



Market Entry Decisions In An Experimental Game Setting

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Abstract

Combining perspectives from population ecology and strategy research, this paper examines the effects of legitimization, heterogeneity among players, and uncertain capacity on market entry decisions in an experimental game setting. We find that heterogeneity and uncertain capacity did little to impair the high levels of coordination between aggregate entry decisions and market capacity. However, introducing legitimization made it difficult for entrants to coordinate their entry decisions at or near threshold values. We also find substantial individual differences in entry strategies - a necessary condition to achieve equilibrium - and no movement away from equilibrium predictions in the direction of Pareto optimal outcomes.

Market entry decisions are among the most important and complex strategic considerations that firms face. Whether viewed from the perspective of *incumbents* – firms already in the market - or *entrants* – firms new to the market – entry decisions present opportunities for substantial rewards as well as threats to a firm's continued prosperity and survival. Narasimhan and Zhang (2000) report that in a typical year over 15,000 new products are introduced in US markets alone and that nearly 80% of new consumer products and 33% of industrial products fail early on. Many of these failures are not due to poorly designed products, or flawed strategies; they can be traced to the dynamic and interdependent qualities of a competitive industry. New entrants take market share away from incumbent firms (Porter, 1981), in effect reducing their share of the "pie". Entrants also intensify competition, bringing additional production or service capacity, new products, and possibly reduced prices (Besanko, Dranove, and Shanley, 2000).

Market entry has been studied from a variety of business perspectives including strategy, marketing and economics. Economic research has long held that entry is a key aspect of the competitive process. Recent studies have examined the effects of entry using dynamic market models (Amel and Liang, 1997), the effects of contests to coordinate entry decisions (Nti, 2000), and "entry-inducing entry" - whether entry by a single firm can induce even further entry by other firms as a result of weakening the incumbent's ability to produce at low cost (Seabright, 1996). Strategy research on market entry decisions has often focused on issues of first mover advantage (Lieberman and Montgomery, 1988; Robinson, Fornell and Sullivan, 1992; Huff and Robinson, 1994), mode of market entry (Madhok, 1997; Anoop, 1997; Pan, Li and Tse, 1999), barriers to entry (Prahalad and Hamel, 1990; Gulati, 1995; Bakema, Bell and Pennings, 1996), and performance (Haveman, 1992; Inkpen and Birkenshaw, 1994; Nitsch, Beamish and Shige, 1996). Finally, research from marketing perspectives center on issues of cannibalization



(Moorthy and Png, 1992; Huey, 1999) timing (Mitchell, 1989; Parry and Bass, 1990; Narasimhan and Zhang, 2000), and brand extensions (Sullivan, 1992). Interestingly, few of the studies mentioned above share a common definition of market entry. Descriptions range from simple brand extensions to foreign direct investment. Further, many of the theories of market entry are criticized for being either too complex or not applicable in broader contexts. For example, Buckley and Casson (1998) argue that the popular theories describing firms' market entry decisions are "too much of a paradigm or framework and too little of a model to provide detailed advice on research design and hypothesis testing". Not only are the theories under attack, but some researchers argue that empirical studies have not produced consistent findings (Pan, Li, and Tse, 1999). Even the long held beliefs of pioneering advantages have come under siege in favor of "prudent laggards" (Narasimhan and Zhang, 2000).

Given criticisms of both empirical results, and specific theories that frame market entry decisions, perhaps a different approach is warranted. To understand what factors are important in making these types of decisions, we step back from these narrower, rather specific theories of market entry and consider more general theories from different schools of organizational research, in particular population ecology and resource dependence. Population ecologists, borrowing analogies from the biological sciences, see organizations engaged in a struggle for existence against others in their "niche" (Davis & Powell, 1992). The ones that survive are the ones that best adapt to powerful or changing environmental forces. This school of research has done much to advance our understanding of organization-environment relationships, and brought a wealth of new study variables, including terms like isomorphism, imprinting, liability of newness, and most important for the present study - legitimation.

Legitimation is described as a "taken for granted status", referring to the industry, niche or other appropriate collection of firms. While there is little disagreement that all industries are characterized by at least some form of competitive pressures due to capacity concerns, ecological studies of organizations have claimed that new industries or markets need first to be legitimated (Hannan, 1986) before there is much opportunity for profits. Firms competing in industries that have yet to achieve this taken for granted status may find support lacking from important stakeholder groups. For example, financing institutions may be reluctant to fund firms with unproven business models, or ventures into new markets; or simply charge a premium if they do opt for funding. Qualified employees may be hesitant to join a business that is not well established, or among the first to leave at the initial sign of weakness or poor performance. Likewise, complementary goods may not be developed to support sales of the new venture, or suppliers may simply demand payment in advance or upon delivery. Lacking full support from stakeholders, it becomes more difficult and/or costly for the early entrants to become profitable and survive.

These types of problems are thought to make firms cautious about entering a market that has yet to legitimate. Indeed, Hannan and Carroll have found a predictable pattern in the population density of newly established markets (1992). During the early period of an industry, very few firms appear willing to enter the market, and those that do enter tend to experience relatively high rates of mortality. This initial period may last many years, as has been the case with the American brewing and life insurance industries which each encountered low entry for over 100 years. However, once a number of firms have entered the market, these organizations



gain a taken for granted status, which can reduce some of the added burden created by various stakeholder groups.

This is the process of legitimation. It is argued this occurs through a "numbers" effect in which, up to a point, the greater the number of firms in the market, the greater the perception of that market's legitimacy and the greater the payoff to market entrants (Hannan, 1991; Aldrich and Fiol, 1995). Ecological studies have shown such a numbers effect on the founding and mortality of firms with some regularity (Hannan and Freeman, 1989; Hannan and Carroll, 1992), however, there is little agreement about the interpretation of this finding or in what ways firm-level strategies for entering new markets might be affected, if at all (Baum and Oliver, 1991, 1992; Petersen and Koput, 1991; Haveman, 1992). In a similar fashion, researchers have been searching for ways to explain why some new markets go through an initial period of "fits and starts", in which the number of firms in the market oscillates between too many and too few, dropping to zero at irregular, sometimes prolonged, intervals. Are such industries struggling to become legitimated? Or, do fools (those less fit, perhaps with greater entry costs) rush in first, and hence fall out before wise firms have prepared for entry (Aldrich and Fiol, 1995)?

Strategy researchers, who generally favor resource dependence arguments over those from population ecology, identify a different set of factors important to market entry decisions. Resource dependence theory holds that firm's behavior can often be explained by patterns of environmental dependence. According to Pfeffer and Salancik (1978), environmental dependence is determined by three fundamental characteristics of the environment: (1) concentration - the extent to which power and authority are dispersed, (2) munificence - the availability or scarcity of critical resources, and (3) interconnectedness - the number and pattern of linkages connecting organizations. This dependence constrains and controls the organization; it is a source of great uncertainty. As the organization seeks to reduce its dependence on the environment, it must constantly balance two opposing forces: certainty and autonomy (Davis & Powell, 1992). Note that managing uncertainty is not unique to resource dependence theorists. Williamson's transaction costs economics (1975) posits uncertainty as one of the three dimensions by which exchanges with the environment are measured, and earlier, both Thompson (1967) and Katz and Kahn (1966) see uncertainty as a powerful force in any characterization of the organization-environment relationship.

In addition to resource dependence arguments, strategy researchers, most notably Bain (1956) and Porter (1981) contend that certain structural aspects of an industry might best explain firms' market entry decisions. These factors, which include control of essential resources, economies of scale and scope, capital requirements, access to distribution channels, and government policy are seen as structural barriers that limit the industry's appeal, or the ability of new entrants to compete successfully. In addition to these structural barriers to entry, Porter, in his classic five-forces theory, argues that the bargaining power of buyers and suppliers, the potential for substitute products, and the general degree of rivalry among existing competitors, influence the perceived attractiveness of an industry or market. He further argues that the greater the number of firms and the higher degree of symmetry between firms can add to rivalry in an industry.

Clearly, population ecology and resource dependence theorists are not the only groups to propose variables important to market entry decisions. While we might consider other schools of



organizational research, such as agency or institutional theory, our intent here is not to compile an exhaustive list of variables. Rather, our interest is in combining perspectives from two (rather different) schools of organizational thought, and demonstrating how certain factors important to market entry decisions can be tested in an experimental setting. Borrowing from the perspectives of population ecology and resource dependence, we examine the effects of legitimation, heterogeneity, and uncertain market capacity on market entry decisions in an experimental game setting. The remainder of the paper is organized as follows. Section 2 addresses some of the shortcomings of the more traditional field or case-based research, and what advantages a game-theoretic perspective might add. Section 3 describes the method and subject population. Section 4 presents the results of the study, concentrating on three main areas: how well aggregate entry decisions tracked market capacity, whether any of the experimental groups moved away from equilibrium predictions, possibly in the direction of Pareto optimal outcomes, and individual differences in entry decisions. Finally, Section 5 provides a discussion of the results.

Traditional Research Methods

Much of the organizational research discussed above has been dominated by field or case-based research. Although informative, this method of research fails to address several weaknesses. First, notably for studies at the population level, there are often multiple explanations for an aggregate result. What is considered to be single market using one level of Standard Industry Classification (SIC) code can be considered a number of different markets when using a more refined SIC code. Related to this problem is the concept of unobserved heterogeneity as posited by Petersen and Koput (1991). Their findings suggest that it is sometimes differentiation of product among competitors that leads to a decrease in mortality rates found in some markets. It is difficult for field studies to readily account for such unobserved heterogeneity. This difficulty means that inference is typically based on theoretical arguments, in which the first or cleverest may prevail. Second, post-hoc studies of industries may be biased by the inability to get archival data on industries that never got off the ground, or did so only for a very limited time. Related is the problem of sample selection, in which those typically studied, being those who in-fact entered, were also those most compelled to do so (whether out of economic or social rationality). The needed contrast with those firms for whom entry was feasible but either never considered or considered and found not to be sensible, is unavailable. Third, the effects of determinant variables of interest are often confounded. That is, we do not have control over the combinations of levels of the purportedly determinant variables, though they may be of separate theoretical or practical interest. This is a most damaging problem for ethnographic or case studies, in which several variables may be contributing to a result. It can also occur in comparative industry studies. For instance, we cannot fully understand the consequences of forming inter-organizational networks if they have only occurred in industries with high stakes.

To overcome these weaknesses, we conducted a series of experimental studies of market-entry games to investigate key unanswered questions about the dynamics of organizational populations. Experiments of this kind cannot tell us the complete story, because they will always lack some features of the markets they intend to simulate. Nevertheless, the key features studied by organizational theorists lend themselves to study using experimental games since they can be readily and meaningfully manipulated. Furthermore, experiments allow us to (1) observe and



record individual choices as they occur, (2) observe markets in which no entries occur, (3) control the levels, and combinations, of population parameters, and (4) in many cases, establish the equilibrium behavior. Hence, market-entry and exit experiments can help resolve disagreements or uncertainties about the micro dynamics that underlie inconsistent, controversial, missing, or otherwise inconclusive field studies. The attractiveness of market entry experiments is that they are simplifications of real entry decisions that can be complicated in a controlled manner, to potentially uncover the factors that make coordination in real entry so difficult.

Games and Entry

Wilson (1992), produced a review of game-theoretical models concerned with preemption (how a firm claims and preserves a monopoly position), signaling (how an incumbent firm reliably conveys information that discourages unprofitable entry or survival of competitors), and predation (how an incumbent firm profits from battling a current entrant to deter subsequent potential entrants). As this study implies, the majority of the research and models seem biased toward incumbent behavior. In contrast, there has been scant formal use of either the theoretical or experimental paradigms of game theory to study problems in newly emerging industries. Yet if history is important, as previous studies have shown, we must understand what goes on as industries or markets begin to emerge in order to fully understand what goes on later in their "life-cycles".

Rapoport (1995) began experimental investigations of market entry decisions in a very simple game with symmetric (structurally homogeneous) players. In his experiment the game is played by a group of n players for T periods (trials). At the beginning of each period, a different positive integer, c (interpreted as the capacity of market) is publicly announced ($1 \leq c \leq n$). Each player then decides, privately and anonymously, whether to enter the market or to stay out. Communication before or during the game was strictly prohibited, with players separated by partitions. Individual payoffs, denoted $H_i(d)$, were computed for each trial using the formula: $H_i(1) = k + r(c - m)$; $H_i(0) = k$.

Here, m is the number of entrants, and k and r are previously determined constants. Entry is indicated by $d=1$, and staying out of the market by $d=0$. The game included $T=20$ trials, with 10 values of c presented once in each of two blocks, in random order. In one session, feedback was provided at the end of each trial regarding c , m , and H_i ; in another, no feedback was given until the end of all trials. Regardless of the feedback condition, Rapoport found positive and highly significant correlations between the values of c and the number of entrants, summarized over subjects and blocks. Further, there was a small and decreasing difference between the values of c and m . The correlation averaged 0.91 in the final session, and the value of $c-m$ averaged 1.20. These results support the Nash equilibrium solution at the group level, which prescribe that either $m=c$ or $m=c-1$. However, the equilibrium solution was not supported at the individual level. The solution prescribes that individuals employ a mixed strategy, entering the market with probability $p=(c-1)/(n-1)$ and staying out with probability $1-p$ (Rapoport, 1995). Instead, individuals used deterministic rules, or pure strategies, in which individual differences were substantial and did not diminish over time.



In a subsequent paper examining coordination and equilibrium behavior in market entry games, Sundali, Rapoport and Seale (1995) illustrated how much subjects in their experiments could have made if somehow they could have tacitly agreed to reduce aggregate entry decisions, then "share the wealth" with some unspecified rotation scheme. Although the experimental design, which prohibited any form of communication, made it both difficult and unlikely for subjects to successfully coordinate on higher payoffs, and subjects showed no signs of moving toward these higher levels, the question remains interesting and important. Intrigued by these early findings, we continue and extend this work focusing on two important methodological changes. First, we conduct the market entry experiments over a computer network rather than employ manual data collection. This allows for significantly more repetitions or "trials". Second, we introduce conditions such as player asymmetry, legitimation thresholds, and uncertain capacity that render the design more realistic for newly emerging markets.

Method

Subjects

One hundred and eighty subjects, recruited through ads in the campus newspaper, postings on campus bulletin boards and announcements in management classes, participated in the series of experiments. Subjects, who were assigned to one of the six experimental conditions, received a \$5 show up fee plus the opportunity to earn between \$20 and \$30 in a 2-hour session, dependent on their performance. Each experimental session (group) contained exactly 20 subjects, however, because the Original Condition (OC) and Asymmetry entry (AE) were intended as baseline studies for this and other research inquiries, each was replicated. In Condition OC, three groups of symmetric subjects faced no entry costs, certain market capacity, and no legitimation thresholds. In Condition AE heterogeneity was introduced between players by charging differential fees, if and only if, a player entered the market. To maintain a game-theoretic solution, the distribution of entry fees, which was equally divided between five different integer values from 1 to 5, was common knowledge. Entry fees remained fixed throughout the sessions. Both groups in this condition also faced certain market capacity and no legitimation thresholds. The single group of subjects assigned to the Uncertainty low (UL) condition did not incur a cost for making a market entry decision, nor face a legitimation threshold, but did encounter uncertainty in the capacity of the market that was realized. Low uncertainty was implemented by announcing that the market capacity would obtain one of three consecutive integer values, with each value equally likely. For example, the market capacity for a given trial might be announced as 6, 7 or 8. Similarly, the group of subjects in the Uncertainty high condition (UH) incurred no cost for making a market entry decision and did not encounter legitimation thresholds. Market capacity for a given trial would obtain one of five consecutive integer values (i.e., 5, 6, 7, 8 or 9), with each value equally likely.

Subjects' per trial earnings in the first four conditions were computed from the following formula:

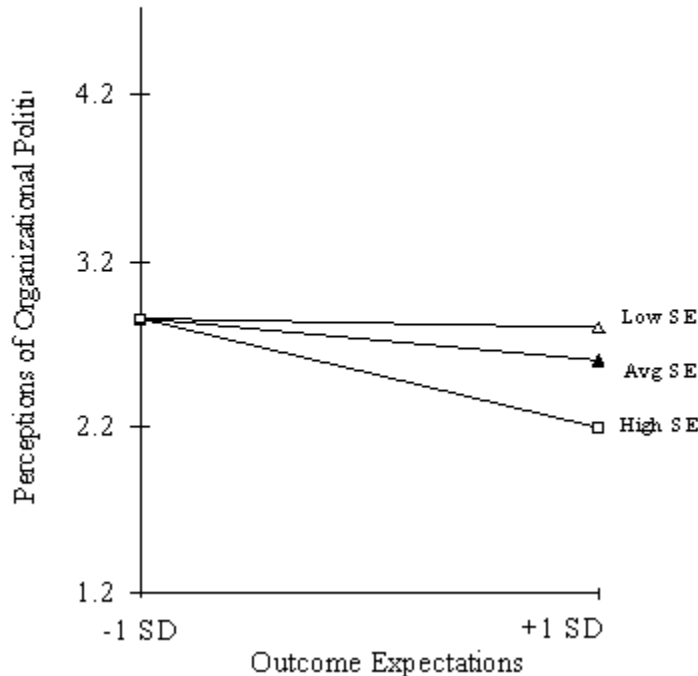


$$H_i(d) = \begin{cases} v & \text{if } d = 0 \\ k + r(c - m) - a_i & \text{if } d = 1 \end{cases}$$

where v , k and r are constants, fixed throughout the experiment at 1, 1 and 2, respectively, c is the actual market capacity for the trial, m is the number of market entrants (determined at the end of the trial), and a_i is the individual (asymmetric) entry cost per trial. This value was set to zero for Conditions OC, UL and UH, and set to 1, 2, 3, 4 or 5, with each value equally likely, for Condition AE. Subjects who chose to stay out of the market ($d = 0$) were guaranteed a payoff of 1, whereas subjects who chose to enter the market ($d = 1$) might earn more or less, depending on the number of other entrants, and their individual entry cost, if any.

The remaining two groups of subjects, Legitimation high (LH) and Legitimation low (LL), faced zero entry costs and certain market capacity, but were presented with legitimation thresholds, which we denote by g . Legitimation concerns can be introduced into the market entry game in a variety of ways. We choose simply to penalize subjects who entered when the market failed to legitimize ($m < g$), and to remove the penalty when the market reached or surpassed the legitimation threshold ($m \geq g$). Thus, the payoff formulas for these two conditions were modified as follows to reflect the penalty:

Figure 2
Organizational Politics Perceptions Regressed on Outcome Expectations: Low, Average and High Self-Efficacy



The legitimation threshold was set at $g=5$ for Condition LL, and $g=10$ for Condition LH

Procedure



Upon arrival at the lab, subjects were randomly assigned to computer workstations and provided with written instructions informing them that they would play 100 repeated trials of a market entry game. The only difference between trials would be the publicly announced market capacity, c . In the first four conditions the value of c was an integer from 1 to 19. In the last two conditions the market capacity was an integer between g and 19. However, in each condition only ten different market capacity values, randomized independently within each block of ten trials, were chosen. Each trial followed a similar pattern where subjects were first informed of the market capacity value, then asked to make a binary decision - they could either enter the market or stay out. After all twenty subjects made their market entry decision, a central computer informed them of the total number of entrants and their earnings for the trial, as well as their cumulative earnings for all completed trials. In Conditions UL and UH subjects also learned the actual market capacity that was realized, and in Conditions LL and LH whether the market reached the legitimization threshold. After all subjects completed reviewing this summary information, the next trial began.

Results

The discussion of results is organized into three sections. In the first section, we examine how well aggregate entry decisions tracked market capacity, beginning with the three groups of Condition OC. Because this condition included symmetric players, certain market certainty, and no legitimization thresholds, it provides important baseline measures for the remaining conditions. Once these baseline measures are established, we examine entry decisions for the remaining conditions, noting whether or not the introductions of player asymmetry, uncertainty in market capacity and legitimization thresholds impaired overall coordination. In the second section of results, we investigate whether any of the groups moved away from equilibrium predictions, possibly in the direction of Pareto optimal outcomes. The final section of results examines individual differences in entry decisions.

Aggregate Entry Decisions

To assess how well entry decisions track capacity, we examine two measures - the correlation coefficient between c and m , and the number of violations of monotonicity. Monotonicity, implied by both the pure and mixed strategy equilibrium solutions, simply requires that m increase in c . A violation is counted whenever $m(c_i) > m(c_{i+1})$. That is, whenever the number of entry decisions for a given value of c is greater than the number for the next highest value of c (within the same block). Table 1 displays the number of entry decisions for the three groups who participated in condition OC. The table is divided into three panels, with each panel showing the number of entry decisions by c , across block. The last three columns of each panel show the total, mean and standard deviation number of entries, respectively, for each value of c . The last two rows of each panel report the total entries and the correlation between c and m for each block of ten trials. Across the three groups the correlations ranged from a low of 0.79 to a high of 0.99. The correlations for each group are lowest in the first block (0.79, 0.81 and 0.89 for groups 1, 2 and 3, respectively), then rapidly increase averaging 0.95, 0.93 and 0.96 across the ten blocks.

This improved level of coordination between market capacity and entry decisions can also be seen in the decreasing number of violations of monotonicity in the number of entry decisions for



each value of c . Across the three groups we find 43 violations of monotonicity with 8 of these occurring in the first block of trials and 5 occurring in the second block of trials. Only three violations can be seen in the final block of trials across the three groups. To test for differences in entry decisions between the three groups we conducted a $3 \times 10 \times 10$ (group by c by block) ANOVA, with block as a repeated measure. The ANOVA indicated a highly significant main effect for c ($F=244.0$, $p<0.000$), no effects for group and block, and no interactions. The main effect for c is clearly visible in Table 1 and captured in the discussion of correlations, above. Due to the lack of main effect for group, data across the three groups will be combined in subsequent analyses.

The entry decisions for subjects in Condition AE are reported on Table 2. The format of this table is identical to that of Table 1, with the number of decisions summarized by block and value of c . The decisions for group 1 appear on the top panel while the decisions for group 2 appear on the bottom panel. The pattern of correlations between c and m are very similar to those noted for Condition OC; the lowest values, 0.84 and 0.89 for groups 1 and 2, respectively, appear in the first block of trials. The correlations for the two groups quickly improve averaging 0.95 and 0.97, respectively, over the ten blocks. The number and patterns of violations to monotonicity are also very similar to those of Condition OC. Across the ten blocks in both groups we find 25 violations, of which 10 occur in the first two blocks. As with Condition OC, there was no between group manipulation; having multiple groups simply affords more reliable baseline measures. However, to test for spurious differences between the two groups we conducted a $2 \times 10 \times 10$ (group by c by block) ANOVA, with block as a repeated measure. Similar to Condition OC, we find a highly significant main effect for c ($F=196.6$, $p<0.000$), no effects for group and block, and no interactions. The data displayed across the two groups in Condition AE will be combined in subsequent analyses.

Table 1
Number of Entry Decisions by c , Across Block - Condition OC

Group 1													
c	Block										Total	Mean	SD
	1	2	3	4	5	6	7	8	9	10			
1	1	0	2	1	0	0	3	1	0	0	8	0.8	1.03
3	8	5	4	2	1	5	2	5	5	4	41	4.1	2.02
5	9	6	4	6	2	8	3	3	5	3	49	4.9	2.33
7	6	7	7	6	9	11	3	11	8	7	75	7.5	2.42
9	5	9	10	11	10	6	8	11	6	9	85	8.5	2.17
11	16	11	10	10	13	11	9	12	13	9	114	11.4	2.17
13	8	14	10	12	12	10	14	13	13	13	119	11.9	1.97
15	11	13	13	15	15	14	14	15	14	13	137	13.7	1.25
17	16	17	17	16	17	19	13	16	17	18	166	16.6	1.58
19	18	18	17	19	18	17	18	18	17	19	179	17.9	0.74
Total	98	100	94	98	97	101	87	105	98	95	973	96.5	
Corr.	0.79	0.98	0.98	0.99	0.97	0.91	0.95	0.96	0.96	0.98		0.95	



Group 2

Block											Total	Mean	SD
c	1	2	3	4	5	6	7	8	9	10			
1	1	1	1	2	0	1	1	0	1	0	8	0.8	0.63
3	4	4	3	2	3	4	5	2	3	5	35	3.5	1.08
5	12	3	6	7	6	3	6	6	3	6	58	5.8	2.66
7	5	8	10	9	5	5	13	6	7	7	75	7.5	2.59
9	3	14	10	9	7	9	10	6	13	7	88	8.8	3.26
11	13	11	11	12	8	14	13	4	17	9	112	11.2	3.58
13	14	9	14	14	13	8	11	12	10	14	119	11.9	2.28
15	10	17	15	12	16	15	17	10	15	16	143	14.3	2.67
17	15	15	16	16	16	17	17	18	16	16	162	16.2	0.92
19	19	19	20	19	19	17	17	18	18	18	184	18.4	0.97
Total	96	101	106	102	93	93	110	82	103	98	984	97.6	
Corr.	0.81	0.92	0.98	0.97	0.98	0.94	0.92	0.92	0.91	0.97		0.93	

Group 3

Block											Total	Mean	SD
c	1	2	3	4	5	6	7	8	9	10			
1	2	1	1	1	1	1	2	2	3	1	15	1.5	0.71
3	5	3	2	5	3	3	4	4	2	3	34	3.4	1.07
5	8	6	2	4	5	7	4	5	3	3	47	4.7	1.89
7	9	6	9	6	4	7	7	8	6	11	73	7.3	2.00
9	3	11	10	11	10	8	7	10	9	8	87	8.7	2.41
11	13	12	7	11	11	11	8	13	10	13	109	10.9	2.08
13	12	12	17	15	9	14	14	13	9	10	125	12.5	2.64
15	13	15	14	11	18	16	14	15	14	14	144	14.4	1.84
17	17	18	15	16	17	17	16	16	18	16	166	16.6	0.97
19	17	18	19	17	19	19	18	19	18	18	183	18.3	0.82
Total	99	102	96	97	97	103	95	104	93	97	983	96.8	
Corr.	0.89	0.99	0.93	0.95	0.96	0.99	0.97	0.99	0.96	0.94		0.96	

Table 2
Number of Entry Decisions by c, across Block - Condition AE

Group 1

Block											Total	Mean	SD
c	1	2	3	4	5	6	7	8	9	10			
1	2	0	0	0	0	1	0	0	0	0	3	0.3	0.67
3	0	1	2	2	3	4	2	1	2	2	19	1.9	1.10
5	7	6	2	3	5	3	3	4	5	4	42	4.2	1.55
7	1	9	3	7	6	7	7	5	4	5	54	5.4	2.32
9	9	3	11	9	8	7	8	8	7	7	77	7.7	2.06



11	9	7	16	9	11	8	10	9	10	9	98	9.8	2.44
13	11	10	10	8	13	11	11	10	12	12	108	10.8	1.40
15	7	16	15	10	13	12	13	13	15	12	126	12.6	2.63
17	12	15	12	11	15	15	15	15	14	16	140	14.0	1.70
19	13	18	14	14	16	16	17	17	17	16	158	15.8	1.62
Total	71	85	85	73	90	84	86	82	86	83	825	82.5	
Corr.	0.84	0.92	0.86	0.95	0.99	0.98	0.99	1.00	0.98	0.99		0.95	

Group 2

Block													
c	1	2	3	4	5	6	7	8	9	10	Total	Mean	SD
1	5	1	1	0	1	0	1	0	0	0	9	0.9	1.52
3	2	4	1	4	2	1	2	3	2	1	22	2.2	1.14
5	3	4	4	5	4	6	2	3	3	4	38	3.8	1.14
7	6	7	5	6	8	7	7	9	6	5	66	6.6	1.26
9	14	8	11	7	6	9	5	6	8	8	82	8.2	2.66
11	9	12	8	10	8	11	9	8	10	8	93	9.3	1.42
13	12	11	13	11	12	9	13	10	12	10	113	11.3	1.34
15	14	15	11	14	13	14	12	15	11	15	134	13.4	1.58
17	16	14	15	17	13	15	15	13	14	15	147	14.7	1.25
19	15	17	18	16	16	17	17	15	16	17	164	16.4	0.97
Total	96	93	87	90	83	89	83	82	82	83	868	86.8	
Corr.	0.89	0.98	0.96	0.98	0.98	0.97	0.97	0.95	0.99	0.99		0.97	

Thus, on the surface, we see no indication that introducing player asymmetry impaired aggregate coordination. However, because the twenty players in each group in this condition were distributed among five different cost types, it is important to examine not only aggregate coordination, but coordination between types. The results of this examination are displayed in Table 3. The five levels of per-trial entry cost represent the column headings and the 10 values of c account for the rows of the table. The frequencies in the table capture the number of times out of 80 (4 players per cost type $\times$ 2 groups $\times$ 10 trials) that players entered the market. For example, the 8 players assigned to cost type 1 entered the market 0 times when $c=1$ was presented, and 5 times when $c=3$ was presented. The total and the predicted number of entries by cost type are reported at the bottom of the table. The predicted number of entries comes from Rapoport, Seale and Winter (in press). In their theoretical analysis of asymmetric players in the market entry game, they provided (efficient) equilibrium predictions for the number of entry decisions by c and cost type. Their predictions included several testable propositions: (1) if $c \leq 5$, only players of type 1 should enter; (2) if $c \leq 9$, only players of types 1 and 2 should enter; (3) if $c \leq 15$, only players of types 1, 2, and 3 should enter; and (4) for any $c \in \{1, 3, 5, \dots, 19\}$ no player of type 5 will ever enter. Tests of these predictions are reported below.

Table 3
Number of Entries by c across Cost Type for Condition AE.

Cost Type						
c	1	2	3	4	5	Total
1	0	2	7	1	2	12



3	5	27	4	1	4	41
5	16	42	12	8	2	80
7	25	48	23	11	13	120
9	30	58	32	16	23	159
11	40	68	40	21	22	191
13	52	65	49	25	30	221
15	66	64	54	42	34	260
17	68	74	69	43	33	287
19	68	78	71	64	41	322
Total	370	526	361	232	204	1693
Predicted*	680	240	160	60	0	1140

* The number of entry decisions if players achieve the efficient equilibrium.

An examination of Table 3 clearly suggests that, although players' aggregate entry decisions were highly correlated with market capacity, the number of entry decisions by cost type was clearly inconsistent with equilibrium predictions. Players assigned to type 1 entered too infrequently, while players assigned to the other types entered too frequently. Proposition 1 (above) suggesting that when $c \leq 5$ only type 1 players should enter is clearly rejected as 112 of the 133 entry decisions came from players of type 2 through 5. Proposition 2, which indicates that only type 1 and 2 players should enter when $c \leq 9$ is also clearly not supported as players of types 3, 4 and 5 entered a total of 159 times over these five values of c . Likewise, Proposition 3 and 4 find no support as players assigned to cost types 4 and 5 entered too frequently for $c \leq 15$, and players assigned to cost type 5 entered a total of 204 times when equilibrium predictions implied no entry decisions.

The number of entry decisions for the two uncertainty conditions (UL and UH) are reported in Table 4. The format of this table is analogous to that of Tables 1 and 2. The pattern of correlations between c and m are nearly identical to those of the two previous conditions; the correlations are lowest in the earlier blocks of trials, then gradually improve over time. Across all ten blocks the mean correlation is 0.94 and 0.91 for Conditions UL and UH, respectively. Violations of monotonicity also reveal patterns consistent with the previous conditions, with 13 of the 38 total violations occurring in the first two blocks of trials. Although a slightly greater proportion (59% vs. 41%) of violations occur in the high uncertainty condition (UH), this difference fails to reach significance.

Table 4
Number of Entry Decisions by c , across Block - Conditions UL and UH

Condition UL													
Block													
c	1	2	3	4	5	6	7	8	9	10	Total	Mean	SD



1	0	2	0	2	1	1	1	1	0	2	10	1.0	0.82
3	4	2	5	2	4	4	3	2	4	1	31	3.1	1.29
5	8	6	5	5	7	4	3	7	6	5	56	5.6	1.51
7	10	2	10	8	4	6	4	10	11	6	71	7.1	3.14
9	7	13	7	8	9	12	9	13	6	8	92	9.2	2.57
11	8	8	7	7	11	10	12	8	9	10	90	9.0	1.70
13	5	15	9	13	14	10	11	12	14	11	114	11.4	2.95
15	13	15	15	13	15	14	17	17	14	13	146	14.6	1.51
17	17	13	14	17	15	15	16	16	16	14	153	15.3	1.34
19	19	17	19	19	19	19	17	19	19	18	185	18.5	0.85
Total	91	93	91	94	99	95	93	105	99	88	948	94.8	
Corr.	0.86	0.89	0.92	0.97	0.97	0.96	0.97	0.94	0.95	0.99		0.94	

Condition UH

Block													
c	1	2	3	4	5	6	7	8	9	10	Total	Mean	SD
2	4	2	4	2	6	2	1	3	1	2	27	2.7	1.57
3	4	1	6	4	3	2	4	5	2	4	35	3.5	1.51
5	3	7	7	4	6	7	5	6	7	5	57	5.7	1.42
7	6	4	11	8	4	3	10	10	4	11	71	7.1	3.25
9	11	11	4	6	9	10	5	12	8	7	83	8.3	2.75
11	5	13	6	12	17	12	5	13	9	13	105	10.5	4.06
13	13	11	10	14	12	9	11	16	11	13	120	12	2.05
15	15	17	12	13	12	13	11	14	14	12	133	13.3	1.77
17	12	16	15	15	17	16	16	17	17	14	155	15.5	1.58
18	16	14	16	17	18	16	16	17	16	16	162	16.2	1.03
Total	89	96	91	95	104	90	84	113	89	97	948	94.8	
Corr.	0.88	0.92	0.81	0.97	0.88	0.93	0.89	0.96	0.97	0.92		0.91	

To test for differences between the low and high uncertainty conditions, we conducted a 2 x 8 x 10 (condition x c x block) ANOVA, with block as a repeated measure. Only the eight values of c that were common to both uncertainty conditions were used in the analysis. The results indicated a highly significant main effect for c ($F = 66.9$, $p < 0.000$), but no effects for condition or block. The interpretation is straightforward, indicating that increasing levels of uncertainty had little effect on aggregate entry decisions; subjects were neither more nor less likely to enter the market as uncertainty in c increased, and aggregate entry decisions were unaffected by experience.

The number of entry decisions for the two legitimization conditions (LL and LH) are displayed in Table 5. The format of this table is comparable to Tables 1, 2, and 4, with the frequency of entry displayed by c across block. The top panel of the table shows entry decisions for the low legitimization condition (LL), and the bottom panel for the high legitimization condition. The familiar pattern of lower correlations between c and m in the first block(s) of trials followed by higher correlations in the remaining blocks is only somewhat evident in Condition LL, but clearly not present in Condition LH. Closer examination of the c by block entry data indicates



that players struggled to legitimate markets when the values of c were at or near the legitimation threshold values. In Condition LL, where the threshold value was $g=5$, markets (trials) with capacities of $c=5, 6$ and 7 never experienced sufficient entries to legitimate. Players who entered on these capacities consistently lost money. However, markets for capacities $c \geq 8$, legitimated 68 out of 70 times.

Table 5
Number of Entry Decisions by c , across Block - Conditions LL and LH

Condition LL

c	Block										Total	Mean	SD
	1	2	3	4	5	6	7	8	9	10			
5	2	0	0	0	0	1	1	0	1	1	6	0.6	0.70
6	1	0	0	1	1	0	1	1	1	1	7	0.7	0.48
7	3	2	2	3	2	1	2	1	0	3	19	1.9	0.99
8	4	2	8	7	7	10	6	9	8	7	68	6.8	2.35
9	13	5	9	13	11	10	8	11	8	8	96	9.6	2.50
11	11	15	13	12	10	12	12	11	12	15	123	12.3	1.64
13	7	16	14	11	14	14	11	15	13	12	127	12.7	2.58
15	18	16	14	15	15	15	15	11	17	12	148	14.8	2.10
17	16	15	16	19	16	16	18	17	17	14	164	16.4	1.43
19	17	18	19	19	18	19	19	19	18	19	185	18.5	0.71
Total	92	89	95	100	94	98	93	95	95	92	943	94.3	
Corr.	0.88	0.92	0.94	0.93	0.95	0.93	0.98	0.91	0.95	0.92		0.93	

Condition LH

c	Block										Total	Mean	SD
	1	2	3	4	5	6	7	8	9	10			
10	4	0	0	0	0	0	0	0	0	0	4	0.4	1.26
11	2	0	0	0	0	0	0	0	0	0	2	0.2	0.63
12	4	0	0	0	0	0	0	0	0	0	4	0.4	1.26
13	10	8	4	2	0	0	2	0	1	0	27	2.7	3.59
14	12	12	12	10	15	14	11	11	16	17	130	13.0	2.36
15	16	14	16	15	15	15	16	15	15	14	151	15.1	0.74
16	18	16	11	18	18	13	16	14	15	15	154	15.4	2.32
17	16	18	18	17	15	18	19	17	16	16	170	17.0	1.25
18	19	18	18	18	17	16	16	16	17	18	173	17.3	1.06
19	19	18	19	19	19	17	19	19	19	19	187	18.7	0.67
Total	120	104	98	99	99	93	99	92	99	99	1002	100.2	
Corr.	0.94	0.95	0.94	0.94	0.89	0.89	0.93	0.93	0.90	0.89		0.92	



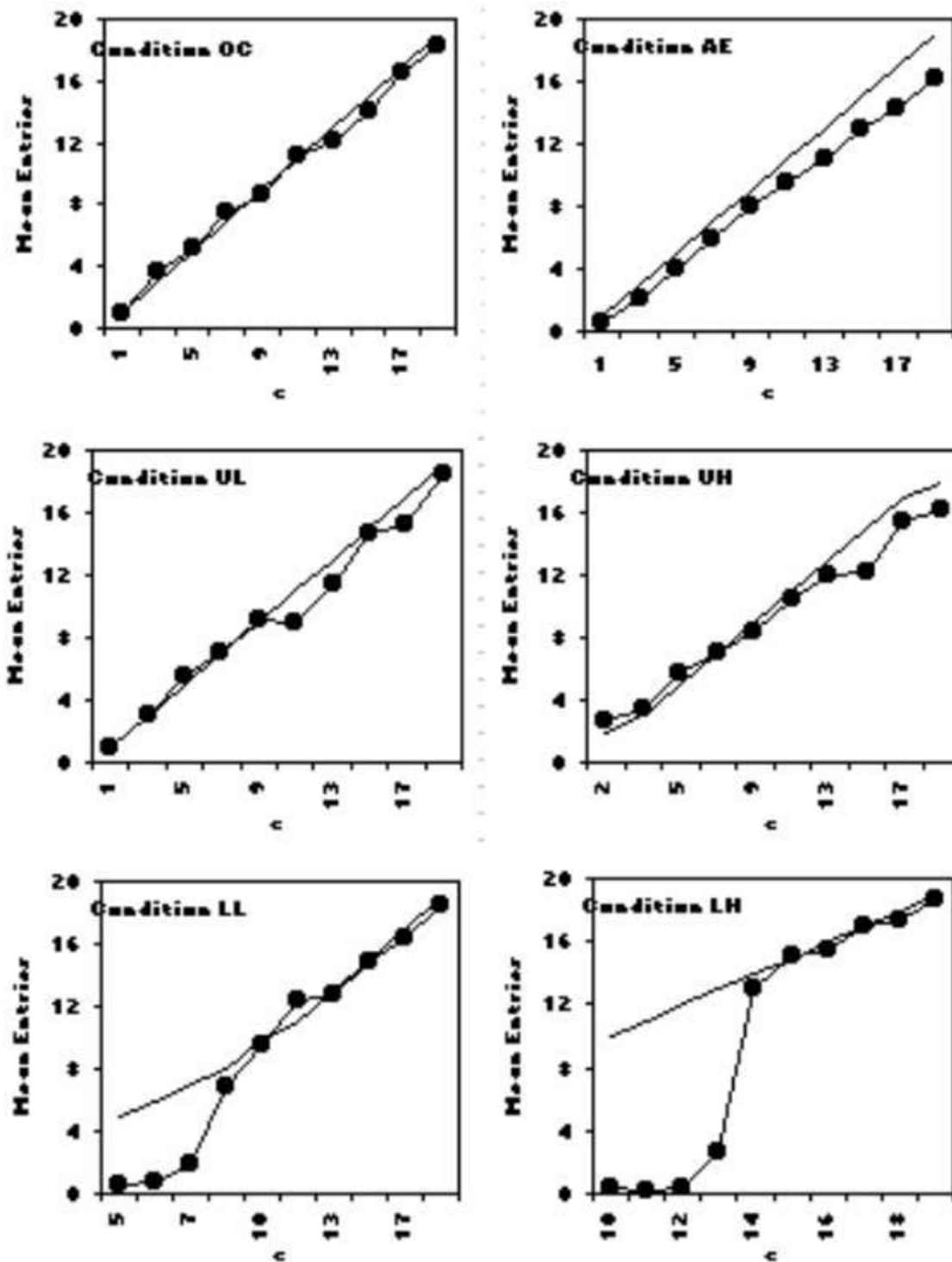
The results for Condition LH, where the threshold value was $g=10$, are even more pronounced. Markets for $c=10, 11, 12$ and 13 (with one exception in block 1) never achieved legitimation. In fact, after the first block of trials, none of the players even attempted to legitimate markets where $c=10, 11$ or 12 . Entry decisions for $c=13$ decayed rapidly as well, dropping from 10 and 8 in blocks 1 and 2, to 4 and 2 in blocks 3 and 4. The remaining markets where $c \geq 14$ legitimated on all 60 occasions.

Although this struggle to achieve legitimation at or near the threshold values had obvious impacts on the correlations between c and m , there is little evidence that this impacted the other measure of coordination - violations of monotonicity. Indeed, the usual pattern of higher violations in the first block of trials, followed by fewer violations in subsequent blocks is maintained. Across both legitimation conditions, 6 violations are noted in block one, followed by only 18 in the remaining 9 blocks. Again, there is no significant difference in the proportion of violations between conditions.

In summary, we find that entry decisions track well with market capacity in all of the experimental conditions, except the legitimation conditions of LL and LH. Here, players struggled to legitimate markets that were at or near threshold values. This result can be seen clearly in Figure 1. This figure is divided into six panels, corresponding to the experimental sessions. In each panel, the mean number of entries (combined over group) by c is displayed as the solid bold line with circular markers. For comparison, the solid line without markers plots $m = c$ for each condition. Note that the values of c presented for Conditions UH and LL do not conform to equal intervals, thus the plots of $m = c$ appear bent at certain values of c . This figure captures the degree of coordination reported in the correlation measures of Tables 1, 2, 4 and 5. In Condition OC mean entries track market capacity across the entire range of values of c . However, in Condition AE mean entries seem to separate, or fall short of market capacity as c increases. This separation or difference is clearly predicted in equilibrium, where higher cost entrants (type 5) stay out of the market.



Figure One
Experimental Sessions



The mean number of entries plotted for the two uncertainty conditions (UL and UH) appear to exhibit more variance in tracking market capacity across the ten values of c . However,



this is an artifact due to the number of observations. Recall that three groups and two groups were combined in conditions OC and AE, respectively. The uncertainty and legitimation conditions contain but a single group. Finally, the mean entries for the two legitimation conditions, plotted on the bottom panel of Figure 1, clearly reveal the difficulty subjects had in coordinating entry decisions at or near legitimation thresholds. However, once market capacity safely exceeded legitimation thresholds ($c > 8$ for Condition LL and $c > 13$ for Condition LH) the usual pattern of entry decisions tracking market capacity returned.

Tacit Coordination Toward Pareto Optimal Outcomes

As mentioned above, players can greatly improve their combined earnings if they succeed in lowering the total number of entry decisions in a given market. This "surplus" profit might then be shared through some sort of rotation scheme, where some players tacitly agree to stay out of the market on certain trials and enter on others. Clearly, this outcome is not in equilibrium as players who choose not to enter would have an incentive to reverse their decision. Further, this level of coordination would prove difficult to achieve, given the player's inability to communicate or form binding agreements. In addition, the previous analyses showing the number of entry decisions by c and block indicated little deviation from equilibrium predictions. Additional support of the players' inability to coordinate decisions in the direction of Pareto optimal outcomes is offered in Figures 2 and 3.



Figure Two

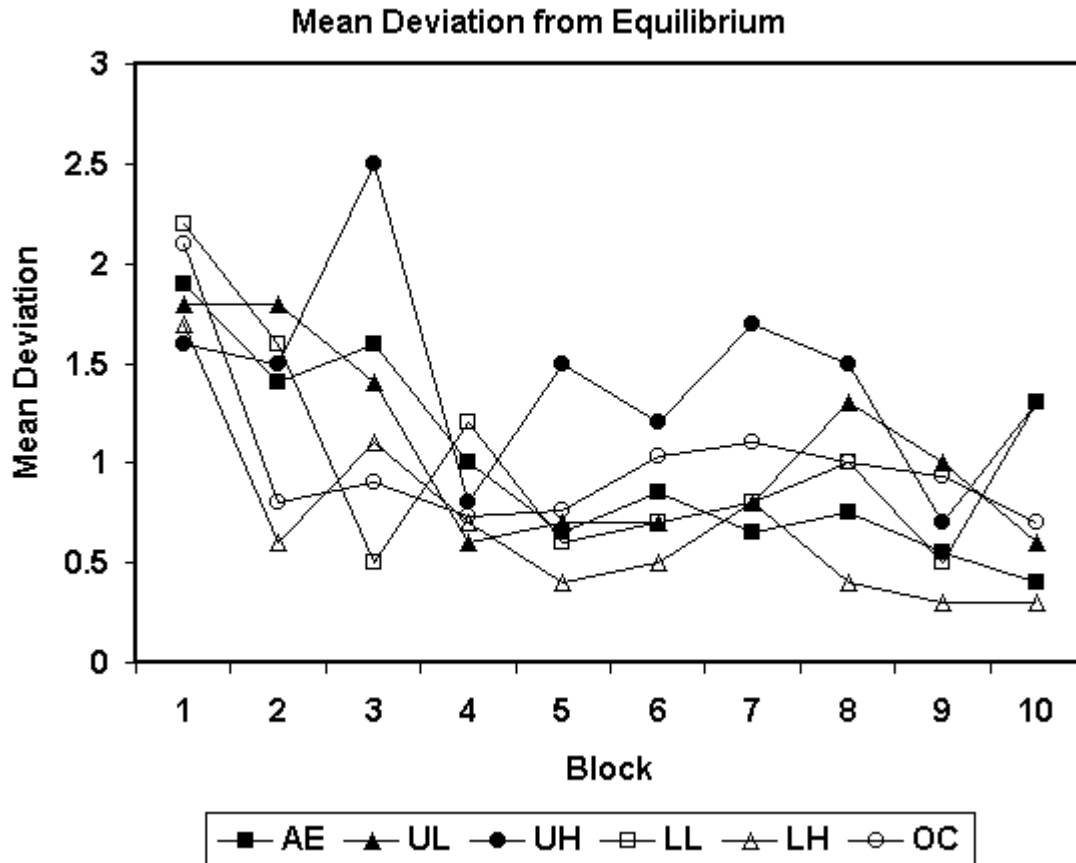


Figure 2 displays the mean deviation from equilibrium by block for each of the six experimental conditions. Mean deviation was computed as

$$\frac{\sum |m_c - m_c^*|}{10}$$

where m_c is the actual number of entries for a given value of c (10 values per block), and m_c^* is the predicted number of entries in equilibrium. In cases where the equilibrium prediction specified more than one level of entry, the value that yielded the lowest mean deviation was used. Notice that if players were successful over time in moving toward more optimal outcomes, the lines on this exhibit would display an increasing or upward trend in the mean deviation measure. In fact, the opposite trend is noticed. Mean deviation averaged 1.9 in the first block of trials, then gradually declined to 0.7 in block ten. Notice also that the mean deviation is higher than average in conditions UH and lower than average in condition LL. These results are confirmed in a 6 x 10 (condition by block) ANOVA, with block as a repeated measure. The ANOVA yielded significant main effects for both condition ($F = 5.19$, $p=0.001$), and block ($F = 7.43$, $p=0.000$), and no interactions.



Figure Three
Six Experimental Conditions

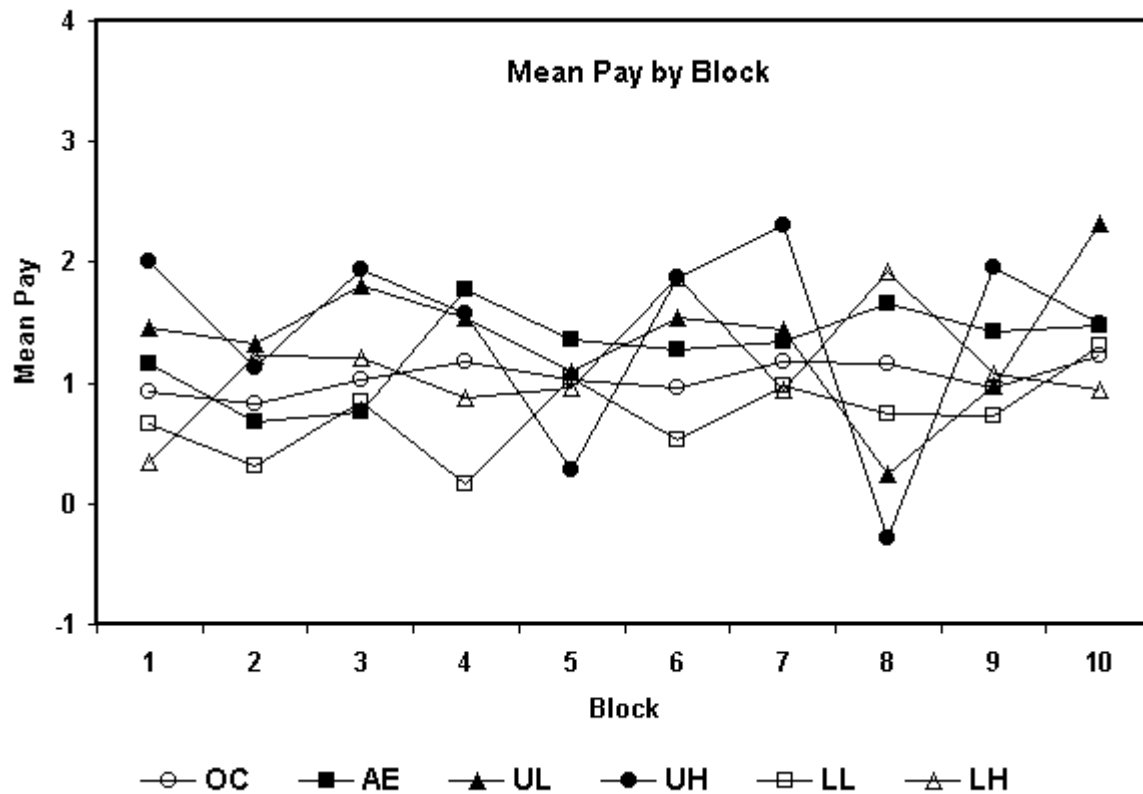


Figure 3 displays the mean pay per block for each of the six experimental conditions. Similar to Figure 2, coordination over time toward more optimal outcomes would reveal an upward trend in the plots. Examination of Figure 3 reveals no such trend. In general agreement with equilibrium predictions, mean pay averaged 1.2 across the ten blocks. However, there is evidence that mean pay varied by experimental condition, with players in condition LL earning less, and players in condition AE earning more. To test these conjectures we conducted a 6 x 10 (condition by block) ANOVA, with block as a repeated measure. The analysis indicated a significant main effect for condition ($F = 2.68, p=0.033$), but no effect for block and no interactions. In summary, we find no indication that players tacitly coordinated their decisions in the direction of Pareto optimal levels of entry. Successful coordination would result in increases in both the mean deviation measure and mean pay - neither finding is apparent.

Individual Differences in Entry Decisions

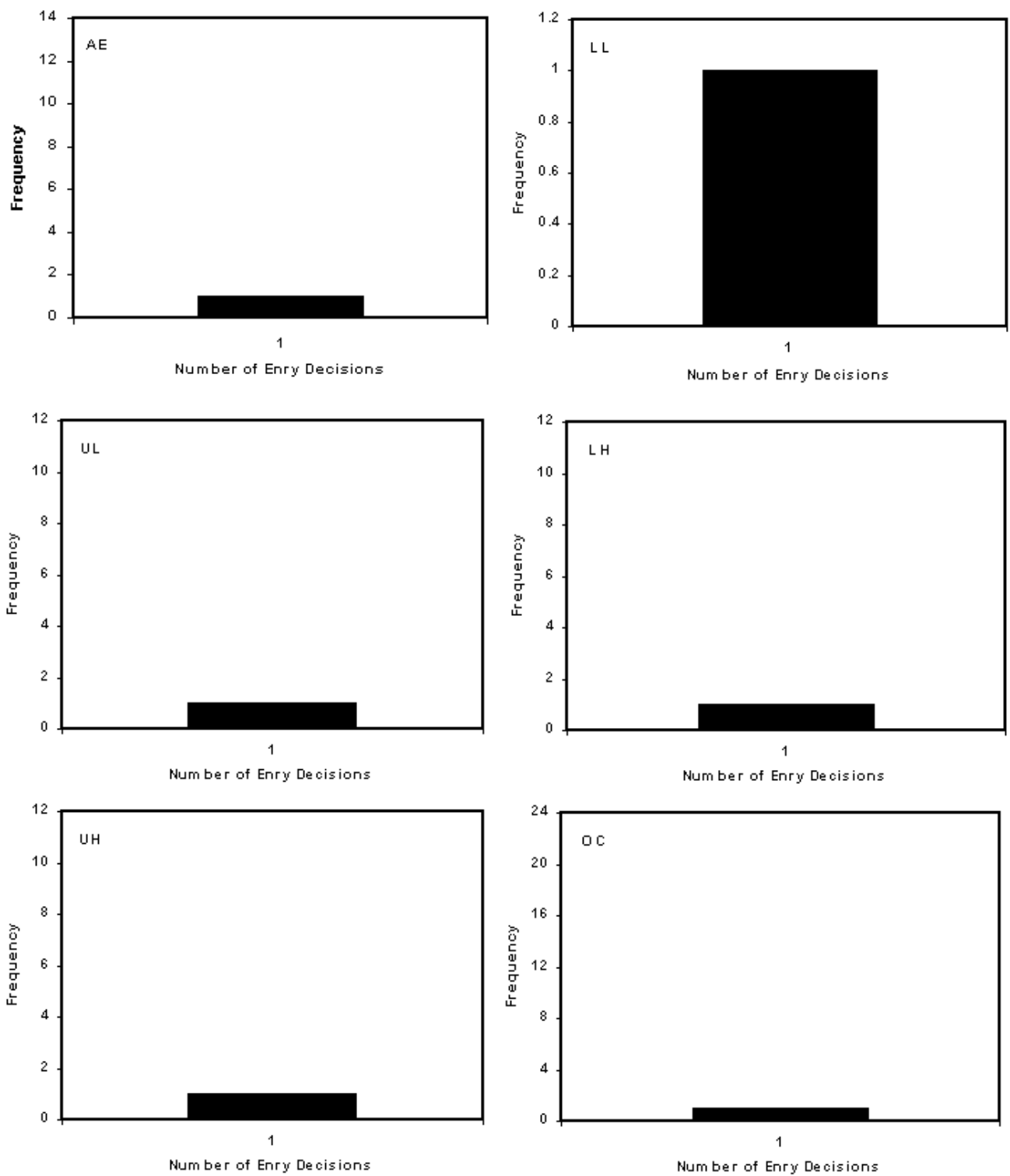
This final section of results examines individual entry decisions across experimental conditions. Figure 4 plots the distribution of players by aggregate entry decisions. The figure is divided into six panels, one for each condition, where the number of entry decisions is represented by class intervals on the horizontal axis, and the number or frequency of players captured by that class is displayed on the vertical axis. Due to differences in equilibrium



predictions, and number of subjects, it is difficult to directly compare the distributions of entry decisions across condition. However, this figure clearly reveals substantial individual differences in the number of aggregate entry decisions within each condition. For example, in Condition AE 2 of the 40 subjects never entered the market, 6 entered between 1 and 20 times, and 2 entered on more than 80 of the trials. In the two uncertainty conditions (UL and UH) we see a similar pattern of large individual differences with several subjects entering either rarely or quite often.



Figure Four
Distribution of Players by Aggregate Entry Decisions

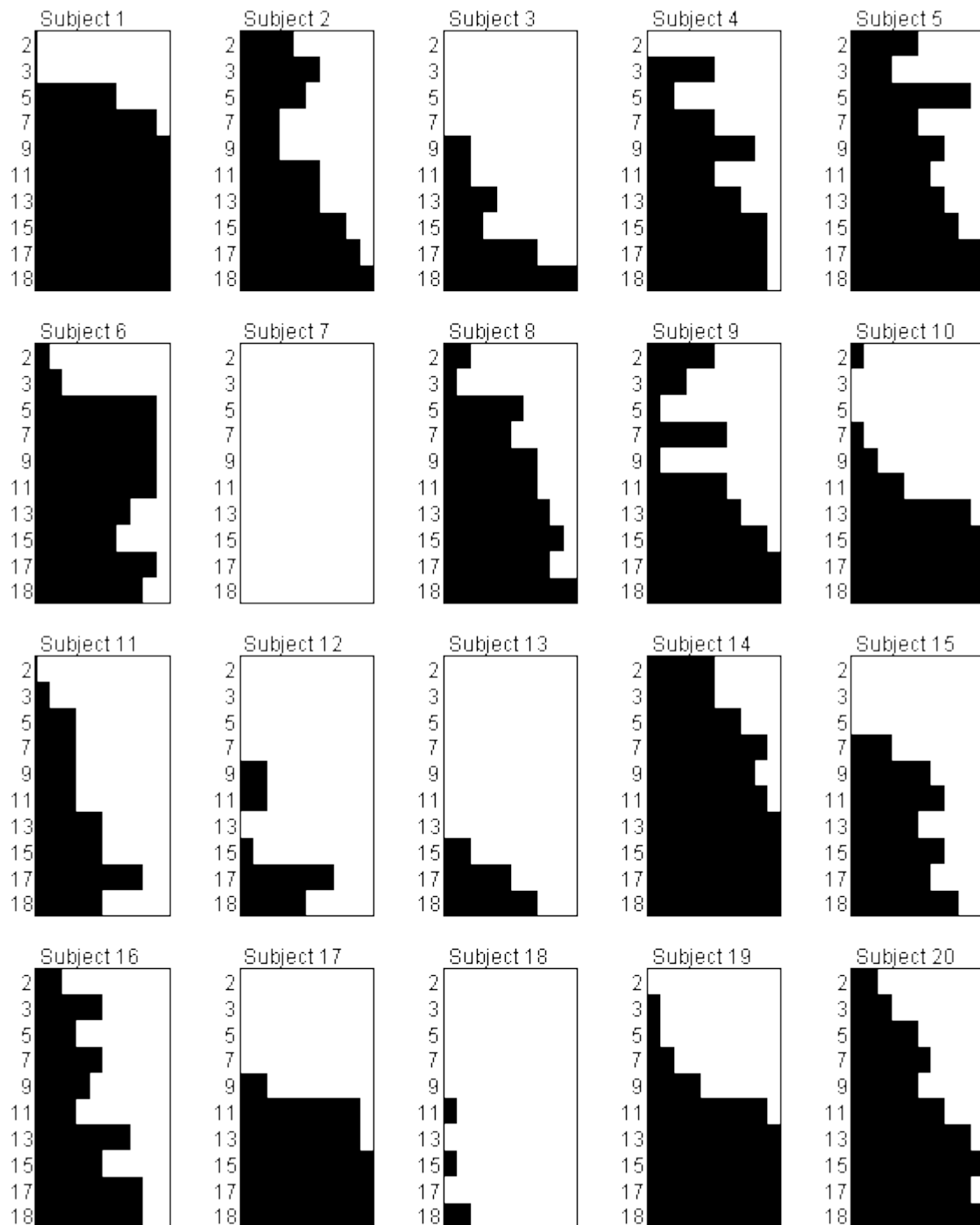




A more detailed picture of individual differences is provided in Figure 5. This figure shows the decision profile for each of the twenty subjects in condition UH. For each profile, the ten market capacity values are listed on the vertical axis. The number of times the subject entered the market for a given value of c is captured by the length of the horizontal bar (due to space constraints, the labels (0 - 10) for the horizontal axis are omitted). For example, Subject 1 never entered the market for $c=2$ or $c=3$, entered six times when $c=5$, entered nine times when $c=7$, and always entered when $c>7$. This subject entered a total of 75 out of 100 trials. Likewise, Subject 7 never entered the market. What's striking about these profiles are the differences in both the number of entry decisions, and each subject's affinity for particular values of c . Consider Subject 5, who entered the market nine times for $c=5$, but less often for larger values of c ($5 < c < 17$). Similarly, consider Subject 9 who entered six times for $c=7$, but only once for each of the adjacent markets of $c=5$ and $c=9$. The only similar pattern that these profiles seem to share is that subjects, generally, tend to enter more on large values of c and less on smaller ones. Due to page limitations, only one group of profiles is portrayed. However, consistent with previous studies, the individual profiles in each experimental session exhibit similar findings - substantial individual differences in both the number of entry decisions, and numerous attractions for particular, but different, values of c .



Figure Five
Individual Differences





Discussion

This paper contributes to the study of coordination in market entry decisions by combining perspectives from both population ecology and strategy research, and testing certain factors in a game-theoretic model. We identify several important insights into what might comprise a model of market entry dynamics. First, from a game theoretic standpoint, individuals are adept at coordinating entry decisions at or near the point of market capacity. That is, subjects' aggregate entry decisions generally approached equilibrium predictions. The high level of coordination, noticed early in the game, is particularly remarkable given the absence of communication or experience with the task. Entry decisions tracked market capacity in all experimental conditions, with the exception of those markets at or near legitimation thresholds. We also noticed an improvement in coordination due to experience; the correlation between capacity and number of entrants improved over time, and the violations to monotonicity decreased. Legitimation, however, did disrupt coordination for markets where the capacity was at or near threshold levels. Generalizing this finding to the natural world might suggest that potential entrants in smaller markets struggle more than potential entrants in larger markets in reaching that "taken for granted status". Entrants in smaller markets face concerns for both legitimation and over-entry, whereas the concerns for entrants in larger markets are primarily over-entry.

Second, introducing player asymmetry and market uncertainty, which renders our design more realistic, did little to diminish these high levels of coordination. In the aggregate, we see no evidence of departure from equilibrium predictions due to heterogeneous players or uncertain capacity. Further examination of the results from the asymmetry condition indicates that although aggregate entry decisions approached equilibrium predictions, the number of entries by cost type did not. Consistent with observations in the natural world, players (or firms) with higher entry costs can, at least in the short run, successfully enter markets, and players (or firms) with lower entry costs may, on occasion, avoid markets despite their innate capabilities to succeed. Increasing levels of market uncertainty appeared to have no effect on aggregate entry decisions. Players, when faced with a market entry decision with uncertain capacity, responded as if they expected the median capacity value to obtain

Third, we also find no evidence of players coordinating their entry decisions toward lower levels of entry that maximized group payoff. For the group as whole to benefit, individuals must be willing to forego a high payoff in one round by not entering, for their turn at a similar high payoff in another round. They must develop a tacit trust among the other group members, somehow agreeing to share the rewards from under-entry. Clearly, given the players inability to communicate, this becomes a nearly impossible task. Perhaps a simpler explanation of failure to move toward Pareto optimal levels of entry is that players did not know that higher group payoffs could be achieved. If important, subsequent studies could facilitate more extensive communication in their research design, explicitly indicate the existence of higher group payoffs in instructional material, or both. However, given a large number of players, and the power of the equilibrium predictions, the authors doubt that reaching or even approaching Pareto optimal levels of aggregate entry holds much hope.



Fourth, consistent with previous market entry results, we find substantial individual differences in both the number of entry decisions and affinity for particular market capacities. Some subjects never entered the market, while others entered on nearly every opportunity. Further, our analysis of individual decision profiles indicates a variety of entry strategies that seem to defy classification. However, these results may well be consistent with the literature on entrepreneurial characteristics and behavior reported by McGrath, MacMillan and Scheinberg (1992) and Gartner (1989). These studies indicate that personality and/or cultural factors may help explain (individual) differences in entrepreneurial behavior. Although our study design did not consider psychographic or demographic variables, this is clearly an avenue for further research.

There are several additional issues that subsequent research might consider. Finding ways to operationalize effects for first mover advantage, barriers to entry or even cannibalization would render the decision making more realistic, as well as improve links with existing streams of strategy literature. Extending the market entry model in these directions would also address Buckley and Casson's (1998) criticisms about the utility of existing models in providing advice on research design and hypothesis testing.

Another alternative that might render the study design more realistic concerns the presentation of market capacity. With our design, we likely created a high degree of instability or turbulence in entry decisions by presenting capacity values in random order that varied from trial to trial. Subsequent designs could control this by presenting the same capacity value for several consecutive trials, then gradually increasing capacity in a stepwise fashion. Another design would limit the number of entrants each trial for a given market capacity, then gradually allow additional entrants to compete with incumbent firms. It would be interesting to see if adding stability (using either design alternative) to the market, makes it more or less likely for lower cost entrants to drive out higher cost entrants over time. Our experimental design also induced heterogeneity by manipulating entry costs. In the natural world, differences between firms are more the rule than the exception. Further, some differences relate directly to a firm's competitive advantage(s). Although cost differences are a natural way to render firms or decision makers dissimilar, other techniques include control of information or feedback, communication ability, or varying subjects' profit potential independent of entry costs. Finally, as mentioned above, future research might attempt to measure the heterogeneity that subjects bring with them to the laboratory. This could be accomplished by introducing survey instruments that capture demographic items, psychological traits, decision-making abilities, or various entrepreneur characteristics. This could lead to the development and greater understanding of an entrepreneurial model of decision making in market entry situations.



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