Solving the Circular Conundrum: Communication and Coordination in Two-Sided Markets

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INTRODUCTION

Facebook was launched by its founder Mark Zuckerberg, a Harvard undergraduate, when he sent an e-mail to a mailing list consisting of about 300 people in his residence hall Kirkland House.[1] Within 24 hours, the site had between 1,200 and 1,500 registered members.[2] Within five months, the site had 150,000 registered users at 40 schools, reaching 250,000 several months later.[3] In five years, the social networking site reached 300 million active users.[4] The rapid expansion of Facebook holds several important lessons for managers and entrepreneurs.

Firms that establish market places face the problem of inducing participation by buyers and by sellers. Participation in Facebook expanded through informal communication among users by word of mouth and e-mail. Facebook users benefitted from participation because the site offered online social interaction. Facebook users had minimal economic risks from initial participation because subscription was free. By facilitating coordination among users, by rewarding participation, and by reducing risks of participation, firms can enhance participation in markets.

Firms that create markets face a *circular conundrum*: Attracting buyers requires attracting sellers, and attracting sellers requires attracting buyers.[5] In this Article, I demonstrate that intermediary firms have three main methods of solving the circular conundrum. First, intermediary firms solve the circular conundrum by *reducing transaction costs* for buyers and for sellers, thus fostering direct coordination between buyers and sellers. Second, intermediary firms solve the circular conundrum by *providing media content and consumer rewards* that give participation incentives to buyers and to sellers. Third, intermediary firms solve the circular conundrum by

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[1] The site Thefacebook.com was launched on Wednesday, February 4, 2004. See J. Cassidy, *Me Media: How hanging out on the Internet became big business*, THE NEW YORKER, May 15, 2006, http://www.newyorker.com/archive/2006/05/15/060515fa_fact_cassidy Accessed October 26, 2009.

[2] Cassidy, 2006, id.

[3] Cassidy, 2006, id.

[4] See http://www.facebook.com/press/info.php?statistics Information accessed October 26, 2009.

[5] The phrase "circular conundrum" refers to the coordination problem faced by an intermediary in a two-sided market. Microsoft's CEO Steve Ballmer first used the phrase "circular conundrum" to describe Microsoft's problem with advertisers only purchasing advertisements on the company's Live Search if there were more search users, while there would only be more search users if there were more relevant advertisements. *See* Yi-Wyn Yen, *Microsoft's 'Circular Conundrum'*, FORTUNE ON CNN.COM, July 24, 2008, http://techland.blogs.fortune.cnn.com/2008/07/24/microsofts-circular-conundrum/. The Court of Appeals' Findings of Fact in the Microsoft case states that "the chicken-and-egg problem (hereinafter referred to as the 'applications barrier to entry') would make it prohibitively expensive for a new Intel-compatible operating system to attract enough developers and consumers to become a viable alternative to a dominant incumbent in less than a few years." *See* U.S. v. Microsoft, Civil Action No. 98-1232 (TPJ), Findings of Fact, 1999, *available at* http://www.usdoj.gov/atr/cases/f3800/msjudgex.htm David Evans uses the phrase "chicken and egg theoretical conundrum." *See* David S Evans, *The Antitrust Economics of Multi-Sided Platform Markets*, 20 YALE J. ON REG. 325 (2003).

acting as market makers, thus reducing participating risks for buyers and for sellers. I apply Game Theory tools to describe the coordination problem and to show how intermediary firms solve the circular conundrum through centralized coordination. Then, I show how the Internet improves actual cross-market coordination by fundamentally changing the structure and performance of intermediated markets and examine several case studies that illustrate reducing transaction costs, providing content and rewards, and acting as market makers. Transaction innovations provided by firms, including electronic commerce over the Internet, have generated a host of new business methods that improve the efficiency of exchange and solve the circular conundrum.

I introduce the term *cross-market coordination* to describe centralized coordination methods used by intermediary firms including reducing transaction costs, providing content and rewards, and acting as market makers. I also apply the term cross-market coordination to describe decentralized coordination between buyers and sellers without going through the intermediary, including search, communication, bargaining, and contracts. Cross-market coordination is essential to creating and organizing markets. Although the benefits of markets for allocating goods and services are widely understood, it is useful to understand how participation of buyers and sellers impacts the economic performance of markets. Buyers and sellers obtain at least three distinct types of *cross-market benefits* from the participation of agents on the other side of the market. Buyers and sellers obtain cross-market benefits from *market thickness effects*, which refers to liquidity and immediacy benefits from having more prospective trading partners. Cross market benefits also stem from *variety and scale effects*, which refers to buyer benefits from product variety and seller benefits from economies of scale. Finally, cross market benefits also arise from *network effects*, which refers to benefits from the connectivity of communications networks. Achieving these three benefits requires participation from both sides of the market. This poses a market coordination problem because the participation of agents on one side of the market depends on their expectations about the participation of agents on the other side of the market. Buyers and sellers have an incentive to engage in cross-market coordination of their participation decisions to achieve cross-market benefits even though they may encounter transaction costs.

Firms acting as intermediaries must address the circular conundrum because they need to attract and serve both buyers and sellers to be economically viable.[6] Intermediary firms benefit from the participation of buyers and sellers because they earn profits from providing transaction

[6] For a discussion of the economic role of firms as intermediaries, see D. F. Spulber, *Market Microstructure and Incentives to Invest*, 110 J. POL. ECON. 352 (2002); D. F. Spulber, *Market Making by Price-Setting Firms*, 63 REV. ECON. STUD. 559 (1996); D. F. Spulber, *Market Microstructure and Intermediation*, 10 J. ECON. PERSP. 135 (1996); D. F. SPULBER, THE THEORY OF THE FIRM: MICROECONOMICS WITH ENDOGENOUS ENTREPRENEURS, FIRMS, MARKETS, AND ORGANIZATIONS (2009).

services. Additionally, intermediary firms benefit from market size because more buyers and sellers generate greater accuracy in gathering information, further enhancing the firms' coordination activities. Intermediary firms also benefit from market size because they have economies of scale in providing transaction services. The economic returns from coordination help to explain the entry of specialized Internet intermediaries such as search firms, online retailers, auctioneers, social network sites, and online match makers.

Markets have two main modes of organization: decentralized and centralized.[7] In a *decentralized* market, buyers and sellers match with each other and determine transaction prices. In a *centralized* market, firms act as intermediaries between buyers and sellers. Practically all markets are "two-sided" in that they consist of collections of buyers and sellers.[8] Elsewhere, I define a "two-sided market" as a collection of individual buyers and individual sellers such that the buyers on one side of the market can transact only with the sellers on the other side of the market.[9] The term "two-sided market" describes both decentralized markets and centralized markets in which intermediary firms help to coordinate the participation of buyers and of sellers.[10] The term "two-sided markets" also has been widely used to describe markets with network effects.[11] Intermediary firms perform an

[7] For an overview of the large literature on market microstructure and intermediation by firms, see D. F. SPULBER, MARKET MICROSTRUCTURE: INTERMEDIARIES AND THE THEORY OF THE FIRM (1999).

[8] *See* Spulber, *supra* note 7. Networks in contrast can be one-sided, if there is only one category of participants, or many sided, with multiple categories of participants.

[9] *See* D. F. Spulber, *Firms and Networks in Two-Sided Markets*, *in* ECONOMICS AND INFORMATION SYSTEMS, HANDBOOK IN INFORMATION SYSTEMS (T. Hendershott, ed., vol. 1, 2006).

[10] The concept of a "two-sided market" has its origins in the work of Böhm-Bawerk who examined interaction between buyers and sellers and introduced the term "two-sided competition." E. VON BÖHM-BAWERK, POSITIVE THEORY OF CAPITAL (W. E. Smart trans. 1891). Shapley and Shubik use the term "two-sided market" in the context of matching although there may be earlier instances in which the term is used. Shapley and Shubik observe that "Two-sided market models are important, as Cournot, Edgeworth, Böhm-Bawerk, and others have observed, not only for the insights they may give into more general economic situations with many types of traders, consumers, and producers, but also for the simple reason that in real life many markets and most actual transactions are in fact bilateral – i.e., bring together a buyer and a seller of a single commodity." Shapley, L. S. and M. Shubik, *The Assignment Game I: The Core*, 1 INT'L J. GAME THEORY 111 (1972).

[11] The literature on matchmaking with network effects applies the term "two-sided market" without necessarily recognizing the large body of earlier work on intermediated markets or on matching markets. For example, Rochet and Tirole define two-sided markets as "markets in which one or several platforms enable interactions between end-users and try to get the two (or multiple) sides 'on board' by appropriately charging each side." J. C. Rochet and J. Tirole, *Two-Sided Markets: A Progress Report*, 37 RAND J. ECON. 645, 645 (2006). They define a platform as something that "enables or facilitates the interaction between the two sides provided that they indeed want to interact." *Id.* at 646. Clearly, a "platform" is an intermediary firm. For a discussion of network effects in the context of technology adoption, see D. F. Spulber, *Unlocking Technology: Innovation and Antitrust*, 4 J. COMPETITION L. & ECON. 915 (2008).

important economic function an earn economic rents by forming markets. This requires solving the circular conundrum.

First, intermediary firms solve the circular conundrum by *reducing transaction costs* of decentralized cross-market coordination, particularly through the provision of communication services to buyers and sellers.[12] When transaction costs are low, buyers and sellers can coordinate their market participation through direct communication, negotiation, and contracts. For example, a buyer and a seller can agree to transact through a particular intermediary, such as an online broker. The parties can also agree to use a certain payment intermediary such as a particular credit card or a company such as Paypal, or they can agree to exchange information using a particular technology standard such as Adobe's portable document format (PDF). In contrast, when there are many buyers and sellers, there can be substantial transaction costs associated with communication, search, bargaining, and contracting. Such transaction costs can make it more difficult to achieve cross-market coordination through direct communication. Intermediary firms have various means of reducing transaction costs of decentralized coordination when there are many buyers and many sellers. Firms can help with coordination through mass marketing by *advertising* their transaction services to buyers and sellers, providing them with information about the firms' prices and services. Also, advertising expenditures help to signal the economic viability of the intermediary, which indicates to individual buyers and sellers that others are dealing with the intermediary. Through advertising, the intermediary firm can provide specific information regarding the level of participation of buyers and sellers, thus inducing coordination. Intermediary firms also provide communication services that reduce the transaction costs of decentralized coordination between buyers and sellers.[13]

Second, intermediary firms solve the circular conundrum by *providing media content and consumer rewards* to induce participation by buyers and sellers. When communication is costly or difficult, buyers and sellers seeking cross-market coordination can encounter strategic complexities.[14] Their participation decisions depend on expectations about

[12] For a discussion of network effects in the context of technology adoption, see D. F. Spulber, *Unlocking Technology: Innovation and Antitrust*, 4 J. COMPETITION L. & ECON. 915 (2008).

[13] Direct coordination between buyers and sellers depends on the transaction costs of coordination. Small numbers of buyers and sellers will generally face lower transaction costs of search, bargaining, and contracting. When transaction costs are low in a market setting, small groups composed of buyers and sellers can coordinate their market participation. Coordination between small numbers of economic agents was examined by Ronald Coase as the solution to the problem of social cost, see R. Coase, *The Problem of Social Cost*, 3 J. L. & ECON. 1 (1960) By analogy, decentralized coordination between buyers and sellers captures the social benefits of market size.

[14] For an extensive survey of the literature on network effects and coordination problems, see Farrell, J. and P. Klemperer, *Coordination and Lock-In: Competition with Switching Costs and Network Effects*, *in* HANDBOOK OF INDUSTRIAL ORGANIZATION 1967 (M. Armstrong and R. Porter, eds., vol. 3, 2007). *See also* Rochet and Tirole, 2006, supra note 8.

the extent of participation on the other side of the market. The payoffs associated with strategic participation decisions may not foster coordination. Intermediary firms use incentives to reduce strategic complexities for buyers and sellers and to induce their cross-market coordination. Intermediary firms can compensate one side of the market for their participation, usually buyers, through media content and consumer rewards. These in-kind and monetary inducements attract one side of the market. The participation of one side of the market then attracts the other side of the market due to cross-market benefits. Thus, incentives induce strategic participation which resolves the cross-market coordination problem. I introduce a strategic model of market participation that examines how firms solve the circular conundrum through incentives for market participation.

Third, intermediary firms solve the circular conundrum by *acting as market makers* to lower the risks of participation for buyers and sellers. When there are transaction costs and strategic complexities, buyers and sellers face risks of participation. Buyers and sellers may be reluctant to incur costs associated with participation due to uncertainty about participation on the other side of the market. Intermediary firms provide market making services that reduce or eliminate the risks of market participation. By assuming the risks associated with market participation though inventory holding and quality guaranties, retail and wholesale firms create incentives for buyers and for sellers to participate in the market. Market making firms stand ready to buy and sell and act as dealers by purchasing for resale and holding inventories. By providing liquidity and immediacy, market makers reduce the risks of entering the market. Buyers and sellers know that they can complete transactions through market participation because market making firms act as counter-parties. This leads to greater market participation, thus solving the cross-market coordination problem. Such coordination by intermediary firms to internalize cross-market benefits can be understood within the broader context of market microstructure. As I discuss elsewhere, firms acting as intermediaries enhance transaction efficiency by pooling and diversifying risk, lowering the costs of matching and searching, alleviating adverse selection, mitigating moral hazard and opportunism, and supporting commitment through delegation of authority.[15] Firms are specialized transaction institutions that improve transaction efficiency by pursuing objectives, notably including profit maximization, that are distinct from the consumption objectives of their owners.[16] This helps firms achieve transaction advantages over direct exchange between buyers and sellers. Firms improve exchange by creating and operating markets and organizations.[17]

The concept of cross-market coordination brings together two fundamental aspects of economic coordination. Centralized coordination by private firms is related to what Friedrich Hayek termed instruments of

[15] Spulber, (1999), *supra* note 4.
[16] Spulber (2009), *supra* note 12.
[17] Spulber (2009), *supra* note 12.

"spontaneous order."[18] Decentralized coordination is related to Ronald Coase's description of private bargaining as a means of resolving the problem of social cost.[19] By solving the circular conundrum, intermediary firms create efficient markets. At first glance, the private benefits from participation appear to be fewer than the social benefits, which would indicate the potential for market failure. Social benefits can differ from private benefits when there are "externalities," that is costs or benefits affecting third parties outside of market transactions. However, the social benefits from market participation are not externalities because they are internalized by transactions between buyers, sellers, and intermediary firms. Intermediary firms have economic incentives to solve the coordination problem so as to take advantage of cross-market benefits and other returns to market size. Buyers and sellers also have incentives to coordinate their participation to obtain cross-market benefits.

The internalization argument made here regarding market participation by buyers and sellers extends the analysis of Liebowitz and Margolis, who show that network effects are internalized by economic transactions.[20] Boudreau and Hagiu argue that multisided platforms use "nuanced combinations of legal, technological, informational and other instruments (including price-setting) to implement desired outcomes."[21] They suggest that there is considerable scope for market failures in intermediated markets involving externalities, information asymmetries, complexity, non-pecuniary motivations and uncertainty. In their view, intermediary firms are "private regulators" whose role is more extensive than simply "getting prices right."[22] Platform firms provide various types of technological coordination while internalizing returns from complementary

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[18] *See* F. A. Hayek, *Spontaneous (Grown) Order and Organized ('Made') Order*, *in* MARKETS, HIERARCHIES & NETWORKS: THE COORDINATION OF SOCIAL LIFE 293-301 (Thompson, G., Francis, J. Levacic, R. and Mitchell, J., eds., 1991); F.A. HAYEK, LAW, LEGISLATION AND LIBERTY, VOLUME 2: THE MIRAGE OF SOCIAL JUSTICE (1976); F. A. Hayek, 1977, *The Creative Powers of a Free Civilization*, *in* ESSAYS ON INDIVIDUALITY (1977).

[19] *See* R. H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960); *see also* D. F. Spulber, *Consumer Coordination in the Small and in the Large: Implications for Antitrust in Markets with Network Effects*, 4 J. COMPETITION L. & ECON. 207 (2008).

[20] *See* S. J. Liebowitz & S. E. Margolis, *The Fable of the Keys*, 33 J.L. & ECON. 1 (1990); S. J. Liebowitz & S. E. Margolis, *Network Externality: An Uncommon Tragedy*, 8 J. ECON. PERSP. 133 (1994); S. J. Liebowitz & S. E. Margolis, *Path Dependence, Lock-in and History*, 11 J.L. ECON. & ORG 205 (1995); S. J. Liebowitz & S. E. Margolis, *Are Network Externalities a New Source of Market Failure?*, 17 RES. IN L. & ECON. 1 (1995); S. J. Liebowitz & S. E. Margolis, *Market Processes and the Selection of Standards*, 9 HARV. J.L. & TECH. 283 (1996); S.J. LIEBOWITZ & S.E. MARGOLIS, WINNERS, LOSERS, AND MICROSOFT: COMPETITION AND ANTITRUST IN HIGH TECHNOLOGY (1999); S. E. MARGOLIS, NETWORK EFFECTS, HANDBOOK OF TELECOMMUNICATIONS ECONOMICS (M.E. Cave et al., eds., vol. 1, 2002).

[21] *See* K. Boudreau & A. Hagiu, *Platforms Rules: Multi-Sided Platforms as Regulators, in* PLATFORMS, MARKETS AND INNOVATION 163 (A. Gawer ed., 2009), at 164.

[22] *See* Boudreau & Hagiu (2009), id. 164.

products.[23] Additionally, intermediary firms use prices and subsidies to address the effects of complementary products.[24]

The Article is organized as follows. Part I considers three sources of cross-market benefits: market thickness effects, variety and scale effects, and network effects. Part II examines how intermediaries foster decentralized coordination between buyers and sellers by lowering transaction costs. Part III examines market participation by buyers and sellers when firms provide incentives through content and consumer rewards. Part IV examines market participation by buyers and sellers when firms reduce participation risks through market making. Part V presents three Internet case studies that illustrate centralized coordination by intermediary firms: Market making by Apple's iPhone App Store, Incentive design by Microsoft's Bing search service, and Matchmaking by Alibaba's business-to-business website. Part VI concludes the discussion.

I. CROSS-MARKET BENEFITS

Buyers and sellers that participate in markets, whether centralized or decentralized, potentially obtain three types of cross-market benefits: market thickness effects, variety and scale effects, and network effects. The cross-market benefits resulting from market thickness effects and from variety and scale effects are specific to two-sided markets. The cross-market benefits resulting from network effects are a special case of standard network effects that depend on the size of networks. Network effects in two-sided markets derive from cross-market benefits in communications networks and compatibility networks. Cross-market benefits provide returns to decentralized coordination between buyers and sellers. Cross-market benefits also provide returns to intermediary firms who centrally coordinate the participation of buyers and of sellers. This Part examines the three types of cross-market benefits.

A. MARKET THICKNESS EFFECTS

Market thickness effects refer to transaction benefits that derive from the number of buyers and sellers. Thick markets improve the quality of buyer-seller matches when there are buyers with heterogeneous preferences

[23] *See* GAWER A. & CUSUMANO M.A., PLATFORM LEADERSHIP: HOW INTEL, MICROSOFT, AND CISCO DRIVE INDUSTRY INNOVATION (2002); Gawer A. & Henderson R., *Platform Owner Entry and Innovation in Complementary Markets: Evidence from Intel*, 16 J. ECON. & MGMT. STRATEGY 1 (2007).

[24] *See* Katz M. & C. Shapiro, *Systems Competition and Network Effects*, 8 J. ECON. PERSP. 93 (1994); SHAPIRO C. & H. VARIAN, INFORMATION RULES (1998); Farrell J. & P.Weiser, Modularity, *Vertical Integration, Open Access Policies: Towards a Convergence of Antitrust Regulation in the Internet Age*, 17 HARV. J.L. & TECH. (2003); K. Boudreau & A. Hagiu, 2009, *supra* note 14.

and sellers with heterogeneous costs and products.[25] Such markets can also provide increased liquidity, meaning that buyers and sellers can locate each other when they need to carry out a transaction. In financial markets, for example, liquidity means that buyers are able to purchase financial assets and sellers are able to sell financial assets without substantial delays and transaction costs. Buyers are attracted to liquid markets not only because of the ease of purchasing financial assets, but also because they know that, if necessary, they will be able to resell the financial assets in the future.

The level of participation in markets affects their allocative efficiency. The thickness of financial markets affects immediacy, or the speed of trading, in addition to liquidity. Grossman and Miller consider market liquidity in terms of the demand and supply of immediacy. In their model, market makers supply immediacy by bearing the risk of delayed trades during the time period between the arrival of final buyers and sellers. Market makers enter the market to equate the supply and demand for immediacy.[26]

The benefits of thick markets have been widely observed in markets for financial assets, labor, and housing. In financial markets, a greater number of traders improves efficiency by increasing liquidity, reducing price volatility and decreasing the adverse effects on prices from changes in the order flow.[27] In labor markets, thick markets generally improve the efficiency of search and matching.[28] In housing markets, thick markets

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[25] Market thickness effects are sometimes referred to as "indirect network effects. *See* Economides, *Economics of Networks*, 14 INT'L J. INDUS. ORG. 673 (1996). Farrell and Klemperer state that "*Indirect* network effects arise through improved opportunities to trade with the other side of a market" (emphasis in original). They add that "If thicker markets are more efficient, then buyers' indirect gain from the reequilibrating entry by sellers can outweigh the terms-of-trade loss for buyers, and vice versa; if so, there is an indirect network effect." *See* Farrell and Klemperer, 2007, supra note 9. In the present discussion, I distinguish between different sources of cross-market benefits.

[26] *See* S. J. Grossman & Merton H. Miller, *Liquidity and Market Structure*, 43 J. FIN. 617 (1988).

[27] *See* Pagano, M., *Endogenous Market Thinness and Stock Price Volatility*, 56 REV. ECON. STUD. 269 (1989). *See also* Kyle, A. S., *Continuous Auctions and Insider Trading*, 53 ECONOMETRICA 1315 (1985); M. Pagano, *Trading Volume and Asset Liquidity*, 104 Q.J. ECON. 255 (1989).

[28] Markets with more participants have better matches. *See* Gan, L. & Q. Li, *Efficiency of Thin and Thick Markets* (Nat'l Bureau of Econ. Research, Working Paper No. W10815, 2004). The average matching quality in a labor market increases with more workers and more firms. *See* Coles, M. & E. Smith, *Marketplace and Matching*, 39 INT'L ECON. REV. 239 (1998); Gan, L. & Q. Zhang, *The Thick Market Effect on Local Unemployment Rate Fluctuations*, 133 J. ECONOMETRICS 127 (2006). Larger cities, with more workers and more firms have less unemployment due to risk diversification. S*ee* Neumann, G. & R. Topel, *Employment Risk, Diversification, and Unemployment*, 106 Q.J. ECON. 1341 (1991). Thick markets affect search costs. *See* Diamond, P., *Aggregate Demand Management in Search Equilibrium*, 90 J. POL. ECON. 881 (1982). *See also* Shimer, R., *The Impact of Young Workers on the Aggregate Labor Market*, 116 Q.J. ECON. 969 (2001); Simon, C., *Frictional Unemployment and the Role of Industrial Diversity*, 103 Q.J. ECON. 715 (1988); Mortensen, D. & C. Pissarides, *Job Creation and Job Destruction in the Theory of Unemployment*, 61 REV. ECON. STUD. 397 (1994). Agglomeration economies affect the efficiency of search.

generate better matching between buyers and sellers of houses.[29] In product markets, the analogous concept of immediacy refers to the benefits realized by the ease of buying and selling goods.[30]

B. VARIETY AND SCALE EFFECTS

Variety and scale effects refer to the benefits that buyers receive from product variety and the benefits that sellers receive from earnings and economies of scale. Variety and scale effects generate market size effects that appear similar to network effects. However, this similarity is misleading because the mechanisms that generate benefit are different on the two sides of the market.

Adam Smith famously observed that the economies of scale are limited by the extent of the market.[31] The benefits of variety and scale in large markets are observed in industrial organization models of monopolistic competition dating back at least to the classic work of Chamberlin.[32] International trade economist Krugman shows that countries obtain gains from trade that derive from increased product variety and economies of scale.[33] The economies of scale and transportation costs associated with agglomeration are an important feature of models in economic geography.[34] Models of clubs emphasize that increased membership generates benefits from scale and costs in the form of congestion, although there are clubs that offer a variety of goods.[35] Hagiu points out that in online markets, buyers

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See Helsley, R. & Strange, W., 1990, *Matching and Agglomeration Economies in a System of Cities*, 20 REGIONAL SCI. AND URB. ECON. 189 (1990). Agglomeration economies affect matching efficiencies. Glaeser, E. & Mare, D., 2001, *Cities and Skills*, 19 J. LAB. ECON. 316 (2001); Wheeler, C., *Search, Sorting and Urban Agglomeration*, 19 J. LAB. ECON. 879 (2001).

[29] L. Gan & Q. Zhang, *The Thick Market Effect on Housing Markets Transactions*, (Nat'l Bureau of Econ. Research, Working Paper No. w12134, 2006).

[30] H. Demsetz, *The Cost of Transacting*, 82 Q.J. ECON. 33 (1968).

[31] SMITH, A., AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS (Regnery Publishing 1998) (1776).

[32] E. H. CHAMBERLIN, THE THEORY OF MONOPOLISTIC COMPETITION: A RE-ORIENTATION OF THE THEORY OF VALUE (8th ed. 1962); *see also* A. M. Spence, *Product Selection, Fixed Costs, and Monopolistic Competition*, 43 REV. ECON. STUD. 217 (1976); A. K. Dixit & J. E. Stiglitz, *Monopolistic Competition and Optimum Product Diversity*, 67 AM. ECON. REV. 297 (1977).

[33] *See* P.R. Krugman, *Increasing Returns, Monopolistic Competition, and International Trade*, 9 J. INT'L ECON. 469 (1979); P.R. KRUGMAN, RETHINKING INTERNATIONAL TRADE (1996).

[34] *See* G. MYRDAL, ECONOMIC THEORY AND UNDERDEVELOPED REGIONS (1957); P.R. Krugman, *Increasing Returns and Economic Geography*, 99 J. POL. ECON. 483 (1991); P.R. Krugman, *What's New about the New Economic Geography?*, 14 OXFORD REV. ECON. POL'Y 7 (1998); M. FUJITA & J.F. THISSE, ECONOMICS OF AGGLOMERATION (2002).

[35] For an overview, see R. CORNES & T. SANDLER, THE THEORY OF EXTERNALITIES, PUBLIC GOODS, AND CLUB GOODS (2nd ed. 1996).

who value variety prefer more sellers, while sellers benefit from higher sales and economies of scale and thus prefer more buyers.[36]

Buyers who value product variety purchase a bundle of *m* goods. Buyers that maximize consumption benefits subject to a budget constraint will have net benefits that depend on the number of goods. Identifying each good with a different supplier, this approach yields a net benefits function for each buyer that depends on the number of suppliers, *U(m)*.

On the other side of the market, each seller earns profits that depend on the demand for their differentiated product. Sellers benefit from more sales. Also, when the seller's costs exhibit economies of scale, greater sales reduce average costs. The seller's profits will therefore, under some conditions, depend on the number of buyers that participate in the market, *H(n)*.[37]

Markets with compatibility of complementary goods are often described in terms of network effects or indirect network effects.[38] For example, Clements states that "[c]onsumers also value a hardware technology for which there is a wide variety of software available, and more software firms associate with a hardware technology if more consumers use it."[39] This framework applies to many types of situations with complements. For example, complementary hardware and software combinations include computers and software, game players and games, compact disc players and music, video players and DVDs, cameras and film, and mobile phones and applications. In addition, there are software platforms such as Microsoft's

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[36] *See* A. Hagiu, Two-Sided Platforms: Product Variety and Pricing Structures, 18 J. ECON. & MGMT. STRATEGY (forthcoming 2009)*; see also* A. Hagiu, Pricing and Commitment by Two-Sided Platforms, 37 RAND J. ECON. 720 (2006).

[37] Suppose, for example, that each buyer purchases at most one unit of the seller's good. Letting *z* be the seller's price, a buyer will purchase a unit of the seller's good only if their consumption benefit is greater than or equal to the seller's price. Then, the seller's total demand will equal the number of buyers that choose to purchase the good at that price. The seller's benefit function depends on the number of participating buyers, *n*. If the seller's cost is *C(n)*, the seller's benefit function equals $H(n) = zn - C(n)$. Another example occurs when all participating buyers have identical demand functions, *D(z)*, where *z* is the seller's price. Then, the seller's total demand depends on the number of buyers because it is the product of the number of buyers and each buyer's demand, *nD(z)*. As a result, the seller's benefit will depend on the number of buyers, $H(n) = znD(z) - C(nD(z))$.

[38] For a discussion of indirect network effects, see M.L. Katz & C. Shapiro, *Network Externalities, Competition and Compatibility*, 75 AM. ECON. REV. 424 (1985); C.F. Chou & O. Shy, *Network Effects without Network Externalities*, 8 INT'L J. INDUS. ORG. 259 (1990); J. Church & N. Gandal, *Network Effects, Software Provision, and Standardization*, 40 J. INDUS. ECON. 85 (1992); J. Church & N. Gandal, *Complementary Network Externalities and Technological Adoption*, 11 INT'L J. INDUS. ORG. 239 (1993); N. Economides, *supra* note 20; J. Church, N. Gandal & D. Krause, *Indirect Network Effects and Adoption Externalities* (Working Paper No. 02-30, 2002). Foerder Institute for Economic Research, N. Economides & S. Salop, *Competition and Integration among Complements, and Network Market Structure*, 40 J. INDUS. ECON. 105 (1992); M.L. Katz & C. Shapiro, *System Competition and Network Effects*, 8 J. ECON. PERSP. 93 (1994); N. Gandal, *A Selective Survey of the Indirect Network Externalities: A Discussion*, 17 RES. L. AND ECON. 23 (1995).

[39] *See* M. T. Clements, *Direct and Indirect Network Effects: Are They Equivalent?*, 22 INT J. OF INDUSTRIAL ORGANIZATION 633 (2004), at 635.

Windows operating system and compatible applications that run on the operating system.

Consider a market with a single hardware technology. Then, buyers that benefit from product variety derive benefits from consuming the hardware and multiple types of complementary software. This yields a benefit function that depends on the number of sellers, each of whom provides a different product. On the other side of the market, each seller of a differentiated software product has a benefit function that depends on the number of buyers.

This situation corresponds to an intermediated two-sided market in the sense that the hardware firm intermediates between consumers of hardware and firms that supply software. The hardware firm faces a circular conundrum because buyer benefits depend on the number of sellers that provide software and because seller benefits depend on the number of buyers who purchase the hardware who then become purchasers of their software.

The hardware firm intermediates between buyers and sellers in two different ways, as a matchmaker or as a market maker. As a matchmaker, the hardware firm sells hardware to buyers and sells licenses to software suppliers.[40] As a market maker, the hardware firm can purchase the complementary software from sellers and resell to the buyers. The hardware firm then becomes a dealer in software, in addition to providing hardware.

C. NETWORK EFFECTS

Network effects refer to benefits that individuals derive directly from the participation of others in a network. The term often is used to designate any type of network-size effects on individual benefits. The concept of network effects has been extended to the study of "two-sided networks," also known as "two-sided markets."[41] Although various economic forces generate size effects, network effects are best used to describe size effects in communications networks and in virtual information networks where compatibility plays an important role. Definitions of two-sided networks typically involve some type of information system that allows communication between buyers and sellers and provides related computation

[40] Hagiu defines "two-sided platforms" as matchmaking intermediaries that "help connect" buyers and sellers without acting as dealers, thus allowing buyers and sellers to transact directly. "Two-sided platforms" include Internet-based firms such as Alibaba, Amazon, eBay, and iTunes. *See* A. Hagiu, *Merchant or Two-Sided Platform*, 6 REV. NETWORK ECON. 115 (2007).

[41] *See* G. Parker & M. Van Alstyne, *Two-Sided Network Effects: A Theory of Information Product Design*, 51 MGMT. SCI. 1494 (2005). The coordination problem in network participation is sometimes referred to as the "chicken-and-egg problem." *See* B. Caillaud & B. Jullien, *Chicken & Egg: Competition among Intermediation Service Providers*, 34 RAND J. ECON. 309 (2003). *See also* D.S. Evans, *The Antitrust Economics of Muti-Sided Platform Markets*, YALE J. ON REG. (2003); J.C. Rochet & J. Tirole, *Platform Competition in Two-Sided Markets*, 1 J. EUR. ECON. ASS'N 990 (2003); J. Wright, *The Determinants of Optimal Interchange Fees in Payment Systems*, 52 J. INDUS. ECON. 1 (2004); M. Rysman, *Competition between Networks: A Study of the Market for Yellow Pages*, 71 REV. ECON. STUD. 483 (2004); K.J. Boudreau, *Too Many Complementors* (HEC Working Paper, **2008).**

services.[42] Such effects should be distinguished from market thickness effects and variety scale effects, as already emphasized.

The concept of network effects originally arose from the benefits of adding subscribers to a communications network.[43] In telecommunications, *demand-side* network effects describe the benefits derived from the number of subscribers to communications networks. Each individual subscriber benefits because they can communicate with more subscribers. Rohlfs, Artle, and Averous assume that consumers derive benefits only from their own membership and the membership of others.[44] More generally, network effects in communications could depend not only on the number of subscribers but also on the volume of their consumption and other factors.

Network effects also are observed as demand-side benefits in virtual information networks in which compatibility plays a role. Software users benefit from using a common format to exchange documents, data, music, photographs, and video. For example, individuals using the portable document format (PDF) can easily communicate by exchanging files. Individuals who exchange information also benefit from using common electronic data storage media for documents, data, music, photographs, and video. Rohlfs argues that demand-side network effects generated bandwagon effects for various technology products: fax, early telephone, picturephone, compact-disc players, VCRs, personal computers, television, and the Internet.[45] Rohlfs also discusses two-way networks.[46] Evans et al. emphasize software platforms that allow compatibility between users and designers of software through applications programming interfaces (APIs).[47] Two-sided platforms also refer to payment mechanisms such as credit cards that involve transmission of information about payments.

Network effects in two-sided markets are sometimes referred to as "indirect network effects." Katz and Shapiro distinguish between direct and indirect network effects.[48] A *direct network effect* refers to the effect of one person's consumption of the network good on another person's benefit obtained from the network good. An *indirect network effect* refers to the effect of prices and features of complementary goods on a consumer's benefit from the network good. Katz and Shapiro define an indirect network effect

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[42] *See* Spulber, *supra* note 7.

[43] *See* J. Rohlfs, *A Theory of Interdependent Demand for a Communications Service*, 5 BELL J. ECON. AND MGMT SCI. 16 (1974); R. Artle & C. Averous, The Telephone System as a Public Good: Static and Dynamic Aspects, 4 BELL J. ECON. AND MGMT SCI. 89 (1973).

[44] Rohlfs (1974) and Artle & Averous *(1973), Id*.

[45] *See* J. H. ROHLFS, BANDWAGON EFFECTS IN HIGH-TECHNOLOGY INDUSTRIES (2001).

[46] *See* Rohlfs (2001), *supra* note 21; *id*.

[47] *See* D. S. EVANS, A. HAGIU, & R. SCHMALENSEE, INVISIBLE ENGINES: HOW SOFTWARE PLATFORMS DRIVE INNOVATION AND TRANSFORM INDUSTRIES (2006).

[48] M.L. Katz & C. Shapiro, *Systems Competition and Network Effects*, 8 J. ECON. PERSP. 93 (1994).

as occurring "through the impact of one consumer's adoption decision on the future variety or prices of components."[49]

Network effects in two-sided networks are a special case of standard network effects. With standard network effects, there are no categories of individuals. The only issue is the number of individuals who join the network. Each individual who joins the network derives benefits from the total number of members of a network. Network effects in two-sided markets, on the other hand, are based on identifying two categories of individuals: buyers and sellers. Each individual derives benefits only from the number of network participants from the other side of the market.

Two-sided network effects are a special case of standard "one-sided" network effects. To see why this is the case, consider a network consisting of many agents and divide the set of agents into two categories designated as buyers and sellers. Buyer *i*'s participation decision is represented by a strategy b_i that takes two values, $b_i = 1$ if the buyer joins the network and $b_i = 0$ if the buyer does not join the network. Seller *j*'s participation decision is represented by a strategy s_j that takes two values, $s_j = 1$ if the seller joins the network and $s_j = 0$ if the seller does not join the network.[50] Let (b, s) represent the vector of all buyer participation decisions and all seller participation decisions. Buyer *i* obtains a benefit $U_i(b, s)$ based on his own participation decision and those of other buyers and sellers. Seller *j* obtains a benefit $H_j(b, s)$ based on his own participation decision and those of other buyers and sellers. In the two-sided markets case, each individual only obtains direct benefits from participation by individuals on the other side of the market.

A general description of network effects specifies that market agents derive benefits from the participation decisions of all other players. A special case of this situation specifies that market agents derive benefits from the participation decisions of only some other players. Two-sided markets correspond to a very particular special case; agents on one side of the market obtain benefits from the participation of agents on the other side of the market.

Formally, by participating in the market, buyer *i* obtains a benefit $U_i(s)$ that is based only on the participation decisions of sellers. By participating in the market, seller *j* obtains a benefit $H_j(b)$ that is based only on the participation decisions of buyers. Given this framework, it is readily demonstrated that the standard description of network effects in two-sided markets is special case of network effects. Let *n* represent total buyer

[49] Katz and Shapiro identify three types of networks: communication, compatibility, and hardware/software complementarity. *Id.* Although they only identify indirect network effects for the compatibility and hardware/software, indirect network effects can also be applied to communications networks when there are two categories of agents. The present discussion argues that network effects fit well with communications and compatibility networks, while hardware/software complementarity derives from underlying variety and scale effects.

[50] This framework can easily be generalized to allow benefits to depend on different levels of individual buyer and seller participation in the network.

participation and let m represent total seller participation.[51] Then, we can write the returns to participation for buyer i as $U_i(m)$ and the returns to participation for seller j as $H_j(n)$.

Stanley J. Liebowitz and Stephen E. Margolis point out that network effects need not create market failures because market participants have incentives to capture these benefits.[52] This analysis has been applied to communications networks, product compatibility, and technology adoption. When coordination between buyers and sellers is not feasible due to transaction costs and communication problems, there is a risk of market failure known as "network externalities."[53] On the basis of network externalities, some argue that governments should regulate network industries either through antitrust or through the provision of subsidies to induce participation by both initial and marginal buyers of the network good.[54]

Putting aside the standard problems and inefficiencies associated with government regulation, such regulations are unnecessary when market failures are absent or minimal. Because the benefits of joining networks are internalized by transactions between market participants, network effects do not generate externalities. The benefits of participation are reflected in the prices, product features, and terms of contractual agreements between buyers and sellers and market-making firms. Accordingly, there is no market failure that might justify regulatory intervention.

This argument applies with even greater force in two-sided markets. Network effects in two-sided markets do not generate externalities because they are intermediated by transactions. Network effects in decentralized two-sided markets are internalized by coordination between buyers and sellers. In centralized two-sided markets, potential network effects also are internalized by transactions of intermediary firms with buyers and with sellers. The intermediary firm has multiple instruments of coordination that handle network effects: reducing transaction costs, providing incentives, and market

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[51] Total buyer participation in the market is obtained by adding the buyers' decisions, $n = \int_0^1 b_i di$. Total seller participation in the market is obtained by adding the sellers' decisions, $m = \int_0^1 s_j dj$.

[52] *See* S. J. Liebowitz & S. E. Margolis, *The Fable of the Keys*, 33 J.L. AND ECON. 1 (1990); S. J. Liebowitz & S.E. Margolis, *Network Externality: An Uncommon Tragedy*, 8 J. ECON. PERSP. 133 (1994); S. J. Liebowitz & S. E. Margolis, *Are Network Externalities a New Source of Market Failure?*, 17 RES. L. AND ECON. 1 (1995); S. J. LIEBOWITZ & S. E. MARGOLIS, WINNERS, LOSERS, AND MICROSOFT: COMPETITION AND ANTITRUST IN HIGH TECHNOLOGY (1999); S. J. Liebowitz & S. E. Margolis, Network Effects, Handbook of Telecommunications Economics (M. E. Cave et al. ed., vol. 1, 2002).

[53] *See* M.L. Katz & C. Shapiro, *Network Externalities, Competition, and Compatibility*, 75 AM. ECON. REV. 424 (1985); M.L. Katz & C. Shapiro, *Technology Adoption in the Presence of Network Externalities*, 94 J. POL. ECON. 822 (1986); M.L. Katz & C. Shapiro, *Systems Competition and Network Effects*, 8 J. ECON. PERSP. 93 (1994).

[54] *See* P.H. Dybvig & C.S. Spatt, *Adoption Externalities as Public Goods*, 20 J. PUB. ECON. 231 (1983).

making. These instruments are means of capturing potential cross-market benefits within economic transactions.

II. CENTRALIZED COORDINATION BY REDUCING TRANSACTION COSTS

Buyers and sellers have economic incentives to coordinate their market participation decisions so as to capture cross-market benefits. Without intermediary firms, buyers and sellers must engage in decentralized coordination through search, communication, bargaining, and contracting. Even with intermediary firms, buyers and sellers face a cross-market coordination problem because they must choose the same intermediaries. Clearly, when there are small numbers of buyers and sellers, the transaction costs of coordination should be low. However, with many buyers and many sellers, there may be transactions associated with communicating and agreeing to transact through an intermediary. This Part considers how intermediary firms solve the circular conundrum by reducing transaction costs so that buyers and sellers can coordinate their participation decisions.

A. STRATEGIC PARTICIPATION IN TWO-SIDED MARKETS

This section presents a market participation game that illustrates the circular conundrum. An intermediary firm transacts with a single potential buyer and a single potential seller. This basic framework is sufficient to present many of the main conceptual issues associated with cross-market coordination.

Generally speaking, a firm is a transaction institution that creates markets and organizations to intermediate transactions.[55] The firm contributes to the economy by improving the efficiency of transactions in comparison with decentralized exchange. Firms provide many types of intermediation services. They reduce the costs of search by creating central marketplaces and matching buyers and sellers. They reduce transaction costs by choosing the terms of exchange and adjusting prices. They reduce contracting costs relative to direct exchange by completing transactions and monitoring the performance of suppliers. They provide reassurance to buyers and sellers by developing reputations for performance.[56] In addition to reducing the transaction costs of exchange, intermediary firms can address the transaction costs associated with market participation before exchange takes place.

The structure of market transactions can be represented using a basic network diagram.[57] The standard "two-sided network" graph in Figure 1 represents a decentralized market. The set of market participants is divided

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[55] *See* D. F. SPULBER, THE THEORY OF THE FIRM: MICROECONOMICS WITH ENDOGENOUS ENTREPRENEURS, FIRMS, MARKETS, AND ORGANIZATIONS (2009).

[56] *See id.*

[57] In graph theory, a network consists of a set of points and the connections between them, as well as information about the points and lines. The points are sometimes referred to as nodes and the connections are referred to as links. In other graph theory works, the points are referred to as vertices and the connections are referred to as edges.

into two groups to represent buyers and sellers. In graph theory, a two-sided network diagram is referred to as a bipartite graph. The points represent individual buyers or sellers and the lines represent the transactions between them. The two-sided network graph is highly useful in understanding markets because it shows the importance of connections between two classes of economic agents. Such graphs are used to represent connections between elements of two sets and are applied to the study of assignment problems. An assignment problem consists of finding the best set of matches between two sets, such as workers and firms, tasks and producers, roommates, and hospitals and residents. A two-sided network is a special case of a network because it partitions the set of points into two subsets—buyers and sellers—and only considers connections between a member of the buyer set and a member of the seller set.

Network diagrams can be extended to represent markets with many categories of participants. In particular, the two-sided network graph can be modified to introduce a third category of economic agents, the intermediary firms. In a centralized market, buyers and sellers transact through an intermediary. When there is one intermediary, the network diagram takes the form of a star graph as in Figure 2. The star graph in Figure 2 represents a "hub-and-spoke" configuration in which the intermediary firm is a transaction hub. By centralizing transactions, the intermediary firm drastically reduces the number of transactions in comparison with a decentralized network. As the number of market participants increases, the difference between the number of transactions in direct exchange and centralized exchange accelerates, as shown by comparing Figures 1 and 2.[58]

Buyers and sellers obtain cross-market benefits by participating in a marketplace. The market may simply be a central location, such as a farmers' market or a trading post. The central location can be established by social custom, a trade association, an association of buyers and sellers, a government body, or an intermediary firm. Buyers and sellers must engage in some form of cross-market coordination before reaching the central market because they must choose whether or not to participate in a particular market. Once at the central location, buyers and sellers transact directly with each other. Buyers and sellers communicate, find trading partners through search, negotiate the terms of exchange, and deal directly with each other to complete transactions.

Buyers and sellers also obtain cross-market benefits by participating in a marketplace that is established and managed by an intermediary firm. Even in this case, buyers and sellers may need to engage in cross-market coordination to choose whether or not to transact through a particular

[58] Multiple intermediaries can increase the number of transactions in comparison with a single intermediary, resulting in greater transaction costs in comparison with centralized coordination by a single intermediary. Even several intermediaries, the total number of transactions is less than decentralized exchange when there are many buyers and many sellers.

intermediary. Buyers and sellers may communicate directly and agree to transact through an intermediary.

To illustrate decentralized cross-market coordination in intermediated markets, consider the following examples. An author may suggest to a reader that the reader can purchase the author's book on Amazon.com. The author and the reader communicate directly prior to purchase, even though Amazon.com eventually handles the business transaction. Similarly, a seller may inform a buyer that his product is available on eBay.com, so that the seller and buyer coordinate their use of a third-party auctioneer. A company can also place advertisements on radio and television telling prospective customers to see their listing in the yellow pages. In this way, sellers and buyers directly coordinate their use of a directory. Retailers and customers can also agree that payments will be made through a particular credit card. The credit card firm serves as an intermediary by handling the payment for these transactions. Similarly, a buyer and a seller might coordinate their use of a transaction technology by agreeing to exchange information using a particular software format such as PDF.

The transaction costs of such cross-market coordination may increase when there are many buyers and many sellers. Even in large markets however, advances in communication reduce the costs of decentralized coordination. Among these advances are ubiquitous communication devices including cell phones, personal digital assistants, and mobile computing. A wide range of Internet-based communication options include e-mail, instant messaging, blogs, web pages, and social networking websites. These communication mechanisms facilitate coordination between many buyers and many sellers.[59]

[59] These new communications technologies also facilitate coordination among buyers, vastly improving communication in comparison to "word of mouth," as well as broadcast and print media. These technologies also enhance communication among sellers, enhancing traditional systems that include trade associations and periodicals.

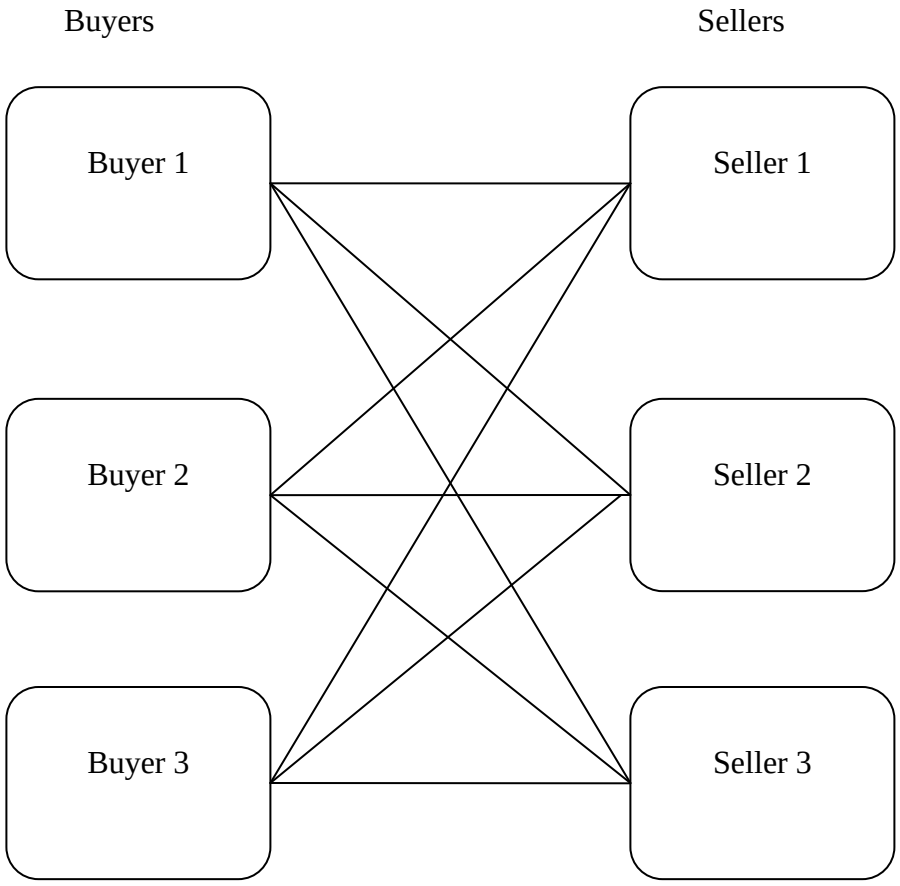

Figure 1 The two-sided market with decentralized exchange.

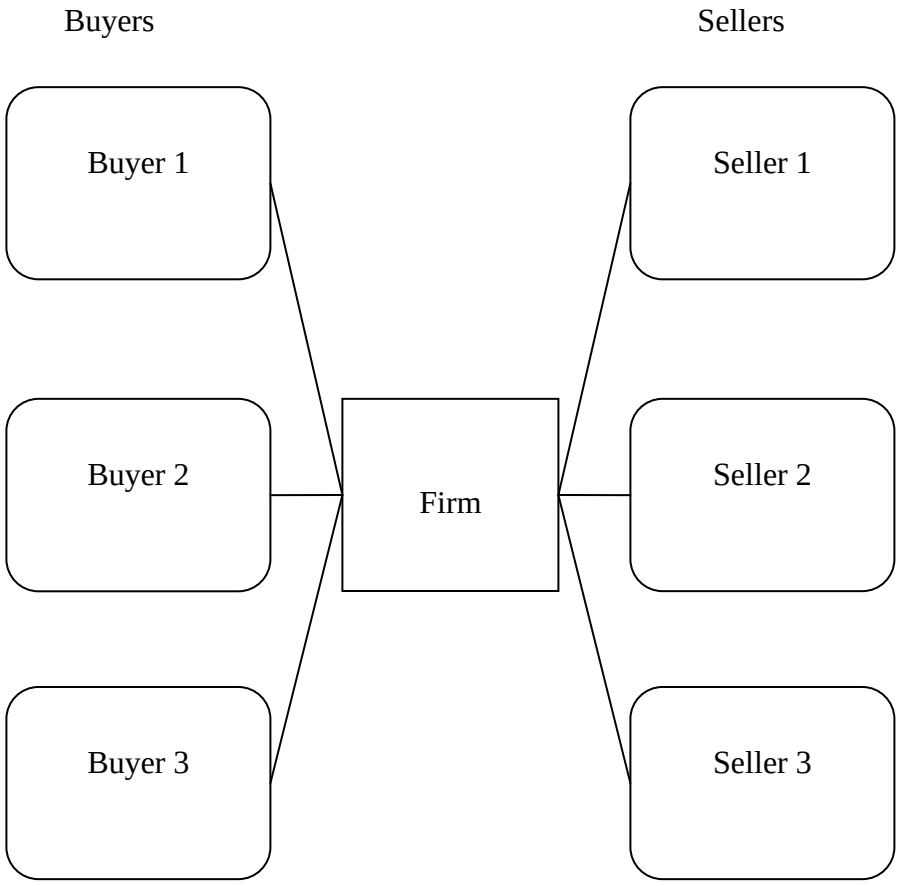

Figure 2 The two-sided market with centralized exchange.

To address the basic problem of cross-market coordination, it is useful to consider a simple two-stage game involving a buyer, a seller, and an intermediary firm. In the first stage, the firm chooses the prices to charge the buyer and the seller for intermediation services. The firm offers a price p to the buyer and a price w to the seller. In the second stage, the buyer and seller decide whether or not to participate in the intermediated market.[60]

It makes a difference whether the buyer and the seller pay the participation charges before or after they transact with each other.[61] For now, suppose that the buyer and the seller pay the participation charges before they transact with each other so that the charges are sunk costs when the buyer and the seller complete their transaction. When the buyer and seller transact with each other through the intermediary, the buyer obtains a benefit u and the seller obtains a benefit h. The participation prices chosen by the firm are assumed to be strictly less than the transaction benefits.

After the participation prices are chosen by the firm, suppose that the buyer and the seller face a noncooperative game in the second stage (see Table 1). A Nash equilibrium consists of strategies that are best responses to each other. An agent's best response to an opponent's equilibrium strategy is the one that maximizes the agent's payoff. At the Nash equilibrium of the market participation game, the buyer's equilibrium participation strategy b^* is a best response to the seller's equilibrium participation strategy s^*, and vice versa.

The participation game shown in Table 1 has two Nash equilibria, which are the outcomes on the diagonal of the table. Market participation by each agent is a best response to participation by the other agent, and nonparticipation by each agent is a best response to nonparticipation by the other agent. For example, if the buyer's equilibrium strategy is to participate in the market, the seller's best response is to participate because the seller would obtain a payoff of $h - w$ rather than a payoff of zero. If the seller's equilibrium strategy is to participate in the market, the buyer's best response is to participate because the seller would obtain a payoff of $u - p$ rather than a payoff of zero. This implies that participate, participate is a Nash equilibrium.

Seller / **Buyer**	Participate $s = 1$	Do not participate $s = 0$
Participate $b = 1$	$u - p$, $h - w$	$-p$, 0
Do not participate $b = 0$	0, $-w$	0, 0

Table 1 The circular conundrum with a firm intermediating between a single buyer and a single seller, with payoffs (Buyer, Seller).

[60] The buyer's participation strategy is represented by b, where $b = 1$ represents the decision to participate and $b = 0$ represents the decision not to participate. The seller's participation strategy is represented by s, where $s = 1$ represents the decision to participate and $s = 0$ represents the decision not to participate.

[61] *See* Spulber, *supra* note 1.

Compare the two Nash equilibria. Both players have higher payoffs at the participation equilibrium than at the nonparticipation equilibrium. The participation equilibrium Pareto dominates the nonparticipation equilibrium because the buyer and the seller are both made strictly better off. Even if the buyer and the seller somehow reach a Nash equilibrium, the presence of multiple equilibria leads to possible inefficiencies. The outcome is inefficient if the buyer and the seller choose the nonparticipation equilibrium, which yields a zero payoff for both of the players. Choosing a Pareto inferior Nash equilibrium is one type of coordination problem.

A further coordination problem arises because of the buyer-seller subgame multiple Nash equilibria. The buyer and the seller cannot choose best-response strategies if they do not know which equilibrium will result. Some suggest that in this type of situation, mistakes and confusion could interfere with coordination between the players, and they might end up splitting their choices.[62] For the participation game presented here, if only one of the agents chooses to participate in the network, it would cause one of the off-diagonal outcomes, which involves a zero payoff for one player and a loss for the other player. Uncertainty about the other player's strategy and these outcomes represent participation risks. These coordination problems are sometimes interpreted as externalities because the participation decision of an agent affects the returns of other agents.

Coordination problems are a reflection of underlying transaction costs. If the buyer and the seller can communicate with each other and reach agreements before playing the participation game, they can choose the best outcome, which is the Pareto dominant Nash equilibrium. If negotiation is costly and the buyer and the seller cannot make contractual commitments, it may be difficult to form an agreement to participate in the market. Cross-market benefits need not lead to externalities and market failure when decentralized coordination is feasible. In decentralized markets, these problems are addressed by the economic agents who originate and terminate the transactions. When transaction costs are low, small groups of economic agents can coordinate their activities through communication and contractual agreements.[63]

The key question is why there would be an absence of coordination. The buyer and the seller have an incentive to coordinate their participation decisions to avoid the off-diagonal outcomes and to achieve the benefits of participation. In addition, when buyers and sellers can communicate and negotiate with each other, they can make explicit agreements. Coase emphasized the ability of small numbers of economic agents to achieve optimal outcomes through bargaining when transaction costs are low and

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[62] *See* M.L. Katz & C. Shapiro, *Systems Competition and Network Effects*, 8 J. ECON. PERSP. 93 (1994); J. Farrell & P. Klemperer (2007) supra note 9.

[63] *See* D. F. Spulber, *Consumer Coordination in the Small and in the Large: Implications for Antitrust in Markets with Network Effects*, 4 J. COMPETITION L. AND ECON. 207 (2008). For a discussion of network effects in the context of technology adoption, see D. F. Spulber, *Unlocking Technology: Innovation and Antitrust*, 4 J. COMPETITION L. AND ECON. 915 (2008).

property rights are clearly defined.[64] The buyer and the seller will choose the participation equilibrium because it is the best outcome. Depending on their relative bargaining power, they may choose to make side payments to achieve the desired outcome.

The problem of decentralized coordination has been studied extensively by game theorists. It lies at the heart of noncooperative games.[65] Basic games such as "the prisoners' dilemma" and "the battle of the sexes" raise questions about coordination because players choose noncooperative strategies without communication. There are also games with multiple noncooperative equilibria in which players can coordinate tacitly or explicitly through pre-play communication.[66] Additionally, coordination between players has been studied in dynamic games with repeated interaction.

A buyer and a seller in a noncooperative game can make pre-play binding agreements with action-contingent side payments. In the prisoners' dilemma game, there exist side payments that transform the payoffs in the game.[67] As a result of these transfers, the players achieve the efficient outcome as a noncooperative equilibrium. When a buyer and a seller choose side payments cooperatively, they can set contingent payments such that they both will choose market participation as a noncooperative equilibrium. However, Jackson and Wilkie show that when players choose side payments noncooperatively, there is no equilibrium that results in the efficient outcome.[68] Thus, even with endogenous action-contingent side payments, the outcome is inefficient. Again, when transaction costs result in noncooperative behavior at the pre-pay negotiation stage, the outcome is inefficient. This implies a role for an intermediary firm. The firm chooses action-contingent side payments that will induce the buyer and the seller to choose efficient participation strategies.

When buyers and sellers are able to communicate and form agreements, they can coordinate their participation activities. Individuals may form interests groups and other types of coalitions to coordinate market participation. There are various ways to build coalitions. For example, individuals may build a coalition by only allowing new members to join if doing so makes every member better off.[69] In the present setting of a two-sided market, this approach would guarantee that buyers and sellers keep

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[64] *See* Coase, *supra* note 4.

[65] *See* J. VON NEUMANN & O. MORGENSTERN, THEORY OF GAMES AND ECONOMIC BEHAVIOR (1944).

[66] *See* J. HARSANYI AND R. SELTEN, A GENERAL THEORY OF EQUILIBRIUM SELECTION IN GAMES (1988); R. W. COOPER, COORDINATION GAMES: COMPLEMENTARITIES AND MACROECONOMICS (1999).

[67] *See* J. M. Guttman, *Understanding Collective Action: Matching Behavior*, 68 AM. ECON. REV. 251 (1978); J. M. Guttman, *A Non-Cournot Model of Voluntary Collective Action*, 54 ECONOMICA 1 (1987).

[68] *See* M. O. Jackson & S. Wilkie, *Endogenous Games and Mechanisms: Side Payments among Players*, 72 REV. ECON. STUD. 543 (2005).

[69] *See* D. G. Arce M., *Stability Criteria for Social Norms with Applications to the Prisoner's Dilemma*, 38 J. CONFLICT RESOL. 749 (1994). This stability criterion applies the Pareto criterion to coalition building and is not based on the Nash equilibrium.

joining the coalition until the Pareto-dominant outcome was attained. The notion of coalition building applies to intermediated markets because the benefits of participation always increase with greater membership on the other side of the market. Generally, with many buyers and many sellers who can communicate and form agreements, it appears likely that both sides will coordinate to achieve the best outcome. For buyers and sellers to choose the Pareto-dominant Nash equilibrium requires that the outcome not be challenged by a coalition of the whole.[70] Hagiu assumes that buyers and sellers choose the best outcome in a two-sided model with network effects.[71] In contrast, Caillaud and Jullien suggest obtain a different outcome in a centralized market by choosing what is best for the firm supplying network services.[72]

A number of game-theoretic ideas suggest how groups of players may choose the best equilibrium among multiple Nash equilibria.[73] Even when there are transaction costs, there may be ways for buyers and sellers to achieve the best outcome. The buyer and the seller may engage in tacit cooperation and simply choose Pareto-dominant Nash equilibrium because it is the most advantageous noncooperative equilibrium. The Pareto-dominant Nash equilibrium is a natural focal point among the equilibria of the market

[70] For example, Katz and Shapiro make this assumption in the context of network effects. *See* M.L. Katz & C. Shapiro, *Technology Adoption in the Presence of Network Externalities*, 94 J. POL. ECON. 822 (1986).

[71] *See* A. Hagiu, Two-Sided Platforms: Product Variety and Pricing Structures, 18 J. ECON. & MGMT. STRATEGY (forthcoming 2009); *see also* A. Hagiu, Pricing and Commitment by Two-Sided Platforms, 37 RAND J. ECON. 720 (2006).

[72] *See* Caillaud & Jullien, *supra* note 35.

[73] Aumann's concept of the Strong Nash equilibrium specifies that an outcome must survive challenges from all possible coalitions of players, which would include the coalition of the whole. This would be sufficient to ensure that buyers and sellers chose the Pareto-dominant outcome. *See* R. Aumann, *Acceptable Points in General Cooperative N-Person Games*, *in* CONTRIBUTIONS TO THE THEORY OF GAMES (H. W. Kuhn and A.W. Tucker eds., vol. 4, Princeton University Press 1959). The Coalition-Proof Nash equilibrium of Bernheim, Peleg, and Whinston weakens the Strong Nash equilibrium concept by requiring the equilibrium to survive challenges from coalitions that themselves survive deviations by subcoalitions. *See* B.D. Bernheim, B. Peleg, & M.D. Whinston, *Coalition-Proof Nash Equilibria I. Concepts*, 42 J. ECON. THEORY 1 (1987). Xue introduces the Negotiation-Proof Nash equilibrium that formalizes the negotiation process as an extensive game of preplay communication and eliminates coalitions that will not form with rational players. *See* L. Xue, *Negotiation-proof Nash Equilibrium*, 29 INT'L J. GAME THEORY 339 (2000). Ambrus introduces the concept of coalitional rationalizability, which is weaker than the concept of Coalition-Proof Nash equilibrium. *See* A. Ambrus, *Coalitional Rationalizability*, 121 Q.J. ECON. 903 (2006). The coalitional rationalizability solution allows groups of players to coordinate on strategies that are mutually beneficial by deleting strategies, but does not require Pareto dominance. Coalitional rationalizability is based on implicit agreements between players rather than explicit communication and commitments. Ambrus and Argenziano apply the solution concept of coalitional rationalizability to coordination in a two-sided market. *See* A. Ambrus & R. Argenziano, *Asymmetric Networks in Two-Sided Markets*, AM. ECON. J. MICROECONOMICS (forthcoming 2009). Ambrus and Argenziano assume that players have linear preferences that are similar in structure to the present model.

participation game.[74] With repeated games, players can learn how to coordinate their choices over time.[75] If buyers and sellers can communicate, but not make contractual commitments, they may still be able to achieve the best outcome. Communication between buyers and sellers can affect expectations that determine the outcome of the participation game.[76]

Buyers and sellers may achieve the best outcome when participation decisions are sequential rather than simultaneous. For example, if the seller moves first, the seller's choice will be revealed to the buyer. In equilibrium, with the payoffs shown in Table 1, the seller will choose to participate. This is because the buyer's best response to participation is also to participate. Anticipating this, the seller then will choose to participate. The buyer knows that the seller's commitment is credible, because the buyer knows that the seller's best response to the buyer's participation is to participate as well, so the seller will not change his decision.

B. SOLVING THE CIRCULAR CONUNDRUM BY FOSTERING DECENTRALIZED COORDINATION

If transaction costs of decentralized coordination are sufficient to prevent pre-play communication and negotiation, the intermediary firm may choose to provide centralized coordination. Intermediary firms reduce the transaction costs of cross-market coordination by providing various communication services. Intermediary firms also foster decentralized coordination through mass marketing.

Intermediary firms provide free communication services that are complements to their paid services. Such communication services help potential buyers and sellers coordination their participation decisions. eBay freely provides information to buyers and sellers about ongoing auctions so that potential buyers and sellers can observe current participation levels. eBay also creates online communities for interest groups and in so doing lowers communication costs for prospective buyers and sellers. Amazon.com offers communication services to book buyers and small booksellers, including rating systems that identify the number of transactions and quality ratings for book sellers. Amazon offers an internal search service that provides potential book buyers with information about books, including the ability to search within books for excerpts contain specific content. Amazon's book listings also appear on Internet search results offered by Google, Microsoft, Yahoo and other search firms based on author, title, or content keywords.

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[74] Thomas Schelling discussed tacit coordination and focal points. *See* T.C. SCHELLING, THE STRATEGY OF CONFLICT (1960). For a discussion of collective rationality and language in choosing among decision rules, see R. Sugden, *A Theory of Focal Points*, 105 ECON. J. 533 (1995).

[75] *See* V. Crawford & H. Haller, *Learning How to Cooperate: Optimal Play in Repeated Coordination Games*, 58 ECONOMETRICA 571 (1990).

[76] For a discussion of pre-pay communication and coordination, see J. Farrell, *Cheap Talk, Coordination, and Entry*, 18 RAND J. ECON. 34 (1987); E. Van Damme, *Stable Equilibria and Forward Induction*, 48 J. ECON. THEORY 476 (1989).

Intermediary firms reduce transaction costs for buyers and for sellers by taking advantage of focal points and locations. For example, centrally-located malls attract buyers due to convenience. This, in turn, attracts multiple sellers, who are drawn in by the scale effects realized by serving many buyers in one location. The variety of sellers attracts buyers seeking a diverse selection of products.

Intermediary firms also reduce transaction costs for buyers and for sellers by advertising their services. Buyers and sellers can learn about the existence and features of the intermediary firm without having to communicate with each other. A number of examples illustrate how intermediaries address the circular conundrum through advertising. Search firms advertise their services through other media such as broadcast and print media, as do directory firms, such as publishers of yellow pages. Credit card companies, such as Visa, Mastercard, Discover, and American Express, advertise their services to potential buyers and sellers though print and broadcast media and through the Internet. Computer technology platforms such as Microsoft's Windows also advertise to potential adopters and application providers. Matchmaking firms, such as match.com and eHarmony, also advertise to potential participants. Advertising by eBay informs prospective buyers and sellers that they can locate a counter party through eBay.

Advertisements for intermediary firms may contain information that indicates buyer and seller participation. Information that indicates the popularity of the service helps buyers and sellers determine that their potential benefits from participation. In addition, high expenditures on advertisements are a signal that the service is successful, or perhaps expects to be successful, and provides an indirect indicator of buyer and seller participation. Signaling though advertising expenditures can inform prospective participants about the advertiser's potential success in competition with other advertisers.[77]

Intermediary firms reduce transaction costs for buyers and sellers by using the services of search firms and online directories. Search firms manage a circular flow of information that matches buyers and sellers.[78] They provide an extensive directory of businesses that buyers use to locate sellers for almost all commercial transactions.[79] Buyers using search engines enter keywords that the search firms use to present content as well as targeted advertisements from multiple sellers. The buyer has the option of clicking on these advertisements and ultimately purchasing an advertiser's product.

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[77] Making the largest advertising expenditure does not guarantee success. Other factors such as quality of service affect whether buyers and sellers select a particular intermediary. This was discovered by online intermediaries who sought unsuccessfully to distinguish their companies through expensive online campaigns that included advertising during the Super Bowl.

[78] *See* D. F. Spulber, *The Map of Commerce: Internet Search, Competition, and the Circular Flow of Information*, J. COMPETITION L. AND ECON. (forthcoming 2009).

[79] *Id*.

Intermediary firms induce participation by using online directories. Yahoo!, Microsoft's MSN.com, and AOL offer extensive directories that include shopping, personals, and yellow pages. Likewise, Business.com provides a directory that has over 65,000 business categories.[80] The online directory @list.org refers to itself as "the most comprehensive online business directory," comprising over 10 million businesses. Yahoo! offers a business-to-business directory with over 250,000 listings and a shopping and services directory with over 400,000 listings.[81] Yahoo! also lists independent company directories for practically every industry from advertising to travel.[82] The Open Directory Project (ODP) refers to its service as "the largest, most comprehensive human-edited directory of the Web. It is constructed and maintained by a vast, global community of volunteer editors."[83] Internet comparison sites and shopping services also perform matchmaking functions that reduce the costs of cross-market coordination.

Competition among intermediary firms to attract buyers and sellers heightens the problem of the circular conundrum faced by each firm. Multiple intermediaries offer sellers the benefits of targeted advertising and variety of communication methods. Buyers benefit by dealing with specialized intermediaries that offer services and access to buyers that are better suited to their needs. However, multiple intermediaries introduce additional coordination problems. Prior to the Internet, the Yellow Pages offered a focal point for obtaining telephone numbers and business addresses. Newspaper classifieds were a focal point in comparison to the variety of online job search websites or online used car listings. To communicate with consumers, advertisers may have listings with multiple directories and multiple search firms. The additional complexity of dealing with multiple intermediaries offsets some of the coordination effects of communication services and targeted advertising.

III. CENTRALIZED COORDINATION BY PROVIDING MEDIA CONTENT AND CONSUMER REWARDS

In addition to reducing the transaction costs of decentralized coordination, intermediary firms can provide media content and consumer rewards. These incentives help to solve the cross-market coordination problem. Incentives for market participation can take the form of in-kind transfers or monetary payments. Internet search firms such as Google, Microsoft, and Yahoo! attract users by content in the form of search results. Publishers of websites and print media provide users with content in the form of news stories, sports results, financial market data, and other types of information. Media companies such as broadcast radio and television,

[80] *See* http://www.business.com/directory/.
[81] *See* http://dir.yahoo.com/Business_and_Economy/.
[82] *See* http://dir.yahoo.com/Business_and_Economy/Directories/Companies/.
[83] *See* www.dmoz.org/.

satellite radio and cable television provide viewers with content such as entertainment, news, sports, talk shows, and other programs.

A. SOLVING THE CIRCULAR CONUNDRUM THROUGH MEDIA CONTENT AND CONSUMER REWARDS

Search and media firms intermediate between sellers that provide advertising and viewers who purchase goods from those sellers. Sellers make payments to search and media firms in return for advertisements. Buyers view the advertisements in addition to the content provided by search firms and media firms. Search firms and media firms provide content to buyers to induce their participation in the market. Buyers receive benefits from viewing the content, regardless of whether or not sellers participate in the market.[84]

This section presents a basic game theory model that illustrates how an intermediary firm provides content to address the circular conundrum. The firm is a monopoly intermediary. The next section considers competition between intermediaries. The intermediary firm provides potential buyers with content and obtains revenues from sellers that purchase advertising. The buyer obtains a benefit x from the content provided by the firm, whether or not the seller purchases advertising. Buyers are charged a price for viewing content, p. The price of content can be free, as with broadcasting, or it can be positive, as with cable television. The seller's payment for advertising is w, whether or not the viewer participates, although this payment can be made contingent on viewer participation. The media firm's costs of content are equal to kx, where the value of a unit of content is less than its cost, $k \leq 1$. Suppose for purposes of illustration that content x is a given amount. The media firm obtains profits equal to $p + w - kx$.

The game is a modification of the game given in Table 1. As before, when the buyer and seller transact with each other through the intermediary, the buyer obtains a benefit u and the seller obtains a benefit h. Table 2 shows the payoffs for the media game. When both the buyer and seller participate, they obtain gains from trade. The media firm induces buyer participation by providing a net benefit to the buyer through content. Suppose that the media firm chooses a participation price that is strictly less than the buyer's benefit from content, $p < x$. The media firm chooses a participation price for the seller that is strictly less than the seller's benefit, $w < h$. Regardless of the seller's participation, the buyer always chooses to participate. The seller's best response to the buyer's participation is also to participate. Therefore, participation by both sides of the market is the only Nash equilibrium. The media firm is profitable in equilibrium. This shows how media firms can resolve the circular conundrum through advertising and provision of content.

The buyer prefers to participate regardless of the seller's participation decision, so the buyer's participation decision is a dominant strategy. If the seller participates, the buyer prefers to participate because the payoff from participating, which equals $x + u - p$, is greater than the payoff from not

[84] Buyers may receive benefits from viewing advertisements or they may experience advertisements as a cost of viewing content.

participating, which equals zero. If the seller does not participate, the buyer still prefers to participate because the payoff from participating, which equals $x - p$, is greater than the payoff from not participating, which again equals zero. The intermediary firm is profitable because there exists prices such that $p + w - kx > 0$.[85]

Seller **Buyer**	Participate $s = 1$	Do not participate $s = 0$
Participate $b = 1$	$x + u - p, h - w$	$x - p, 0$
Do not participate $b = 0$	$0, -w$	0, 0

Table 2 The circular conundrum with a media firm and payoffs (Buyer, Seller).

Because participation is a dominant strategy for the buyer, the seller chooses the best response to the buyer's decision to participate. The seller chooses to participate because the seller's payoff from participating, which equals $h - w$, is greater than the seller's payoff from not participating, which equals zero. Therefore, there is a unique Nash equilibrium, which involves both the buyer and the seller choosing to participate. This means that when content is more valuable to the buyer than the cost of participation, $x > p$, both parties choose to participate. This eliminates strategic uncertainty associated with multiple Nash equilibria.

The analysis helps to explain the provision of content by media, including broadcast, cable, print, Internet website publishers, and Internet search firms. These firms provide content (entertainment, news, search results) that attracts buyers, whether or not advertisers participate. The intermediary's provision of valuable content therefore solves the circular conundrum by inducing a unique equilibrium with participation by both the buyer and the seller. By offering content to buyers, often at no charge, the intermediary induces strategic participation by buyers. In turn, the benefits of buyer participation induce strategic participation by sellers. The provision of incentives through content solves the problem of multiple equilibria and thus resolves potential coordination problems associated with cross-market benefits. The intermediary firm's provision of content internalizes cross-market benefits and induces equilibrium participation.

B. THE CIRCULAR CONUNDRUM WITH COMPETING FIRMS

More generally, intermediary firms in media and Internet search must compete for viewers. Competition is sufficiently vigorous that broadcast media and Internet search firms offer free access to content. Competition between firms makes the circular conundrum more complex. As in the case

[85] Let $p = x$ and $w = h$. Then, because $k \leq 1$, the firm's profits are positive, $p + w - xk = (1 - k)x + h > 0$. Then, slightly lowering prices such that $p < x$ and $w < h$ still gives positive profits.

of a monopoly intermediary, there may be multiple Nash equilibria. For example, Table 3 shows an intermediation game in which choosing to transact through firm 1 or through firm 2 are both Nash equilibria. If transacting through either firm offers similar prices and transaction benefits, there is no Pareto-dominant Nash equilibrium. If one firm is better for buyers and the other is better for sellers, there is again no Pareto-dominant Nash equilibrium.

If one firm is better both for buyers and for sellers, buyers and sellers may tacitly coordinate by choosing the Pareto-dominant firm. As discussed previously, when prior communication is feasible, buyers and sellers can explicitly coordinate their choices. With side payments, a buyer and a seller will choose the firm that offers the greatest total benefits net of participation costs. As before, timing can solve the coordination problem. If there is a single buyer and a single seller, and the agent on one side of the market makes a commitment to one of the firms, the agent on the other side also will transact through that firm.

Seller **Buyer**	Transact through firm 1 $s = 1$	Transact through firm 2 $s = 2$
Transact through firm 1 $b = 1$	$u - p_1, h - w_1$	$- p_1, - w_2$
Transact through firm 2 $b = 2$	$- p_2, - w_1$	$u - p_2, h - w_2$

Table 3 The circular conundrum with competition between firms intermediating between a single buyer and a single seller, with payoffs (Buyer, Seller).

The provision of content by media firms again can provide coordination. Suppose that the two firms offer the same transaction services and suppose that prices are equal. Suppose that one firm provides better content, so that the firms are vertically differentiated in terms of content. For example, one search firm provides more comprehensive search results than the other firm. There is only one buyer. The game is represented in Table 4.

Assume that the buyer's benefits from firm 1's content are greater than the buyer's benefits from firm 2's content plus the benefits from transacting with the seller, $x_1 > x_2 + u$. Then, the buyer will choose the media firm with the best content, regardless of the choice made by the seller. The seller will choose the firm that provides the better content to the buyer. Then,

there will be a unique Nash equilibrium, with both the buyer and seller transacting through firm 1.[86]

The model can be generalized to address a market with many buyers. With multiple buyers who have different preferences, media firms can segment the market by offering different content. Media firms offer content targeted at specific demographic groups and viewers self select by choosing to view the content they prefer. When sellers are differentiated, they can advertise their products with the media firm that targets the market segment that is best suited to their products.[87] Advertisers benefit by targeting their advertising messages to the specific interests of different demographic groups. Search firms such as Google, Microsoft, and Yahoo! adjust advertising messages to individual users on the basis of keywords and online behavioral marketing.[88] Web sites and some search firms offer content targeted at specialized interests. For example, WebMD offers medical advice and specialized search services.

Seller **Buyer**	Transact through firm 1 $s = 1$	Transact through firm 2 $s = 2$
Transact through firm 1 $b = 1$	$x_1 + u - p,\ h - w$	$x_1 - p,\ -w$
Transact through firm 2 $b = 2$	$x_2 - p,\ -w$	$x_2 + u - p,\ h - w$

Table 4 The circular conundrum with competing media firms and payoffs (Buyer, Seller).

With multiple buyers who have different preferences, firms can split the market through price discrimination. Ambrus and Argenziano consider competition between two network firms who each can establish one or two networks. They show that with homogeneous consumers, a monopolist network firm establishes only one network. With two types of consumers, a monopolist network firm will choose to establish two networks under some

[86] If the buyer acts before the seller, it is sufficient for one of the media firms to provide content that is better than that of the other firm, $x_1 > x_2$. The buyer will choose firm 1 and the seller will follow.

[87] A market with differentiated buyers and differentiated sellers and multiple intermediaries can be represented using a two-sided Hotelling market model. The two-sided Hotelling model is introduced by D. F. Spulber, *supra* note 1 and developed by A. Alexandrov, G. Deltas, and D. F. Spulber, *Competition between Differentiated Intermediaries*, Northwestern University Working Paper (2009).

[88] *See* Spulber, *supra* note 33. These firms also adjust their offerings on the basis of an end-user's geographic location. See Dan Jerker B. Svantesson, *Geo-location Technologies and Other Means of Placing Borders On the 'Borderless' Internet*, 23 J. MARSHALL J. COMPUTER & INFO. L. 101, 109-10 (2004); Jack Goldsmith & Timothy Wu, Digital Borders, LEGAL AFF. Jan.-Feb. 2006 40, at 43.

conditions. The network firm price discriminates by offering one network that is larger and cheaper on one side of the market and another network that is larger and cheaper on the other side of the market. A similar outcome occurs with competing firms, with one firm supplying a single network that is larger and cheaper on one side of the market and the other firm supplying a single network that is larger and cheaper on the other side of the market.[89]

Another aspect of competition between intermediary firms involves "multihoming."[90] Sellers are said to be "multihoming" when they transact through multiple intermediary firms. Sellers advertise their products through multiple media outlets, directories, and search firms. Suppose that there is a single buyer and a single seller. Suppose also that the firm makes the seller's payment contingent on buyer participation. When a seller offers his products through both firms, the buyer will choose to transact through one of the firms, so that one intermediary firm operates in equilibrium and the other firm does not. With identical intermediary firms, each firm has an equal chance of winning the market. When sellers can multihome, buyer decisions determine the transactions of the intermediary firms.

With multihoming by sellers, buyer rewards can differentiate the competing intermediary firms. For example, credit card companies compete by offering contingent payments in the form of cash back or discounts from selected sellers. Such contingent rewards solve the coordination problem with multihoming sellers. When the seller multihomes, the seller receives a payoff of $h - w$ from either firm and is indifferent between transacting through either firm. The intermediary firm offers the buyer a payment that is contingent on his participation and completion of a transaction. Firm 1 offers the buyer a contingent payment x_1 and Firm 2 offers the buyer a contingent payment x_2. The buyer receives a payoff of $x_1 + u - p$ by transacting with firm 1 and a payoff of $x_2 + u - p$ by transacting through firm 2. It follows that the buyer chooses the intermediary firm with the largest contingent consumer rewards.

IV. CENTRALIZED COORDINATION BY ACTING AS A MARKET MAKER

This Part shows how market making by firms addresses the circular conundrum and internalizes cross-market benefits. Market-making firms include traditional retailers and wholesalers as well as online retailers. Organized exchanges, many of which are operated by firms rather than associations, offer market-making services for securities, commodities, currencies and other financial assets. Financial firms that provide dealer services include banks, securities brokerages, mutual funds, and insurance companies. The discussion shows that one-to-one matching and market making yield the same outcome with a monopoly intermediary.

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[89] A. Ambrus and R. Argenziano**,** *Asymmetric Networks in Two-Sided Markets*, 1 AMERICAN ECONOMIC J.: MICROECONOMICS, 17 (2009), February.

[90] *See* Caillaud & Jullien, *supra* note 35.

A. THE CIRCULAR CONUNDRUM WITH MARKET MAKING FIRMS

With decentralized exchange, a buyer-seller pair divides the surplus through some type of pricing or bargaining process. Each buyer-seller pair has different gains from trade, which is the difference between the buyer's willingness to pay and the seller's costs. Buyers and sellers face a coordination problem when there are costs to market participation. They receive cross-market benefits from market thickness effects, so that the greater the participation on the other side of the market, the greater their returns.

Market-making by firms addresses the strategic participation problem by providing liquidity or immediacy. Traditional retail intermediaries and other types of dealers solve the coordination problem by purchasing from sellers for resale to buyers. This serves to disconnect the participation decisions of buyers and sellers and eliminates market thickness effects from participation decisions. Sellers participate by making profitable sales to the firm, regardless of buyer decisions. Buyers participate because they obtain a surplus from dealing with the retailer. This is the traditional method of purchasing to stock. Retail firms incur the costs of holding inventories while providing buyers with the benefits of immediacy. Market making firms establish the terms of exchange and complete transactions.

Some Internet retailers solve the coordination problem without making purchases from sellers. Decisions are made sequentially because sellers' products are displayed on the online retailer's website, thus indicating to buyers that the sellers are participating in the online market. When a buyer orders the products, the retailer in turn orders the products from the sellers. The online retailer need not purchase the goods in order to demonstrate the sellers' commitment to the online market. This corresponds approximately to a traditional retailer purchasing to order.

More generally, firms can provide contractual incentives for buyers and sellers to overcome imperfect coordination.[91] Firms can insure buyers and sellers against the possibility of not finding a trading partner. Market making firms in financial markets provide liquidity by standing ready to buy and to sell if an individual does not find a trading partner. This serves to guarantee that buyers and sellers will be able to transact whenever they participate in the market.[92]

The basic model can be applied to illustrate how market making by firms affects strategic participation decisions. The coordination game with a market making firm is shown in Table 5. The firm guarantees that a buyer and seller can complete a trade, whether or not the other side of the market

[91] *See* I. Segal, *Contracting with Externalities*, 114 Q.J. ECON. 337 (1999).

[92] Intermediaries offer many types insurance to reduce risks for buyers and sellers. For example, retailers offer product quality guaranties and the ability to return unsatisfactory products. Online ticket broker StubHub, located at www.stubhub.com, guarantees that the tickets sold on its site are valid and that they will arrive on time.

participates. The market maker eliminates the possibility of loss associated with imperfect coordination.

To illustrate the market making model, consider the underlying transaction between a buyer and a seller. Suppose that the buyer and the seller exchange a unit of a good at a price, Z. The buyer receives a consumption benefit U and the seller incurs a production cost, C. The buyer's net benefit from direct exchange with the seller is $u = U - Z$. The seller's net benefit from direct exchange with the buyer is $h = Z - C$.

Suppose that the market making firm acts as a dealer and purchases the output of sellers for resale to buyers. Buyers and sellers are guaranteed to transact with the intermediary at the posted prices so that they do not face the risk of being rationed. Then, buyers and sellers no longer need to take into account participation rates on the other side of the market. The market making firm intermediates between buyers and sellers by posting ask and bid prices. The market making firm offers all buyers an ask price, P, and offers all sellers a bid price, W.

The market making firm changes the payoffs in the participation game in an important way. As a result of market making, the buyer strictly prefers to participate regardless of the seller's participation decision because the buyer's return from participation, $U - P$, is greater than zero. The seller strictly prefers to participate regardless of the buyer's participation decision because the seller's return from participation, $W - C$, is greater than zero. This means that participation becomes a dominant strategy for both the buyer and the seller. As a result, participation by both the buyer and the seller is the dominant-strategy equilibrium. The intermediary firm solves the coordination problem through market making.

Seller / **Buyer**	Participate $s = 1$	Do not participate $s = 0$
Participate $b = 1$	$U - P$, $W - C$	$U - P$, 0
Do not participate $b = 0$	0, $W - C$	0, 0

Table 5 The circular conundrum with a market making firm and payoffs (Buyer, Seller).

B. MARKET MAKING WITH MANY BUYERS AND MANY SELLERS

Market making by intermediary firms is likely to work best in markets with economies of scale in transactions. This is suited to markets with high volumes and low margins, such as retailing and wholesaling and some types of financial markets. The market-making game described in the preceding section generalizes to a market with many buyers and many sellers. In the general framework, buyers differ in terms of their willingness to pay and sellers differ in terms of their production costs. Consider a model of the economy in which there is a continuum of buyers, i, and a continuum of

sellers, j, each of which is uniformly distributed on the unit interval, [0, 1]. Let n be the number of buyers that deal with the firm in equilibrium and let m be the number of sellers that deal with the firm in equilibrium.

With decentralized exchange, a buyer of type i transacts with a seller of type j at price $Z(i, j)$. This allows for bargaining power to differ across buyer-seller pairs. A type-i buyer who transacts with a type-j seller has net benefits

$$u(i, j) = U - i - Z(i, j). \tag{1}$$

A type-j seller who transacts with a type-i buyer has net benefits

$$h(i, j) = Z(i, j) - C - j. \tag{2}$$

Buyers and sellers face a coordination problem because the likelihood of a match and the quality of a match depend on market participation. There are multiple participation equilibria. For example, there is a nonparticipation equilibrium, where no buyers participate as a best response to no seller participation and no sellers participate as a best response to no buyer participation.

With many buyers and many sellers, transaction costs may prevent direct coordination. An intermediary firm that provides matchmaking services faces a circular conundrum because it must induce participation by buyers and by sellers. As already discussed, the intermediary firm can foster cross-market coordination by reducing transaction costs for buyers and sellers and by providing content and consumer rewards.

Market making by an intermediary firm solves the circular conundrum with many buyers and many sellers by eliminating participation risks. In the market making model with homogeneous products, the buyer's net benefits equal

$$u(i, P) = U - i - P, \tag{3}$$

The seller's net benefits with homogeneous products equal

$$h(j, W) = W - C - j. \tag{4}$$

The main implications of these benefit functions is that buyers and sellers obtain net benefits that do not depend on the other side of the market. The market maker offers bid and ask prices so that buyers and sellers are not affected by the characteristics of their trading partner as in one-to-one matching. Also, the market making firm guarantees trades at the bid and ask prices which eliminates the strategic participation decisions.

The buyers' participation is determined by the marginal buyer.[93] This means that the marginal buyer's type corresponds to the total number of buyers, $i = n^*$, which is determined by

(5) $$U - n^* = P,$$

The sellers' participation is determined by the marginal seller.[94] This means that the marginal seller's type corresponds to the total number of sellers, $j = m^*$, which is determined by

(6) $$W = C + m^*.$$

The participation decisions of buyers and sellers do not depend on participation by the other side of the market. The market making firm absorbs the participation risks.

With a profit-maximizing market making firm, buyer and seller participation rates are equal in equilibrium,

(7) $$n^* = m^*.$$

The market making firm adjusts the ask and bid prices such that the market clears in equilibrium. Applying equal participation levels for buyers and sellers, the firm's profit function equals

(8) $$\Pi = (P - W)n = (U - C - 2n)n.$$

The firm's profit-maximizing pricing decisions determine the equilibrium participation levels. The profit-maximizing participation levels are equal to

(9) $$n^* = m^* = (¼)(U - C)$$

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[93] As before, buyer i's decision to participate is represented by a strategy b_i that takes two values, $b_i = 1$ if the buyer joins the network and $b_i = 0$ if the consumer does not join the network. Total buyer participation in the market is obtained by adding the buyers' decisions, $n(p,w) = \int_0^1 b_i di$. The strategy set for a buyer is $B_i = \{0, 1\}$ and the strategy vector for the buyers $b = (b_1, \ldots, b_n)$ is an element of $B = \prod_{i=1}^{n} B_i$.

[94] As before, each seller decides whether or not to participate in the market network. Seller j's decision is represented by a strategy s_j that takes two values, $s_j = 1$ if the seller joins the network and $s_j = 0$ if the seller does not join the network. Total seller participation in the market is obtained by adding the sellers' decisions, $m(p,w) = \int_0^1 s_j dj$. The strategy set for a seller is $S_j = \{0, 1\}$ and the strategy vector for the sellers $s = (s_1, \ldots, s_n)$ is an element of $S = \prod_{j=1}^{n} S_j$.

The profit-maximizing ask price equals $P^* = (¼)(3U + C)$ and the profit-maximizing bid price equals $W^* = (¼)(U + 3C)$. Figure 3 shows the market making equilibrium with buyer demand and seller supply curves.

The market making firm addresses cross-market coordination between buyers and sellers. By eliminating participation risks, the market making firm provides cross-market coordination and solves the circular conundrum. The market model with homogeneous products applies to markets in which buyers and sellers derive benefits from market thickness effects.

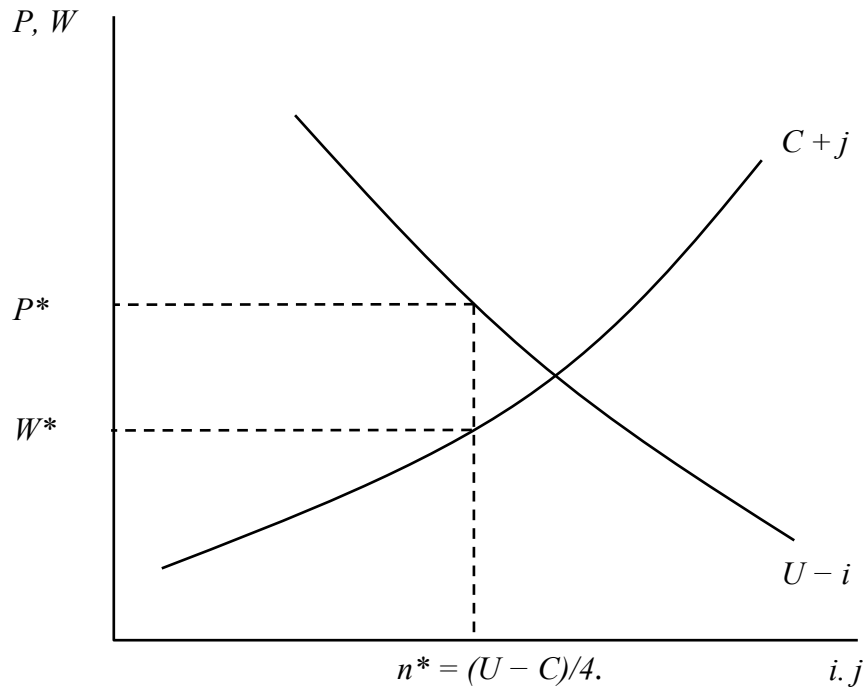

Figure 3 The market equilibrium with a market making firm.

C. MARKET MAKING WITH VARIETY AND SCALE EFFECTS

The previous section showed how market making firms solve the circular conundrum in a market with homogeneous products. That conclusion applies primarily to cross-market benefits from market thickness effects. This section extends the analysis by showing how market making firms solve the circular conundrum in markets with product variety and scale effects. Similar results apply to cross-market benefits from network effects.

By offering guarantees to at least one side of the market, market making firms can address cross-market coordination problems.

Consider a market with many-to-many matching. For example, a farmer's market involves many buyers and many sellers. Buyers generally seek to purchase a variety of products and sellers seek to serve multiple buyers. Internet search firms also offer many-to-many matching between buyers and sellers. Media firms offer many-to-many matching between different types of buyers who view the content and many types of sellers who post advertisements. Online auctioneers such as eBay also match many types of buyers with many types of sellers.

In practice, most firms offer some combination of one-to-one matching and many-to-many matching. For example, credit card companies match many buyers with many sellers, although each individual transaction is one-to-one.[95] Internet matchmaking services such as match.com and eHarmony provide each individual on one side of the market with multiple potential matches on the other side of the market. Realtors provide one-to-one matchmaking, although they show each house to multiple buyers and they show multiple houses to each buyer.[96]

An intermediary firm that offers many-to-many matching faces a circular conundrum. As before, the noncooperative participation game has multiple equilibria. In particular, zero participation by all buyers and all sellers is an equilibrium of the buyer-seller participation game. The matchmaking firm faces a cross-market coordination problem in trying to attract both buyers and sellers. The matchmaking firm must induce participation both by buyers and by sellers to attain the best outcome.[97]

An intermediary firm can address the circular conundrum by offering the convenience of one-stop-shopping. For example, a retailer brings together many types of buyers and many types of sellers by buying multiple products and offering them for resale. By purchasing from suppliers, the retailer absorbs their risks of nonparticipation by buyers. In turn, buyers benefit from the immediacy provided by the retailer. Online retailers solve the problem of participation for most of their products by displaying merchandize catalogs in a wide range of product categories and purchasing to

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[95] *See* S. Chakravorti, *Theory of Credit Card Networks: A Survey of the Literature*, 2 REVIEW OF NETWORK ECONOMICS **50** (2003). Participation is complex because it consists of consumers, the consumers' banks (credit card issuers), merchants, and the merchants' banks (acquirers).

[96] *See* A. Yavas, *Marketmakers Versus Matchmakers*, 2 J. FIN. INTERMEDIATION 33 (1992); A. Yavas, *Middlemen in Bilateral Search Markets*, 12 J. LAB. ECON. 406 (1994); A. Yavas, *Economics of Brokerage: An Overview*, 2 J. REAL EST. LITERATURE 169 (1994); A. Yavas, *Search and Trading in Intermediated Markets*, 5 J. ECON. AND MGMT. STRATEGY 195 (1996).

[97] Hagiu observes in a model with product variety that if the intermediary is a matchmaker, sellers care about the number of consumers, whereas if the intermediary is a dealer, sellers do not care about the number of consumers. Hagiu, *supra* note 21; s*ee also* A. Hagiu, *Two-Sided Platforms: Product Variety and Pricing Structures*, 18 J. ECON. AND MGMT. STRATEGY (forthcoming 2009).

order.[98] A shopping mall operator addresses the circular conundrum by establishing a centralized location that attracts many types of buyers. By contracting with sellers, the shopping mall obtains participation by one side of the market, which can then attract participation by buyers.

Another approach is for the intermediary firm to purchase a variety of goods from sellers and to resell them to buyers as a bundle. By bundling goods, the intermediary firm eliminates the participation risks for both sides of the market. Buyers purchasing the bundle obtain a variety of goods without having to consider participation by sellers. By selling their goods to the intermediary, sellers do not have to consider market participation by buyers. Bundling therefore provides a solution to the circular conundrum in markets with variety and scale effects and in markets with network effects.

Cross-market coordination provides an important explanation for bundling that differs from standard approaches. Firms bundle goods to reduce the transaction costs of pricing and managing separate products.[99] Additionally, consumers may not have the sophistication to combine complements or to recognize how technological change affects product bundles.[100] There has been extensive study of bundling by firms with market power.[101] However, bundling is consistent with competition between providers of product bundles and is commonly observed in competitive industries.[102]

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[98] For example, Amazon.com, the leading Internet retailer, offers products arranged in the following categories: books; movies, music and games; digital downloads and the Kindle electronic reader, computers and office, electronics, home and garden; grocery, health, and beauty; toys, kids, and baby; apparel, shoes and jewelry; sports and outdoors; tools, auto, and industrial. Amazon built online brand recognition by moving into Internet book retailing early, and then extended its brand to a wide array of products. Amazon branched out into auctions, electronics, toys and video games, tools and hardware, lawn and patio products, kitchen products, and even automobiles. Amazon states on its website that it offers "Earth's Biggest Selection (TM) of products, including free electronic greeting cards, online auctions, and millions of books, CDs, videos, DVDs, toys and games, and electronics."

[99] *See* Y. Bakos, *The Emerging Role of Electronic Marketplaces on the Internet*, 41 COMM. OF THE ACM ARCHIVE 35 (1998); Y. Bakos & E. Brynjolfsson, *Bundling Information Goods: Pricing, Profits, and Efficiency*, 45 MGMT. SCI. 1613 (1999); S. J. Liebowitz & S. E. Margolis, *Bundles of Joy: The Ubiquity and Efficiency of Bundling in Markets*, 5 J. OF COMPETITION L. AND ECON. 1 (2009).

[100] *See* P.T. Spiller & B. A. Zelner, *Product Complementarities, Capabilities and Governance: A Dynamic Transaction Cost Perspective*, 6 INDUS. AND CORP. CHANGE 561 **(1997).**

[101] *See* W.J. Adams & J.L. Yellen, *Commodity Bundling and the Burden of Monopoly*, 90 Q.J. ECON. 475 (1976); R. Venkatesh & Wagner Kamakura, *Optimal Bundling and Pricing under a Monopoly: Contrasting Complements and Substitutes from Independently Valued Products*, 76 J. BUS. 211 (2003); C. Matutes & P. Regibeau, *Compatibility and Bundling of Complementary Goods in a Duopoly*, 40 J. INDUS. ECON. 37 (1992); R.P. McAfee, J. McMillan, & M.D. Whinston, *Multiproduct Monopoly, Commodity Bundling, and Correlation of Values*, 104 Q.J. ECON. 371 (1989); M.D. Whinston, *Tying, Foreclosure, and Exclusion*, 80 AM. ECON. REV. 837 (1990).

[102] *See* D.S. Evans, M. Salinger, 2005, *Why Do Firms Bundle and Tie? Evidence from Competitive Markets and Implications for Tying Law*, 22 YALE J. ON REG., **37** (2005); B. H.

Consider a model of a decentralized market in which buyers and sellers engage in many-to-many matching. Because buyers derive variety benefits from the number of sellers and sellers derive profit benefits from the number of buyers, market participants face a cross-market coordination problem. This model is an extension of the basic market model that allows for cross-market benefits resulting from variety and scale effects. The model can also be adapted to address network effects.

There is a continuum of buyers, *i*, and a continuum of sellers, *j*, each of which is uniformly distributed on the unit interval, [0, 1]. For simplicity, suppose that all goods have the same price, *Z.* More generally, prices could differ across buyer-seller pairs, *Z(i, j)*, allowing bargaining power to differ across buyer-seller pairs. A type-*i* buyer who purchases *m* goods has net benefits

(10) $$u(i, m) = U(m) - i - Zm.$$

The term *U(m)* is the buyer's cross market network effect from consuming one unit each of *m* goods. A type-*j* seller who transacts with *n* buyers has net benefits

(11) $$h(j, n) = Zn - C(n) - j.$$

The cost term *C(n)* is the seller's sale of a unit of a good to *n* buyers.[103]

Consider first a centralized market with a matchmaking intermediary. The market equilibrium again consists of a two-stage game. In the first stage, the firm chooses the prices to charge buyers and sellers for intermediation services. In the second stage, buyers and sellers decide whether or not to participate in the intermediated market.

The matchmaking firm charges a participation fee of *p* to each buyer and *w* to each seller. Buyers consume a unit of the good provided by each

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Kobayashi, *Does Economics Provide a Reliable Guide to Regulating Commodity Bundling by Firms? A Survey of the Economic Literature*, 1 J. COMPETITION L. AND ECON. 707 (2005).

[103] Buyers and sellers base their participation decisions on expectations about participation on the other side of the market. Each buyer decides whether or not to participate in the market. Buyer *i*'s decision is represented by a strategy b_i that takes two values, $b_i = 1$ if the buyer joins the network and $b_i = 0$ if the consumer does not join the network. Total buyer participation in the market is obtained by adding the buyers' decisions, $n(p, w) = \int_0^1 b_i di$. The strategy set for a buyer is $B_i = \{0, 1\}$ and the strategy vector for the consumers $b = (b_1, \ldots, b_n)$ is an element of $B = \prod_{i=1}^{n} B_i$. Each seller decides whether or not to participate in the market network. Seller *j*'s decision is represented by a strategy s_j that takes two values, $s_j = 1$ if the seller joins the network and $s_j = 0$ if the seller does not join the network. The strategy set for a seller is $S_j = \{0, 1\}$ and the strategy vector for the consumers $s = (s_1, \ldots, s_n)$ is an element of $S = \prod_{j=1}^{n} S_j$. Total seller participation in the market is obtained by adding the sellers' decisions, $m(p, w) = \int_0^1 s_j dj$.

seller that deals with the firm. Sellers provide one unit of their good to each of the buyers that deal with the firm. For a given level of participation prices, it can be established that there exists an equilibrium of the buyer-seller participation game that Pareto dominates all other equilibria. It can be shown that the active buyers and sellers are those with the highest willingness to pay.

The matchmaking firm faces a circular conundrum.[104] Each buyer's benefit depends on expectations about sellers' participation, $u(i, m) - p$. Each seller's benefit depends on expectations about buyers' participation, $h(j, n) - w$. The matchmaking firm can address the circular conundrum by reducing transaction costs of coordination between buyers and sellers and by providing content and consumer rewards.

The intermediary firm can solve the circular conundrum through market making. In particular, consider a market making firm that bundles products. The firm purchases a bundle of n units of the good that is offered by each seller and sells a bundle consisting of m goods to each buyer. Let P be the ask price of a bundle and let W be the bid price paid to each seller for n units of that seller's good. In equilibrium, the number of buyers that participate in the market is given by the indifference condition for the marginal buyer,

$$U(m^*) - n^* = P. \tag{10}$$

The number of sellers that participate in the market solves the indifference condition for the marginal seller,

$$W = C(n^*) + m^*. \tag{11}$$

The equilibrium number of buyers, $n^*(P, W)$, and the equilibrium number sellers, $m^*(P, W)$, are shown in Figure 4.

[104] Given the matchmaker's participation prices (p, w), the buyers and sellers play a Nash game in participation decisions. Let (b^*, s^*) denote a Nash equilibrium. Each buyer's participation decision, denoted by b_i^*, is a best response to the participation decisions of other buyers and sellers. Each seller's participation decision, denoted by s_j^*, is a best response to the participation decisions of other buyers and sellers.

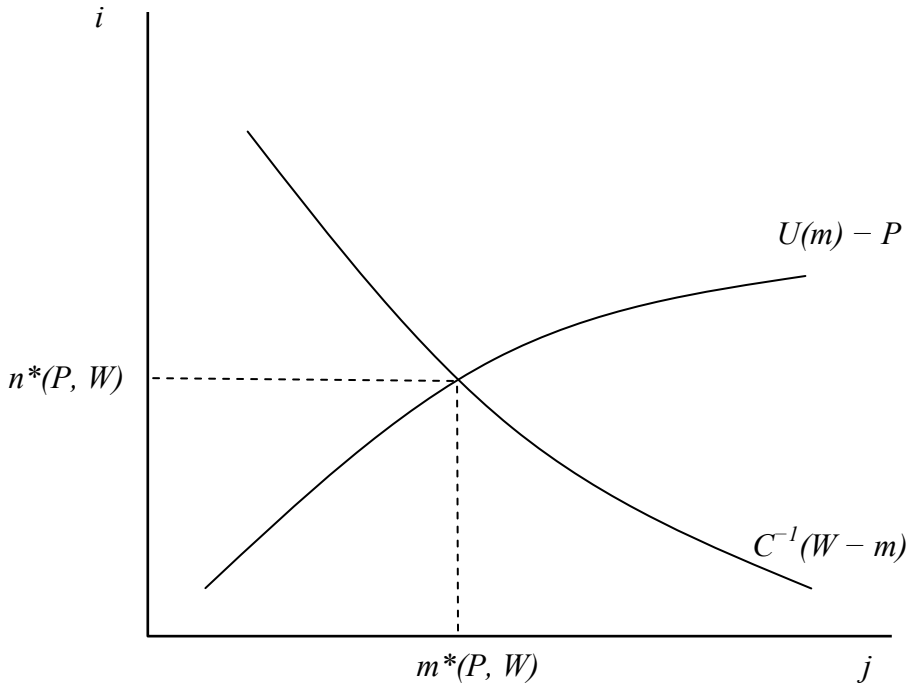

Figure 4 The market equilibrium number of buyers and number of sellers with an intermediary firm that bundles purchases and sales.

The market making firm chooses the ask and bid prices of bundles to maximize profits,

$$\Pi = P\, n^*(P, W) - W m^*(P, W).$$

The market making firm's pricing decisions take into account the variety and scale effects in a two-sided market. The market making firm's profits can be rewritten as a function of the number of participating buyers and the number of participating sellers,

(12) $$\Pi = (U(m^*) - n^*)n^* - (C(n^*) + m^*)m^*.$$

The firm seeks buyer and seller participation levels that maximize profits, which in turn determine the bid and ask prices that the firm chooses. The higher buyer demand due to the variety effects creates an incentive to increase the price to buyers, while the effect of the number of units purchased from sellers creates an incentive to lower the price to buyers. The same tradeoff applies to the seller side of the market.

Bundling by the market making firm solves the circular conundrum. Although buyers derive benefits from the number of goods in a bundle provided by the intermediary, they are not affected directly by the participation rates of sellers. Although sellers derive benefits from the number of units they sell to the intermediary, they are not affected directly by the participation rates of buyers. By bundling its purchases and its sales, the market making firm decouples cross-market participation effects and internalizes cross-market benefits.

V. CASE STUDIES

This Part presents three case studies that illustrate how Internet intermediary firms address the circular conundrum. In each case, the intermediary firm applies multiple market coordination strategies. The first case study looks at market making by Apple's iPhone App Store. The second case study examines coordination incentives associated with the entry of Microsoft's Bing search service. The third case study considers matchmaking by the Chinese business-to-business website Alibaba.

A. MARKET MAKING: APPLE'S IPHONE APP STORE

Apple Computer launched its iPhone in June of 2007 and in its first two years obtained about one percent of mobile phone sales worldwide.[105] Apple not only sold the iPhone hardware, it also sold software applications for its mobile phones, known as "apps." The apps included a vast array of software programs such as video games and personal organizers. Apple's earnings from the sale of apps supplemented its hardware earnings, allowing Apple to obtain about twenty percent of mobile phone industry profits.[106]

Apple faced a circular conundrum in the market for apps. Buyers of its mobile phones enjoyed cross-market benefits from the variety of apps and sellers of apps enjoyed cross-market benefits from the number of buyers of apps. Apple benefited from the market for apps because the software was a demand-side complement to its mobile phones. Apple applied a variety of techniques to address the circular conundrum in the market for apps. These techniques were highly successful, and within one year Apple had sold more than 1.5 billion apps.[107] Apple's market coordination activities boosted sales of mobile phones and applications software and "spawned a cottage industry of software developers."[108]

Apple reduced the transaction costs of decentralized coordination between buyers of software and developers of software through its promotion of the iPhone and accompanying software. The iPhone was sold directly by

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[105] R. Neate, The Magic Profits of the iPhone, July 23, 2009, www.telegraph.co.uk/finance/newsbysector/mediatechnologyandtelecoms/5896004/The-magic-profits-of-the-iPhone.html

[106] *Id.*

[107] *Id; see also* Y. I. Kane, *Seeking Fame in Apple's Sea of Apps*, WALL STREET JOURNAL, July 15, 2009, *available at* http://online.wsj.com/article/SB124761263919341941.html.

[108] *Id*.

Apple as well as by retailers (Best Buy, WalMart) and telecommunications providers (AT&T). Apple's media advertisements for the iPhone identify the availability of apps for the phone. Apple's iPhone website further promotes the apps, stating the following: "Your iPhone gets better with every new app. Applications for iPhone are like nothing you've ever seen on a mobile phone. Explore some of our favorite apps here and see how they allow iPhone to do even more."[109]

Through market making, Apple reduced participation risks for buyers and sellers of apps. By establishing its App Store, Apple served as an apps dealer. Rather than relying on a decentralized software market, Apple centralized the market and handled all software transactions. It was estimated that Apple earned thirty percent of the sales price of every app sold.[110] Because software is an information good, developers faced risks associated with investing in the costs of developing an app, although they did not face risks associated with production and inventories. By creating and operating a software market, Apple coordinated software transactions for buyers and sellers. Apple's centralized software market provided buyers with one-stop shopping efficiencies and allowed sellers to avoid retail transactions.

Apple's App Store offered more than 65,000 apps in twenty categories, such as games, business, education, news, sports, entertainment, finance, travel, and fitness.[111] The App Store offered users the ability to search for apps by category or by keyword and provided recommendations for particular apps, product descriptions, and user reviews, as well as wireless downloads.[112] Apple listed free and paid apps using a ranking based on the number of downloads, which reduced the costs of advertising and promoting apps for apps suppliers.[113] Apple's ranking provided a market coordination device.[114] According to one mobile phone advertising firm, "[b]ecoming one of the apps featured in Apple's commercials, print ads, or on the App Store in the 'New and Noteworthy,' 'What's Hot,' and 'Staff Favorites' section is the 'golden ticket' to success."[115]

Apple offered incentives for buyers to enter its App Store in the form of free apps.[116] Video games were an important category of free apps. Other examples of free apps included Twitterrific, which links the user with the

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[109] http://www.apple.com/iphone/apps-for-iphone/

[110] Neate, *supra* note 97.

[111] *See* http://www.apple.com/iphone/apps-for-iphone/; *see also* Y. I. Kane, *Getting Noticed On the iPhone App Store*, WALL STREET JOURNAL, July 14, 2009, *available at* http://blogs.wsj.com/digits/2009/07/14/getting-noticed-on-the-iphone-app-store/.

[112] *See* www.apple.com/iphone/iphone-3gs/app-store.html

[113] Kane, *supra* note 103.

[114] "Developers say the key to succeeding on the App Store is to appear on the lists of top-ranked apps that Apple compiles. The 25 most downloaded apps appear on the first page of the store when someone accesses the site from their iPhone. People also find apps through keyword searches or by browsing categories." Kane, *supra* note 99.

[115] Kane, *supra* note 103.

[116] P. Cohen, *The Best Free App Store Games (So Far)*, MACWORLD, July 14, 2008, *available at* http://www.macworld.com/article/134488/2008/07/bestfreegames.html.

social networking site Twitter; Sportstap, which provides sports news; and Pandora, which features streaming music. Apple also offered free apps targeted to small businesses. For example, Salesforce Mobile allows sales personnel to store client information and it helps managers "view sales targets, top pending deals and reports that break down what's selling well and what's not—and possible reasons why."[117] To add yet another incentive, the iPhone came with apps already installed, including e-mail, and Google Maps with global positioning satellite (GPS),[118] In addition, the App Store attracted repeat business by continually offering new free and paid apps.[119] The free apps provided incentives for buyers to enter the app store and view advertisements for paid apps.

B. INCENTIVES IN SEARCH: MICROSOFT'S BING

Microsoft introduced a search service named Bing that rebranded and extended its earlier search services.[120] At the time of Bing's launch, the dominant search firms were Google, Yahoo! and Microsoft.[121] Google had launched its search engine in 1998 and Microsoft offered MSN Search, later renamed Live Search.[122] Yahoo! had entered the search market as one of the first full-text search engines.[123] Yahoo!'s web portal offered search services based on its directory of web pages and then developed an internal searchable directory. Google held the leading market share in the Internet search industry.[124] Microsoft's Bing search service faced the problem of the circular conundrum because it had to attract both users and advertisers.

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[117] R. Richmond, *For Business Owners, iPhone Apps Abound*, THE WALL STREET JOURNAL, July 29, 2009, *available at* http://online.wsj.com/article/SB124881952727688085.html.

[118] www.apple.com/iphone/apps-for-iphone/.

[119] Kane, *supra* note 99.

[120] Bing was launched on June 3, 2009, see http://www.mediaweek.com/mw/content_display/esearch/e3i6ec2932c7d29e992f5208cc43d1f15b7

[121] Some of the discussion in this section draws upon Spulber, *supra* note 47.

[122] In 1996 and 1997, more search engines entered the market, including About, Looksmart, Snap, Hotbot, AskJeeves, and Northern Light. By 1999, there were 11 major search engines: AltaVista, EuroSeek, Excite, Google, HotBot, Infoseek, Lycos, Microsoft, Northern Light, Snap and Yahoo. *See* S. Lawrence & L. Giles, *Accessibility of Information on the Web*, 400 NATURE 107 (1999).

[123] In addition to Yahoo!, Webcrawler, Lycos, Excite, Infoseek, Altavista, and Magellan entered the market between 1994 and 1995. Gandal studies early entrants into search (for the years 1998 and 1999) and finds that any first mover advantage that may have existed declined over time. Gandal suggests that the search market is characterized by low barriers to entry and fierce competition and that consumers have been primarily interested in obtaining the most relevant hits for their queries. *See* N. Gandal, *The Dynamics of Competition in the Internet Search Engine Market*, 19 INT'L J. INDUS. ORG. 1103 (2001); *see also* S. Lawrence & L. Giles, *Searching the World Wide Web*, 280 SCIENCE 98 (1998).

[124] According to a report on March 24, 2009, search engines' market shares in terms of usage are as follows: Google Global 81.57%, Yahoo - Global 10.07%, MSN - Global 2.97%, AOL - Global 1.89%, Microsoft Live Search 1.74%, Ask – Global 0.95%, AltaVista – Global 0.07%, Excite – Global 0.03%, All the Web - Global 0.01%, and Lycos - Global 0.01%. *See* http://marketshare.hitslink.com/search-engine-market-share.aspx?qprid=4; http://marketshare.hitslink.com/search-engine-market-share.aspx?qprid=5.

The existence of paid advertising on search engines is sufficient to demonstrate that users of search engines respond to advertisements. Some users of search engines are simply interested in the information contained in search results and thus may not benefit from seller participation. For these users, advertisements that accompany search results may reduce their benefits from search. However, other users of search engines are prospective buyers that derive benefits from advertising. These users not only view advertisements but click on links contained in the advertisements and purchase products from advertisers. Search users who are prospective buyers benefit from the level of seller participation, which affects the quality and relevance of advertising.

Search firms are intermediaries between search users, who are prospective buyers, and advertisers, who are prospective sellers. Search firms provide users with content in the form of search results and earn revenues from advertisers. The cross-market benefits in search markets have elements of market thickness effects, variety and scale effects, and network effects. Market thickness effects are present because the search firm is a matchmaker that brings buyers and sellers together. Prospective buyers then benefit from the level of seller participation and prospective sellers benefit from the level of buyer participation.

Search also exhibits variety and scale effects. Search users benefit from the variety of sellers because they are more likely to find products that match their specific needs. Advertisers benefit from the number of users of a search service because the volume of users affects click-through levels and ultimately sales. Also, the volume of users of search engines increases the information provided by users through their keyword search and other online behavior. This helps Internet search engines optimize their directories and their matching of users with advertisers and helps advertisers target their marketing messages.[125] The enhanced information obtained by monitoring the activities of a greater number of search users thus generates scale effects for advertisers. Information scale effects are limited for leading search engines because a high volume of search usage generates numbers of observations that are likely to exceed the requirements of statistical sampling.

Search engines exhibit network effects because they are communications systems. Users obtain benefits from the number of advertisers because they can connect to those advertisers by clicking on their advertisements. The greater the number of advertisers, the more comprehensive the searchable directory offered by the search firm. Users of the search engine prefer a more comprehensive directory because it offers access to a greater number of sellers. Advertisers benefit from the number of users of a search engine because they can potentially reach more users through their advertisements. These benefits are analogous to network effects obtained by subscribers to a telecommunications system.

Bing's circular conundrum was complicated by competition because it needed to draw users and advertisers from established search firms like

[125] *See* Spulber, *supra* note 47.

Google and Yahoo! that had greater market shares. Bing also faced the standard difficulties associated with improving and rebranding an existing service, as it supplanted its Live Search service. Microsoft resumed earlier discussions with Yahoo! exploring a possible merger or alliance.[126] The companies ultimately agreed to create a search service in which Yahoo! would rely on the Bing search engine, thereby increasing search traffic on Bing.[127] The agreement offered scale economies because Yahoo! would avoid the costs of operating and further developing its search engine. The agreement provided a means of consolidating users and advertisers and addressed the circular conundrum.

In addition to its agreement with Yahoo!, Bing addressed the circular conundrum with a combination of the instruments identified in the preceding discussion. First, Bing sought to reduce transaction costs for buyers and sellers by fostering decentralized coordination between buyers and sellers through advertising. Microsoft spent $80 million to $100 million to advertise the launch of Bing,[128] promoting its search service through social networking sites such as Facebook and Twitter. Bing initially focused on specific areas such as online shopping and travel. It indexed millions of product reviews as a means of providing information to buyers about potential sellers in these targeted areas.[129] Microsoft identified individual advertisers, formed promotional contracts with them, and identified those advertisers to search users visiting the Bing website. By clicking on the "shopping" link, search users visiting bing.com could view a directory of advertisers.[130] In travel, Bing offered a reservation service and a comparison shopping service for airline, hotel, car rental, and other travel suppliers.[131] Bing also announced blog features to promote participation by buyers and sellers of travel services.

Second, Bing offered users both improved content and consumer rewards. Microsoft described the content improvement as a "decision

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[126] P. McDougall, *Microsoft, Yahoo Said to Renew Search Talks*, INFO. WK., July 17, 2009, *available at* http://www.informationweek.com/news/internet/search/showArticle.jhtml?articleID=218501143.

[127] The partnership was announced on July 29, 2009. *See* I. Fried, *Microsoft, Yahoo Reach Search Ad Deal*, CNET NEWS, July 29, 2009, *available at* http://news.cnet.com/8301-13860_3-10298303-56.html. The two companies had about 28 percent of searches at the date of the agreement, with Yahoo! accounting for approximately 20 percent and Microsoft about 8.4 percent. *See* J. E. Vascellaro & N. Wingfield, *Microsoft, Yahoo Reach Search Deal*, WALL STREET JOURNAL, July 29, 2009, *available at* http://online.wsj.com/article/SB124886852386589989.html; *see also* I. Fried, *Microsoft, Yahoo Reach Search Ad Deal*, CNET NEWS, July 29, 2009, *available at* http://news.cnet.com/8301-13860_3-10298303-56.html.

[128] J. LeClaire, *Bing Boosts Microsoft's Search Share in First Month*, NEWSFACTOR.COM, July 1, 2009, http://www.newsfactor.com/news/Bing-Boosts-Microsoft-s-Search-Share/story.xhtml?story_id=0010003B452O.

[129] *See* M. Oiaga, *3 Million Product Reviews Available for Online Shoppers*, July 28, 2009, http://news.softpedia.com/news/3-Million-Product-Review-on-Bing-117681.shtml.

[130] Bing's shopping service was a rebranding of MSN shopping.

[131] Bing's travel service was a combination and rebranding of its Farecast and MSN travel services.

engine" rather than a search engine. Users would obtain help in making decisions in such areas as travel and shopping. Bing offered improved displays of results, such as previews of websites on the content page. Bing further offered consumer rewards to users in the form of cash back on specific products as a percentage of the price. The program applied to customers of selected advertisers. According to Microsoft, "Bing cashback is a new program that combines the power of Bing with a comparison-shopping engine to bring consumers some of the best deals on the web. The program rewards consumers with a cash-back rebate for a purchase, and gives advertisers the opportunity to sell on a cost-per-acquisition (CPA) basis."[132]

Third, Bing endeavored to improve participation by reducing risks. Bing set zero prices for buyers while offering keyword auctions for sellers, as did other search engines. Bing offered advertisers the ability to choose the terms of each transaction: "You can establish the amount of cash back you want to reward customers. Additionally, you have direct control on how your products are listed compared to the competition."[133] The main instrument of risk reduction was the pay-per-click system. Bing stated that advertisers can "Avoid extra expenses with a pay-per-click (PPC) bidding process that doesn't require constant attention. Bing cashback is based on a CPA [cost-per-acquisition] model, so you have a guaranteed ROI [return on investment] on every sale."[134] Bing pointed out to advertisers: "You can remove risk when listing your products with Bing cashback because it's based on a CPA model. You don't have to invest extra time or money in undesired fees traditionally associated with PPC campaigns. This also helps you avoid click fraud and click arbitrage." Contingent payments based on transactions reduce the risk associated with coordination because advertisers only pay when advertisements generate transactions. Advertisers typically allocate their online advertising budgets across multiple search firms[135] and track various metrics of advertising performance on search engines. According to the online advertising firm The Search Agency, the initial introduction of Bing raised their click through rates by fifteen percent and conversion rates by eighteen percent, while reducing the cost per acquisition by three percent.[136] Bing's introduction raised Microsoft's market share in search and formed the basis of its partnership with Yahoo!.[137]

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[132] http://advertising.microsoft.com/advertising/bing-cashback.

[133] *Id.*

[134] *Id.*

[135] For example, The Search Agency is an online marketing firm that had approximately 50 clients for which it managed over 100 million keywords. The company's clients spend between 3 percent and 10 percent of their online advertising budget on Microsoft search according to an interview with Frank Lee, the senior vice president of client services for The Search Agency. *See* Practical Ecommerce Staff, *Pay-per-click Advertising: Bing Delivering Improved Results, Expert Says*, PRACTICAL ECOMMERCE: INSIGHTS FOR ONLINE MERCHANTS, June 30, 2009, http://www.practicalecommerce.com/articles/1166-Pay-per-click-Advertising-Bing-Delivering-Improved-Results-Expert-Says.

[136] *Id.*

[137] According to the *Wall Street Journal*, the market research group comScore Inc. (SCOR) found that Microsoft's U.S. search market share in terms of search queries "jumped from

C. MATCHMAKING: ALIBABA

Alibaba is "business-to-business marketplace," which is a matchmaker for companies that are buyers and sellers. Jack Ma, named one the world's best CEOs, established Alibaba in 1999 in Hangzhou, China.[138] The company began by providing basic matchmaking with a goal of later adding complex international trade intermediation services, including contract negotiation, price adjustment, logistics, insurance brokerage, customs brokerage, and payments.[139] In 2004, Alibaba had over one million registered members from over 200 countries.[140] Within five years, Alibaba had grown to over 40 million registered users from more than 240 countries.[141]

Alibaba offered a search engine that identified businesses that are potential buyers or potential sellers for a particular product. Buyers or sellers using the web site could focus their search on a specific country or region. In addition, the web site offered a directory of businesses covering every category of business from agriculture to transportation. The company offered supplier certification provided by an independent third party that were designated as "gold suppliers." Additionally, Alibaba provided a searchable business directory matching potential buyers and potential sellers.

Alibaba applied a number of techniques to solve the circular conundrum. Early usage patterns suggested that Alibaba offered cross-market benefits that resulted from basic network effects. Alibaba provided an alternative to the social network connections (guanxi) that traditionally have been essential to doing business in China.[142] Chinese businesses initially viewed electronic marketplaces as communications systems that improved on telephone and fax by providing "asynchronous communications, overcoming time and geographic limitations and multimedia transmission."[143] In addition, Chinese businesses viewed a presence on

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9.1% to 12.1% in the first two weeks since Bing's launch." Additionally, "Google has about 75% of paid clicks, while Yahoo Inc. (YHOO) is in second place with about 20%. Microsoft, by comparison, accounted for just under a 5% share of U.S. paid clicks." *See* Jessica Hodgson & Scott Morrison, *Bing Drives Microsoft's Paid Clicks Up 13%*, June 23, 2009, WALL STREET JOURNAL, *available at* http://online.wsj.com/article/BT-CO-20090623-710315.html.

[138] *See* A. Bary, *World's Best CEOs*, BARRON'S, March 24 2008. Alibaba also operated various other companies, including Taobao, which was an online auction for consumers corresponding to eBay, and Alipay, an online bill payment system. Alibaba was headquartered in Hong Kong and its largest investors were Goldman Sachs and Softbank. *See* Q. Hu, X. Wu, & C. K. Wang, *Lessons from Alibaba.com: Government's Role in Electronic Contracting*, 6 INFO 298 (2004). The company raised $1 billion in a 2007 initial private offering (IPO). *See* T. Wang, *Jack Ma's Five-Year Plan*, FORBES, May 7, 2009.

[139] *See* Hu et al. id.

[140] *See* Hu et al. id.

[141] *See* Company overview, http://news.alibaba.com/specials/aboutalibaba/aligroup/index.html.

[142] R. M. Davison & C. X. Ou, Guanxi, Knowledge and Online Intermediaries in China, 2 CHINESE MGMT. STUD. 281 (2008).

[143] H. Qing examines the results of a study of Chinese websites using data from the period 2004-2006. *See* H. Qing, *e-Market Benefit—Findings from Chinese Main Websites Case*

electronic markets in the form of an e-mail address and a web page as necessary for business development.[144] Business surveys discovered a "peer encouragement effect" in which a firm with more customers and business partners using electronic commerce was more likely to use it for their own business transactions.[145]

Alibaba offered media content as a means of inducing participation by both buyers and sellers. Alibaba offered free content both to buyers and to sellers, including community forums, international trade news, and an extensive guide to import-export transactions and regulations. Alibaba was successful due to the "China's foreign trade regime, the image of low product cost of China, Alibaba's contingent adaptation to users' changing requirements, and e-commerce environments."[146]

The company focused on branding and value-added services as means of increasing the volume of transactions. According to Ma, his goal was building a global brand rather than short-run profits: "If Alibaba cannot become a Microsoft or Wal-Mart, I will regret it for the rest of my life."[147] Ma emphasized that his focus was on China's small and medium-sized enterprises (SMEs) because Alibaba matched China's SMEs with corporate buyers abroad. To increase the participation of SMEs, Alibaba provided them with marketing and sales training and assistance in opening online storefronts and helped to arrange financing.[148] Additionally, Alibaba provided assistance to SMEs to focus on product differentiation rather than solely on price competition.[149] Further building participation, Alibaba acquired Yahoo! China in 2005, including its Chinese website and related technology and, in exchange, Yahoo! received an ownership stake in Alibaba.

Alibaba further expanded the volume of its transactions by changing from a focus on Chinese exports to operating a global trading platform for SMEs. The company offered Chinese-language storefronts to U.S., European, and Indian SMES selling to Chinese businesses.[150] Alibaba turned to Indian SMEs selling such products as consumer electronics, clothing, toys, and software, while hiring Indian software engineers.[151] With 40,000 Indian SMEs joining each month, Alibaba passed 1 million members in India.[152]

Studies, *in* INTEGRATION AND INNOVATION ORIENT TO E-SOCIETY (W. Wang ed., vol. 1, 2007). The questionnaire-based study is titled The Report on the Survival and Development of e-Market in China 2004-2006 and covers 3628 businesses.

[144] *Id*.

[145] *Id*.

[146] *See* J. Guo, I. H. Lam, I. Lei, X. Guan, P. H. Iong, & M. C. Ieong, *Alibaba International: Building a Global Electronic Marketplace*, E-BUSINESS ENGINEERING, 2006. ICEBE '06. IEEE International Conference, Oct. 2006, pp: 545-548.

[147] T. Wang, *Jack Ma's Five-Year Plan*, FORBES, May 7, 2009.

[148] *Id*.

[149] *Id*.

[150] K. Hille, *China's Internet Godfather*, FINANCIAL TIMES, January 18, 2009.

[151] R. Patil, *China's Alibaba opens up to India*, HINDUSTAN TIMES, March 22, 2009, *available at* http://www.hindustantimes.com/StoryPage/StoryPage.aspx?id=46f1896b-eecc-44bb-b78b-18c3a3866391.

[152] *Alibaba.com surpasses 1 million SME members in India*, June 22, 2009,

Additionally, faced with a decline in international trade, Alibaba hosted a trade fair to connect 30,000 online merchants from its TaoBao consumer website with 400 Chinese export-oriented SMEs to introduce their goods to Chinese consumers.[153]

VI. CONCLUSION

Buyers and sellers experience cross-market benefits from each others' participation. These cross-market benefits result from market thickness effects, variety and scale effects, and network effects. Cross-market benefits should not cause externalities because the benefits are captured by transactions between buyers and sellers and by transactions intermediated by firms. Buyers and sellers will seek to coordinate their participation decisions to take advantage of cross-market benefits. Additionally, intermediary firms provide centralized coordination of the participation decisions of buyers and sellers to capture returns from cross-market benefits.

Intermediary firms help to induce market participation by buyers and sellers by reducing the transactions costs of decentralized coordination. Firms promote their intermediation services through marketing and sales that substitute for direct communication between buyers and sellers. Internet companies advertise their websites through other media, including mailings, print, and broadcast media. Additionally, intermediary firms offer centralized marketplaces with community forums, store fronts, and networking tools that reduce the costs of communication between buyers and sellers.

Intermediary firms also induce participation by buyers and sellers through participation incentives. Intermediary firms typically provide incentives for participation by buyers through content, consumer rewards, and free or discounted access fees. This in turn induces participation by sellers, thus mitigating or eliminating coordination problems associated with cross-market benefits. Therefore, incentives for buyer participation internalize cross-market benefits within intermediated transactions. Internet media and broadcast media provide content to viewers to induce their participation. Internet search firms offer search content to their users. Apple Computer offered free software to users of its iPhone App Store. Microsoft's Bing offered search users consumer rewards and enhanced content to aid in shopping and travel decisions.

Intermediary firms also induce market participation through market making. A market making firm reduces participation risks by providing a centralized market place, adjusting prices, and acting as a counterparty in transactions. Market making by firms supplements other coordination activities such as technological standardization for suppliers of complementary products. Electronic commerce offers a variety of innovative

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http://news.alibaba.com/article/detail/alibaba/100121912-1-alibaba.com-surpasses-1-million-sme.html.

[153] http://news.alibaba.com/article/detail/alibaba/100103634-1-alibaba-group-helps-chinese-manufacturers.html.

business models that establish many new kinds of markets, including online retailing such as Amazon and online auctions such as eBay. The discussion highlighted Microsoft's Bing search service, Apple's iPhone App Store, an online market for complementary products, and Alibaba, an online international business-to-business matchmaker.

Intermediary firms design transactions that internalize benefits for buyers and sellers in two-sided markets. By reducing the costs of cross-market communication, providing incentives for participation, and creating and operating markets, firms help to increase participation of buyers and sellers. More participation by buyers and sellers in turn increases cross-market benefits. By solving the circular conundrum, intermediary firms mitigate any potential externalities associated with cross-market benefits.