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## The impact of individual differences on network relations

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## Conclusions

### 6.1 Summary of the findings

A well established notion in the social sciences is that people form relationships in their social networks because this allows them to gain access to resources, beneficial outcomes, and objectives that otherwise would require greater efforts or would not even be attainable. Social networks then play the role of promoting the goals which actors pursue. The majority of past research has studied the formation of social relationships considering that actors are identical (*homogeneous*) in terms of abilities or preferences about their behaviors, and thus in terms of the benefits associated with their alternatives. While clearly unrealistic, the homogeneity assumption was used with the aim of investigating to what extent individual differences can be *explained* as the result of a social process, without assuming differences a priori. However, it is increasingly recognized that actors interacting in social networks differ in relevant characteristics, which can often influence the resulting pattern of relationships they establish and the particular way in which relationships take place.

Thus, the question of how individual differences between the actors influence their choices becomes salient. It is likely that individual decisions about relationships and behavior lead to selective choices about interaction partners, given who they are, resulting in the inclusion of some actors and the exclusion of others. Furthermore, it is likely that patterns of inclusion and exclusion in the relationships that take place in a social network result in differentiated access to benefits and opportunities, leading to inequality in the benefits that the *included* actors have compared to the benefits accrued by the *excluded* actors. In accordance, this dissertation has studied the emergence of patterns of relationships, exclusion, and unequal opportunities to access benefits, as a consequence of the micro-processes between heterogeneous actors, by addressing *the conditions under which differences in individuals characteristics between people lead to social exclusion*.

We have focused on two types of settings in which individual differences play a fundamental

role in the emergence of relational and behavioral patterns: productive exchanges and coordination games. For each setting we have considered what the essential individual characteristic is that can help explain patterns of relationships and motivate choices of inclusion/exclusion between actors. Our work on productive exchange, for instance, is concerned with individual differences that are relevant for knowledge-intensive production. Therefore, we have studied how differences in the productive capacities of the actors influence their choices and the pattern of relationships that come about from them. In our work on coordination games, where actors aim to coordinate with others in their choice, we have focused on differences in the individual preferences actors have for one choice or the other. In this way, we have focused on cases of conflicting preferences where actors want to choose alike with those around them but they differ on which is the best choice to coordinate on.

In both settings the choices actors make imply the natural constraint that resources and opportunities are scarce. In productive exchange, if an actor uses her resources with a partner, she cannot use them with someone else simultaneously. In coordination games, if an actor is choosing a convention to coordinate with some of her friends, she cannot simultaneously choose a different convention to coordinate with others. The result is that some actors will be excluded by others. We have particularly studied these choices in the two settings mentioned above. In the following sections we discuss the main results of our studies.

### 6.1.1 Results on productive exchange networks

The studies on productive exchange networks in this dissertation are based on the problem of how do people form collaborative relationships when they differ in the way they can influence the achievable outcomes. To do so, we have used a common game theoretic setting in which individuals choose their partners and their level of involvement in each relationship by allocating their resources between them. We have studied two particular problems in productive exchange networks, always within the general domain of this dissertation in which we want to understand *if individual differences between people can affect the individual choices and lead to patterns of exclusion*.

Our first problem addressed theoretically how and under what conditions social exclusion arises in knowledge-intensive collaboration, modeled as productive exchange between strategically interacting individuals. As argued by social exchange theory, collaboration (i.e. productive exchange) is a fundamental aspect of social and economic life (Molm, 1994a, 1997). Collaborations are conceptualized as productive exchanges that improve the welfare of all participants involved. However, on the downside, productive exchange can also result in social exclusion, when actors have the freedom to select their relationships from a pool of heterogeneous potential partners. A key innovation of our model is the distinction of two types of expertise in knowledge-intensive production, generalist and specialist expertise, from which we have been able to contribute to the research program on how inequality results from differences at the individual level.

The results of our model point to the individual expertise as an antecedent of actors' incentives to form more or less collaborations. The more generalists there are, the more projects are formed but the less resources are invested in each. Moreover, if actors are free to rearrange their connections if a more profitable option is available, there will be segregation between types of expertise. The specialists exclude the generalists from the exchange even though the generalists are interested in collaborating with them. Therefore, those who need collaboration the most, to be optimally productive, are least likely to be included in collaborative exchanges.

In this sense, our first study has shown theoretically that heterogeneity in expertise can breed social exclusion and inequality in productive exchanges. This is a very important complement to the literature on social exchange, especially works addressing structural differences as determinants of inequality, such as the position of an actor in the social network. Specifically, our study provides antecedents to the structural approach by tackling the problem of how the network of relationships comes about and how likely it is that some actors result in certain position given who they are.

Our second problem on productive exchange uses the same setup in which actors with different productive capacities form collaborative relationships between them. In this case, the chapter is a behavioral game theoretic experiment where we ask how the severity of the coordination problem actors face (with whom to relate and how) can reduce the sustainability of the relationships along time. This is a problem where exclusion and inequality are also seen as part of a process that goes between periods of time and not only in an isolated, one-shot case, such as in the previous problem. To address this question we designed an experiment that varies, in three treatments, the way actors can solve a severe coordination problem. Thus, we show experimentally how the severity of the problem, which results from the heterogeneity in the individual characteristics of the actors, can lead to exclusion in productive exchanges networks.

The results of our experiment suggest that the number of potentially stable outcomes in the network does not affect the likelihood of reaching them. Specifically, if there are less Nash equilibria in one network and more in the other, there is not evidence that the one with less equilibria will lead to more stability in the collaborative relationships than the one with more equilibria. However, the existence of outcomes in which pairs of actors find no incentives to change how they behave can ensure stable configurations; suggesting that individual rationality is not enough, and dyadic rationality is also necessary to reach stability. In addition, because not all networks have equilibria that holds also for dyadic rationality (i.e. equilibria in the core) we have analyzed a different notion of stability where relationships are sustained along time, even if actors' choices to respond to the behavior of others are not necessarily best responses.

Generally in all experimental conditions subjects use reciprocity as the criteria to sustain their exchange relationships. Thus, networks evolve by means of a reciprocal behavior in which actors are likely to maintain and reinforce relationships along time. The maintenance of these relationships leads to the exclusion of those partners that are not reciprocating to the allocations they receive (i.e. allocations to a combined project). Moreover,

in cases where there are no equilibria in the core, reciprocity serves as a mechanism that leads subjects to stable, *sustainable*, relationships even outside of equilibrium.

In this sense, our second study shows experimentally that there are valuable mechanisms, such as reciprocity, which help actors achieve stability in their relationships and sustain their collaborative exchanges. Reciprocity helps actors reach equilibrium outcomes in cases where there are equilibria stable to dyadic improvements. In other cases, reciprocity can help actors reach stable relationships outside of equilibria. Thus, the severity of the coordination problem reduces the sustainability of relationships if that severity is measured by the existence of equilibria in the core, but the sustainability of relationships can be nonetheless observed if subjects chose to reciprocate to their partners' behavior along time, outside of equilibrium.

### 6.1.2 Results on coordination games on networks

The studies on coordination games in networks are based on the problem of what types of networks of relationships and patterns of behavior result from the choices actors make when there are conflicting preferences between them. To do so, we have used a common setting in which individuals choose a convention (i.e. a social setting) and they gain benefit by choosing alike with those around them. We have studied two particular problems in coordination games on networks, where actors have different preferences on the conventions they would rather coordinate on, given they earn benefits depending not only on how many others they coordinate with, but also on which choice they coordinate on.

Our first study on coordination provides a theoretical model in which actors are considered to have different individual preferences, and their preferences are based on the gains they get for coordinating on a specific choice. In many social and economic situations, actors pursue coordination (or anti-coordination) with their neighbors in a network, but also have intrinsic preferences among the available options. Here we introduce a model, which allows us to analyze this issue by means of a simple framework in which players endowed with an idiosyncratic identity interact in a social network. Actors have individual preferences for a specific behavior given what is prescribed by their identity. In addition, the complementarities exerted from coordinating with others, make it profitable in some cases for actors to choose the option they prefer less and be compensated by the benefits they gain through coordinating with others. This conflict in preferences can naturally lead to inequality in the benefits actors gain from their choices given the interplay of social influence (i.e. complementarities) and individual preferences.

The results of this theoretical study show that the choices actors make, given their preferences and the choices of those around them, are determined by two thresholds. These thresholds represent the number of neighbors they need to coordinate with in order to choose what they like or what they dislike. Intuitively, these thresholds illustrate that an actor requires less support from those around her to choose what she prefers, but more pressure to choose the disliked option. As a consequence, the pressure exerted by

the actor's peers to influence her behavior is not the same when introducing individual heterogeneity in the characteristics of the actors, compared to settings where actors are homogeneous.

We defined the degree of heterogeneity as the proportion of actors, in the network, having preferences for one action or the other. By means of this, we can better capture the influence of heterogeneity on the micro-processes (i.e. behavioral patterns) that separate or integrate neighbors depending on their choices. In cases where actors do not know the preferences of those around them in the network (incomplete information), the model provides conditions for inequality in the benefit actors can achieve, given their own individual preferences.

For high degrees of heterogeneity in the population, the predicted outcome is such that every actor can choose her preferred action. Thus, the more heterogeneous the population, the more likely actors find enough support to choose the action they like. However, if the degree of heterogeneity is not so high that there is clearly a minority, actors in the minority perceive greater pressure from those in the majority. In turn, all actors are more likely to choose the behavior preferred by the majority, although for some this is not their preferred behavior.

This first study has shown theoretically that heterogeneity in preferences can lead to exclusion when the different sets of actors are of a similar size, because neither can exert enough influence on the other to make them choose differently to what they prefer. This exclusion, recall, is expressed as the impossibility to interact and gain profit with those choosing differently but only with those actors choosing the same social convention. However, if the sizes differ so that a set of actors with a specific preference is a majority, the majority exerts a stronger pressure on those actors in the minority. Thus, the pattern of behaviors is such in which actors are choosing the same convention, although a portion of the population is not choosing what they like but what is better for them given the influence of those around them. These results complement the findings on coordination games in homogeneous populations by showing how differences in individual preferences can nonetheless result in outcomes where all actors choose the same behavior. Although the existence of heterogeneity implies conflict, given that actors require more pressure to coordinate with those who are different from them and less influence to do so with those who are alike, it is the level of heterogeneity that can actually lead to separation between them.

Our second study examines the interplay between a person's individual preference and the social influence others exert, when they can to choose their neighbors in the network. This is a natural extension of our first work on coordination games, where actors could only choose how to behave but not their social network. Just as in our previous work, we provide a model of network relationships with conflicting preferences, where individuals are better off coordinating with those around them, but not all prefer the same action. We tested our model through an experiment, varying the level of conflicting preferences between individuals by varying the level of heterogeneity in the population. That is, in some cases all actors have the same preference (no conflict in preferences) and in others

there is heterogeneity so that a conflict arises. If there is a very large majority we denote it as low conflict, and when the majority is almost as representative as the minority we denote it as high conflict.

In this second study we proposed a model where actors can decide what relations to form and what behavior to adopt, while in the model of the previous study we focused on behavior but actor's relationships were given. By means of developing this theoretical model and testing it through a laboratory experiment, we can address conditions for segregation and inequality. Segregation emerges when actors, who can freely form relationships between them, choose to affiliate with a specific subgroup of the population, which can be others who share their same preferences or others who chose their same behavior. There is inequality in the way benefits are obtained in a relationship when actors coordinate on the same choice but for some the choice is their preferred option, while for others the choice is the disliked one.

The results of our experiment suggest that preferences are more salient than social influence. This means that even if subjects could achieve a greater benefit (i.e. monetary earnings in the experiment) by affiliating with most others and coordinating with them on one same action, their preference for a behavior inhibits this integration. Thus, in situations with conflicting preferences, where there is heterogeneity in the population of actors regarding to their motivation to choose one action or another, subjects form relationships mainly with others who share the same preference. This leads to two undesirable outcomes: network segregation and social inefficiency. Network segregation results because actors separate between those who like one action and those who like the other. Social inefficiency results because in the aggregate, if all actors integrate and coordinate on one same action, the complementarities of their interactions can be the highest but they are more inclined to segregate. In this regard we find that the same force that helps people individually reduces the total productivity of society in a great way.

## 6.2 A general comment on the findings and on further research

In general, our findings show that heterogeneity, at first sight, appears as a clear determinant of social exclusion and segregation. Regardless of whether we are addressing problems of productive exchange or coordination games, the existence of individual differences between the actors poses great coordination problems. Thus, there is difficulty for the actors to find suitable exchange partners and interact with them, due to the threat of coordination failures. In fact, failing to coordinate with a productive exchange partner means losing one's resources. An actor could instead be better off if she had used her resources in a collaboration with another partner. Thus, even when some potential partners are more attractive than others one is better off coordinating with a less attractive partner if the first one does not reciprocate to the relationship.

In the same way, there are difficulties for actors to choose which behavior to adopt, especially if they have preferences for one choice but it appears that their benefits could be greater if choosing a behavior they dislike. This can occur when most of one's neighbors prefer one's disliked choice, for the coordination with a larger majority can give them greater gains than choosing alike with a small minority. Therefore, as such, heterogeneity poses difficulties in coordinating with others, which can determine social exclusion and segregation between actors.

Nonetheless, when the micro-processes that lead to patterns of behavior and networks of relationships at the macro level are studied in more detail, we can observe that this is not always the case. Heterogeneity leads to greater complexity in the interactions, but there are ways in which actors find coordination mechanisms even in complex settings. Thus, achieving valuable outcomes by sorting out the coordination difficulties that heterogeneity brings about. A first main aspect that helps actors not only coordinate with others but also sustain their relationships is to have the freedom to choose their improvements as a dyad. That is, actors can attempt to improve their well-being by unilaterally making changes.

However, because there are different potential partners around them, improving in one case without others changing their behavior as well (i.e. their allocation of resources) leads to outcomes where the focal actor improves but her partners are not necessarily better off. In this sense, they will have incentives to change the way they use their resources between relationships. This leads to better outcomes for them but not necessarily for their partners. Nonetheless, a simple change in how actors choose their changes from individual to dyadic deviations can greatly simplify their coordination problems. Pairs of actors change together, and they can easily reach stable outcomes where relationships are sustainable and great benefits are gained. This is a natural consequence, given that relationships in our studies are focused on dyadic interactions. This implies that at the dyadic level, if pairs of actors coordinate on their changes, say by means of reciprocating to each other, their relationship will be sustained and stable along time. Furthermore, we have empirically observed this is so even for cases where actors are not best responding to the partners' choices.

In other contexts, even when dyadic improvements are considered, say for instance in coordination games, it is likely that segregation between actors takes place. Those who choose one behavior will separate from those who choose the other behavior. As a consequence, in the aggregate, the social welfare is reduced. However, even though heterogeneity in preferences leads to conflict and segregation, having low levels of heterogeneity can result in integration. If there is a large majority and a small minority, the former can exert pressure on the latter and influence their behavior. In this sense, actors are better off integrating and forming relationships with those around them regardless of their preferences. If so, if they end up all choosing the behavior preferred by the majority.

Nonetheless, such an outcome was only observed as a theoretical finding. When the empirical assessment was made, segregation was pervasive. Subjects used their individual preference as a way of simplifying the coordination problem of choosing with whom to



relate and how to behave. This helped them reduce coordination failure and improve their gains in each period they interacted with others. However, the same force that facilitated their relationships lead to segregation between those who preferred one choice and those who preferred the other. It is likely that in cases where interactions allow for a natural extension such as communication between the actors, the mechanism that can lead to segregation, their individual characteristics, would not be the only force. Arguably, with communication actors with conflicting preferences can reach agreements on how to behave. This could lead to outcomes at the network level, where they can integrate and coordinate on a common choice, improving their individual gains and the social welfare.

In what remains of this conclusion chapter we address some extensions for further research, which can complement and extend the lines of research that have been studied in this dissertation.

### 6.2.1 Theoretical extension: Behavioral rules

Schelling (1978) points to *behavioral rules* as some of the main elements interacting in social games. That is, the choices actors can make and the order in which they can choose. This is specifically important when the assumptions about actors' decision-making (i.e. their behavior) are derived from one theory of action or another, and when actors are assumed to interact between them for single events (i.e. one shot-interactions) or for multiple occasions (i.e. repeated interactions). Thus, our first extension points to the theoretical approach on behavioral rules in our models. Particularly, our modeling on heterogeneity has been derived from the other two elements interacting in the social game: who we are (individual roles) and what we can do (result rules).

We developed a theoretical model for productive exchange in Chapter 2 and theoretical models for coordination games in Chapters 4 and 5. These chapters share a common approach in the way actors are modeled at the micro-level, for they are all based on the same theory of action: rational choice theory. In particular, actors are assumed to play a best response to the behavior of their partners. Thus, the allocation of resources for a given productive exchange is optimal in relation to the allocation of resources made by a partner. Similarly, an actor's choice of behavior in a coordination game is optimal in relation to the aggregation of choices of those around her in the network. Clearly, in both cases, depending on the individual characteristics of the focal actor.

However, as suggested in the empirical findings of Chapter 3, actors do not always find it easy to best respond to the behavior of those around them. In many cases, their behavior is based on a less complex strategy: reciprocity. Thus, if we want to explain variations in the way actors form and maintain relationships in social networks, we need to introduce reciprocity as an essential part of an actors' decision-making process.

Naturally, including reciprocity into the analysis requires that the interactions studied are repeated along time, which is not the case of the theoretical models in this dissertation. For this reason, a complementary extension is to model the influence reciprocity has on

the decisions actors make by studying how behavior and the network of relationships co-evolve along time. In principle, this could also inform us about situations of no repetition as well as those of repeated interactions. This was not the focus of our work in this book. The goal we pursue here is that of understanding the effect of individual differences on relationships, and to see whether individual differences can result in exclusion and inequality. Nonetheless, it would be desirable to be able to integrate the analysis of individual differences between the actors in the co-evolution of networks and behavior.

### 6.2.2 Empirical extension: Communication

With the studies in Chapter 3 and 5, we aimed to contribute to the empirical validation of the effects of individual differences between the actors on patterns of exclusion and inequalities between them. Laboratory experiments allow for controlled environments, which help understand the effect that particular variables have on behavior and emerging network configurations. Naturally, empirical studies can only address so many considerations of the theoretical predictions at a time. Consequently, much more empirical work is needed with the aim of understanding heterogeneity and its effects on inequality and exclusion. Without systematic empirical tests of the implications of theoretical models, it is difficult to judge which assumptions might be problematic, and to decide on how future theoretical research should be developed. Nonetheless, laboratory experiments can be informed about limitations of the theoretical models through the findings of other laboratory experiments, even if they were applied to different social games, due to the consistent and systematic way in which they are developed.

Within the so called *experimental economics* tradition of laboratory experiments, there are specific protocols that permit regularities in the findings. For instance, subjects are never deceived, they are always paid with monetary incentives for their outcomes in the experiments, experimental outcomes depend strategically on the choices of the different subjects, and subjects do not know the identity of those they are interacting with in the experiment; which controls for any type of influence that the relationship between two subjects might bring. From this, we consider a main empirical extension needed in experiments on heterogeneity in individual characteristics between actors interacting in social networks: communication between actors when playing the games.

Communication is a fundamental aspect of human relationships. Furthermore, applied to network relationships, the theoretical modeling of networks assumes that in cases of bilateral deviations, actors have decided to simultaneously change their choices after talking to each other. This means that even when it is not stated explicitly, in most network interactions communication is implicitly assumed. Communication plays a determinant role on actors' decision making, even for cases in which agreements derived from the communication between actors are not enforceable (i.e. non-binding agreements). Specifically, communication between actors simplifies the coordination problem they face and reduces the uncertainty about how potential partners will behave. This consequently leads to greater benefits, and facilitates how actors achieve stable outcomes. The introduction of

communication in our experimental work could influence actors by helping them achieve more profitable outcomes, but could also bring a detrimental effect on the abuse of power if relationships are unequal. Thus, the effect of including communication in our experimental work is not straightforward. Next we discuss possible results.

In Chapter 3 we run a laboratory experiment to understand how actors solve the complex coordination problem of choosing with whom they relate and how they allocate resources among their different relationships. Actors interact repeatedly with the same partners in their group, which allows them to create stronger relationships between them. Particularly, in such a detailed type of exchange where actors choose partners and specific amounts of resources, communication can greatly help them make agreements. Thus, simplifying the coordination problem. Moreover, *pre-play* communication, the possibility actors have of talking to each other before making any decision in the game, has been shown to facilitate coordination in Nash equilibrium outcomes (Farrell and Rabin, 1996). This suggests that with regard to productive exchange networks, communication would help achieve stable outcomes for the very complex cases in which there is a huge multiplicity of them.

Finally, applied to our main interest, the effect that individual differences between actors have on their network relations, communication could also play a detrimental role. If actors perceive their individual characteristics to be influential on the choices of others, communication can be a mechanism for the transmission of threats that can lead to unfair exchanges between powerful actors and those who are more dependent on them. Communication can help transmit threats about how an actor would be willing to leave an existing partner if the counterpart relates to others or reduces her involvement in their joint exchange. For instance, communication can allow specialized actors to make generalists allocate more resources into a joint coproduction because the former are more attractive partners and their bargaining power is greater. Thus, on one hand communication can help simplify the complexity of coordination problems in productive exchange networks, but on the other, it can bring about stronger patterns of inequalities and exclusion by potentiating the strength that more attractive partners have upon the least attractive ones.

Including communication in our laboratory experiment in Chapter 5 could also allow us to better understand the complexity of the interplay between individual preferences and social influence. On the one hand, if actors can express how willing they are to form relationships with others, even if those others have different identities, communication would help them improve their well being and reduce coordination failures between them. Think about the case of a large majority and a small minority (i.e. Low Conflict treatment). If the 3 subjects in the minority achieve connection and coordinate with the 12 subjects in the majority, they would be better off than if segregated. In fact, in our experiment we observed that subjects in the minority attempted to connect to the majority but failed. This can be due to the lack of opportunities to communicate between them.

Thus, it is possible that in real life contexts the minority actors could have the opportunity to express their desire to integrate with the majority. Even at the expense of sacrificing their identities for the sake of the benefits that social relationships bring about. For

instance, in the case of a large majority, if a member of the small minority achieves coordination with the majority due to their communication channels, this actor would immediately be better off than if she had stayed with her minority. The complementarities of the group size could compensate for the loss in identity. However, for cases where the minority and the majority are not too different in size, the effect of communication is not clear, for it is not only the deviation of a small number of others that is needed but the integration of a larger group. That is, a minority member is strictly better off switching from her minority group, where she chooses her preferred behavior, to the majority group, where she would choose the disliked behavior, if more of her minority partners were also joining the larger majority. So that if only some but not all actors in the minority would integrate into the majority to gain from the benefits of belonging to a larger group (i.e. a larger coalition), those who are sacrificing their identity benefits might end up worse off than before.

Thus, on the one hand, communication can help increase benefits for actors in small minorities by allowing them to coordinate with a large majority. This is possible even if the transition from one behavior to another would not be simultaneous for all actors in the minority. But, on the other, communication can cause great losses for the minority if the groups are of similar size, because the way the transition takes place matters a lot.

### 6.2.3 Concluding remarks

In this book we have studied how inequality can be the by-product of social exclusion as it results from exchanges between heterogeneous individuals. A first general element to take away from our four studies is that individual differences play a key role in understanding individual choices and aggregate outcomes. Compared to situations where actors are assumed identical, or where their individual characteristics are considered non relevant to their interactions, our work has shown how influential characteristics such as expertise or preferences are in shaping behavior. The second general element to draw from this set of studies is that heterogeneity in individual differences is not in itself a determinant of social exclusion. Even if actors differ in very relevant characteristics, there are settings where exclusion is not necessary. For instance, researchers with specialized expertise can collaborate with others who have a different type of expertise, such as the generalists. In similar ways, individuals with conflicting preferences can choose alike and coordinate in the products they purchase; because interacting and exchanging with others is very valuable and can provide great benefit to actors.

The third general element to take away is that for some settings, nonetheless, social exclusion is inevitable in the presence of heterogeneity in individual characteristics. Specifically, settings in which actors have the possibility to readjust their interactions and their interaction partners. In these scenarios, where pairs of actors can redefine their relationships, say by forming a relationship if they do not have one or severing the relationship if they have it, rational actors will be motivated to improve their wellbeing by carefully selecting particular relationships. This in turn excludes those others who cannot provide the most

valuable outcomes.