Ratings, certifications and grades: dynamic signaling and market breakdown.

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Abstract

We consider the effect of having public revelation of information (e.g. rating, grade) on signaling and trading in a dynamic model. Competing buyers offer prices to a privately informed seller who can reject these offers and delay trade. This delay is costly and the seller has no commitment to the duration of the delay. We show how the external public information allows for signaling in equilibrium. More interestingly, we characterize the dynamics of trade and prices. If the signal is not fully revealing, then there is no trade just before the revelation of external information. A lemons market develops endogenously over time and prevents any trade close to the release of the public announcement. On the other hand, if the external signal is fully revealing then trade occurs even close to the final period; however, in this case there is a discontinuity in prices.

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1 Introduction

Many real world markets, such as labor markets and financial markets, feature a privately informed seller who faces a pool of uninformed buyers. A growing literature, starting with Spence's (1973, 1974) seminal work on education, explores how the seller can signal his type in this wide range of markets. In Spence's original work, education is modeled as a static choice, so that more able seller/worker could commit to more 'units' of education. In practice, many markets are dynamic and often the signaling variable is the time to agreement. Moreover, commitment is rare so agents make a new decision in every period; in particular, the seller can quit signaling at any time. This lack of commitment is likely to disturb signaling, as pointed out by Weiss (1983), Admati and Perry (1987) and Swinkels (1999).

In this paper, we follow the above literature in examining a fully dynamic game (a la Swinkels (1999)), but incorporate another important feature of many markets: the release of external information. In particular, we introduce a public signal that is not fully controlled by the seller or buyers. Some examples are: a grade that partly reflects the ability of a student, an earning announcement, an FDA approval, or a court decision that may affect a firm's value. More generally, this external information can be any realization of some uncertainty. As we show, the release of this information enables signaling despite the lack of commitment. However, our focus is on how it affects the resulting trading patterns.

We consider a generic trading model in which an informed seller faces competitive uninformed buyers. The seller owns an indivisible asset and he is privately informed about its value. With the asset as labor, the model includes educational signaling as a special case. The model is dynamic and trade can take place at any point in time (formally we divide time into many small periods). In each period, buyers make simultaneous sealed offers to the seller. The seller decides whether to accept or reject. If he accepts any offer, the game ends; if he rejects all offers, the game continues. Since the cost of delay can depend on the seller's privately known value for the good, rejection can signal information about his type. The new feature of the model is that after a fixed time (at time $t = 1$) an external signal (a grade) is publicly revealed.[1]

A crucial assumption is that if trade takes place before $t = 1$ the terms of trade cannot be made contingent on future realization of the final signal. Such restriction arises naturally

[1] We focus on the case in which the timing of the external signal is fixed and commonly known, which is a reasonable assumption in some markets. We also discuss the effects of relaxing this assumption in the last part of the paper. We also assume that final offers are made after the grade arrives at $t = 1$.By Swinkels (1999) this is without loss of generality.

in markets where the signal is not generated if the trade takes place before $t = 1$; or is observable but not verifiable in court. The feasibility of such contingent payments may also be affected by the seller's limited liability, preventing him to pay any money back after low signal realization, or by possible manipulation by the buyer. In other markets some limited contingent contracts are possible and used in practice. Examples of such contracts include product warranties or collars in financial markets.

Our equilibria do not rely on the offers becoming public. Hence, off-equilibrium beliefs do not provide commitment to the seller (see Noldeke and Van Damme (1990)). We follow Swinkels (1999) in assuming the opposite extreme. In each period there are two new buyers who replace the two (old) incumbent buyers whose offers were rejected in the previous period. This replacement assumption provides tractability to a model of private offers. We examine the conditions under which there is signaling in equilibrium. More importantly, we analyze how the external information affects the resulting trading patterns and prices. Our main results can be summarized as follows:

- With the release of public information the seller can employ costly signaling, if waiting costs are not too high. This contrasts a dynamic signaling model without external information, where the unique sequential equilibrium involves full pooling and trade in the first period whenever delay is unproductive (Swinkels (1999)).

- When the external signal is noisy, there is a discontinuity in trade, i.e. close to the announcement no trade takes place. The intuition is that a lemons market develops endogenously. For example, with a noisy grade and two types the low type is overpaid in the last period and the high type is underpaid, but still paid more than average. As the announcement approaches, waiting costs become small and the reservation price of each type approaches his payoff in the last period. Buyers would hence have to pay more than the average type accepting an offer if trade occurred just before graduation (importantly, any price that the high type accepts the low type does as well).

- If the external signal is fully revealing, then there is no market breakdown. In contrast to the noisy signal case, there is trade even just before the release of the external information. However, there is a discontinuity in prices around that time. In particular, average transaction prices upon the release of the external signal are strictly higher than prior prices. The intuition can be illustrated by the following example. Suppose that the distribution of *graduating* types (i.e. types that do not trade before the grade

is revealed) is uniform between $[10, 20]$. The average price upon graduation is therefore 15. Just before graduation the highest offer that can be made is 15 as the agent's type is unknown. However since waiting costs are minimal, types above 15 would reject such an offer. For the buyers not to lose money, trade just before graduation occurs only with types lower than 15, so the highest price they can offer is 12.5 or less. That implies a strict jump in prices.

It is interesting to point out that we do not need to assume that costs of delay are strictly decreasing in value. As we later discuss, this is very useful in financial applications where the seller tries to sell a company he owns. In this case, costs follow from discounting and do not vary by type. In our setup, signaling is still possible as the high types expect to receive better offers upon the realization of the external signal.

Literature Review

This paper is related to the literature on dynamic signaling that started with Spence's (1973, 1974) papers on educational signaling. In these papers, he suggests that workers may over-invest in education in order to signal their productivity. Cho and Kreps (1987) formalized this and showed that if the worker can commit to the length of education, then, in the unique equilibrium satisfying standard refinements, the agent obtains least-costly full separation (known as the Riley outcome, Riley (1979)).

Weiss (1983) and Admati and Perry (1987) pointed out that long-term commitment is difficult in many markets and may disturb signaling. Swinkels (1999) formalized this argument in a paper that is the most related to ours. He showed that if offers are private, then the unique sequential equilibrium is full pooling. Before school starts the firms offer wages equal to the average productivity and all types accept. Therefore, the lack of commitment makes it very difficult to use non-productive education for signaling. We differ from Swinkels (1999) in that we introduce exogenous release of information; this exogenous information is the focus of this paper. Another difference lies in that rather than the often-used framework of education, we describe a generic dynamic trading model. As we discussed above, this generality is needed for some of the applications we consider in which there are no explicit differences in delay costs across types.

Noldeke and Van Damme (1990) show how signaling can be restored as off-equilibrium beliefs may provide commitment for the worker to continue signaling. In their model, offers are public and there are many sequential equilibria. They employ a standard refinement (Never a Weak Best Response from Kohlberg and Mertens (1986)) to select a unique one. In

that equilibrium, firms believe that a worker is the highest type whenever she deviates from the equilibrium by rejecting an offer. As a result, the firms have no incentive to approach the worker publicly and the worker signals his type over time. As the length of the periods converges to zero, the equilibrium outcome converges essentially to the Riley outcome: in the limit the workers separate at the beginning of the game. Swinkels (1999) shows that it is critical that offers are made public, given that firms have incentives to approach the worker privately.

Weiss (1983) was the first to examine the role of grades in an education model. Similar to our paper, he observes that signaling may occur even if costs do not vary by type. His model differs from ours in two important dimensions. First, in his model there is full commitment as agents choose duration of education and firms are not able to approach them until graduation.[2] As a result, there are no trade patterns before graduation. In contrast, these trade patterns are the main focus of our paper. Second, in his model, grades provide information not available to any agent ex-ante. Therefore, grades are productive as they yield new information and serve an important allocative role. In fact, he motivates his assumption that the firms do not offer wages before graduation by assuming that firms care not only about a worker's own assessment of his ability, but also about the grades per se. In our model, grades may or may not provide new information; more importantly, if there was no information asymmetry between the seller and the buyers then trade would occur immediately and efficiently.

There are few papers that examine static models in which there is a role for external release of information. Teoh and Hwang (1991) examine a model in which a firm can control the release of some information. The firm can choose not to release information and wait for it to become public. They show that the firm may actually decide to disclose bad information rather than a good one. Feltovich, Harbaugh and To (2002) examine a model in which there is an external noisy signal. They show that with more than two types, high types may choose not to signal (or countersignal) in order to be separated from medium types.

Finally, Kojarczyk, Lucas, and McDonald (1991, 1992) consider a model in which a seller times the issuance of equity in a market with external information release. In this model, buyers are not aware that the seller exists until he decides to issue the equity. Therefore, they cannot approach him in the interim period. In other words, this is a model of pure signaling. In contrast, we allow the buyers and the seller to be active on the market, allowing

[2] In fact, in contrast to our model, Weiss (1983) assumes that the timing of the grade is chosen by the seller.