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Futures Market

Taking Stock of Virtual Markets

Despite the recent uproar over the Pentagon's plan for a futures market on terror attacks, Internet-based virtual stock markets show promise in predicting business success, the outcome of sporting events and yes, perhaps even coup d'états.

By Martin Spann and Bernd Skiera

"Pentagon Prepares a Futures Market on Terror Attacks" blared the headline in the New York Times above an article on the Pentagon's "policy analysis market" (PAM) project. The Pentagon intended to employ a "virtual stock market" — for the aggregation of information and derivation of forecasts — to help predict foreign-policy events such as a coup d'état in a particular country or terrorist attacks. Needless to say, the plan received plenty of attention [3], most of it negative from individuals expressing outrage that predicting such distasteful events would even be considered an appropriate goal of any stock market, real or virtual.

A new paper in *Management Science*, however, shows that such virtual stock markets can be powerful predictive tools [4]. When it comes to designing virtual stock markets such as the "policy analysis market," the devil is in the details. As the heated and perhaps politically motivated debate continues in the mainstream media, we would like to add some additional thoughts on this issue from an academic point of view while showing which details matter in virtual stock market design.

Internet-based virtual stock markets (VSM) are an innovative approach that can be used to predict future market developments and events of political, as well as business and economic interest. The basic idea of such a VSM is to bring a group of participants together via the Internet and let them trade shares of virtual stocks. These stocks represent a bet on the outcome of future market situations. Their value depends on the realization of these market situations, thus making the stock prices a predictor of these market situations. Basically, virtual stock markets are a method to organize Internet-based interactions with experts, consumers and other persons in order to elicit their information concerning future events. Such types of VSMs have been applied successfully in the field of political forecasting for over a decade, showing a high predictive validity, often outperforming opinion polls in terms of forecast accuracy [1, 2].

The application of the underlying market mechanism to forecast problems other than election outcomes is a straightforward conclusion. However, the apparent simplicity of the mechanism, i.e., just to let people trade stocks and use the corresponding stock prices as forecasts, may dilute the difficult task of how to design such a VSM so that it will work appropriately. Further, not every prediction problem is suited to be

solved by VSMs. The current debate over the policy analysis market highlights the need to discuss the potential benefits and shortcomings of VSMs [3], along with appropriate VSM design and prediction problems.

Why and When do Virtual Stock Markets Work?

The theoretical background of VSMs is the so-called efficient market hypothesis, which states that a market is efficient if all available information is always fully reflected in the prices. Thus, the price of a specific stock — Microsoft, for example — tells us what all market participants know about it, e.g., current and expected future earnings. If the stock is related to a future event and pays \$1 if the event (e.g., George Bush is re-elected) occurs and no money if it doesn't, its price tells us how likely market participants think that this event will take place. The basic idea of a VSM is therefore to create stocks with their cash dividend (payoff) depending on the relevant market outcome and let people trade these stocks (actually, in financial markets this type of security is known as a "future").

How does the information of market participants get reflected in the stock prices? Suppose a VSM where participants can trade a type of stock that pays \$1 for every 1,000 bottles a local beer producer sells in October. The current price of this stock is \$100, reflecting an expected sale of 100,000 bottles. However, a participant at the VSM, say Bernd, thinks that 95,000 is a more realistic expectation, because he has information about the cancellation of the local soccer team's big party in mid-October. Therefore, he starts to sell shares at \$100, which he thinks will only get a payoff of \$95 each. Bernd increases the supply of this stock, leading to a price below \$100. Bernd's new information is now reflected in the stock price. The same logic applies if Bernd thinks a stock is undervalued and buys. Thus, by trying to make a profit, it is Bernd's best strategy to make transactions according to his individual assessments of the future event's outcome.

When do VSMs Work?

First, the future market situation or event to be predicted must be stated in a manner that makes it clear for participants to know how their expectations relate to the cash dividend of the respective shares of stock. Such an unambiguous basis for the cash dividend requires the future market situation or event to be quantifiable so that participants are able to assign a numeric value to their expectations.

Second, participants need to have some knowledge about the future market situation to be predicted. Thus, only a few experts among participants can be sufficient to achieve good predictions, but if no one has any information about the issue to be predicted, you might just as well roll a dice.

Third, the incentive created by the payoff mechanism has to be sufficient for experts to invest their time and participate as well as reveal their true valuations.

The Design Matters

VSMs need the right design, otherwise they cannot work properly. The different design issues to be taken into consideration can be separated into three categories: 1. the choice of the forecasting goal, 2. the creation of incentives for participation and information revelation, and 3. the financial market design [4].

The choice of the forecasting goal requires the designer to formulate the payoff rule and to select a savvy group of participants. Possible prediction issues corresponding to specified events can be: 1. the prediction of an absolute number; e.g., sales in a particular period, 2. the prediction of a relative number; e.g., market share in a particular period, or 3. the occurrence or non-occurrence of a particular event; e.g., the completion of a development project at a particular point in time. In the first two cases, the payoff rule can just multiply the actual absolute or relative number by a certain payment factor (e.g., \$1 for every percentage point). The third case is represented by a binary payoff rule; e.g., \$1 for occurrence of the event and \$0 otherwise.

If the desired experts are unknown, a VSM can be promoted widely in the attempt to provide the incentives such that the experts will show up and participate, possibly from all over the world. When experts have already been identified or the forecasts of the VSM represent critical information (e.g., in cases of confidential company data), access can be restricted to selected groups. Both our empirical results and those from political stock markets indicate that VSMs work well for different payoff rules and different durations of VSMs, as well as unrestricted and restricted participation.

In order to create incentives for experts to participate and reveal their assessments of future market developments, a potential reward should be established according to the participants' performance. The reward should reflect their portfolio's value *after* the cash dividends of the shares of virtual stock have been determined at the end of the VSM. Basically, the initiator of the VSM can choose between two alternatives. The first alternative is to require participants to invest their own money and to link their monetary reward to their performance on the VSM. The idea is that the investment of participants' own money creates a strong incentive to perform well. However, some experts might not participate because they are unwilling to accept the risk of financial losses. In addition, playing with real money might be considered gambling, which is illegal in some quarters. Furthermore, additional accounting and administration costs occur for managing the investments and the payoffs. Therefore, a second alternative is to waive a required investment and provide participants with an endowment of shares of virtual stocks and virtual money instead, and to reward the best performing participants.

Usually, participants in political stock markets are required to invest their own money. Participants can use their initial investment to buy (and later sell) stocks, which will receive a real money payoff according to the election results. However, because real money is at stake, participants can actually lose money, and certain restrictions for the design of VSMs apply if the initiator of the VSM does not want to lose money [4]. The second alternative is to create a rank order tournament according to the final portfolio values of participants. The participant with the highest portfolio value receives a prize and additional prizes for the runner-ups are possible. We applied rank order tournaments in our studies, with

prizes ranging from an annual ticket for a large cinema chain to a state-of-the-art cell phone.

A final conclusion is difficult to draw. Our empirical studies as well as the political stock markets show that both the investment of participants' own money and real money cash outs according to final portfolio values or participants' endowment in combination with rank-order tournaments and prizes lead to good results. If participants' own money is at stake, they may have a higher incentive to perform well. However, well-designed rank-order tournaments might attract experts that are not willing to invest their own money and might also provide participants with sufficiently high incentives.

The illustration mentioned above of some of the design issues in general shows that every VSM application's design should be thoroughly discussed and tested prior to its actual application.

Application to Business Forecasting

VSM can be applied to any quantifiable business-forecasting problem where potential traders possess relevant knowledge. As such, sales, market share, profit, company stock price or time-to-market of new product introductions can be predicted. Furthermore, any binary event (e.g., bankruptcy, litigation victory, change of management or successful product introduction) is a possible prediction issue, too.

In our studies, we apply VSMS for predicting: 1. the U.S. box-office success (gross revenues) of movies prior to their release, 2. the prediction of the box-office success (number of visitors) of movies in Germany, 3. the chart position of pop music singles in Germany, and 4. the usage of different cellular phone services at a large telecommunications company. The first three applications were widely promoted and open to the public. In contrast, the fourth application was restricted to 20 selected employees in the marketing and planning departments of the respective telecommunications company.

Our empirical studies show encouraging results for the applicability of VSMS for business forecasting purposes [4]. Apparently, such VSMS can be conducted easily via the Internet in terms of organizational and technical aspects. In addition, VSMS seem to work well under different incentive structures and even with a very limited number of participants.

Related to forecasting, VSMS can also be applied to identify knowledgeable participants or experts. The basic idea of such an application is that a participant's performance at a virtual stock market can be used as an indicator of his or her knowledge and involvement in the issue to be predicted at the VSM. Applied with consumers as participants, VSMS can be a tool to detect knowledgeable consumers or "trend scouts" which, for example, could be consulted by companies for purposes such as testing new products.

If participants are managers, the VSM can identify those with a good forecasting ability and market understanding, who could be promoted to positions that require this capability. This approach could be extended to the area of manager appraisal. Since the forecasting of market developments is an important task for most companies, they also require

this ability from their managers. Therefore, a company might link rewards to the forecast accuracy of their executives. Consequently, manager appraisal and remuneration could be based on a manager's performance on a VSM for business forecasting problems.

What Else can VSMs Predict?

There are numerous areas for additional applications. Stock market games that trade the outcome of sport events can be found on the Web and their data can be used to predict these sport events. Related to election forecasting via political stock markets, any event in the public domain is a potential prediction issue for VSMs. Such applications can be the predicted voting behavior of members of Congress or the Supreme Court. Also, economic indicators can be and sometimes have been predicted by VSMs (e.g., inflation or unemployment rate, GDP growth, or the rates set by the Federal Reserve Bank).

One obvious extension along these lines is an application of VSMs to predict foreign policy events — the basic idea of the proposed and controversial policy analysis market (www.policyanalysismarket.org). Its goal was the prediction of political stability, as well as future events like a coup d'état. Leaving others to debate whether this forecasting goal is ethical, we want to comment on the proposed design of the PAM VSM and its usefulness. For this project to function correctly, two central questions have to be asked. First, do potential participants possess relevant information? Second, can the VSM elicit this information?

Applied within a known expert community (e.g., police, secret service, think tanks or the state department) such a market can elicit information in these organizations while still being nonpublic. However, if the goal is to obtain further information from the "outside," then anyone can access the VSM and the predictions. If the attraction of valuable outside information appears realistic, it might be beneficial to open such a market to the public. As the information traded on such a VSM is likely to be rather confidential, the restriction to a selected expert community appears more suitable.

The answer to the second question relies on the design of the specific stocks. A political stability index is an unambiguous basis for the payoff of a stock. However, it might be difficult to predict for participants. Even if a participant of such a VSM has knowledge about future economic or political instabilities, it would probably be difficult to translate these into a future value of such an index, being a composite measure. Therefore, this information might not be elicited by using corresponding stocks on a VSM.

A further benefit of a VSM similar to the "policy analysis market" is the aggregation of information by an "objective" mechanism, i.e., the market mechanism. In this instance, trading based on new information is reflected in the prices irrespective of the hierarchical position of the trader. Thus, the opinion and trade of the junior analyst is as valid for the VSM as the trade of his or her boss. A VSM can express information which otherwise might have been buried in large documents or hierarchies. On top of that, the VSM can identify persons or agencies with a better ability to predict than others based on their performance on the VSM. Hence, performance on the VSM could serve as an additional

source of political clout for different agencies. Additionally, well-performing participants could be asked to conduct in-depth studies or invited to restricted, separate VSMs for confidential forecasting issues.

Conclusions

VSMs can be a powerful instrument for business and other forecasting issues. Special care should be taken when designing such markets. Participants need to understand what they are trading — this is probably more important if complex indicators are predicted than if marketing managers forecast their company's future sales. When critical information is at stake, access to the VSM should be restricted to your expert community. The incentives on the VSM do not have to be large; at political stock markets and in our empirical studies, the best-performing traders never received more than a few hundred dollars in return.

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