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Harnessing the wisdom of crowds: Decision spaces for prediction markets

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Abstract The increased metabolism of business in the modern world has served to heighten both the frequency and the difficulty of organizational decision making. Practitioners and academics are constantly looking for decision-making mechanisms that can be used to address these challenges. One recently emerged mechanism is prediction markets: a group decision-making tool that uses a market mechanism to rapidly aggregate information held by large, diverse groups of participants. Prediction markets have a number of benefits and have been demonstrably successful in a number of contexts; however, it is important to recognize that they are suited to some types of decisions and contexts but not to others. This article examines the benefits of prediction markets and develops a framework that can be used to identify in which situations prediction markets can be profitably deployed within organizations. It also provides a roadmap for practitioners to use to guide their own organizational deployment of prediction markets.

1. Harnessing the wisdom of crowds

Decision making is a central pillar of management (Mintzberg, 1980). The complexity of organizational decision making is constantly increasing due to the faster metabolism of business, caused by a wide variety of factors such as heightened competition; globalization; the emergence of new technologies; accelerating innovation; and new regulatory, environmental, and ethical constraints (Haase & Franco, 2011).

Most organizations employ the expert judgment of human beings to make decisions about complex systems. However, the accuracy and reliability of individuals is restricted by cognitive, physiological, and psychological limitations (Simon, 1997). Group decision making can address some of the problems associated with individual decision making, and thus offers a path to improved decision making. Group decision making is seen as being particularly useful in situations that require judgments to be made or in situations where information must be aggregated from sources widely separated by time and space.

However, group decision making is also subject to limitations. First, as groups get larger, they tend to

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get progressively more unwieldy and difficult to manage. This tends to limit the size of effective decision-making groups to between four and seven people. In turn, limiting the number of people participating limits the amount of information, knowledge, and opinions available to the group, thus counteracting the strengths of group decision making. Second, group decision making is subject to socially induced phenomena such as group think (Janis & Mann, 1979), information cascades (Boddy, 2005), and group polarization (Myers & Bishop, 1971).

The fundamental importance of decision making and the limitations of existing techniques motivate a continuing search for improved tools and techniques (Jalonen & Lönnqvist, 2009). This article aims to highlight to practitioners the features and potential utility of a novel group decision-making technique called a prediction market. Prediction markets have structural features that enable them to overcome some of the limitations associated with more traditional methods. By using a market mechanism to collect and aggregate opinions, prediction markets can avoid the scaling issues associated with more traditional forms of group decision making. In addition, by using limited communication channels and incentives for truthful revelations, they can reduce the impact of socially induced biases. These features mean that prediction markets are a potentially powerful decision-making tool in an organization's arsenal.

Providing practitioners with innovative decision-making methodologies is an important step in making organizational decision making more efficient and effective. However, improving organizational decision making also entails understanding the context and nature of the decision. Using an appropriate decision-making mechanism will improve decision quality; equally however, the use of a novel but inappropriate technique may adversely affect decision quality through errors and misplaced confidence in faulty conclusions. Until now, there has been insufficient work identifying which decision contexts are appropriate for prediction markets. This article contributes by presenting a framework that allows managers and practitioners to evaluate the suitability of prediction markets for a particular decision-making situation.

We begin by introducing prediction markets and positioning them as group decision-making tools. We identify their strengths and describe current practical applications of prediction markets. We then develop a framework that identifies for what type of decisions prediction markets are useful. Finally, we embed this framework in a larger process which describes how organizations can operationalize the use of prediction markets.

2. Introducing prediction markets

As defined by Tziralis and Tatsiopoulos (2007, p. 75), prediction markets are ''markets that are designed and run for the primary purpose of mining and aggregating information scattered among traders and subsequently using this information in the form of market values in order to make predictions about specific future events.'' The theoretical roots of prediction markets can be found in Hayek's conceptualization of markets as near perfect transmitters of information (Hayek, 1945). While it is relatively easy to point to specific examples of market failure, in general, speculative markets such as those in stocks, commodities, and futures options do a credible if imperfect job of aggregating relevant information into market prices (Hanson, 2007). This position is backed by a substantial body of empirical evidence (Kolb, 1997; Malkiel, 2003, 2005; Roll, 1984).

A prediction market is created by offering for sale to a group of participants a contract on the outcome of a future event of interest. For example, suppose an organization wishes to forecast whether or not a project will reach its next milestone on time. The organization could create a contract that will pay a holder $1 on the date of the milestone if the milestone is reached or $0 otherwise. The organization would set the initial price of the contract at 50 cents and then offer it for sale to individuals participating in the project. Under these circumstances, if an individual believes that the project is likely to reach its milestone on time, he/she would buy the contract in the expectation of a greater reward in the future. Equally, if a rational individual believes the project will not reach its milestone, he/she would sell (or 'short') the contract. This buying and selling of contracts will have the effect of moving the price of the contract.

This two-outcome model can be easily extended to allow for the creation of contracts across a range of disjoint outcomes. For example, a prediction market can be created wherein participants are asked to forecast what will be the most commercially successful of a range of products. They can also be used to allow participants to forecast values rather than select from a particular set of options; for example, participants may be asked to forecast the volume of sales of a particular product.

Prediction markets differ from traditional financial markets in two important ways. First, participants trade in contracts whose value is not inherent, but rather dependent upon the outcome of a future uncertain event (Hall, 2010). In a prediction market, the trade of contracts allows participants to exchange information. The trade of

contracts also acts as a decision mechanism, since the price of the contract at any point in time can be viewed as the consensus opinion of all the participants in the market as to the likelihood of an event occurring.

The second distinguishing characteristic of a prediction market is that its primary concern is the elicitation of information. In the modern world, many markets exist that allow participants to trade assets whose value is dependent upon an uncertain future event. While these markets can be viewed as prediction markets from a certain perspective, we will generally follow the guidelines proposed by Wolfers and Zitzewitz (2004), which steer away from markets where the primary role is enhancing the enjoyment of an external event through taking on risk. Similarly, we will not consider markets whose primary rationale for existence is enabling the hedging of financial risk.

2.1. Why prediction markets?

Researchers have identified a number of theoretical benefits of prediction markets over comparable information aggregation mechanisms such as polls or expert groups (Servan-Schreiber, Wolfers, Pennock, & Galebach, 2004). For example, prediction markets incentivize the revelation of truthful information. Prediction markets are created by offering contracts for trade whose value is dependent upon the outcome of a future event. Individual participants buy and sell these contracts. Rewards for correct forecasts accrue to the individuals who hold the relevant contracts. The provision of a direct financial incentive to an individual can serve as a counterweight to the emotional, political, and professional factors that may inhibit revealing truthful information in a group setting.

In addition, prediction markets implicitly contain an algorithm for information aggregation. The operation of the market in contracts and the trading it facilitates automatically creates the equilibrium price which is used as a proxy for estimates about the event of interest (Hall, 2010). By allowing experts to trade with each other, prediction markets allow disparate opinions and beliefs to be aggregated into a coherent, consistent whole (Hahn & Tetlock, 2006a). As well as providing a mechanism for aggregating the private beliefs of individuals, prediction markets can also enable individual participants to extract information by observing market estimates (Kálovcová & Ortmann, 2009) and to correct biases in publicly available information (Gruca & Berg, 2007).

Several authors point out that prediction markets implicitly weight the information supplied by participants (Berg & Rietz, 2006; Graefe & Weinhardt, 2008; Hahn & Tetlock, 2006a). If participants are more confident of their beliefs in a particular topic, they will be willing to buy more of the relevant contracts, and vice versa.

The nature of the market structure also means that prediction markets can scale to very large groups (Hahn & Tetlock, 2006b). When considering a market that utilizes information technology to enable trading, the only real limits on the number of participants are computational. Furthermore, prediction markets can be created utilizing participants from outside traditional organizational boundaries, recruiting participants from suppliers, customers, and other stakeholders in order to improve the decision-making process.

Another benefit is that prediction markets can operate in real time (Hall, 2010; Polgreen, Nelson, & Neumann, 2006). This gives them a significant advantage over other comparable information aggregation methods such as polls. Finally, prediction markets can be designed in such a way as to allow trader anonymity (Remidez & Joslin, 2007). Power relationships and social interactions are often seen as responsible for some of the weaknesses of group decision making (Ellis & Fisher, 1994). By allowing anonymity, prediction markets can reduce these effects. The utility of this attribute may vary, but the ability to allow it demonstrates the flexibility of prediction markets.

2.2. Prediction markets in practice

Modern operational prediction markets can be broadly divided into public and private prediction markets. A public prediction market is one that invites participation from the general public. Some public prediction markets operate using real currency; participants invest their own money in the market and gain or lose according to their performance. Other public prediction markets use virtual currency to enable trading. Table 1 lists some examples of these prediction markets.

Private prediction markets, which limit participation to specific groups, are most pertinent to this discussion. Private organizations can use prediction markets to tap into the valuable private information and tacit knowledge held by employees and other stakeholders in the organization (Gruca & Berg, 2007).

A large number of case studies describe industrial applications of prediction markets. For example, Siemens has successfully utilized prediction markets in project management: To estimate if it was likely to hit project milestones, the company used a prediction market to aggregate the opinion of the

Table 1. Selected operational prediction markets

Type	Example
Public (Real Currency)	Intrade (http://www.intrade.com) Betfair (http://www.betfair.com) Iowa Electronic Markets (http://tippie.uiowa.edu/iem/index.cfm)
Public (Virtual Currency)	The Hollywood Stock Exchange (http://www.hsx.com) Hubdub (http://www.hubdub.com) Lumenogic (http://www.lumenogic.com) Foresight Exchange (http://www.ideosphere.com)
Private	Qmarkets (http://www.qmarkets.com) Inkling Markets (http://www.inkling.com) Crowdcast (http://www.crowdcastnetwork.com) Prokons (http://www.prokons.com)

developers working on the project (Ortner, 1997). Acxiom used a prediction market to generate collective estimates of how long tasks would take in a series of projects revolving around implementing a new integrated software testing environment (Remidez & Joslin, 2007). Hewlett Packard has used prediction markets to generate sales forecasts by allowing sales and marketing employees to estimate what they believed the sales of various product lines would be, and then rewarding them according to their accuracy (Chen & Plott, 2002). A similar exercise by a major Austrian mobile phone provider asked employees and other stakeholders to estimate the gross market shares of all major brands in the Austrian mobile phone network (Waitz & Mild, 2009). Intel has used prediction markets to forecast demand for product lines in order to estimate and manage demand inventory risk (Hopman, 2007). Moving away from sales forecasting, hospitals such as the Royal Devon and Exeter Hospital have used prediction markets to capture and aggregate the tacit knowledge of doctors, nurses, medical staff, administrators, and support staff to generate demand estimates for medical and emergency services (Rajakovich & Vladimirov, 2009). Eli Lilly has used prediction markets to evaluate what drugs will be successful, while Microsoft has used them to forecast sales of software (Hahn & Tetlock, 2006a). Other organizations reported in the literature as having used prediction markets include Motorola, Qualcomm, InfoWorld, MGM, Chiron Corporation, TNT, EA Games, Yahoo, Corning, MasterFoods, Pfizer, Abbott, Chrysler, General Mills, and O'Reilly Media (Tziralis, Vagenas, & Ponis, 2009).

Prediction markets have other potential applications. Passmore, Cebeci, and Baker (2005) described how prediction markets can be used to support the Human Resource function in organizations. Other authors have suggested that prediction markets can have applications in the domain of risk management (Garvey & Buckley, 2010). Sunstein (2006) offers a valuable list of possible applications of prediction markets, with voluminous references to discussions and case studies.

Something that is slowing the adoption of prediction markets is lack of guidance regarding the suitability of prediction markets for particular problems (Strumpf, 2009). Existing case studies describe the use of prediction markets in specific contexts such as marketing or project management. However, the literature is silent on how a manager can decide whether or not a prediction market is applicable to the problem he or she is considering in the first place. We address this by analyzing which decision spaces suit the attributes of prediction markets, providing both academics and practitioners with a framework to evaluate the suitability of prediction markets in particular contexts.

3. Attributes of decisions

Optimum decision making is dependent upon selecting a decision-making mechanism that is suitable for the given context (Hitt, Black, & Porter, 2005). In this section, we discuss the key attributes of decision-making contexts and how they affect the suitability of prediction markets as a decision-making tool.

3.1. Information distribution

Decision making requires information, and having access to relevant, accurate, and timely information is seen as being an important determinant of decision quality (Roskin, 1985, 1989; Simon, 1997). Programmed decisions are "routine, generic, computational, procedural, and predictable" (Dinur, 2011, p. 698). In these contexts, the information required to make accurate, high-quality decisions is well known and easily available. However, in other decision-making contexts, information is more diffuse. The challenges of utilizing

information for decision making include overcoming the uncertainty inherent in information (Dinur, 2011) and not having enough information (e.g., Galbraith, 1977) or having too much of it (Edmunds & Morris, 2000).

The cognitive, psychological, and physiological limitations of individual humans place fundamental limits on how much information any person can know, recall, or utilize (Simon, 1997). For this reason, groups are generally seen as being superior to individuals in decision-making contexts that require the collection, analysis, and interpretation of large amounts of data, particularly where that data is widely dispersed: groups have access to more information and more information sources than a solitary individual (Maier, 1967), group memory is clearly superior to individual memory in terms of both range and accuracy (Miner, 1992), and groups can utilize more information than solitary individuals (Maier, 1967).

Many decision-making contexts require the collection of large amounts of information from a widely dispersed population. Examples include determining customer reaction to a new product and making forecasts about complex social systems. Traditional group decision-making processes such as committees, nominal group technique, and the Delphi method use verbal, written, and non-verbal communication channels to allow participants to signal and exchange information. These methods do not scale well to larger groups. Prediction markets can scale easily to very large groups. This gives them a distinct advantage in such decision-making contexts.

3.2. Judgment decisions

The merits of group versus individual decision making can be analyzed in terms of the distinction Simon (1997) draws between factual decisions and value decisions. Factual decisions will eventually be objectively proved correct or incorrect whereas value decisions can only be validated by their acceptance (March, 2009).

Most decisions lie somewhere along a continuum defined at one extreme by a pure factual decision and at the other extreme by a pure value decision. Prediction markets are better at solving fact-oriented decisions than value-oriented decisions. First, value decisions often require commitment to the decision taken. The low bandwidth communication channel used in prediction markets means they are relatively poor at developing group cohesiveness. This reduced cohesiveness vis-à-vis other group decision-making processes suggests that their ability to create commitment to a decision is questionable. Second, value decisions often require the creation of radically different alternatives. The generation of such alternatives is facilitated in group decision processes by the exchange of ideas and concepts in a social setting. Since the limited communication channels offered by prediction markets inhibit these exchanges, prediction markets are less useful at generating alternatives than other forms of group decision making and thus less suitable for decision-making contexts involving judgments.

3.3. Legitimacy

The legitimacy of a decision and acceptance of the decision by affected stakeholders is often an important measurement of the quality of a decision (Hitt et al., 2005; Roskin, 1985, 1989). Increased legitimacy and acceptance of decisions is associated with improved motivation and performance (De Dreu, Nijstad, & van Knippenberg, 2008). Maier (1967) suggested that a low-quality solution that has good acceptance can be more effective than a higher-quality solution that lacks acceptance. Therefore, group decision making is seen as superior in providing a decision with legitimacy (Ellis & Fisher, 1994; Jennings & Wattam, 1998).

When the legitimacy of a decision reached is of concern, the positioning of prediction markets vis-à-vis other group decision-making tools is undecided. Legitimacy is bestowed upon a group decision-making process by a participant's acceptance of it. For example, individuals in a group may see their role as being to advise a single chairperson who is solely responsible for the decision. Alternatively, they may see legitimacy as being provided by a simple majority, a two-thirds majority, or some other combination thereof. In this case, all that can be said is that if a prediction market is seen as being an effective decision-making tool, its legitimacy will be evaluated by an organization in the same way as the legitimacy of any other group decision-making tool.

3.4. Urgency

Many decision-making contexts entail time constraints, which can be more or less pressing (Roskin, 1989). Groups are usually conceived of in the literature as moving through a number of stages (Tuckman & Jensen, 1977), and the decision making typically involves additional processes such as voting or negotiation to enable the selection of alternatives (Ellis & Fisher, 1994). All of these actions take time, which means that groups inevitably take longer than individuals to reach decisions (Boddy, 2005; Ellis & Fisher, 1994). This in turn implies that

in situations where time constraints are severe, group decision making is a less suitable mechanism than individual decision making.

If a decision is urgent, prediction markets are generally a more favorable solution than other forms of group decision making. As has been noted in the section comparing prediction markets to other forms of group decision making, prediction markets operate in real time. While individual decision making will always maintain an edge over any form of group decision making when speed is of the essence, prediction markets offer the ability to reach decisions more quickly than most other forms of group decision making. This speed advantage arises from the ability of prediction markets to operate in real time and their ability to reduce the coordination problems associated with assembling groups. This is particularly the case when a preexisting pool of participants is available that is familiar with the problem domain and experienced in using prediction markets.

3.5. Confidentiality

In many decision-making situations, confidentiality is a key concern. The public revelation of a decision—or the processes and argumentation that led to the selection of a particular alternative—may have serious negative consequences. The greater the number of individuals involved in making a decision, the likelier it is that information will leak out regarding the decision-making process (Jennings & Wattam, 1998). In such situations, group decision making carries with it the risk of unintended revelation of information.

When considering decision spaces in which confidentiality is a key concern, prediction markets are at a disadvantage vis-à-vis other group decision-making processes. This disadvantage arises from two factors. First, the nature of prediction markets means that the decision (i.e., the price of the contract) is always publicly available to participants in the process. Therefore, in order to keep the decision confidential, participant discretion must be absolute. Second, prediction markets, as with all group decision-making processes, derive most of their advantages over individual decision makers from including more participants in the decision-making process. However, the inclusion of more participants in any process effectively reduces the confidentiality of the process. Because prediction markets are most effective in situations where large groups of individuals are involved in the decision-making process, it stands to reason that a situation where confidentiality is a key concern works against the strengths of prediction markets and therefore renders these markets less suitable for application in such decision spaces.

3.6. Responsibility

Responsibility is another important attribute of decisions. In many situations, responsibility for the consequences of a decision needs to be clearly apportioned. This is referred to as decision ownership (Turban, Aronson, Liang, & Sharda, 2007). In situations where groups make decisions, responsibility is diffused among the group (Ellis & Fisher, 1994). Therefore, if a decision requires ownership, it is considered appropriate to limit decision making to individuals or groups that are as small as possible (Hitt et al., 2005).

Prediction markets are at a disadvantage relative to other group decision-making processes in such situations in two ways. First, the nature of a prediction market is such that the consensus that emerges is essentially the aggregation of all the trades made on the market. It is impossible to point to any one trade—and by extension, any one trader—and say that it had a greater or lesser impact than any other trade upon the decision reached. Since the contract price in a prediction market is an emergent property of the market, responsibility for the final decision reached can only be apportioned by dividing it equally among every active trader in the market. Second, the lack of ability to assign ownership is exacerbated by the utility of prediction markets being linked to the number of participants in the market, similar to the problem surrounding confidentiality: as the number of participants increases, responsibility becomes diffuse to the point of meaninglessness.

3.7. Summary

The analysis in this section identifies the suitability of prediction markets as decision-making mechanisms based upon the attributes of the decision space. The results of this synthesis are summarized in Table 2. This analysis clearly shows that prediction

Table 2. Suitability of prediction markets based on decision space attributes

Decision Attribute	Appropriateness
Information Distribution	Widely dispersed information favors prediction markets
Judgment Decisions	Disfavors prediction markets
Legitimacy	Disfavors prediction markets
Urgent Decision	Favors prediction markets
Confidentiality	Disfavors prediction markets
Responsibility	Disfavors prediction markets

markets are distinctive from other forms of group decision making. In certain decision spaces, the unique attributes of prediction markets make them potentially superior to other forms of group decision making. In non-programmed decision spaces, or situations where urgency or the collection of large amounts of information from a disparate population are preeminent concerns, prediction markets are potentially very useful tools to improve the effectiveness of organizational decision making. In other situations, however, their utility is much less certain.

Prediction markets are likely to be most useful when the organization is aware of the existence of a large pool of information that it is unable to tap. An obvious example here would be project management. Information about how likely a project is to succeed or fail is distributed among a large group of individuals, namely those participating in the project. However, gathering this information through traditional means is an expensive and labor-intensive process, which often involves transitioning several bureaucratic layers—with the attendant associated difficulties. The characteristics of prediction markets means they are ideally suited to tasks such as these.

Another obvious area in which relevant information is widely distributed is sales and marketing: internally among customer-facing employees such as salespeople, accountants, and support staff (i.e., employees who may not interact often) and externally among actual customers. Gathering information from such a disparate group would be difficult using traditional group decision-making tools. However, prediction markets are ideally suited for this task. Their scalability and ability to operate in real time allow organizations to run continuous, large-scale market-sensing operations at a minimum cost.

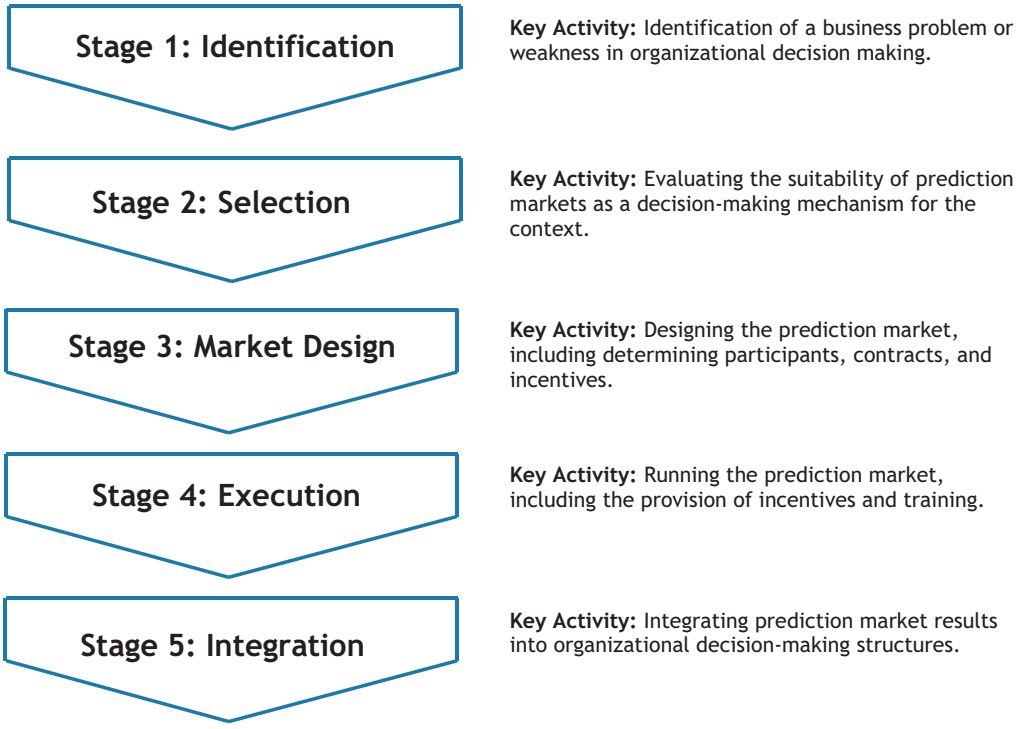
The utility of prediction markets in these problem spaces has been established in the literature. These examples are not meant to serve as an exhaustive list of the applications of prediction markets; rather, they are offered as illustrations of the utility of the framework we developed. This framework allows practitioners to quickly evaluate whether or not prediction markets are a suitable methodology to solve the problem they are presented with.

4. Deploying prediction markets in practice

This article has synthesized the literature on decision making and prediction markets to develop a framework that clearly identifies the attributes of decision spaces which render them more or less suitable for the use of prediction markets. For practitioners, this framework provides an important tool that can be used to guide evaluation and deployment of prediction markets in an organizational setting.

This deployment of prediction markets within an organizational process consists of five sequential stages, as shown in Figure 1. The first step, common

Figure 1. Organizational deployment of prediction markets



in many decision-making frameworks, is identification. At this stage, management comes to recognize that a problem exists—a realization which may arise from a number of prompts, such as analysis of internal organizational inefficiencies, external pressure from competitors, or recognition of untapped business opportunities. Regardless of the precise nature of the prompt, the outcome is organizational recognition that decision-making processes need to be reconfigured with a view toward improving their quality and efficacy.

The second stage, selection, is concerned with improving decision quality through the selection of a contextually appropriate decision mechanism. At a macro level, the organization may consider contrasting approaches such as empowering an individual to make a decision or utilizing a group to make a judgment. The Vroom-Yetton decision model is a well-known tool that can aid managers in analyzing a decision context (Vroom & Yetton, 1973). By answering a series of questions and traversing a decision tree, a manager will arrive at a recommendation as to the appropriate decision-making approach to use in a particular context (e.g., autocratic, consultative, or group based). It is at this stage that the analysis in this article makes its key contribution. Upon deciding a macro-level approach, such as group based, managers must still select from a range of potential approaches; for example, the nominal group technique or the Delphi method, to name two. The framework developed in this article allows managers to decide if a prediction market is an appropriate tool for the given situation.

If the problem space presented appears suitable for the use of prediction markets, the next step is market design. Hall (2010) provides a detailed overview of the four main issues that must be addressed at this point. First, contracts must be created which are both suitable for trade and relevant to the decisions. Crucially, these contracts must revolve around questions that can be definitively answered at some point in time. For many problem contexts, suitable contracts may be self-evident. For example, a sales forecasting problem can use contracts tied to the future sales of a product (Chen & Plott, 2002); in a project management context, contracts may be tied to delivery dates or estimation accuracy (Passmore et al., 2005).

The second issue that must be addressed is that of incentive design. Much of the power of prediction markets is derived from the provision of individualized incentives. The incentives provided to traders may not necessarily be financial. Reputation or entertainment value has been demonstrated as a powerful motivator in a number of contexts. However, given the nature of the problems being considered in organizational settings, some form of monetary incentive is likely to be required. In most cases, the simplest and most effective way of structuring incentives is to link the reward an individual receives to their trading performance. In other words, the more virtual cash a participant accrues on the prediction market, the more real cash they receive, without any need for a one-to-one correspondence. The key balancing act the prediction market designer faces here is ensuring that the financial rewards are sufficiently high to encourage truthful information revelation and information search, but not so high as to prompt maladaptive behavior search as manipulation (Hall, 2010).

The market designer will also need to consider the audience of the prediction market: which participants will be invited to trade on the market. In general, the power and accuracy of prediction markets increases in line with the number of participants in the market (Christiansen, 2007). This leads to the general principle that market designers should seek to attract as many participants from as many groups of stakeholders as possible. For example, a designer seeking to generate sales forecasts would invite not only sales people in the organization but also other customer-facing employees—such as accountants and logistics personnel—and potentially the organization's customers. However, this desire for high participation may need to be balanced against budgetary constraints and other issues such as confidentiality.

The final issue the designer of a prediction market must consider is how much to budget for the project (Hall, 2010). The market designer will require financial resources to cover two main costs: the operational cost associated with the prediction market (e.g., developing/purchasing suitable software, training costs) and the cost associated with covering the incentives offered to induce participation in the market. The market designer can typically deduce an upper limit of his/her budget by considering how much the information gathered by a prediction market is worth to the organization, this by calculating the expected value of perfect information (EVPI) and the expected value of sample information (EVSI) using standard methodologies (Anderson, Sweeney, Williams, & Martin, 2007).

Following on from the design of the prediction market, the organization reaches the execution stage, in which the market is actually opened for trading. The organization will need to consider a number of operational issues at this point, such as when and to which participants the prediction market will be available. The other key process that may be required at this stage, particularly if this is the first deployment of a prediction market in a particular

context, is the provision of training. Participants may require both conceptual training in how prediction markets work and also skills training on how to use the particular platform selected.

The final stage is integration. In this stage, the output of the prediction market must be analyzed and integrated into the organization's decision-making processes. In particular, it is necessary for the organization to decide how the forecasts generated by the prediction market will be utilized by existing decision-making bodies. In some cases, the pure forecast may be used to guide decisions, although it is more likely that the forecasts generated by the prediction market will be one of a range of inputs into the decision-making process. The nature of the integration that occurs will likely depend on two factors. First, the nature of the decision-making context will influence the weight assigned to the prediction market forecasts. Second, the perceived maturity of prediction markets as a forecasting and decision-making tool will also influence the weight attached to the forecasts generated by the prediction market. Prediction markets are still a relatively novel group decision-making mechanism. It is likely that a certain amount of bedding-in time, during which prediction markets will have to display consistent performance, will be required before organizational decision makers will be entirely comfortable with using their output. In this context, a key activity for the prediction market designer in this stage of the implementation process is capturing and analyzing data that can be used to evaluate the effectiveness and efficiency of the prediction market.

5. Conclusions

By positioning prediction markets as a group decision-making tool, this article makes a number of contributions for both practitioners and academics. First, by framing prediction markets using the terminology and language of decision making, this article serves to increase awareness of prediction markets and their unique capabilities. It will allow prediction markets to be integrated fully into the general management literature. This increased exposure will offer managers and business leaders the chance to deploy these innovative group decision-making systems in a manner that will improve the competitive positioning of their organizations and allow them to more effectively harness the information and knowledge that exist inside every business organization. Second, this article presents a framework which examines the characteristics of decision spaces that are suitable for prediction market deployment. It provides a simple tool, grounded in the literature, that allows practitioners to determine whether or not prediction markets are suitable for the decision space in which they are engaged. Finally, this article contributes by integrating this framework into a larger implementation pathway that describes how practitioners can evaluate the decision-making contexts they are faced with and where to appropriately deploy organization prediction markets as a means of improving organizational decision making.

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