CHAPTER

Digital marketing☆

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☆ This builds heavily on our Journal of Economic Literature paper, 'Digital Economics.'

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Digital technology is the representation of information in bits, reducing the costs of collecting, storing, and parsing customer data. Such technologies span TCP/IP and other communications standards, improvements in database organization, improvements in computer memory, faster processing speeds, fiber optic cable, wireless transmission, and advances in statistical reasoning.

These new digital technologies can be seen as reducing the costs of certain marketing activities. Digital marketing explores how traditional areas of marketing such as pricing, promotion, product, and placement change as certain costs fall substantially, perhaps approaching zero. Using the framework in our recent summary of the digital economics literature (Goldfarb and Tucker, 2019), we emphasize a shift in five different costs in addressing the needs of customers.

1. Lower search costs for customers.
2. Lower replication costs for certain digital goods.
3. Lower transportation costs in transporting digital goods.
4. Lower tracking costs enabling personalization and targeting.
5. Lower verification costs of customers' wishes and firms' reputations.

We argue that each of these costs had the distinction of affecting marketing earlier and more dramatically than many other firm functions or sectors. As a consequence, marketing has become a testing lab for understanding how these shift in costs may affect the broader economy. This link between marketing and economics is important because each of these shifts in costs draws on familiar modeling frameworks from economics. For example, the search cost literature goes back to Stigler (1961). Search costs are lower in digital environments, enabling customers to find products and firms to find customers. Non-rivalry is another key concept, as digital goods can be replicated at zero cost. Transportation cost models, such as the Hotelling Model, provide a useful framework for the literature on the low cost of transportation of digital goods. Digital technologies make it easy to track any one consumer's behavior, a theme of advertising models at least since Grossman and Shapiro (1984). Last, information models that emphasize reputation and trust help frame research that shows that digitization can make verification easier.

Early work in digital economics and industrial organization emphasized the role of lower costs (Shapiro and Varian, 1998; Borenstein and Saloner, 2001; Smith et al., 2001; Ellison and Ellison, 2005). Goldfarb and Tucker (2019) analyzed how these shifts have been studied in the economics literature. We aim to focus on the extent to which quantitative marketing has led, and has been the first empirical testing ground for, many of these changes. As such, we will focus on work in quantitative marketing aiming to understand the effect of technology. In doing so, we will not emphasize

work from the consumer behavior literature or methodology-focused work from the marketing statistics literature. We will also not emphasize studies in the marketing strategy literature that document correlations which are of managerial importance, rather than measuring the causal effects of digital technologies.

1 Reduction in consumer search costs and marketing

Search costs matter in marketing because they represent the costs consumers incur looking for information regarding products and services. The most important effect of lower search costs with respect to digital marketing is that it is easier to find and compare information about potential products and services online than offline. Many of the earliest reviews about the impact of the internet on the economy emphasized low search costs in the retail context (Borenstein and Saloner, 2001; Bakos, 2001) and the resulting impact on prices, price dispersion, and inventories. These papers built on a long-established economic literature on search costs (Stigler, 1961; Diamond, 1971; Varian, 1980). Recent work in marketing has examined the search process in depth, documenting the clickstream path and underlying search strategies (Bronnenberg et al., 2016; Honka and Chintagunta, 2017).

1.1 Pricing: Are prices and price dispersion lower online?

Perhaps the dominant theme in the early literature was the impact of low search costs on prices and price dispersion. Brynjolfsson and Smith (2000) hypothesized that low internet search costs should lower both prices and price dispersion. They empirically tested these ideas, comparing the prices of books and CDs online and offline. They found that online prices were lower. Similarly, Brown and Goolsbee (2002) showed that insurance prices are lower online and Orlov (2011) found that airline prices are lower online. A series of related studies (Zettelmeyer et al., 2001; Scott Morton et al., 2003; Zettelmeyer et al., 2006) showed how digitization reduced automobile prices, though not equally for all types of consumers. While prices fell, the results of the literature on price dispersion have been more mixed. Brynjolfsson and Smith (2000) show substantial price dispersion online. Nevertheless, they find that online price dispersion is somewhat lower than offline price dispersion. Baye and Morgan (2004) emphasize persistently high levels of price dispersion online. Orlov (2011) suggests that online price dispersion is higher.

The persistence of price dispersion is a puzzle. Broadly, the literature gives two main answers. First, the earlier economics literature has emphasized that retailers differ, so the service provided for the same item differs across retailers. Firms with stronger brands command higher prices, though this has been decreasing somewhat over time (Waldfogel and Chen, 2006). This decline in importance of brands in the digital environment, as shown in Hollenbeck (2018), is related as we discuss to the reduction in verification costs.

Second, as a counterpoint to the notion that there are exogenously given differences in seller quality that formed the basis of the early economics literature – the marketing literature has emphasized the extent to which search can be influenced by the seller. In other words, in marketing we recognize that search costs are endogenous and a reflection of a firm's marketing strategy. Honka (2014) and De los Santos et al. (2012) provide surprisingly large estimates of the cost of each click in the online context. By forcing customers to conduct an extra click or two, sellers can increase the relative cost of search in areas where they are weak. For example, a high-quality, high-price firm might make it easy to compare product quality but difficult to find prices. Chu et al. (2008) show that price sensitivity is lower in online grocery compared to offline grocery. Fradkin (2017) has shown a similar phenomenon in the context of Airbnb. A number of scholars have shown that such endogenous increases in search costs can be sustained in equilibrium (Ellison and Ellison, 2009) and profitable (Hossain and Morgan, 2006; Dinerstein et al., 2018; Moshary et al., 2017).

Ellison and Ellison (2009) showed how firms can obfuscate prices. They emphasize a setting where search costs should be very low: An online price comparison website. They show that retailers that display prices on that website emphasize their relatively low priced products. Then, when consumers click the link and arrive at the retailer's own website, they are shown offers for higher prices and higher margin goods. Thus, price dispersion is low at the price comparison website where search costs are low, but dispersion is high where comparison is more difficult. More recently, Moshary et al. (2017) demonstrate the effectiveness of similar price obfuscation in the context of a massive field experiment at StubHub. The experiment compared purchase prices and demand estimates when the service fees for using StubHub were shown early in the search process versus immediately before purchase. The experiment showed that customers were less sensitive to the same fee when it was shown late in the process. The company deliberately made some price information more difficult to find, and this increased quantity demanded at the same price.

Another area where search costs are endogenous to firm marketing strategy reflects the use of devices. Firms recognize that tablets and mobile devices, with smaller screens, may facilitate this process of restricting the information that consumers see initially (Xu et al., 2017; Ghose et al., 2013). A developing area of marketing is trying to understand, given this different environment, how best to present price information to consumers to maximize profits in a mobile environment (Andrews et al., 2015; Fong et al., 2015).

The early online price dispersion literature and the more recent literature demonstrating endogenous online search costs show where a close study of marketing contexts has been able to add nuance to a puzzle noted in the economics literature, by exploring how firms can increase search costs for consumers in a digital environment.

1.2 Placement: How do low search costs affect channel relationships?

Reduced search costs facilitate exchange more generally, often enabled by large digital platforms. Many major technology firms can be seen as platform-based businesses. For example, Google and Facebook are platforms for advertisers and buyers. Jullien (2012) highlighted that digital markets give rise to platforms because of low search costs that facilitate matching and enable trade. Horton and Zeckhauser (2016) emphasize that many large digital platforms are driven by low search costs that enable efficient use of unused capacity for durable goods. This emphasis on unused capacity, and the need to match supply and demand, means that much research takes a market design perspective (Einav et al., 2018). Cullen and Farronato (2016) emphasize the challenges of matching supply and demand over time and the importance of economies of scale in matching. Zervas et al. (2017) emphasize how supply changes in response to changes in demand. Bapna et al. (2016) emphasize that platform design can also be informed by consumer theory.

These platforms often provide an alternative type of distribution channel, through which sellers can reach buyers. This can enable new markets and affect incumbents. For example, several papers have examined the accommodation industry (Fradkin, 2017; Farronato and Fradkin, 2018; Zervas et al., 2017). Zervas et al. (2017) examine how the introduction of Airbnb as a channel for selling accommodations reduced demand in the incumbent hotel industry in a particular way. Airbnb provided a channel for selling temporary accommodation. This enabled accommodations to go on and off the market as demand fluctuated. Consequently, the impact of Airbnb is largest in periods of peak demand (such as the SXSW festival in Austin, Texas). In these periods, hotel capacity is constrained. Airbnb 'hosts' play a role in providing additional capacity. This means that hotel prices do not rise as much.

Digital platforms serve as distribution channels in a wide variety of industries, including airlines (Dana and Orlov, 2014), books (Ellison and Ellison, 2017), food trucks (Anenberg and Kung, 2015), entertainment (Waldfogel, 2018), and cars (Hall et al., 2016). In many of these cases, a key role of online platforms is to provide an additional channel to overcome capacity constraints (Farronato and Fradkin, 2018). These constraints may be regulatory, as in the case of limited taxi licensing, related to fixed costs and technological limits as in the case of YouTube as a substitute for television, or both, as in the case of accommodation, where hotel rooms have high fixed costs and short term rentals are constrained by regulation.

Given that a key role of these online platforms is to overcome capacity constraints in offline distribution channels, this provides a structure for understanding where new online platforms may arise. They will likely appear in places where existing distribution channels generate capacity constraints, particularly in the presence of large demand fluctuations. Furthermore, it provides a structure for identifying which existing channels and incumbent sellers will be most affected by online platforms: Those in which capacity constraints generate a key source of their profits. As Farronato and Fradkin (2018) show, hotels lost their ability to charge unusually high prices during periods of peak demand.

In summary, digital platforms facilitate a reduction in search costs. This creates an opportunity for sellers working at a small scale to find buyers. By enabling an influx of sellers, online platforms overcome capacity constraints, creating new opportunities for sellers, new benefits to buyers, and new threats to the existing distribution channels and the larger incumbent sellers. Much of the initial literature on platform or two-sided networks was led by economists inspired by antitrust litigation in credit cards (Rochet and Tirole, 2003; Armstrong, 2006). However, recently the literature has exploded in marketing because so many large platforms are primarily marketing channels – such as Amazon, Facebook, and Google. This means that the digital marketing literature is at the core of much of the debate about the extent to which such platforms represent a challenge for antitrust regulators (Chiou and Tucker, 2017b).

1.3 Product: How do low search costs affect product assortment?

Anderson (2006) emphasized that the internet increases the purchase of niche or 'long tail' products relative to mainstream or superstar products. Consistent with this hypothesis, Brynjolfsson et al. (2011) find that the variety of products available and purchased online is higher than offline. Zentner et al. (2013) use a quasi-experimental estimation strategy to show that consumers are more likely to rent niche movies online and blockbusters offline. Datta et al. (2018) demonstrate that the move to streaming, rather than purchasing, music has led to a wider variety of music consumption and increased product discovery, which in turn increases the variety of music available (Aguiar and Waldfogel, 2018). Zhang (2018) links this discovery of relatively unknown products to low search costs. Empirical evidence suggests that this increase in variety increased consumer surplus (Brynjolfsson et al., 2003).

Furthermore, Quan and Williams (2018) suggest that the increase in the variety of products purchased by consumers has been overestimated by the literature. In particular, they note that tastes are spatially correlated, and examine the consequences of spatially correlated tastes on the distribution of product assortment both online and offline. The key finding is that offline product assortment has been mis-measured, because products that might appear to be rarely purchased in a national sample could still have sufficient local demand in certain markets that they would be available. Drawing on this insight, they build a structural model of demand and show that the welfare effects of the internet through the long tail are much more modest than many previous estimates. These relatively low welfare benefits of the long tail or the benefits of increased variety are consistent with Ershov's (2019) research in the context of online software downloads from the Google Play store, which emphasizes the general benefits of a reduction in search costs for consumers.

While much of the popular discussion has emphasized the long tail, the effect of search costs on product assortment is ambiguous. If there are vertically differentiated products, low search costs mean that consumers will all be able to identify the best product. Bar-Isaac et al. (2012) provide a theoretical framework that combines superstar and long tail effects as search costs fall, demonstrating that lower search costs hurt middle-tier products while helping extremes. Elberse and Eliashberg (2003) document both effects in the entertainment industry.

As noted above, search costs can be endogenously chosen by firms. Recommendation engines are one tool through which firms choose which attributes to emphasize, lowering search costs in some dimensions and not others. Fleder and Hosanagar (2009) show that simple changes to recommendation engine algorithms can bias purchases toward superstar or long tail effects. Superstar effects occur when the recommendation engine primarily suggests 'people who bought this also bought'. In contrast, long tail effects occur when the engine instead suggests 'people who bought this disproportionately bought'. Consistent with this framing, Zhang and Liu (2012) and Agrawal et al. (2015) show how recommendation engines can lead to a small number of products receiving the most attention when they focus on showing which products are most popular. In contrast, Tucker and Zhang (2011) provide an example in which a recommendation engine which highlights the popularity of a digital choice has asymmetrically large effects for niche products. This occurs for a different reason than the one highlighted in Fleder and Hosanagar (2009). In this case, the release of popularity information allowed niche sellers to appear to be relatively popular and consequently signal their quality or general attractiveness.

Overall, reduced search costs appear to increase product assortment while also increasing sales at the top of the distribution. We have empirical evidence of both long tail and superstar effects, probably at the expense of products in the middle of the distribution. While the variety of products offered has increased, Quan and Williams (2018) highlight that the welfare consequences of this appear to be small in the context of a particular set of online products. This contrasts with the evidence summarized in Waldfogel (2018) who argues that digitization has led to a substantial increase in consumer welfare in the entertainment industry. Currently, the literature does not have a systematic structure for identifying when increased product assortment will have a large welfare impact. The evidence presented by both Quan and Williams (2018) and Waldfogel (2018) is compelling. It suggests that the particular characteristics of the product category will determine welfare effects. It remains an open research question what those characteristics might be, and this is something we feel that marketing contexts are well able to exploit.

1.4 Promotion: How do low search costs affect advertising?

Advertising is often modeled as a process for facilitating search (Bagwell, 2007). Online search costs affect advertising in a variety of ways. For example, low search costs online can also change the nature and effectiveness of offline advertising. Joo et al. (2014) show that television advertising leads to online search. Such searches can in turn lead to better information about products and higher sales. In other words, the ability to search online can make other advertising more effective, and it can enable advertisers to include an invitation to search in their messaging.

Modeling advertising as a search process is particularly useful in the context of search engine advertising. This is advertising that responds directly to consumer search behavior. Consumers enter what they are looking for into the search engine. Advertisers respond to that statement of intent. Search engine advertising allows both

online and offline advertisers to find customers. Kalyanam et al. (2017) show how search engine ads affect offline stores. Even within search engine advertising, search costs vary. Ghose et al. (2012) demonstrate the importance of rank in search outcomes. Higher ranked products get purchased more. Narayanan and Kalyanam (2015) and Jeziorski and Moorthy (2017) both document that rank matters in search engine advertising in particular, but that this effect varies across advertisers and contexts.

Despite the widespread use of search advertising, there is some question about whether search advertising is effective at all. Li et al. (2016) discuss how industry attributes consumer purchases to particular advertising. Search engine advertising appears most effective because people who click on search ads are very likely to end up purchasing and because the click on the search ad is often the 'last click' before purchase. Many industry models treat this last click as the most valuable and hence search engine advertising is seen as particularly effective. Li et al. (2016) argue that the industry models overestimate the effectiveness of search ads.

Blake et al. (2015) describe why the effectiveness of search advertising may be overestimated. They emphasize the importance of the counterfactual situation where the ad did not appear. If the search engine user would click the algorithmic link instead of the advertisement, then the advertiser would receive the same result for free. The paper shows the result of a field experiment conducted by eBay, in which eBay stopped search engine advertising in a randomly selected set of local markets in the United States. Generally, eBay sales did not fall in markets without search engine advertising compared to markets with search engine advertising. In the absence of search ads, it appears that users clicked the algorithmic links and purchased at roughly the same rate. This was particularly true of the branded keyword search term 'eBay'. In other words, careful analysis of the counterfactual suggested that search engine advertising generally did not work (except in a small number of specialized situations). This research led eBay to substantially reduce its search engine advertising.

Simonov et al. (2018a) revisit the effectiveness of search engine advertising and focus on advertisements for the branded keyword, but for less prominent advertisers than eBay. Using data from search results at Bing's search engine, they replicate the result that search engine advertising is relatively ineffective for very well known brands. They then demonstrate that search engine advertising is effective for less well known brands, particularly for those that do not show up high in the algorithmic listings. Overall, these papers have shown that understanding the search process – for example through examining heterogeneity in the counterfactual options when search advertising is unavailable – is key to understanding when advertising serves to lower search costs. Coviello et al. (2017) also find that search advertising is effective for a less well-known brand. Simonov et al. (2018b) show that competitive advertising provides a further benefit of search engine advertising: If competitors are bidding on a keyword (even if that keyword is a brand name), then there can be a benefit to paying to search engine advertising even for advertisers who appear as the top algorithmic link.

In other words, Blake et al. (2015), Simonov et al. (2018a), and Simonov et al. (2018b) together demonstrate what might seem obvious *ex post*: Search advertis-

ing meaningfully lowers search costs for products that are relatively difficult to find through other means. This finding is nevertheless important. Search advertising is a multi-billion dollar industry and many marketers appear to have been mis-attributing sales to the search advertising channel.

These three papers provide a coherent picture of how search engine advertising works. The open questions relate to how changes in the nature of search advertising – and the addition of new search channels such as mobile devices and personal assistants – might affect this picture. As we move off the larger screens into more limited bandwidth devices, then search costs may rise and even strong brands may benefit from search advertising.

Tools and questions from economics – such as thinking about the right counterfactual – have led to an extensive and important literature on search engines that spans marketing and economics. Even though search engines are so recent, the speed with which this literature has sprung up reflects the growing importance of search engines and other search mechanisms in the digital economy.

2 The replication costs of digital goods is zero

Digital goods are non-rival. They can be consumed by one person without reducing the amount or quality available to others. Fire is a non-rival good. If one person starts a fire, they can use it to light someone else's fire without diminishing their own. The non-rival nature of digital goods leads to important implications for marketing, particularly with respect to copyright and privacy. The internet is, in many ways, a "giant, out of control copying machine" (Shapiro and Varian, 1998). This means that a key challenge for marketers in the era of digitization is controlling product reproduction – free online copying – by consumers.

2.1 Pricing: How can non-rival digital goods be priced profitably?

Non-rival goods create pricing challenges. If customers can give their purchases away without decreasing the quality of what they bought, this creates challenges to the ability to price positively. The initial response by many producers of digital products was both legal (through copyright enforcement) and technological (through digital rights management). The effectiveness of such policies on consumer purchases is theoretically ambiguous, and the empirical evidence is mixed (Varian, 2005; Vernik et al., 2011; Danaher et al., 2013; Li et al., 2015; Zhang, 2018).

Non-rivalry can lead to opportunities for price discrimination. Lambrecht and Misra (2016) examine price discrimination in sports news. In this context, the highest willingness to pay customers appear all year, while casual fans primarily read news in-season. Therefore, it is profitable for a sports website to provide more free articles during periods of peak demand. During the off-season, more content should require a subscription because that is when the highest value customers appear. Rao and Hartmann (2015) examine price discrimination in digital video, comparing options to rent

or buy a digital movie. The paper shows that in the zero marginal cost digital context, dynamic considerations play an important role.

The marketing literature has long being focused on tactical and practical questions about how to price (Rao, 1984). Therefore, it is not surprising that scholars at the boundary between marketing and economics have been exploring the new frontier question about how to price non-rival digital goods.

2.2 Placement: How do digital channels – some of which are illegal – affect the ability of information good producers to distribute profitably?

Digital channels affect the ability of the producers of information goods to distribute profitably. For example, music industry revenue began to fall in 1999 and this has been widely blamed on the impact of digitization generally and free online copying in particular (Waldfogel, 2012). This leads to a question of optimal restrictions on free online copying by governments through copyright and by firms through digital rights management. While the direct effect of free online copying is to reduce revenues, such free copying may induce consumers to sample new music and buy later (Peitz and Waelbroeck, 2006). Furthermore, Mortimer et al. (2012) show that revenues for complementary goods (like live performances) could rise. Despite this ambiguity, the vast majority of the empirical literature has shown that free online copying does reduce revenue across a wide variety of industries (Zentner, 2006; Waldfogel, 2010; Danaher and Smith, 2014; Godinho de Matos et al., 2018; Reimers, 2016).

The core open marketing questions therefore relate to the development and distribution of complementary goods. To the extent that free and even illegal channels for distribution are inevitable for many digital goods, what are the opportunities for intermediaries to facilitate profitable exchange? In other words, besides selling tickets to live music, it is important to understand the ways in which industry has reacted to these changes. As free video distribution becomes widespread through platforms like YouTube and through illegal channels, it may generate incentives to offer subscription bundles (as in Netflix) rather than charging per view (as in the cinema). It may also generate incentives to produce merchandizable content, and then earn profits through toy and clothing licensing, theme parks, and other channels. This in turn may affect the role of entertainment conglomerates in the industry. If merchandizing is necessary, then companies like Disney may have an advantage because they own theme parks, retail stores, and other channels. Aside from Mortimer et al. (2012), our empirical understanding is limited as to how complements to digital information goods arise, how they work, and how they change the nature of the firm.

2.3 Product: What are the motivations for providing digital products given their non-excludability?

Intellectual property laws exist because they can generate incentives to innovate and create new products. The non-rival nature of digital goods leads to widespread viola-

tion of copyright and questions about what constitutes fair use. Many people consume digital products without paying for them. While the owners of copyrighted works are harmed, the provision of a product at zero price increases consumer surplus and eliminates deadweight loss. It also allows for valuable derivative works. In a static model, this is welfare-enhancing. Consumers benefit more than producers are hurt.

Therefore, the key question with respect to digitization and copyright is with respect to the creation of new products. Waldfogel (2012) provides evidence that suggests that the quality of music has not fallen since Napster began facilitating free online copying in 1999. While digitization did reduce incentives to produce because of online copying, the costs of production and distribution fell as well. For distribution, low marginal costs of reproduction meant that early-stage artists could distribute their music widely and get known, even without support from a music label or publisher (Waldfogel, 2016; Waldfogel and Reimers, 2015). The title of the new book 'Digital Renaissance' (Waldfogel, 2018) summarizes a decade of his research emphasizing that digitization has led to more and better quality entertainment despite increased copying, largely because of reduced production and distribution costs. In our view, the argument Waldfogel presents is convincing. The challenge for marketing scholars is to extend this literature by understanding better the profitable provision of goods which serve as complements to digital goods.

2.4 Promotion: What is the role of aggregators in promoting digital goods?

Non-rivalry means that it is easier for companies to replicate and aggregate the digital content of other firms. Such aggregators both compete with the producing firms content and promote the producing firm's content (Dellarocas et al., 2013). Thus, the distinction between advertisement and product can become ambiguous. This tension has been empirically examined in the context of the new aggregators. Examining policy changes in Europe, three different studies have shown that news aggregators served more as promotion tools than to cannibalize the revenues of producing firms (Calzada and Gil, 2017; Chiou and Tucker, 2017a; Athey et al., 2017b). For example, Calzada and Gil (2017) show that shutting down Google News in Spain substantially reduced visits to Spanish news sites. Chiou and Tucker (2017a) found similar evidence of market expansion looking at a contract dispute between the Associated Press and Google News. Therefore, in general empirical evidence suggests that news aggregators appear to have a market expansion effect rather than being cannibalizing.

3 Lower transportation costs

Information stored in bits can be transported at the speed of light. Therefore digital goods and digital information can be transported anywhere at near-zero cost. Furthermore, the transportation cost to the consumer of buying physical goods online can be relatively low. As emphasized by Balasubramanian (1998), the transportation costs

of traveling to an offline retailer are reduced, even if an online retailer still needs to ship a physical product.

3.1 Placement: Does channel structure still matter if transportation costs are near zero?

Digitization added a new marketing channel (Peterson et al., 1997). For digital goods, this channel is available to anyone with an internet connection. For physical goods bought online and shipped, this channel is available to anyone within the shipping range. In the United States, this means just about anybody with a mailing address. A variety of theory papers examined the impact of the online channel on marketing strategy (Balasubramanian, 1998; Liu and Zhang, 2006). These papers build on existing models of transportation costs that build themselves on Hotelling (1929). They model online retailers as being equidistant from all consumers, while consumers have different costs of visiting offline retailers, depending on their location.

Empirical work has generally supported the use of these models. The new channel competed with the existing offline channels for goods that needed to be shipped (Goolsbee, 2001; Prince, 2007; Brynjolfsson et al., 2009; Forman et al., 2009; Choi and Bell, 2011) and for goods that could be consumed digitally (Sinai and Waldfogel, 2004; Gentzkow, 2007; Goldfarb and Tucker, 2011a,d; Seamans and Zhu, 2014; Sridhar and Sriram, 2015). Forman et al. (2009) aim to explicitly test the applicability of Balasubramanian (1998) to the context of online purchasing on Amazon. Using weekly data on top-selling Amazon books by US city, the paper examines changes in locally top-selling books when offline stores open (specifically Walmart, Target, Barnes & Noble, and Borders). The paper shows that when offline stores open, books that are relatively likely to appear in those stores disproportionately fall out of the top sellers list. The paper interprets this as evidence of offline transportation costs by consumers of visiting retailers: When a retailer opens nearby, consumers become more likely to buy books offline. If the retailer is relatively far away, then consumers are more likely to buy online. A key limitation of this paper is that the data are ranked sales, rather than actual purchase data. Work with purchase data is more limited, though Choi and Bell (2011) show similar evidence of online-offline substitution in the context of online diaper purchasing.

This result of online-offline substitution is not always evident. For multi-channel retailers, while substitution does occur in many situations, there are particular situations in which the offline channel enhances the online channel, such as when a brand is relatively unfamiliar in a location where a new store opens (Wang and Goldfarb, 2017; Bell et al., 2018). In particular, Wang and Goldfarb (2017) examined US sales at a large clothing retailer with a substantial presence both online and offline. During the period of study, the retailer substantially expanded the number of offline stores. Using internal sales data, as well as information on website visits, the analysis compares locations in which sales were high at the beginning of the sample period with locations in which sales were low. For places that already had high sales, opening an offline store reduced online purchasing. In these places, online and offline served as

competing channels, consistent with the prior literature. In contrast, in locations in which sales were low, the opening of offline stores led to an increase in online sales. This increase occurred in a variety of product categories, not only those that required the customer to know whether the clothes fit. The evidence suggests a marketing communications role for the offline channel.

These results suggest more nuance than simply 'online is a substitute for offline.' They suggest some validity to the widespread use among practitioners of the jargon term 'omnichannel' (Verhoef et al., 2015). In particular, while the previous paragraph summarized a long and careful literature that suggests the arrival of online competition reduced offline sales – and that new offline competitors reduce online sales – within a firm the results are more nuanced. The offline store can drive traffic to the online channel and in doing this it serves two roles: Sales channel and communications channel. This suggests the possibility that an online store can also drive traffic to an offline channel – there is a nascent literature that explores this but, as might be expected, establishing causality is hard.

3.2 Product: How do low transportation costs affect product variety?

In the absence of the online channel, all purchases would be made offline. Each person would be constrained to purchase the products available locally. As highlighted above in the context of the long tail, the online channel provides access to a much wider variety of products and services. Sinai and Waldfogel (2004) show that online media enables non-local news consumption. In particular, they show that digitization makes it relatively easy for African Americans living in primarily white neighborhoods to read similar news to African Americans living in African American neighborhoods. In addition, digitization makes it relatively easy for whites living in African American neighborhoods to read similar news to whites living in white neighborhoods. Similarly, Gandal (2006) shows that online media enables local language minorities to read news in their language of choice. Choi and Bell (2011) document that sales of niche diaper brands are higher online in zipcodes where such brands are generally not available offline. Low transportation costs enable product variety, by reducing geographic barriers to distribution. While tastes are spatially correlated (Blum and Goldfarb, 2006; Quan and Williams, 2018), distribution is not limited by local tastes. As discussed earlier, Quan and Williams (2018) show that spatially correlated tastes are reflected in offline offerings. This means that the welfare impact of online product variety is smaller than it might seem if measured by number of varieties available. Combined, these results suggest that the welfare impact of increased product variety will disproportionately accrue to people with distinct preferences from their neighbors, what Choi and Bell (2011) call 'preference minorities'. This provides an additional layer for interpreting the results of Quan and Williams (2018). If the welfare impact of increased online variety accrues to local minorities, then it might indicate a larger benefit than straight utilitarian analysis might suggest.

3.3 Pricing: Does pricing flexibility increase because transportation costs are near zero?

Low transportation costs constrain online pricing in several ways. First, there is the competition highlighted above, both between the various online retailers and between online and offline retailers. Second, one aspect of low online transportation costs involves the reduced physical effort when consumers are not required to carry items home from the store. Pozzi (2013) shows that online grocery buyers stockpile more than offline grocery buyers, purchasing in bulk when a discount appears. This ability to stockpile further restricts online pricing strategies. Third, it is difficult, though not impossible, to charge different prices for the same item at different locations; the media has not treated retailers well who have been caught charging different online prices to buyers in different locations (even if to match local offline store prices) (Valentino-Devries et al., 2012; Cavallo, 2017).

3.4 Promotion: What is the role of location in online promotion?

Location matters in online promotion. This is partly because – as mentioned above – tastes are spatially correlated. In addition, a long sociology literature, at least since Hampton and Wellman (2003), shows that social networks are highly local. Marketers have long known that word of mouth is perhaps the most effective form of promotion (Dellarocas, 2003). Online word of mouth has become increasingly important, as we discuss in the context of verification costs, but offline word of mouth remains a key tool for promotion even for products sold entirely online. Even though individuals can communicate with anyone anywhere, much online communication is between people who live in the same household or work in the same building. Promotion through local social networks can be effective (Bell and Song, 2007; Choi et al., 2010). For example, in the context of online crowdfunding of music, Agrawal et al. (2015) show that local social networks provided early support that helped promote musicians to distant strangers. There is also suggestive evidence that online recommendations are more effective if provided by people who live nearby (Forman et al., 2008). In other words, although the transportation costs for digital costs are near zero, and the transportation costs for consumers of visiting stores are reduced, a different type of transportation cost persists. This leads to spatially correlated social networks, which in turn leads to spatially correlated word-of-mouth promotion. While the online word-of-mouth literature has grown rapidly, there is still little understanding of how online and offline social networks interact. We expect the quantitative marketing literature to be well placed to address this. As Facebook and online social network platforms become increasingly important promotion channels, this gap in understanding limits our ability to design online promotion strategies.

4 Lower tracking costs

Literatures on search, replication, and transportation all began in the 1990s and were well established in the early digital marketing literature. More recently, it has become clear that two additional cost shifts have occurred: Tracking costs and verification costs have fallen.

It is easy to track digital activity. Tracking is the ability to link an individual's behavior digitally across multiple different media, content venues, and purchase contexts. Often, information is collected and stored automatically. Tracking enables extremely fine segmentation, and even personalization (Ansari and Mela, 2003; Murthi and Sarkar, 2003; Hauser et al., 2014). This has created new opportunities for marketers in promotion, pricing, and product offerings. The effect in placement has been weaker simply because often there are coordination difficulties between different vertical partners that make tracking harder.

4.1 Promotion: How do low tracking costs affect advertising?

Marketing scholars have been particularly prolific in studying the impact of low tracking costs on advertising. The improved targeting of advertising through digital media is perhaps the dominant theme in the online advertising literature (Goldfarb and Tucker, 2011b; Goldfarb, 2014). Many theoretical models on how digitization would affect advertising emphasize targeting (Chen et al., 2001; Iyer et al., 2005; Gal-Or and Gal-Or, 2005; Anand and Shachar, 2009). Much of this work has emphasized online-offline competition when online advertising is targeted, and the scarcity of advertising space online and offline (Bergemann and Bonatti, 2011; Athey et al., 2016).

A large empirical literature has explored various strategies for successful targeting. Goldfarb and Tucker (2011c) show that targeted banner advertising is effective, but only as long as it does not take over the screen too much. Targeting works when it is subtle, in the sense that it has the biggest impact on plain banner ads, relative to how it increases the effectiveness of other types of ads. Tucker (2014) shows a related result in the context of social media targeting. Targeting works when it is not too obvious to the end consumer that an ad is closely targeted.

Other successful targeting strategies include retargeting (to a partial extent) (Lambrecht and Tucker, 2013; Bleier and Eisenbeiss, 2015; Johnson et al., 2017a), targeting by stage in the purchase funnel (Hoban and Bucklin, 2015), time between ad exposures (Sahni, 2015), search engine targeting (Yao and Mela, 2011), and targeting using information on mobile devices (Bart et al., 2014; Xu et al., 2017). In each case, digitization facilitates targeting and new opportunities for advertising.

In addition to better targeting, better tracking enables the measurement of advertising effectiveness (Goldfarb and Tucker, 2011b). Early attempts to measure banner advertising effectiveness included Manchanda et al. (2006) and Rutz and Bucklin (2012). Tracking makes it relatively straightforward to identify which customers see ads, to track purchases, and to randomize advertising between treatment and control groups. More generally, prior to the diffusion of the internet, advertising measure-

ment has relied on aggregate correlations (with the exception of a small number of expensive experiments such as Lodish et al., 1995).

Perhaps the clearest result of the increased ability to run advertising experiments because of better tracking is the finding that correlational studies of advertising effectiveness are deeply flawed. For example, Lewis et al. (2011) use data from banner ads on Yahoo to show the existence of a type of selection bias that they label 'activity bias'. This occurs because users who are online at the time an advertisement is shown are disproportionately likely to undertake other online activities, including those used as outcome measures in advertising effectiveness studies. They show activity bias by comparing a randomized field experiment to correlational individual-level analysis. Measured advertising effectiveness is much lower in the experimental setting. One interpretation of this result would be to treat correlational analysis as an upper bound on the effectiveness of advertising. Gordon et al. (2019) demonstrate that this is not correct, and instead it is best to treat correlational analysis as having no useful information for measuring advertising effectiveness in the context they study. They examine a series of advertising field experiments on Facebook. Consistent with Lewis et al. (2011), they show that correlational analysis fails to measure advertising effectiveness properly. Importantly, they show that sometimes correlational analysis underestimates the effectiveness of an advertisement. Schwartz et al. (2017) demonstrate the usefulness of reframing experimental design as a multi-armed bandit problem.

Measurement challenges extend beyond the need to run experiments. Ideally, advertising effectiveness would be measured based on the increase in long term profits caused by advertising. Given the challenge in measuring long term profits, research has focused on various proxies for advertising success. For example, in measuring the effectiveness of banner advertising, Goldfarb and Tucker (2011c) used data from thousands of online advertising campaigns and randomized advertising into treatment and control groups. The analysis delivered on the promise of better measurement, but the outcome measure was far from a measure of long term profits. In order to get a systematically comparable outcome measure across many campaigns, the paper used the stated purchase intent of people who took a survey after having randomly allocated into seeing the advertisement or seeing a public service announcement. Advertising effectiveness was measured as the difference in stated purchase intent between the treatment and control groups. This is a limited measure of effectiveness in at least two ways. First, only a small fraction of those who saw the ads (whether treatment or control) are likely to take the survey and so the measure is biased to the type of people who take online surveys. Second, purchase intent is different from sales (which in turn is different from long term profits).

In our view, for the purpose of comparing the effectiveness of different types of campaigns, this measure worked well. We were able to show that contextually targeted advertising increases purchase intent compared to other kinds of advertising, and that obtrusive advertising works better than plain advertising. Furthermore, we found that ads that were both targeted and obtrusive lifted purchase intent less than ads that were either targeted or obtrusive but not both. At the same time, this mea-

sure would not be useful for measuring the return on advertising investment or for determining the efficient allocation of advertising spending.

To address questions like these, subsequent research has built new tools for measuring actual sales. Lewis and Reiley (2014) link online ads to offline sales using internal data from Yahoo! and a department store. The paper linked online user profiles to the loyalty program of the department store using email addresses. With this measure, they ran a field experiment on 1.6 million users that showed that online advertising increases offline sales in the department store. While still not a measure of long term profits, this outcome measure is more directly related to the true outcome of interest. This came at the cost of challenges in comparing across types of campaigns and across categories.

This study was possible because the research was conducted by scholars working in industry. Such industry research has been important in developing better measures of outcomes, as well as more effective experimentation. Other examples include Lewis and Nguyen (2015), who show spillovers from display advertising to consumer search; Johnson et al. (2017a), who provide a substantially improved method for identifying the control group in the relevant counterfactual to firms that choose not to advertise; and Johnson et al. (2017a), who examine hundreds of online display ad campaigns to show that they have a positive effect on average.

Even in the presence of experiments and reliable outcome measures, Lewis and Rao (2015) show that advertising effects are relatively low powered. In other words, the effect of seeing one banner ad once on an eventual purchase is small. It is meaningful and can deliver a positive return on investment, but demonstrating that requires a large number of observations. Johnson et al. (2017b) show that better controls can increase the power of the estimated effects, though this effect is modest. In addition, they found that careful experimental design and sample selection can lead to a substantial boost in power.

In general, given these findings, advancing the literature poses some challenges for marketing scholars. This is because it appears increasingly necessary, given the high variance of advertising effectiveness and small effect sizes, to work with marketing platforms to calibrate effects. This need is magnified because of the use of advertising algorithms in these platforms which make understanding a counterfactual problematic (Eckles et al., 2018). It is unlikely that advertising platforms would encourage researchers to study newer issues facing their platforms such as algorithmic bias (Lambrecht and Tucker, 2018) or the spread of misinformation through advertising (Chiou and Tucker, 2018).

This is important because some of the biggest research questions that are open in digital marketing communications are no longer simply about advertising effectiveness. Instead, there are now large policy issues about the consequences of the ability to track and target consumers in this way. An example of the challenges facing the online targeting policy debate, is the extent to which regulators should be worried about advertising that is deceptive or distortionary. Though there has been much discussion about the actions of firms such as Cambridge Analytica that use Facebook data to target political ads, as of yet there has been limited discussion in marketing

about the issues of deceptive uses of targeting. Again, we expect this will be a fruitful avenue of research.

4.2 Pricing: Do lower tracking costs enable novel forms of price discrimination?

Low tracking costs can enable new ways to price discriminate. Early commentators on the impact of digitization emphasized this potential (Shapiro and Varian, 1998; Smith et al., 2001; Bakos, 2001). Tracking means that firms can observe customer behavior and keep tabs on customers over time. This enables behavioral price discrimination (see Fudenberg and Villas-Boas (2012) and Fudenberg and Villas-Boas (2007) for reviews). This literature emphasizes how identifying previous customers affects pricing strategy and profitability (Villas-Boas, 2004; Shin and Sudhir, 2010; Chen and Zhang, 2011). While digital price discrimination has received a great deal of attention in the theory literature, empirical support is limited. Other examples of online price discrimination include Celis et al. (2014) and Seim and Sinkinson (2016).

Perhaps the best example is Dube and Misra (2017), who document that targeting many prices to different customers can be profitable in the context of an online service. This paper relies on a large scale field experiment to learn the optimal price discrimination policy. It then demonstrates that the learned policy outperforms other pricing strategies, using an experiment. In other words, the paper demonstrates the opportunity in price targeting and convincingly shows it works in a particular context using experimental design.

One area where we have seen high levels of price discrimination is online advertising. Individual-level tracking means that there are thousands of advertisements to price to millions of consumers. Price discrimination is feasible but price discovery is difficult. As a consequence, digital markets typically use auctions to determine prices for advertising. Auctions facilitate price discovery when advertisements can be targeted to individuals based on their current and past behavior.

In the 1990s, online advertising was priced according to a standard rate in dollars (or cents) per thousand impressions. Early search engine Goto.com was the first to recognize that an auction could be used to price discriminate in search advertising. Rather than a fixed price per thousand on the search page, prices could vary by search term. Today, both search and display advertising run on this insight, and a large literature has explored various auction formats for online advertising (Varian, 2007; Edelman et al., 2007; Levin and Milgrom, 2010; Athey and Ellison, 2011; Zhu and Wilbur, 2011; Arnosti et al., 2016). As long as an auction is competitive, the platform is able to price discriminate with much more detail than before. While this might generate more efficient advertising in the sense that the highest bidder values the advertisement the most, it also may enable the platform to capture more of the surplus from advertising. In other words, by enabling better price discrimination, advertising auctions likely lead to the familiar welfare effects of price discrimination between buyers and sellers, in this case the buyers and sellers of advertising. The impact on

consumer welfare is ambiguous and likely depends on the particular way in which advertising enters the utility function.

4.3 Product: How do markets where the customer's data is the 'product' lead to privacy concerns?

Tracking is an opportunity for marketers to segment. It also creates privacy concerns. Therefore, low tracking costs have led to a resurgence of policy interest in privacy.

A core question in the privacy literature is whether privacy is an intermediate good that is only valuable because it affects consumers indirectly (such as through higher prices) or whether privacy a final good that is valued in and of itself (Farrell, 2012). The theoretical literature has focused on privacy as an intermediate good (Taylor, 2004; Acquisti and Varian, 2005; Hermalin and Katz, 2006), while policy discussions often emphasize privacy as a final good. Research outside of marketing such as Acquisti et al. (2013, 2015) have argued that this discussion has been complicated by inconsistent behavior of consumers towards their desires for privacy – leading to a privacy paradox – where consumers behave in a way which contradicts their stated preferences (Athey et al., 2017a).

Many examples of privacy regulation have been aimed at marketers. Such regulation limits what marketers can do with data. It affects the nature and distribution of outcomes (Goldfarb and Tucker, 2012). For example, European privacy regulation in the early 2000s substantially reduced the effectiveness of online advertising in Europe (Goldfarb and Tucker, 2011e). Assuming that opt-in policies mean that fewer users can be tracked, Johnson (2014) builds a structural model to estimate the financial costs of opt-in privacy policies relative to opt-out. The estimates suggest that opt-in policies can have substantial financial costs to platforms. While negative effects of privacy regulation have been shown in a variety of contexts (Miller and Tucker, 2009, 2011; Goldfarb and Tucker, 2011e; Miller and Tucker, 2018; Johnson et al., 2017c), firm-implemented policies that protect the privacy of their consumers can have strongly positive effects (Tucker, 2012, 2014).

Privacy regulation also affects the nature of product market competition (Campbell et al., 2015). It can either constrain the ability of smaller firms to compete cost-effectively (Campbell et al., 2015), or lead firms to intentionally silo data about consumers (Miller and Tucker, 2014).

In our view, the empirical privacy literature in marketing is surprisingly sparse. Marketers have an important role to play in the debate about data flows because we are among the primary users of data. While there has been some progress on research with respect to marketing policy, we have little empirical understanding of the strategic challenges that relate to privacy. How should firms balance customer demands for privacy and the usefulness of data to provide better products? What is the best way to measure the benefits of privacy to consumers, given that short term measures suggest consumers are often not willing to pay much to protect their privacy, while the policy debate suggests consumers may care in the longer term? Overall, there are a number of opportunities for marketing scholars to provide a deeper understanding of

when increased privacy protection will generate strategic advantage. We expect that one such opportunity will be regulations, such as the EU General Data Protection Regulation (GDPR) which came into effect in May 2018. It was significant as the first privacy regulation which has had a truly global impact and therefore affects not just firms within the EU but across the world.

4.4 Placement: How do lower tracking costs affect channel management?

Lower tracking costs can make it easier for a manufacturer to monitor behavior in retail channels by tracking prices available online. Israeli (2018) discusses the usefulness of minimum advertised pricing restrictions that manufacturers sometimes impose on retailers to reduce downstream price competition. Using a quasi-experimental setting, the paper demonstrates that easier tracking of online prices makes minimum advertised pricing policies more effective. Easier tracking enables different levels of control in channel relationships. We believe there are opportunities for further research in this area, especially in understanding how conflicts over control of digital technologies affects channel conflict. A recent example of such work is Cao and Ke (2019), who investigate how channel conflict emerges when it is possible to pinpoint precisely a pair of eyeballs that may be interested in a particular search query and try and advertise to them.

5 Reduction in verification costs

Reduced tracking costs have had an additional effect of improving verification. This was not anticipated in the early literature which emphasized online anonymity. Perhaps the most familiar verification technology in marketing is the brand (Shapiro, 1983; Erdem and Swait, 1998; Tadelis, 1999; Keller, 2003). The ability to verify online identity and reputation without the need to invest in mass market branding has affected marketing in a variety of ways. Verification is likely to continue to improve, with the advent of new digital verification technologies such as blockchain (Catalini and Gans, 2016).

5.1 Pricing: How willingness to pay is bolstered by reputation mechanisms

Digital markets involve small players who may be unfamiliar to potential customers. An estimated 88% of online Visa transactions are with a merchant that the customer does not visit offline (Einav et al., 2017). While brands do play a role online (Brynjolfsson and Smith, 2000; Waldfogel and Chen, 2006), for small players to thrive, other verification mechanisms are needed. Online reputation mechanisms reduce the importance of established brands and enable consumers to trust small online sellers. Furthermore, Hollenbeck (2018) provides evidence that online reputation mecha-

nisms can reduce the importance of offline brands. In particular, the paper demonstrates that high online ratings lead to higher sales in offline independent hotels. Luca (2016) finds a similar result for restaurants.

There are many ways that a platform might regulate the behavior of its users. This includes systems that ban users who behave undesirably. However, the majority of platforms lean on online ratings systems. In such systems, past buyers and sellers post ratings for future market participants to see. There is a large literature on the importance of eBay's online rating system to its success, as well as a variety of papers that explore potential changes and improvements to that system and their impact on prices, market outcomes, and willingness to pay (Resnick and Zeckhauser, 2002; Ba and Pavlou, 2002; Lucking-Reiley et al., 2007; Cabral and Hortacsu, 2010; Hui et al., 2016). For example, Hui et al. (2016) demonstrate that eBay's reputation system is effective in reducing bad behavior on the part of sellers, but it needs to be combined with eBay's ability to punish the worst behavior in order to create a successful marketplace on which small sellers can thrive. Perhaps the key theme of this literature is that online reputation mechanisms increase willingness to pay and sometimes enable markets that otherwise would not exist.

5.2 Product: Is a product's 'rating' now an integral product feature?

In addition to enhancing trust and willingness-to-pay, ratings systems provide information on product quality. The rating becomes a key feature of a platform. Ratings inform consumers about the best products available within the platform, and are therefore a key element of the overall product offering. Platforms benefit because rating information guides consumers to the highest quality products. For example, Chevalier and Mayzlin (2006) demonstrate that positive reviews lead to higher sales in the context of online retail. Even online identities that are consistent over time but not connected to a name or home address can influence consumption (Yoganarasimhan, 2012). For some online platforms, such as Yelp, their product is to provide ratings about offline settings. As noted above, Luca (2016) and Hollenbeck (2018) show that high online ratings improve sales in offline restaurants and hotels, particularly for independents. In both cases, the online rating system is a substitute for a widely known chain brand. Godes and Silva (2012) also show that such ratings have the potential to exhibit dynamics that reflect real economic effects. This insight is built on by Muchnik et al. (2013), who document herding in ratings behavior on a news website.

In addition to the idea of a rating system controlled by the platform as being an integral product feature, organic and digital forms of word-of-mouth are also essential heuristics that consumers use when making purchase decisions about a product (Godes and Mayzlin, 2009). Work such as Toubia and Stephen (2013) has also studied why it is that consumers post word of mouth on platforms such as Twitter, and has drawn a distinction between the intrinsic and extrinsic utility that consumers derive from posting. Lambrecht et al. (2018), however, suggest that some of the most attractive potential spreaders of word-of-mouth, people who start memes on social platforms, are also the most resistant to advertising.

5.3 Placement: How can channels reduce reputation system failures?

In addition to understanding the successes of reputation systems, a wide literature has explored when reputation systems fail. A key source of failure is the inability to verify whether the person doing the online rating actually experienced the product. Mayzlin et al. (2014) and Luca and Zervas (2016) show evidence that firms seem to give themselves high ratings while giving low ratings to their competitors. A related issue is selection bias in who chooses to provide ratings (Nosko and Tadelis, 2015). Anderson and Simester (2014) show evidence of a related problem: Many reviewers never purchase the product. They review anyway and these reviews distort the information available. In response to these and other concerns, platforms regularly update their reputation systems. For example, Fradkin et al. (2017) document two experiments made at Airbnb to improve their reputation system. What was striking about these experiments is that rather than too many 'fake' reviews being a problem, instead here the challenge the platform faced was incentivizing users to give accurate accounts of negative experiences. This paper established that too much 'favorable' opinion can be a problem in such settings.

The existing literature has provided a broad sense of when and how online reputation systems might fail. This suggests new opportunities for scholars focused on market design. Given the challenges in building online reputation systems, it is important to carefully model and build systems that are robust to these failures.

5.4 Promotion: Can verification lead to discrimination in how goods are promoted?

Improved verification technology meant that the early expectations of online anonymity have not been met. For example, early literature showed that online car purchases could avoid the transmission of race and gender information, thereby leading to a reduction of discrimination based on these characteristics (Scott Morton et al., 2003).

As verification technology has improved, this anonymity has largely disappeared from many online transactions. This has led to concerns that online identities can be used to discriminate. For example, when information about race or gender is revealed online, consumers receive advertisements for different products and may even receive offers of different prices (Pope and Sydnor, 2011; Doleac and Stein, 2013; Edelman and Luca, 2014).

One recent example of this has been the question of algorithmic bias in the way that advertising is distributed – something that has been highlighted by computer scientists (Sweeney, 2013; Datta et al., 2015). In Marketing and Economics, Lambrecht and Tucker (2018) show that a career ad that was intended to highlight careers in the STEM fields that was shown to more men than women, did so due to the price mechanism underlying the distribution of ads. Male eyeballs are cheaper than female eyeballs, so an ad algorithm that is trying to be cost-effective will show any ad to fewer women than men.

This type of apparent algorithmic bias is a surprising consequence of improvements in verification technology. In the past, it was not possible to verify gender easily. Instead, firms used content to separate out likely gender affiliation – such as assuming men were more likely to read fishing magazines and women more likely to read beauty magazines. However, in a digital ecosystem where characteristics such as gender can be verified, it means that there is now the possibility that inadvertently our ability to classify gender could lead to perceptions of bias in areas where the distribution of content in a non-gender-neutral way is problematic.

6 Conclusions

Digital marketing is inherently different to offline marketing due to a reduction of five categories of costs: Search, reproduction, transportation, tracking, and verification.

In defining the scope of this article, we drew boundaries. We focus on understanding the impact of the technology on marketing using an economic perspective. Therefore, we did not discuss much work written in marketing that focuses on methodology, such as the statistical modeling in digital environments literature (Johnson et al., 2004; Moe and Schweidel, 2012; Netzer et al., 2012). We also did not detail the consumer behavior literature on the effect of digital environments (Berger and Milkman, 2012; Castelo et al., 2015).

This overview highlights that changes to marketing that result from the change of costs inherent in the digital context are not as obvious as initial economic models may imply. Instead, as may be expected, the complexities of both firm and consumer behavior have led to less than predictable outcomes. It is these less predictable outcomes which have allowed marketing contexts to inform the economics literature on the likely effects of digitization outside of marketing.

Going forward, we anticipate the most influential work to fall into one of three categories. First, there are still many opportunities to unpack the existing models and identify new complexities in how the drop in search, reproduction, transportation, tracking, and verification costs affect various aspects of marketing. Many recent papers fall in this category, including Blake et al. (2015), Simonov et al. (2018a), Hollenbeck (2018), and Farronato and Fradkin (2018). In the above discussion, we have highlighted some areas that we see as particularly important topics for future research.

Second, as policies change, new business models arise, and new technologies diffuse, there will be opportunities to understand these changes in light of existing models. Recent papers of this type include Bart et al. (2014), Miller and Tucker (2018), Lambrecht and Tucker (2018), and Johnson et al. (2017c).

Third, some of the changes brought by digitization and other advances in information technology will require recognition of different types of cost changes. Just as the early internet literature emphasized search, replication, and transportation costs, and only later were tracking and verification costs recognized as important consequences, we anticipate technological change to lead to the application of other well-established

models into new contexts. For example, one recent hypothesis is that recent advances in machine learning can be framed as a drop in the cost of prediction which can be modeled as a reduction in uncertainty (Agrawal et al., 2018).

For each of these categories, economic theory plays a fundamental role. Search theory provided much of the initial impetus for the digital marketing literature. It provided hypotheses on prices, price dispersion, and product variety. Some of these hypotheses were supported, but others were not. In turn, this generated new models that could explain the data, and the cycle continued. Models of reproduction costs, transportation, tracking, and verification played similar roles. This led to a much deeper understanding of the consequences of digitization on marketing.

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