda_2\right\}$. If $\bar{\lambda} > \lambda_2$, there exist three symmetric equilibria with the M&A intensities $\lambda^* \in \left\{\lambda_1, \lambda_2, \bar{\lambda}\right\}$.

Proposition 5 shows that equilibria with low M&A activity, low markups, and low product qualities can co-exist with other equilibria with high M&A activity, high markups, and high product qualities. A graphical counterpart of Propositon 5 is provided with Figure 2. In the right hand side region, only one equilibrium exist, while several exist in the left hand side region. This leads to two natural questions. First, which one of these equilibria are stable? Second, which one is associated with the highest social welfare?

The stability of the equilibrium depends on the sign of the first derivative of the best-response function evaluated at these equilibria. An interior equilibrium λ is stable if and only if $\tilde{\lambda}'(\lambda) < 1$. Because we have two interior equilibria, it then follows that the equilibrium with lower (resp. higher) λ is stable if $\tilde{\lambda}(\cdot)$ is strictly convex (resp. concave). Thus, when the best-response function is strictly convex, the stable equilibria are the extreme ones, $\{\lambda_1, \bar{\lambda}\}$.[5]

Proposition 6 (Stability)**.** *Let*

$$a = \mathbb{E}_g[\varepsilon + 2A]\,\mathbb{E}_g[\varepsilon] + \frac{2\sqrt{v_0}}{K}\mathbb{E}_g[\varepsilon + A] - \frac{1}{2}\mathbb{E}_g\left[\varepsilon^2\right] + \frac{1}{2}A^2,$$

$$b = \frac{1}{2\eta}\mathbb{E}_g[\varepsilon + 2A]\,\mathbb{E}_g[\varepsilon] + \frac{1}{2\eta}A^2,$$

$$c = \frac{4(\rho+\eta)}{K^2}\chi_0 - \frac{1}{\rho+\eta}\left(\mathbb{E}_g[\varepsilon + A]\right)^2,$$

and

$$d = -\frac{1}{2\eta}\frac{1}{\rho+\eta}\left(\mathbb{E}_g[\varepsilon + A]\right)^2.$$

If

$$\frac{(b-a)\,cd - 2d\,(bc-ad) - (b-a)\,d^2\lambda}{(c+d\lambda)^3} > 0$$

for all $\lambda \in [0, \bar{\lambda}]$, then an equilibrium associated with λ_1 is stable; an equilibrium associated with λ_2 is unstable; and an equilibrium associated with $\bar{\lambda}$ is stable, provided that $\lambda_2 < \bar{\lambda}$.

Propositions 5 and 6 are interesting due to their potential empirical and regulatory implications. Assume that the best-reponse function is strictly convex. Note that λ_2 is increasing in the marginal cost of M&A activities, χ_0, under the stated assumptions. As a result, for a sufficiently small χ_0 such that $\lambda_2 < \bar{\lambda}$, the economy may be in the stable and maximal equilibrium $\bar{\lambda}$, characterized by high M&A activity, high markups, and high product qualities. Suppose regulators were concerned about these high M&A activity and high markups and tightened the anti-trust policy, thereby making χ_0 larger.

[5] We numerically confirm that for a large range of parameter values, the best-response function is strictly convex.

If the increase in χ_0 is sufficiently large to make $\lambda_2 > \bar{\lambda}$, then the economy moves to the unique stable equilibrium λ_1, with low M&A activity, low markups, and low product qualities. Is this necessarily better for the social welfare, or even for the consumers' welfare?

If the regulators decided that the tightened antitrust policy was a bad idea, they could revert it. However, it does not guarantee that the economy would return to original maximal equilibrium, because the equilibrium with λ_1 is stable. That is, the economy may be trapped in the lowest M&A equilibrium with low product qualities. Hence, our model with M&A search complementarities questions the extent to which unintended consequences of some antitrust policy changes may successfully be reversed.

2.4 Welfare

Next, we turn to the welfare analysis. At this point, it is not clear whether the equilibrium with the lower M&A effort λ_1 would have higher social welfare, as several forces in the model operate with opposite effects on welfare. On the one hand, this equilibrium is characterized by less investment in M&A activities and rent-seeking activities, which improves social welfare. On the other hand, due to lower M&A activities, equilibrium product qualities are lower, leading to lower consumer and producer surpluses in bilateral trade between buyers and sellers, as well as lower labor earnings, and in turn, to lower social welfare. To determine which effect dominates, we conduct a careful welfare analysis. We start by defining the the flow social welfare as

$$\rho\mathcal{W} = \int \left(-v\left[\theta\left(\varepsilon\right)\right] + \omega \left\{ \max_{y} \varepsilon u\left(y\right) - c\left(y\right) \right\} + \omega c_0 y^*\left(\varepsilon\right) \right) dF\left(\varepsilon\right) - \chi\left(\lambda\right),$$

where $y^*\left(\varepsilon\right) = \arg\max_{y} \varepsilon u\left(y\right) - c\left(y\right)$. The first term inside the integral is the flow cost of rent-seeking activities by a seller of product quality ε. The second term is the flow gains from trade. Note that there is no coefficient $\theta\left(\varepsilon\right)$ inside the flow gains from trade because the social planner considers the shares of the surplus that accrue to the buyer $\left(1/\left(\theta\left(\varepsilon\right)+1\right)\right)$ as well as to the seller $\left(\theta\left(\varepsilon\right)/\left(\theta\left(\varepsilon\right)+1\right)\right)$, which sums up to 1. The last term inside the integral is the earnings of the hand-to-mouth workers who make the production possible. Thus, the integral stands in for the aggregation of rent-seeking costs and gains from trades including labor earnings across all product-quality types according to their steady-state measure F. The term outside the integral is the flow cost of M&A activities.

By using our main assumptions regarding utility, $u(y) = \sqrt{y}$, production costs, $c(y) = c_0 y$, rent-seeking costs, $v(\theta) = v_0\theta$, and M&A search costs, $\chi(\lambda) = \frac{1}{2}\chi_0\lambda^2$, the flow social welfare is

$$\rho\mathcal{W} = \int \left(-v_0\theta(\varepsilon) + \frac{\omega}{4c_0}\varepsilon^2 + \frac{\omega}{4c_0}\varepsilon^2\right) dF(\varepsilon) - \frac{1}{2}\chi_0\lambda^2.$$

Finally, by using the sellers' optimal choice of $\theta(\varepsilon)$s, we obtain the following proposition.

Proposition 7 (Equilibrium welfare given λ)**.** *Let $K = \sqrt{\frac{\omega}{c_0}}$. Assume the supports of the distributions F and G are bounded below such that all $\varepsilon \geq \frac{2\sqrt{v_0}}{K}$. Then, the equilibrium welfare is given by*

$$\mathcal{W}(\lambda) = \frac{1}{\rho}\left(v_0 - \frac{K\sqrt{v_0}}{2}\mathbb{E}_f[\varepsilon] + \frac{K^2}{2}\mathbb{E}_f\left[\varepsilon^2\right] - \frac{1}{2}\chi_0\lambda^2\right),$$

where $\mathbb{E}_f[\varepsilon]$ and $\mathbb{E}_f\left[\varepsilon^2\right]$ are given by (4) and (5), respectively.

The first part of the welfare, $\frac{1}{\rho}\left(v_0 - \frac{K\sqrt{v_0}}{2}\mathbb{E}_f[\varepsilon]\right) < 0$, is the welfare cost of market power. In an equilibrium with high average product quality, the welfare cost of market power is larger, i.e., it is more negative. This is because firms selling high-quality products are able to charge larger markups. However, in an equilibrium with high product quality, the welfare gain from trading surpluses and labor earnings, $\frac{1}{\rho}\left(\frac{K^2}{2}\mathbb{E}_f\left[\varepsilon^2\right]\right)$, is higher as well. Thus, our theoretical model with explicit formulae for the first two moments of the product quality distribution provides us with a framework to weigh the opposing welfare effects of M&A activities against each other.

3 Quantification and Counterfactuals

3.1 Numerical Example

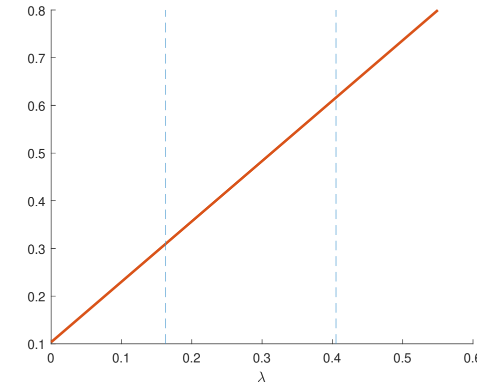
We now provide quantitative implications of our model by using numerical simulations, as in Choi and Rocheteau (2024). In particular, we follow David (2021), to calibrate parameters that capture the main features of the firm size distribution. We therefore set the exit shock, η, to 0.065 and the discount rate, ρ, to 0.04. Following Cavenaile, Celik and Tian (2021), we also target the efficiency gains, A, to 0.06. The last three parameters are the search cost, χ_0 set to 1800, the reduced-form parameter K that combines the operating cost and the flow of entrants to 17.2, and finally the rent-seeking cost, ν_0, to 0.04.

With the described parameter choices, the stable interior equilibrium of our model (i.e., the equilibrium with λ_1) matches four of the empirical moments reported by Cavenaile, Celik and Tian (2021): the effective merger arrival rate ($\lambda_1 = 0.1625$), average net markup ($\mathbb{E}_f [\mu(\varepsilon)] = 0.3498$), variance of markups ($\mathbb{V}_f [\mu(\varepsilon)] = 0.12$), and average profitability (0.144).[6] We see this simple calibration as a first step towards bringing the model to the data, with the main goal of providing mostly a qualitative assessment of the forces in the model.

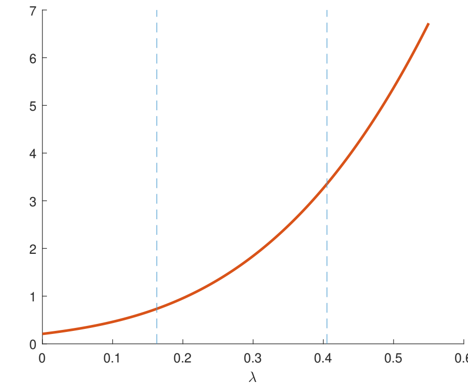
We next illustrate the relationship between the equilibrium M&A intensities and the endogenous market structure in Figure 3. The high search intensity equilibrium is associated with higher average quality, larger quality variance, and larger markups. Because consumer welfare is tied to the goods' quality, the consumer welfare is also higher in the high intensity equilibrium. Importantly, the relationship between search intensity and market concentration, as measured by the HHI is non-monotonic, this is in large part due to the concavity of the markups. As a result, while markups rise, they do not rise as much as the average quality, which improves due to M&A synergies. Therefore, while the bilateral bargaining protocol delivers heterogenous markups, the increase in concentration is dominated by the positive impact of mergers in this setting.

Some of the results relate to the recent of work of Menzio (2024), who argue that interpreting the markups through the lens of the monopolistic competition models could lead to incorrect policy recommendations. In Menzio (2024), markups are efficient. In contrast, while markups are not necessarily efficient in our model, they have efficiency-enhancing properties. If firms were not able to charge markups, they would not engage in the costly M&A activities, and so, the equilibrium search intensity would be zero. It is clear from panels (e) and (f) of Figure 3 that $\lambda = 0$ leads to the lowest social welfare and consumer welfare. Firm profits arising from markups incentivize the firms to search for M&A partners, which in turn enhances the product quality distribution. When the product quality distribution is better (in the sense of first-order stochastic dominance), in our numerical example, consumers are on net better off even though they end up paying a larger markup for firms' products.

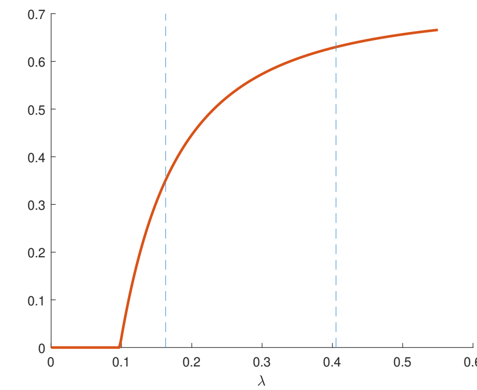
[6] Following Cavenaile, Celik and Tian (2021), we define the empirical profitability ratio as the ratio of operating income before depreciation to sales. Its counterpart in our model is equal to the ratio of static profit flow after rent-seeking cost to sales.



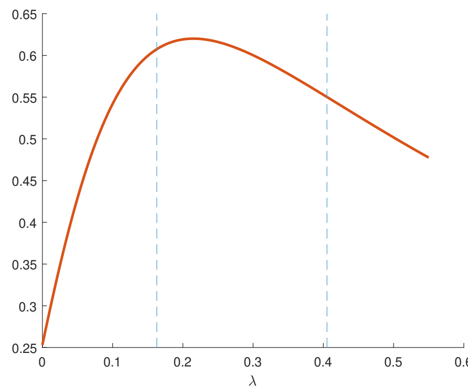
(a) Average Quality



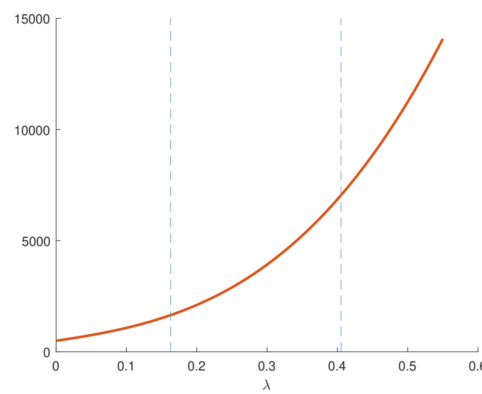
(b) Variance of Quality



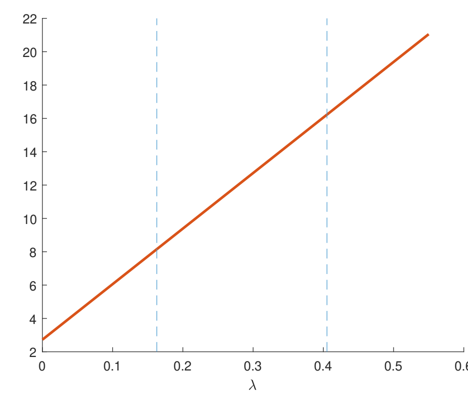
(c) Average Mark-up



(d) HHI



(e) Welfare



(f) Consumer Welfare

Figure 3: Impact of M&A Search Intensity

Note: The dashed vertical line represent the low and high equilibrium search intensities, λ_1 and λ_2.

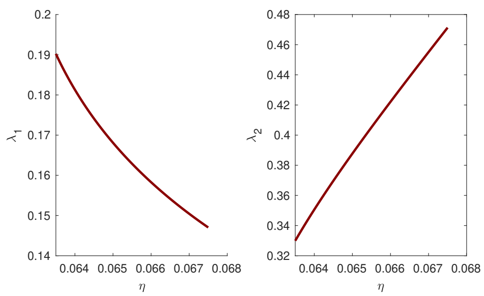
3.2 Counterfactual Policies

Search intensities are the key drivers of the model's outcomes, as seen in the previous section. We now study the impact of exogenous changes in the model's parameters on equilibrium search intensities. While our framework does not model antitrust policies explicitly, we interpret the magnitude of the search costs as an indicator of the stringency of antitrust policies. There are several ways in which more stringent antitrust policies increase the costs of concluding an acquisition, for instance by requiring more detailed and lengthier pre-merger filing. More stringent merger reviews can also lead to costly break-up fees. While only a small fraction of the proposed deals require a Second Request, unsuccessful mergers can be very costly.[7] For instance, the acquisition of T-Mobile USA by AT&T that was ultimately blocked by the DOJ led to a breakup fee of around $4.2 billion (Fidrmuc et al., 2018).

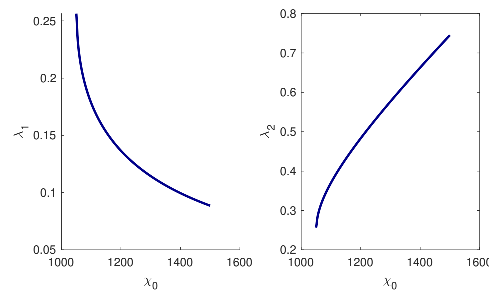
Figure 4 shows the comparative statics for the two interior equilibrium search intensities, λ_1 and λ_2, with respect to all the exogenous parameters. The low M&A equilibrium λ_1 is the only stable interior equilibrium and its comparative statics typically follow from direct effects, and so, are straightforward to interpret. The high M&A equilibrium λ_2 is an unstable equilibrium. That is, it is best understood as a self-fulfilling prophecy sustained thanks to the M&A search complementarities. For example, Panel (b) shows that λ_1 decreases with the M&A search cost χ_0. When it is more costly to search for M&A partners, firms search less leading to a lower equilibrium search intensity λ_1. However, λ_2 increases with χ_0. This high search intensity λ_2 is optimal for a firm only because other firms are choosing this high search intensity λ_2, generating large M&A surpluses. If the search cost χ_0 is larger, firms would collectively need to choose an even higher search intensity to generate even larger M&A surpluses so that the complementarities would outweigh the increase in χ_0. That's why higher χ_0 leads to a higher equilibrium search intensity λ_2.

Another example is Panel (c), which shows that λ_1 increases with the M&A synergy benefit A. A higher A implies a larger M&A surplus. In turn, firms search more leading to a higher equilibrium search intensity λ_1. However, λ_2 decreases with A. Again, the intuition follows from the self-fulfilling nature of this equilibrium. This high search intensity λ_2 is optimal for a firm only because other firms are choosing this high search intensity λ_2, generating large M&A surpluses. Now, a higher A implies that it is pos-

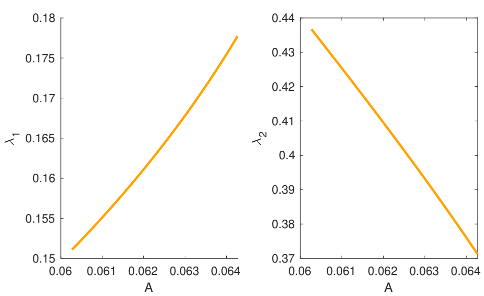
[7] "Just to step back, in any given year, we see up to 3,000 merger filings that get reported to us. Around 2% of those actually get a second look by the government, so you have 98% of all deals that, for the most part, are going through." https://techcrunch.com/2024/06/15/ftc-chair-lina-khan-on-startups-scaling-and-innovations-in-potential-law-breaking/



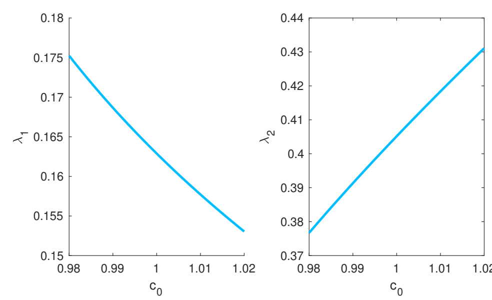
(a) Exit Rate



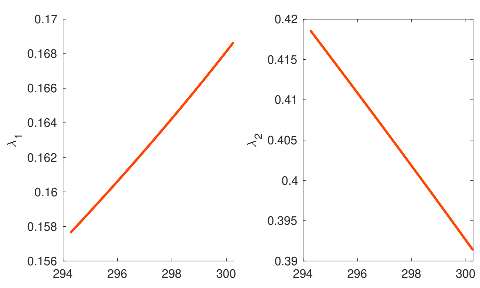
(b) Search Cost



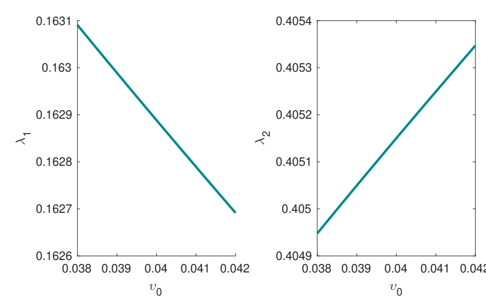
(c) Efficiency Gains



(d) Operating Costs



(e) Flow of Buyers



(f) Rent-seeking Costs

Figure 4: Impact of parameter changes on M&A intensity

Note: Each panel shows the impact on λ_1 and λ_2, the two candidate equilibrium search intensities, of exogenous changes in the model's parameters.

sible to generate the same large surpluses by choosing a lower search intensity. That's why higher synergy benefit A leads to a lower equilibrium search intensity λ_2. The other comparative statics of λ_1 and λ_2 also follow from the same logic, and so, they exhibit opposite signs of slopes in each of those panels as in Panel (b) and (c).

4 Conclusion

We propose a search-theoretic framework to understand how the distribution of market power responds to changes in the structure of the economy. The stylized model admits closed-form solution under certain parametric assumptions. We show that several equilibria can arise, and that the equilibrium with a higher search intensity, when it exists, leads to higher welfare. Key to this finding is the fact that, while our bilateral bargaining protocol delivers endogenous markups that are increasing with the firm's output, the efficiency impact of M&A appears to dominate. Our findings could have important implications for the design of antitrust policies. Policies that are designed without taking the dynamic effect on search intensities may inadvertently push the economy into a low-search equilibria with negative welfare consequences. An important avenue for future research is to study how different markup specifications could shape these dynamic incentives.

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Mathematical Appendix

Proof of Proposition 1

We first derive the characteristic function of the last term on the RHS of (1):

$$\int_{-\infty}^{\infty}\left[\frac{\lambda}{2}\int_{-\infty}^{\infty} f\left(\varepsilon'\right) f\left(\varepsilon - A - \varepsilon'\right) d\varepsilon'\right] e^{iz\varepsilon} d\varepsilon = \frac{\lambda}{2}\int_{-\infty}^{\infty}\left[f\left(\varepsilon'\right)\int_{-\infty}^{\infty} f\left(\varepsilon - A - \varepsilon'\right) e^{iz\varepsilon} d\varepsilon\right] d\varepsilon'$$

$$= \frac{\lambda}{2}\int_{-\infty}^{\infty}\left[f\left(\varepsilon'\right)\int_{-\infty}^{\infty} f\left(\varepsilon - A - \varepsilon'\right) e^{iz\left(\varepsilon - A - \varepsilon'\right)} d\left(\varepsilon - A - \varepsilon'\right)\right] e^{iz\left(A+\varepsilon'\right)} d\varepsilon'$$

$$= \frac{\lambda}{2} e^{iAz}\int_{-\infty}^{\infty}\left[f\left(\varepsilon'\right)\hat{f}\left(z\right)\right] e^{iz\varepsilon'} d\varepsilon' = \frac{\lambda}{2} e^{iAz}\hat{f}\left(z\right)\int_{-\infty}^{\infty} f\left(\varepsilon'\right) e^{iz\varepsilon'} d\varepsilon' = \frac{\lambda}{2} e^{iAz}\left(\hat{f}\left(z\right)\right)^{2}.$$

Using the linearity and differentiability of the characteristic function, one can obtain the characteristic functions of all other terms in (1), which leads to (2). By equating the LHS of (2) to zero, we obtain a quadratic equation for $\hat{f}(z)$. Its negative root gives the steady-state characteristic function (3). Its positive root does not lead to a characteristic function because it violates the fact that $\hat{f}(0) = 1$.

Proof of Proposition 2

To characterize the n^{th} moment of the steady state distribution we use the KFE taken at steady state. We have

$$(\eta + \lambda)\hat{f}(z) = \left(\eta + \frac{\lambda}{2}\right)\hat{g}(z) + \frac{\lambda}{2} e^{iAz}\left(\hat{f}(z)\right)^{2}.$$

Using the generalized Leibniz rule we have

$$\frac{d}{dz^n}\left[\frac{\lambda}{2} e^{iAz}\left(\hat{f}(z)\right)^{2}\right] = \frac{\lambda}{2} e^{iAz}\sum_{k+l+m=n}\binom{n}{k,l,m} i^k A^k \hat{f}^{(l)}(z)\,\hat{f}^{(m)}(z)$$

$$= \frac{\lambda}{2} e^{iAz}\sum_{l=0}^{n}\sum_{m=0}^{n-l}\binom{n}{n-l-m,l,m} i^{n-l-m} A^{n-l-m}\hat{f}^{(l)}(z)\,\hat{f}^{(m)}(z)$$

$$= i^n\frac{\lambda}{2} e^{iAz}\sum_{l=0}^{n}\sum_{m=0}^{n-l}\binom{n}{n-l-m,l,m} A^{n-l-m} i^{-l}\hat{f}^{(l)}(z)\, i^{-m}\hat{f}^{(m)}(z)$$

Now rewrite the double summation by singling out the two terms corresponding to $(l, m) \in \{(n,0),(0,n)\}$ and for which the corresponding multinomial term $\binom{n}{0,n,0} = 1$ such that

$$\frac{d}{dz^n}\left[\frac{\lambda}{2}e^{iAz}\left(\hat{f}\left(z\right)\right)^2\right] = i^n\frac{\lambda}{2}e^{iAz}\left(i^{-n}\hat{f}^{(n)}\left(z\right)\hat{f}\left(z\right) + \hat{f}\left(z\right)i^{-n}\hat{f}^{(n)}\left(z\right)\right)$$
$$+ i^n\frac{\lambda}{2}e^{iAz}\sum_{l=0}^{n-1}\sum_{m=0}^{\min\{n-l,n-1\}}\binom{n}{n-l-m,l,m}A^{n-l-m}i^{-l}\hat{f}^{(l)}\left(z\right)i^{-m}\hat{f}^{(m)}\left(z\right).$$

Finally, because by property of the characteristic function $i^{-n}\hat{f}^{(n)}\left(0\right) = \mathbb{E}_f\left[\varepsilon^n\right]$, then taking the $n-th$ derivative, multiplying by i^{-n}, and evaluating at $z = 0$ equation 4 we have

$$\eta\mathbb{E}_f\left[\varepsilon^n\right] = \left(\eta + \frac{\lambda}{2}\right)\mathbb{E}_g\left[\varepsilon^n\right]$$
$$+ \frac{\lambda}{2}\sum_{l=0}^{n-1}\sum_{m=0}^{\min\{n-l,n-1\}}\binom{n}{n-l-m,l,m}A^{n-l-m}\mathbb{E}_f\left[\varepsilon^l\right]\mathbb{E}_f\left[\varepsilon^m\right];$$

therefore expressing the $n-th$ moment of f in terms of the $n-th$ moment of g and strictly lower order moments of f. It is clear than $\mathbb{E}_f\left[\varepsilon^1\right]$ is strictly increasing in A and in λ. It then follows by induction that every moment of f is strictly increasing with A and λ.

Proof of Proposition 3

The first equation obtains by rearranging (11). The second equation obtains by plugging (11) into (7). Then, the second equation, together with (6), implies the last equation.

Proof of Proposition 4

We first conjecture a solution of the form

$$V\left(\varepsilon\right) = V_0 + V_1\varepsilon + V_2\varepsilon^2$$

for V_0, V_1, and V_2 to be determined. Then, by plugging this conjecture into the buyer's HJB (equation (12)) and matching coefficients, we obtain

$$V_0 = \frac{v_0}{\rho+\eta} + \frac{\tilde{\lambda}}{8(\rho+\eta)^2} K \left[-4\sqrt{v_0}\mathbb{E}_g[\varepsilon + A] + \frac{\tilde{\lambda}}{\rho+\eta} K \mathbb{E}_f[\varepsilon + A]\mathbb{E}_g[\varepsilon + A] \right.$$
$$\left. + K\mathbb{E}_g\left[\varepsilon^2\right] + KA\left(2\mathbb{E}_f[\varepsilon] + A\right) \right],$$

$$V_1 = \frac{K}{4(\rho+\eta)} \left(-4\sqrt{v_0} + \frac{\tilde{\lambda}}{\rho+\eta} K\mathbb{E}_f[\varepsilon + A] \right),$$

and

$$V_2 = \frac{K^2}{4(\rho+\eta)},$$

which completes the proof.

Proof of Proposition 5

In a symmetric equilibrium, a buyer's search intensity is equal to the aggregate search intensity $\tilde{\lambda} = \lambda$. Thus, the FOC (14) becomes

$$\lambda = \left[\left(1 + \frac{\lambda}{2\eta}\right) \mathbb{E}_g[\varepsilon + 2A]\mathbb{E}_g[\varepsilon] - \frac{2\sqrt{v_0}}{K}\mathbb{E}_g[\varepsilon + A] + \frac{1}{2}\mathbb{E}_g\left[\varepsilon^2\right] + \frac{1}{2}\left(1 + \frac{\lambda}{\eta}\right) A^2 \right]$$
$$\times \left[\frac{4(\rho+\eta)}{K^2}\chi_0 - \frac{1}{\rho+\eta}\left(1 + \frac{\lambda}{2\eta}\right)\left(\mathbb{E}_g[\varepsilon + A]\right)^2 \right]^{-1}.$$

By rearranging,

$$\frac{K}{4\eta(\rho+\eta)\sqrt{v_0}}\lambda^2 + \left[-\frac{2(\rho+\eta)}{K\sqrt{v_0}\left(\mathbb{E}_g[\varepsilon + A]\right)^2}\chi_0 + \frac{K(\rho+3\eta)}{4\eta(\rho+\eta)\sqrt{v_0}} \right]\lambda$$
$$+ \frac{K}{2\sqrt{v_0}}\left(1 + \frac{\frac{1}{2}\left(\mathbb{E}_g[\varepsilon^2] - A^2\right) - \frac{2\sqrt{v_0}}{K}\mathbb{E}_g[\varepsilon + A]}{\left(\mathbb{E}_g[\varepsilon + A]\right)^2}\right) = 0.$$

Then, it is a matter of algebra to verify that this quadratic equation has the two following roots:

$$\lambda_1^r = \frac{4\eta(\rho+\eta)^2}{K^2\left(\mathbb{E}_g[\varepsilon + A]\right)^2}\chi_0 - \frac{\rho+3\eta}{2} - \sqrt{\Delta}$$

and

$$\lambda_2^r = \frac{4\eta(\rho+\eta)^2}{K^2\left(\mathbb{E}_g[\varepsilon + A]\right)^2}\chi_0 - \frac{\rho+3\eta}{2} + \sqrt{\Delta}.$$

where

$$\Delta \equiv \left[-\frac{4\eta\left(\rho+\eta\right)^2}{K^2\left(\mathbb{E}_g\left[\varepsilon+A\right]\right)^2}\chi_0+\frac{\rho+3\eta}{2}\right]^2 \\ -2\eta\left(\rho+\eta\right)\left[1+\frac{\frac{1}{2}\left(\mathbb{E}_g\left[\varepsilon^2\right]-A^2\right)-\frac{2\sqrt{v_0}}{K}\mathbb{E}_g\left[\varepsilon+A\right]}{\left(\mathbb{E}_g\left[\varepsilon+A\right]\right)^2}\right].$$

Note that agents' exogenously specified choice set is $\left[0,\bar{\lambda}\right]$. Then, the roots above imply that $\lambda_1 \equiv \max\left\{0,\lambda_1^r\right\}$ is always an equilibrium. $\lambda_2 \equiv \lambda_2^r$ is an equilibrium provided that $\lambda_2 \leq \bar{\lambda}$. Finally, in the most unrestricted case of $\lambda_2 < \bar{\lambda}$, $\bar{\lambda}$ constitutes the third equilibrium, an equilibrium with maximal possible search effort.

Proof of Proposition 6

Re-write the best response function (14):

$$\tilde{\lambda}\left(\lambda\right)=\frac{a+b\lambda}{c+d\lambda}$$

for a, b, c, and d stated in the Proposition. Then, $\tilde{\lambda}\left(\cdot\right)$ is strictly convex if

$$\tilde{\lambda}''\left(\lambda\right)=\frac{\left(b-a\right)cd-2d\left(bc-ad\right)-\left(b-a\right)d^2\lambda}{\left(c+d\lambda\right)^3}>0,$$

which completes the proof.

PUBLICATIONS

A Search-Based Theory of Mergers and Acquisitions

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