

## Platforms: A Multiplicity of Research Opportunities\*

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October 2013

This version: March 2014

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\* This paper is based on the discussion among participants in a workshop (with the same title) at the 9<sup>th</sup> Invitational Choice Symposium at Erasmus University, the Netherlands, in June 2013. We are very grateful to the co-chairs, Benedict Dellaert and Bas Donkers, for giving us the opportunity to hold this workshop at the symposium. Please direct all feedback to the co-chairs at [ssrira@umich.edu](mailto:ssrira@umich.edu) and [pmanchan@umich.edu](mailto:pmanchan@umich.edu). The usual disclaimer applies.

# Platforms: A Multiplicity of Research Opportunities

## Abstract

Platforms refer to intermediaries that facilitate economic interaction between two sets of agents wherein the decisions of one set of agents is likely to have an effect on the other via direct and/or indirect externalities. Given their nature, platforms need to find the appropriate balance between the competing objectives of agents and act as catalysts by facilitating the beneficial effects of externalities. In this paper, we discuss the current theoretical and empirical literature on two-sided platforms. We then identify three dimensions that offer opportunities to advance the empirical literature: (a) unanswered theoretical and conceptual questions, (b) data-related opportunities, and (c) methodological challenges.

Keywords: Platforms, Two-sided Markets, Internet Commerce, Simultaneity

## 1. Introduction

Platforms refer to intermediaries that facilitate economic interaction between two sets of agents wherein the decisions of one set of agents is likely to have an effect on the other via direct and/or indirect externalities.<sup>1</sup> A classic example of platforms is a television network that brings together advertisers and viewers. The externality arises because an advertiser's decision to advertise on a television network depends on the size and composition of the audience that accesses the platform. Similarly, the size and the composition of the audience depends on the cost of accessing the platform, e.g., as a function of the number of ads.

Although the above example is unambiguously accepted as a two-sided platform, there are three alternative definitions in the literature. The first definition, initially proposed by Evans (2003), is based on the presence of cross-network externalities between one or more groups. Rochet and Tirole (2006) propose an alternative outcome-based definition wherein the volume of transactions on the platform is affected by the pricing structure, i.e., the aggregate level of prices across all sides and the relative level of prices charged to each side (with price broadly defined as access and/or usage fee). They point out that platform price structure would matter because of (a) the presence of transaction costs between the interacting sides and (b) constraints imposed by the platform on the pricing of transactions between groups. The third definition of two-sided platforms is due to Hagiu and Wright (2011). The authors argue that the first two definitions are over-inclusive and define a multi-sided platform as “*an organization that creates value primarily by enabling direct interactions between two (or more) distinct types of affiliated customers.*” By requiring direct interactions between the two groups that is only facilitated by the platform, and not mediated by it, they rule out the re-seller format. In contrast, supermarkets would qualify as platforms under the first and second definitions, as broadly speaking, suppliers care about customers and vice-versa with respect to the assortment and prices at a supermarket.

We echo the sentiment in Rysman (2009) that the definition of two-sided markets is more a semantic issue. Instead, the definitional criterion ought to be the importance of the “two-sidedness” in determining

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<sup>1</sup> If there is only one intermediary, then agents are “single-homing” else they are “multi-homing.” Participation and profitability is different in these two settings (discussed later in detail).

outcomes of interest. For example, it might be reasonable to characterize a supermarket as two-sided if the extent to which it is able to offer variety as a result of its suppliers' decisions varies significantly with patronage on the customer side. If this effect is limited, then it might not be worthwhile to study this market as a platform. Furthermore, the importance of two-sided issues in a market might evolve over time. Therefore, we need to evaluate the value of characterizing a market as two-sided based on the importance of the cross-network effects at a given moment.

Given the ubiquity of platforms, it is useful to classify them into four broad types (as suggested in Evans and Schmalensee 2008). The first category of platforms is *exchanges* (e.g., eBay or eHarmony), which facilitate transactions between buyers and sellers by enabling them to search for feasible contracts. The second group of platforms is *advertiser-supported media* such as television and newspapers, which bring advertisers and audiences together. The third class of platforms is *transaction systems* such as payment cards, bringing together the merchants and their customers. The fourth category is *hardware/software platforms* such as video game consoles and computer operating systems. A video game console platform brings together software developers that are more likely to offer a wide variety of games if the platform has a large installed base. At the same time, users are likely to prefer a platform that offers a wide(r) variety of games. In our opinion, this category also includes *standards* (though Evans and Schmalensee 2008 do not include them explicitly). A standard acts as a platform and can arise either de facto (via market outcomes) or through third party intervention (e.g., governments, international bodies etc.). Shriver (2013) considers an example in motor fuels, where the government classified E85 as an alternative fuel, mandated the use of the fuel by government fleets, and encouraged private sector adoption by providing generous subsidies.

Most of the extant work on platforms is theoretical and operationalized in stylized analytic models. While there has been some empirical research in this area, the field is relatively nascent. Our objective is to develop an agenda for future empirical research on (multi-sided) platforms. In our view, there are three dimensions of this area that are likely to prove fertile. Given that the extant theoretical research on platforms provides many insights and/or predictions, the first dimension is the identification of theoretical findings that can be empirically tested. In addition, we discuss some important conceptual issues that warrant further

investigation. The second dimension pertains to exploiting new and richer sources of data that are becoming increasingly available in the context of two-sided markets. While data requirements for conducting empirical research in two-sided markets are significantly higher than in traditional markets, such data are becoming increasingly more accessible to researchers. Getting a critical mass of researchers together is likely to accelerate the discovery and use of platform data. The third dimension is the isolation and solving of idiosyncratic methodological challenges that arise in the analysis of platform data.

The rest of the paper is organized as follows. We first discuss the key findings in the theoretical literature on two-sided platforms. Next, we discuss the main empirical findings in this area. We then present some avenues for future research in the area of platforms. We conclude in the final section.

## 2. Theoretical Research

Theoretical research has sought to characterize some basic properties that arise in two-sided markets. The fundamental issue in two-sided markets is that of “getting both sides on board.” This can lead to a chicken-and-egg problem. For instance, when there are positive cross-group externalities, neither group may choose to participate based on unfavorable expectations regarding the other side. Researchers have examined various facets of this aspect.

First, the presence of cross-group externalities raises the possibility that markets might “tip,” resulting in a dominant firm cornering much of the market. Unlike in traditional markets, such a condition can persist and dissuade further entry because consumers hold unfavorable beliefs about (participation on) a rival platform, i.e., the chicken-and-egg problem works against competitive entry. Caillaud and Jullien (2003) show that such a tipping equilibrium may occur only when it is efficient and is per-se not a sign of market power. When both sides of the market can only single-home, and platforms are otherwise undifferentiated, it is efficient for the market to support only a single firm and, indeed, this obtains in equilibrium. However, the situation is different when both sides can multi-home. When multi-homing improves market efficiency, competing platforms can co-exist and realize positive profits: the outcome is however asymmetric (even though the platforms are *a priori* symmetric), with one platform cornering a larger portion of the interactions.

If multi-homing is not efficient, then again a tipping equilibrium obtains, but the dominant firm can realize positive profits.

Second, the chicken-and-egg problem suggests that an important role for the platform is to coordinate expectations on one or more sides in order for the market to obtain. Hagiu (2006) studies markets where one side (sellers) makes their participation decisions before the other side (buyers). He shows that if sellers have unfavorable expectations about buyer adoption, then a monopoly platform may delay announcing its price for buyers till after sellers have adopted, since this reassures sellers that it will ex-post attract enough buyers. Hagiu and Spulber (2013) further show that a platform can overcome unfavorable expectations of sellers by providing first-party content (e.g., in-house video games developed by the console manufacturer) that can substitute for the content to be provided by sellers.

Third, a platform can “balance” the demand from each side of the market by formulating a suitable pricing structure that accounts for the cross-group externalities. It is often the case that one of the sides is subsidized, whereas the other side generates profits. Rochet and Tirole (2003, 2006) and Armstrong (2006) show for settings with usage-based and membership-based externalities that such “distortions” are not indications of predatory pricing (on the subsidized side) or market power (on the profit generating side), but can actually improve market efficiency. This literature stream shows that the price structure depends on the relative size of cross-group externalities and the whether groups single-home or multi-home. With respect to the first issue, the side that exerts a more positive externality on the other side is more aggressively targeted by the platform through a lower price. Further, any aspect that increases the platform’s surplus on one side of the market will cause the price on the other side to fall, as the externality created by the other side has now become more valuable. For the second issue, the most interesting situation arises when one group multi-homes while the other single-homes. In this case, the platform creates a “competitive bottleneck” for the multi-homing side to interact with the single-homing side, thereby effectively leading to a de-facto monopoly situation on the multi-homing side. This leads to higher prices on the multi-homing side. In turn, this leads to

intense competition to gain a larger monopoly access on the single-homing side, and hence this side is subsidized.

More recently, research has started to examine non-price dimensions of two-sided markets. For example, Hagiu (2007) shows that the merchant mode is more profitable when the chicken-and-egg problem is more severe and the degree of complementarity amongst sellers is higher. The platform mode is preferred when seller's investment incentives are more important and there is asymmetric information about seller product quality. Hagiu and Wright (2013) provide more insights into this tradeoff showing that it depends on control rights, marketing spillovers across products, and product assortment. There is also growing interest in how a platform may facilitate transactions in a marketplace where buyers are uncertain about seller quality. In the context of online daily deals, Subramanian and Rao (2013) show that while sellers may not be able to signal their quality through price and the platform may not be able to screen out low-quality merchants through a suitable contract, the platform can make the marketplace more transparent by enabling social learning. However, it may not always be in the interest of the platform to do so.

### **3. Empirical Literature**

Empirical work on two-sided markets can be classified into three categories based on the research objective: (a) investigating the presence and magnitude of cross-network effects, (b) studying decisions made by the platform, such as price structure, and (c) evaluating policy implications.

#### **3.1. Presence and Magnitude of Cross-network Effects**

Gandal, Kende, and Rob (2000) are among the first to explicitly measure cross-network externalities. They measure the effect of hardware prices and software titles in the diffusion of CD players, and find that a 10% increase in CD titles would have an effect equivalent to that of lowering price by 5%. Similarly, in the context of the personal digital assistants market, Nair et al. (2004) find that the availability of software on a platform is a function of the installed base of the hardware and the sales of hardware is a function of the number of available software titles. Akerberg and Gowrisankaran (2006) estimate the size and importance of network externalities in the automatic clearing house (ACH) banking industry and find that most of the impediment to

ACH adoption is from the large customer fixed cost of adoption. A common implication of these findings is that it is important for a platform to provide appropriate incentives in order to ensure that there is a critical mass of agents on both sides of the market.

In the context of advertising supported media, researchers have documented both positive and negative indirect network externalities. For example, in the market for yellow pages, Rysman (2004) finds that there are significant positive cross-network effects on both sides; advertisers value more readers and vice versa. In contrast, Wilbur (2008) finds a negative effect of the number of television advertisements on audience size (viewers are ad averse) and a positive effect of audience size on advertiser demand (advertisers are viewer loving). Thus, while it is clear that advertisers always value access to more readers, the value that readers place on advertising is ambiguous.

Several studies have empirically investigated the evolution of cross-network externalities. In the context of video game systems in the U.S., Clements and Ohashi (2005) find that introductory pricing is an effective practice at the beginning of the product cycle, and expanding software variety becomes more effective later. Chu and Manchanda (2013) quantify two-way cross-network effects in online consumer-to-consumer platforms. They find that the cross-network effect is asymmetric with the installed base of sellers having a much larger effect on the growth of buyers than vice versa. The growth in the number of buyers is driven primarily by the seller's installed base and product variety with increasing importance of product variety. The growth in the number of sellers is driven by buyer's installed base, buyer quality, and product price with increasing importance of buyer quality.

### **3.2. Platform Decisions**

Researchers have also examined competition, price structure, and market power in two-sided markets. Kaiser and Wright (2006) study the price structure in the magazine industry and find that consistent with advertisers valuing readers more than readers valuing advertisements, prices for readers are subsidized and that magazines make all their money from advertisers. In their empirical investigation of the Spanish newspaper market, Esteban-Bravo and Vidal-Sanz (2013) find that the prices that readers pay for newspapers are lower than the unit cost of producing a copy. This result reinforces the notion that newspapers have traditionally

subsidized readers at the expense of advertisers. In the context of the Italian newspaper market, Argentesi and Filistrucchi (2007) find evidence of collusion on the newspaper cover price and competition on advertising. This result is somewhat consistent with the theoretical predictions (e.g., Evans and Schmalensee (2007) and Ruhmer (2011) that it is difficult to sustain a full-fledged collusion in two-sided markets, while platform profits can be higher with semi-collusion (Dewenter, Haucaup and Wenzel 2011).

On the temporal dimension, Liu (2010) empirically studies firms' optimal pricing strategies in the video-game console market, where network effects and consumer heterogeneity provide competing incentives for penetration pricing and price skimming. In the context of the U.S. print newspaper industry, Pattabhiramaiah et al. (2013) consider two plausible explanations for the rising subscription prices despite the decline in preference for print readership: (a) newspaper firms' strategic decision to serve only the higher willingness-to-pay segment of readers and (b) the reduced incentive to subsidize readers at the expense of advertisers, owing to a declining demand for newspaper advertising (Sridhar and Sriram 2013, Seamans and Zhu 2013). Based on their empirical analysis, they find that the second explanation rationalizes most of the increase in subscription prices.

### **3.3. Market Outcomes and Policy Implications**

The presence of cross-network effects can have some unique policy implications on three dimensions: (a) market structure, (b) implications of mergers, and (c) standard setting. Chen and Xie (2007) examine the competitive implications of asymmetric customer loyalty in two-sided markets and find that in the presence of a cross-market network effect, a midlevel of loyalty advantage in the primary product market can lead to an overall profit disadvantage. Dubé et al. (2010) study tipping and concentration in the video game console market. Consistent with the theoretical prediction in Caillaud and Jullien (2003), they find that cross-network effects can lead to a strong, economically significant increase in market concentration.

As with single-sided markets, mergers among firms in two-sided platforms are likely to arouse regulatory scrutiny if the post-merger firm is likely to wield significant market power. Merger analysis is, however, considerably more complex in the two-sided markets case due to cross-“side” demand effects: prices on each

side of the market are jointly determined by the costs and demand functions on both sides. These cross-side effects in turn raise complications for how markets are defined and how market power is measured. In theory, markets should be defined by the set of firms serving the same customers on both sides of the market; in practice, this may prove quite difficult if firms offer differentiated products. Similarly, market power in two-sided markets may no longer be inferred directly from price-cost markups as there is no longer a predictable relationship between price and marginal cost on a given side of the market.

The evidence on the consequences of platform mergers are currently mixed. Several studies have found that mergers in two-sided markets would be beneficial to either side of the market. Chandra and Collard-Wexler (2009) develop a two-sided market model and derive predictions on post-merger price changes. They find that (in the Canadian newspaper market) greater concentration did not lead to higher prices for either side. Song (2013) estimates platform markups in the TV magazines in Germany and finds that the magazines typically set copy prices below marginal costs and earn profits from selling advertising pages. He also finds that mergers are much less anticompetitive than in one-sided markets and could even be welfare enhancing. On the other hand, there is evidence on the deleterious effects of mergers. Filistrucchi et al. (2012) study mergers in the Dutch newspaper market and find that taking into account two-sidedness predicts an increase in ad rates where a one-sided analysis would not. Fan (2013) estimates a structural model of newspapers that incorporates both product quality and prices. She shows that subscription prices would increase, while quality, circulation, and ad revenues would decrease.

## **4. Opportunities for Research**

### **4.1. Unanswered Theoretical and Conceptual Questions**

Empirical research on platforms has mostly focused on pricing decisions (e.g., Rysman 2009). While pricing is an important decision in the context of platforms, other important aspects have been less explored. A notable exception is a stream of research on reputation systems, which mostly used data obtained from Ebay.com (Resnick and Zeckhauser 2002, Resnick et al. 2006, Cabral and Hortacsu 2010). Researchers have also investigated the effect of different information disclosure formats on the growth of user base (Tucker and

Zhang 2010), and the effect of linking among developers at content websites (Ma et al. 2013). However, many questions remain open in this area. First, how does heterogeneity among buyers or sellers affect a platform? Although empirical research till date has focused the size of networks, we argue that the type of agents that a platform attracts on either side might be at least as important as the actual number of agents. The increasing availability of data at the individual buyer/seller level can enable researchers to perform detailed analyses of horizontal and vertical differentiation among buyers and sellers. This, in turn, could enable researchers to advise platform firms on management issues such as user selection and quality control.

Second, what are the effects of search and advertising in platform markets on nature and quantity of transactions between buyers and sellers, as well as on platform revenues? Advertising and consumer search are critical for web-based commerce. Exchange platforms such as Taobao.com often derive a substantial portion of their revenue through advertising and add-on services. The provision of such services greatly affects the interactions among buyers and sellers. The optimal quantity of search functionality and/or regulated advertising is therefore a crucial platform management question.

Given the relatively large theory literature, there is scope to empirically test theoretical predictions. For example, the theoretical literature on advertising media suggests that the ability of advertisers to target their advertising to specific audience can have an impact on advertising rates (e.g., Bergemann and Bonatti 2011). While there has been some effort to empirically test this finding, there is scope to validate it in a variety of contexts. To illustrate, as newspapers erect “pay walls” for content on their website, the ensuing audience is likely to be different (and probably more attractive to advertisers) from the users who access free content. If this is true, newspapers can generate more advertising revenues from their online advertisers after erecting pay walls despite the drop in web traffic. Similarly, there are several instances when a platform plays a dual-role, both as a facilitator of exchange between buyers and sellers, and as a buyer/seller itself. For example, Amazon.com, operates a marketplace linking independent sellers and buyers, and at the same time, sells to buyers directly. When should a platform play such a dual role? What is the effect of platform involvement on buyer and seller participation, especially in a dynamic context? The theory literature (e.g., Hagiu (2007) and

Hagiu and Wright (2013)) makes some empirically testable predictions regarding a firm's choice of organizational form between merchant/re-seller and the two-sided platform.

Another stream of interesting research questions pertain to conditions under which it is efficient for governments to mandate standards. The theory literature has recognized some advantages and disadvantages of government intervention under different conditions. These are when the speed of adoption is critical and the choice of standards is arbitrary (Lemley and McGowan (1998) and when little technological progress is likely (Besen and Johnson 1986, Farrell and Klemperer 2007). Empirical research can shed light on the effect of government intervention in specific industries via appropriate counterfactual analyses performed conditional on empirically estimated parameters.

In addition, researchers can also identify interesting research opportunities by considering traditional markets e.g., supermarkets as platforms. For example, researchers have investigated how retail prices respond to changes in demand, especially in terms of cyclical/counter-cyclical pricing. Taking a two-sided perspective, researchers can study how the interactions between manufacturers and retailers change in response to the varying composition of consumers during peak and off-peak seasons (via the measurement of wholesale prices and side payments such as slotting allowances).

Testing theoretical predictions that vary by market conditions promises to be another avenue for research in this area. For example, the empirical findings in Dubé et al. (2010) that cross-network effects can lead to increase in market concentration is consistent with the theoretical prediction in Caillaud and Jullien (2003). Nevertheless, the theoretical literature also predicts that if consumers are sufficiently heterogeneous in their preference of videogame platform (e.g., Nintendo Wii vs. Microsoft Xbox) then it is possible for competing platforms to co-exist.

#### **4.2. Methodological Challenges**

In addition to the substantive issues discussed above, researchers also have the opportunity to contribute to research on platforms by addressing some unique methodological challenges. For example, a well acknowledged problem while studying the behavior of agents in two-sided platforms is the issue of simultaneity. Since platforms bring together two sets of agents with interdependent preferences and actions,

their decisions are likely to be simultaneously determined. Breaking this simultaneity and inferring causal effects would require identifying suitable excluded variables. In instances, where reasonable excluded variables are hard to identify, non-parametric approaches have been developed (e.g., Manski and Pepper 2000, 2009; Shriver et al. 2013). Methodological advancements might also help in recovering economically important parameters that might be hard to recover using extant approaches. A case in point is the scenario when one side of the market experiences no variation in usage and access fees (e.g., extreme subsidy in the form of free access of news content to readers). Given that there is no variation in prices, one cannot infer the price sensitivity of the subsidized side of the market. Researchers can identify potential approaches to circumvent this problem and recover the parameter of interest.

Another methodological challenge that is relatively underexplored in the context of two-sided platforms is the notion of multiple equilibria. Given that there are cross-network effects between agents on either side, different parameter values that characterize their incentives can potentially rationalize the observed outcomes. In this regard, the challenge is very similar to the issue of multiple equilibria encountered in entry models (e.g., Bresnahan and Reiss 1991, Berry 1992). In the presence of multiple equilibria, researchers need to identify appropriate selection criteria to pick reasonable candidates (e.g., Lee and Pakes 2009). We believe that this is a fertile area to advance the research on platforms on the methodological front.

As we discuss below, the increasing availability of rich and granular data provides some opportunities to explore new questions and potentially obtain richer insights. Nevertheless, empirical analysis of granular data might pose computational challenges, especially with advanced econometric techniques. Moreover, granular data typically come with the problem of numerous zero observations, especially on purchases, which in turn can lead to additional computations challenges.

### **4.3. Data-Related Opportunities**

The rapid growth of web-based platforms over the last decade greatly brightens the prospect for empirical research on platforms. Many web-based platforms including consumer-to-consumer (C2C) websites such as Ebay and Taobao, e-commerce websites such as Amazon, business-to-business (B2B) sites such as Alibaba,

content platforms such as Youtube or Epinions, reverse auction sites such as Priceline, and matching websites such as Match.com have gained prominence in the last few years. These platforms enable rich dynamic interactions among participants on both sides as well as between the platform and its participants. With a large number of such platforms, where information is often publicly available, there are a lot of opportunities for empirical research.

Data from these web-based platforms are usually of much finer granularity than those from “traditional,” offline platforms. Most datasets from web-based platforms contain information at the individual buyer and seller level. Such information might include user demographics, inception date, product offerings, number of past transactions, and reputation measures (Yao and Mela 2008, Cabral and Hortacsu 2010). Furthermore, information about individual transactions may also be available, where product description, prices, and bidding history are recorded (Cabral and Hortacsu 2010). In certain cases, datasets also contain detailed longitudinal records of participant actions such as content production and linking (Ma et al. 2013), or even contain clickstream data that record every aspect of participant actions (Tucker and Zhang 2010). Even when only the market level information is used at these web-based platforms, such data (number of buyers and sellers, number of transactions, average transaction prices) are recorded at much higher frequencies than in the case of offline platforms, e.g., at daily level instead of quarterly level (Chu and Manchanda 2013). The availability of such high-frequency data can be valuable for three reasons. First, higher frequency data enable researchers to construct a high dimensional longitudinal panel even when data are available only for a short temporal span. Second, higher frequency observations allow the researcher to use richer controls for unobservables, for example, in the form of high-frequency fixed effects. This, in turn can allow the researcher to address some common endogeneity concerns, say, related to platform pricing over time if the frequency of these fixed effects is shorter than that of the price changes. Third, the high-frequency data can facilitate studying high frequency fluctuations that may get smoothed out when the data are temporally aggregated.

Ad networks and exchanges promise to be another rich source of data for empirical research on platforms. Ad networks are platforms that enable online publishers to sell their excess ad inventory to advertisers. By consolidating inventory across multiple online publishers, ad networks make it easier for

advertisers to reach their target audience in the fragmented online market. Ad exchanges are also platforms wherein advertisers can auction ad space to the highest bidding advertisers. Since the clearing price can vary across publishers, specific pages within a publisher, and over time, data from ad exchanges can provide rich insights into how advertisers value ad targeting.

Recent changes in government policy such as the implementation of the Affordable Care Act (ACA) also offer unique research opportunities (e.g., Handel et al. 2013). The new health exchanges that are to be launched as a part of the ACA can provide researchers opportunities to study the choices made by insurance providers, patients, and healthcare providers. Given that healthcare accounts for a significant fraction of the U.S. GDP and the current emphasis on lowering healthcare cost, there are opportunities to answer research questions of great practical importance.

## **5. Conclusion**

In this paper, we have attempted to provide a (brief) overview of extant and emerging research in the area of platforms. The two-sidedness of platforms distinguishes them from other institutional settings and the rapid advances in the digitization of markets are likely to give rise to many more, multi-faceted platform settings. Our hope is that this overview will engender novel and impactful research, both substantive and methodological, in this important area. With that in mind, we have tried to isolate three possible areas that are likely to prove most fertile for empirical research. The first focuses on taking data to the many insights from the rich theoretical literature. The second is oriented around the notion of the large and possibly qualitatively different data streams that platforms are giving rise to. Finally, since researchers typically encounter unique challenges in this domain, there is scope to make research contributions by developing new methods and techniques. We hope that researchers interested in working in this area will benefit from our paper.

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