Prediction Markets as Web 2.0 Tools for Enterprise 2.0

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ABSTRACT

In today's fast-changing business environment, companies and stakeholders are confronted with a new range of business decisions. These decisions are constrained by events that are out of the scope of competencies of the decision makers. In this context, prediction markets, which have demonstrated their efficiency in predicting the outcome of major elections, could support companies in leveraging the knowledge and competencies of their collaborators. Using the power of Web 2.0 and the participative collaboration of the crowd, prediction markets are well designed to assess this new range of decisions. The simple buy and sell mechanism use the crowd as proxy toward various information sources. Moreover, the decision task is distributed between the traders, leaving them the tasks of framing the problem, setting the evaluation criteria and collecting the supporting information, aggregating their results with the current market price. This paper presents the capabilities of prediction markets in an Enterprise 2.0 context and makes propositions regarding their deployment. This paper gathers the experience of the authors on designing and implementing prediction markets in various contexts.

Keywords

Prediction markets, decision making, Enterprise 2.0.

INTRODUCTION

In August 2004, Google raised $1.4 billion for its IPO. For the first time, they used an auction mechanism to define an IPO price. However, their IPO price was 15.3% below the first-day market capitalization. This results in a waste of $350 million for Google. At the same time, Joyce Berg from the University of Iowa was experimenting on a prediction market "to forecast the market capitalization of Google at the close of the first day of trading" (Berg, Neumann, & Rietz, 2009). Iowa's prediction market was only 4% over it. This could have saved Google $225 million.

Prediction markets are new form of social software enabling people to share and build knowledge on top of widely scattered bits of information. Like other Web 2.0 tools, they embrace McAfee's definition of freeform social software, being (1) optional, (2) mostly free of upfront workflow, (3) egalitarian or indifferent to formal organizational identities and (4) accepting of many types of data (McAfee, 2009).

We did various research on enterprise applications of prediction markets to assess their capabilities in this context. This paper presents one specific use of prediction markets in an enterprise environment to support the R&D portfolio management process. We first present prediction markets and their characteristics. We then show why they are appropriate tools for solving some managerial issues in a Web 2.0 context and then present the various implications, organizational and managerial, for enterprises implementing such tools in their kitbag. Finally, we compare the efficiency of prediction markets and multi-criteria decision models (MCDM), enlightening some key success factors of the prediction market approach.

PREDICTION MARKETS AS A WEB 2.0 TOOL

The underlying idea of prediction markets is based on Hayek's hypothesis (Hayek, 1945) and the efficient market hypothesis (Fama, 1970). In his critiques of central planning in democracy, Hayek claims that in competitive markets the information scattered among all the participants is efficiently aggregated in the price function. Furthermore, Fama (Fama, 1970) found that in an efficient market, each new available piece of information is almost instantaneously incorporated in the price of a security. Thus, the current price of a security represents the traders' expectation about the future value of the underlying product. Built on these concepts, prediction markets are Web 2.0 tools for predicting the outcome of uncertain future events. The securities are associated with future events, and the value of the securities represents the aggregated expectation of the traders regarding the outcome of the event.

To illustrate the functioning of a prediction market, we will take a current outcome from the Foresight Exchange[1] as an example. The "Claim Canc – Cancer Cured by 2010" aims at predicting that the cancer mortality in the United States will be reduced by 90%, relative to 1994, in any year through 2010.

In this case, this "Claim Canc – Cancer Cured by 2010" share will pay the following:

$$\begin{cases} \$100 \text{ if cancer mortality is reduced by 90\% in 2010;} \\ \$0 \text{ otherwise.} \end{cases}$$

The price p of the security represents the expected payoff, taking into account that we are in an efficient market. If T represents the cancer mortality,, and $\mathbf{Pr}(T)$ the probability that cancer mortality is reduced by 90% in 2010, then the price p would be:

$$p = \mathbf{Pr}(T) \times 100 + [1 - \mathbf{Pr}(T)] \times 0$$

At any given time, we can derive $\mathbf{Pr}(T)$ from p which represents the consensus among the traders regarding the probability that cancer will be cured by 2010.

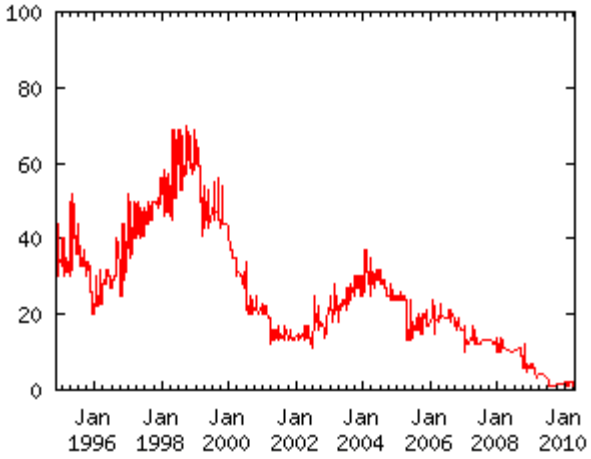

Figure 1. Variation of "Claim Canc" price on Foresight Exchange

As presented in Figure 1, the current price for the share is at $1. It means that the traders currently agree that the probability that cancer will be cured by 2010 is 1%. As seen in Figure 1, this price has evolved a lot during the past fifteen years. This is due to the fact that traders steadily accumulated new information during this period, which led them to adapt their beliefs about this issue. In the case of new information arising concerning the probability of a cancer cure before the end of the year, traders will buy shares at the current price, which in turn will raise the price on the market. Empirical evidences and economic theories suggest that prediction markets'

1 http://www.ideosphere.com

predictions "equal or outperform predictions made by groups, voting, experts, and opinion averaging" (Einbinder, 2006).

Prediction markets provide incentives for both revelation and discovery of information and provide an algorithm to aggregate this information (Wolfers & Zitzewitz, 2004). Moreover, they provide this aggregated information in the form of an easily understandable indicator: the price of the shares.

Prediction markets fully benefit from the possibilities offered by Web 2.0. Their web-based architecture supports a completely decentralized utilization, allowing the aggregation of information dispersed through the enterprise, whether locally or throughout the world. Prediction markets also use the business resources in an optimal way to generate value, using the knowledge scattered through its employees in a process referred to as "crowdsourcing". Moreover, they propose an incentive mechanism based on the social recognition of the employees having contributed in the most informed way to the market. Finally, the prediction markets offer real-time information, continuously updated with new information incorporated by employees.

Such markets have applications to decision-making, and have proven to be an accurate predictor of future events. Currently, researchers from different disciplines are studying prediction markets: politics, economy, law, finance, decision science and computer science.

There are different uses and case studies of prediction markets. There are numerous public prediction markets such as the Iowa Electronic Markets (IEM) dealing mostly with election markets, Foresight Exchange (FX) offering shares on scientific and general topics, Hollywood Stock Exchange (HSX) dealing in box office movies, InklingMarkets supporting the possibility of creating one's own market and NewsFutures dealing in various shares on sport, politic and people. And then there are more and more experiments being made within organizations to support business forecasts. These forecasts are very broad, from sales (HP), new product launch date (Google), ideation process (GE, Rite Solutions), project management (Siemens, Microsoft)... These experiments present interesting results and are an important source of inspiration for our own research.

WHY PREDICTION MARKETS IN THE ENTERPRISE?

Researches and experiments show that the main benefits of prediction markets are: efficiency, freedom, flexibility and motivation (Malone, 2004). They help in making contributors aware of the underlying topic's issues and motivate them to rapidly share their beliefs with the rest of the traders. In an organization, these markets encourage collaborators to position themselves regarding the outcome of company's relevant issues and to support companies in becoming more transparent in their way of assessing these issues. By leveraging the knowledge of the whole organization, prediction markets are drivers for initiating explanations and for increasing comprehension within the company (Rudzinski, 2009).

There are many applications where prediction markets can bring an alternative to traditional tools. Based on their characteristics, they are well suitable for applications where information is largely scattered, where informed people are geographically dispersed, where informed people are not clearly identified, where statistical data are lacking, and where the forecast must be made in a very short timeframe. They are, on the other hand, not well adapted to situations where information is available or can be collected at lower cost, where there is no information available at all, or where a more economic method can be used effectively.

We propose here to study an application that gathers several of these issues: the management of R&D portfolios. R&D project portfolio management is a periodic activity that aims at optimizing the research effort of the company, while enabling it to select a portfolio that corresponds to its strategic objectives and without exceeding the resources available.

Recent investigations have shown that, to be effective, portfolio management must apply a mix of various qualitative and quantitative methods (Chien, 2002; Cooper, Edgett, & Kleinschmidt, 2001). However, the use of quantitative methods presents weaknesses, mainly for (1) *selecting the right criteria*, (2) *collecting the data* and (3) *negotiating the portfolio between the different stakeholders*.

To support these issues, we suggest a Web 2.0 paradigm shift with a new tool to address the portfolio management issues.

Our statement is that *a specifically designed prediction market improves the R&D portfolio management process*. Prediction markets collect information coming from different actors, who trade on the market and aggregate this information in an automatically negotiated equilibrium price, corresponding to the valuation of the project. All actors directly or indirectly linked to the project, can trade (buy or sell) contracts concerning the projects, based on their own appreciation of the project. The traders are both the leaders and the teams of the project, and also the senior management, people from marketing and finance, as well as from all the other businesses units concerned about R&D. The narrow expertise of a particular company activity, such as research, but also marketing, sales, customer care or finance, will enable them to build their own opinion about the project, in the light of their activity field.

The result of all aggregated appreciations will, de facto, include a multitude of implicit criteria related to all company activities. Such a market mechanism addresses the three weaknesses mentioned above. Our finding shows that (Gaspoz & Pigneur, 2008):

- Using implicit comparison criteria, prediction markets enable the reaching of a great diversity of appreciation criteria in a completely transparent way and to aggregate them in a price, representing an actual consensus on the claim. This is particularly true when an ontology, shared by all actors, is used to describe the projects' claims, enabling each trader to have the same reference frame.
- Using a relatively basic mechanism, based on the buying and selling of contracts, prediction markets can aggregate very efficiently, and in real time, the information disseminated between a wide range of actors, making superfluous the implementation of a specific actualization process. In addition, this quote not only represents the actualized consensus concerning the value of the project, but also represents the evolution of this consensus during the whole project life.
- Using an automatic market-maker, prediction markets enable the obtaining of a continuous negotiation of the value of each project of the portfolio among all the actors, according to their relative influence on the market. In addition, this mechanism allows the obtaining of a greater adhesion towards the decisions since the price at a given time is the result of the negotiation of all actors concerning the advisability of carrying out a given project.

Given these results, using prediction markets should not only make the entire process more effective, but also increase the quality of the decisions and raise their acceptance among employees given their own participation in the process.

HOW TO DEPLOY A PREDICTION MARKET?

Deploying a prediction market in an enterprise is not a straightforward activity. Except the deployment and the adoption of a new tool, a prediction market will have significant consequences on the enterprise itself, more exactly on its management. There are two types of constraints: those related to the tool and those related to the firm.

Constraints related to the tool

By definition, prediction markets require: (1) many participants to guarantee the diversity of information, (2) liquidity to support the aggregation of information. If we try to translate these issues into a roadmap to implement prediction markets for R&D portfolio management it becomes:

- embodying all participants who own some pieces of information, the more the better,
- asking the right question to the participants to make sure that they all have an equivalent comprehension of the evaluation they are asked to give,

- giving enough incentives to motivate participants to reveal and aggregate their own private information on the market,
- managing enough liquidity on the market to assure an optimal price equilibrium.

Participants

The more participants we would like to become involved on the market, the more attention should be given to this topic. In fact, restricting the market to a handful of participants sharing the same comprehension of the topic would probably result in a common perception of the task to be done. However, there is a great risk that the market would not be as effective as desired, these participants probably sharing the same belief on the outcome of the different shares. To mitigate this risk, we should integrate "noise traders" on the market to add sufficient opportunities for best informed traders to reveal all their information, continuously adjusting the market's price (Barner, Feri, & Plott, 2004; Hahn, Tetlock, & Lien, 2005; Hanson & Oprea, 2004).

Formulation

From an R&D portfolio management perspective, we should consider the impact of the different projects on the company. Bitman (Bitman & Sharif, 2008) proposes using five perspectives to assess the portfolio's projects, allowing us to define the questions to be answered by the traders:

- **Reasonableness.** Can the project be successfully completed?
- **Attractiveness**. Will the employees want to perform the project?
- **Responsiveness**. Are there any ethical, moral, environmental or legal considerations that make it especially attractive, or conversely, inadvisable to carry out?
- **Competitiveness**. In what ways and to what extent does the project improve the firm's capability and competency?
- **Innovativeness**. To what extent will the project help us to sustain our competitive advantage?

Incentive

Many experiments—including ours—have suffered from the traders' lack of willingness to actively participate on the market (Gaspoz, 2010). There are many factors influencing the engagement of the traders in real-life experiments. The most important is the fact that they are not paid—unlike those involved in experiments—to participate on the market, but rather to do their daily business. Some successful incentives in various enterprise contexts comprise (Siegel, 2009):

- **Ongoing communication**. Use blogs, newsletters or mailing-lists to catch the attention of the traders.
- **Interesting insights**. Use the data created by people trading to discover other insights.
- **Profile/interview your users**. Use the best players as vectors for your communication.
- **Champions**. Make sure that the top management is involved and communicate its involvement.
- **Cash and prize incentives**. Lottery systems picking a winner from the pool of users are better than allocating a prize to the best trader.
- **Competition as incentive**. Take advantage of the natural organizational rivalries that already exist.

Liquidity

Comprehension and incentive having been solved, the liquidity problem should not remain an important problem. As seen before, the implementation of some trading mechanisms coupled with the right provisioning of traders' accounts—in cash and/or shares—should guarantee enough liquidity on the market. Furthermore, to our knowledge, it seems that there are no experiments failing due to illiquid markets.

Constraints related to the enterprise

The use of a Web 2.0 tool to carry out R&D portfolio management activities implies a whole series of constraints on the enterprise implementing it. Rising directly from their mode of operation—a large employees' crowd sharing bits of information scattered through the firm—prediction markets imply transparency from the enterprise.

The prediction markets have broad implications within the organization in which they are deployed. First of all, the use of a crowd of participants from various departments and with various hierarchical levels implies from the management a recognition of a bottom-up evaluation, bypassing the official channels. The manager must be ready to accept the results from the prediction market, even if they go to against his own evaluation. In strongly politicized firms, this can have positive effects on the release of information, but it can also have consequences for the managerial practices.

Then, to motivate the employees to fully enter into the process, one needs to set up the necessary incentives as we saw previously, but one also needs to have a strong support and engagement from the top management. It must actively support and promote the prediction market, but must also communicate the results and the decisions that are made consequently.

As the process is by definition open and participative, the most delicate element to manage is the transparency. The prediction market enables everyone to observe the consensus building resulting from the transactions made by the employees. This information is available to all participants. Consequently, to keep the motivation and the assiduity of the traders, the enterprise must find a way to take this information into account in its organizational processes. This goes from the communication of the results to the communication of the decisions arising from these results. Thus the employees will see their input taken into account and will be motivated to continue to feed the market with new information. It should be noted that, as in any evaluation process, the result of the market should not be obligatorily the one selected, but in the event of divergence, the reasons will have to be communicated. This will have two consequences: to support the motivation and to generate new information which will be integrated and reflected on the different markets.

Finally as in any participative process, the recognition of the contributions of the employees should be particularly addressed. Whereas the usual incentives used by the enterprise help managers to reward the performance of the collaborators by various means such as promotions, bonuses and encouragements, but the recognition of the performances on the market cannot be addressed by the same manner. Indeed, the results on the market, apart from the employees for whom it is the principal occupation, are not dependent on the results obtained in their principal function. These results can follow from a good network, a better estimate of the confidence or a better risk approach. Consequently, the enterprise needs to set up some rewards in order to recognize the performances on the prediction market. Except for the various means already mentioned for rewarding good predictors, the firm can use the card of the social recognition, commonly accepted in Web 2.0 context, presenting the results of its employees in an official way, exploiting the healthy competition between employees.

In conclusion, the implementation of prediction markets within the firm will be accompanied by a double process: one, purely technical, aiming at the installation of the tool and the necessary environment, the second, to adapt the managerial culture. This second process is characterized by the transition from the enterprise towards an Enterprise 2.0, defined by McAfee as: "Enterprise 2.0 is the use of emergent social software platforms within companies, or between companies and their partners or customers" (McAfee, 2009).

HOW EFFICIENT ARE PREDICTION MARKETS IN COMPARISON TO TRADITIONAL APPROACHES?

To better assess the advantages of using prediction markets over traditional tools, we made a comparative analysis of prediction markets and multi-criteria decision models (MCDM) (Gaspoz, Ondrus, & Pigneur, 2008). We invited a group of 16 experts representing 14 different companies to express their predictions about the future of mobile payment (Ondrus & Pigneur, 2007). The predictions were collected during interviews and then entered in a MCDM tool. Results were presented back to the expert, who had the opportunity to adapt his

prediction based on others inputs. We also asked a group of 29 masters' students in business information systems to enter their predictions using a prediction market during a one month experiment.

A considerable effort is required for the MCDM approach compared to the PM approach, especially for the data collection process. Each company and its experts need to be met individually. The experts need more support while we elicited their preferences than the traders, who just buy or sell. A multi-criteria analysis requires a relatively large amount of data to collect. In the prediction markets, the participation of the players is self-organized. This facilitates the overall management of the analysis. However, the success of the prediction market's outcome depends on the goodwill of the players to participate and trade without the pressure of the project managers. The MCDM experiment lasted 8 months, while the second lasted only one month. The experiment showed that the results of the prediction market are globally similar to the ones obtained with the MCDM approach (Ondrus, Gaspoz, & Pigneur, 2007).

Based on these results, we propose some key success factors for MCDM and prediction markets. Our recommendations should support further explorations of these approaches.

MCDM methods are well suited for situations where a group of relevant experts want to compare their opinions. For their part, prediction markets need a crowd ready to trade and share their beliefs. Their actions generate a prediction through an implicit data aggregation mechanism relying on information disseminated among the crowd. This works particularly well when the corporate crowd is familiar with the topic.

To setup an MCDM analysis, a facilitator should be hired to meet each expert individually. Face-to-face meetings are essential for sharing the results, as they are usually centralized in standalone software. Prediction markets only need a facilitator who can setup a claim on the platform. Then, traders can play anytime and anywhere using a web browser. The major challenge of prediction markets is to gather a motivated crowd that will trade regularly.

The efforts required for the MCDM approach are rewarded by the assurance that the set of data collected is valid since the facilitator supervises the whole process. To overcome this issue in prediction markets, the crowd automatically regulates the market. Even if a trader introduces a bias into the market by performing irrational actions, the crowd would neutralize him/her by doing opposite actions. At some point, the defective trader would be evinced, as his/her financial resources to trade would vanish.

MCDM methods are used when experts need to have a precise explanation of the phenomenon. The criteria, weights and evaluations are useful indicators for unveiling possible weak signals. Looking at the data collected, we could explain precisely how we reached these outcomes. As a result, the establishment of a consensus could be reached after several rounds of analysis (i.e. Delphi). Prediction markets' outcome is by nature a consensus of the crowd based on many rounds of trades. The aggregated results provide a simple but powerful indication. In addition, one can analyze the evolution of the trends by just looking at the history of price traded. However, it is much harder to explain the behavior of the traders over time.

Despite similar results, both approaches revealed some benefits and demonstrated their complementarity (Gaspoz et al., 2008). On one side, the MCDM approach brings an analytic explanation of the phenomenon by a controlled and criteria-based evaluation. On the other side, prediction markets provide a synthetic aggregation of numerous individual beliefs that is constantly adjusted and made available for everyone. Furthermore, the outcome of prediction markets could be enhanced by requesting more information about the actions of the players. The objective would be to monitor the behavior of the players in order to confirm that they are not just following the trend generated by the market.

Comparing two different approaches–prediction markets and MCDM–we found that prediction markets are well adapted to solve business issues. Moreover, running an experiment assessing mobile payment technologies, we showed that prediction markets are as good as MCDM at assessing technologies, but are also more efficient.

We showed that, even in the presence of non-expert participants, prediction markets are faster to set up and more resource saving (time, education, costs) than MCDM, for achieving the same outcome. These findings would

help practitioners to design better technological forecasting tools and stakeholders to efficiently run their technology assessments or to improve their IT investment decisions.

Running these experiments with two different participants groups enabled us to confirm that a crowd of graduate students is able to perform as well as selected and renowned experts. This could seem to be counter-intuitive at first sight, but it only confirms the findings from various experiments on prediction markets.

CONCLUSION

This paper presents a Web 2.0 decision making tool to increase the efficiency of the decision making process in Enterprise 2.0 companies. It relies on many characteristics of Enterprise 2.0 companies like the enhanced collaboration between dispersed collaborators through social networks tools, the commitment of all collaborators in the knowledge management process and the dedication of the organization toward open and participatory decision processes.

Prediction markets, even if they cannot pretend to be used as a one fits all solution, have a real strategic advantage to play in a fast-evolving business context. They have the ability to promptly leverage pieces of information scattered through the organization, without requesting a single stakeholder knowing what to search for and where to search it. They are able to achieve a consensus between the traders without the need of a specific activity in the decision process. Moreover, due to the engagement of a large crowd in the decision process, final decisions are subject to a broaden adhesion within the company.

In conclusion, prediction markets could really help enterprises to improve their decision making process. Thus, given their specificities, they need to be deployed in a favorable environment, currently summarized as Enterprise 2.0. This involves numerous managerial issues as we discussed in the previous sections, but also opens new perspectives to build upon the collective knowledge of the enterprise.

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