

Thesis summary and contribution - Noémie Cabau

This document provides an overview of my research. I am Noémie Cabau, a third year Ph.D. student at the economics department of Université Paris Dauphine. I work under the supervision of Sidartha Gordon. My main fields of research are information economics, game theory and network theory. I intend to get a double degree from Concordia University (Canada) as well. My supervisor at Concordia is Ming Li.

My Ph.D. thesis is entitled: "*Essays in contract theory and network formation games*". It is composed of four chapters, each of them on distinct topics. The format of my four chapters is the one of a scientific paper. I use a theoretical modelling approach exclusively. In what follows, I give a short summary of each chapter, and I present their contribution to the existing literature.

1 The research project: summary and contribution

A theory on the carrot and the stick: how contracting for the rights over an offense performs as a marginal deterrent

Summary If your neighbor is about to commit an offense against you, how could you make him change his mind? This is the question I propose to answer to in this paper. If your neighbor is not aware that his action is punishable by law, you could first threaten him to take the case to court. If he is deterred, this is what scholars refer to as the marginal deterrence of the legal sanction. What if he is aware of the punishment, yet he is not deterred? This is where my paper offers a solution. You two could simply negotiate the right over the harmful action. If your neighbor consents to leave you the right over it, then you need to compensate him. But instead of having to compensate his entire benefit from carrying on the harmful act, you will only need to compensate his net benefit from committing the offense and being fined. Now, if you consent to leave the right over the harmful act to your neighbor, then the latter must afford to pay you damages that are at least what the court would have imposed. This contracting mechanism amplifies the scope for marginal deterrence, by enlarging the set of potential offenders from those who are deterred by the threat of the legal sanction to all those who prefer to give up their right over the harmful act.

Contribution My paper contributes to the literature on marginal deterrence. Citing Bentham (1789, [1]), an object of punishment is "to induce a man to choose always the least mischievous of two offenses; therefore where two offences come in competition, the punishment for the greater offense must be sufficient to induce a man to prefer the less." In the economic literature, Becker (1968, [2]) is the first one to give normative answers about the optimal level of the legal sanction against an offense, and the optimal probability of being convicted for committing such an offense. Becker finds that the optimal probability of apprehension depends on, among other things, the cost of catching and convicting offenders; and that the optimal level of the sanction should be the highest one possible i.e., one that amounts to the perpetrator's total wealth. An interesting criticism of Becker's work is Shavell's (1992, [3]), who bases his argument on the idea that the probabilities of apprehension against two acts may not be independent from each other. Meaning, enforcement efforts may be of a general nature, affecting in the same way the probabilities of apprehension of several harmful acts. Shavell concludes that when the probabilities of apprehension for several offenses are equal to each others, the level of sanction against the least harmful of two acts should be strictly less than the punishment against the most harmful act. This, in order to leave a scope for marginal deterrence: an individual who would benefit more from committing the most harmful act may change his mind and opt for the least harmful one, because the sanction against each offense makes the least harmful act more profitable, in net terms, than the more harmful act. My model

builds on that of Shavell, and provides an answer in the case where an agent in Shavell's framework fails to be marginally deterred. Assume that an agent must choose between two harmful acts he may take. One act implies a low level of harm against society, gives a low benefit to its perpetrator and it is not punished by law; and another act is relatively more harmful against society, gives a high benefit to the perpetrator however it is punished by a fine. I assume that the perpetrator and the victim are given the possibility to contract for the rights over the two harmful acts. I show that allowing the parties to contract enables to increase the scope of marginal deterrence beyond what the legal sanction can achieve by itself. And that for contracting to increase this scope for marginal deterrence, it should be that an act is punished by law only if the harm it causes against society exceeds the benefit to the perpetrator.

Collective action on an endogenous network (Job market paper)

Summary In the literature on interagency and organizational communication, the question of designing an effective communication network is of particular importance. In times of crisis, an ideal communication network enables the different nodes (that can be understood as departments, teams, etc) to share as much information as possible via short and reliable communication channels. My paper offers a theoretical modeling of the problem of designing a communication network on a set of nodes such that the network allows them to process and relay information as fast (which is measured by the distance between the different departments) and to as many of them as possible (this variable is captured by the reach of each department), under a financial constraint. (In normal times, maintaining a very densely connected structure would be too costly). The decentralized version of the problem is also featured: it may be more relevant in environments where the communication network is shaped by individual, thus decentralized, decisions such as in political or activist groups. The decentralized version of the model is a non-cooperative game where a group of agents are given the possibility to form links towards each others. An agent pays for the links he initiates. The objective of the agents is to maximize the value of the network they form, value that is measured by the reach (i.e. the number of people an agent has a path to) of every individual of the group, minus their own expenditure in links. The strict Nash networks have simple architectures e.g. wheel, a disconnected variant of a wheel network and the empty network. The centralized version of the model, where a central planner must choose a network with high value and pays all links that he creates, is a potential game. I show that the networks that maximize the potential function are a strict subset of the strict Nash networks of the decentralized version of the game: these networks are the wheel network and the empty network. I then explore an alternate version of the game where the value of the network depends both on the reach and the closeness of every agent. The closeness of an individual is measured by the distance from the agent to the rest of the group. When the cost of a connection is not too low and the group size is fairly small, I show that the equilibrium candidates all have flower architectures, that are either connected or disconnected. A flower architecture trades-off the cost of more links against the benefit of shorter distance between the individuals that is made possible by a central agent. For a given total number of links in the network, the advantage of a connected flower, compared to a disconnected flower, is that all agents are able to reach each others; and the advantage of a disconnected flower, compared to a connected flower, is that the agents who can reach each others are relatively closer. For a larger group size, I am able to characterize the architectures of the equilibrium candidates among a strict subset of all possible networks. The results seem to corroborate the effectiveness of the flower architectures, connected and disconnected, however the results lack robustness.

Contribution The first contribution is to generalize Bala and Goyal's (2000, [4]) model of endogenous network formation. In their model, Bala and Goyal consider that the payoff of an agent is a function of his own reach, or alternatively, of his own closeness to the rest of the group. Therefore, an agent balances the cost of link formation against his own private benefit. In my model, an agent's objective is to place links in the network so as to maximize: (i) the number of pairs of agents the link allows to connect, and (ii) the decrease in the distance from any agent who will use

the link to reach some other agents. Meaning, an agent balances the cost of link formation against the social benefit to the entire group. Interestingly, my results differ from those of Bala and Goyal on the connectedness properties of the equilibrium networks. Other than that, we both find that the connected equilibrium networks have flower architectures.

The second contribution of my paper is that it complements the literature on interagency and organizational communication. For the works in this field that motivate my analysis, see in particular Adams (1969, [5]), Kapucu (2006, [6]). My results give the architectures for the communication networks that are the most effective to promote a fast and dense communication between nodes, given a fixed budget for building the network. If the problem is simply to maximize the number of nodes that can communicate with each others, and if the cost of link formation is not too high, then the most effective architecture is that of a wheel network (the network looks like a loop on all nodes). If the problem is to maximize the closeness of the nodes, then the most effective architectures are that of the flower networks. In these architectures, the communication is centralized around one individual (the center of the flower network) who relays any information that he receives (information that is therefore sent by anyone who has a path to this central agent) to anyone himself can reach. Given a total budget for building the network, different sorts of flower architectures may be optimal. Either the communication is established via relatively short communication channels but only a strict subset of nodes are able to communicate with each others, the rest of the nodes being either specialized in sending or receiving information (disconnected flowers). Or else every node is in capacity to relay information to any other node, however the information passes by longer communication channels, which may increase the risk of errors / delay occurring during the transmission (connected flowers).

Secret Rebates and List Prices in Negotiations between Countries and Pharmaceutical Firms (co-written with Sidartha Gordon)

Summary During the negotiation over the price of a drug between a pharmaceutical firm and an institutional payer (a country), it has been noted that the list price, that is, the public price of the drug, may differ significantly from the net price paid by the country to the manufacturer. The net price corresponds to the publicly observed price minus some secret rebate, which amount is known only by the two parties involved in the negotiation. For a pharmaceutical monopoly producer, hiding the net price charged to a payer, by only making the list price observable, has a simple motivation: if negotiations are carried out sequentially, secrecy on the net price charged to a payer prevents subsequent ones from claiming for no less advantageous deals. For the country, we make the assumption that rebates lead to a less effective access to the drug than the analogous list price reduction. We micro-fund this assumption by considering that patients pay, out of their pocket, a fraction of the list price of the drug. We provide a model of the interaction between two countries and a manufacturer, assuming that the countries negotiate sequentially with the firm. Then, we characterize the set of Pareto-efficient and individually rational (PO-IR) trades. We also provide conditions under which such trades involve secret rebates. Our findings are the following. If the list price in the first country exceeds the monopoly price on the second market, then no PO-IR contract has a positive rebate. The intuition behind the result lies on our assumption that a rebate is less effective at increasing the size of the treated population than a corresponding reduction in the list price. When the firm has no incentive to hide the list price concluded with the first country, the contracts that maximize both of the parties' payoffs are the contracts that have the greatest quantity traded, thus the contracts that have no rebate. Rebates are typically used when the list price in the first country falls below the monopoly price in the second country. In these instances, we find an interesting relation between the net price, list price and rebate: the larger the list price, the larger the rebate and the lower the net price. Among all contracts that are PO-IR, the contract that gives the highest level of welfare to the country is the contract that has the largest list price, the largest rebate and the lowest net price; to the contrary, the contract that gives the firm the highest total profit is the one that has the lowest list price, the lowest rebate and the largest net price.

Contribution Our paper contributes to the literature on drug prices and secret rebates. Works by Vogler and Paterson (2017, [7]), Danzon and Towse (2003, [8]) investigate the potential effects of transparent negotiations on the levels of drug prices. Our results push forward the idea that transparency may cause an inflation of drug prices in the countries that are the first ones in the order of the negotiations. The work that is the most related to ours is Jelovac's (2002, [9]). In her paper, the author studies the relation between the patients' co-payment for buying drugs and the list price of the a patented pharmaceutical. We use a similar utility function for the first country and model our negotiation process between a country and the firm along the same lines. However, we suppose that that the level of coverage of the drug is independent from the outcome of the negotiation, and that the level of private contributions are determined only once the negotiation is over, and must guarantee that the social security does not run a deficit. We find that the optimal policy for the first country consists in reducing private contributions as much as possible i.e., the country uses the whole value of the rebate towards a decrease in the private contributions.

Asymmetric Information in Markets for Pharmaceutical Drugs : International Price Referencing and Secret Rebates (*co-written with Sidartha Gordon*)

Summary We model the sequential negotiations of two institutional payers (countries) with a pharmaceutical firm. Each negotiation is featured as a bargaining game on potentially two periods, and the value of the drug is assumed to be common. Furthermore, we assume that the firm holds private information on the date at which the drug will become obsolete because of the entry of a superior substitute, which affects its willingness to accept a lower price in exchange for an earlier deal. The information contained in the list price agreed with the first country enables the second country to extract a greater surplus from the firm. As a result, if it is farsighted, the firm is then more reluctant to accept a low offer from the first country which reduces its surplus, making a high list price coupled with a secret rebate an attractive option for the first country and for the firm. We also rationalize the use of the international reference pricing (IRP) by the second country. (The international reference pricing is a price cap on the price at which a country buys the drug that is calculated in function of the prices that other countries which negotiated earlier on have gotten.)

Contribution To the best of our knowledge, our paper is the first one that rationalizes the usage of IRP and secret rebates. We show that, irrespective of the outcome of the negotiation between the first country and the firm, the price that is paid by the second country is a function of the price paid by the first one; and that secret rebates are therefore mutually advantageous for both the firm and the first country. We also contribute to the part of the literature that investigates the potential effects of transparency on drug prices. See the works by Vogler and Paterson (2017) and Danzon and Towse (2013). We show that when secret rebates are not allowed, this leads to a price inflation in the first country, while the effect on the price in the second country is ambiguous.

References

- [1] J. Bentham, "An introduction to the principles of morals," *London: Athlone*, 1789.
- [2] G. S. Becker, "Crime and punishment: An economic approach," in *The economic dimensions of crime*, pp. 13–68, Springer, 1968.
- [3] S. Shavell, "A note on marginal deterrence," *International review of Law and Economics*, vol. 12, no. 3, pp. 345–355, 1992.
- [4] V. Bala and S. Goyal, "A noncooperative model of network formation," *Econometrica*, vol. 68, no. 5, pp. 1181–1229, 2000.

- [5] D. S. Adams, "Emergency actions and disaster reactions: An analysis of the anchorage public works department in the 1964 alaskan earthquake," tech. rep., OHIO STATE UNIV COLUMBUS DISASTER RESEARCH CENTER, 1969.
- [6] N. Kapucu, "Interagency communication networks during emergencies: Boundary spanners in multi-agency coordination," *The American Review of Public Administration*, vol. 36, no. 2, pp. 207–225, 2006.
- [7] S. Vogler and K. R. Paterson, "Can price transparency contribute to more affordable patient access to medicines?," 2017.
- [8] P. M. Danzon and A. Towse, "Differential pricing for pharmaceuticals: reconciling access, r&d and patents," *International journal of health care finance and economics*, vol. 3, no. 3, pp. 183–205, 2003.
- [9] I. Jelovac, "On the relationship between the negotiated prices of pharmaceuticals and the patients? co-payment," in *VI EHEW meeting, Marseille*, vol. 8, 2002.