PREDICTION MARKETS: AN EXTENDED LITERATURE REVIEW

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This paper presents an attempt to study and monitor the evolution of research on prediction markets (PM). It provides an extended literature review and classification scheme. The former consists of 155 articles, published between 1990 and 2006. The results show that an increasing volume of PM research has been conducted in a very diverse range of areas. The articles are further classified and the results of this classification are presented, based on a scheme that consists of four main categories: description, theoretical work, applications, and law and politics. A comprehensive list of references concludes this literature review. It is the authors' intention to provide an expedient source for anyone interested in PM research and motivate further interest.

INTRODUCTION

PM emerged fairly recently as a promising forecasting mechanism able to handle efficiently the dynamic aggregation of dispersed information among various agents. The interest that this mechanism attracts seems to be increasing at a steady rate, in terms of both business interest and academic work. This review surveys and examines relevant existing literature and its trends, while it is also designed to provide a unique starting point for the further study of PM literature.

While there is no universally accepted terminology and definition of PM, the following definition is used, based on that given by Berg and Rietz (2003): Prediction markets are defined as 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.

PM is an exciting area for research, partly because of its novelty and the exploding growth of interest in it. This paper presents a comprehensive review and classification of the literature on PM research, starting from its introduction and the first applications of the PM concept in the early nineties (Hanson (1990), Hanson (1992), Kuon (1991) and Forsythe et al. (1992)) up until the writing of this paper. The scheme used represents the authors' view of the focus and direction of PM research and reveals a rapid growth in the number of published articles. The current state and direction of research topics should be of interest to many and we hope that this review will serve as a roadmap of PM for both academics and practitioners.

The paper is organized as follows. Firstly, the research methodology is described, followed by a commentary on the current – and diverse – terminology existing in the PM field, along with the evolution and growth of the literature and research itself. Subsequently, a classification method is introduced and its results are analysed. The article finally concludes by presenting research implications and an extended list of PM references.

RESEARCH METHODOLOGY

This survey is the outcome of an attempt to collect and study the totality of PM related academic work. Thus far, no relevant literature review could be identified. Hitherto, there existed, for example, no publication outlet dedicated exclusively to PM research. Therefore, the inclusion of every potential source of academic knowledge dissemination was essential.

As a result, all journal articles, conference proceedings papers, books or book chapters, master's theses, doctoral dissertations or other unpublished academic working papers and reports that are referring to the concept of PM were collected, studied and are cited herein. The search was conducted mostly through the World Wide Web, as well as electronic libraries and academic databases. The literature review finally resulted in identifying 155 articles, which are classified by type of publication as shown in Table 1. By its very nature, this review could therefore be characterised as extended but by no means as exhaustive. Nevertheless, it serves as a comprehensive basis for understanding PM research.

TERMINOLOGY

PM is not a unique and globally adopted descriptor of the concept and mechanism that was defined previously. On the contrary, the terminology used to address this concept is rather wide. The literature search was based on the following five more usual and relevant descriptors: "prediction markets", "information markets", "decision markets", "electronic markets" and "virtual markets". Moreover, the references of each article found were further examined as to identify relevant citations that use perhaps another descriptor. The full text of each article was then reviewed to eliminate those articles that were not actually related to PM. The final selection of 155 articles was then classified on the basis of the prevalent descriptor used in each article to describe the concept of PM. The distribution is depicted in Figure 1. Other descriptors which were identified during the research, include "political stock markets" (Berlemann and Schmidt (2001), Bohm and Sonnegard (1999), Brüggelambert (2004), Forsythe et al. (1994), Forsythe et al. (1992), Hansen

TABLE 1
NUMBER OF ARTICLES PER TYPE OF PUBLICATION

Type of publication	Number of articles
Journal articles	58 (37%)
Books & book chapters	22 (14%)
Conference proceedings	15 (10%)
Masters theses & doctoral dissertations	7 (4%)
Working papers, reports & unpublished work	53 (35%)
Total	155 (100%)

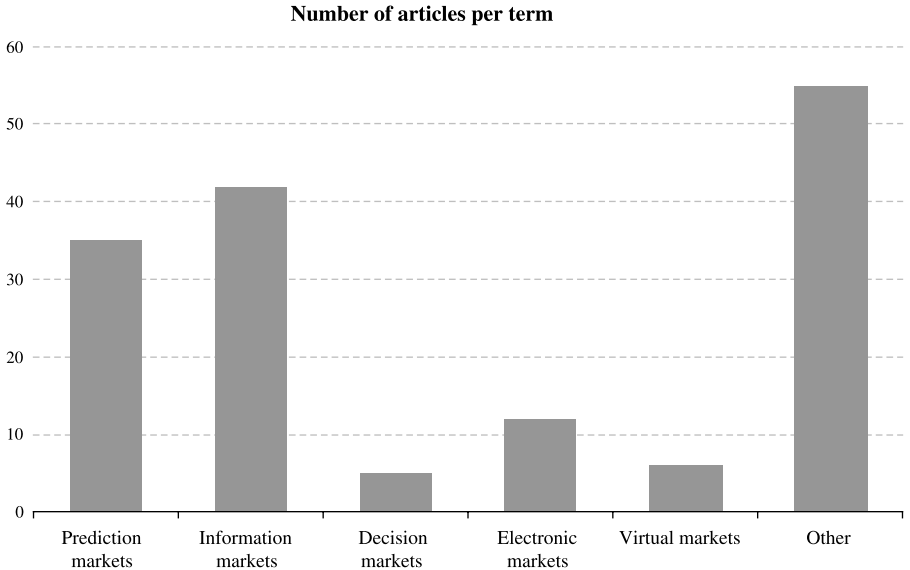**Number of articles per term**

FIGURE 1. Number of articles per term used to describe the concept of PM.

et al. (2004), Hauser (2005), Jacobsen et al. (2000), Murauer (1997) and Ortner et al. (1995)), "election stock markets" (Antweiler and Ross (1998), Brüggelambert and Crüger (2002), Forsythe et al. (1995), Forsythe et al. (1998), Forsythe et al. (1999), Kou and Sobel (2004) and Kuon (1991)), "artificial markets" (Pennock et al. (2000), Pennock et al. (2001) and Pennock et al. (2001)) and "idea futures" (Hanson (1990), Hanson (1992) and Passmore et al. (2005)).

It becomes clear that the terminology used to describe the same concept is very diverse and extensive. This fact could lead to the division of the PM society and research at a very early stage of its development and makes the agreement on globally accepted and standardised terminology all the more important, the authors argue.

EARLY WORKS AND EVOLUTION

The series of articles that Hanson published between 1990 and 1992 (Hanson (1990), Hanson (1990), Hanson (1991) and Hanson (1992)) are the very first introductory texts on the topic of PM. The earliest application of a PM mechanism, the Iowa Electronic Markets, was initiated in 1988 and was originally designed to study market dynamics while predicting the outcome of US presidential elections. Forsythe, Nelson, Neumann and Wright wrote the first academic article on the Iowa Electronic Markets in 1992 (Forsythe et al. (1992)).

The early works of the nineties focused mainly on political stock markets applications. Aside from the papers on the most popular PM, the Iowa Electronic Markets (Berg et al. (1996), Berg et al. (1997), Forsythe et al.

(1994), Forsythe et al. (1992) and Forsythe et al. (1999)), other election markets were described and analysed, like the one founded as early as 1990 in Germany (Beckmann and Werding (1996) and Kuon (1991)) as well as others in Canada (Antweiler and Ross (1998), Forsythe et al. (1995) and Forsythe et al. (1998), Austria (Murauer (1997) and Ortner et al. (1995)) and Sweden (Bohm and Sonnegard (1999)). Ortner also made important contributions to the field with his doctoral dissertation in 1996 (Ortner (1996)) and the description of PM's first application as a business tool by Siemens Austria in 1997 (Ortner (1997) and Ortner (1998)).

PM literature up until 1998 is limited to mainly those above-mentioned articles. In the following years however, this survey witnesses a significant increase in the amount of PM literature. The publication trend, as depicted in Figure 2, could be roughly described as being of exponential growth: the number of relevant articles in 2002 corresponded to 14, increased to 22 during 2004, while in the first 8 months of 2006 there were already 34 published articles.

Among these most recent articles it is of paramount importance to mention the pioneering work of Pennock on a dynamic pari-mutuel market framework (Pennock (2004)) and of Hanson on combinatorial market design (Hanson (2003)). Other equally significant contributions, both in terms of citations and implications, were made by Spann and Skiera (2003), Wolfers and Zitzewitz (2004) and Berg and Rietz (2003) among others. This substantial increase of literature makes the need for further classification of
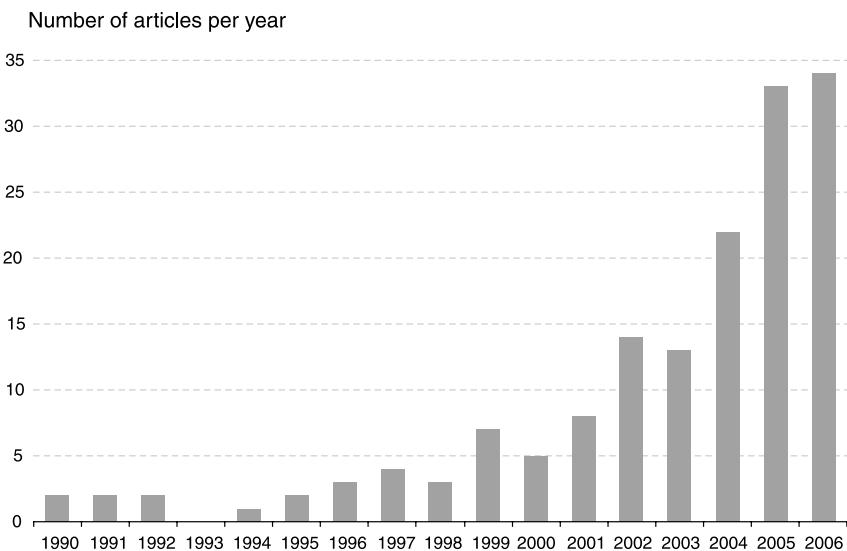
Number of articles per year

FIGURE 2. Publication trend.

articles in terms of their nature of PM research indispensable. This need is addressed in the following section.

CLASSIFICATION METHOD

The classification framework, shown in Figure 3, was based on the literature review and the nature of PM research. The papers were classified into four broad categories: (a) description, (b) theoretical work, (c) applications and (d) law and policy; and each category is further divided into subcategories. It has to be stated, however, that this framework is designed to be rather practical than strictly documentary, serving as a navigation tool for researchers. Each paper was assigned to the category that describes most accurately the core of its PM relevant contents alone. The categories' breakdown is described hereafter.

(a) Description

This category covers descriptive literature on PM research, including introductory texts, general description, open questions, etc.

1. Introduction: This subcategory contains mostly short and rudimental texts on the basics of PM, which are often a subsidiary topic of the publication.
2. General description: The subcategory covers lengthy and detailed articles that usually address the analysis of a variety of aspects on PM.
3. Open problems: This consists of works that highlight issues which have yet to be addressed by the literature in a fully satisfactory way.
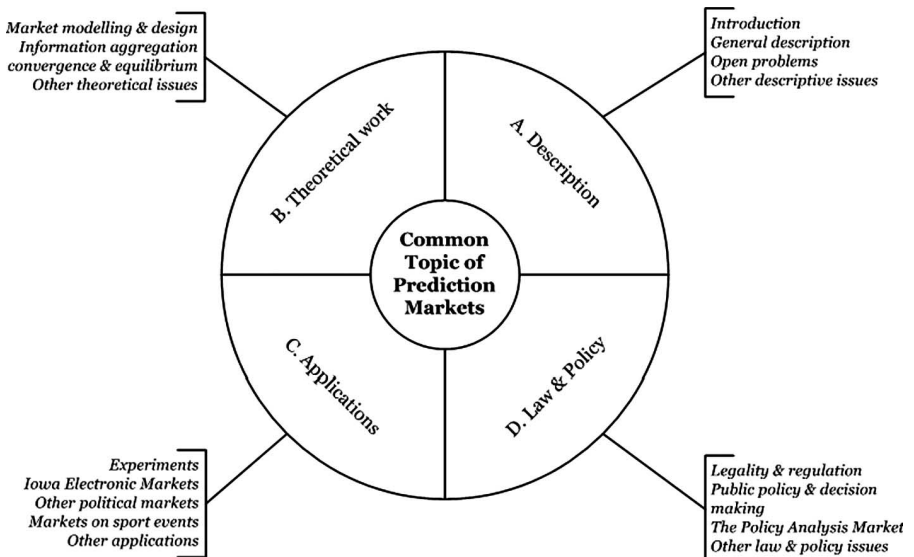

FIGURE 3. Classification of topics in PM literature.

4. Other descriptive issues: This subcategory contains papers that discuss other descriptive issues on PM, such as taxonomy, its potential use in education and other fields.

Theoretical work

The literature in this category includes papers of theoretical nature and is divided into the following three areas:

1. Market modelling and design: This contains various texts dealing with aspects on PM modelling, framework design and analysis.
2. Information aggregation convergence and equilibrium: The subcategory consists of papers discussing the convergence and equilibrium properties of the information aggregation process that is hosted by PM.
3. Other theoretical issues: This includes works on other theoretical issues that could not be assigned to the previous two subcategories, such as the interpretation of PM prices.

Applications

This broad category includes the totality of papers describing or analysing applications of the PM concept, either of experimental or practical nature.

1. Experiments: This is comprised of various experimental applications of the PM concept, held in academic or some other environment.
2. Iowa Electronic Markets: The subcategory contains all the papers that focus on the description and analysis of results of the Iowa Electronic Markets.
3. Other political markets: This covers all the literature referring to political stock markets applications, with the exception of the Iowa Electronic Markets. The references include political stock markets in Germany, Canada, Austria, Sweden, Netherlands, Australia and Taiwan.
4. Markets on sport events: This subcategory comprises of articles of PM applications in various sport events. Comparisons of real-money and play-money markets are also included in this subcategory.
5. Other applications: The subcategory contains the rest of applications that could not be assigned to any of the previous ones and includes among others business and entertainment web games applications.

Law and Policy

This last category consists of law and policy literature on PM research.

1. Legality and regulation: This subcategory is comprised of papers referring to aspects on the legality of PM and provides directions for their regulation.

2. Public policy and decision making: The works of this subcategory address the potential of PM in improving policy analysis and public decision making.
3. The Policy Analysis Market: This covers all the literature describing the Policy Analysis Market, a PM application that was designed to support policy analysis on sensitive political issues, such us international affairs and terrorism.
4. Other law and policy issues: This subcategory covers other law and policy aspects on PM.

CLASSIFICATION RESULTS

The 155 papers found were classified according to the above mentioned model. The distribution of articles by topics is shown in Figure 4. The majority of published research concerns the applications of PM (72 articles, 47%), whereas 36 articles (23%) were to found to be mainly of descriptive nature and 27 (17%) of theoretical nature.

Table 2 lists the number of description articles. 40% (13 articles) were general descriptions to the concept of PM, while 30% (10 articles) were of introductory nature.

Table 3 shows the number of articles categorised as theoretical works. The majority of them (16 articles, 59%) refers to market modelling issues, followed by 33% (9 articles) denoting to the study of convergence and equilibrium properties.
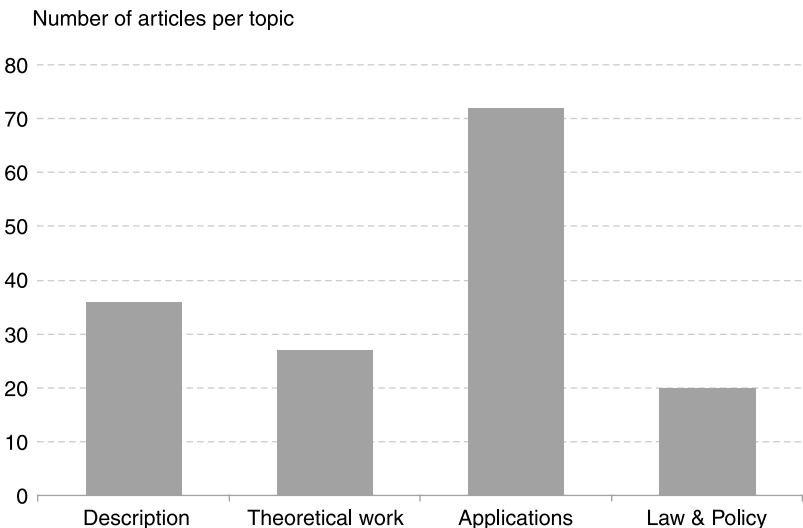

FIGURE 4. Classification results of PM literature.

TABLE 2
NUMBER OF DESCRIPTION ARTICLES

Description	Number of articles
Introduction	13 (36%)
General description	13 (36%)
Open problems	5 (14%)
Other descriptive issues	5 (14%)
Total	36 (100%)

TABLE 3
NUMBER OF THEORETICAL WORK ARTICLES

Theoretical work	Number of articles
Market modelling	16 (59%)
Information aggregation convergence & equilibrium	9 (33%)
Other theoretical issues	2 (7%)
Total	27 (100%)

TABLE 4
NUMBER OF APPLICATION ARTICLES

Applications	Number of articles
Experiments	13 (18%)
Iowa Electronic Markets	16 (22%)
Other political markets	21 (29%)
Markets on sport events	7 (10%)
Other applications	15 (21%)
Total	72 (100%)

TABLE 5
NUMBER OF LAW AND POLICY ARTICLES

Law & Policy	Number of articles
Legality & regulation	4 (20%)
Public policy & decision making	11 (55%)
The Policy Analysis Market	4 (20%)
Other law & policy issues	1 (5%)
Total	20 (100%)

Table 4 lists the number of articles of each PM application subcategory. 21 articles (29%) were written on other PM than the Iowa political markets, 16 on Iowa Electronic Markets (22%), 15 on other applications (21%) and 13 on various experiments (18%).

AN EXTENDED LITERATURE REVIEW

TABLE 6

CLASSIFICATION OF REVIEWED LITERATURE

	Reference
(a) Description	
Introduction	Boyle and Videbeck (2005), Cherry and Rogers (2006), Dahan and Hauser (2002), Hahn and Tetlock (2005), Hahn and Tetlock (2006), Hanson (1990), Hanson (1991), Hanson (1992), Kambil and van Heck (2002), Passmore et al. (2005), Spann and Skiera (2003) and Sunstein (2006)
General description	Abramovicz (2006), Ankenbrand and Rudzinski (2005), MacKie-Mason and Wellman (2006), Schrieber (2004), Soukhoroukova and Spann (2006), Spann and Skiera (2003), Spann and Skiera (2004), Surowiecki (2004), Tziralis and Tatsiopoulos (2006), Wolfers and Zitzewitz (2004), Wolfers and Zitzewitz (2006), Williams (2005) and Yang (2005)
Open problems	Bubb (2005), Hanson (2006), Sunstein (2004), Sunstein (2006) and Wolfers and Zitzewitz (2006)
Other descriptive issues	Ankenbrand and Rudzinski (2005), Manne (2005), Passmore et al. (2005), Pennock et al. (2001) and Simkins (1999)
(b) Theoretical work	
Market modelling and design	Bergfjord (2006), Chan (2001), Chan (2005), Chen et al. (2006), Fang et al. (2005), Fortnow et al. (2004), Hanson (2002), Hanson (2003), Kazumori (2004), McAdams and Malone (2005), Pennock (1999), Pennock (2004), Pennock et al. (2002), Pennock and Wellman (2001), Tetlock and Hahn (2006) and Tetlock et al. (2005)
Information aggregation convergence & equilibrium	Berg et al. (2003), Feigenbaum et al. (2005), Gjerstad (2005), Hanson (2002), Hanson and Oprea (2004), Koessler et al. (2005), Noeth et al. (1999), Ottaviani and Sorensen (2005) and Pennock and Wellman (1997)
Other theoretical issues	Manski (2006) and Wolfers and Zitzewitz (2006)
(c) Applications	
Experiments	Barner et al. (2004), Berlemann and Forrest (2002), Chan et al. (2002), Chan et al. (2001), Chan et al. (1999), Chen et al. (2001), Chen et al. (2003), Chen et al. (2004), Hanson et al. (2006), Jaisingh et al. (2002), Ledyard et al. (2005), Plott and Chen (2002) and Rietz (2005)
Iowa Electronic Markets	Berg et al. (2000), Berg et al. (1996), Berg et al. (1997), Berg and Rietz (2002), Berg and Rietz (2003), Berg and Rietz (2006), Bondarenko and Bossaerts (2000), Erikson and Wlezien (2006), Forsythe et al. (1992), Forsythe et al. (1999), Fowler (2006), Kou and Sobel (2004), Oliven and Rietz (2004), Pagon (2005) and Rickershauser (2006)

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TABLE 6
CONTINUED

	Reference
Other political markets	Antweiler and Ross (1998), Beckmann and Werding (1996), Berlemann and Schmidt (2001), Bohm and Sonnegard (1999), Brüggelambert (2004), Brüggelambert and Crüger (2002), Filzmaier et al. (2003), Forsythe et al. (1995), Forsythe et al. (1998), Hansen et al. (2004), Hauser (2003), Hauser and Huber (2005), Jacobsen et al. (2000), Kuon (1991), Leigh and Wolfers (2006), Murauer (1997), Ortner (1996), Ortner et al. (1995), Rhode and Strumpf (2006), Wang et al. (2005) and Wolfers and Leigh (2002)
Markets on sport events	Bean (2005), Chen et al. (2005), Debnath et al. (2003), Rosenbloom and Notz (2006), Schmidt and Werwatz (2002), Servan-Schreiber et al. (2004) and Smith et al. (2005)
Other applications	Gruca (2000), Gruca et al. (2001), Gruca et al. (2003), Gruca et al. (2005), Gurkaynak and Wolfers (2006), Mangold et al. (2005), Ortner (1997), Ortner (1998), Pennock et al. (2000), Pennock et al. (2001), Skiera and Spann (2004), Snowberg et al. (2005), Snowberg et al. (2006), Soukhoroukova and Spann (2005) and Tetlock (2004)
(d) Law & Policy	
Legality & regulation	Abramovicz (1999), Bell (2002), Bell (2006) and Hahn and Tetlock (2006)
Public policy & decision making	Abramovicz (2006), Abramovicz (2004), Einbinder (2006), Hahn and Tetlock (2004), Hahn and Tetlock (2005), Hahn and Tetlock (2005), Hahn and Tetlock (2006), Hanson (2003), Hanson (2006), Ledyard (2006) and Wolfers and Zitzewitz (2004)
The Policy Analysis Market	Hanson (2005), Hanson (2006), Meirowitz and Tucker (2004) and Polk et al. (2003)
Other law & policy issues	Abramovicz (2004)

Table 5 shows the number of articles in law and policy related topics. Public policy and decision making was the dominant subcategory, as 55% (11 articles) were published on this topic.

Table 6 presents a summary of all reviewed articles and assigns each of them to their respective subcategory. This is a helpful resource for anyone looking for PM articles in a specific area.

CONCLUSIONS AND RESEARCH IMPLICATIONS

As the nature of research on PM is difficult to be limited to specific disciplines and the origin and growth of the literature is rather recent, the relevant material is scattered across various sources of academic writings. As a result, the research for this literature review was not focused exclusively on journal articles, but also extended to conference proceedings papers, books, book chapters, master's theses, doctoral dissertations and other unpublished academic working papers and reports. This wide literature survey was undertaken in order to identify all PM related academic articles from all possible sources of PM research. This resulted in the identification of 155 PM articles published between 1990 and 2006.

Although this review cannot claim to be exhaustive, it does provide reasonable insights into the state of the PM research. The authors feel that the results presented in this paper have several important implications.

(a) Undoubtedly, PM research and applications will significantly increase in future.
(b) There is a strong need to standardise the terminology used to refer to the PM concept.
(c) The formation and dissemination of a fully appropriate PM mechanism, such as the dynamic pari-mutuel presented by Pennock Pennock (2004), could lead to the expansion of PM research and applications.

REFERENCES

M Abramovicz 'The law-and-markets movement' *American University Law Review* (1999) 49 327–431.

M Abramovicz 'Trial by market: A thought experiment' The George Washington University Law School (2004) Public Law and Legal Theory Working Paper No. 180.

M Abramovicz 'Deliberative information markets for small groups' in R W Hahn and P C Tetlock (eds) *Information Markets: A New Way of Making Decisions* (Washington D.C., AEI Press, 2006) pp 101–125.

M Abramovicz 'Predictive decisionmaking' *Virginia Law Review* (2006) 92 69–122.

M Abramovicz 'Information markets, administrative decisionmaking, and predictive cost-benefit analysis' *University of Chicago Law Review* (2004) 71 933–1020.

B H Ankenbrand and C Rudzinski 'Description & analysis of markets' (2005).

B H Ankenbrand and C Rudzinski 'Taxonomy for information markets' (2005).

W Antweiler and T W Ross 'The 1997 UBC election stock market' *Canadian Business Economics* (1998) 6 15–22.

M Barner, F Feri and C R Plott 'On the microstructure of price determination and information aggregation with sequential and asymmetric information arrival in an experimental asset market' Division of the Humanities and Social Sciences, California Institute of Technology (2004) Social Science Working Paper No. 1204.

G Bean 'Decision market predictions: Separating efficiency and bias' Stanford University (2005).

K Beckmann and M Werding ''Passauer Wahlborse' Information Processing in a Political Market Experiment' *Kyklos* (1996) 49 171–205.

T W Bell 'Gambling for the good, trading for the future: the legality of markets in science claims' *Chapman Law Review* (2002) 5 159–180.

T W Bell 'The prediction exchange: progress in promoting the sciences and useful arts' Chapman University School of Law (2006) Working Paper.

J Berg, R Forsythe, F Nelson and T Rietz 'Results from a dozen years of election futures market research', University of Iowa (2000) Working Paper.

J Berg, R Forsythe and T A Rietz 'What makes markets predict well? Evidence from the Iowa electronic markets' in A W, G W, H P, M B and V D E (eds) *Understanding Strategic Interaction: Essays in Honor of Reinhard Selten* (New York, Springer, 1996) pp 444–463.

J Berg, F Nelson and T Rietz 'Accuracy and forecast standard error of prediction markets' Departments of Accounting, Economics and Finance, Henry B. Tippie College of Business Administration, University of Iowa (2003).

J Berg, R Forsythe and T A Rietz 'The Iowa electronic market' in D Paxson and D Wood (eds) *Blackwell Encyclopedic Dictionary of Finance* (Oxford UK, Blackwell, 1997) pp 111–113.

J Berg and T A Rietz 'Longshots, overconfidence and efficiency on the Iowa electronic market' Tippie College of Business, University of Iowa (2002) Working Paper.

J Berg and T A Rietz 'Prediction markets as decision support systems' *Information Systems Frontiers* (2003) 5 79–93.

J Berg and T A Rietz 'The Iowa electronic markets: stylized facts and open issues' in R W Hahn and P C Tetlock (eds) *Information Markets: A New Way of Making Decisions* (Washington D.C., AEI Press, 2006) pp 142–169.

O J Bergfjord 'Prediction markets as a tool for management of political risk' Norwegian School of Economics and Business Administration (2006).

M Berlemann and N Forrest 'Forecasting inflation via electronic markets. Results from a prototype market' Dresden University of Technology (2002) mimeo.

M Berlemann and C Schmidt 'Predictive accuracy of political stock markets: Empirical evidence from a European perspective' Humboldt Universität Berlin (2001) Working Paper No. 373 2001-57.

P Bohm and J Sonnegard 'Political stock markets and unreliable polls' *Scandinavian Journal of Economics* (1999) 101 205–222.

O Bondarenko and P Bossaerts 'Expectations and learning in Iowa' *Journal of Banking and Finance* (2000) 24 1535–1555.

G Boyle and S Videbeck 'A primer on information markets' ISCR, Victoria University of Wellington (2005).

G Brüggelambert 'Information and efficiency in political stock markets: using computerized markets to predict election results' *Applied Economics* (2004) 36 753–768.

G Brüggelambert and A Crüger 'Election markets: experiences from a complex market experiment' in F Bolle and M Lehmann-Waffenschmidt (eds) *Surveys in Experimental Economics: Bargaining, Cooperation and Election Stock Markets* (Heidelberg, Physica-Verlag, 2002) pp 167–191.

R Bubb 'From uncertainty to risk? Problems with using prices in prediction markets to improve decision making' George Mason University (2005).

N T Chan, E Dahan, A Kim, A Lo and T Poggio 'Securities trading of concepts' MIT (2002) Working Paper No. 172.

N T Chan, E Dahan, A W Lo and T Poggio 'Experimental markets for product concepts' MIT (2001) Working Paper No. 149.

N T Chan, B LeBaron, A W Lo and T Poggio 'Agent-based models of financial markets: a comparison with experimental markets' MIT (1999).

N T Chan 'Artificial markets and intelligent agents' Doctor of Philisophy Thesis, Department of Electrical Engineering and Computer Science, MIT (2001).

K-Y Chen, L R Fine and B A Huberman 'Forecasting uncertain events with small groups' *Proceedings of 3rd ACM conference on Electronic Commerce*, Tampa, Florida, USA (2001) October 14–17 pp 58–64.

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K-Y Chen, L R Fine and B A Huberman 'Predicting the future' *Information Systems Frontiers* (2003) 5 47–61.

K-Y Chen, L R Fine and B A Huberman 'Eliminating public knowledge biases in information-aggregation mechanisms' *Management Science* (2004) 50 983–994.

K-Y Chen 'Markets as an information aggregation mechanism for decision support' Doctor of Philosophy Thesis, School of Information Sciences and Technology, The Pennsylvania State University, Pennsylvania (2005).

K-Y Chen, C-H Chu, T Mullen and D M Pennock 'Information markets vs. opinion pools: an empirical comparison' *Proceedings of 6th ACM conference on Electronic commerce* (Vancouver BC, Canada, ACM Press, 2005).

K-Y Chen, T Mullen and C-H Chu 'An in-depth analysis of information markets with aggregate uncertainty' *Electronic Commerce Research* (2006) 6 201–221.

M A Cherry and R L Rogers 'Markets for markets: origins and subjects of information markets' *Rutgers Law Review* (2006) 58 339.

E Dahan and J R Hauser 'The virtual customer' *Journal of Product Innovation Management* (2002) 19 332–353.

S Debnath, D M Pennock, C L Giles and S Lawrence 'Information incorporation in online in-game sports betting markets' *Proceedings of 4th ACM conference on Electronic commerce* (San Diego, CA, USA, ACM Press, 2003) pp 258–259.

M Einbinder 'Information markets: using market predictions to make today's decisions' *Virginia Law Review* (2006) 92 149–186.

R S Erikson and C Wlezien 'Are political markets really superior to polls as election predictors?' *Proceedings of Annual Meeting of the Midwest Political Science Association* Chicago (2006) April 5.

F Fang, M Stinchcombe and A Whinston '"Putting your money where your mouth is" - Information elicitation mechanism design when agents privately know their quality of information' (2005).

J Feigenbaum, L Fortnow, D M Pennock and R Sami 'Computation in a distributed information market' *Theoretical Computer Science* (2005) 343 114–132.

P Filzmaier, M Beyrl, F Hauser and J Huber 'Wahlbörsen als interdisziplinäres instrument der sozialforschung - erfahrungen aus wahlen in österreich' *SWS Rundschau* (2003) 3/2003 387–410.

R Forsythe, M Frank, V Krishnamurthy and T W Ross 'Using market prices to predict election results: the 1993 ubc election stock market' *Canadian Journal of Economics* (1995) 28 770–794.

R Forsythe, M Frank, V Krishnamurthy and T W Ross 'Markets as predictors of election outcomes: campaign events and judgement bias in the 1993 ubc election stock market' *Canadian Public Policy* (1998) 24 329–351.

R Forsythe, F Nelson, G Neumann and J Wright 'The 1992 Iowa political stock market: september forecasts' *The Political Methodologist* (1994) 5 15–19.

R Forsythe, Nelson F, G R Neumann and J Wright 'Anatomy of an experimental political stock market' *American Economic Review* (1992) 82 1142–1161.

R Forsythe, T A Rietz and T W Ross 'Wishes, expectations and actions: a survey on price formation in election stock markets' *Journal of Economic Behavior & Organization* (1999) 39 83–110.

L Fortnow, J Kilian, D M Pennock and M P Wellman 'Betting boolean-style: a framework for trading in securities based on logical formulas' *Decision Support Systems* (2004) 39 87–104.

J H Fowler 'Elections and markets: the effect of partisanship, policy risk, and electoral margins on the economy' *The Journal of Politics* (2006) 68 89–103.

S Gjerstad 'Risk aversion, beliefs, and prediction market equilibrium' University of Arizona (2005) Working Paper.

T S Gruca 'The iem movie box office market: integrating marketing and finance using electronic markets' *Journal of Marketing Education* (2000) 22 5–14.

T S Gruca, J Berg and M Cipriano 'Do electronic markets improve forecasts of new product success?' University of Iowa (2001).

T S Gruca, J Berg and M Cipriano 'The effect of electronic markets on forecasts of new product success' *Information Systems Frontiers* (2003) 5 95–105.

T S Gruca, J E Berg and M Cipriano 'Consensus and differences of opinion in electronic prediction markets' *Electronic Markets (2005) 15 13–22.*

R S Gurkaynak and J Wolfers 'Macroeconomic derivatives: an initial analysis of market-based macro forecasts, uncertainty and risk' in C Pissarides and J Frankel (eds) *Nber International Seminar on Macroeconomics* (Cambridge, MIT Press, 2006).

R W Hahn and P C Tetlock 'Harnessing the power of information: a new approach to economic development' AEI-Brookings Joint Center for Regulatory Studies (2004) Working paper No. 04-21.

R W Hahn and P C Tetlock 'Big ideas: the market's last frontier' *Milken Institute Review* (2005) 7 83–89.

R W Hahn and P C Tetlock 'Making development work' *Policy Review* (2005) 132 27–39.

R W Hahn and P C Tetlock 'Using information markets to improve public decision making' *Harvard Journal of Law & Public Policy* (2005) 29 214–289.

R W Hahn and P C Tetlock 'Introduction to information markets' in R W Hahn and P C Tetlock (eds) *Information Markets: A New Way of Making Decisions* (Washington D.C., AEI Press, 2006) pp 1–12.

R W Hahn and P C Tetlock 'A new approach for regulating information markets' *Journal of Regulatory Economics* (2006) 29 265–281.

R W Hahn and P C Tetlock 'A new tool for promoting economic development' in R W Hahn and P C Tetlock (eds) *Information Markets: A New Way of Making Decisions* (Washington D.C., AEI Press, 2006) pp 170–194.

J Hansen, C Schmidt and M Strobel 'Manipulation in political stock markets - preconditions and evidence' *Applied Economics Letters* (2004) 11 459–463.

R Hanson 'Could gambling save science? Encouraging an honest consensus' *Proceedings of Eight International Conference on Risk and Gambling*, London (1990).

R Hanson 'Market-based foresight: A proposal' *Foresight Update* (1990) 10 1–4.

R Hanson 'More market-based foresight' *Foresight Update* (1991) 11 11.

R Hanson 'Idea futures: encouraging an honest consensus' *Extropy* (1992) 3.

R Hanson 'Disagreement is unpredictable' *Economic Letters* (2002) 77 365–369.

R Hanson 'Logarithmic market scoring rules for modular combinatorial information aggregation' George Mason University (2002) Working Paper.

R Hanson 'Combinatorial information market design' *Information Systems Frontiers* (2003) 5 107–119.

R Hanson 'Shall we vote on values, but bet on beliefs?' George Mason University (2003) Working Paper.

R Hanson 'Designing real terrorism futures' Department of Economics, George Mason University (2005).

R Hanson 'Decision markets for policy advice' in E Patashnik and A Gerber (eds) *Promoting the General Welfare: American Democracy and the Political Economy of Government Performance* (Washington D.C., Brookings Institution Press, 2006).

R Hanson 'Foul play in information markets' in R W Hahn and P C Tetlock (eds) *Information Markets: A New Way of Making Decisions* (Washington D.C., AEI Press, 2006) pp 126–141.

R Hanson 'Impolite innovation: the technology and politics of 'terrorism futures' and other decision markets' in E Patashnik and A Gerber (eds) *Promoting the General Welfare: American Democracy and the Political Economy of Government Performance* (Washington D.C., Brookings Institution Press, 2006).

R Hanson and R Oprea 'Manipulators increase information market accuracy' George Mason University (2004) Working Paper.

R Hanson, R Oprea and D Porter 'Information aggregation and manipulation in an experimental market' *Journal of Economic Behavior and Organization* (2006) 60 449–459.

F Hauser 'Die Presse Online-Wahlbörse 2002 - Eine Finanzwirtschaftliche Betrachtung' MSc. Thesis, University of Innsbruck, Innsbruck, Austria (2003).

F Hauser and J Huber 'Systematic mispricing in experimental markets – evidence from political stock markets' *Proceedings of International Conference on Finance*, Kopenhagen, Denmark, 2005, 2–4 September.

B Jacobsen, J Potters, A Schram, F v Winden and J Wit '(in)Accuracy of a european political stock market: The influence of common value structures' *European Economic Review* (2000) 44 205–230.

J Jaisingh, S Mehta and A Chaturvedi 'An experimental study of information markets' *Proceedings of The 7th INFORMS Conference on Information Systems and Technology,* San Jose, California, USA (2002).

A Kambil and E van Heck *Making Markets: How Firms Can Design and Profit from Online Auctions and Exchanges* (Boston, MA, Harvard Business School Press, 2002).

E Kazumori 'Foundations of information aggregation mechanisms' *Proceedings of 2nd Workshop on the Economics of Peer-To-Peer Systems* Harvard University (2004) June 4–5 2004.

F Koessler, C Noussair and A Ziegelmeyer 'Individual behavior and beliefs in experimental parimutuel betting markets', Max Planck Institute of Economics, Strategic Interaction Group (2005) Discussion Papers on Strategic Interaction No. 2005–12.

S G Kou and M E Sobel 'Forecasting the vote: a theoretical comparison of election markets and public opinion polls' *Political Analysis* (2004) 12 277–295.

AN EXTENDED LITERATURE REVIEW

B Kuon 'Typical trading behavior in the German election markets 1990' Universität Bonn (1991) Discussion Paper No. B-204.

J Ledyard, R Hanson and T Ishikida 'An experimental test of combinatorial information markets' California Institute of Technology (2005).

J Ledyard 'Designing information markets for policy analysis' in R W Hahn and P C Tetlock (eds) *Information Markets: A New Way of Making Decisions* (Washington D.C., AEI Press, 2006) pp 37–66.

A Leigh and J Wolfers 'Competing approaches to forecasting elections: economic models, opinion polling and prediction markets' National Bureau of Economic Research Inc. (2006) Working Paper No. 12053.

J K MacKie-Mason and M P Wellman 'Automated markets and trading agents' in T Leigh and L J Kenneth (eds) *Handbook of Computational Economics* (Amsterdam, The Netherlands, Elsevier, 1 ed., 2006) pp 1381–1431.

B Mangold, M Dooley, R Dornfest, G W Flake, H Hoffman, T Kasturi and D M Pennock 'The tech buzz game' *IEEE Computer* (2005) 38 94–97.

H G Manne 'Insider Trading: Hayek, Virtual Markets, and the Dog That Did Not Bark' George Mason University School of Law (2005) Working paper No. 7-2005.

C F Manski 'Interpreting the predictions of prediction markets' *Economic Letters* (2006) 91 425–429.

D McAdams and T W Malone 'Internal markets for supply chain capacity allocation' MIT Sloan School of Management / MIT Center for Coordination Science (2005) Working paper No. 4546-05 / 224.

A Meirowitz and J A Tucker 'Learning from terrorism markets' *Perspectives on Politics* (2004) 2 331–335.

G Murauer 'Vergleich Von Wahlprognosen Durch Meinungsumfragen Und Bewertung Durch Börsen Anhand Der Oberösterreichischen Landtagswahl 1997' MSc Thesis, Technische Universität, Vienna (1997).

M Noeth, C F Camerer, C R Plott and M Weber 'Information aggregation in experimental asset markets: traps and misaligned beliefs' (1999).

K Oliven and T A Rietz 'Suckers are born but markets are made: individual rationality, arbitrage, and market efficiency on an electronic futures market' *Management Science* (2004) 50 336–351.

G Ortner 'Experimentelle Aktienmärkte Als Prognoseinstrument: Qualitätskriterien Der Informationsverarbeitung in Börsen Am Beispiel Political Stock Markets' Doktor der Sozial- und Wirtschaftswissenschaften Thesis, Sozial- und Wirtschaftswissenschaftliche Fakultät, Universität Wien, Vienna (1996).

G Ortner 'Forecasting markets - an industrial application, Part I' Technical University of Vienna, Department of Managerial Economics and Industrial Organization (1997) Working paper.

G Ortner 'Forecasting Markets - an industrial application, Part Ii' Technical University of Vienna, Department of Managerial Economics and Industrial Organization (1998) Working paper.

G Ortner, A Stepan and J Zechner 'Political stock markets. The Austrian experiences' *Zeitschrift für Betriebswirtschaft*, 1995, 123–135.

M Ottaviani and P N Sorensen 'Aggregation of information and beliefs in prediction markets' (2005).

A Pagon 'Polls and markets in the 2004 Presidential election: A risk premium to explain deviations between polling predictions and market prices' Department of Economics, Stanford University (2005).

D L Passmore, E D Cebeci and R M Baker 'Market-based information for decision support in human resource development' *Human Resource Development Review* (2005) 4 33–48.

D L Passmore, E D Cebeci and R M Baker 'Potential of idea futures markets in educational technology' *The ICFAI Journal of Derivatives Market* (2005) October pp 56–66.

D M Pennock 'Aggregating probabilistic beliefs: market mechanisms and graphical representations' Doctor of Philosophy Thesis, Computer Science and Engineering Department, University of Michigan (1999).

D M Pennock 'A dynamic pari-mutuel market for hedging, wagering, and information aggregation' *Proceedings of 5th Asian conference on Electronic commerce* (New York, USA, ACM Press, 2004) pp 170–179.

D M Pennock, S Debnath, E J Glover and C L Giles 'Modeling information incorporation in markets with application to detecting and explaining events' *Proceedings of 18th Conference on Uncertainty in Artificial Intelligence (UAI-2002)* Morgan Kaufmann, Alberta, Canada (2002) pp 405–413.

D M Pennock, S Lawrence, C L Giles and F Å Nielsen 'The power of play: efficiency and forecast accuracy in Web market games' NEC Research Institute (2000) No. 168.

D M Pennock, S Lawrence, C L Giles and F Å Nielsen 'The real power of artificial markets' *Science* (2001) 291 987–988.

D M Pennock, S Lawrence, F A Nielsen and C L Giles 'Extracting collective probabilistic forecasts from web games' *Proceedings of 7th ACM SIGKDD international conference on Knowledge discovery and data mining* San Francisco, California (2001) 174–183.

D M Pennock and M P Wellman 'Representing aggregate belief through the competitive equilibrium of a securities market' *Proceedings of 13th Conference on Uncertainty in Artificial Intelligence (UAI-97)* Providence, RI, USA (1997) 392–400.

D M Pennock and M P Wellman 'A market framework for pooling opinions' (2001).

C R Plott and K-Y Chen 'Information aggregation mechanisms: concept, design and implementation for a sales forecasting problem' Division of the Humanities and Social Sciences, California Institute of Technology (2002) Social Science Working Paper No. 1131.

C Polk, R Hanson, J Ledyard and T Ishikida 'The policy analysis market: an electronic commerce application of a combinatorial information market' *Proceedings of 4th ACM conference on Electronic commerce*, San Diego, CA, USA (2003) 272–273.

P W Rhode and K S Strumpf 'Manipulating political stock markets: A field experiment and a century of observational data' University of North Carolina (2006) Working Paper.

J Rickershauser 'Judging the consequential events of the 2004 Presidential campaign: prediction markets, volatility, and campaign effects' Department of Political Science, Duke University (2006).

A T Rietz 'Behavioral mis-pricing and arbitrage in experimental asset markets' Department of Finance, Henry B. Tippie College of Business, University of Iowa (2005).

E S Rosenbloom and W Notz 'Statistical tests of real-money versus play-money prediction markets' *Electronic Markets* (2006) 16 63–69.

C Schmidt and A Werwatz 'How accurate do markets predict the outcome of an event? The Euro 2000 soccer championships experiment' Max Plack Institute for Research into Economic Systems (2002) Technical Report No. 09–2002.

J M Schrieber 'The application of prediction markets to business' MSc Thesis, Engineering Systems Division, MIT (2004).

E Servan-Schreiber, J Wolfers, D M Pennock and B Galebach 'Prediction markets: does money matter?' *Electronic Markets* (2004) 14 243–251.

S P Simkins 'Promoting active-student learning using the world wide web in economics courses' *Journal of Economic Education* (1999) Summer 1999 278–291.

B Skiera and M Span 'Opportunities of virtual stock markets to support new product development' in S Albers (ed) *Cross-Functional Innovation Management* (Wiesbaden, Verlag Gabler, 2004) pp 227–242.

M A Smith, D Paton and L V Williams 'Market Efficiency in Person-to-Person Betting' *Economica* (2005).

E Snowberg, J Wolfers and E Zitzewitz 'Information (in)efficiency in prediction markets' in L V Williams (ed) *Information Efficiency in Financial and Betting Markets* (Cambridge, UK, Cambridge University Press, 2005).

E Snowberg, J Wolfers and E Zitzewitz 'Partisan impacts on the economy: evidence from prediction markets and close elections' National Bureau of Economic Research Inc. (2006) Working Paper No. 12073.

A Soukhoroukova and M Spann 'New product development with internet-based information markets: theory and empirical application' *Proceedings* (2005) Regensburg, Germany.

A Soukhoroukova and M Spann 'Informationsmaerkte' *Wirthschaftsinformatik* (2006) 48 61–64.

M Spann and B Skiera 'Internet-based virtual stock markets for business forecasting' *Management Science* (2003) 49.

M Spann and B Skiera 'Taking stock of virtual markets. how can internet-based virtual stock markets be applied or business forecasting and other forecasting issues?' (2003) 30(5), pp 61–64

M Spann and B Skiera 'Einsatzmöglichkeiten virtueller börsen in der marktforschung' *Zeitschrift für Betriebswirtschaft* (2004) 74 25–48.

C R Sunstein 'Group judgments: deliberations, statistical means, and information markets' AEI-Brookings Joint Center for Regulatory Studies (2004) working paper No. 04–17.

C R Sunstein 'Deliberation and information markets' in R W Hahn and P C Tetlock (eds) *Information Markets: A New Way of Making Decisions* (Washington D.C., AEI Press, 2006) pp 67–100.

C R Sunstein *Infotopia: How Many Minds Produce Knowledge* (USA, Oxford, University Press, 2006).

J Surowiecki *The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations* (New York, Doubleday, 2004).

P Tetlock and R Hahn 'Optimal liquidity provision for decision makers' AEI Brookings Joint Center for Regulatory Studies (2006) Working Paper No. 06–18.

P Tetlock, R Hahn and D Lien 'Designing information markets for decision making' AEI-Brookings Joint Center for Regulatory Studies (2005) Working Paper No. 05–23.

P Tetlock 'How efficient are information markets? Evidence from an online exchange' Department of Finance, University of Texas, Austin (2004) working paper.

AN EXTENDED LITERATURE REVIEW

G Tziralis and I Tatsiopoulos 'Prediction markets: aspects on transforming a business game into a valuable information aggregation tool' *Proceedings of 3rd Future Business Technology Conference* (2006) Athens, Greece (2006) 17–19 April pp 35–39.

S-C Wang, S-P Li, C-C Tai and S-H Chen 'Statistical properties of an experimental political futures market' Institute of Physics, Academia Sinica, Taiwan & Department of Economics, National Chengchi University, Taiwan (2005).

L V Williams 'Models, markets, polls and pundits: a case study of information efficiency' in L V Williams (ed) *Information Efficiency in Financial and Betting Markets* (Cambridge, UK, Cambridge University Press, 2005).

J Wolfers and A Leigh 'Three tools for forecasting federal elections: lessons from 2001' *Australian Journal of Political Science* (2002) 37 223–240.

J Wolfers and E Zitzewitz 'Prediction markets' *Journal of Economic Perspectives* (2004) 18 107–126.

J Wolfers and E Zitzewitz 'Using markets to inform policy: The case of the Iraq war' University of Pennsylvania (2004) Working paper.

J Wolfers and E Zitzewitz 'Five open questions about prediction markets' in R W Hahn and P C Tetlock (eds) *Information Markets: A New Way of Making Decisions* (Washington D.C., AEI Press, 2006) pp 13–36.

J Wolfers and E Zitzewitz 'Interpreting prediction market prices as probabilities' National Bureau of Economic Research Inc. (2006) No. 12200.

J Wolfers and E Zitzewitz 'Prediction markets in theory and practice' in S Durlauf and L Blume (eds) *The New Palgrave Dictionary of Economics* (McMillan, 2nd ed., 2006) pp forthcoming.

A Yang 'Information Markets: A tool for effective decision making' (2005) No. Econ 191A-B.