Information

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The amount of information that different market participants possess can have profound impacts on market prices, product quality, levels of output and the organization of firms.[1] Information can also impact the optimal decisions of competition authorities and other regulatory entities.

Information is a valuable resource; nonetheless, rational decision-makers (e.g., consumers, firms, and regulators) frequently make decisions in the absence of full information. This is because some information may be unobtainable, and information that is obtainable is generally costly to acquire and disseminate. For context, consider a consumer who is interested in purchasing a product, but owing to uncertainty about the prices or qualities offered by different sellers, must expend time and effort to learn the prices and/or qualities of different firms. Rational consumers typically stop short of visiting each seller before purchasing: Eventually, the marginal benefit (in terms of expected savings or quality improvements) of gathering information from another seller is small compared to the costs of gathering information. Likewise, because it is costly for firms to disseminate information about prices and product characteristics, rational firms typically do not spend exorbitant sums on advertising campaigns designed to disseminate information about each and every product characteristic to each and every potential consumer.[2]

Several corollaries follow from these observations. First, because it generally would be prohibitively costly for a firm to disseminate every bit of information about a product that might potentially interest consumers, and prohibitively costly for consumers to process all such information, it is rarely the case that perfect disclosure is in the best interest of consumers and/or firms. Second, because rational decision-makers typically make economic decisions in the absence of perfect information, *ex post* decision errors frequently arise from optimal *ex ante* decisions. Such errors need not imply the decision-making process was flawed. The classic example is insurance: The fact that a homeowner did not file an insurance claim does not mean

[1] *See* Chapter 12 of Baye and Prince (2022) for an introductory treatment of the economics of information.

[2] Optimal search may be sequential search (in which case the buyer visits a seller and purchases from it if the expected benefits of sampling another store are less than the expected cost, and otherwise does not purchase and samples another store), fixed sample size search (where a buyer commits in advance to visit a fixed number of stores and purchases from the one offering the best price/quality), or a combination of both of these types. *See* Morgan and Manning (1985).

she made a mistake by purchasing insurance in the first place. As another example, consider the decision errors associated with a competition authority's decision to block a merger or to allow it to proceed. Essentially, such a decision-maker is considering two hypotheses: The null hypothesis that the merger is not anticompetitive, and the alternative hypothesis that the merger is anticompetitive—that is, it will raise prices, reduce output, and/or reduce quality. Thus, the competition authority is vulnerable to two types of decision errors. The first is the so-called *Type I error* (or false positive): Blocking a merger when the null hypothesis is true—that is, blocking a merger that is pro-competitive or benign. The second is a *Type II error* (or false negative): Not blocking a merger when the null hypothesis is false—that is, allowing an anticompetitive merger to be consummated. With uncertainty, both types of errors are possible when employing an optimal decision-making process; hence, the realization of either outcome does not necessarily indicate that the competition authority's decision-making process was flawed.

For information to be economically material to a given decision, it must impact the decision; that is, it must induce the decision-maker to make a different decision with the information than she would make without it.[3] The *value of information* in this context is the change in the decision-maker's welfare (in dollars) that arises as a result of her making a different decision with the information than without the information.[4] By way of example, if a consumer's binary decision to purchase a frozen turkey is not influenced by information about the color of the turkey's feathers, that information has zero value for his purchase decision. Intuitively, the consumer would be willing to pay zero for this information in advance of purchasing a turkey. In contrast, if (in the actual world) a consumer paid Firm A $20 for a product but would have paid Firm B $8 for the same product in a "but-for" world where she knew both firms' prices in advance of purchasing, the value of the (price) information is $12. Intuitively, the consumer would have been willing to pay up to $12 for this information in advance of purchasing the product from Firm A at $20.

The degree of information in the marketplace has important implications for competition and antitrust policy, as well as for consumer protection. We next discuss how the information available to market participants impacts whether a horizontal merger is likely to harm competition through adverse horizontal or coordinated effects. Consider a scenario where firms in the relevant market sell similar products. As a general matter, a lack of price transparency may result in *search frictions*, *switching costs*, and other *transaction costs* that give sellers some degree of market power. Intuitively, in this environment a firm may be able to raise its price

[3] *See* Rose (1999, p. 16), who states: "The value of information is zero if information procurement does not result in the choice of a different action." For a review of relevant literatures, *see* Baye, et al. (2003, 2006).

[4] A decision-maker's welfare depends on the relevant objective function. When the decision-maker is a consumer, welfare depends on his or her utility function (or preferences); when the decision-maker is a competition authority or regulator, welfare depends on the objective of that entity (e.g., maximizing social welfare, consumer welfare, or more cynically, the welfare of special interest groups).

above cost because it is costly for consumers to respond by identifying a lower price and/or switching to an alternative seller. In contrast, when both consumers and firms are well-informed about all prices in the marketplace and switching costs are low, a firm that attempted to charge a price significantly above relevant costs would risk losing customers to rivals. For this reason, transparent price information in markets where three or more firms sell similar products and switching costs are low tends to mitigate concerns about adverse horizontal effects from mergers, as even post-merger, consumers can easily identify and switch to the lowest-priced firm. However, this same informational structure may raise concerns about coordinated effects, as price transparency allows firms to easily identify and punish competitors who deviate from a collusive agreement. Conversely, when prices are not transparent and it is costly for both consumers and firms to observe prices, a competition authority may be less concerned about coordinated effects but more concerned with the horizontal effects of a merger.

Effects related to these *horizonal* and *coordinated* considerations can also arise outside of a horizontal merger context. To be concrete, consider an auction. An auction is an environment where potential buyers (or sellers) submit bids indicating the amount they are willing to pay to buy (or accept to sell) an item. For example, in a Federal Communications Commission (FCC) spectrum auction, the highest bidder wins the right to exclusively use a band of spectrum for private use, such as providing cellular services. Likewise, state highway departments often procure services through auction; in this case, the contractor bidding the lowest price for the specified product wins the contract.

Auctions tend to be efficient mechanisms in environments where it is inefficient to "divide" the item and the seller (buyer) has significant uncertainty about the value of the item to individual buyers (sellers). Returning to FCC spectrum auctions, participating firms have an idea about their valuation of the spectrum rights but face considerable uncertainty about the valuations of competing bidders. The FCC uses auctions not only because it is uncertain about valuations, but also because of inefficiencies associated with divvying up an available band of spectrum into smaller and smaller bands to sell to many buyers.[5] Generally, the welfare of the seller (or the buyer in a procurement auction) increases with the number of bidders.

The information available to bidders also impacts the expected amount received by the seller (or the expected amount paid by the buyer in a procurement auction). For example, when bidders are imperfectly informed about the value of an item that has a *common value* (or alternatively, when values to individual bidders are *correlated* across bidders), rational bidders shrink their bids to avoid the *winner's curse*.[6] Since auctions tend to be more competitive when

[5] For example, signal interference on adjacent bands could result in performance (and hence, value) degradation.

[6] The winner's curse arises because the winner of a common (or correlated) value auction has the most optimistic estimate of the item's true value. If bidders' value estimates are correct on average, a bidder who bids based purely on his value estimate and wins the auction will therefore end up paying more

bidders are well-informed, one might speculate that a seller (e.g., the FCC in a spectrum auction) would benefit by providing as much information as possible to bidders. Indeed, in early FCC spectrum auctions, the FCC posted the bids and identities of bidders at each round of bidding, allowing bidders to increase bids based on the observable information. While this and other information disclosed by the FCC could theoretically increase bids[7], there is a Catch 22: Providing information to bidders about the actions of competitors can facilitate collusion. Bajari and Yeo (2009) provide empirical evidence that the transparent nature of rivals' bids in early spectrum auctions made it easier for bidders to tacitly collude by permitting them to readily identify "cheaters" and punish deviators, and that these "coordinated effects" were significantly mitigated when the FCC stopped providing this information to bidders.

Thus far we have primarily focused on how the *level* of information can impact competition. How information is *distributed* among market participants—namely, the degree of asymmetric information—is also important. The impact of information on competition frequently depends on whether there is *symmetric information* (in which case market participants are symmetrically informed or uninformed) or *asymmetric information* (some market participants are better informed than other participants). As is the case with information generally, there can be degrees of asymmetric information.

Information can be asymmetric because some participants have *hidden characteristics* that they know but are unknown to other market participants. The classic example, attributable to Akerlof (1970), is a used car market in which sellers of cars are informed about their vehicle's quality but buyers are not. In this case, market participants have asymmetric information about the quality of each car being sold. To see how asymmetric information impacts market outcomes, suppose the average car in the market (based on its quality) is worth $10,000. One might reason that in a competitive market, the average price of a car would be $10,000. This reasoning is wrong. If the price were $10,000, only sellers of "lemons" would be willing to sell their car at such a price; sellers of high-quality cars worth, say, $20,000, would not. Hence, a $10,000 market price attracts only sellers with cars worth less than $10,000, so the average car in the market is worth less—say, $5,000. But if we continue this reasoning and surmise that the competitive price must be $5,000, only people with cars worth less than $5,000 are willing to sell at that price, again leading to the average car in market being worth less than $5,000. Following the logic of this "unravelling" to its conclusion, the only equilibrium involves no used cars being sold. This problem—called *adverse selection*—arises because any putative

than the item is actually worth. Rational bidders therefore shrink their bids to avoid this "winner's curse."

[7] This would be the case if such disclosure mitigated the "winner's curse" and/or information revealed by the FCC was statistically "linked" to bidders' value estimates. For a discussion of the so-called *linkage principle*, *see* Milgrom and Weber (1982).

competitive price attracts (or *selects*) only sellers with *adverse* hidden characteristics (e.g., low quality cars).

One doesn't have to look hard at the real world to recognize that used car markets are alive and well, thanks to a variety of competitive solutions to the so-called "lemons problem." Some companies specialize in inspecting used cars; car dealers have strong incentives to establish a reputation for selling peaches instead of lemons. And dealers often offer money-back guarantees and/or certify the quality of their used cars. More broadly, many online platforms (including eBay) mitigate adverse selection problems by investing in reputation systems (to rate sellers) or by providing buyers with "money-back guarantees." In markets with severe adverse selection problems, the realization of economies of scale or scope in these and other institutional investments (and hence, larger sized firms or platforms) may be necessary to overcome adverse selection problems that would otherwise arise in highly fragmented markets with numerous small sellers.

Hidden actions are another type of asymmetric information that can impact resource allocation. The classic example is Holmström (1979), who considers an environment where the owner of a business (the *principal*) hires a manager (the *agent*) to oversee business operations. There is separation of ownership and control; that is, the principal is not physically present to observe the effort of the agent. In addition, the firm's profits are subject to random shocks (e.g., demand fluctuations) that prevent the principal from ascertaining whether, say, unusually low profits are due to bad luck or shirking by the agent. Because the agent's effort is hidden from the principal, this environment is vulnerable to *moral hazard*—the agent has an incentive to take a hidden action (shirking) that benefits the agent at the principal's expense.

In practice, it can be difficult for regulators to remedy market imperfections arising from imperfect and/or asymmetric information because regulators lack the full set of information needed to induce efficient outcomes. Consequently, optimal regulatory policies must consider both the expected benefits and costs of regulatory solutions, including Type I and Type II errors. Additionally, as discussed below, market solutions to these and other information problems may have features that are at odds with regulatory objectives. In these instances, it is important for regulators to use relevant but-for benchmarks instead of comparing market outcomes to unattainable "perfect information" benchmarks.

Consider a common solution to the principal-agent/moral hazard problem: An *incentive contract* that links the agent's unobservable effort to an observable measure of performance that the agent can influence. The classic example of an incentive contract is payment via commissions, which links a salesperson's compensation to measurable sales, which depend upon the salesperson's unobservable effort. The idea is that a hefty sales commission (say, 30 percent) provides the salesperson an incentive to work hard to increase sales, and but-for the commission, sales (and output) would be lower because of the salesperson's incentive to shirk rather than work hard. In this case, the 30 percent commission in the actual world results in greater output than in the but-for world without the commission.

Or consider *price signaling*, where a firm signals that its product is high quality by charging a high price. For a high price to credibly signal quality (and hence, provide the firm an incentive to produce a high-quality product in the first place), it must be the case that a firm selling a low-quality product cannot profitably mimic by charging a high price for a low-quality product. As a general matter, this requires some sort of asymmetry between the two firms—for instance, the high-quality firm being larger and enjoying economies of scope or scale that the low-quality firm is unable to achieve.

Notice that these two strategies—commissions and price signaling—are competitive solutions to asymmetric information problems: But-for high commissions, output would be lower; but-for the ability of the high-quality firm to charge high prices to signal its high quality, quality would be lower.

More broadly, firms, managers, owners, shareholders, and even regulatory bodies are "principals" who typically operate in asymmetric information environments. They rely on various "agents" to act on their behalf. As discussed above, a large organization may be necessary to achieve the scale or scope required to establish, create and/or implement mechanisms that solve asymmetric information problems. Firms may also attempt to solve these problems via behaviors (e.g., high commissions to induce efficient effort or high prices to signal quality) that might seem inherently suspect when viewed through a lens of perfect information. In some instances, efficient (output or quality-enhancing) solutions to informational asymmetries may require a manufacturer to resort to agreements with retailers (e.g., slotting allowances or resale price maintenance[8]) or to vertically integrate (the most exclusive of all "exclusive contracts") to overcome informational and/or agency problems. In these instances, regulating prices or the terms of incentive contracts—or preventing a vertical merger—may adversely impact market prices, output and/or quality by interfering with effective market solutions. Because regulators have asymmetric information (and hence, may be uncertain whether troubling behavior reflects the naked exercise of market power or pro-competitive responses to informational asymmetries), both Type I and Type II errors are possible.

In concluding, we note that more recent economic research has focused on how *information gatekeepers* (Baye and Morgan 2001) and other *platforms* operating in two-sided markets impact competition and the welfare of market participants in environments ranging from online shopping (Brynjolfsson, et al. 2003) and auctions (Bajari and Hortaçsu 2004) to crowdsourcing (Belleflamme, et al. 2015) as well as privacy (Acquisti, et al. 2016). As Goldfarb and Tucker (2019) note, the *digitization of information* has profoundly changed access to information. But the economic factors at play and discussed above have not changed.[9] By way of example, digitization and tracking have made it easier for firms to obtain the information necessary to

[8] *See* Klein (2009).

[9] *See* Chiou, et al. (2022) for a discussion of digitization in the context of merger policy.

engage in price discrimination, but this has not fundamentally changed how economists evaluate whether price discrimination results in competitive harm.

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