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Costly information transmission in continuous time with implications for credit rating announcements

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ABSTRACT

This paper formulates a continuous-time information transmission model in which an altruistic sender privately observes a stochastic state variable, and incurs a communication cost when she broadcasts a message. We characterize the sender's optimal announcement strategy using an ordinary differential equation. We prove the optimality of the sender's strategies using a martingale verification argument and show that the sender's optimal strategy involves sending discrete messages. Furthermore, we apply the model to the timing decision of credit rating announcements and provide a framework to study various aspects of rating announcements, such as the probability of rating reversals and the expected time before a rating change.

We study the implications of communication cost in a dynamic setting. In addition to misalignment of incentives in the strategic information transmission model proposed by Crawford and Sobel (1982), we argue that communication cost may also explain the commonly observed discrete ranking categories.

The seminal work of Crawford and Sobel (1982) led to a large body of the literature on strategic information transmission which we do not attempt to survey here. Applications and extensions of the Crawford and Sobel (1982) model are usually studied in the context of political science, such as lobbying, debate and voting, and the provision of financial and economic advice. Earlier models, however, lack rich time dynamics of the underlying state variable.[1] Dynamic issues in information transmission, such as the timing choice of the information sender and the statistical properties of the stochastic process affecting communication, lead to many interesting questions. For example, a stock analyst may follow a stock for many years and make investment recommendations based on the time series of expected future stock returns. In similar spirit, credit rating agencies continuously monitor and calculate the expected default frequencies (EDF) of bond issues and occasionally make rating announcements. Unlike earnings per share forecasts, which are made periodically, analysts or credit rating agencies need to decide when to revise previously issued recommendations or ratings.

With exception of Admati and Pfleiderer (2004) and Kartik (2009), most papers in the information transmission literature assume that the information sender and receiver have misaligned incentives and that the sender incurs no explicit cost when communicating her information to the receiver.[2] This paper complements the "cheap talk" literature by

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[1] In repeated cheap-talk models, such as Sobel (1985), Morris (2001), and Wang (2009), the state variable is assumed to be i.i.d.

[2] Admati and Pfleiderer (2004) study a single-stage communication game when the sender is altruistic but may be overconfident and may face a broadcasting cost. Kartik (2009) studies a model of strategic communication between an uninformed receiver and an informed but upwardly biased sender, where the sender bears an explicit cost of lying.

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studying situations where messages have explicit costs.[3] For example, there are costs to preparing and disseminating information when arranging conference calls, analysts' presentations and press releases, and filing financial statements, research reports, management discussions and analysis. Communication costs may become an especially important consideration for credit rating agencies: in addition to explicit broadcasting costs, rating stability is a major concern for these agencies. A change in credit rating can be costly for two reasons: institutional investors may need to rebalance their portfolios and a rating change may trigger stock price reactions (Holthausen and Leftwich, 1986; Hand et al., 1992). For these reasons, rating agencies prefer to keep ratings stable and avoid frequent rating changes (Cantor and Mann, 2006).

This paper is closely related to Gul and Pesendorfer (in press) who construct a continuous-time game of campaign in which parties provide costly information to voters. Information flows continuously as long as one player is willing to incur its cost. Despite differences in methodology, the equilibrium found in their game shares similar features with ours: the unique subgame perfect equilibrium of the game is stationary and involves the use of a threshold strategy; and, each party chooses a threshold and stops providing information once the voter's (receiver's) belief is less favorable than the threshold. The model generates a comparative static result that the lower the cost of information provision, the more aggressive is the party's threshold; this is consistent with the intuition of our model. The focus of their paper, however, is on the competition on information provision between the two senders. The Brownian motion formulation we use allows for richer time dynamics of the underlying variable and allows us to better analyze the effects of the underlying volatility. Other advantages of the continuous-time setting include a clean characterization of the optimal strategy through an ordinary differential equation, the ability to compute comparative statics, and the ease to generalize the model to broader settings.

We characterize the unique Markov perfect Nash equilibrium (MPNE) communication strategy by the Hamilton–Jacobi–Bellman (HJB) equation.[4] MPNE for infinite horizon dynamic games is widely used in economics to model repeated interaction between agents where changes in economic environment can be captured by a state variable. While traditionally, HJB equations are used to characterize Markov perfect equilibrium (Basar and Olsder, 1982; Ricon-Zapareto, 2004; Rowat, 2007), the solutions to HJB equations provide only necessary conditions for the players' optimal equilibrium strategy. In this paper, we prove the optimality of the solution using a martingale verification argument (Duffie, 2001).[5]

In our model, a sender privately observes a state variable that follows a Brownian motion. A receiver needs to rely on the sender's message to form a belief of the state variable. The sender is altruistic and truly wants to communicate her information accurately. However, she faces a fixed broadcasting cost when she sends a message. We show that in an unrestricted message space, the sender's optimal strategy involves sending discrete messages in equilibrium, similar to the equilibrium outcome of "cheap talk" games.

We apply a variation of the baseline model to credit rating announcement decisions. Special attention has been paid to the tradeoff between rating accuracy and stability in recent years. Rating agencies are often accused of being slow to adjust their ratings. In a special report published by Moody's, Cantor and Mann (2006) argue that the criticism reflects the rating agency's desire to meet the market's demand for both rating accuracy and stability. While the desire for rating accuracy is captured by the sender's quadratic loss utility function in our model, the preference for stability is reflected by the cost incurred whenever a new rating is announced. Altman and Rijken (2004) find that to achieve rating stability, rating changes are triggered only when the gap between the current (EDF-implied) rating and the model predicted rating exceeds a certain threshold. This outcome arises endogenously in our model.

In a reduced form model, we assume that the credit rating agency has committed to placing corporate bonds in a fixed system of rating categories, and assume that the receiver is not fully rational. We show that the sender optimally sets a tolerance band around the cutoff point of each interval. She makes an announcement only when the state variable exceeds the boundary of the tolerance band.[6] The receiver, however, incorrectly understands this as the fundamentals being at the threshold between the two rating categories. The sender's optimal strategy is characterized by an ordinary differential equation which allows us to study the comparative statics of the results relatively easily.

Our paper is also related to the costly disclosure literature started by Verrecchia (1983) and subsequent work surveyed in Verrecchia (2001). These papers focus on proprietary costs of disclosure, that is, the cost to disclosing private information that may hurt the firm's value. In our paper, disclosure of information does not change the value of the underlying state variable.

Finally, in the Appendix, we show how the basic model presented in the paper can be modified to study an alternative costly information transmission problem when the sender is committed to making periodical announcements.

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[3] This paper is related to other papers on information transmission with costly messages or signals, such as Austen-Smith (1994) and Austen-Smith and Banks (2000).

[4] See Lockwood (1996) for discussions of the uniqueness of MPNE in non-linear differential games.

[5] Similar use of the martingale verification argument can be found in Wang and Wang (2010) for optimal portfolio choice problems.

[6] Löffler (2005) studies the rating announcement problem by solving for the optimal size of the tolerance band in a pre-fixed rating system by minimizing the probability of a rating bounce. We take a different approach by explicitly modeling the costs and benefits of the timeliness of rating announcements. As pointed out in Martin-Herran and Ricon-Zapareto (2005), such trigger strategy is common in constructing MPNE for continuous time dynamic games.