Price Transparency in Health Care: Impact, Impending Transformation, Competition Strategy, and Policy Implications

Hemant K. Bhargava, UC Davis

December 10, 2019

We are at the edge of an imminent massive transformation in an industry sector that accounts for about 20% of spending today, namely health care. This transformation will occur on account of emerging technologies for price transparency which will give decision-making stakeholders (e.g., patients and their advising physicians) timely access to accurate and personalized information about costs of care. Price transparency technologies are (and will be) as revolutionary in health care as Google and Amazon have been to shopping in general. While these technologies are motivated by the pressing need to reduce health care spending through price competition and reduction in market prices, these effects are by no means guaranteed. Achieving them will require careful design and implementation, but also prudent management and regulation that reflects an understanding of how market forces will interact with price transparency technologies to cause transformation in the nature of insurance plans, quality and variety of products and services, and business models and competition within price transparency technologies.

Keywords: health care, drug price transparency.

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1 Introduction

Information technologies—and information—have deeply transformed firms, markets and industries, over and over again (Malone et al., 1987; Brynjolfsson and Saunders, 2009). Examples of substantial transformation include retail, travel and banking. Technology transforms how goods are made and exchanged, how they are priced, what goods are made and where they are sold, who the winners and losers are, and the industry structure itself. Not surprisingly, major transformations are accompanied by voluminous research, often on assessing the impact of technology, the nature of transformation, and attribution of effects. For instance, it took three decades of research to understand and settle the effect of IT at the individual, firm and economy levels (see e.g., Brynjolfsson, 1993; Mithas et al., 2012). This kind of research, although extremely valuable and insightful, is predominantly backward-looking. Similarly, although technology-driven transformation creates new winners and losers and disrupts existing industry structure, there is a substantial time lag in understanding these effects and in designing suitable regulations (Reins, 2019).

We are at the edge of an imminent massive transformation in an industry sector that accounts for about 20% of spending today, namely health care. This transformation will occur on account of *price transparency* (explained in §2 and illustrated in Table 1), a concept that is simple and yet radical in the context of health care where consumers must routinely make decisions while blind about the prices they would pay. The aim of price transparency is that decision-making stakeholders (e.g., patients and their advising physicians) have timely access to accurate and personalized information about costs of care.[1] In the US, such transparency is being created due to a mix of entrepreneurial activity and emerging technologies (e.g., dedicated "search engines" such as TrueView, Gemini Health, CashMD which provide *ex ante* information about prices, products, and providers), cross-provider data exchange and app technologies (e.g., PokitDok), industry consortia (e.g., the Surescripts alliance for medications), federal government mandates,[2] and actions by indi-

[1] Our primary experience and knowledge is around price transparency for prescription and over-the-counter *drugs*, a category that itself accounts for about 20% of all health care spending.

[2] Obama administration, https://www.hhs.gov/about/news/2019/11/15/trump-administration-announces-historic-

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	Drug Name	# Days	Patient Co-Pay	Total Cost
Requested:	Benicar 40mg Tablet	30	$73.72	$294.89
Alternative 1:	Olmesartan Medoxomil 40mg Tab	30	$26.45	$71.48
Alternative 2:	Valsartan 160mg Tablet	30	$1.1	$2.98
Alternative 3:	Losartan 100mg Tablet	30	$1.17	$3.16

Table 1: Example of price transparency in prescription drugs, featuring data on prices and alternative products. Prices are displayed for the "requested drug" initially chosen by the physician for a patient with hypertension, and for three additional clinically equivalent alternatives recommended by the system (in the same category, they block angiotensin-II receptor proteins), for discussion and choice between the physician and patient.

vidual states (Mehrotra et al., 2014). It takes little imagination to realize that price transparency in health care could potentially have profound and wide-ranging consequences, affecting every aspect of the industry, including but not limited to prices, price dispersion, product variety and quality, profits, new innovations, distribution of market power within the industry, etc.

The motivation and purpose of this article is threefold. First, although price transparency is likely to have profound effects, the scope and direction of these effects is debatable and unclear; in other words, price transparency will not necessarily lead to lower prices or less dispersion in prices (see e.g., Blumenthal et al., 2019). On this issue, the paper provides two sets of insights based on existing theory and past experiences: i) Price transparency will have differential impact across different spending categories in health care; we use three of these—prescription drugs, elective hospital procedures, and emergency procedures—to illustrate the different mechanisms and outcomes, ii) First-order effects of price transparency (changes in price levels, price dispersion, and spending) will likely be surpassed by second-order effects, i.e., by the strategic responses of firms in the industry to the first-order effect of price transparency (e.g., changes in product assortment, levels of customization etc.). A good understanding of these effects should help steer the design and implementation context of price transparency technologies towards positive outcomes.

Our second motivation concerns the market for price transparency technologies. While the preferred (and sensible) business model today for firms that provide price transparency is to be fi-

price-transparency-and-lower-healthcare-costs-for-all-americans.html

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nanced based on savings from price transparency (which occur to payors and patients), we identify limitations and a paradox under this model in the longer term; consequently, we propose likely directions in which the business model might and should evolve, including the potential for corruption in the functioning of these technologies. Third, again based on theory and past experiences in the transformative effects of information technology, we explore the realignments in market power that might occur on account of these technologies; it behooves us to anticipate, predict and plan for these transformations rather than merely wait to assess their effects, and then regulate and reorganize. The underlying message of this article is that rather than being surprised or unprepared for significant transformation, industry leaders, policy makers, providers and consumers, should be able to anticipate, control and manage the direction and magnitude of transformation so that it can be directed towards more positive directions.

2 What Exactly is Price Transparency?

On June 24, 2019, the US President issued an *Executive Order on Improving Price and Quality Transparency in American Healthcare*.[3] With the intent of empowering healthcare patients to make well-informed decisions about their care, the order requires that patients be given information about the price of healthcare services including price comparisons for common services that are offered by multiple providers. The scope of such "shoppable" services is immense: citing the 2019 Annual Report of the Council of Economic Advisers, the order notes that 73% of the 100 highest-spending categories in inpatient care are shoppable, and so are 90% of the top 300 categories in outpatient care. This section discusses proposed regulations and their limitations (§2.1) and then offers some ideas to make the design of price transparency more meaningful, covering what information is presented and how (§2), the need for interpretation of price (and product) data jointly with trusted experts (§2.3) and the timing of price information (§2.4).

[3] `https://www.whitehouse.gov/presidential-actions/executive-order-improving-price-quality-transparency-american-healthcare-put-patients-first/`

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2.1 Regulations on Design of Price Transparency

Among the various federal and state action plans around price transparency in health care, the most notable ones are the series of actions around the so-called *price transparency rule* put out by the Center for Medicaid Services (CMS) and the Department of Health and Human Services (HHS). These include the "final rule" released by CMS in August 2018,[4] the "Executive Order on Improving Price and Quality Transparency in American Healthcare to Put Patients First" issued on June 24 2019,[5] and specification of two rules by the HHS (on behalf of CMS) on November 15 2019.[6] Under these rules, hospitals were required, beginning January 1 2019, to start publicly posting "standard charges" for all of their services. Specifications around this rule include that the data be posted on the Internet, be in machine-readable format, and be updated once a year. Moreover, the "Transparency in Coverage" rule requires insurance providers to identify clearly what services are covered and what part of costs are borne by patients as out-of-pocket costs.

These rules help make price transparency real, but the specifications also expose flaws that limit the value and positive impact of these rules. These flaws include a) lack of data currency (prices are required to be correct only once per year), b) inaccuracy and customization of data (regulations only require disclosure of list prices, which can vary substantially from actual prices charged to specific payors), and c) non-personalization of price data (i.e., it does not help individual patients identify what *they* would pay for a specific service). Besides these, two serious limitations include d) that price data for individual services is of little value unless there is also a list of competing or substitutable services and their prices, and e) that in health care, giving price (and even substitute services) data to patients is of little value because most people have no expertise to evaluate the options and choose on the basis of price and other attributes.

[4] https://www.federalregister.gov/documents/2018/08/17/2018-16766/medicare-program-hospital-inpatient-prospective-payment-systems-for-acute-care-hospitals-and-the

[5] https://www.whitehouse.gov/presidential-actions/executive-order-improving-price-quality-transparency-american-healthcare-put-patients-first/

[6] https://www.cms.gov/newsroom/press-releases/trump-administration-announces-historic-price-transparency-requirements-increase-competition-and

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The structural flaws identified in items (c), (d), and (e) above are crucial. For instance, a hospital website filled with "chargemaster" prices would create transparency but likely have little impact (Frakt and Mehrotra, 2019). Price transparency will not induce price competition when data are generic rather than personalized to individual patients, posted in silos by individual sellers, and given directly to patients. However, although these regulations are modest in their goals and inadequate in design, this should not be a reason to dismiss the idea of price transparency. Like most innovations, the present state of price transparency is only the first arrow from the quiver. Our intent below is to lay out what the future design of price transparency could or should be.

2.2 Making Price Data Useful: Accurate, Current, Personalized

A few conditions for price transparency to play a useful role in inducing price competition include being current, accurate, personalized, and being accompanied with data about substitutable alternatives. At the outset, the role of health insurance creates a need to distinguish between prices paid by patients or consumers (i.e., co-payments and other out-of-pocket expenses) and prices paid by payors (e.g., private insurance companies or government). We shall be explicit about the distinction when necessary; in some cases, though, the two can be aligned through incentives or transfer payments from payors to patients. Beyond this, the content and format of price information will have a crucial influence on its effects.

1. Price information, such as a price sheet of goods and services from a hospital, should ideally be personalized with regard to a patient's insurance plan and other contextual details. It should specify both total costs and the patient's out-of-pocket costs. Even personalized price data would have limited value unless given in a format which enables price-comparison, for instance of the same type of surgery across different hospitals or the same drug sold by different pharmacies. Inspirations and examples of actionable price information abound in other industries, as illustrated in Fig. 1a which displays prices (and non-price terms) from

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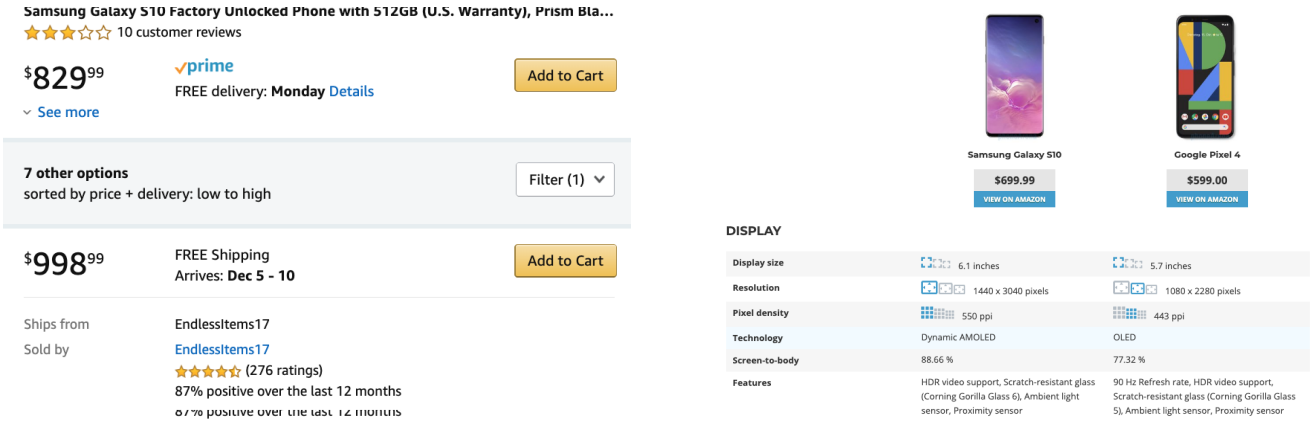

(a) Prices from different sellers of the same product.

(b) Alternative products and their prices.

Figure 1: Two alternative aspects of price transparency.

multiple sellers for the same product (Samsung's Galaxy S10 phone).

2. The value of price information is further amplified when the information also includes reasonably close *alternatives and their prices*, ideally in a side-by-side comparison. Fig. 1b illustrates this, displaying information about an alternative product (Google Pixel 4 phone) against the requested one (Galaxy S10 phone). Information about *alternatives* truly empowers the decision maker to reject the requested product based on comparative price (and feature) information.

Accordingly, we take a more expansive interpretation of "price transparency" as providing both price and product information from multiple sellers and for multiple related products, as indicated in Fig. 2. This sort of technology makes the health care marketplace more electronic by reducing buyers' search costs (á la Bakos, 1997).

2.3 Cost of Care Conversations with Trusted Experts

Shopping for health care is quite unlike shopping for a smartphone. In the latter case, most shoppers feel empowered enough to make their own decisions; even when the shopper is not an "informed expert" the cost of an incorrect choice is essentially financial. In health care, choices

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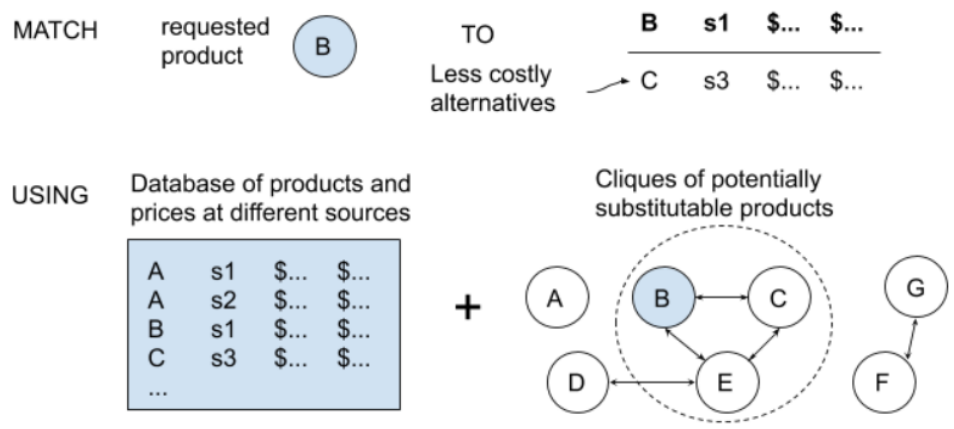

Figure 2: Price transparency mechanics. Alternative products and prices are identified through a mix of technologies including cross-industry data exchange, API calls, searchable catalogs and contracts, machine learning and human intelligence.

have more complex consequences, and hence patients have limited ability to act on information about prices or substitute alternatives. To be actionable, such information needs to be delivered in conjunction with a trusted expert (e.g., a physician) and in the correct context (e.g., a medical consultation visit to a physician). This element is missing in proposed regulations, however it has been emphasized by industry stakeholders.[7] Having the right context is especially relevant in light of recent research which indicates that price data offered directly to patients had little impact on spending (Desai et al., 2016; Robinson et al., 2017).

2.4 Timing and Location of Price Data

The format and context in which price transparency is implemented will play a key role in shaping the effects of price transparency. A final relevant aspect is defining price transparency is the timing of price information, and whether and how the shift in timing affects the decision making process. Consider the stylized sequence of steps depicted in Fig. 3. For certain services, like emergency hospital procedures, information is presently revealed between steps (4a) and (4b), *after* services

[7]See, for instance, a call for research proposals by the Robert Wood Johnson Foundation, `https://www.rwjf.org/en/library/funding-opportunities/2019/expanding-cost-conversations-between-patients-and-their-providers.html`.

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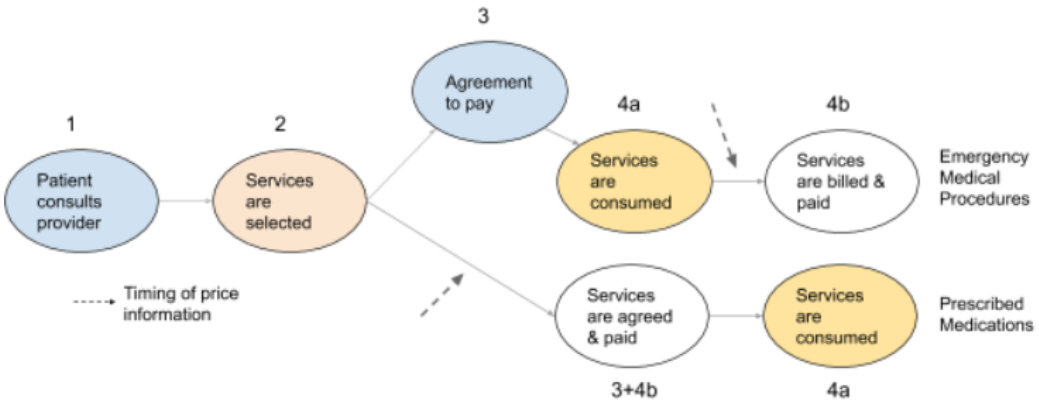

Figure 3: Timing of actions and decisions, vs. timing of price information. Prices for emergency services are usually revealed only after consumption, while drug prices can be learnt before consumption but after selection, often causing repeat consultation with the physician (the process for non-emergency services is a hybrid). Price transparency would be meaningful if it shifted the information point upstream (leftward) in a manner that affected the outcome of decision making and selection, step (2).

are consumed (i.e., they have been selected and patients have committed to pay); hence price pays little role in the decision process. For elective and non-urgent procedures, For prescription drugs (where step 4b often occurs before 4a) price information typically occurs between steps (3) and (4b) but after services have been selected in consultation with the physician. Conversely, providing price data too early (before step 1) and too broadly (i.e., for an entire list of services vs. a tiny subset that is relevant to a patient) will also be of little value. One can therefore define transparency as the revelation of price (and product) information at a sufficiently upstream step (i.e., leftward in Fig. 3 after step 2) such that it leads to a more informed decision.

3 How will Price Transparency Affect Prices and Products?

The market for health care services today is characterized by price opacity at the time of decision-making and rendering of the service, for instance in the case of hospital procedures (see Fig. 3). Numerous reports in the popular press document instances of astonishingly high prices which have stunned and frustrated health care consumers. Opacity also extends at the "product" level in the

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sense that the patient, and even the provider, cannot be sure *ex ante* exactly what services, drugs, or procedures will be needed (e.g., during a surgery). When prices are opaque and set through numerous bilateral negotiations, sellers can get away with charging different prices for the same product in different regions, through different intermediaries (e.g., insurance plans), and at different times. In health care, such differences can be wild, with a price dispersion ratio of 20:1 or even 40:1 at different times.[8] Even when price information is revealed before commitment to purchase (as with prescription drugs) thereby enabling patients to reject an expensive service, the delay in learning about prices is not costless. Patients who are concerned about medication prices and co-payments might have to re-consult the doctor to switch to a less expensive medication or, worse, choose to under-medicate by splitting pills, taking smaller dosages, or may forego the medication entirely. A recent article, based on data from the National Center for Health Statistics describes cost-related medication changes in several categories, indicating non-adherence rates as high as a third of patients in some segments (Carroll, 2019).

How will price transparency affect the level of prices and price dispersion across sellers? Intuitively, price transparency—through *ex ante* visibility and comparison—should cause a reduction in price dispersion and price levels (Bakos, 1997), and consequently a reduction in overall spending and increase in adherence rates. For instance, Wu et al. (2014) found, for MRI tests, that price transparency increased the use of less costly providers and triggered competition among them. However, as noted above, there is also evidence to the contrary, including some findings that patient groups which received price data had slightly higher levels of spending than those that did not (Desai et al., 2016). Reasons for price transparency's failure to cause lower spending include apathy, lack of incentives (e.g., patients may have zero to low co-payments even for expensive services), and perceptions that higher prices imply higher quality (Volpp, 2016). Hence, the full picture of the effects of price transparency on price levels is evidently more complex in terms of

[8]The consumer-focused website GoodRX posts price variation data at `https://www.goodrx.com/blog/most-least-expensive-cities-prescription-medications/`.

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outcomes and the mechanisms through which transparency affects prices. This part of the paper discusses these mechanisms and evaluates how they apply to health care.

3.1 Effect of Price Transparency on Consumption and Prices

A cursory analysis might suggest that price transparency would cause lower prices, because buyers will curtail consumption or switch to lower priced alternatives when facing firms that charge excessively high prices (that are known in advance). However, the direction in which price information will influence prices and consumption depends on several additional factors. One, when lack of price information was previously causing risk-averse consumers to decline a service, then the availability of price data (if prices are low enough) might cause increase in consumption of services. Second, if lack of price transparency allowed firms to price discriminate (e.g., uninsured patients often pay higher prices than insured patients or those on Medicare), then transparency could potentially increase prices by reducing sellers' ability to offer lower prices to selected customer segments. Another mechanism follows from the work of Johnson and Myatt (2006) who show that the effect of new information (e.g., about product attributes, alternatives, and prices) depends on the specific way in which it alters the demand curve; such information can lead to better matches (vs. the matches that occur with imperfect information) that are more efficient and increase total welfare but are accompanied by higher prices.

3.2 A Smorgasboard of Actors

In shopping for most conventional products, there are a few actors with clear and simple roles: a seller sets prices and gets paid, and the buyer is generally both the decision maker and payor. Price transparency and search technologies have a direct bearing on such transactions because the buying decision and outward flow of money are co-located and, conversely, pricing and inflow of revenue are co-located. The process is more complex and muddled for health care services (see

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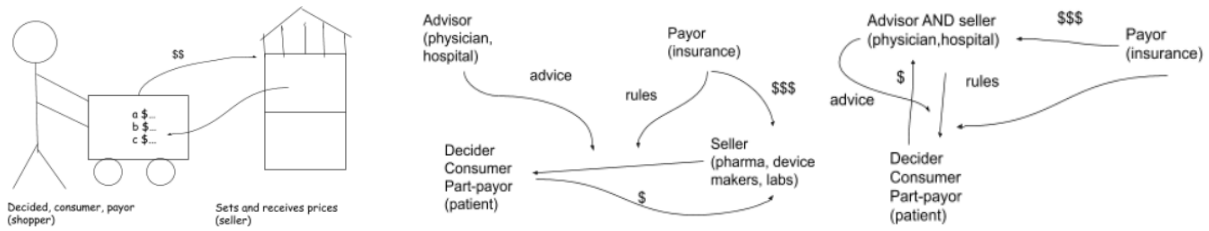

(a) General shopping. (b) Medications. (c) Hospital services.

Figure 4: Mix and role of actors in shopping for (a) general products vs. health care including (b) medications and (c) hospital services. Selling and advising roles are separated for prescription drugs, but often co-mingled for hospital services.

Fig. 4).

3.2.1 Who's the Decision Maker? Who has the Expertise?

First, decision making is shared in a complex way among multiple parties. In principle, the patient is the decision maker, however in reality the payor (private insurance firm, government, or employer) also exerts significant influence in what services are covered or allowed. More importantly, because most patients do not have sufficient expertise to form judgements about alternative care options or to make cost-value tradeoffs, their physician (or other healthcare provider) also takes on a significant decision making role, jointly with the patient. Indeed, there is sufficient evidence from other domains that giving consumers more information can make them worse off through poor decision-making (Barber and Odean, 2000; Hibbard and Peters, 2003; Thaler and Tucker, 2013; Spann and Tellis, 2006). Therefore, price (and quality) data may be beneficial for patients only when it is consumed under guidance of a trusted expert (e.g., physician), and only when hospitals and other provider organizations offer physicians proper incentives, training and guidance in conducting cost of care conversations with patients (Sloan and Ubel, 2019). This raises the need to examine whether it would be efficient to shift some of this burden to trained physician assistants.

The effect of price transparency in this setting can depend on several additional factors besides

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the level of savings and availability of alternatives. One is the willingness and ability of physicians (or other care providers) to indulge in cost of care conversations, which have an opportunity cost in time, require new knowledge and techniques, and create a need to advise on tradeoffs that are subjective and may vary by patients. Another is the level of trust that patients feel when their medical advisors begin infusing cost factors into their recommendations. Overall, empirical research studies can examine the extent to which the propensity to switch towards less expensive services depends on design of the cost of care conversation, degree of choice available, savings levels (to the patient and the payor), nature of alternatives (e.g., differences in brand, dosage, format of drug, etc.), disease categories, length of treatment, and patient and physician characteristics.

3.2.2 The Flow of Money: Who Pays, Who gets Paid?

Second, while primary responsibility for decision making rests with the patient (with advice from physicians), major responsibility for payment (and hence incentives for cost cutting) falls onto the patient's insurance provider who can exert only generic control on decision-making through rules for coverage and patient co-payments. This misalignment might even cause patients to pick higher-cost options in the belief that they are higher quality (Volpp, 2016). Third, the relationship between the seller and advisor roles is muddled: for prescription drugs (or laboratory work), payments flow to the seller (pharma, labs) so that physicians can be considered neutral advisors; for hospital procedures, however, payments flow to physicians (and notably the hospital or facility that they practice in) which weakens their view as neutral advisors and suggests that their incentives as providers will distort the effects of price transparency.

Given these differences in structure and incentives, price transparency should have a differential impact for different types of health care spending categories. Moreover, for the latter case (hospital services) the effects should also depend on whether hospitals are paid for services rendered vs. outcomes achieved. Intuitively, price transparency should have more positive effects (reduction in prices and spending) in the case of drugs and hospital services that are rendered under value-

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based-care models (i.e., payments are linked to outcomes) vs. fee-for-service or capitated models (i.e., payments are linked to volume of services). However, we shall see that this simple intuition doesn't necessarily hold because the effects of price transparency are more intricate.

3.3 Competitive Effects of Price Transparency

Putting aside other factors (such as the separation or co-mingling or decision-making, payor and seller roles), the competitive effects of price transparency are themselves quite intricate. Basic economic intuition might suggest that when buyers can easily access data on prices (and product attributes), then sellers would be forced to lower prices in order to be more competitive, and moreover that any price variations across sellers (caused by, say, loyalty effects, better location etc.) should also be reduced. This result can formally be proven with basic models of search costs especially for more commoditized goods (Bakos, 1997).

A more nuanced application of economic theory suggests contrarian outcomes, i.e., that better price transparency can lead to higher prices. One mechanism is developed in Pereira (2005) with a mix of firms that have low vs. high marginal costs, wherein buyers' reservation prices fall as they get easier access to price data; however, while market prices might drop within an equilibrium, under some conditions the market switches from a *competing equilibrium* (where all firms compete for all consumers, regardless of consumers' tendency to price-shop) to a *segmenting equilibrium* (where low cost firms primarily appeal to more price-sensitive consumers, and vice versa) leading to increase in both prices and price dispersion.

3.4 Strategic Response of Healthcare Providers

If price transparency does lead to a reduction in prices and reduces profits of healthcare providers (pharmaceutical companies, device makers, laboratories, hospitals, etc.), they are likely to make strategic changes to counteract this loss in profit. Price transparency will increase seller firms'

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incentives for investing in product differentiation, and this higher level of differentiation can lead to both higher prices and lower social welfare (Kuksov, 2004).

Another strategic reaction by firms is to make investments in increasing quality. For instance, R&D and other investments could reduce negative side effects of medications, and technological investments could be made to reduce failure rates during surgery. Such investments are more likely to occur when the prevailing share of high quality products in a category is relatively low (and conversely there is a high fraction of low quality products): the reason is that price and product transparency will erode the market share of lower quality products, outweighing the effects of intensified price competition (Fishman and Levy, 2015). Extreme price competition might hinder investment in, for instance, individualized drugs[9] (e.g., based on genetic factors) which have extremely high prices initially but could become affordable with mass production and adoption.

3.5 Strategic Redesign of Health Insurance Plans

Insurance plans exist to remove the burden and risk on people who fall sick, hence insurance companies cover the bulk of fees for various medical services. However, most plans also impose some fees on patients in order to partially incentivize them for managing their health and controlling spending. Until now, though, due to lack of price transparency, patient co-payments are predominantly defined as constant amounts for specific services. That is there is presently an equilibrium in consumers' lack of timely access to price information and lack of incentives or responsibility for managing spending. Thus, a patient who has a co-pay of $5 for a drug that costs $500 as well as an alternative drug that costs $50 has little incentive to pick the $50 option. This distortion between overall price differences and price differences seen by the patients mitigates the effect of transparency on choice, prices and spending. Indeed, in some cases, insurance providers that back price transparency technologies are considering making side or transfer payments to patients who pick less expensive (and presumably equally effective) alternatives. This approach, however,

[9] https://www.nytimes.com/2019/10/09/health/mila-makovec-drug.html.

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is a band-aid on an unsuitable design. One should therefore expect price transparency—once it is sufficiently diffused and begins to influence choices—to cause the redesign of insurance plans such that incentives for frugality or prudent choice are better aligned.

A second potential transformation is the mix of insurance plans that are set up as an integrated staff and facilities system (e.g., Kaiser), a health maintenance organization (HMO), or a preferred provider organization (PPO). Traditionally, the tradeoff between HMOs and PPOs has been seen as one of choice vs. cost (PPOs offer more choice of providers, and then to cost more). However, price transparency has the potential to invert this tradeoff. Consider, presently, how a customer of a PPO makes choices: they might know what alternatives they have (i.e., hospitals, laboratories, or other providers) however they are not well-informed about product and price alternatives, hence price has little impact on choices. Once price transparency is sufficiently mature, PPO customers will be able to make informed comparisons across multiple providers, forcing PPO providers to become more competitive on various factors including price. HMOs members, on the other hand will have less choice and potentially higher cost.[10] Thus, the mix of health insurance plans might tilt towards a greater fraction of choice-based plans such as PPOs.

4 Business Model for Price Transparency Technologies

Price transparency technologies serve (at least) a quadruple of actors: 1) patients who receive price information, 2) payors (e.g., health insurance companies, employers) who also pay for the patients' health care, 3) pharmaceutical companies (and other medical services providers) who sell the products and set prices, and 4) care providers (hospitals, physicians, nurses, pharmacists) through whom price information is provided and interpreted. Price transparency, if it leads to spending reduction and then lower prices, presumably will benefit the first two groups and hurt the third one. The effect on the fourth group, which is secondary in the sense that it is neither the

[10] I'm grateful to my colleague Prof. Mingdi Xin (UC Irvine) for this insight.

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product maker nor eventual consumer, may be mixed and dependent on the nature of compensation models of health care providers. Given the nature of gain or loss to different actors, and the uncertainty in both the direction and magnitude of gain, raises the question *how, and by whom, should price transparency technologies be funded?*

4.1 Business Model Paradox

One lesson learnt from the last two decades of intensive growth in consumer-focused Internet and IT applications is: avoid charging consumers directly, use low (or zero or negative prices) to fuel adoption, and instead develop alternative business models that leverage the large installed base of users so acquired. In the case of price transparency technologies, as noted above, beneficiaries (assuming these technologies are successful at reducing prices and spending) included both consumers and institutions, namely insurance providers. Indeed, given the present structure of most health insurance plans, the potential for savings to insurance providers is substantially larger than the savings that patients might incur from selecting less expensive alternatives. This explains why the present business model and push for price transparency is founded on the technologies being financed by insurance providers. This group gains from spending reduction due to lower payouts, which would consequently enable them to offer plans at lower premiums.

Let D represent the willingness of insurance providers to spend on development and maintenance of price transparency technologies. Then $D = f(q, \Delta, \rho(\Delta, q, \mathbf{X}))$ depends on three related factors, the quality q of the technology (accuracy of prices, and the level of precision and recall in finding alternatives), level of price dispersion Δ in the market (specifically variation among prices of equivalent drugs) and the propensity ρ of decision makers (patients and providers) to switch to less expensive alternatives, which is a function of Δ, q, and a variety of other factors $\mathbf{X}$ comprising attributes of patients, physicians, insurance, institutional setting, etc. However, starting with a scenario where Δ and q are high, consider what might happen if ρ is also high. Patients and insurance providers should then enjoy substantial savings from picking less expensive alternatives leading

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to high D and hence good funding for price transparency technologies. However, a high ρ should cause sellers to reduce prices and there should also be a reduction in dispersion (i.e., variation in market prices for the same or similar product), causing D to fall and making it less necessary to use the technology before making choice decisions. At the extreme, if Δ falls towards zero, then the business model collapses. This is the basic business model paradox for price transparency technologies: their high quality and success reduces the incentive to pay for them, while also causing potential losers (product firms, which include pharmaceutical firms and device makers who have an interest in protecting high prices) to exert their power and deep pockets to influence the design and operation of these technologies.

4.2 Sponsored Search: Influence and Distortion of Search Results

What is the alternative then? History and experience in other domains suggests some alternative directions and business models, notably payment-influenced (or "sponsored") results. Consider the behavior of general-purpose search engines such as Google, specialist shopping oriented search technologies (e.g., Amazon, and even Google Shopping), travel search (Expedia, TripAdvisor, and again Google). While all search technologies have origins in, and still retain, *idealist* or *organic* search algorithms, they also feature varying degrees of *sponsored search* wherein the list, ranking, display or placement of search results is influenced or distorted through arrangements with the sellers who are being ranked. Sponsored search has contributed the bulk of Google's revenues for almost two decades. Similarly distortions of search results, ranking or recommendations, have occurred historically in airline reservation services (display bias), radio stations playing music (payola scandals), university loan officers (loan scandals); indeed the potential for medical products firms to incentivize doctors to promote their products (with both good and negative effects) has existed within the practice of healthcare as well (Campbell, 2007; Moynihan, 2008; Fugh-Berman and Ahari, 2007). Long-term sustenance of *unbiased* search technologies is rare, with notable exceptions such as *Consumer Reports*.

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When queried for flights between Los Angeles and Cleveland on July 15,1982 leaving at 7:00 AM, the first screens of the displays are as follows:

Sabre

	Airline	Flight #	City Pair	Depart Time	Arrive Time
1	AA	166	LAXORD	0700	1238
2	AA	108	CLE	1317	1524
3	AA	446	LAXDFW	0720	1208
4	AA	254	CLE	1303	1628
5	TW	136	LAXSTL	0730	1254
6	TW	482	CLE	1343	1608

Apollo

	Airline	Flight #	City Pair	Depart Time	Arrive Time
1	UA	70	LAXCLE	1150	1900
2	UA	66	LAXCLE	1100	1805
3	DL	486	LAXCLE	1130	1937
4	CO	314	LAXDEN	0700	1005
5	UA	642	CLE	1115	1555
6	UA	694	LAXDEN	0715	1025
7	UA	642	CLE	1115	1555

Figure 5: Display bias in computerized reservation systems owned by airlines.

Why do search or price transparency technologies shift towards a business model based on sponsored payments? The reason includes a combination of factors, a) the business model paradox from charging end-users, b) the opportunity to monetize sellers, and c) competition between search technologies. On the last point, a technology that is financed by end-users would lose market share to a competing technology that is free to end-users (but monetizes sellers through sponsored results). A likely strategy for the latter is to forego sponsored results initially in order to capture market share and then introduce sponsored payments when it is sufficiently powerful.

The above discussion pertains to price transparency technologies developed by third-party firms that are neither health care providers nor producers of health care services and goods. However, in many industries search technologies are built from within the industry. For instance, the earliest industry-wide airlines reservation systems were owned by individual airlines themselves (the first, SABRE, was developed and owned by American Airlines). This leads to a related kind of distortion of search results because the technology provider has natural incentives to promote its own products. Fig. 5 provides an example of such bias within two airline reservation systems, owned by American Airlines and United Airlines, displaying different results for the same search. Such distortion can offer significant competitive advantage to the product firm that also owns the search technology. American (and United) Airlines were able not only to promote their own products in various markets, but also to extract significant rents by promoting other airlines in markets where

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they did not compete with these airlines (Copeland and McKenney, 1988). Hence, even when price transparency technologies are originally developed and owned by third-party firms, the potential economic gain from jointly operating in both the search and the product market creates incentives for industry movement in both directions. We explore this next.

4.3 Shifts In Market Power

Information is power. As a price transparency technology become successful (i.e., by being free-to-use in a world with high Δ, while enabling price savings and finding good product alternatives) it acquires market power over both consumers (who must use them to find products and to benefit from savings) and sellers (whose sales now depend on whether and how they are ranked) from whom it can demand payments for favorable placement. In the extreme case, the search technology becomes a marketplace provider with sufficient power to squeeze sellers through royalty payments (e.g., Uber, Apple AppStore, Google Play Store, Amazon Marketplace, Atlassian Marketplace, etc. are all examples of marketplace providers that collect 20%-30% of revenues from product sales).

Computerized industry-wide airline reservation systems are a notable example of how a search technology evolved to create competitive advantage, achieve significant market power, and eventually become an "anticompetitive weapon" in its industry (Copeland and McKenney, 1988). Alternately, if a search technology firm is threatened by product firms (either through sponsored results, or for instance being sued by product firms for claiming equivalence between certain products), it can also counterattack by moving from a marketplace role into the product space (e.g., Amazon.com with Amazon Marketplace and Amazon Basics). In doing so, its role and data visibility at the marketplace level can endow it with distinct, and possibly illegitimate, competitive advantage in entry into specific products. For instance, a drug price transparency system that observes massive price dispersion for specific classes of drugs may choose production, distribution or research roles for those drugs.

The above discussion does not imply that price transparency technologies will definitely move

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in the direction of corruption or distortion, in light of the basic business model paradox. Neither must one assume that such actions are necessarily in conflict with consumer interest. For instance, sponsored search can make search technologies superior through a signaling function wherein better-quality producers (which are not perfectly known to the search engine), confident about their eventual success, would pay the search engine to promote their own products. Similarly, if search or marketplace technologies intelligently use industry-wide data to enter sub-markets with high price dispersion and high margins, such entry has the potential to create lower prices and higher consumer surplus. The important point is that a recognition and understanding of the economic forces and business models underlying price transparency technologies is necessary in order to develop the right business practices, industry policies, or regulations, that nudge the technologies in the right direction.

5 Conclusion

Price transparency is poised to arrive and make a big impact in the health care industry. While its development and introduction is motivated by the pressing need to reduce health care spending through price competition and reduction in market prices, these effects are by no means guaranteed. Achieving them will require careful design and implementation, but also prudent management and regulation that reflects an understanding of how market forces will interact with price transparency technologies.

While present regulations focus on removing a veil of secrecy in pricing and in reducing variation in prices across multiple markets, these are not crucial factors for promoting price-based competition and choice. Instead, it is vital that price data be well-timed (relative to the decision), personalized at an individual level (e.g., based on insurance plan rules, deductibles, co-payments etc.), and up to date. Most importantly, price data about proposed products needs to be combined with a selection of potentially substitute alternative products. The simultaneous availability of

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price and attribute data is essential to achieve price-based comparison and choice. Finally, price and product data will be useful only if patients obtain it within a context where they can seek guidance from trusted advisors (e.g., physicians) who are trained and incentivized to engage in cost of care conversations.

Fortunately, the above characteristics are not a distant dream. They are already being delivered by cutting-edge emerging innovators such as *Gemini Health* (in the case of prescription drugs). Price transparency may not deliver positive results despite all these factors. Critical variables and success factors include price sensitivity of patients in the context of health and life-related choices, alignment between incentives of patients and payors to pick less expensive alternatives, willingness and ability of physicians (and their employers) to engage in cost of care conversations with patients, business model imperatives of price transparency providers, and industry-wide regulations that affect the degree to which firms can play multiple roles in the market.

Overall, if price transparency technologies are properly designed, implemented, and regulated, they can cause such profound transformations in the entire health care system that it can negate or make irrelevant several of the more strong-armed approaches to health care reform that are being discussed today.

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