A common characteristic of markets is that each agent who takes part in them possesses information that is not available to the market. An example of this information is how much each agent values being in the market and obtaining items or services that it offers, detail about these items and services, and her arrival and departure time from the market. This information is called private information of the agents and is crucial for the market to know it in order to have stability. Thus, every market faces the challenge of truthfully eliciting information from the agents. To achieve this, the fundamental requirement is to offer the right incentives to agents. This is why, when a market succeeds in motivating the agents to truthfully report their private information, the incentive compatibility property is said to be satisfied and the market (or mechanism that it adopts) is said to be incentive compatible.

Depending on the market and the economic model in place, there can be several methods of providing incentives. Monetary incentives are one of the most powerful incentives for rational agents whose aim is to maximize their own utility. In particular, both payments and monetary penalties can be designed to motivate agents to behave as desired. Nevertheless, other techniques that do not rely on monetary policy can be adopted to incentivize agents. In what follows, I discuss both monetary and non-monetary approaches.

Mechanism Design with Monetary Payment

For markets where agents compete with each other, like auctions where bidders aim to win the items that are auctioned off, mechanism design [Mas-Colell et al. 1995] provides techniques to design payment rules that guarantee incentive compatibility. In particular, in designing a mechanism an allocation rule, that describes which agent gets which object, and a payment rule, that describes how much each agent has to pay, must be specified. Typically, one of the fundamental aspects of a payment rule that guarantees incentive compatibility is that the payment of an agent must depend on the information reported by the other agents and not on her own. These rules are referred to as standard payment rules. During my PhD, I focused on a particular type of market where standard payment rules do not incentivize agents to truthfully report their private information.

The scenario I considered is the one of the federation of service providers where a central provider collects information about services from multiple service providers and uses this information to offer customers services that are targeted for them. Note that providers can have potentially different information about the same services. Online movie or music streaming are examples of such services. In this case the center provides customers with recommendations about movies or music that, if selected, are streamed by one of the providers. The information that providers communicate to the center can be the list of movies a given customer watched and how she rated them. Also advertisements can be seen as a service. Consider a federated search engine that offers customers the possibility to do multi-domain queries, i.e., with a unique query, customers can ask for information about several different domains and obtain correlated answers [Ceri and Brambilla 2010; 2012]. In order to offer this service, the federated search engine interrogates domain-specific search engines and correlates the organic results they communicate to her. However, other than the search results, the domain-specific search engines communicate to the center information about ads, i.e., how valuable each ad is and the probability that a given customer clicks on it.

Thus, the federated search engine faces the problem of merging the information obtained and deciding which ads to display and how much to charge the advertisers. Also in this
case, potentially different information about the same ad can be communicated by different domain–specific search engines.

The crucial aspect of this type or market is that, since the information communicated to the center about the same service are merged, information interdependencies arise. Due to this, if standard payment rules are used, agents can be incentivized to strategically misreport their private information. In my work, I overcome this problem by designing a different type of payment rules. Since with standard payment rules a potential misreport is due to the fact that the information reported by an agent affect the other agents’ payment, in the payment rules I consider, agents’ reports are not taken into account. Indeed, payments depends on the services that a customer actually selects. Essentially the payment is contingent to what happens that can be observed by the mechanism, like clicks made by the customers. This is why these are called execution–contingent mechanisms. Other than proving that standard payment rules cannot be adopted if incentive compatibility must hold, I designed several execution–contingent mechanism for this scenario that differs for the set of properties (other than incentive compatibility) that are guaranteed [Ceppi et al. 2011; Ceppi et al. 2012].

Scoring Rules

As mentioned in the previous section, designing payment rules is not the only way of using money to incentivize agents to truthfully report their private information. Indeed, penalties can be designed such that, instead of incurring them, agents prefer to report their information in the most accurate way. In the literature, scoring rules [Gneiting and Raftery 2007] are typically applied to design penalties that guarantee incentive compatibility. Differently from designing mechanism with payment, scoring rules can be applied also in setting where agents do not compete among each other.

In my work, I used techniques based on the combination of mechanism design with payment and scoring rules to address the problem of designing personalized payments for customers who are buying storage. The novelty of this work is that customers are allowed to describe their requirements in a fine–grained way and, the more the specified requirements represents the actual need of customers, the better (in term price per storage units, e.g., gigabyte) the contract they can sign. In the work, I consider three types of contracts for personalized payments: flexible, fixed or score-based. When the customer chooses the flexible contract, she pays at the end of it. The contract determines the price per storage unit that the storage operator computes on the basis of the reported information of the customer, and the final price the customer pays is equal to the price per storage unit reported times the number of storage units she actually uses. Instead, if the customer chooses the fixed contract, she pays in advance the total price for the required service where the storage estimates both the amount of storage units the customer will use and the price per storage unit she is required to pay. Finally, if the chosen option is the score-based contract, the customer agrees to pay a basic fixed price per storage units plus a score. The basic fixed price guarantees that the storage does not make a loss by providing the service to the customer. The score, being dependent on the actual number of storage units used by the customer and the bounds she reports, provides her with incentives to communicate accurate information.

I designed payment rules for both the flexible and fixed contracts, as well as penalties to apply in the cases when the payment rules would not otherwise guarantee that customers are always incentivized to truthfully communicate their requirements. In particular, a customer is charged a penalty when the storage operator observes that she violated the reported requirements (i.e. she reports the upper bound on number of storage units she will use but she actually exceeds the bound). When the penalty is applied, it is guaranteed that the customer’s total payment (i.e., the payment that depends on the reported information plus the penalty) is higher than the payment she would have had by truthfully reporting her information. I also explore several ways in which appropriate scores for the score-based contract can be computed.
Mechanism Design with Partial Verification

Monetary incentives are not the only way to motivate agents to truthfully report their information. Knowing that a mechanism can verify if the reported information corresponds to the actual private information and, accordingly with this, can take actions like removing the misreporting agents from the market incentivizes agents to communicate to the mechanism their private information. Mechanism design with partial verification adopts this idea [Green and Laffont 1986; Fotakis and Zampetakis 2013; Fotakis et al. 2013; Krysta and Ventre 2010]. The assumption made is that, part of all the different information that an agent can report can be easily verified by the mechanism. Consider the case of an online market where agents’ arrival and departure times are part of their private information. The mechanism can observe if an agent who states that her arrive time is $t$ is actually in the market at $t$. Thus, if the agent reports an earlier arrival time, the mechanism detects her lie, but if the agent is in the market at $t$, the mechanism cannot infer if she actually arrived at time $t$ or before $t$. Following the idea of mechanism design with partial verification, I am exploring how monetary incentives can be substituted with partial verification of the information that agents can report. In particular, considering different classes of mechanisms, e.g., deterministic incentive compatible mechanisms, universally truthful mechanisms, random mechanisms, I identify the smallest area of information that agents could report but that does not need to be verified in order to preserve incentive compatibility and the outcome of the corresponding mechanism with payment. As a next step, I am interested in studying how the obtained results change when a cost for the verification is introduced in the mechanism, i.e., when the market needs to make an effort that can be quantified in monetary term to verify the information of the agents.

REFERENCES


