Three Games of Asymmetric Information

Eero Mäenpää
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Abstract

This thesis is a collection of three essays that study three different economic settings in which asymmetric information has a central role.

The first essay studies the externalities that employers’ selective hiring policies cause for other employers. Employers match with workers in the unemployment pool, observe noisy signals about their productivity and hire candidates with good enough signals. A high (low) threshold for acceptable signals induce strong (slight) adverse selection into the unemployment pool which may rationalize adopting a high (low) threshold, resulting in multiple equilibria. Employers are better off in an equilibrium with a high threshold, in contrast to the workers who prefer a low threshold. The model can explain statistical discrimination between demographic groups and can be adapted to other applications such as the credit market.

The second essay compares the first-price and the second-price auctions in a setting where the buyers receive random outside offers after bidding but before paying for the item. The winner of the auction can costlessly default on the payment if she is offered a cheaper price. The first-price auction collects more revenue and has lower optimal reservation price under standard assumptions. The seller can benefit from setting a price ceiling along with a reservation price.

In the third essay (joint with Mikael Mäkimattila), we examine start-ups’ incentives to innovate, enter and compete on a market occupied by an incumbent firm which is willing to eliminate competition with buyouts. When a start-up’s innovation effort and success are private, it may achieve a successful sell-out without bringing technological advancements to the market. This weakens the incentives to innovate and encourages market entry without competitive advantage. To obtain a good buyout deal, a start-up with no innovation must enter and compete aggressively as to mimic an innovative start-up. We analyze the effects of competition policy: allowing buyouts decreases innovation to an inefficiently low level, increases socially wasteful market entry and leads to inefficient production by the non-innovative start-ups. However, allowing buyouts intensifies the initial competition before a buyout.

Keywords game theory, information economics, statistical discrimination, auctions, merger policy
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List of Essays and Author’s Contribution

This thesis consists of an introduction and the following essays:

I  Screening with Common-Pool Externalities  
   *Unpublished manuscript*, single authored.

II Auctions with Outside Offers  
   *Unpublished manuscript*, single authored.

III Fake It Till You Exit  
   *Unpublished manuscript*, joint with Mikael Mäkimattila.  
The authors contributed evenly in all phases of the research.
Introduction

This thesis comprises three essays that explore three thematically distinct topics. The first essay studies the externalities that employers’ selective hiring policies cause for other employers. I find that an employer may be reluctant to hire job candidates, or just a certain type of candidate, only because other employers likewise are reluctant. The phenomenon may give rise to discrimination. In the second essay, I compare the first-price and the second-price auctions in a setting where the buyers can default on the payment should they find a cheaper outside offer. In this setting, the first-price auction generally collects more revenue for the seller who might also benefit from setting a price ceiling. In the third essay (joint with Mikael Mäkimattila), we study how merger policy affects start-up firms’ incentives to innovate, enter markets, and compete with the market incumbents. The model predicts that a lenient policy towards start-up acquisitions discourages innovation and promotes wasteful entry and production by inefficient start-ups.

These seemingly disparate topics actually have a lot in common. Broadly speaking, each of these settings is a game in which players with somewhat incompatible objectives interact strategically: an acquiring firm wants to buy out the start-up on the cheap while the start-up is seeking a lucrative exit; each bidder in the auction aspires to win, and a worker hopes to be hired even when her output is not worth the salary. Uncertainty prevents a straightforward resolution to these issues. An employer who would see through the applicants would never mishire, a seller aware of the buyers’ preferences would not even bother arranging an auction, and a firm knowing its rivals inside out would make only successful acquisitions. The uncertainty is asymmetric. The workers know their abilities, the buyers know their preferences and the start-ups know their technologies while employers, sellers or acquirers must resort to imperfect measures to deal with their informational disadvantage.

Dynamics further complicate the lives of the subjects. The players must account for future and not just pursue instant utility. Bidders shade their bids in the auction anticipating a better deal later on, and the start-up weights the cost of market entry against the profits it expects to make upon entering. Each setting exhibits delays: an unemployed worker can apply for jobs at a limited rate, the auctioneer has an issue with defaulting buyers for not being able to collect payments immediately, and the merging firms must eat into each other’s profits by competing for a while before attempting a merger.

Systematic analysis of these economic phenomena is made possible by modeling, that is, making useful abstractions. Microeconomic models are not meant to be holistic descriptions of individuals, firms or of all the aspects they might consider when making real-world decisions. They rather highlight something essential about the subject of study while trimming away unnecessary details. Whatever is included or assumed away should be made extremely clear when setting up the model.
Namely, the reader should learn who the players are, what their preferences and available actions are, and, as emphasized in this thesis, what the players know about these primitives. This is the first thing the reader will encounter when delving into the analysis in each of the essays.

What usually goes without saying, but is even more crucial, is the model for decision making: the players can reason about the future, new information and other players’ strategies, and accordingly adjust their own strategies to optimally serve their purposes. Neither should this model be taken literally but as a useful approximation. Given the stylized nature of other model primitives, these requirements do not necessarily require excessive sophistication from the players: in the second-price auction analyzed in the second essay, for instance, the buyers must just figure out their own valuations for the auctioned item.

Model primitives are merely a list of ingredients. To base economic predictions on a model, one must define what kind of strategies and beliefs constitute an equilibrium. In the scope of this thesis, the following requirements are relevant. First of all, no player wants to change her strategy given the other players’ strategies (Nash, 1950, 1951). In dynamic games, this requirement is often complemented with sequential rationality (Selten, 1965). For example, a sequentially rational incumbent firm can credibly threaten an entering start-up with fierce competition only when aggression is optimal if the start-up enters anyway. Under uncertainty, the players further have to form and operate under consistent, probabilistic beliefs on the world (Harsanyi, 1968). In dynamic games with asymmetric information, even sequentially rational players may hold pathological beliefs which therefore have to be regulated, as in Fudenberg and Tirole (1991) or in the third essay in this thesis. Nonetheless, these requirements do not guarantee a unique prediction. It can be an issue that has to be addressed, as in the second and the third essay, or it can be of particular interest, as in the first essay.

Once model primitives are introduced and equilibrium is defined, the results will follow and are not debatable as far as the math is done correctly. This by no means implies that the conclusions should be taken at the face value. The adopted methodology merely shifts the debate from the formal analysis to the model itself. Ultimately, the economic predictions are as valid as is the analogy between the reality and the model.

The lack of detail in the models makes them adaptable. In the second essay, I model an auction but remain agnostic whether a bicycle, an apartment, or a firm is being sold. The model in the first essay is an equally accurate, or inaccurate, depiction of an entry-level labor market or start-up financing. The third essay has a fairly long sequence of strategic interaction between an entering start-up and an incumbent firm and arguably has fewer analogies in other contexts. Yet, the industry does not need to be specified. In fact, after exchanging labels the unifying theme in this thesis could have been, say, technology start-ups. Many stories can be told within a single model which makes the conceptual framework and the methodology, rather than an application, natural common denominators between the essays which I next summarize.
Essay I: Screening with Common-Pool Externalities

This essay is built upon two fundamental observations: employers screen out unproductive job candidates with varying degrees success. However, if the employers are somewhat successful in the task, less productive workers remain for other employers.

I present a dynamic model where unemployed workers, who differ in productivity, are matched with homogeneous employers. An employer observes a noisy signal of job candidate productivity, and bases her hiring decision on the signal and her prior information about unemployed workers. The prior information depends on what kind of candidates the other employers screen out as the rejected candidates continue applying elsewhere. If other employers have been highly selective, demanding very good signals from hired candidates, fewer productive candidates remain in the unemployment pool. This makes the Bayesian employer more sceptical about the candidate so that she likewise requires a very good signal from the candidate. Conversely, laxer selection criteria in the past may rationalize current lax criteria, which leads to multiple equilibria. The criteria may be conditioned on an observable trait of the candidate, such as gender or race, which may manifest as statistical discrimination.

The model provides a novel explanation why multiple equilibria may arise from informational externalities. Complementary work includes Boone and Watson (2007), Dier (2008), Gehrig and Stenbacka (2011), Fishman and Parker (2015) and Cavounidis et al. (2023). In these papers, past investment in screening technology rationalizes the investment today. The current model also provides a parsimonious explanation for statistical discrimination in the labor market. Adjacent work explaining statistical discrimination with informational externalities includes Cavounidis et al. (2023), in which discriminated workers are screened on-the-job and others are not, and Gu and Norman (2020) in which the discriminated self-select into low-paying occupations.

Essay II: Auctions with Outside Offers

The payment for goods often cannot be collected at the instant a buyer is found. Reasons for the delay range from arranging collection to securing financing. Meanwhile, the buyer may find a cheaper alternative, and if the seller lacks sufficient means to retain her, she will default on the payment. Then the best the seller can do is to design the sales mechanism, or auction, as to collect the most revenue while limiting the risk of default.

I augment the classical independent private valuations auction setup (see e.g. Vickrey (1961) and Myerson (1981)) with random outside offers that are observed after bidding concludes but before transfers are paid. The buyers are protected by an ex-post participation constraint: the winner of the auction can costlessly default on the payment to the seller if the outside offer turns out to be cheaper. In this setting, a first-price auction, as opposed to the second-price auction, turns out to be an advisable way of arranging the sale to multiple buyers: it collects more revenue and has the lower optimal reservation price of the two, which makes it the more efficient one as
well. The seller may also benefit from setting a price ceiling that makes the buyers less likely to
default.

As a novelty, I study outside offers and ex-post participation constraints together. Outside offers without the additional constraint are studied in Che et al. (2022) and Lu and Wang (2021). In the former, the buyer forfeits a deposit by defaulting, in the latter the buyer cannot default. Ex-post participation constraints with dynamically arriving information about the buyers’ preferences, rather than outside offers, are studied in Krähmer and Strausz (2015), Heumann (2020) and Bergemann et al. (2020). Limiting the risk of default as a rationale for adopting a price ceiling is also novel to the literature, see Grebe et al. (2021).

Essay III: Fake It Till You Exit

A successful start-up is bound to be acquired by another firm (Ederer and Pellegrino, 2023). To reach that point, the start-up typically needs to come up with something innovative, to enter and to gain foothold on the market. Since a start-up tends to have a short history and employ novel technologies, it likely has private information about its prospects.

We build a model on these primitives. A start-up can, in this chronological order, make a risky innovative investment, enter the market, compete with and be bought out by an incumbent firm, barring a strict policy against buyouts. Innovative effort cannot be demonstrated to the incumbent firm which can neither observe whether the investment produces an innovation.

If acquisitions are prohibited, a non-innovative start-up never enters the market as it cannot profitably challenge the incumbent firm. With acquisitions allowed, the incumbent firm wishes to buy out the competing start-up. It has to offer better buyout terms to an innovative start-up. If the incumbent cannot tell an innovative start-up apart from a non-innovating one, it ends up paying premium to the latter. To avoid raising the acquirer’s suspicions, the non-innovating start-up cannot act in the market differently than an innovating one would. It adopts a fake-it-till-you-exit strategy: it enters the market and sells at a deficit until it is acquired, which is wasteful.

A lenient policy towards buyouts allows a non-innovative start-up to extract information rent from the market. Entry by these inefficient firms is stimulated and the return of the initial innovative investment is decreased. A lenient policy towards mergers therefore creates a moral hazard problem: the start-up may shirk from the unobservable innovation effort and hope for a lucrative buyout deal. On the flip side, consumers only care about prices and therefore benefit from intensified pre-buyout competition which results from ‘faking’.

The related literature makes no distinction between innovation and entry (for example Bisceglia et al. (2023)) while the start-up’s incentives to innovate and enter diverge here. In our model, as in the aforementioned paper, ‘entry for buyout’ (Rasmusen, 1988) is driven by information rent that the entrant can extract rather than its negotiation power against the incumbent, as in Mason and Weeds (2013). We are also not aware of other work in which an entrant adopts a similar
fake-it-till-you-exit strategy to facilitate its own exit, or in which there is a moral hazard problem in start-up innovation. In Saloner (1987), an incumbent firm signals strength with low prices to another incumbent firm, which is weaker in the sense that it has higher costs and no bargaining power, to be able to acquire the competitor for a cheaper price. Our model can be seen as a counterpart for ‘limit pricing’ (Milgrom and Roberts, 1982) where an informed incumbent signals in prices to a potential entrant to deter entry.

References


