INFORMATION USE IN A BUSINESS GAME

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ABSTRACT

The use of information is studied by altering the available information for firms playing a business game. It is found that the firms used information about market demand and the exact number of periods that the game is played, but to a lesser extent information in reports. The alterations of available information did not have a significant effect on profits. The decisions in the business game can generally be characterized by dispersion and rigidity, which is similar to what has been observed in real markets.

INTRODUCTION

"Decision makers gather information and do not use it; ask for more and ignore it; make decisions first and look for relevant information afterwards; gather and process a great deal of information that has little or no direct relevance to decisions" – March (1994, p. 226).

Many situations when firms compete are situations where the information available for decision making is limited. It seems reasonable to assume that some information is available in most decision making situations, and that this information is used for decision making. Moreover, most decision makers request relevant information for their decision making. Presumably, this requested information is used to improve decisions. However, it may be the case that some information is not used in decision making and that it does not improve decisions. Since decision making on competitive markets is such an important aspect of business, it is of great interest to study what information is used in decision making.

It might be difficult to observe what information is available and what information is used for decision making in business life. Furthermore, situations in real markets might also have specific properties that cannot be neglected when examining the available information and the decisions made. Therefore, a constructed situation can offer a good alternative for examining information use in decision making (Smith, 1994; Holt, 1995). In a constructed situation, both the information available for decision making and the decision making situation can be reasonably controlled.

In basic experiments in economics, Huck, Normann and Oechssler (1999) found that firms imitated successful decisions, if they had the necessary information. Huck, Normann and Oechssler (2000) also found that information about competitors' decisions made firms more competitive and they earned less profit. However, real markets are characterized by substantial and persistent price dispersion (e.g. Stigler, 1961; Pratt, Wise and Zeckhauser, 1979; Baye, Morgan and Scholten, 2004) and by price rigidity (Carlton, 1986; Blinder, Cancetti, Lebow and Rudd, 1998). Price dispersion means that firms tend to make different decisions on price and price rigidity means that firms tend to stick to their price decisions over time. These two characteristics

imply that firms do not use available information to adjust their decisions with respect to decisions of other firms.

The difference in complexity between decision making situations in experiments in economics and in real markets may be the explanation for the different characteristics of decisions. Business games have an advantage compared to basic experiments in economics as they are closer to real business life conditions (Edman, 2000). The amount and the use of information in a business game have been studied earlier; for example, Biggs (1975) noted the importance of the amount of information, where too much or too little information may cause frustration, and Neal (1999) put forward the idea that information about the market demand may be more relevant than information about competing firms.

Casimir (2000) is one of a number of studies suggesting that business games can be used to teach about information. However despite widespread use of business games, Wolfe and Crookall (1998) acknowledge gaps in the knowledge about the gaming process and about elements that contribute to effective use. When Faria (2001) reviews what business games teach, he emphasizes the importance of research on what type of learning that might occur through participation in a game. The information available for decision making in a game can be used as an element to assess learning and knowledge of basic facts and concepts, since the use of information requires related knowledge. That is, if firms use additional information to improve their decisions, they have related knowledge, but if decisions are not improved the firms do not have the knowledge.

To sum up, the general idea in this study is to use a business game as an experiment. By altering information conditions for firms playing the game, the use of information in decision making is studied. The following questions are posed: What information is used in decision making? What effect does this information have on the decisions and on performance? Is the use of information in the business game similar to the use of information in experiments in economics or to the use of information in real markets?

METHOD

Participants. The participants playing the business game were students in their first year at a Stockholm School of Economics in Sweden (age $M = 21.1$, $SD = 2.3$). It was mandatory for the students to play the game, as they played it for educational purposes as part of a course. The data consists of about 1200 students, in 210 firms, who played the game in five consecutive years with different information conditions. The game was played as a competition among the firms, where the participants in the firm with the highest equity at the end of the game each year, received a small reward (total value of around $30).

The business game. The game is described in detail in Edman and Stahl (2002). It deals with an oligopoly market

where five firms compete by producing and selling similar, but not identical, storable products. The objective of a firm is to maximize the equity at the end of the game.

The firms decide upon four variables in each period (investments in machinery, production quantity, advertising, price). As the decisions are made, three outcome variables are calculated (interest rate, demand, sales). The game has dynamic properties, where four state variables are carried over from one period to the next (machine capacity, stocks, cumulative advertising, balance in checking account). Equity is calculated as the value of machine capacity and stocks plus the balance in the checking account.

The demand for a firm's products in a period is dependent not only on the price and the cumulative advertising of that firm, but also on the prices and the cumulative advertising of the other firms competing in the same market. Hence, the game has the characteristics of an oligopoly market, where there is interdependence among the firms. In this connection it should be mentioned that there are no random factors involved in the game, not even with regard to the demand for the products. Thus, the decisions of the firms completely determine the outcome.

The game is symmetric since all firms face the same costs and demand for their products. The game is divided into periods, where the decisions of all firms are made simultaneously. All firms start with the same amount of equity. If a firm has negative equity, it goes into bankruptcy. The firm can then receive a money grant from the government and continue to play the game. At the end of the game, the grant with interest is deducted from the equity of the firm.

Original information conditions. In the written rules and at the briefing before each game, the firms received the following specific information about the demand for their products in period 1: "If all firms have the price $ 25 and advertising of $ 50, all firms will sell 15 units". This information is called a reference point of demand. Firms received reports after each period. The information in these reports was varied between different periods. The firms received information about the prices of the other firms in all periods; after periods 2 – 5 the firms received total sales and total advertising; after periods 2 and 5 the firms received information about the sales of each firms; after period 3 the firms received information about cash, stock, and capacity of

each firm; after period 5 the firms received information about the advertising of each firm. The firms did not receive exact information about how many periods the game would be played. The game was stopped without further notice after 5 – 10 periods, usually after 6 – 7 periods.

Altered information conditions. The original information conditions were altered in each of four consecutive years (called year 2 – 5 in Table 1 below). The first alteration was to change the reference point to: "If all firms have the price $ 30 and advertising of $ 100, all firms will sell 12 units". The reports were also altered from varied reports in different periods to all reports in all periods. The second alteration was that three firms received varied reports in different periods and two firms received all reports in all periods when competing in the same market. The firms were informed about the asymmetric information conditions. The third alteration was to give the firms so-called demand tables, where they could, for the mean price and the mean advertising of the other firms, see their own sales for a number of combinations of decisions on price and advertising. The firms received all reports in all periods and they received information that the game would be played exactly for six periods. The fourth alteration was to change the reference point to be the same as in the first alteration (price 30, advertising 100, and sales 12), but the reports were varied in different periods as in the original information conditions.

To sum up the information conditions: there are six different information conditions; that is, the original information condition year 1, one alteration of the information condition in each of years 2, 4 and 5, and two alterations year 3. The following abbreviations are used for the information conditions: V – varied reports, A – all reports, R – altered reference point, I – information about asymmetric information, D – demand table, E – exact number of periods. The reference points of demand are abbreviated 25/50/15 or 30/100/12. The original information conditions and the alterations are summarized in Table 1, and the numbers of firms and the number of bankruptcies in each information conditions. For combined alterations, the abbreviations are also combined, for example in Table 1, VI means varied reports and information about asymmetric information, and AI means all reports and information about asymmetric information.

Table 1. Information conditions, number of firms and number of bankruptcies.

Information	Year - Information condition				
	1 - V	2 - RA	3 - VI/AI	4 - DAE	5 - RV
Reference point	25/50/15	30/100/12	25/50/15	25/50/15	30/100/12
Demand table	No	No	No	Yes	No
Reports	Varied	All	Varied/All	All	Varied
Asymmetric conditions	No	No	Yes	No	No
End of game, periods	5 – 10	5 – 10	5 – 10	6	5 – 10
Number of firms	40	40	27/18	40	45
Number of bankruptcies	2	1	1/1	8	6

By making comparisons of decisions between pairs of information conditions, the effect of the alteration of specific information can be assessed. The following comparisons of decisions will be made to study the effect of:

- Alteration of the reference point (V – RV)
- Additional information in reports (RV – RA and VI – AI)
- Information about asymmetric information (V – VI)
- Demand table and exact information about how many periods the game will be played (RA – DAE)

Procedure. In each of the five years, the students were divided into nine separate game sessions to play the business game. The game was played during three consecutive weeks, three evenings each week. In each game session, the groups of participants, acting as firms, consisted of two to nine participants. The game took about three to four hours to play, including the briefing before the game started and the debriefing at the end of the game, which together took about one hour. The participants could ask questions about the game at the briefing and also during the game session. For instance, they sometimes needed help to understand the reports. However, no answers were given to questions about specific decision alternatives or how many periods the game would be played. It should be pointed out that the different firms were not allowed to exchange information with each other during the game. The game was played with a test period, where the firms can test their decisions. The game was then restarted from "scratch" and played for a number of periods. At the start of the game, the time for decision making was about 20 minutes. In later periods of the game, this time decreased.

RESULTS

The results are based on six periods playing of the game. To give an overview of the decisions for the six different information conditions, Figures 1 and 2 show mean prices and mean advertising. Decisions on production are not illustrated as the mean production for the different information conditions are very similar. Decisions on investments are strongly related to decisions on production. Therefore only decisions on production are analyzed. The appendix shows mean and standard deviations of price, advertising, production and equities in six periods for the six information conditions (V – varied reports, RA – altered reference point and all reports, VI – varied reports and information about asymmetric information, AI – all reports and information about asymmetric information, DAE – demand table, all reports and exact number of periods, RV – altered reference point and varied reports).
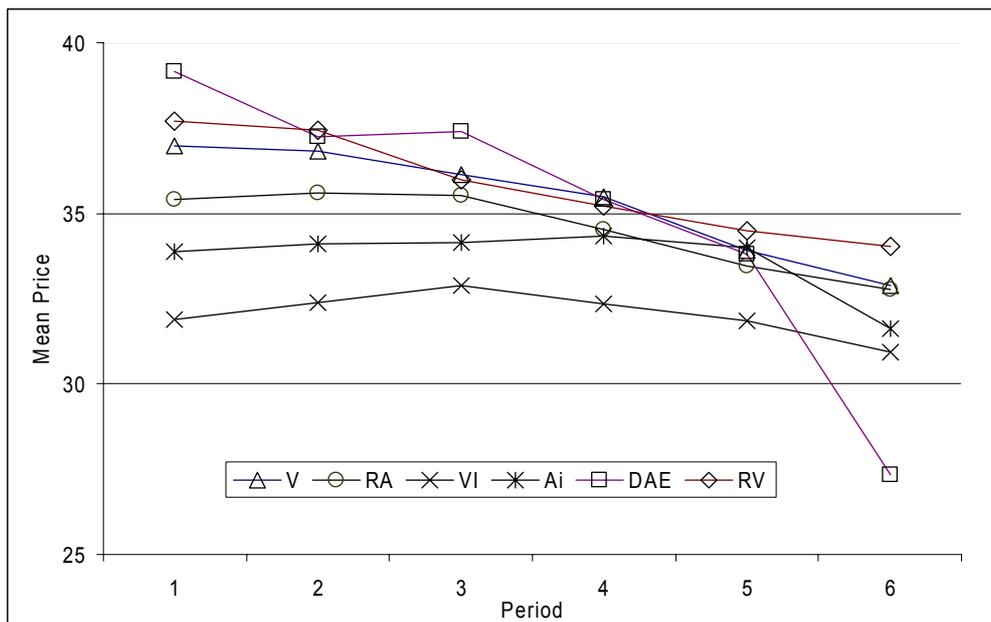

Figure 1. Mean prices of firms with different information conditions.

Figure 1 shows that generally for the six different information conditions, mean prices decrease from range 32 – 39 in period 1, to range 31 – 34 in period 6. There is one exception for firms with demand table and exact information about the number of periods (DAE) in period 6, where the mean price is lower (27).
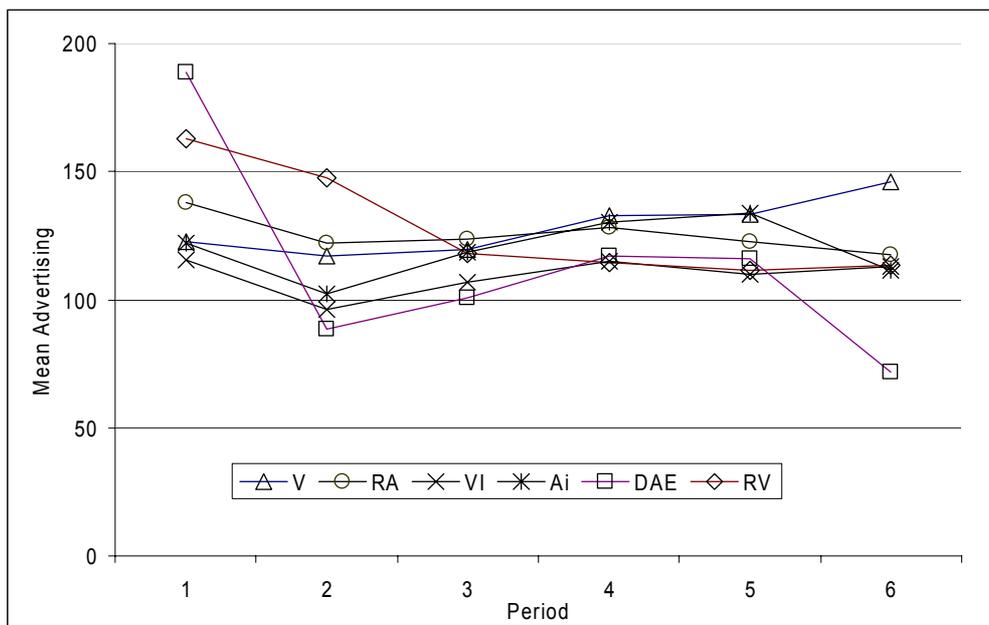
Figure 2. Mean advertising of firms with different information conditions.

Figure 2 shows that generally for five of the six different information conditions, mean advertising is in range 96 – 163. There are two exceptions, namely for firms with demand table and exact information about the number of periods (DAE) in period 1 where the mean advertising is higher (189) and in period 6 where the mean advertising is lower (72).

To assess the overall use of specific information in all of the six periods of the game, the statistical test multiple analysis of variance is used (Hair, Anderson, Tatham and Grablowsky, 1984). The test uses decisions as dependent variables: prices, advertising and production, and it uses information conditions as independent variables: reference point, information in reports, information about asymmetric information conditions, and demand table and information about the number of periods the game will be played. Table 2 shows F values for differences between decisions in all six periods for different information conditions, by pair-wise comparisons of each independent variable. The notion "Total" in Table 2 refers to tests where all three decision variables are tested at the same time. It shall be pointed out that univariate analysis of F-test for differences between the decisions in each of the six periods for the three decision variables give similar results to those shown in Table 2.

Table 2. Multiple analysis of variance with F values (Significance of F *p<.05, **p<.01).

	Information condition – Pair-wise comparison				
	V – RV	RV – RA	VI – AI	V – VI	RA – DAE
Decisions	Reference point	Varied/ All reports	Varied/ All reports	Asymmetric information	Demand table End of game
Price	.63	1.13	.38	1.02	4.31**
Advertising	2.78*	1.37	.57	1.43	7.06**
Production	.48	.60	1.60	1.03	.98
Total	2.78**	1.19	1.48	.99	4.20**

Table 2 shows that the alteration of reference point (V – RV) has significant effect on advertising, and also for the three decision variables combined. Table 2 also shows that the demand table and information about the exact number of periods the game will be played (RA – DAE), have significant effect on prices, advertising and the three variables combined. Alterations of reports (RV – RA and VI – AI) and information about asymmetric information conditions (V – VI) have no significant effects on decisions.

Performance in the game is measured with equity at the end of period 6. The mean equities for the six different information conditions are in the range 384 – 524 (standard deviation in range 179 – 303), but there are no significant differences between the equities (F(5, 204) = .99, p = .43). The largest difference between the means on equities is between firms with information about asymmetric information (VI – AI), but the difference is not significant (F(1, 43) = 2.63, p =.11).

Dispersion among decisions on price and advertising are measured with coefficient of variance (standard deviation divided by mean). Table 3 shows the maximum and the minimum coefficient of variance in six periods for the six information conditions. Table 3 also shows mean absolute adjustments of decisions from one period to the next.

As mentioned, the firms received information in reports, either varied reports (V) or all reports (A), about the decisions the other firms made. The firms could adapt their decisions to the mean decisions of the other firms in the previous period or to the decisions of the leader in the previous period.

Adaptation is defined as: A firm has adapted its decision in a period, if the absolute difference between the mean decision or the decision of the leader in the previous period is smaller in the present period compared to the previous period. Table 3 shows adaptation in percent.

Table 3. Coefficient of variances, absolute adjustments and adaptation of decisions.

| | Information condition | | | | | |
	V	RA	VI	AI	DAE	RV
Coefficient of variance						
Price maximum	.29	.21	.20	.19	.28	.22
Price minimum	.16	.11	.11	.11	.16	.18
Advertising max	.60	.44	.47	.56	1.42	.54
Advertising min	.34	.33	.33	.27	.42	.40
Mean absolute adjustment						
Price	2	2	2	2	5	2
Advertising	33	28	29	24	73	37
Adaptation in percent to						
Mean price	32	38	44	40	36	34
Leader price	39	48	53	42	45	39
Mean advertising	33	32	37	28	30	37
Leader advertising	45	39	50	48	47	44

Table 3 shows the ranges for the coefficients of variance, .11 – .29 for prices and .33 – 1.42 for advertising. The maximum coefficient of variance for advertising (1.42) for firms with demand table and exact information when the game will end (DAE) is in period 6. In periods 1 – 5 it is .67. With this exception, there are no large differences in dispersion measured with coefficients of variance between the six different information conditions. However, the dispersion among decisions is substantial.

Firms with demand table and exact information when the game ended (DAE) made significantly larger absolute adjustments on price ($F(5,1044) = 19.20$, $p = .00$) and on advertising ($F(5,1044) = 27.43$, $p =.00$). Firms without this information made absolute adjustments between periods on price of about 6% (absolute adjustment on price of about 2) and on advertising of about 25% (absolute adjustment on advertising of about 30). Hence, the adjustments on prices show rigidity, while the adjustments on advertising are larger.

The adaptations of decisions are in the range of 28 – 53 % and about the same for all six information conditions. With two exceptions, the adaptations are less than the 50 % that would be obtained by binary decisions whether to adapt or not. Therefore, the decisions of the firms cannot be characterized by adaptiveness to the decisions of other firms.

DISCUSSION

A business game was used as an experiment to study what information firms use in their decision making. It was found that information about market demand and information about the exact number of periods the game was played was used in the decision making. Decisions on price and advertising differed significantly when firms had this information available. However, additional information in reports did not have significant effects on decisions. These results are in line with the idea put forward in Neal (1999). The time for decision making may have been too limited to make use of additional information in the reports. However, the time was sufficient to make use of demand tables.

Compared to basic experiments in economics (Huck et al. 2000), firms did not become more competitive in the sense that equity at the end of the game decreased when firms had additional information available. However, there were differences in decisions when firms had this additional information and these differences can have a positive effect on equity when other firms competing on the same market do not have this information (Edman, 2000).

The use of information in the business game was more similar to the use of information in real markets compared to the use of information in experiments in economics. Dispersion among decisions in real markets can be explained by asymmetric conditions for the firms. However, the business game is symmetric in the sense that all firms face the same costs and demand for their products and dispersion among decisions in the game have to be explained by differences in how firms use information in their decision making. It could be argued that information conditions with limited information about market demand and no exact number of periods when the game would end have most resemblance to information conditions in real markets. With these conditions, the firms in the game adjusted their decisions the least; that is, firms showed most rigidity, especially for prices. Furthermore, firms in the business game were not particularly adaptive to the decisions of other firms. This may be explained with the relative complexity of the business game compared to basic experiments in economics.

Although the results in this study rely on a fairly large number of firms, replications and further alterations of the information conditions would be beneficial. For further developing the knowledge of gaming/simulation (Wolfe and Crookall, 1998), it would be of interest to adjust the parameters in the game.

The results from this study can be used to improve learning when playing this business game and possibly other games (Faria, 2001). First, market demand and exact number of periods is relevant information when playing the game and

may be provided for pedagogical reasons. Second, the use of the information in the reports needs to be improved. Third, characteristics such as dispersion and rigidity of decisions in real markets can be demonstrated in the game. This is of great importance since these characteristics are in conflict with traditional economic theory.

REFERENCES

Baye, M., Morgan, J. & Scholten, P. (2004) "Persistent Price Dispersion in Online Markets", in *The New Economy* (D. W. Jansen, Ed.), University of Chicago Press, forthcoming.

Biggs, W. (1975) "Some Impacts of Varying Amounts of Information on Frustration and Attitudes in a Finance Game". *Simulation Games and Experiential Exercises in Action,* 2, 103-110.

Blinder, A., Cancetti, E., Lebow, D. & Rudd, J. (1998) *Asking about prices: A new approach to understanding price stickiness*. New York: Russell Sage Foundation, 1998.

Carlton, D. (1986) "The Rigidity of Prices." *American Economic Review*, 76(4), 637-658.

Casimir, R. (2000) "Teaching about Information with Management Games", *Developments in Business Simulation & Experiential Learning*, 27, 42-47 .

Edman, J. (2000) *Information use and decision making in groups - A study of an Experimental Oligopoly Market with the Use of a Business Game*, Stockholm, Sweden: EFI, Stockholm School of Economics. Doctoral thesis.

Edman J. & Ståhl, I. (2002) "The anatomy of a business game", *SSE/EFI Working Paper Series in Business Administration*, The Economic Research Institute, Stockholm School of Economics, 2002:8.

Faria, A. (2001) "The changing nature of business simulation/gaming research: a brief history", *Simulation and Gaming*, 32(1), 97-110.

Hair, J., Anderson, R., Tatham, R. & Grablowsky, B. (1984) *Multivariate Data Analysis With Readings*. New York: Macmillan Publishing Co.

Holt, C., (1995) "Industrial organization: A survey of laboratory research", in J. Kagel & A. Roth (Eds.), *The Handbook of Experimental Economics*, 349–443. Princeton, New Jersey: Princeton University Press.

Huck, S., Normann, H. & Oechssler, J. (1999) "Learning in Cournot Oligopoly – An Experiment." *Economic Journal*, 109, C80-C95.

Huck, S., Normann, H. & Oechssler, J. (2000) "Does Information about Competitors' Actions Increase or Decrease Competition in Experimental Oligopoly Markets?", *International Journal of Industrial Organization*. 18(1), 39-57.

March, J. (1994) *A Primer in Decision Making – How Decisions Happen*. New York: The Free Press.

Neal, D. (1999) "How consistent are winning strategies? The role of competitor analysis and budgets on performance in a simulation." *Simulation and Gaming*, 30(2), 118-131.

Pratt, J., Wise, D. & Zeckhauser, R. (1979) "Price Differences in Almost Competitive Markets." *Quarterly Journal of Economics*, 93(2), 189-211.

Smith, V. (1994) "Economics in the Laboratory". *Journal of Economic Perspective*, 8(1), 113-131.

Stigler, G. (1961) "The Economics of Information". *Journal of Political Economy*, 69(3), 213-225.

Wolfe, J. & Crookall, D. (1998) "Developing a scientific knowledge of gaming/simulation", *Simulation and Gaming*, 29(1), 7-19.

APPENDIX

Mean decisions and equities (with standard deviations in parentheses) for different information conditions.

Information condition	Period					
	1	2	3	4	5	6
	Price					
V	37 (11)	37 (10)	36 (7)	35 (6)	34 (6)	33 (6)
RA	35 (8)	36 (6)	36 (5)	35 (4)	33 (4)	33 (5)
VI	32 (6)	32 (6)	33 (6)	32 (5)	32 (4)	31 (3)
AI	34 (7)	34 (6)	34 (4)	34 (4)	34 (6)	32 (4)
DAE	39 (8)	37 (8)	37 (7)	35 (6)	34 (6)	27 (8)
RV	38 (8)	37 (8)	36 (7)	35 (6)	34 (7)	34 (6)
	Advertising					
V	122 (44)	117 (40)	120 (47)	133 (56)	133 (71)	146 (87)
RA	138 (51)	122 (54)	124 (44)	128 (42)	123 (40)	118 (48)
VI	116 (41)	96 (40)	107 (43)	115 (55)	110 (43)	113 (38)
AI	122 (68)	102 (29)	118 (31)	130 (40)	134 (53)	111 (48)
DAE	189 (79)	89 (57)	101 (53)	117 (50)	116 (78)	72 (102)
RV	163 (65)	147 (75)	118 (51)	115 (49)	112 (55)	114 (61)
	Production					
V	10 (4)	11 (4)	12 (4)	12 (3)	12 (4)	13 (4)
RA	10 (3)	11 (3)	12 (3)	12 (3)	12 (3)	13 (3)
VI	10 (2)	12 (3)	13 (4)	13 (4)	13 (3)	12 (3)
AI	11 (4)	12 (4)	12 (3)	13 (2)	13 (3)	13 (4)
DAE	10 (4)	11 (4)	12 (4)	12 (4)	12 (4)	13 (5)
RV	11 (5)	11 (4)	11 (5)	11 (5)	12 (5)	12 (5)
	Equity					
V	199 (46)	230 (87)	277 (117)	318 (157)	382 (172)	432 (215)
RA	190 (35)	217 (66)	256 (100)	303 (133)	372 (174)	446 (221)
VI	193 (43)	223 (70)	255 (84)	294 (102)	351 (133)	427 (179)
AI	183 (64)	239 (60)	292 (76)	351 (106)	428 (168)	524 (221)
DAE	144 (74)	197 (111)	248 (149)	296 (195)	370 (227)	431 (303)
RV	166 (49)	149 (96)	207 (103)	259 (141)	318 (170)	384 (213)

V	varied reports
RA	altered reference point and all reports
VI	varied reports and information about asymmetric information
AI	all reports and information about asymmetric information
DAE	demand table, all reports and exact number of periods
RV	altered reference point and varied reports