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Andrea Galeotti

Short employment history. I am a professor at the Department of Economics at the European University Institute. I received my PhD in Economics from the Tinbergen Institute, Erasmus University, the Netherlands, in 2005 under the supervision of Professor Sanjeev Goyal (University of Cambridge). I joined the University of Essex in September 2004 as Assistant Professor (tenure track position). In March 2005 I went on unpaid leave from the University of Essex for approximately two years to visit California Institute of Technology (Caltech) as a postdoctoral scholar of the Social and Information Science Laboratory-Caltech. In September 2006, I returned to the University of Essex. I was promoted to Associate Professor in November 2009 and to Professor in January 2010. I moved to the European University Institute in January 2015. In these years I have been a Visiting Scholar at Kellogg-Northwestern, Columbia University, and the Center of Rationality at Hebrew University. Since 2010 I have been a board member of The Review of Economic Studies, since 2012 I have been co-editor of The Economic Journal, and since 2015 I have been associate editor for The Journal of Economic Theory. In 2016 I co-edited the Oxford Handbook of the Economics of Networks.

A broad picture of my research interest. The complex set of relationships among economic agents has profound effects on individuals' behaviour and economic outcomes. They are critical for the trade of many goods and services, and in job searches. They influence our opinions, which products we buy, how much education we obtain. They shape our political attitudes and our likelihood of succeeding professionally. They are important in determining how diseases spread and they are essential to understanding the optimal design of organisations and the optimal design of policies based on peer-effects. These premises, which find empirical support in a variety of studies, are at the basis of the recent development of the economic theory of networks. Economic networks are composed of individually rational agents connected via well-specified relationships. The specification of what a relationship is, or means, can be tailored to the specific economic questions we intend to address. This generality allows the development and expansion of the economic theory of networks in a variety of different economic contexts, see Jackson (2010), Goyal (2007), Vega-Redondo (2010), and Bramoulle, Galeotti and Rogers (2016).

Since the start of my Ph.D. in September 2000, my main research has focused on contributing to this research agenda. Research on networks, in the last 20 years or so, has first set up a

common tool to model and study complex relationships within the economic paradigm. It has then successfully expanded to economic areas, such as developmental economics, industrial organizations, labour economics, macroeconomics, organisational economics, and financial economics, where a network perspective seems to be natural and, most importantly, is needed to gain additional insights on economic phenomena.

Research on the economics of networks borrows methods, ideas and concepts from graph theory, sociology, social psychology, theoretical epidemiology, and statistical physics, and shapes them within the economic paradigm. An economic view of networks complements existing work on social science, by allowing us to describe how such informal institutions emerge from the strategic interaction of individually rational agents and to evaluate possible inefficiency that networks generate.

Early career research. My early research has focused on two general questions about social and economic networks: how social and economic networks form, and how social and economic networks affect agents' behaviour.

A man contribution in this area is the development of a theoretical framework to study how the location of a player in a network affects her behaviour, under the realistic assumption that agents have partial information about the network they are embedded in, see Galeotti et al. (2010) and Galeotti and Vega-Redondo (2011). We modelled this as a Bayesian game, in which the prior information about the network is its degree distribution and the type of an agent is her degree. Due to its tractability, this framework has now been adopted to model a variety of applications.

An important role of connections is to transmit and aggregate information that is dispersed across agents. Individual's incentives to acquire information are, however, determined by their ability to access information from social contacts. Empirically, we observe a stark degree of social specialisation in information acquisition and sharing: only a few people have a great deal of information on specific topics–*the mavens*–and all the others acquire most of the information on these topics by networking with these few. Empirical work has also encountered difficulties in determining demographics and observables that would be able to distinguish the two types of agents. In Galeotti and Goyal (2010) we combine a simple model of network formation (e.g., Bala and Goyal (2000), Galeotti et al. (2006), Jackson and Wolinsky (1996)) with a local public good model in a network (e.g., Bramoulle an Kranton (2007)). An agent trades off the cost of searching information with the costs of forming connections and accessing information from others. We show that equilibrium outcomes are reminiscent of the social

differentiation in information acquisition described by empirical work, even if agents are ex-ante identical. The framework of Galeotti and Goyal (2010) has been extended in several dimensions and it has been tested in different laboratory experiments.

ERC-starting grant. In October 2011 I was awarded a five-year ERC-starting grant for a project titled *Networks, Markets and Organizations*. The project ended in October 2016. It was composed of two projects, and I now describe the main research questions and outputs.

A network perspective of markets. Following a time honoured tradition in economics, most theories of markets assume that every agent is free to trade with every other agent in the economy. Markets are defined by the characteristics of the goods being traded, the information possessed by the agents, and the interaction technology. Relationship specific characteristics, such as the geographical location of the partners and the reciprocal reputations are generally abstracted away. In contrast, an extensive literature in sociology, anthropology, economics and economic history emphasizes the importance of partner specific relationships in the functioning of an economy.

A simple way to model heterogeneous trading relationships is to represent the economy as a network, where a link between two agents describes the feasibility of an exchange. The presence of a link can be broadly interpreted as anything which allows or facilitates trade. For example, networks arise when bonds of trust between trading partners are particularly important, as is the case in the trading of goods whose value requires effort to be properly assessed. Furthermore, transportation costs and heterogeneous geographical location naturally gives rise to a network. The set of markets where relationships between trading partners are important includes those for used goods, diamonds, artworks and antiques, agricultural goods in developing economies, and so on. In all these examples, goods often go through a long chain of intermediate owners before they reach their final consumer. Furthermore, the motivation for trade is, for most of these intermediate owners, uniquely speculative. They find it profitable to buy the good in the expectation of reselling it at a higher price.

The primary aim of this project was to develop and study a basic asymmetric information model of trade with resale in networks. A theory of exchange in networks, which accounts for resale possibilities, is challenging because the willingness to pay of each trader may depend on the expected willingness to pay of the traders to whom he is connected and, ultimately, on the entire architecture of the networked market. The three key objectives were: 1. To understand how given trading mechanisms, such as auctions or bilateral bargaining, and the architecture of the network, jointly shape the properties of the market equilibrium. 2. To

understand equilibrium outcomes when agents are allowed complete freedom in establishing contractual arrangements with their neighbours. 3. To understand the circumstances under which market outcomes are efficient, despite the frictions generated by the network.

The importance and novelty of this project was to explain the complex patterns of trade, and the outcomes that arise, in economies with three distinctive properties: asymmetric information, dynamic resale, and specific traders' relationships. Overall, the study has increased our understanding of how impediment to trading opportunities impacts on the function of different markets, and it has suggested possible way to organise and regulate markets where trading networks are in place.

The project has led to two main publications. In Condorelli, Galeotti and Renou (2017) we developed a model of bargaining with asymmetric information in a network. We showed how network location affects the bargaining outcome in a subtle way: during bargaining the seller tends to exploit traders with poor connections, by credibly threatening to negotiate with better connected traders. In turns, this simple mechanism leads to pricing dynamics that are reminiscent to fire-sale and hot-potato trade dynamic. In addition, the incentive of traders to trade with poorly connected traders leads to possibly inefficient intermediation.

In Choi, Galeotti and Goyal (2017), we developed a posted price model in a network. The model maps traditional concepts of market power, competition and double marginalisation into networks, allowing for the study of pricing in complex structures of intermediation. The theoretical results showed how agents, who are critical in connecting buyers and sellers, can command high price-margin. The theoretical model is then tested in a lab-experiment. Our experiments complement our theoretical work and point to node criticality as an organising principle for understanding pricing, efficiency and the division of surplus in networked markets, which confirms the importance of the notion of criticality in understanding what network locations generate market powers.

This project has contributed to the theory of economic networks. A central and open issue in that literature is the understanding of the role of connections in determining the terms of trade and the efficiency of a market. The study of exchange in networks finds its origins in sociology with Emerson (1967). This sociological literature has provided substantial experimental evidence on these issues but only recently have economists and computer scientists tried to formalize these ideas in a coherent theoretical framework. In contrast to the work I have developed, most of existing work focused on the exchange of goods in two-sided markets, which can be seen as specific market architecture, and does not allow for resale, e.g. see Manea (2016) for a survey. Only a few papers have studied general network structures

and the possibility of resale but always in complete information settings, see Condorelli and Galeotti (2016) for a survey.

Organizations and Networks. Organisations are often equated with, and modelled as, hierarchies. Hierarchical firms first arose at the end of the nineteenth century and began to dominate developed economies in the twentieth century. They had a big impact on productivity growth, the demand for skills, and the urbanisation of modern economies, and they also challenged the paradigm of competitive markets, as many markets became dominated by a few large firms. Many scholars in management currently claim that another organisational revolution is taking place. Partly due to vast improvements in information and communication technology in the last few decades, many observers see a trend away from simple hierarchical architectures towards more complex structures. These new architectures, sometimes referred to as virtual or network organisations, tend to be more decentralised and rely on horizontal rather than vertical relationships for coordination. Leadership is also based more on informal influence and personal networks, rather than formal authority.

Despite the prevalence of hierarchical organisations in the twentieth century, economists have only recently begun to shed light on the role of hierarchies in coordinating economic activity. Most prominently, Bolton and Dewatripont (1994) and Garicano (2000) show that hierarchical structures are indeed optimal if one models organisations as information-processing or problem-solving institutions. In these models, decentralisation is seen as a way to save on communication costs. So, improvements in communication technology result in more centralisation, not less. Perhaps more problematic is that the above approaches do not allow for an analysis of network-like organisations where communication flows are lateral, rather than vertical. They are therefore less suited to understanding recent trends in organisation design away from hierarchies.

The principal aim of this project was to shed light on the trade-offs between centralised organizations, in which the vast majority of ties are with a few central agents and communication is hierarchical, and more decentralised networks in which there are many central agents and communication is bi-lateral. The key objectives were: 1. To understand the costs and benefits associated with centralised and decentralised organisations. 2. To understand in which circumstances optimal organisations are centralised and when they are decentralised. 3. To understand the dynamic of transition from one organisational network to another. 4. To understand who are the key players in an organisation, and how different organisational networks shape the demand for talents and the pay structure within the organisation.

The project has led to three main publications. In Galeotti, Ghiglino and Squintani (2013) we studied the process of information aggregation in an organisation when communication is cheap-talk and agents are free to exchange information with each other agent in the organisation. An agent wishes to take an action that matches her ideal action, and try to persuade other agents to take actions that are as close as possible to her ideal action. The analysis reveals that strategic communication leads to a congestion effect which, in turns, determines an upper bound on how much information can be aggregated. This upper bound can be partially relaxed, and so organisations can become *wiser*, by carefully structuring communication and by optimally allocating decision rights to agents. The optimal allocation of decision right and communication is studied in more details in Dewan et al. (2015).

In Dessein, Galeotti and Santos (2016), we studied optimal communication flows in organisations. The project brought together some ideas present in the literature of organisational economics with the literature on economics of networks. Building on Arrow (1974) and Bolton and Dewatripont (1994), this project viewed organisations as an "incompletely connected network of information flows" (Arrow, p 18-19). But rather than modelling firms as information-processing or problem-solving institutions, we followed a recent literature in organisational economics which posits that the central role of organisations is to be adaptive to a changing environment, while maintaining coordination between its members, e.g. Dessein and Santos (2006).

In Dessein, Galeotti and Santos (2016) a production process can be coordinated ex ante, by letting agents stick to a pre specified plan of action. Alternatively, agents may adapt to task-specific shocks, in which case tasks must be coordinated ex post, using communication. We abstracted from limit of communication due to strategic reasons. In this model, communication is limited because attention is scarce. We show that scarce resource in attention implies that an optimal organisation coordinates only a few tasks ex post. Those tasks are higher performing, more adaptive to the environment, and influential. Hence, scarce attention requires setting priorities, not just local optimisation, and it implies that communication flows in the organisation are highly asymmetric across divisions. Our results provide micrcofoundations for a central idea in the management literature that firms should focus on a limited set of core competencies.

ERC-consolidator grant. In June 2017, I was awarded a five-year ERC-consolidator grant for a project titled *Oligopoly markets and networks*. This research proposal constitutes the research programme that I intend to follow in the next five years. I provide a short overview

of the main research questions.

Digital Marketing. Firms are more and more keen on devising and experimenting with marketing strategies that incorporate social influence. This interest is reflected in the popularity of expressions such as word of mouth communication, viral marketing, seeding and referral strategies. Some well known examples of marketing programmes that successfully leverage social influence are discussed next.

- In the case of conspicuous consumption goods, fashion goods, as well as social interaction goods, firms often seed the market, by offering free products to selected influential consumers. A classic example is celebrities receiving free expensive products.

- Other examples of price discrimination based on consumers' influence are Klout Perks programs. These programs allow companies to provide exclusive rewards, coupons and discounts to consumers based on their influence on other consumers. The influence of a consumer is summarised by his or her Klout score, a number between 1-100. Klout constructs this index using the information on the user's activity in different social networking websites. As explained in Klout.com, "Influence is the ability to drive action. When you share something on social media or in real life and people respond, that's influence. The more influential you are, the higher your Klout Score."

- Another relevant example of price discrimination takes the form of referral rebates, which allow sellers to price discriminate based on consumers' levels of influence, even without knowing their levels of influence at the time of purchase.

- Referrals are often also combined with seeding pricing strategies. Dropbox rapidly grew from around one hundred thousand users in the autumn of 2008 to over four million by the spring of 2010. This success is attributed, to a great extent, to its official referral program that offered free storage to both referrer and referee. A similar example is the referral program of Airbnb.

Firms, through their product design of network goods and marketing strategies, can leverage network effects and increase the willingness-to-pay of consumers. Conducting market research on the level of influence across consumers is therefore a key investment for the design of effective marketing strategies. The aim of my project is to develop a theoretical framework that will allow us to clarify the role of social influence in the design of marketing strategies and

product design, and its welfare implication. Specifically, the project formulates the following questions.

1. I want to study firms' incentives to conduct market research on the network of consumers. What are the network characteristics that increase the incentive to acquire such information? Relative to a social planner, are firms over-investing or under-investing in information acquisition? How do firms incorporate information on consumers' social influence in their pricing strategy?

2. I want to study the relationship between conducting market research on social influence and the firms' incentives to alter the product design of network goods. This question has been overlooked in the marketing and economic literature, even if there is a basic intuition about why it is important to understand such a relation. As the technology to acquire information on the level of influence becomes more efficient, firms will be able to leverage network effects more effectively. As a consequence, consumers will value the object "just because it is social". Whether firms use quality/product design to complement or substitute this effect is, a-priori, not clear.

3. I will compare a monopoly with an oligopoly framework and study the effect of competition on firms' incentives to acquire information on consumers' networks. How do consumer surplus, aggregate welfare and profits depend on network characteristics when firms price network effects competitively?

4. Questions 1-3 focus on firms' incentives to acquire information about consumers' local networks. In many contexts, however, consumers can choose whether to grant access or to conceal information that could be useful to assess their influence. What are the incentives of consumers to grant access to this information? Will self-interested consumers release more or less information than socially efficient?

The importance of this project is that it will provide a tractable and rigorous framework to evaluate how the increasing ability of firms to gather information on consumers' influence affects outcomes of markets with network effects. From a positive perspective, the outcome of the project will enhance our understanding of the costs and benefits for firms to acquire information on consumers' networks, and the costs and benefits for consumers to grant access to such information. These costs and benefits will depend on the underlying market structure, e.g., monopoly versus oligopoly, and the characteristics of the underlying network of

consumers. They will also interact with the other strategic decisions that are available to firms and that will be studied in the project, like product design. In turn, this analysis will lead to new predictions, with the aim of guiding empirical work in marketing and in economics. From a normative perspective, the project will provide guidance for competition authorities, that may be concerned with the effects on consumer surplus and welfare, in allowing firms to use the newly available information on network effects in product markets. This is part of a more general debate about the extent to which the law should facilitate informational privacy, given the technological developments leading private and state organisations to enjoy unprecedented abilities to collect personal data; see Froomkin (2000).

The project's innovativeness can be highlighted by briefly discussing the strands of research in social science to which it contributes. The project relates to the literature on optimal marketing strategies in the presence of social influence. This is a recent and active field of research in economics, marketing, and computer science. I refer to Bloch (2016) and Mayzlin (2016) for two complementary surveys of this line of research. The literature has primarily focused on optimal advertising and seeding strategies (distributing, initially, free products to key consumers) given an exogenous process of product diffusion, e.g., Galeotti and Goyal (2009), Campbell (2013).

Only few papers have studied how firms can incorporate social effects in their pricing strategy. These few papers, and this is common also to my project, build on the classical literature on network effects and network industries initiated in the 1980s by Farrell and Saloner (1985) and Katz and Shapiro (1985). Bloch and Querou (2013) and Candogan et al. (2012) study optimal pricing of a monopoly in a setting where the monopoly and the consumers have perfect knowledge of the pattern of network effects across consumers. Chen et al (2015) extends the framework of Candogan et al. (2012) to allow for competition.

This project develops a framework to expand the research questions addressed in the existing literature. The above papers assume that firms and consumers have complete information about the specific structure of network effects. Those models are, therefore, not appropriate to investigate the benefits and the costs for firms (resp. consumers) to acquire information (resp. to grant access to information) on consumers' networks. The main methodological innovation is to model consumers' networks as a random graph and to limit the information that consumers and firms have about the network effects. Under the random graph formulation, the pattern of network effects is summarised by the in-degree distribution of an underlying network of interactions, and the level of influence of a consumer is simply her in-degree. Borrowing from Galeotti et al. (2010), I then assume that when making consumption decisions,

consumers know their level of influence and the distribution of influence, but they face residual uncertainty about the level of interactions of other consumers. I can finally describe the information that firms have about network effects, by considering the fraction of consumers for whom firms observe their level of influence.

Fainmesser and Galeotti (2016) studied a specific formulation of this framework. They consider a monopoly model and compare the case where the monopoly has no information about consumers' networks, with the case in which the monopoly knows the level of influence of each consumer. Fainmesser and Galeotti (2016) show that this novel formulation leads to a tractable closed-form solution of the optimal pricing strategy, and it allows to relate aggregate statistics of the distribution of network effects to consumer surplus and monopoly profits. This project will use the tractability of this framework in order to address the aforementioned questions of information acquisition, product design and competition.

Strategic choices in complex processes of production. Complex processes of production and distribution lead to multiple chains often competing in the supply of final goods, e.g., see Hummels et al. (2001) and Antras and Chor (2013). The specific contractual arrangements among the single components of this system, and their individual decisions, like pricing and investments in technology, affect final consumers' demand, and naturally give rise to an interconnected system. The following three examples clarify the contexts of interest:

- Supply chains. Consider agricultural supply chains like the one describing the production of coffee. At the start, there is a farmer in a developing country who typically works on a small farm. The farmer chooses from among a few intermediaries who process his coffee cherries to obtain beans. These intermediaries then sell the beans to one of the small number of exporting trading firms. The exporters sell to dealers/brokers who, in turn, sell to roasters (such as Nestle). These roasters then sell to large supermarkets and local stores. Finally, consumers buy the coffee from a retailer. Each agent in this supply chain makes a variety of strategic decisions, which eventually shape the quality and the price of the final product. These decisions also shape the profits that each other agent in the supply chain can hope to get, and therefore they determine how much entry we should expect in each step of the production process.

- Network of patents. Manufacturers often produce final goods by licensing a set of patents. In fields where innovation is rapid and cumulative, it is often the case that there are patents which are, to some extent, substitutes. When the holder of a patent decides his pricing strategy (the license fee), he must take into account what are the

patents that can substitute that patent and how many other complementary patents are used to produce each final good. As these considerations determine the pricing behaviour and the profitability of a patent holder, the very same considerations also affect the decision of an agent to invest in innovation. How can we think about strategic pricing in this system? How do we evaluate a possible merger amongst two or more patent holders? How do different contractual arrangements amongst patent holders, such as a patent pool, affect market outcomes? What are the effects of different contractual arrangements on R&D investments?

- Communication networks. In many communication networks, like wireless networks and the Internet, messages flow along a sequence of service providers and, often, there are multiple service providers that can be used. The capacity of each service provider along the path is key to having good quality communication. What are the incentives of service providers to invest in capacity? How does this depend on the architecture of the underlying communication network? What type of mergers will improve consumer surplus?

The aim of this project is to formulate a general but tractable model of strategic behaviour, in interconnected systems, that is adequate to understand the functioning of complex processes of production and distribution. Within the model:

1. I would like to understand equilibrium pricing and profits in interconnected systems.

2. I would like to understand the incentives of different components to invest in more efficient technologies.

3. I would like to investigate the firms' incentives to form robust networks. What are the externalities that interfere with first best network design?

4. I would like to develop metrics that can guide policy makers to evaluate the effect of mergers in interconnected systems, as well as to evaluate the efficiency of observed contractual agreements. Are there simple rules of thumb that allow distinguishing between efficient and inefficient mergers in, say, supply chains or amongst patent holders?

The project will provide both a positive and normative contribution. From a positive perspective, the outcome of the project will enhance our understanding of firms pricing behaviour, and of the costs and benefits of firms when investing in better technologies. These costs and

benefits will depend on the underlying connections across firms, and the characteristics of consumers' preferences that will determine the degree of substitutability or complementarity amongst final goods. In turn, this analysis will lead to new predictions that will guide empirical work in industrial organisation. From a normative perspective, the project will provide guidance for competition authorities that may be concerned with the effects on consumer surplus and welfare in allowing firms to merge when embedded in a complex production and distribution process.

The project's innovativeness can be highlighted by briefly discussing the strands of research in social science to which it contributes. The study of strategic behaviour in networks is a very active area of research. A recent survey of the literature on network games can be found in Bramoulle and Kranton (2015). At a general level, this sub-project contributes to this research agenda by applying network games to the realm of oligopoly markets. The strategic nature of the game that firms play in the network is derived from the assumptions that regulate the production process and the underlying oligopoly market of interest. In addition, the application of network games to the examples noted above, e.g., supply chains, communication networks and network of patents, is, to a large extent, novel.

Recent work in economics has focused on the optimal allocation of ownership rights along a supply chain, and on stable contracts along supply chains, e.g., Antras and Chor (2013) and Ostrovsky (2008). Some other work has focused, instead, on the role that production supply chains play in translating idiosyncratic shocks into volatility at the aggregate level, e.g., Acemoglu et al. (2012). My focus on how the structure of supply chains affects strategic behaviour and market power is very different from the questions studied in this existing literature. A deeper understanding of price formation and market power in networks is important to understand modern economies.

This project is related to the work on strategic intermediation in networks. For a survey of this literature we refer to Condorelli and Galeotti (2015). Part of this literature has focused on understanding how different trading protocols affect the outcome in a model where a set of agents, the intermediaries, connects sellers to buyers. Three protocols of price formation have been studied: auctions, bargaining, and posted prices. The merit of this literature is to highlight how different trading protocols can induce inefficiencies in a market with strategic intermediation. In these models, however, the primary function of intermediaries is to give access to a service, e.g., they buy and resell the object. The object is not transformed during its journey along the chain, and final buyers only care about accessing the final service at the lowest possible price. These papers, therefore, assume that competing chains are a perfect

substitute. An important contribution of this project is to develop a model that allows for heterogeneity across chains. This heterogeneity is reflected, from the view point of consumers' demand, by different levels of substitutability and complementarity across competing chains. In this sense, this part of the project will enrich existing work on strategic intermediation in networks in a way that it becomes more empirically relevant and, at the same time, more appealing for policy evaluation.

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