Mitigating Information Imperfections:
A Market-Creation Role for Multi-Sided Platforms

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Abstract:

Information imperfections are double-edged swords. On the one hand, the inability to find buyers or the lack of trust in sellers can prevent market formation. On the other hand, firms that can address these information problems stand to profit handsomely. We examine markets in which buyers and sellers are separated by information imperfections and decompose the problem into a four-level value chain with two distinct information intermediaries, one to address buyers and the other to address sellers. We then suggest that while multi-sided platforms (MSPs) have not connected with the market imperfections literature, MSPs are well-suited to addressing information imperfections. Accordingly, we develop a taxonomy of market structures involving two intermediaries and identify where MSPs might engage. We illustrate how the taxonomy can be used by imagining a restructuring of the healthcare market in which information imperfections are mitigated throughout the value chain. We contribute to the literatures on market design by introducing MSPs as a source of design inspiration. We also contribute to the MSP literature by placing MSPs into the broader value chain in which information imperfections must be addressed.

Keywords: market failure, information asymmetry, multi-sided platform, market creation

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INTRODUCTION

The concept of market imperfections has contributed to our understanding of two related issues, market failure (Bator 1958) and competitive strategy (Yao 1988; Oberholzer-Gee and Yao 2013, 2018: 464). In the extreme, market imperfections might be so great, that market transactions fail to take place. Information often presents such hurdles, as when sellers are unable to find buyers. But to the extent that firms can mitigate these obstacles, these mitigation measures are, in essence, "the true building blocks of longer-term strategic success." For example, another common information problem is assessing buyer or seller quality, i.e., trust. Profitable strategies can be built around brands as proxies of firm reputation, scale economies in brand building (to prevent rivals from competing away brand advantage), and assuring quality through warranties or money-back guarantees. Thus, information imperfections are a mechanism through which firms can obtain or maintain supra-normal profits (Oberholzer-Gee and Yao 2018).

The role of information, both for market quality and for competitive strategy, is likewise central to the research on multi-sided platforms (MSPs), also known as two-sided markets. The ability of online platforms to connect buyers and sellers is unprecedented in human history and the reach of online platforms has disrupted old markets in sector after sector. Yet despite their impact on markets and extensive research on MSP strategy, MSPs have not been connected with the research on market imperfections.

In this paper, we submit that connecting these bodies of scholarship yields greater analytical power both for understanding MSP strategy and for how MSPs create, disrupt, and improve markets. We first decompose the information imperfections that separate buyers and sellers into buyer-side problems and seller-side problems. Under this decomposition, a value chain between buyer and seller would include an "aggregator," who solves buyer-side problems,

and a "convenor," who solves seller-side problems; profit opportunities exist in both aggregating and convening. Because these situations are two-sided, these entry opportunities are for an MSP to dis-intermediate and re-intermediate buyers and sellers.

Indeed, the aggregator and convenor roles are so often integrated into a single MSP that the literature models them as a single cost function (e.g., Rochet and Tirole 2006). However, decomposing the information imperfections allows for the identification of entry opportunities and a more accurate analysis of the industry structure of a market. We develop a taxonomy of market structures based on vertical integration along the value chain. Within a 2x2, market quality or efficiency can be assessed. In other words, we connect organization design with market design.

To illustrate how our framework can be used, we apply our framework to the health care market, a notoriously difficult and dysfunctional market. We use basic criteria—price transparency, price stability, and liquidity—to assess market quality and trace market quality to the incentives of firms along the value chain.

By bringing MSPs into conversation with the market imperfections literature, we gain access to a strategy literature that guides the design of MSPs. For example, Hagiu (2016) classifies platform strategy decisions into four categories—how many sides to serve, pricing, design, and governance. Thus, market design is reduced to the design of an organization, which the MSP literature addresses. But we also contribute to the MSP literature, placing MSPs into a value chain that can be analyzed and assessed. Where should an MSP operate? What information imperfections should it address? Our taxonomy clearly lays out the structure of markets where MSPs can profitably be inserted.

LITERATURE REVIEW

The literature on market imperfections and market failure has thus far remained disconnected from a more recent literature on two-sided markets. Two-sided markets, or MSPs, are admittedly a small subset of markets over all, but they are an important subset that has attracted substantial scholarly and practical attention because of their disruptive effect on incumbent market structures. We therefore seek to bring these two literatures together to improve the identification of strategic opportunities and to assess market quality problems and solutions.

Market imperfections and the economic theory of market failure

The research on market imperfections is rooted in the economic theory of market failure. On the one hand, the theory describes the anatomy of market failure (Bator 1958). The conditions that interfere with effective competition—market power, information imperfections, transactions costs, and externalities—are viewed negatively from the point of view of the market. On the other hand, they are the same conditions that allow firms to earn supra-normal profits (Yao 1988, Oberholzer-Gee and Yao 2013, Mahoney and Qian 2013).

Market power is the ability of a firm to price above the level that would prevail under perfect competition. A firm gains market power when it achieves production economies of scale (Caves et al. 1975), product scope (Baumol et al. 1982), cumulative learning (Rapping 1965), or network size (Tirole 1994).

Information imperfections refer to buyers or sellers lacking information that is critical for efficient exchange. Efficient exchanges between buyers and sellers require information for them to find alternatives. If buyers are unaware of near-equivalent products offered by rival sellers, a

seller can price above the level that would prevail under perfect competition (Chatain and Zemsky 2011).

Transaction costs are the costs of drafting, negotiating, and safeguarding contractual agreements, including the costs of governing transactional relationships and securing commitments. The costs alter equilibrium price levels by changing the nature and level of market activity (Williamson 2010). When transaction costs are high, parties involved in intermediate product market contracting use alternative modes of governance to reduce transaction costs.

Whereas the aforementioned three conditions were discussed in detail by Oberholzer-Gee and Yao (2018: 465), the fourth condition, externalities, has not been elaborated (as the authors acknowledged in their footnote 6). We provide an elaboration here that connects three types of externalities to a firm's supra-normal profits. First, a firm's technology can generate a negative externality in the form of pollution that creates a trade-off between government failures and market failures (Acemoglu and Verdier 2000). A firm reduces cost by not cleaning its emissions that cause pollution. Second, there are externalities in a firm's learning and R&D process where knowledge spillovers can reduce a firm's cost (Stiglitz 1989). Third, two-sided markets involve a cross-platform externality in which one set of customers attracts a second, distinct, set of customers. Pricing in such markets can involve pricing below cost on one side in order to charge higher prices to the other side (Parker and Van Alstyne, 2005). The third type of externality is particularly important, because this type presents profit opportunities to MSPs. Exploiting two-sided network externality, firms selling operating systems, Internet browsers, games, music, and video profitably give their products away free-of-charge. These firms give away products without metering tie-ins to those same consumers. MSPs are often observed among these firms.

Recent developments in the research on market imperfections propose *residual market imperfections*—the imperfections that persist in spite of competition among firms and government intervention—as "the true building blocks of longer-term strategic success" (Oberholzer-Gee and Yao 2018: 464). The research explains (1) what imperfections, if any, characterize the market, (2) how one's strategy (and the strategies of rival firms) might exploit such imperfections, and (3) how and why the market imperfections may change over time (p.471). For example, in a market characterized by information imperfections, a firm might exploit such market imperfections by creating brands to signal its quality level to consumers. The market imperfections may change over time as government mandates quality rating system.

MSPs as information intermediaries

MSPs, which bring two or more sides on board and enable interactions between them, represent an alternative to vertically integrated firms, resellers and input suppliers. Hagiu and Wright (2015a) observe that professional service firms are moving away from pure vertically integrated models in which all client services are provided by their employees (e.g. traditional staffing agencies, consulting firms and taxi companies), and towards the MSP model, in which they enable independent contractors or professionals to deal directly with clients (e.g. Elance–oDesk, the Gerson Lehrman Group, and Uber). The authors examine the economic trade-offs in the enable (MSP) vs. employ (VI) decisions, where the MSP mode involves contractual relationships between buyers and professionals, to which the focal firm is not a party, but merely an enabler of those contractual relationships. Their research highlights the trade-off between the need to coordinate decisions that generate spillovers across professionals (best achieved by a vertical

integrated firm) and the need to both motivate unobservable effort by professionals and ensure professionals adapt their decisions to their private information (best achieved by an MSP).

Other economic trade-offs are faced by an intermediary choosing whether to be an MSP marketplace or a reseller (Hagiu and Wright 2013; Hagiu and Wright 2015b). In addition to trade-offs, tensions also arise between operating as an MSP and/or as an input supplier. For example, in the personal computer market, Apple produces its own hardware, and manages a two-sided platform between consumers and software providers. By contrast, Microsoft contracts with independent manufacturers for hardware, and manages a three-sided platform between consumers, software providers, and hardware providers.

The research on MSPs covers three streams of literature that examine how MSPs address market inefficiencies due to information imperfections. The first stream focuses on auction design. Using eBay data, Tadelis and Zettelmeyer (2015) find quality rankings of cars helpful because buyers are heterogeneous in their demand for quality, whereas Lewis (2011) examines the level of disclosure in eBay's market for used cars. Given the low number of buyers that typically bid on eBay, Yin (2007) analyzes whether prices converge on the true common value of a good, and finds that there is only partial convergence and underpricing remains.

The second stream examines reputation systems. Dellarocas (2003) views a reputation system as a way to mitigate information asymmetry. Elfenbein et al. (2015) find positive effects for "reputation badges" on eBay. Hui et al. (2016) show that the addition of eBay's buyer-protection policy gives buyers more confidence to make purchases and serves to discipline sellers. Solutions to the problems of information imperfections are technical solutions. However, technical solutions can be compromised when sellers manipulate their reputations by paying

buyers for positive reviews. Li et al. (2020) find that only high-quality sellers, not low-quality ones, pay buyers for reviews, based data from Taobao.

The third stream studies opportunistic behavior of platform users. False information is a common problem, as Tadelis (2016) reveal in his review article about the design experimentation, trial and error, and the cat-and-mouse game that platforms must play against users who continuously try to game the system. For example, sellers have a litany of ways to cheat buyers on eBay (Gavish and Tucci 2006); 16% of restaurant reviews on Yelp are fake and the number is growing (Luca and Zervas 2015).

FRAMEWORK: DESIGN SOLUTIONS FOR MARKET IMPERFECTIONS

How should market imperfections be solved? Experts within the fields of economics, law, and policy disagree about the appropriate design solutions to market imperfection problems (Oberholzer-Gee and Yao 2018: 469). The debate centers on what and how additional information should be provided to reduce information imperfections (Fung et al. 2009). For the purposes of our analysis, we focus on exchange imperfections, especially incomplete information (i.e., the problem of finding buyers and sellers) and asymmetric information [the classic "lemons" problem identified by Akerlof (1970)]. Incomplete information results in search costs. When buyers fail to find sellers (and vice versa), market failure occurs. Asymmetric information causes the price a buyer is willing to pay to decline. When sellers withdraw from a goods market because buyers anticipate *ex ante* misrepresentation by sellers, market failure occurs. Solving these problems requires locating buyers for sellers (and vice versa) and ensuring quality of both sides.

Two types of "market makers" solve exchange imperfections along a value chain

Given the possibility for information imperfections on both buyer and seller side, we separate the two solutions. This corresponds with the distinct activities that firms perform to address these very different problems and constituents. For example, while credit card companies are typically modeled as operating a single platform (e.g., Rochet and Tirole 2003), in practice, servicing credit card customers involves very different activities and costs than servicing merchants. We, therefore, decompose the two functions. Meanwhile, we are agnostic about whether the problem is information incompleteness or information asymmetry.

Fulfilling these two roles are *Aggregators* who attract and assure buyers and *Convenors* who attract and assure sellers. Aggregating is a valuable function because it allows sellers to easily locate and sell to customers. Convening is valuable because it helps buyers easily locate and purchase from trusted sellers. Aggregators and Convenors may have to address incomplete information, asymmetric information, or both. These functions are arranged vertically in a value chain as shown in Figure 1.

Figure 1: A value chain of information intermediaries addressing exchange imperfections

Buyers (B) –Aggregators (A) –Convenors (C) – Sellers (S)

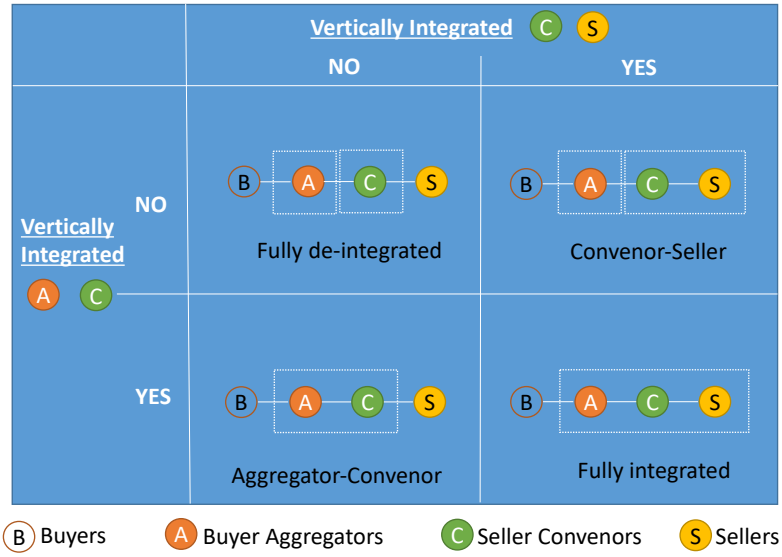
In our model of a value chain, buyers (B) are separated from sellers (S) by information imperfections. In order for a market to occur, the information imperfection must be reduced enough for buyer-seller transactions to take place. Any of the actors in the value chain can engage in imperfection-reducing activities, which are always costly but can be profitable. For example, sellers can invest in a brand, which reduces information asymmetry and assures buyers

of quality. Aggregators could interface with buyers to reduce help sellers find buyers, thus reducing incomplete information.

Strategic opportunities can be identified through this decomposition of the value chain. For example, a department store convenes sellers and solves both types of information imperfections. First, it gathers goods from a variety of sellers into one place, reducing information incompleteness. Second, it carefully selects the goods for a certain quality level that buyers will expect, reducing information asymmetry. If sellers invested in their brands, this would further reduce information asymmetry or reduce the need for the department store to do so. The department store also performs some aggregation activities, such as advertising to customers to draw them into their stores. However, because its Aggregation is imperfect, there is an opportunity for a mall operator to engage in aggregation.

Within this value chain structure, a variety of vertical integration options are possible. A Convenor could vertically integrate backward into Sellers, a Convenor could vertically integrate forward into an Aggregator. All three could vertically integrate, or none might integrate. These four possibilities are arranged in a 2x2 matrix in Figure 2.

Figure 2: Taxonomy of vertical integration options for buyer-seller value chain



This taxonomy helps clarify why MSPs have succeeded so well in addressing information imperfections. The lower-left Aggregator-Convenor cell brings both functions into a single firm. These are the MSPs that are most extensively studied in the literature, such that the two distinct activities are regarded as a single activity. But the upper left, fully de-integrated cell could involve two MSPs, each addressing a different information imperfection. The lower right hand side of the taxonomy vertically integrates the Aggregator, Convenor and Sellers and so could not involve an MSP. The upper right hand cell involves integrating Convenor and Seller, which cannot be an MSP, but the Aggregator could be an MSP.

These cells can be used to compare different value chain structures. Is the Aggregator-Convenor more efficient than a fully integrated value chain? The performance of value chains can be assessed and compared in terms of market-quality variables. Three such variables are price transparency, price stability, and liquidity or availability. The taxonomy also guides us to

imagine counterfactuals, whether to imagine a strategic opportunity or to create a better market than currently exists.[1]

Some examples illustrate how our taxonomy can be used. In the market for automobile tires, a seller's reputation for quality reduces information asymmetry for a product whose underlying quality cannot directly be observed. Goodyear's reputation, for example, earns higher premiums than competitors. Uniroyal, a rival with a weaker brand, took a different strategy. It helped develop tire grading standards for regulators, so that its tires ranked among the top. Uniroyal then launched a campaign to advertise its high rankings (Oberholzer-Gee and Yao 2018). If sellers invest less in their brands, the burden of mitigating the lemons problem may fall to Convenors. If tire brands were to dilute their reputations with low-quality products, a role for a Convenor would arise, in performing the careful selection for high quality that would provide buyers with sufficient information about quality.

Identifying weaknesses in the value chain can also be imagined in the taxi industry. Before ride-hailing services came to dominate the hired ride industry, dispatch services acted as Convenors to bring taxis together loosely. But there was virtually no Aggregator in this market to bring riders together. Taxis therefore frequented high-traffic, high-demand areas to take their chances individually. Seeing an opportunity in creating an Aggregator role and improving the Convenor role, app-based ride-hailing services entered and quickly dominated the industry as Aggregator-Convenors.

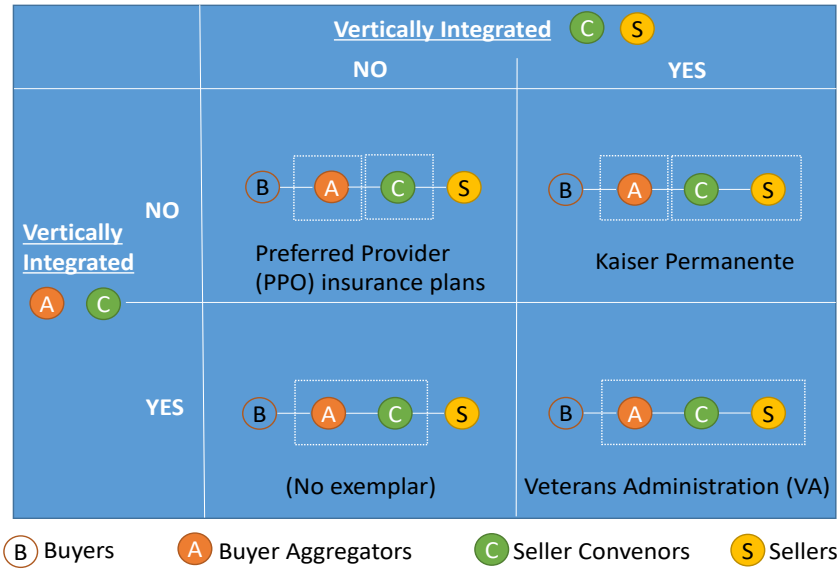
[1] Herbert Simon (1996: 111, 114) famously argued that to design is to devise "courses of action aimed at changing existing situations into preferred ones". Whereas natural sciences "are concerned with how things are," design is concerned with "how things ought to be."

APPLICATION: HEALTH CARE

In addition to the ability to identify strategic opportunities, our analysis also presents opportunities for assessing the quality of the markets that MSPs produce and trace quality outcomes back to the incentives to produce various dimensions of quality. For example, Kuan and Lee (2021) argue that a social network might choose a low-cost governance strategy, resulting in low-quality discourse and information. Meanwhile, Diamond and Kuan (2018) show that ownership and incentives predict governance strategy and thus the market quality of an MSP. Diamond and Kuan (2018) also suggest measures of quality, since MSPs can be the organizational form underlying a market: price stability and transparency, and "liquidity" or availability.

Our taxonomy also presents the opportunity to imagine options that are currently non-existent or counterfactual. Just as the decomposition of the value chain identifies entry opportunities, so too does the taxonomy identify empty cells. In this section, we apply the taxonomy to a notoriously dysfunctional and inefficient market in which firms and policymakers alike are actively experimenting and seeking solution: healthcare. Figure 3 provides exemplars, with the caveat that subtleties and variations can deviate from the extreme, stylized form of the taxonomy. We note that three of four cells are occupied by firms serving a variety of healthcare consumers and we imagine how the fourth, currently unoccupied cell, might emerge.

Figure 3: Taxonomy of value chains and exemplars



1. Fully de-integrated

In the top left quadrant, firms that aggregate, convene and sell goods or services operate at arms-length. In the healthcare value chain, Aggregators include employers who offer their employees a selection of health plans from which to choose, but also include state-operated "exchanges" where individuals can find a menu of insurance plans. Convenors in this context are insurers who negotiate services and prices with a set of sellers, offer a menu of sellers and services to Aggregators, and handle payment to sellers. Finally, Sellers are healthcare providers like physicians, hospitals, etc.

While the market can generate high-powered incentives for firms that must compete for customers on quality and service, the industry has evolved such that consolidation has concentrated bargaining power at the Seller and Convenor level, minimizing incentive power.

Hospitals and physician groups have merged so that in many large markets, only one or two Seller entities remain. Similarly, insurers have struggled to remain competitive in many regions, reducing choice, often to a single Convenor. This consolidation can, in some cases, be attributed to the propensity for monopoly of MSPs, i.e., the winner-take-all outcome. Insurers are MSPs serving employers on one side, and healthcare providers on the other. Similarly, healthcare exchanges are MSPs, serving insurance companies on one side and small businesses or individuals on another.

The low-powered incentives of the resulting small-numbers bargaining game are problematic for market quality, as measured by price stability and transparency. A federal rule that took effect January 2021 requires hospitals to reveal their prices, which they have fought to keep secret. These recent pricing disclosures show substantial price discrimination, sometimes by an order of magnitude, such as $6241 and $60,584 for the same procedure (a C-section) at the same hospital (Mathews, McGinty and Evans 2021). Prices are negotiated by Convenors, in this case insurers including public insurers like Medicaid and Medicare, and Sellers, and these prices are crucial to competitiveness for both parties. That is, both parties have an incentive to keep information private. This lack of price transparency extends to Buyers, in this case patients, who cannot observe prices and make decisions based on price. Thus, Aggregators are unable to reduce costs, with Buyers unable to choose cheaper options.

2. Convenor-Seller

The upper-right quadrant, Capitation, is a business model that seeks to address the problem of incentives. Fuchs (1974) observed a conflict of interest at the heart of increasing healthcare costs, namely that doctors are paid for the services they prescribe. Only doctors have the expertise to

diagnose a problem and prescribe a treatment—patients are generally unable to perform either function—and are therefore unchecked in prescribing costly activities, which patients feel compelled to undertake and pay for. A remedy for this is to incentivize doctors and other healthcare providers to optimize the cost and quality of patient care. Charging patients a fixed fee for healthcare eliminates the doctor's incentive to over-prescribe unnecessary treatments—doing so would only eat into the doctor's profit from that patient.

This research led to experiments in healthcare management organizations (HMOs), most notably Kaiser Permanente, a large hospital chain that sells its services for a fixed fee to employers and individuals and thus performs the insurance and payment function of the Convenor, but because Kaiser hires doctors and operates its own hospitals, it vertically integrates backward into the Seller function.

The quality of the resulting market in terms of price stability and transparency, and liquidity is driven by the incentives of HMOs. Costs and how the HMO makes profits are private competitive information for the HMO. Thus, prices are all but eliminated, with costs associated with patient care are controlled by the HMO by restricting output. Because the HMO's incentives are designed to control cost and reduce consumption, HMOs use primary care physicians as gatekeepers to higher-cost specialty care. Moreover, output can be restricted through long wait times, which are long a complaint of HMOs. In short, price transparency and liquidity are problematic with HMOs and are driven by the incentives of the HMO business model.

3. Fully integrated

A somewhat similar alternative to the de-integrated model is the single-payer model, which can be observed in the Veteran's Administration (VA). The VA system provides all US veterans with

free healthcare services using facilities that are owned by the VA and personnel who are employees. That is, the VA is an Aggregator, identifying and including a set of Buyers, in this case veterans, but also performs the Convenor role covering costs, as well as the vertically integrating into the Seller role.

Here, again, prices are completely hidden to patients. All patient costs are covered by the VA. Rationing occurs through the restriction of output. Excessively long wait times to access care led to a Congressional uproar and measures requiring the VA to reimburse veterans for when they go to a non-VA private physician. Thus, as with Capitation, price transparency and liquidity are problematic. The VA faces an additional challenge in terms of governance that for-profit firms do not face. Problems of quality have to be addressed through government action rather than allowing the VA to be disciplined by competition the way Kaiser is.

4. Aggregator-Convenor

How might an efficient market be generated instead? What industry structure and organizational form are involved in a solution? In the lower left quadrant of the taxonomy, a single firm integrates the Aggregator role with the Convenor role. This is not so unusual a solution as the MSP literature largely assumes the vertical integration of these two roles. In this context, it combines the insurer role, which is an MSP, with the Aggregator role, which can be an MSP as well (e.g., government healthcare exchanges).

A single MSP could strategically choose to make prices stable and transparent and create incentives to increase liquidity. Price stability and transparency are a hallmark of MSPs, with posted prices that sticky. Grocery stores are careful to honor posted prices at the checkout counter and prices for consumer goods have remained remarkably sticky (cite?) such that

manufacturers reduce the volume of a tube of toothpaste rather than increase its price. But MSPs can incentivize availability or liquidity, by managing supply chains to prevent stock-outs or encouraging entry.

Thus, a healthcare MSP could make information about Sellers available to Buyers, including through the posting of prices and payment for services. Rules could govern how frequently posted prices change, thus bringing stability to prices. And liquidity could be increased by promoting entry and the retention of Sellers in the market.

How might an MSP enter an industry structure rife with consolidation and market power? One possibility is for existing Aggregators to vertically integrate into the Convenor role. Employers could create an MSP using funds currently allocated to paying Convenors. Because one MSP could serve multiple Aggregators, Aggregators could collectively organize the MSP, thus increasing the quality and reducing the cost to each Aggregator.

To illustrate, we propose the large employers in Seattle collectively organize an MSP. Amazon, Boeing, Costco, Starbucks, and Microsoft, all behemoths from different industries, employ most of the region's highest-paid, most sought-after Buyers of healthcare. Each large firm is thus an Aggregator, one of which, Amazon, has sought to change how healthcare is organized. Hence a demonstrated appetite by large employers to find a solution to a costly and vexing problem. Instead of paying a Convenor, or insurer, these Aggregators build an MSP. Sellers, who are currently consolidated, would resist disclosing prices. Therefore, only a collective action by big Aggregators is likely to permit entry by such a new and disruptive MSP. However, the existing industry structure has been damaging to Sellers, with physicians retiring in droves because of burnout from the lack of control over the practice of medicine imposed by the

existing incentives. The possibilities of creating an efficient market using MSP theory are significant.

DISCUSSION

The research on MSPs has contributed analyses of how MSPs address market inefficiencies due to information imperfections. However, how MSPs produce and disclose information as information intermediaries has not been connected to the research on market imperfections. The connection we forge between the two bodies of research contributes a cross-fertilization that brings improvements to each body.

Contribution to the research on market imperfections

To the research on market imperfections, we contribute a taxonomy where a value chain between buyer and seller has two types of market-making information intermediaries. We arrive at the taxonomy be decomposing the buyer-seller value chain. Along the value chain, the two types of market-making information intermediaries are "aggregator," who solves buyer-side problems, and "convenor," who solves seller-side problems. The then use the decomposition to articulate how problems of information imperfections can be solved and how problem solving can be allocated across the value chain.

Moreover, the market-making information intermediaries are two-sided. So, we also use the decomposition to explain what entry opportunities are available for an MSP to dis-intermediate and re-intermediate buyers and sellers. Therefore, the taxonomy we contribute presents ways to bring MSPs into the mix of design solutions for market imperfections. As we

mentioned earlier, MSPs are strategically important and economically important. Yet, MSPs have not be incorporated into the research on market imperfections.

We also contribute an explanation for how organization design is connected to market design. Marketplaces can be designed by firms. Firms design markets by making designs about designing MSPs. There are four categories of decisions in designing MSPs, as argued in Hagiu's taxonomy of platforms (2014): (1) the number of sides a platform serves, (2) design, which includes features and functionality, (3) pricing, and (4) governance. Our taxonomy of vertical integration options for buyer-seller value chain, as presented in Figure 2, articulates which market makers are served by the same firm. In some cases, the firm serving as market makers is an MSP. In other cases, they are not. Put differently, some design solutions for mitigating problems of information imperfections involve MSPs, but others do not.

The two types of market makers that we analyze in this paper complement the four characteristics submitted by Tajedin, Madhok, and Keyhani (2019) about "digital firm-designed markets": basis of coordination, basis of adaptation, approach to knowledge constraints, and role of authority.

Contribution to the research on MSPs

To the research on MSPs, we contribute an explanation for why there are opportunities for MSPs along the buyer-seller value chain. In offering an explanation, we raise the question: is there an opportunity for MSPs at all? This question is the heart of *residual market imperfections*. More specifically, we ask: Are there imperfections that persist in spite of competition among firms and government intervention? Are these imperfections profit opportunities for aggregating and

convening? Our taxonomy emphasizes where along the buyer-seller value chain there are opportunities for MSPs.

Asking these questions allows us to contribute an analysis that extends the pairwise comparisons in the literature, which poses MSPs an alternative to vertically integrated firms, resellers and input suppliers. In our analysis, MSPs represent one part of the design solutions, not an alternative by itself. Some of the design solutions we analyze do not involve MSPs at all. Using our taxonomy, we can compare vertical integration options. As we mentioned earlier, a Convenor could vertically integrate backward into Sellers, and a Convenor could vertically integrate forward into an Aggregator. Our comparison highlights that a firm can design marketplaces, and such design is not limited to a choice between MSP and an alternative. The design is to choose a vertical integration option. As such, we can compare the same MSP that changes its design over time such as Amazon Retail vs. Amazon Basics where the latter vertically integrates backward into Sellers.

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