Online Appendix to "The Role of Context and Team Play in Cross-Game Learning"

David J. Cooper and John H. Kagel

I. Robustness Checks for Session level Effects: A central issue in the statistical analysis presented in the text is how to control for the clustering found in the data. The data contains repeated observations from the same individuals/teams which are clearly not independent. To account for this, the standard errors for the regressions reported have also been corrected for clustering at the player level (i.e., individual or team as appropriate).[1] Given the shared feedback and the repeated interactions within sessions, observations from different players within the same session are also not likely to be totally independent. The entry rate controls partially capture these session effects, but roughly two thirds of the session effect remains unaccounted for, implying a continued need to control for session effects.[2] Clustering at the player level does not correct the standard errors for this correlation within sessions.

In correcting for session effects we face two problems. By design, we try to run sessions that are as large as possible to reduce any repeated game effects. This has the unintended side effect of giving us a relatively small number of sessions. All the methods of controlling for clustering are biased towards Type 1 errors (incorrect rejections of the null) with a small number of clusters. (A decent rule of thumb is that at least 20 clusters are needed to avoid these Type 1 errors.) We therefore face the problem of having a sufficient number of clusters included in the dataset. The second problem is how to balance Type 1 vs Type 2 errors. The most conservative approach, treating each session as an observation discards a wealth of information and increases the risk of Type 2 errors (incorrect failure to reject the null).[3] While less extreme, the same concern is raised by clustering at the session level – this still conservative approach to correcting the standard errors makes Type 2 errors relatively likely.

In designing the regressions presented in this appendix, we address these problems. The regression presented in Table A.1 uses the largest possible subset of the data. All of the data for EH to EL crossovers is included as well as all available data (from OSU) for inexperienced play of the limit pricing game with ELs. The resulting regression is a bit like a Swiss Army knife, but includes data from 32 separate sessions giving us a reasonable number of clusters. This is the largest set of sessions we can construct for the EL game while making certain that no subject is in more than one session (e.g. clusters are independent).

Our approach to resolving the tradeoff between Type 1 and Type 2 errors is to use multiple approaches to the clustering problem. Models 1 and 2 in Table A.1 control for clustering at the player and session level respectively. Model 3 uses a random effects specification with the random effect at the player level. Model 4 uses a nested random effects specification a random effect at the player level is nested within a random effect at the team level (also see Brandts and Cooper, 2006). Model 2 takes the most conservative approach and is therefore most prone to Type 2 errors. Model 3 uses the most permissive approach and thus is most likely to yield Type 1 errors. By comparing the results of Models 1 – 4 we get a sense of the range of possibilities as well as gaining some insight into the power of session effects: If

[1] This is the standard "cluster" option in Stata. (Moulton, 1986; Liang and Zeger, 1986) The datasets have been constructed to minimize the problems caused by rematching in the 2x2 treatment. Specifically, we avoided including observations from the same individuals as inexperienced and experienced subjects in the 2x2 treatment as their partner is invariably changed.

[2] In the nested probit regressions, described below, the parameter controlling for session effects decreases by about a third when the entry rate differential control is included.

[3] See Frechette (2006) for a compelling argument that treating each session as a single observation is a flawed approach to analyzing experimental data. See, Lui, Kagel, and Lee (2006) for an exercise in explicitly modeling session level effects in these signaling game experiments.

the results are very similar between Models 1 and 2 and between Models 3 and 4, it suggests that the session effects are not terribly important.

The regressions reported below examine the robustness of three points from the main text in 1x1 games:

1) Following the crossover in Experiment 1, strategic play by MLs is significantly more frequent with meaningful context than with abstract context.
2) Considering the crossover in Experiment 1, MLs display positive transfer with meaningful context and negative transfer with abstract context.
3) Transfer by MLs in Experiment 2 is significantly lower with the change in meaningful context.

We also check one point from an earlier paper:

4) Following a crossover from the limit pricing game with high cost entrants to the limit pricing game with low cost entrants (as in Experiment 1), strategic play by MLs is significantly greater in 2x2 than 1x1 games (Cooper and Kagel, 2005). As reported in the text, these games all employed abstract context.

Table A.1 provides a detailed examination of points 1, 4, and 5. The dataset contain all plays by MLs as inexperienced subjects in the game with low cost Es as well as all plays by MLs following the crossover from high to low cost Es. Data is being drawn from seven treatments[4] – the cost of having an adequate number of clusters is an extraordinarily cluttered regression. The dependent variable is a dummy for strategic play defined as choice of 5, 6, or 7. The independent variables consist of treatment dummies interacted with cycle dummies. Rather than wading through the multitude of independent variables, we call attention to three specific interactions which have been highlighted in the table. The variable "Meaningful Context * Crossover Cycle 1" (which is highlighted) captures the effect of meaningful context on strategic play following the crossover. Following point 1 above, this should be positive and significant. The variable "2x2 * Crossover Cycle 1" (also highlighted) measures the effect of teams of the frequency of strategic play by MLs following the crossover. Following point 4, this parameter should also be positive and significant.

The regressions shown in Table A.1 do not include entry rate controls. The results of these regressions are shown in Table A.2 and will be briefly discussed below. To generate the entry rate differential for an observation, we calculate the entry rate over all observations in the same session and same cycle at output levels 4 and 6 and then take the difference. The entry rate differential is demeaned, and the variable is set equal to zero (the average) for missing observations. Use of alternative controls for Es' behavior has little impact on our conclusions. For example, including the entry rates for 4, 5, and 6 as independent variables yields almost identical estimates for the parameters of interest. Using the entry rate for the current cycle is the best proxy for Ms beliefs for early periods following the crossover, the observations of greatest interest. If, as an alternative, we used the entry rate differential for *all* preceding periods, this variable would largely reflect periods with high cost Es, when Es' payoffs and actions are quite different than following the crossover. If we only use preceding periods following the crossover, the variable is largely undefined for these critical periods. This is the same as the procedure with entry rate controls for the regressions reported in the text.

Table A.1 does not include the estimates of the random effects term(s) for Models 3 and 4, but these terms are always significant at the 1% level. In other words, there are significant individual and session

[4] The inexperienced subject treatments are as follows: 1x1, abstract context; 1x1, meaningful context; 2x2, abstract context; and 2x2 meaningful context. The experienced subject sessions are all crossover sessions between the game with high and low cost Es: 1x1, abstract context; 1x1 meaningful context; and 2x2, abstract context.

effects. We have also dropped parameter estimates for inexperienced subject play prior to the cross-over sessions as they are not of direct interest here. Parameter estimates *cannot* be directly compared between models, particularly between those with and without random effects. Adding a random effects term makes the variance of the error term larger and therefore forces parameter estimates to become larger (either more positive or more negative).

The effect of meaningful context on play following the crossover is quite robust. Regardless of how we control for clustering, the parameter estimate for "Meaningful Context * Crossover Cycle 1" is always significant at the 1% level. This conclusion is only slightly weakened by the inclusion of entry rate controls, as the effect is always significant at the 5% level and generally remains significant at the 1% level. The size and significance of the context effect is largely unchanged for the second cycle following the crossover, as measured by "Meaningful Context * Crossover Cycle 2."

Analogous results obtain for the effect of team play. Across Models 1- 4, the team effect is always significant at the 1% level as measured by "2x2 * Crossover Cycle 1." The effect is persistently significant, as can be seen from the estimates for later periods, and remains significant with the addition of entry rate controls.

Tables A.3 and A.4 display regressions examining the robustness of point 2 – the positive transfer with meaningful context and the negative transfer with abstract context in Experiment 1. The models in Table A.3 are identical to those in Table A.1 (notice that the log likelihoods are identical), but the dummies have been rearranged so the crossover sessions are differenced from the corresponding inexperienced subject sessions. For example, the dummy "Abstract Context * Crossover Cycle 2" captures the difference between the second cycle following the crossover with abstract context and the second cycle of the inexperienced subject control sessions with abstract context. The purpose of these regressions is to capture whether (significant) positive or negative transfer occurs. Parameter estimates not related to this question have been suppressed – any useful information available from these parameters can already be Seen in Table A.1.

The critical variables on Table A.3, which are highlighted, are "Abstract Context * Crossover Cycle 1" and "Meaningful Context * Crossover Cycle 1." These variables capture the crossover effects in cycle 1 for 1x1 sessions with abstract and meaningful context respectively. The results reported in Table 4 of the text are robust to varying the controls for clustering. Without controls for the entry rate differential, significant negative transfer occurs following the crossover in 1x1 sessions with abstract context, and significant positive transfer occurs for 1x1 sessions with meaningful context, with the latter extending into cycle 2 following the crossover. Table A.4 reproduces the regressions from Table A.3 with the entry rate differential added as an independent variable. This eliminates the statistical significance of the positive crossover effect with meaningful context in cycle 1 following the crossover, but the positive crossover effect reported in cycle 2 remains and is now extended into cycle 3. The negative crossover effect with abstract context now extends into model 4 (the nested random effect specification) and into cycle 2 following the crossover. Tables A.3 and A.4 also show significant positive cross-game learning for 2x2 sessions with abstract context compared to 1x1 games with abstract context consistent with the results reported in Cooper and Kagel (2005).

The regressions shown in Tables A.5 and A.6 explore the robustness of point 3 – transfer by MLs in Experiment 2 is significantly lower with the change in meaningful context. To get an adequate number of clusters, the dataset used for Table 7 of the text is supplemented with observations following the crossover in Experiment 1. This is our best available source of additional independent clusters for experienced play in games with low cost Es. This data is dummied out of the regressions – in other words the estimates reported in Tables A.5 and A.6 do not reflect this data except through the standard errors. None of the associated parameter estimates are reported as they are not of direct interest.

Recall that Table 7 of the text reported mixed results for Experiment 2. Without entry rate controls, the negative crossover effect with the change in meaningful context in Experiment 2 fails to achieve statistical significance. This conclusion holds regardless of how the regression controls for clustering model. The base for the regressions shown in Table A.5 is quantity-price crossover sessions with abstract context. The critical variable is "1 x 1 * Meaningful Context * Crossover Cycles 2 – 4" which is highlighted. The parameter estimate for this variable is always negative but is not statistically significant in any of the specifications. The statistically significant effect found with entry rate controls in the text (Model 2 in Table 7) is not robust to alternative clustering methods as show in Table A.6. Interestingly, the positive effect from a change in meaningful context reported for the second cycle following the crossover (1 x 1 * Meaningful Context * Crossover Cycles 3 – 4, also highlighted) is always significant in Table A.5. This is consistent with a recovery from a stall in the previous cycle as subjects have more time to reflect on the changes in the payoff tables and context. However, looking at Table A.6, the significance of this result is generally not robust to the inclusion of entry rate controls.

Conclusion: Our most important results are robust to the specifics of how we control for clustering. In Experiment 1, meaningful context leads to significantly more strategic play by MLs following a crossover from games with high cost Es and also changes the nature of transfer from negative to positive. The powerful effect of playing in teams is equally robust.

In Experiment 2, the statistically significant negative effect of meaningful context on transfer between the quantity and price games (after controlling for entry rates) is not robust to how we control for clustering. However, as noted in the text, our confidence in the existence of a negative crossover effect in Experiment 2 is based on both the results reported in the text and the replication of these results in an earlier experiment. This is discussed in detail in Section II below.

II. Replication of Experiment 2 for 1x1 Games: Crossovers from the quantity to the price game were conducted using a somewhat different computer interface and a different subject pool (primarily undergraduates at the University of Pittsburgh). As with Experiment 2 these were 1x1 sessions and compare abstract context sessions in which the context is unchanged by the crossover with meaningful context sessions that changed both the payoffs and the context from the quantity to the price game or vice versa. Payoffs in the quantity game are the same as those reported in Tables 1a and 1c in the text, with somewhat different payoffs (but the same labeling) as in the price game reported in the text (see Table A.10 for the payoff values used). Subjects in the crossover sessions had all participated in one inexperienced subject session with low cost Es. Each crossover session began with one cycle of the same game with low cost Es, followed by three cycles of the game with payoffs switched from the quantity game to the price game or the price game to the quantity game. Inexperienced subject sessions all had three 12 period cycles, and each cycle in the crossover sessions consisted of 12 plays of the game. Other than this, procedures were essentially the same as the crossover sessions reported in Experiment 2 in the text.

Figure A.1 compares the frequency of strategic play between the crossover sessions and the control sessions. The top panel shows abstract context sessions while the bottom panel shows meaningful context sessions. The crossover (when relevant) takes place between Cycle 1 and 2. Visual inspection of the top panel shows a continuation of the learning process (increased levels of strategic play by MLs) in the abstract context crossover and control sessions. In contrast, with meaningful context there is a pause in the learning process in the crossover sessions which is quite noticeable relative to the controls.

Table A.7 reports probit regressions comparing the effects of the crossover on strategic play by MLs with abstract and meaningful context. This is the same difference in difference specification reported in the Table 7 in the text except, to simplify the regressions, no data from control sessions has been included.[5] We also report regressions on the Ohio State data using the same specification. In both cases the coefficient value for the cycle immediately following the crossover (Meaningful Context by Crossover Cycles 2-4) is negative, but only achieves statistical significance in Model 2 which includes the entry rate differential.

Table A.8 reports ordered probits again using the difference in difference specification. In this case we see a statistically significant negative effect of the change in meaningful context in the cycle immediately following the crossover both with and without entry rate controls. This reflects differences in the frequency with which MLs choose 5 versus 6 and 7 immediately following the crossover, with MLs in abstract crossover sessions choosing 6 and 7 (mostly 6) relatively more frequently than 5 when playing strategically.[6]

Table A.9 reports the frequency of strategic play in the 1x1 crossover sessions broken down by context and cycle. This is the same data as in the regressions for Tables A.7 and A.8. Strategic play is subdivided into play of output level 5 and output levels 6 and 7. For the Pittsburgh data with abstract context the increase in the frequency of strategic play from cycle 1 to 2 (i.e., before and after the crossover) is made up almost exclusively of increased choice of 6 and 7. In contrast, choice of 6 and 7 decrease in the meaningful context sessions (along with the stall in the learning process). For the Ohio State data, there is a large increase in the frequency with which 6 and 7 are chosen with abstract context between cycles 1 to 2 along with the increase in the overall frequency of strategic play. With meaningful context, there is a much smaller increase in the frequency with which 6 and 7 were chosen in the cycle following the crossover, along with the stall in the overall level of strategic play. For both the Pittsburgh data and the Ohio State data, the effect of (changing) meaningful context has two parts: (1) a stall in the learning process and (2) a shift in *how* MLs play strategically.

III. Comparing 1x1 Games with 2x2 Games: Table A.11 reports probit regressions comparing the frequency of strategic play between the 2x2 games with meaningful context and the 1x1 games with meaningful context. The dataset is the same one used to generate Figure 8 in the main text, and includes the data from Experiment 2. The specification includes dummies for the cycle as well as interactions between the cycle dummies and dummies for the 2x2 treatment. Model 2 also includes the entry rate differential as an independent variable. The standard error is adjusted for clustering at the "chunk" level.[7] Model 1 which does not account for entry rate differences between treatments shows significantly higher levels of strategic play in the 2x2 games for all cycles of play (the dummy variables 2x2* Cycle). Model 2 accounts for entry rate differences between treatments, which proves to be statistically significant, and results in eliminating the statistical significance of the 2x2*Inex Cycle 1 dummy. The results support the notion that the differences in the level of strategic play between 1x1 and 2x2 games are statistically significant with or without controls for entry rates, as claimed in the text.

The simulation results for team play relative to the truth win's norm are the same as those reported in Cooper and Kagel (2005). Because of clustering in the data, simulations are needed to correctly calculate the error bars. The simulated 2x2 data is based on 100,000 simulated 2x2 data sets for each cycle of play, with the same number of teams in each data set as in the experiment. Simulated 2x2 play is based on randomly drawing two individuals (with replacement) from the 1x1 sessions. The likelihood of any

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[5] There were three sessions for each of the treatments reported with the following number of subjects in each session: abstract control (44), meaningful context control (36), abstract crossover (48), and meaningful context crossover (47).

[6] Use of output level 7 is very rare. In the entire Pittsburgh data set, crossover and control sessions, there are only three such choices (out of 2030 observations).

[7] That is, for teams we must account for the fact that there is correlation between observations from the same team, but also for potential correlation between observations from different teams that shared a common member. The approach employed here follows the procedures described in the statistical appendix to Cooper and Kagel (2005). Briefly, any two teams that share a common member are assigned to the same chunk.

individual being drawn is proportional to the number of times that individual was an MH in that cycle, with the probability of playing strategically based on the observed frequency of strategic play as an MH in that cycle. A simulated team was considered to have played strategically if either of its members played strategically. The error bars then display the 5^{th} and 95^{th} of the distribution of percentages of strategic play in a simulated 2x2 data set.

Finally, Table A.12 compares strategic play following the crossover in Experiment 1 between 1x1 games with meaningful context and the 2x2 games with abstract context reported mentioned in the discussion section of Experiment 1. As in Table A.11, clustering is done at the “chunk” level here. The 1x1 meaningful context sessions serve as the baseline with the “2x2 crossover cycle” variables capturing the difference between the 1x1 and 2x2 sessions. Absent controls for entry, there are higher levels of strategic play following the crossover in the 2x2 games, but no statistically significant differences once one accounts for entry rate differences between the two cases. (The entry rate difference, hence the incentive to play strategically, is much greater in the 2x2 sessions.)

Additional references:

Frechette, G. (2006) “Session Effects in the Laboratory,” unpublished manuscript.

Liu, X, Kagel, J. H. and Lee, L-F. (2006) “Dynamic Discrete Choice Models with Lagged Social Interactions: with an Application to a Signaling Game Experiment,” unpublished manuscript.

Table A.1
Comparing Crossover Effects Going from High to Low Cost Es
(Alternative Controls for Individual and Session Effects)

Variable	Model 1	Model 2	Model 3	Model 4
Individual and Session Effects	Clustering Player Level	Clustering Session Level	Random Effects Player Level	Nested Random Effects (Player/Session)
# Clusters	419	32	419	419/32
Constant	-1.471*** (.217)	-1.471*** (.242)	-2.896*** (.421)	-2.882*** (.562)
Crossover Cycle 2	.781*** (.239)	.781*** (.198)	1.489*** (.392)	1.484*** (.389)
Crossover Cycle 3	1.596*** (.237)	1.596*** (.254)	3.271*** (.444)	3.248*** (.439)
Meaningful Context * Crossover Cycle 1	1.091*** (.288)	1.091*** (.244)	1.866*** (.520)	2.041*** (.763)
Meaningful Context * Crossover Cycle 2	1.100*** (.282)	1.100** (.447)	1.985*** (.445)	2.122*** (.714)
Meaningful Context * Crossover Cycle 3	.316 (.283)	.316 (.447)	.640 (.443)	.770 (.707)
2x2 * Crossover Cycle 1	1.560*** (.280)	1.560*** (.259)	2.949*** (.521)	2.945*** (.739)
2x2 * Crossover Cycle 2	1.450*** (.298)	1.450*** (.363)	2.905*** (.482)	2.862*** (.703)
2x2 * Crossover Cycle 3	1.170*** (.307)	1.170*** (.356)	1.909*** (.533)	1.846*** (.725)
Log Likelihood	-1414.62	-1414.62	-1053.68	-1046.41

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Note: Parameter estimates are identical in Models 1 and 2, as clustering only affects the size of the standard errors. Because these are non-linear models, parameter estimates cannot be directly compared across the various models. Specifically, moving to random effects will cause larger parameter estimates holding marginal effects fixed.

Table A.2
Comparing Crossover Effects Going from High to Low Cost Es
(With Entry Rate Controls and Alternative Controls for Individual and Session Effects)

Variable	Model 1	Model 2	Model 3	Model 4
Individual and Session Effects	Clustering Player Level	Clustering Session Level	Random Effects Player Level	Nested Random Effects (Player/Session)
# Clusters	419	32	419	419/32
Constant	-1.743*** (.263)	-1.743*** (.279)	-3.095*** (.473)	-3.004*** (.501)
Crossover Cycle 2	.425 (.285)	.425 (.422)	.958** (.403)	.963** (.404)
Crossover Cycle 3	1.244*** (.255)	1.244*** (.168)	2.627*** (.469)	2.618*** (.458)
Meaningful Context * Crossover Cycle 1	.737** (.320)	.737*** (.247	1.403** (.560)	1.469** (.661)
Meaningful Context * Crossover Cycle 2	.885*** (.278)	.885** (.342)	1.685*** (.480)	1.761*** (.598)
Meaningful Context * Crossover Cycle 3	.395 (.270)	.395 (.317)	.821* (.447)	.869 (.590)
2x2 * Crossover Cycle 1	1.006*** (.319)	1.006*** (.265)	2.142*** (.600)	2.122*** (.670)
2x2 * Crossover Cycle 2	1.133*** (.299)	1.133*** (.311)	2.466*** (.559)	2.421*** (.613)
2x2 * Crossover Cycle 3	.720** (.317)	.720** (.322)	1.369** (.561)	1.346** (.643)
Entry Rate Differential	1.139*** (.204)	1.139*** (.243)	1.444*** (.261)	1.301*** (.300)
Log Likelihood	-1364.20	-1364.20	-1039.52	-1037.18

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Note: Parameter estimates are identical in Models 1 & 2 – clustering only affects the size of the standard errors.

Table A.3
Experiment 1: Comparing Outcomes Against Within Treatment Controls
(Alternative Controls for Individual and Session Effects)

Variable	Model 1	Model 2	Model 3	Model 4
Individual and Session Effects	Clustering Player Level	Clustering Session Level	Random Effects Player Level	Nested Random Effects (Player/Session)
# Clusters	419	32	419	419/32
Abstract Context * Crossover Cycle 1	-.564** (.242)	-.564** (.275)	-.938** (.451)	-1.007 (.647)
Abstract Context * Crossover Cycle 2	-.385* (.232)	-.385 (.395)	-.620* (.355)	-.687 (.588)
Abstract Context * Crossover Cycle 3	.152 (.308)	.152 (.367)	.207 (.463)	.068 (.639)
Meaningful Context * Crossover Cycle 1	.727*** (.244)	.727*** (.194)	1.127*** (.394)	1.338** (.659)
Meaningful Context * Crossover Cycle 2	1.214*** (.253)	1.214*** (.412)	2.294*** (.406)	2.454*** (.658)
Meaningful Context * Crossover Cycle 3	.467 (.318)	.467 (.388)	.845* (.466)	.845 (.641)
2x2 * Crossover Cycle 1	.698*** (.232)	.698*** (.155)	1.482*** (.407)	1.425** (.629)
2x2 * Crossover Cycle 2	.444 (.287)	.444 (.287)	1.133** (.478)	1.031 (.648)
2x2 * Crossover Cycle 3	1.322*** (.336)	1.322*** (.279)	2.116*** (.556)	1.925*** (.671)
Log Likelihood	-1414.62	-1414.62	-1053.68	-1046.41

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Note: Parameter estimates are identical in Models 1 and 2, as clustering only affects the size of the standard errors.

Table A.4
Experiment 1: Comparing Outcomes Against Within Treatment Controls
(With Entry Rate Controls and Alternative Controls for Individual and Session Effects)

Variable	Model 1	Model 2	Model 3	Model 4
Individual and Session Effects	Clustering Player Level	Clustering Session Level	Random Effects Player Level	Nested Random Effects (Player/Session)
# Clusters	419	32	419	419/32
Abstract Context * Crossover Cycle 1	-700** (.277)	-700** (.288)	-1.078** (.499)	-1.030* (.552)
Abstract Context * Crossover Cycle 2	-.613*** (.226)	-.613** (.310)	-.911** (.405)	-.891* (.471)
Abstract Context * Crossover Cycle 3	.296 (.307)	.296 (.326)	.162 (.431)	.067 (.490)
Meaningful Context * Crossover Cycle 1	.333 (.258)	.333 (.311)	.547 (.386)	.864 (.583)
Meaningful Context * Crossover Cycle 2	.800*** (.260)	.800** (.319)	1.690*** (.388)	1.982*** (.587)
Meaningful Context * Crossover Cycle 3	.691** (.312)	.691** (.301)	.979** (.418)	.934** (.548)
2x2 * Crossover Cycle 1	.385 (.242)	.385** (.192)	1.041** (.528)	1.000* (.550)
2x2 * Crossover Cycle 2	.114 (.293)	.114 (.289)	.630 (.563)	.555 (.576)
2x2 * Crossover Cycle 3	1.016*** (.341)	1.016*** (.304)	1.531*** (.530)	1.406** (.600)
Entry Rate Differential	1.139*** (.204)	1.139*** (.243)	1.444*** (.274)	1.302*** (.298)
Log Likelihood	-1364.20	-1364.20	-1039.52	-1037.18

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Note: Parameter estimates are identical in Models 1 and 2, as clustering only affects the size of the standard errors.

Table A.5
Experiment 2: Crossover from Quantity to Price Game
(Alternative Controls for Individual and Session Effects)

Variable	Model 1	Model 2	Model 3	Model 4
Individual and Session Effects	Clustering Player Level	Clustering Session Level	Random Effects Player Level	Nested Random Effects (Player/Session)
# Clusters	275	21	275	275/21
Constant	-.015 (.193)	-.015 (.142)	-.552* (.283)	-.166 (.301)
Cycles 2 – 4	.361** (.163)	.361 (.296)	.781** (.325)	.841** (.359)
Cycles 3 – 4	.053 (.168)	.053 (.186)	.118 (.332)	.114 (.347)
Cycle 4	.162 (.158)	.162 (.310)	.669* (.347)	.718*** (.331)
1 x 1 * Meaningful Context * Crossover Cycles 1 – 4	-.277 (.265)	-.277 (.215)	-.829** (.401)	-.999** (.438)
1 x 1 * Meaningful Context * Crossover Cycles 2 – 4	-.346 (.221)	-.346 (.303)	-.547 (.429)	-.611 (.453)
1 x 1 * Meaningful Context * Crossover Cycles 3 – 4	.472* (.247)	.472* (.256)	1.056** (.449)	1.017** (.469)
1 x 1 * Meaningful Context * Crossover Cycle 4	-.079 (.200)	-.079 (.332)	-.208 (.470)	-.221 (.451)
1 x 1 * Abstract Context * Control Cycles 1 – 4	-.208 (.274)	-.208 (.420)	-.276 (.490)	-.307 (.595
1 x 1 * Abstract Context * Control Cycles 2 – 4	-.254 (.238)	-.254 (.326)	-.056 (.458)	-.143 (.540)
1 x 1 * Abstract Context * Control Cycles 3 – 4	.261 (.231)	.261 (.275)	.775 (.504)	.875* (.523)
1 x 1 * Abstract Context * Control Cycle 4	.071 (.233)	.071 (.372)	-.200 (.505)	-.291 (.489)
Log Likelihood	-1188.89	-1188.89	-701.62	-696.56

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Notes: Parameter estimates are identical in Models 1 & 2 – clustering only affects the size of the standard errors.

Table A.6
Experiment 2: Crossover from Quantity to Price Game
(With Entry Rate Controls and Alternative Controls for Individual and Session Effects)

Variable	Model 1	Model 2	Model 3	Model 4
Individual and Session Effects	Clustering Player Level	Clustering Session Level	Random Effects Player Level	Nested Random Effects (Player/Session)
# Clusters	275	21	275	275/21
Constant	-1.468*** (.357)	-1.468*** (.338)	-1.714*** (.507)	-.944* (.546)
Cycles 2 – 4	.825*** (.182)	.825*** (.277)	1.126*** (.418)	1.091*** (.376)
Cycles 3 – 4	-.093 (.185)	-.093 (.286)	-.072 (.463)	-.021 (.278)
Cycle 4	-.230 (.214)	-.230 (.478)	.464 (.363)	.491 (.315)
1 x 1 * Meaningful Context * Crossover Cycles 1 – 4	-.187 (.279)	-.187 (.300)	-.546 (.425)	-.815* (.474)
1 x 1 * Meaningful Context * Crossover Cycles 2 – 4	-.492** (.223)	-.492 (.315)	-.642 (.481)	-.642 (.453)
1 x 1 * Meaningful Context * Crossover Cycles 3 – 4	.275 (.268)	.275 (.314)	.846 (.516)	.874** (.403)
1 x 1 * Meaningful Context * Crossover Cycle 4	.109 (.230)	.109 (.492)	-.089 (.436)	-.115 (.426)
1 x 1 * Abstract Context * Control Cycles 1 – 4	.035 (.283)	.035 (.325)	.156 (.507)	-.356 (.680)
1 x 1 * Abstract Context * Control Cycles 2 – 4	-.331 (.251)	-.331 (.353)	-.196 (.586)	-.230 (.529)
1 x 1 * Abstract Context * Control Cycles 3 – 4	.062 (.263)	.062 (.406)	.748 (.626)	.780 (.467)
1 x 1 * Abstract Context * Control Cycle 4	.158 (.262)	.158 (.484)	-.226 (.512)	-.283 (.463)
Entry Rate Differential	2.233*** (.438)	2.233*** (.489)	1.606*** (.516)	.146** (.064)
Log Likelihood	-1119.11	-1119.11	-696.65	-694.26

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Notes: Parameter estimates are identical in Models 1 & 2 – clustering only affects the size of the standard errors. The data set includes a large number of observations from experienced subject sessions with a crossover between the high and low cost entrant games. Only observations where the low cost entrant game was played are included. These provide a source of additional independent clusters based on experienced play of the low cost entrant game. This data is dummied out of the regressions – in other words the estimates reported above do not reflect this data. None of these parameter estimates are reported above as these are not of direct interest.

The base for the regressions are quantity-price crossover sessions with abstract context.

Table A.7
Probit Regressions, Crossover from Quantity to Price Game
Standard Errors Corrected for Clustering at the Individual Level

Dependent Variable: Strategic Choice by MLs

Location	Pittsburgh		Ohio State	
Variable	Model 1	Model 2	Model 1	Model 2
Constant	-.210 (.160)	-.194 (.158)	-.015 (.194)	-.136 (.209)
Cycles 2 – 4	.263* (.145)	.350** (.169)	.361** (.164)	.803*** (.216)
Cycles 3 – 4	.378** (.161)	.304* (.183)	.053 (.169)	-.087 (.183)
Cycle 4	.358* (.190)	.294 (.207)	.162 (.159)	-.212 (.255)
Meaningful Context * Crossover Cycles 1 – 4	.406* (.229)	.396* (.228)	-.267 (.266)	-.198 (.278)
Meaningful Context * Crossover Cycles 2 – 4	-.352 (.224)	-.429* (.247)	-.346 (.222)	-.485** (.225)
Meaningful Context * Crossover Cycles 3 – 4	-.079 (.206)	-.058 (.212)	.472* (.248)	.284 (.275)
Meaningful Context * Crossover Cycle 4	-.203 (.232)	-.202 (.231)	-.079 (.201)	.099 (.242)
Entry Rate Differential		.425 (.411)		2.132*** (.722)
Log Likelihood	-738.32	-737.06	-512.45	-492.59

Note: The base is 1x1 abstract context crossover sessions. Cycles are longer in the Pitt data (12 periods) than in the OSU data (8 periods).

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Table A.8
Ordered Probit Regressions, Crossover from Quantity to Price Game
Standard Errors Corrected for Clustering at the Individual Level

Dependent Variable: (Transformed) Output Choice by MLs

Location	Pittsburgh (1149 obs., 95 subjects)		Ohio State (778 obs., 98 subjects)	
Variable	Model 1	Model 2	Model 1	Model 2
Cycles 2 – 4	.207* (.121)	.248* (.138)	.457** (.160)	.860*** (.175)
Cycles 3 – 4	.160 (.134)	.125 (.147)	-.020 (.164)	-.145 (.174)
Cycle 4	.509*** (.151)	.477*** (.166)	.251 (.153)	-.085 (.214)
Meaningful Context * Crossover Cycles 1 – 4	.516*** (.185)	.511*** (.185)	-.259 (.181)	-.189 (.195)
Meaningful Context * Crossover Cycles 2 – 4	-.392** (.195)	-.428** (.204)	-.425** (.200)	-.567*** (.197)
Meaningful Context * Crossover Cycles 3 – 4	.189 (.177)	.199 (.180)	.565** (.223)	.429* (.238)
Meaningful Context * Crossover Cycle 4	-.229 (.202)	-.226 (.202)	-.262 (.193)	-.115 (.214)
Entry Rate Differential		.197 (.293)		1.898*** (.539)
Log Likelihood	-1425.89	-1425.50	-902.06	-881.43

Note: The base is 1x1 abstract context crossover sessions. Cycles are longer in the Pitt data (12 periods) than in the OSU data (8 periods). Choices from the price game have been transformed into output levels.

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Table A.9
Detailed Frequencies of Strategic Play
(Cross-Over from Quantity to Price Game)

Cycle	Pittsburgh						Ohio State					
	Abstract (output levels)			Meaningful (output levels)			Abstract (output levels)			Meaningful (output levels)		
	5	6 & 7	5 - 7	5	6 & 7	5 - 7	5	6 & 7	5 - 7	5	6 & 7	5 - 7
1	37.5%	4.2%	41.7%	20.4%	37.3%	57.7%	18.8%	30.6%	49.4%	19.3%	19.3%	38.5%
2	34.7%	17.4%	52.1%	31.0%	23.2%	54.2%	3.5%	60.0%	63.5%	10.0%	29.1%	39.1%
3	47.9%	18.8%	66.7%	27.3%	38.5%	65.7%	2.3%	63.2%	65.5%	10.3%	49.5%	59.8%
4	38.2%	40.3%	78.5%	17.1%	54.1%	71.2%	0%	71.3%	71.3%	13.0%	50.0%	73.0%

Cycle 1 is quantity game. Cycles 2-4 are the price game with price levels transposed to corresponding output levels in the price game.

Table A.10
Payoffs Used in Pittsburgh for Price Game

Existing Firm's Payoffs as a Function of Other Firm's Choice
(A Player's Payoffs as a Function of B Player's Choice)

Low Cost *(A2)*		
Price *(A's Choice)*	**Enter** *(B's choice)*	
	This *(x)*	**Other** *(y)*
1	204	545
2	333	678
3	355	700
4	378	723
5	350	695
6	283	648
7	250	615

High Cost *(A1)*		
Price *(A's Choice)*	**Enter** *(B's choice)*	
	This *(x)*	**Other** *(y)*
1	-428	-220
2	-298	-110
3	8	165
4	103	448
5	125	470
6	148	493
7	125	470

Other Firm's Payoffs
(B's Payoffs)

Other Firm Enters *(B's Choice)*	**Existing Firm's Type** *(A's Type)*	
	Low Cost *(A2)*	**High Cost** *(A1)*
This *(x)*	219	594
Other *(y)*	281	281

Labeling in bold applies to meaningful context. Labeling in italics and in parentheses applies to abstract context.

Table A.11

Probit Regressions Comparing 2x2 Sessions with 1x1 Sessions
(Low Cost Entrants – Meaningful Context)

Dependent Variable: Strategic Choice by MLs (1208 obs)

	Model 1	Model 2
Constant	-1.106 *** (0.154)	-0.713 *** (0.161)
Inex Cyc2	0.302 (0.187)	0.118 (0.190)
Ex Cyc1	0.814 *** (0.214)	0.282 (0.250)
Ex Cyc2	0.829 *** (0.236)	0.510 ** (0.246)
Ex Cyc3	1.354 *** (0.236)	0.807 *** (0.253)
Ex Cyc4	1.437 *** (0.228)	0.750 *** (0.271)
2x2 * Inex Cyc1	0.399 ** (0.202)	0.318 (0.215)
2x2 * Inex Cyc2	1.181 *** (0.209)	0.917 *** (0.240)
2x2 * Ex Cyc1	1.841 *** (0.459)	1.877 *** (0.466)
2x2 * Ex Cyc2	2.449 *** (0.300)	1.930 *** (0.339)
2x2 * Ex Cyc3	1.641 *** (0.499)	1.501 *** (0.517)
2x2 * Ex Cyc4	dropped (no variation)	dropped (no variation)
Entry Rate Differential		1.506 *** 0.418
Log Likelihood	-608.881	-589.608

Robust standard errors (“chunk”)

*	Significant at 1% level
**	Significant at 5% level
***	Significant at 10% level

Table A.12
Comparing Crossover Effects Going from High to Low Cost Entrants with 2x2 Games

Probit Regressions: Dependent Variable is Strategic Choice by MLs
(816 obs, 136 players)

Variable	Model 1	Model 2
Constant	-.379** (.190)	-.310 (.192)
Crossover Cycle 2	.789*** (.183)	.498** (.200)
Crossover Cycle 3	.820*** (.228)	.999*** (.277)
Abstract Context * Crossover Cycle 1	-1.091*** (.289)	-.638* (.352)
Abstract Context * Crossover Cycle 2	-1.010*** (.283)	-.829*** (.295)
Abstract Context * Crossover Cycle 3	-.316 (.283)	-.487* (.271)
2x2 * Crossover Cycle 1	.469* (.260)	.199 (.273)
2x2 * Crossover Cycle 2	.350 (.294)	.193 (.289)
2x2 * Crossover Cycle 3	.854** (.317)	.032 (.399)
Entry Rate Differential		1.732*** (.557)
Log Likelihood	-449.64	-431.03

Standard errors corrected for clustering at the player level.

* statistically significant at the 10% level
** statistically significant at the 5% level
*** statistically significant at the 1% level

Figure A.1
Effect of Context on Quantity-Price Crossover, Proportion of Strategic Play
University of Pittsburgh Data