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Investments and the holdup problem in a matching market☆

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ABSTRACT

This paper studies the properties of the steady state equilibrium in a bilateral matching market with ex ante investments at the market entry stage. Investment incentives depend on search frictions because both parties in a match are partially locked-in when they bargain over the joint surplus from their sunk investments. The associated holdup problem is more important for the long side of the market. In the extreme case of perfectly substitutable investments only the agents on the short side make investments. When market frictions become negligible, the market equilibrium approaches the Walrasian outcome.

1. Introduction

This paper studies investment incentives in a bilateral dynamic matching market with search frictions.[1] On both sides of the market new agents arrive each period and decide whether to enter the market. Upon market entry agents make investment decisions before participating in the matching process. In a match they negotiate about sharing the joint surplus from their sunk investments. Since switching to an alternative bargaining partner involves search costs, both parties in a match are partially locked-in. This generates a holdup problem for the agents' investment decisions at the market entry stage. We investigate how the resulting underinvestment effect depends on market conditions.[2] It turns out that the holdup problem is more important for the long side of the matching market. Therefore, these agents invest less than the agents on the short side of the market, even when the investments of all agents are equally productive. Indeed, in the case of investments in homogeneous capital only the agents on the short side of the market acquire ownership of capital.

In our model the market entry decisions, the investments on both sides of the market, the numbers of active traders and the traders' matching probabilities are interdependent and determined endogenously. To keep the analysis tractable and to focus on the long-run equilibrium properties, we study the equilibrium in a steady state, where all variables are stationary over time. We prove existence of a steady state equilibrium under general assumptions on the matching process and the productivity of investments. In contrast with most of the literature, investments are not required to be complementary but they can also be substitutes. This makes our analysis applicable to a variety of matching markets. A standard example is a labor market, where firms invest in physical capital and workers in human capital. Another application are premarital human capital acquisitions of men and women in a marriage market. A further example is markets where buyers and sellers meet randomly and the sellers invest in product or process innovation before a match.

In our setting, the productivity of investments is independent of the trading partners' identity. Nonetheless, in a match the traders are partially locked-in because they face search frictions. The level these frictions determines the degree to which investments effectively become relation-specific in a particular match. The agents discount future utilities and so their outside options decrease with the expected length of time to achieve a transaction with an alternative bargaining partner. Thus the agents' discount rate reflects the degree of asset specificity in a match. Following Rubinstein and Wolinsky (1985), we can study a 'frictionless market' by considering the equilibrium outcome when the time cost associated with the matching process becomes negligible. In this limit, the parties in a match are no longer locked-in and the holdup problem disappears, because switching to another trading partner is costless.

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[1] The presence of search frictions distinguishes our model from assignment markets which are studied e.g. by Shapley and Scarf (1974), and Talman and Yang (2011).

[2] Taylor (1995) studies the determination of bargaining power and prices in a dynamic market. In his model, however, there are no investments and price offers are public to all market participants.

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We show that in such a 'frictionless market' the agents' investments at the market entry stage are indeed efficient in the sense that they maximize the joint surplus from a match.

The holdup problem in its classical formulation refers to relationship-specific investments in environments with incomplete contracts.[3] The trading partners make investments that have little value outside the relationship. These investments are observed by the partners but are not verifiable in court. Therefore contracts are incomplete, and the partners negotiate the division of the surplus ex post at a stage where the investments are sunk. Accordingly, they will not be able to appropriate the full marginal benefit of their investment, which typically leads to underinvestment in specific assets.[4] In our setting, we do not need to appeal to the idea that investments are not verifiable and therefore non-contractible. Instead, the agents cannot contract over the levels of investments simply because investments are made before entering the matching process and meeting a contract partner. As emphasized by Acemoglu and Shimer (1999), this seems relevant in many situations. For instance, in a labor market firms invest before hiring workers and workers acquire human capital before finding a job.

The holdup problem in our context may provide an explanation of asset ownership that differs from the theory of property rights as developed by Grossman and Hart (1986) and Hart and Moore (1990).[5] In their theory, the residual control right associated with the ownership of physical assets determines the parties' outside options in ex post bargaining and, therefore, affects their ex ante incentives for human capital investments. Before making these investments, agents can contractually reallocate property rights. The resulting cooperative allocation of asset ownership then minimizes the inefficiencies generated by the holdup problem.[6] In our model the agents acquire physical assets through their ex ante investments. Since investment incentives depend on the nature of the matching process, the non-cooperative allocation of asset ownership is determined by market conditions. Consider for example a labor market where unemployed workers are randomly matched with entrepreneurs, who seek to fill vacancies. As Samuelson (1957) notes, in a competitive Walrasian market it remains unclear whether workers or entrepreneurs become the owners of capital. But we show that only the entrepreneurs will invest in homogeneous capital inputs whenever there are more unemployed workers than vacancies. In this situation the holdup problem is more serious for the workers than for the entrepreneurs. Therefore the entrepreneurs can realize a higher marginal return on their investment and only they become capitalists.

Our analysis relies on the steady state equilibrium of a dynamic matching market, similar to the one used by Rubinstein and Wolinsky (1985) and Gale (1987). On each side of the market there is a constant number of active agents who remain in the market until they have traded. Their matching probabilities reflect the relative number of active agents. At each point in time, there is a constant flow of potential market entrants. In the steady state, the number of agents who enter is identical to the number of agents who exit after a trade. We combine the market entry stage with the agents' investment decisions. Each agent who enters the market selects his investment as a best response against the equilibrium choices of the other agents. Our assumptions on the productivity of investments include the different categories that have been considered in the literature on the holdup problem. The model applies for instance to a buyer–seller market in which the sellers make 'cooperative investments' in product quality to increase the buyers' valuation of the good. We also allow for 'selfish investments' as for example the acquisition of human capital by workers in a labor market. Further, our analysis applies not only to 'one-sided investments' but also to 'two-sided investments'. In the latter case, the investments on both sides of the markets may be substitutes as well as complements.

This paper relates to a few articles that study investment incentives in matching environments. Masters (1998) shows that underinvestment occurs in a matching model of a labor market, in which the ex ante investments of workers and firms are complementary. He shows that the resulting coordination failure can be overcome by incorporating an intermediary. Our analysis reveals that inefficient low levels of investment also occur when investments are substitutes. This may apply, for example, to a marriage market in which household income is simply determined by the sum of both partners' human capital investments. We show that in such environments small differences in the matching probabilities can induce substantial differences in the investment incentives on the two sides of the market. Another distinct feature of our model is that the number of active traders and their matching rates are determined endogenously by entry, whereas it is fixed in Masters (1998). Indeed, in our model the matching probabilities have to adjust to ensure that the agents on both sides of the market realize non-negative expected profits from entering. Actually, we show that competition at the entry stage implies a zero profit condition for one side of the market. This is achieved by an adjustment of the relative numbers of active agents and their matching probabilities, which affect their outside options and the split of surplus in a match. In turn, the bargaining outcome determines the marginal returns from investments. Therefore, equilibrium investments depend on the relative numbers of agents at the entry stage.

Acemoglu (1996) analyzes a one-period matching model of a labor market with an equal number of workers and firms. In a match, workers receive a fixed fraction of the firm's output. Ex ante firms invest in their capital stock and workers choose their education level. As physical and human capital are complements, firms want to invest more when they expect to be matched with more skilled workers. This creates an externality for the workers' investment incentives, and the rate of return on the human capital of a worker is increasing in the average human capital of the workforce. While our model is applicable to a labor market environment, there are several differences with Acemoglu (1996). As we consider a dynamic matching market, the workers' share of output is not fixed but endogenously determined, because the bargaining parties have the outside option to reenter the matching process in the next period. Further, as the number of workers and firms is determined by market entry decisions, in our model their numbers are typically not equal. Our setting thus allows us to study how investment incentives differ on the long and the short side of the market. Also, we do not require the assumption of complementarity of the investments. Indeed, for the case of perfect substitutes our model generates the interesting observation that only the short side of the market chooses to invest.

A labor market in which firms make one-sided investments before matching workers is studied by Acemoglu and Shimer (1999). They show that ex post bargaining over wages will always induce inefficiencies: As long as workers have some bargaining power,

[3] See e.g. Grout (1984), Williamson (1985), Hart and Moore (1988). Schmitz (2001) provides a survey on the holdup problem and incomplete contracts.

[4] While some authors argue that non-contractibility necessarily leads inefficient investments (Hart and Moore, 1988, Che and Hausch, 1999, and Schmitz, 2010), others have identified contractual devices and environments that induce first-best investments even with incomplete contracts (Chung, 1991; Aghion et al., 1994; Nöldeke and Schmidt, 1995; Edlin and Reichelstein, 1996; Rogerson, 1992; Che and Sakovics, 2004; Evans, 2008).

[5] Hart (2009) presents a different explanation of asset ownership in which the driving force is payoff uncertainty, rather than the non-contractibility of investments.

[6] Gans (2005) modifies this approach by studying a non-cooperative market for asset ownership.