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Maintaining Efficiency While Integrating Entrants From Lower-Performing Environments: An Experimental Study*

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Abstract

Efficient growth often requires the integration of individuals from lower-performing groups, firms, or societies into higher-performing ones. Such integration may be difficult without facilitating interventions or restrictions. We explore, using a laboratory experiment, the effectiveness of two regularly-employed entry restrictions: entry quotas and entry exams. We use a coordination game with Pareto-ranked equilibria, in which we allow an efficiently-coordinated group and an inefficiently-coordinated one to arise endogenously. We then allow individuals to move from the low-performing group to the high-performing one. We vary whether such movement is unrestricted, is limited to one entrant per period, or is subject to passing an entry exam. We find both kinds of restrictions improve the efficient integration of entrants, but that there is no additional benefit obtained by their combination. The restrictions lead to improved behavior among entrants, but they have a stronger influence on the maintenance of good behavior among incumbents in the high-performing group.

JEL Codes: C72, C92, M12
Key Words: Growth, Entry, Coordination, Experiments

1 Introduction

An important issue in the pursuit of large efficiently-performing groups is how to incorporate new entrants. For example, a growing economy might need to rely on immigration to provide a suitable labor supply. Similarly, profitable firms often expand by integrating individuals through external hiring.

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In most cases, the growing group is one that has previously performed well on some important dimension, such as productivity or profitability, leading to a desire to maintain such high performance while undergoing growth. Incumbents in the growing entity have a history of working well together, expecting high performance from one another, and obtaining efficient coordination of their actions. Conversely, entrants are often from lower-performing entities, such as poorer nations or less profitable firms, where expectations of others' behavior are lower and where the resulting behavior is either coordinated on less efficient equilibria, or perhaps not coordinated at all. This creates an important concern: when incorporating entrants from low-peforming groups, how can growing entities maintain the high performance that has made them successful? In order to grow successfully while incorporating new entrants, it must be that both new entrants adapt their behavior to the higher standards of the better-performing group and also that incumbents in the high-performing group maintain the good behavior that has previously led to success.

In this paper, we use a laboratory experiment to explore two common policies for facilitating the successful entry of individuals from lower-performing groups into ones that have historically performed more efficiently. The first policy we examine is an entry exam, whereby individuals are required to demonstrate knowledge or skills prior to being granted entry. For example, countries set thresholds for granting entry to immigrants, such as sufficiently high professional or educational standing, or may implement naturalization exams as a requirement for citizenship. A club may require entrants to demonstrate knowledge of the club's history prior to entry. Finally, many firms use pre-employment testing as a way of screening potential job applicants for desirable qualities. The second policy is an entry quota, whereby the number of entrants in a given time period is regulated. For example, a country may limit the number of immigrants that are allowed entry in a given year, as the United States did with the 1924 Immigration Act. Similarly, a club may limit the number of new members it accepts. Or a firm may explicitly target a slow-growth strategy as a way to maintain efficient practices.

We focus on a production context in which there is high action interdependence – using a "minimum-effort" or "weak-link" coordination game, in which efficiency (output) is determined by the lowest input by any group member.[1] Thus, in order to perform well, a group needs *all* players to make high input choices. This makes it particularly difficult to incor-

[1] While situations that exactly mirror this game – i.e., in which production is determined by the minimum input – are rare, the game is a useful model for contexts in which the level of interdependence is sufficiently high that output is sensitive to the actions of small numbers of individuals. The game has been applied to study diverse contexts, such as firm production (Brandts and Cooper, 2006), public goods provision (Hirschleifer, 1983), and shared security (Kunreuther and Heal, 2003).

porate new entrants since efficiency can be harmed if either any entrant or any incumbent selects lower input. Growth in such environments may also be particularly difficult because larger group sizes have a harder time obtaining efficient coordination (see Van Huyck et al., 1990; Weber 2006).

In a standard game of this sort there is some number N of players who each select from an ordered set of strategies $x_i \in (1, \ldots, K)$ and produce some collective output that is an increasing function of the minimum choice among all the players. Players benefit from higher output levels, but selecting higher strategies is costly – players only want to select a higher strategy if *all* other players do so as well. The set of pure-strategy Nash equilibria for the game consists of all outcomes in which players select the same strategy. The incentives are such that equilibria corresponding to higher effort choices are *more efficient* than those in which players make lower choices and the *efficient* equilibrium corresponds to all players selecting strategy K. Our version of the game is augmented by including an element that leads to the group output being an increasing, concave function of the number of players in the group. Thus, holding the minimum choice in the group constant, output is greater when the group is larger. This creates a *ceteris paribus* efficiency gain from having larger groups. It is still the case, though, that growth in the size of the group decreases earnings if it leads to coordination on a lower-output equilibrium.

In our experiment, we divide each group into two endogenously-determined subgroups – one "*high*-performing" small subgroup and one "*low*-performing" large subgroup. Our procedure reliably creates small, efficiently-coordinated subgroups and large subgroups coordinated on inefficient levels of output. Earnings in the small groups are higher.

We then allow participants from the Low subgroup to voluntarily move to the High subgroup. Given our payoff structure, such movement can lead to a Pareto improvement whereby both incumbents in the High subgroup and entrants from the Low subgroup can earn higher payoffs. But this improvement is only realized if entry does not lead to lower output levels.

Our subgroups can therefore represent, for example, a large country or firm coordinated on inefficient practices, and a smaller one that is more successful. Migration from the large subgroup into the smaller one can make everyone better off, but only if the entrants adapt their behavior to the actions that have thus far yield efficient coordination in the smaller subgroup. To our knowledge, ours is the first experimental design that repeatedly creates two such subgroups, and then uses them to explore the effects of movement from the inefficient group into the efficient one.

Our primary purpose is to explore the relative effectiveness of alternative mechanisms

for regulating entry in to the successful subgroup. We consider four treatments, corresponding to varying degrees of entry regulation. In a *Baseline* treatment, we impose no restrictions, allowing anyone who wants to move to do so. In a *Quiz* treatment, there is no limit on the number of entrants, but all entrants must successfully complete a short quiz demonstrating both the ability to calculate game payoffs and knowledge of historical outcomes in the High subgroup. In a *Quota* treatment, only one participant is allowed to move per period, with multiple requests accepted or declined by a random lottery. Finally, in a *Combined* treatment, both restrictions are simultaneously in place. We include the combined treatment to determine the extent to which there are benefits from employing multiple policies simultaneously.

Previous research in economics, organizations, and sociology explores the determinants of successful assimilation of new entrants into entities such as countries, firms, or work teams (Borjas, 1995; Cable and Judge, 1996; Card, 2005; Chatman and Flynn, 2001; Friedberg, 2001; Ortega, 2005; Rumbaut, 1997). Some of this work explicitly addresses the need for and effectiveness of different policies to regulate entry. For example, Warne (1921) argued for the importance of government policies to regulate and ensure the assimilation of immigrants into U.S. society, noting that, "If the volume of total immigration is likely at any time to become so large as to make ineffective our forces of assimilation, then this volume should be decreased by restrictive measures; if the elements comprising any particular group or race, no matter how few in number relatively, are unassimilable into our American life then these too should be restricted" (p. 185). More recently, Borjas (1994) discussed how changes to a points-based scoring system used to evaluate immigrants to Canada significantly affected the educational attainment of admitted immigrants. In an organizational context, Ryan and Sackett (1987) demonstrated that pre-employment screening can be useful for discriminating between honest and dishonest employees. O' Reilly III, Chatman, and Caldwell (1991) demonstrated that greater correspondence between an individual's characteristics and the organization's culture yields more successful outcomes in hiring, such as longer employee retention.

Our work adds to this literature, by employing a laboratory experiment to explore different policies for regulating entry. While the laboratory necessarily sacrifices some degree of generalizability to these real-world contexts, it also allows us to avoid concerns that are present in the field. For example, in evaluating the effectiveness of different policies for regulating entry in real-world groups, the endogenous selection of policies makes inference about whether outcomes are truly the result of a particular policy difficult. In the laboratory, however, we can avoid this concern by randomly-assigning groups to different policies.

Our work is more closely related to a small number of experimental studies that explore alternate methods for determining group composition, and their effect on efficiency in production games. For example, Weber (2006) shows how groups that start of small and grow can maintain efficient coordination, but only when entrants are exposed to a group's prior history. However, there are at least two ways in which the experiment in Weber (2006) leaves open important questions about how to manage the growth of real-world groups. First, entry in Weber (2006) drew from participants with no prior history of playing the game. This is unlike many real-world situations, in which entry occurs by drawing from people from lower-performing environments, where there may be a history of failure or inefficiency. In our experiment, entry involves incorporating participants with a strong history of low-efficiency outcomes. This difference in the prior experience of entrants is important since it may very well be the case that the slow growth in Weber (2006) proves ineffective when incorporating entrants from lower-performing groups. The past poor performance background of these entrants' groups may make their efficient assimilation more difficult than when they have no history. Second, Weber (2006) does not consider alternative mechanisms for regulating entry, as we do here. Thus, the experiment in Weber (2006) does not directly address the effectiveness of entry quizzes or quotas – instead, the experiment primarily serves as a demonstration that slow growth *can* facilitate efficient coordination in large groups. Here, we begin to explore the *best* way in which to achieve this goal. There are also other differences between our experiment and Weber's. For example, in Weber (2006), entry is exogenously determined, according to a growth schedule determined by the experimenter and which subjects know in advance. In contrast, in our experiment the movement of subjects across groups takes place more naturally: subjects decide whether they wish to move to the more efficient group, and then face any entry regulations prior to successfully doing so.

In other related work, Ahn, Isaac and Salmon (2008, 2009) use a public goods environment to explore how endogenous group selection influences contributions, with players having the opportunity to enter and exit groups. Their experiments vary the degree to which both entry and exit from groups are restricted, finding that both restricted entry and exit significantly influence contributions.

2 Experimental Design

In our experiment subjects played a version of a weak-link coordination game over a total of 25 periods. Earnings from the game were denominated in Experimental Currency Units

(ECU), which were converted to money at a rate of 60 ECUs=$1.

2.1 The Game

In each period subjects had 7 tokens that they could either keep or contribute to a group account. We will let x_i denote the amount contributed. For every token retained the subject received 3 ECUs. The total return on the tokens contributed to the group account depended on the number of players in the group, N, and the minimum of the tokens contributed among the group (N). Let x_{-i} represent the vector of contributions of all of the other members of i's group. Then the total return on the group contribution was $6 * N^{.25} * \min(x_i, x_{-i})$. We will refer to $6 * N^{.25}$ as the group account multiplier since it tells us the per token return for the minimum number of tokens contributed to the group account. Finally, contributing to the group account cost an individual $x_i^{1.5}$. The entire payoff function is contained in equation 1

$$\pi(x_i, x_{-i}) = 3 * (7 - x_i) + 6 * N^{.25} * \min(x_i, x_{-i}) - x_i^{1.5} \tag{1}$$

The properties of this game are standard for weak-link games as described above. For any group size $N \geq 2$, any level of contribution is a Nash equilibrium if all players are contributing the same amount. All players contributing 7, or the maximum number of tokens, is the Pareto dominant or efficient equilibrium. To make certain that subjects would be able to understand the incentives generated by this payoff function we provided them with multiple payoff tables corresponding to differing values of N and we provided the ability in the software to calculate prospective earnings by entering a hypothetical minimum for others as well as an own contribution to see the resulting payoff for as many combinations as they liked prior to making a decision in a period.

2.2 Stages

Each session involved 20 subjects who were split into 2 separate 10-person groups. These groups were fixed for the duration of the session and there was never any interaction across those groups. The experiment proceeded in three stages.

In Stage 1 which consisted of periods 1-3, all members of a 10-person group played the weak-link game together. In the instructions for this stage, subjects were given a payoff table corresponding to $N = 10$ to which they could refer in making their choices.[2] At the end of every period in Stage 1, subjects saw their own contribution, the minimum contribution

[2] Copies of all instruction scripts are available from authors.

in the group, the group account multiplier for the group, and their own earnings for the period.

Stage 2 took place over periods 4-10. At the beginning of period 4, each 10-person group was split into two sub-groups that we called the "High" and "Low" sub-groups. The High sub-group consisted of the two members from the 10-person group who had contributed the most in Stage 1. The Low sub-group consisted of the other 8 who were obviously the lowest 8 contributors during Stage 1.[3] Subjects received additional verbal and written instructions about the new subgroups, including additional payoff tables corresponding to values of $N = 2$ and $N = 8$. The experiment software told subjects to which group they were assigned and gave them a complete contribution history of their fellow group members. The instructions used the labels "High" and "Low" to refer to the sub-groups, and were also explicit about how the subgroups were determined. Subjects then began Stage 2 of the experiment, playing the weak-link game with only those in their 2 or 8-person sub-group. After every period in Stage 2 subjects saw the same information as before about their own subgroup but they were also given information about what was happening in the other subgroup including the number of group members, the group account multiplier and minimum group contribution.

Our expectation was that the High sub-groups would be able to coordinate on a high level of contributions by the end of Stage 2, while the Low sub-groups would fail to achieve high coordination and would instead play several periods with low minimum group contributions. This was necessary in order to set up Stage 3 of the experiment in which we allowed subjects in the Low sub-group the opportunity to move to the High sub-group. Stage 3 lasted from period 11 through the final period, 25. Prior to each period, subjects still in the Low sub-group were asked if they wished to move to the High sub-group. Moves into the High sub-group were irreversible and subjects who began in the High sub-group were never allowed the option of moving into the Low sub-group. We chose this limited flexibility to allow us to precisely address our main research question of whether successful groups could maintain their level of efficient coordination during an influx from the lower performing group. Other than the ability to transition groups, this stage proceeded the same as in Stage 2 in terms of the information provided to the subjects at the end of a period.

[3] Subjects were not told prior to this event that they would be divided in this way so their Stage 1 contributions could not have been made strategically to try to get into the High (or Low) sub-group.

2.3 Treatments

The mechanism underlying the group transitions varied according to our four treatments. Complete verbal and written instructions were provided to members of both sub-groups about the group transition mechanism that would be used. This is important, as it meant that members of the High sub-group knew what restrictions governed entry into their sub-group. Also, at the beginning of each period, following any movement from the Low sub-group to the High subgroup, all subjects saw the number of people in each of the two subgroups and had the opportunity to explore payoffs for their current (and possibly new) group size.

In the first, Baseline, treatment any subject indicating a desire to move from the Low sub-group into the High one was allowed to do so. At the beginning of a period, Low subgroup subjects wishing to move indicated this choice on the computer and were then moved into the High subgroup. Thus, there were no restrictions on movement from the Low to High sub-group. The other three treatments involved some degree of restrictions.

In our second, Quota, treatment only one subject was allowed to move from the Low to High sub-group per period. This was implemented by the software randomly selecting one subject from among all those expressing a desire to change sub-groups to actually do so, while the remaining subjects wishing to move were forced to remain in the Low sub-group. As in the Baseline, at the beginning of a period subjects in the Low subgroup again indicated whether they wished to move to the other subgroup. On the next screen, they found out whether they had been able to do so.

In the third, Quiz, treatment subjects had to correctly answer a two question quiz in order to move between sub-groups. Any subjects expressing an interest in moving and successfully answering the quiz questions were allowed to move to the High subgroup. One question asked subjects something about the history of the High subgroup from the prior period (such as the size of the subgroup or the minimum contribution level). The other question gave subjects a sample set of contributions and asked them to calculate the payoff for one of the players. We gave subjects extensive instructions on how to do this calculation and the software pre-calculated for them the group account multiplier, $6 * N^{.25}$, as well as the cost of contributing, $x_i^{1.5}$, which made the calculation quite straightforward. We also provided subjects with access to the standard Windows calculator.

The last treatment is the Combined mechanism, as it imposes both a quiz and a quota restriction. In this treatment all subjects wishing to transition answered the same two kinds of questions as in the Quiz treatment. But among all those getting both answers correct,

only one was allowed to move.

We conducted 9 sessions of this experiment for a total of 18 groups and 180 subjects. Eight of the sessions were conducted at the xs/fs lab at Florida State University with 2 sessions of each treatment or 4 independent 10-person groups per treatment. We also have one additional session of the Combined treatment which was conducted at the Pittsburgh Experimental Economics Laboratory (PEEL) at the University of Pittsburgh. Average total earnings were $22.03 (including a $10 participation fee) for an experiment lasting 1 to 1.5 hours. The software used for this experiment was programmed in Z-Tree, Fischbacher (2007).

3 Results

Recall that in our experiment, each 10-person group remained fixed for the entire experiment. However, in Stages 2 and 3, the 10-person group consisted of a High and a Low subgroup of potentially varying size. For simplicity, in the rest of the paper we refer to these subgroups using the term "group," and when we use the terms "group minimum" or "group size" we are referring to the subgroups. We explicitly note any instances in which we are referring to the entire 10-person group.

3.1 Summary Statistics

We begin by first presenting a series of summary statistics and graphical depictions of the data, before presenting the formal results through a series of regressions. Table 1 presents a first look at the data, summarizing two individual-level variables (average overall contributions and average overall profits) and two group-level variables (average group size and average group minimum) for each treatment. The results, are presented separately for Stage 2 (periods 4-10) and for the last 10 periods from Stage 3 (16-25). The reason to present the summary statistics from those ranges is that the Stage 2 numbers demonstrate how well the two kinds of groups perform prior to the experimental treatment, and thus whether our Stage 2 manipulation did indeed produce differentially-efficient "low" and "high" groups, while the last 10 periods of Stage 3 demonstrate the overall effect of the treatment after most of the group transitions have taken place.

There are a number of features that are readily apparent in the summarized data. First, we see that indeed the Low groups fail to coordinate on a good equilibrium in Stage 2 (the average contribution level is generally around 1) while the High groups are able to coordinate on more efficient equilibria (the average contribution levels are between 4 and

		Contribs		Group Min		Group Size		Profits	
		4-10	16-25	4-10	16-25	4-10	16-25	4-10	16-25
Low Groups	Baseline	1.8	2.2	1.0	2.4	8	2.2	22.7	25.7
	Quota	1.1	3.1	0.5	2.9	8	1.6	21.2	26.2
	Quiz	1.2	1.1	0.6	0.9	8	2.2	22.1	23.8
	Combined	1.4	0.8	1.0	0.5	8	2.6	24.8	21.8
High Groups	Baseline	4.0	0.5	3.6	0.3	2	8.1	25.1	21.7
	Quota	4.5	3.0	4.0	2.7	2	9.2	25.8	35.9
	Quiz	5.5	3.8	5.0	3.4	2	8.5	26.8	35.4
	Combined	4.9	3.4	4.6	3.3	2	7.6	27.5	37.2

Table 1: Summary statistics from Low and High groups by period and treatment.

5). Thus, our Stage 2 group assignment worked as we expected. Second, in Stage 3, most of the Low group subjects choose to move into the High group, though in every treatment there are some occasions in which subjects chose to stay in the Low group.

Next, if we look at average contributions and minima in Stage 3 for the High groups we see that in the Baseline contributions collapse to near 0 on average while in the three treatments with entry restrictions the High groups are generally able to maintain coordination on more efficient (higher) equilibria, though with perhaps some backsliding relative to their average contributions in Stage 2. The Low group contributions are not our main focus, but we interestingly find that in some of the Low groups the few remaining subjects by periods 16-25 are sometimes able to improve the efficiency of coordination (reflected both in higher average contributions and group minima, relative to Stage 2). Since our primary interest is in what happens in the High groups, and particularly in how entry into the High groups responds to our treatments, we largely ignore contributions and minima in the Low groups in the remainder of our analysis. Finally we see that subjects' profits generally follow the pattern indicated by the contributions and minima. That is, profits are better for High than Low group subjects (except in the Baseline) and profits for High group subjects are higher in the three treatment conditions than in the Baseline.

Interestingly, we find little difference between the High groups in the three treatments for periods 16-25 in contributions, minima or earnings. This suggests that the Quota and Quiz mechanisms generally work equally well, and that there is no substantive gain from having both mechanisms in place. We explore these differences more precisely in the next section.

Figures 1 and 2 examine the time paths of these results, showing the averages of each of

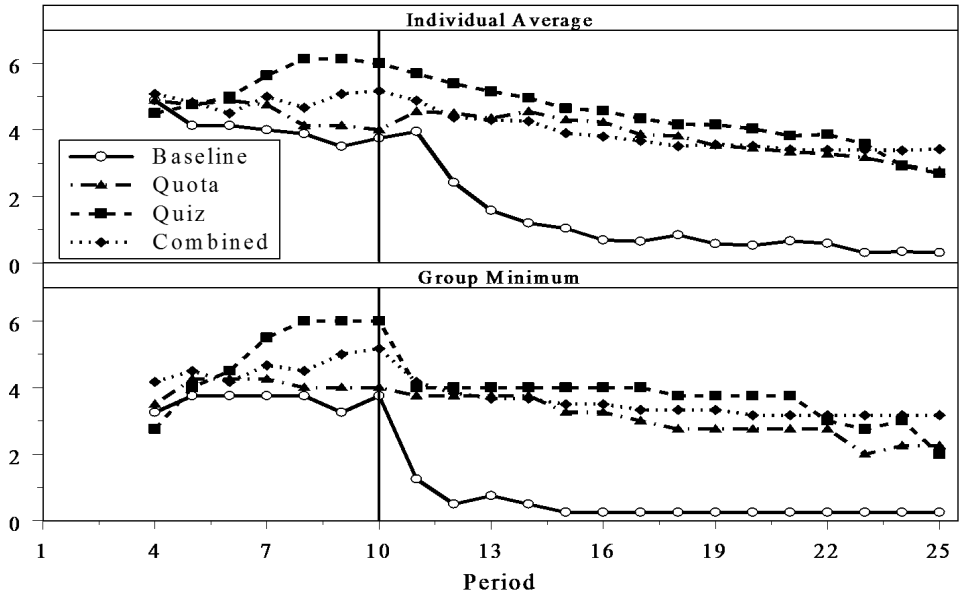

Figure 1: Averages of individual and group minimum contributions for High groups.

the summary statistics for each period in the High groups and by treatment.[4] The trends displayed in the figures display the same characteristics indicated by the summary statistics. In the three treatments with restrictions on entry average contributions and minima drop modestly from Stage 2 to Stage 3, while in the Baseline they start at about the same level but then collapses to almost zero. The earnings graph in Figure 2 similarly shows the earnings per period in the three treatments to be well above the earnings per period in the Baseline

Looking at entry into the High group ("Group Size" in Figure 2), we see the time pattern of how group size evolves. While the Baseline and Quiz result in nearly identical total group movement in the first five periods of Stage 3, the Baseline had a larger growth spurt in the first period or two, with the growth in the Quiz treatment catching up soon after. The Quota and Combined treatments not surprisingly lead to slightly slower growth but we observe convergence to similarly large group sizes in later periods across all treatments.

Figure 3 shows more detail on group movement. The graph presents the average number of attempted and successful movements between groups, by treatment, for periods in which at least one move was attempted. This figure shows that, in Period 11, there are approximately the same number of attempted moves in all three treatments as in the Baseline. In the three treatments with restrictions, many of those initial attempts fail in Period 11,

[4] We do not provide similar figures for the Low groups to conserve space and again due to the fact that their behavior following the transition to Stage 3 is not the element of interest.

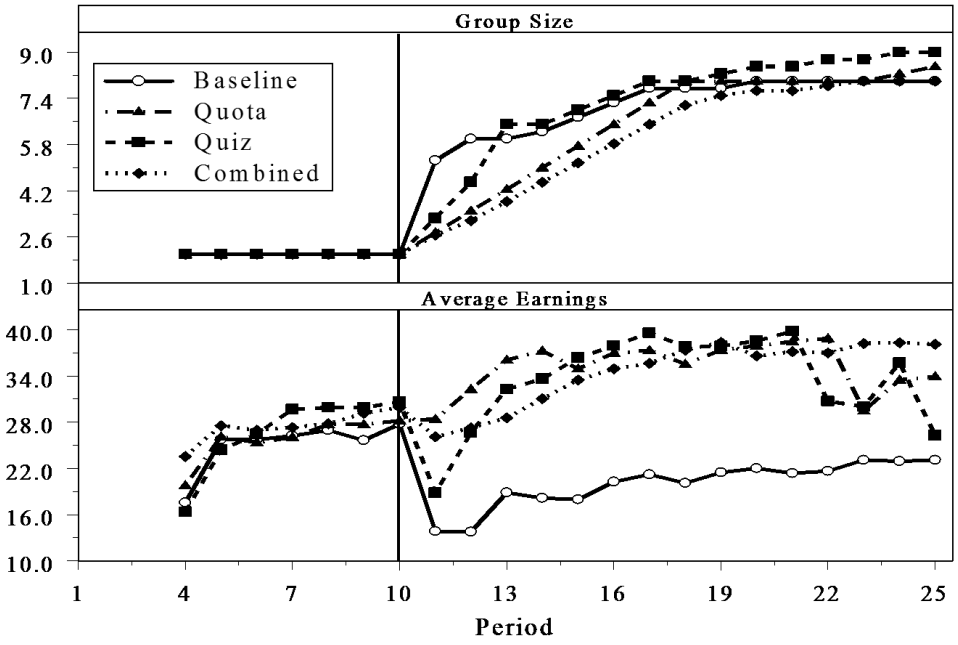

Figure 2: Average group size and individual earnings for High groups.

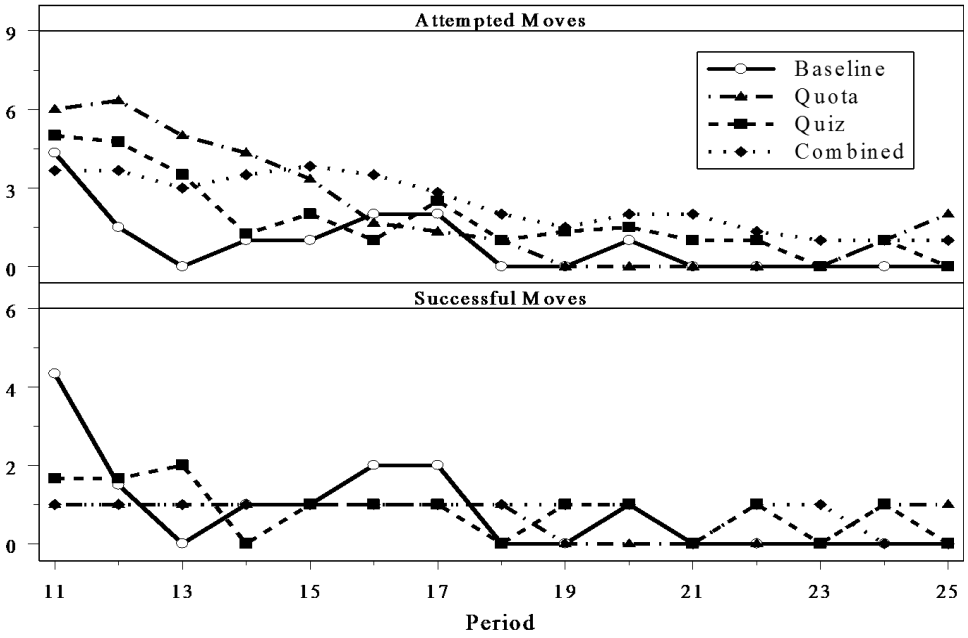

Figure 3: Average attempted and successful moves per period per group with attempted moves in that period.

leading there to be substantially fewer successful moves in those treatments than in the Baseline. After Period 11, while there are more attempted moves in the three treatments than in the Baseline, there are approximately the same number of successful moves in all treatments. Therefore, while the treatments limiting movement produce a large difference in the number of successful moves in the first period in which movement is allowed, their effect on total movement in subsequent periods is not substantial.

There is, however, a potentially important difference in movement between the Quiz treatment and the Quota and Combined treatments. In the latter two, the average number of successful moves per period is 1 but that is also the maximum and minimum number of moves as well due to the enforced quota mechanism.[5] In the Quiz treatment, however, we see that the average number of successful moves per group is around 2 for periods 11-13 and since there was no explicit limit on the number of moves allowed in a period there is also variation in this number, with some groups experiencing perhaps 3-4 successful moves and other experiencing only 1. This heterogeneity in successful moves could well lead to differential behavioral consequences in the Quiz treatment, relative to the Quota and Combined treatments, as the High groups in the Quiz treatment potentially have to incorporate a steady influx of newcomers at a higher rate in those early periods than High groups in either the Quota or Combined treatment. But as Figures 1 and 2 reveal, the differential effects on outcomes of such faster entry are minimal.

For our first set of basic statistical results we provide a set of non-parametric Wilcoxon rank-sum tests on whether group-level averages differ between the treatments and the Baseline in each phase. The $p-$values resulting from these pairwise tests are in Table 2. For each test, an observation consists of the average contribution (or average group minimum) over a stage for each group meaning we have four total observations for the Baseline, Quiz and Quota treatments and six observations for the Combined treatment. Given that we are aggregating across all periods in a stage for each group, this test represents a very conservative test of whether or not there were differences across treatments. Examining the results of the tests in Table 2 we see that there are no differences between either average contributions or group minimum contributions in Stage 2, i.e. periods 4-10. On the other hand, in the last 10 periods of Stage 3, periods 16-25, we find that all of the treatments are significantly different from the Baseline with regard to both overall average contributions and group minimum. While we have not included the results from the tests, none of the three treatments are found to be significantly different from each other.

[5] There are instances of groups with 0 moves per period, but the data for this figure excludes those as the interest is on examining the attempt/success rate of moves and not the attempt rate of moves.

	Average of Individual Contributions		Minimum of Group Contributions	
	Periods 4-10	Periods 16-25	Periods 4-10	Periods 16-25
Quota	0.886	0.057	0.886	0.037
Quiz	0.686	0.029	0.468	0.027
Combined	0.831	0.010	0.669	0.013

Table 2: P-Values from Wilcoxon Rank-Sum tests of differences in distributions of High group averages between treatments and baseline.

3.2 Contributions and Earnings

For a more detailed regression analysis of treatment effects on contributions and earnings, we employ an estimation strategy that allows us to examine the treatment effects in Stage 3 conditional on behavior in Stage 2. We employ a standard differences-in-differences structure for panel data, in which we specify binary variables for the different treatment effects activated throughout the sessions, $Quota$, $Quiz$ and $Combin$, a binary variable corresponding to Stage 3, $S3$, and then interactions of those treatment effects with the Stage 3 dummy. These interaction terms measure any difference between behavior after the introduction of the group transition mechanism treatment has occurred (in Stage 3) but conditioned on the behavior in that population prior to the treatment being implemented. For the full specification see equation 2. In order to accommodate any subject- or group-level heterogeneity we use a random effects panel structure with the random effect, c_i, on the individual or group level depending on the regression. The regressions at the individual level include robust standard errors clustered at the subject level but due to the low number of clusters for the group level regression we will only use robust standard errors. Since our regressions will be conducted separately for those in High groups and Low groups we want to begin this analysis after those group identities have been established. Consequently these regressions do not include data prior to period 4.

$$\begin{aligned} y_{it} = \alpha_0 + \alpha_1 GS_i + \alpha_2 Period + \alpha_3 Quota + \alpha_4 Quiz + \alpha_5 Comb + \\ \beta_0(LG * S3) + \beta_3(LG * S3 * Quota) + \beta_4(LG * S3 * Quiz) + \beta_5(LG * S3 * Comb) + \\ \gamma_0(HG * S3) + \gamma_1(HG * S3 * GS_i) + \gamma_2(HG * S3 * Period) + \\ \gamma_3(HG * S3 * Quota) + \gamma_4(HG * S3 * Quiz) + \gamma_5(HG * S3 * Comb) + c_i + \varepsilon_{it} \end{aligned} \quad (2)$$

Our first regressions look at individual contributions and earnings using data from each individual per period as the unit of observation. To allow us to cleanly separate the be-

havioral treatment effects among those subjects who were initially in the High group from those who were initially in the Low group we run separate regressions for both types of subjects. For the subjects initially in the Low groups they have two sets of Stage 3 treatment variables. One set measures the effect of being in a particular treatment on behavior while still in the Low group and the other set measures the behavior while in the High group (if a move has occurred). Since those initially in the High group are restricted to be only in that group, they have only one set of Stage 3 interactions. These regressions can be found in the first four columns of Table 3.

The key variables for this study are the Stage 3 treatment variables for subjects in the High groups, γ_3, γ_4 and γ_5. The fundamental question motivating this study is the degree to which any of the treatment mechanisms facilitates efficient coordination (higher contributions) in the High group once entry from the Low group is allowed in Stage 3. Thus, we are interested in how the treatment mechanisms influence both whether subjects originally in the Low group make higher contributions once in the High group in Stage 3 and whether subjects originally in the High group make high contributions in Stage 3. The regressions show results consistent with the summary statistics from the prior section. By examining the regressions on individual contributions we see that, for those initially in the Low group who move to the High group in Stage 3, conditional on being in one of the three treatments their contributions are on average 3.6 units higher than for subjects who move in the Baseline condition as indicated by the values of γ_3, γ_4 and γ_5. in the first column. For those initially in the High group, contributions drop by about 1.6 in the Baseline treatment in Stage 3, γ_0 in the second column, while contributions in the other three treatments are about 2 units above that, γ_3, γ_4 and γ_5. The overall effect of the treatments on contributions in Stage 3 for those initially in the High group can be calculated by taking a linear combination of the Phase 3 binary variable (which measures the omitted treatment, Baseline) with the relevant interaction, $\gamma_0 + \gamma_{3,4,\text{ or }5}$. These come out to be 0.267, 0.566 and 0.338 for the Quota, Quiz and Combined treatments respectively with none of those total effects being significantly different from 0. Thus, on net, subjects who begin in the High groups do not drop their contributions once entry takes place in Stage 3, while they do drop their contributions in the Baseline condition.

The regressions in the third and fourth columns of Table 3 show similar results for subjects' earnings. By examining the same coefficients again we see that earnings for those that began in the Low Group increase substantially when they move to the High group in the three treatments but not in the Baseline, where they actually decline. For those that begin in the High groups, their earnings fall substantially in the Baseline treatment during

	Individual Contrib		Individual Earnings		Group Min
	Initially in Low	Initially in High	Initially in Low	Initially in High	High
GroupSize, α_1	-0.092**	-0.045	0.196	0.714***	-0.190***
	(0.045)	(0.056)	(0.185)	(0.269)	(0.043)
Period, α_2	-0.0384**	-0.113***	0.269***	0.309***	>-0.001
	(0.019)	(0.020)	(0.053)	(0.106)	(0.021)
Quota, α_3	-0.647***	0.464	-0.643	0.747	0.429
	(0.219)	(1.060)	(1.247)	(2.529)	(1.160)
Quiz, α_4	-0.710***	1.411	-1.525	1.654	1.357
	(0.232)	(0.970)	(1.323)	(2.347)	(1.359)
Combined, α_5	-0.400*	0.869	2.071	2.365	0.988
	(0.237)	(1.016)	(1.334)	(2.118)	(1.107)
Low Group * Stage 3, β_0	0.296		0.307		
	(0.376)		(1.503)		
LGS3 * Quota, β_3	-0.165		-1.521		
	(0.407)		(1.577)		
LGS3 * Quiz, β_4	0.270		-2.910*		
	(0.468)		(1.575)		
LGS3 * Combined, β_5	-0.505		-2.621*		
	(0.414)		(1.563)		
High Group * Stage 3, γ_0	0.405	-1.642*	-4.942**	-11.80***	-2.222***
	(0.537)	(0.953)	(2.304)	(2.982)	(0.451)
HGS3 * GroupSize, γ_1	0.177**		0.854***		
	(0.071)		(0.324)		
HGS3 * Period, γ_2	-0.133***		-0.398***		
	(0.024)		(0.133)		
HGS3 * Quota, γ_3	3.690***	1.909*	18.01***	12.39***	2.057***
	(0.415)	(1.023)	(2.069)	(3.035)	(0.497)
HGS3 * Quiz, γ_4	3.584***	2.207**	19.14***	10.01***	1.884***
	(0.436)	(1.097)	(1.565)	(3.720)	(0.588)
HGS3 * Combin, γ_5	3.692***	1.980*	16.99***	11.32***	1.857***
	(0.469)	(1.033)	(1.829)	(3.192)	(0.478)
Constant, α_0	2.813***	4.916***	19.23***	21.50***	3.989***
	(0.399)	(0.906)	(2.063)	(1.942)	(0.990)
Obs (Clusters)	3168 (144)	792 (36)	3168 (144)	792 (36)	396 (18)

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 3: Regressions of Individual contributions and earnings as well as Minimum Contribution by group.

Stage 3 but again by testing linear combinations of the Baseline effect with the interactions we see that earnings do not fall during Stage 3 in the three treatments.

Further evidence regarding the effectiveness of the treatments can be found in the last column of Table 3, which presents a similar regression using the minimum contribution in a group in a period as the unit of observation. We only conduct this regression for the High groups, since this is our focus. We see that the group minimum drops significantly during Stage 3 in the Baseline condition, γ_0 in the last column, while minima in the three treatments are significantly above the Baseline, $\gamma_{3,4 \text{ and } 5}$. Tests on the linear combinations to identify the total effect on the group minima for the treatments again show that there is no statistically significant difference between Stage 2 and Stage 3 for the three treatments.

Another observation from Table 3 is that there again appears to be no difference between the three treatment mechanisms. While we will not present all of the relevant test statistics, in every regression the coefficients for the High group / Stage 3 interactions with the three treatments are statistically indistinguishable across treatments. That is, the beneficial effects of the three mechanisms are identical for contributions, earnings and minima. This indicates that either a quiz or quota restriction works equally well, and that combining the two kinds of entry restrictions yields no discernible additional benefits.

3.3 Responses to Group Transitions

Another way of understanding the behavioral effects of the group transition mechanisms can be found in Tables 4 and 5. Table 4 shows some summary statistics for average contributions for one and three periods before and after transitioning groups for subjects originally in Low groups and average contributions in the one and three periods before and after group transitions are allowed for those originally in High groups. For the Low group members we have also included the ± 1 period contributions for only those subjects moving into a High group in period 11 as this is the first period in which group movement is allowed. These statistics provide a finer grained measure regarding how the subjects respond to group transitions.

For those originally in the Low groups, the average contribution prior to moving is approximately 1 in all treatments but after group transition it is above 4 in the three treatments with entry restrictions but only 2-3 in the Baseline. It is important to note that for those who moved in period 11 the average of the contributions by those subjects in period 11 was 4.54. So while overall there is a larger increase after moving groups in the three treatments than in the Baseline this seems mostly due to subjects moving after

	Original Low Group Members		Original High Group Members	
	Before Own Move	After Own Move	Before Stage 3	Stage 3
	1 Period (Periods 10 and 11 Only)		1 Period	
Baseline	1.25 (0.69)	3.29 (4.54)	3.75	3.00
Quota	0.77 (0.33)	4.35 (5.67)	4.00	4.13
Quiz	1.21 (0.80)	4.89 (4.80)	6.00	6.25
Combined	1.47 (1.25)	4.22 (5.00)	5.17	4.83
	3 Periods		3 Periods	
Baseline	1.32	2.34	3.71	2.29
Quota	0.99	4.49	4.08	4.04
Quiz	1.31	4.60	6.08	5.71
Combined	1.38	4.00	4.97	4.64

Table 4: Summary statistics of contributions before and after group transitions.

period 11 in the Baseline treatment having a much lower post-move increase than those who moved in period 11. This difference will be key to understanding the treatment differences we found above.

For those originally in the High groups we measure behavior before and after group transitions are allowed, which means we are looking at the last one or three periods of stage 2 versus the first one or three periods of Stage 3 (period 10 vs 11 and then periods 8-10 vs 11-13). The table shows that for the three treatments there is a small increase or negligible drop in the periods right after group transitions are allowed but there is a larger initial drop in the Baseline condition and this drop worsens over the first 3 periods while that worsening does not occur in the three treatments. As further evidence, among the 8 incumbents in the High Groups for the Baseline treatment, 4 of them decreased their contributions between periods 10 and 11 while only 3 incumbents did so among the 28 total incumbents in the other three treatments combined. [6] So it appears that those initially in the High Group in the Baseline drop their contributions as soon as group transitions are allowed while in the other three treatments contributions are stable. This is particularly interesting due to the fact that the average contribution among those moving into the High groups in the Baseline sessions is higher at 4.54 than the period 10 High group contribution average which was 3.75.

Of course there are other elements in the experiments that could be responsible for some of these contribution differences. For example, contributions are likely affected by subjects' individual characteristics as well as by the prior period group minimum in the High group

[6] The breakdown is 1 out of 8 in the Quota treatment, 0 out of 8 in the Quiz treatment and 2 out of 12 in the Combined treatment.

	Contributions After Move / Stage 3 Begins			
	Original LG Members		Original HG Members	
	1 Period	3 Periods	1 Period	3 Periods
Group Minimum from	0.698***	0.565***	0.830***	1.246**
High Group $t-1$	(0.0781)	(0.066)	(0.0562)	(0.511)
Avg of Own Contributions	0.0825	0.354***	-	-0.529
x Periods Before Move	(0.138)	(0.116)		(0.510)
Stage 1 Average	-	-	0.511	1.007***
			(0.331)	(0.297)
Quota	0.524	1.755***	1.396*	2.581***
	(0.449)	(0.364)	(0.700)	(0.491)
Quiz	0.844	1.787***	1.874**	2.839***
	(0.511)	(0.376)	(0.826)	(0.531)
Combined	0.379	1.311***	0.933	1.794***
	(0.448)	(0.354)	(0.666)	(0.468)
Constant	0.832**	-0.139	-1.825	-3.801***
	(0.392)	(0.293)	(1.353)	(1.195)
Observations	114	111	36	36
R^2	0.565	0.668	0.890	0.874

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 5: Regressions on behavior before and after group transitions.

into which an entrant is moving. Table 5 reports regressions testing the robustness of the above observations on how transitions affect contributions, controlling for those additional factors. The regressions use as the dependent variable the average of the contributions a subject made for the one or three periods after a group transition (Low subjects) or after group transitions are allowed (High subjects). The independent variables are the subject's own contributions in the previous one or three periods, the minimum in the High Group from the prior period, as well as the treatment binary variables. For the subjects in the High groups we have added an additional control which is the average level of contributions from the 10 person group in Stage 1. This may well be important to the behavior of the members of the High groups because the observation of what happened at the beginning of the experiment may have helped to form their expectations of how new members from the Low group will behave.

For those moving from Low groups into High groups (first two regressions), we see that the immediate response is the same across all treatments but then diverges in the ± 3 period regression. When looking only a single period on either side of a move into a High Group, on

average all movers increase their contributions as a function of the minimum from the target group in the prior period and there are no differences across treatments. By looking three periods on either side though we see substantial differences between treatments emerge. The reaction of those subjects originally in the High groups (second group of regressions) to the possibility of entry is quite interesting. Here we see a negative constant (though insignificant in the ± 1 period regression) and the treatment variables are all positive and almost all significant even in the ± 1 period regression.

The combination of these regressions with the summary statistics presents a clear picture of what generated the differences in the outcomes between the Baseline sessions and the other three. The typical story expected for why coordination might break down in a well coordinated group once new members are allowed in is that the new members might not match the prior behavior of the existing members, leading to a degradation of efficient coordination. This, however, is exactly what we do not see hurting the coordination of High groups in this experiment. Instead, in the Baseline treatment, where we observe a significant decline in coordination after unregulated group movement is allowed, it appears that the subjects moving from the Low groups to the High groups are actually selecting contributions that are quite high and even higher than those originally in the High group. In fact across all treatments it is relatively rare for a new group member in period 11 to be among the lowest contributors in his group. A summary of how often incumbents versus new entrants are among the minimum contributors in the High Groups in period 11 is shown in Table 6. What we see is that new entrants are generally less likely to be the minimum contributors in their group than are incumbents. For example, across all the High Groups in period 11 in all treatments, incumbents selected the minimum choice in their group more frequently (18 of 36, or 50 percent) than did new entrants (7 of 25, 28 percent). As a result, across all 16 High groups in period 11, the minimum contribution was determined more often exclusively by an incumbent (9 groups) than either by new entrants (6 groups) or a combination of both incumbents and new entrants (1 group). This set of observations, combined with the contribution data presented above, provides strong evidence that the new group members are not driving contributions down in the Baseline treatment. Clearly any differences in the ability of groups to sustain coordination is hard to attribute to differences in behavior by those initially in the Low groups, and more the result of behavior by incumbents in the High groups.

The difference in outcomes across treatments is apparently due to the differential response among treatments in how members of the High group respond to the advent of group moves. In the Baseline treatment we observe the High group members responding to the

	Baseline	Quota	Quiz	Combined
Number Incumbents in High Groups	8	8	8	12
Incumbents at Min	2	5	3	8
Number New Entrants in High groups	13	3	5	4
New Entrants at Min	2	2	2	1

Table 6: Frequency of incumbents versus new members being minimum contributor in High group in period 11.

influx of new members by decreasing their contributions, perhaps in expectation that one of the new members will not match the previous group behavior. Even though the new members do match the prior behavior, the response by the High group members starts the unraveling of coordination that we previously observed. In the other three treatments, where there is a mechanism in place to regulate entry, the members of the High group do not respond to the advent of group moves with this initial drop in contributions, the new members match the high contributions of the initial members and the groups are able to sustain efficient coordination.

4 Conclusion

This study explores the effectiveness of different mechanisms for allowing small, efficiently-coordinated groups to grow successfully by incorporating new group members from lower-performing groups. We investigated three different mechanisms similar to ones commonly used outside of the laboratory to restrict entry. One was a simple Quota mechanism limiting the number of entrants in a period. The second was a Quiz through which entrants had to demonstrate a minimum level of knowledge of the growing group's history and of the incentive structure in our production environment. Finally, the third was a combination of the Quota and Quiz mechanisms. The results of the experiment show that any of the three mechanisms work equally as well in allowing successful growth without a substantial breakdown in efficient coordination, while our Baseline treatment with no such restrictions on group entry generated almost complete breakdown in efficiency.

These results demonstrate not only that the small group can grow successfully, as in Weber (2006), but that the exact mechanism used to limit the influx of new members may be less important than the presence of some mechanism. This is a surprising and important finding as it indicates there are ways for a group to grow quickly while maintaining efficient coordination. While the size of High Groups in the Quiz treatment lagged that of the High

Groups in the Baseline by a period or so, their growth rates were otherwise quite similar. Yet the High groups in the Quiz treatment substantially outperformed those in the Baseline. And there was only a negligible difference between the success of the High groups in the Quiz and the other two restricted treatments, even though the High groups in those other two treatments grew at slower rates. Moreover, in Weber (2006) entry involved incorporating entrants with no history of playing the game, while here we show that successful growth can be achieved even when entrants come from groups that have previously faced a total collapse in coordination.

One might well imagine other reasons that the Quiz mechanism should have performed better than the Quota mechanism, as anyone who passed the quiz was guaranteed to have a good understanding of how payoffs are generated and to also know the history of successful coordination in the High group that they were about to join. Not only might this knowledge make entrants more likely to understand the need to maintain efficient coordination, but it might also have convinced incumbents in the well-coordinated High group that newcomers would not degrade their high contributions. Such screening was found to be quite important in a public goods setting in Ahn, Isaac and Salmon (2008, 2009), in which high contributing groups were able to maintain their high degree of cooperation only when existing group members were given the ability to approve or reject incoming members. In our Quota treatment there was no ability to screen, only a limitation on the numbers allowed to enter, and yet this mechanism worked equally as well as the Quiz in this coordination game environment.

The above results indicate a substitutability between limited entry without information and information without limited entry. When only one person enters the efficient group at a time, everyone is sufficiently secure that the efficient coordination will not be harmed even if the incumbents do not know much about that person. Similarly, when multiple people enter but those people have demonstrated relevant knowledge, everyone is similarly sufficiently confident that growth will not harm the efficient coordination. But the combination of the two mechanisms yields no discernible additional benefit. This suggests that as long as there is *some* mechanism to ensure that everyone is sufficiently confident that entry will not overwhelm efficiency, growth will be successful. Given that the only difference in growth rates occurred in the first period in which moves were allowed, this suggests that fear of what will happen with entry in that first period is critical – once groups have learned that they can grow successfully, they subsequently do so.

Finally, we also learn something interesting about the role of beliefs when looking at the instances in which growth failed to yield large successful groups. The decay in efficiency in

the Baseline appears to be driven more by the behavior of incumbents in the High groups than by the behavior of entrants from the Low groups. That is, in the Baseline treatment subjects moving from the Low group match the high choices from previous periods in the High group. But High group incumbents lower their choices when entry occurs with no regulation. Therefore, the mechanisms in our experiment that regulate entry appear to work primarily by reassuring the High group incumbents that the new entrants will match the previous high standards in their group. Combined with the above results, this suggests that a crucial role for policies intended to help groups manage growth may be in how they provide such reassurance to existing group members, rather than in their actual ability to screen or slow down the entry of new ones.

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