ESSAYS ON BEHAVIOR AND INCENTIVES IN INSTITUTIONS

DISSERTATION

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By

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This dissertation consists of three chapters. The first chapter, “Sequential Demands in Multi-Issue Legislative Bargaining”, presents a new model of legislative multi-issue bargaining. Legislators have to approve a policy position and a budget distribution. I investigate whether legislators prefer to bundle both issues in one bill or bargain over them separately. Although bundling issues allows for trade-offs between issues, I find that the preference for bundling, postulated by the literature, disappears when a bargaining game is used that restricts the bargaining power of the first mover. I use a modified demand bargaining game and show that it leads to a second mover advantage when issues are bundled. This induces the first mover to separate issues in most cases. The previous literature offers a rationale for bundled issues, such as omnibus legislation. This chapter provides a rationale for separated issues that has been missing before. Besides the fact that issues are almost always separated, the model predicts that the median legislator’s ideal point is implemented as the policy position and that the budget is divided evenly among the members of a minimum winning coalition.

The second, "Multi-Issue Legislative Demand Bargaining: A Pilot Experiment", chapter presents an experimental investigation of the theoretical model presented in the first chapter. I design two treatments, one with bundled issues and one with separated. I test whether subjects recognize the strategic difference between bundled
and separated issues in the demand bargaining game. I find that subjects behave substantially different in the two treatments. In the separating treatment, they meet equilibrium predictions in more than 80% of the observations. In the bundling treatment, the data qualitatively matches the theory. Subjects behave strategically and the predicted second-mover advantage in payoffs can be found in the data.

In the third chapter, “Learning Differences in Mixed Common Value Auctions”, I examine behavior of inexperienced and experienced bidders in mixed common value auctions. In all previous studies of behavior in common value auctions, subjects had the same level of experience. I design an experiment with mixed auction markets, in which subjects are both experienced and inexperienced. I find that mixing experience levels in the same auction market has an effect on the behavior of inexperienced subjects, and gender is important: Inexperienced males bid more aggressively in mixed auction markets than in markets with only inexperienced bidders, but inexperienced females bid less aggressively. Experienced bidders do not react significantly different in mixed auction markets than in markets with only experienced bidders. These findings have two implications: First, they shed additional light on the different learning behavior of males and females. And second, they give an indication of the robustness of learning to changes in the environment.
To my parents Hajo and Hannelore and my brothers David and Julian.
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TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sequential Demands in Multi-Issue Legislative Bargaining</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.2 The Model</td>
<td>4</td>
</tr>
<tr>
<td>1.3 Equilibrium</td>
<td>7</td>
</tr>
<tr>
<td>1.3.1 Bundling Issues</td>
<td>9</td>
</tr>
<tr>
<td>1.3.2 Comparing Bundling and Separating</td>
<td>11</td>
</tr>
<tr>
<td>1.4 Extension to Heterogeneous Policy Intensity</td>
<td>13</td>
</tr>
<tr>
<td>1.5 A Remark on the Robustness of Separating as the Optimal Choice</td>
<td>15</td>
</tr>
<tr>
<td>1.6 Concluding Remarks and Directions for Future Research</td>
<td>16</td>
</tr>
<tr>
<td>2. Multi-Issue Legislative Demand Bargaining: A Pilot Experiment</td>
<td>20</td>
</tr>
<tr>
<td>2.1 Introduction</td>
<td>20</td>
</tr>
<tr>
<td>2.2 Theoretical Background and Hypotheses</td>
<td>23</td>
</tr>
<tr>
<td>2.3 Experimental Design</td>
<td>27</td>
</tr>
<tr>
<td>2.4 Results</td>
<td>31</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>25</td>
</tr>
<tr>
<td>Equilibrium Predictions for the Bundling Treatment</td>
<td>25</td>
</tr>
<tr>
<td>2.2</td>
<td>26</td>
</tr>
<tr>
<td>Equilibrium Predictions for the Separating Treatment</td>
<td>26</td>
</tr>
<tr>
<td>2.3</td>
<td>28</td>
</tr>
<tr>
<td>Payoffs in Dollar from Hospital Location</td>
<td>28</td>
</tr>
<tr>
<td>2.4</td>
<td>33</td>
</tr>
<tr>
<td>Average Payoffs in the Final Decision</td>
<td>33</td>
</tr>
<tr>
<td>B.1</td>
<td>75</td>
</tr>
<tr>
<td>Data Description</td>
<td>75</td>
</tr>
<tr>
<td>B.2</td>
<td>76</td>
</tr>
<tr>
<td>Bid Factor Regression for Inexperienced Subjects</td>
<td>76</td>
</tr>
<tr>
<td>B.3</td>
<td>77</td>
</tr>
<tr>
<td>Average Bid Factors of Inexperienced Subjects, I=Inexp., Mi=Mixed, M=Male, F=Female (SE in parentheses.)</td>
<td>77</td>
</tr>
<tr>
<td>B.4</td>
<td>77</td>
</tr>
<tr>
<td>Average Profits by Subject and Bankruptcies for Inexperienced, I=Inexp., Mi=Mixed, M=Male, F=Female (SE in parentheses.)</td>
<td>77</td>
</tr>
<tr>
<td>B.5</td>
<td>78</td>
</tr>
<tr>
<td>Bid Factor Regression for Experienced Subjects</td>
<td>78</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1</td>
<td>$D_i^*$ for different $b$.</td>
<td>73</td>
</tr>
<tr>
<td>A.2</td>
<td>$\hat{g}_2^*(b)_1$ for $b \geq 1$.</td>
<td>74</td>
</tr>
<tr>
<td>A.3</td>
<td>$\frac{\partial}{\partial b} (\hat{g}_2^*(b))$ for $b \geq 1$.</td>
<td>74</td>
</tr>
<tr>
<td>B.1</td>
<td>Average Bid Factors of Inexperienced Subjects in Inexperienced Treatment</td>
<td>76</td>
</tr>
<tr>
<td>B.2</td>
<td>Average Bid Factors of Inexperienced Subjects in the Mixed Treatment</td>
<td>78</td>
</tr>
<tr>
<td>B.3</td>
<td>Average Bid Factors of Experienced Subjects in Experienced Treatment</td>
<td>79</td>
</tr>
<tr>
<td>B.4</td>
<td>Average Bid Factors of Experienced Subjects in Mixed Treatment</td>
<td>79</td>
</tr>
<tr>
<td>B.5</td>
<td>Inexperienced Males and Females and their Experienced Opponents</td>
<td>80</td>
</tr>
</tbody>
</table>
CHAPTER 1

SEQUENTIAL DEMANDS IN MULTI-ISSUE LEGISLATIVE BARGAINING

1.1 Introduction

In this chapter, I present a new model of legislative multi-issue bargaining. Legislators have to approve decisions on several dimensions, i.e. policy dimension and a budget distribution. I want to address the question when legislators prefer to bundle these types of issues in the same bill and approve them simultaneously, and when they prefer to treat the two dimensions independently and approve two different bills. When the issues are separated into different bills, legislators forego any possible trade-offs between the two dimensions because they cannot commit to trades between dimensions. In my model, the choice of the agenda includes an option to either separate or bundle the issues, and I develop predictions about when either one is more likely. This will depend on parameters of the model, such as the policy ideal point of the first mover and the degree of polarization in the legislature.

In most democracies, several distinct issues are sometimes approved in the same bill. At the same time, there are many bills dealing with only one issue at a time. In any legislature we observe a mix of single-issue bills and bundled bills.\(^1\) The previous

\(^1\)See e.g. Huber (1992) on restrictive legislative procedures in the United States and France.
literature on legislative bargaining or agenda choice, however, remains silent on the reason for the coexistence of both types of proposed bills, and on how to rationalize the choice of bundling versus separating. More precisely, there is no theoretical model that can display separating and bundling of issues as the optimal choices in different contexts or under different parameters.

Many previous models of legislative bargaining simply assume bundling as the only option for the agenda setter (e.g. Morelli 1999, Banks and Duggan 2000, 2003). Other models consider the choice of the agenda setter to separate or bundle issues (e.g. Baron and Ferejohn 1989, Jackson and Moselle 2002) but all assume a bargaining game that makes bundling always optimal for the agenda setter. They specifically use the alternating offer games introduced by Baron and Ferejohn (1989). This game yields such a large bargaining power to the agenda setter that she always considers it optimal to use her advantageous positions on all the issues in question and bundle them all together in a bill.²

In this paper, I propose a model that endogenizes the choice of separating and bundling. The first mover can decide whether issues are bundled or separated. I use a bargaining game with weakened first mover power. It is a modified version of the demand bargaining game introduced by Morelli (1999). I show that in this bargaining game, the first mover does not have an advantage in the bargaining process. Often,

²For the optimality of issue-bundling in bargaining situations other than a legislature see e.g. Inderst (2000) and Chen (2003). In and Serrano (2003) argue that bargaining issue by issue is inefficient because no trade-offs can be made. Chen (2003) finds that negotiators prefer to separate issues only if the probability of a breakdown of the negotiations is large.

Lang and Rosenthal (2001) present the only model, to my knowledge, in which bargaining over subsets of issues can be optimal in the absence of obstructions to the bargaining process. They use, however, convex utility functions and add uncertainty about the identity of the proposal maker. The convexity of the utility functions makes players risk loving, and so they prefer to settle issues by frequent lotteries. I do not consider their framework suitable for discussing legislative bargaining or many other bargaining situations.
she even has a clear disadvantage. In many cases, this disadvantage leads her to prefer separating issues. When issues are separated, trade-offs between dimensions are not possible because legislators cannot commit to trades across independent bills. The decisions on the two dimensions rely on policy compromise rather than trading and are therefore less polarized. In the equilibria with separated issues, the median legislator’s ideal point is always approved as the policy position and the budget shares are divided evenly among the members of the winning coalition. When the first mover decides to bundle issues, legislators trade off issues against each other. The policy outcome is more tilted towards the ideal point of the first mover and the budget shares are such that the second mover receives more than the first. In this model, the likelihood of separating and bundling is related to parameters of the model, such as the ideal point of the first mover and the degrees of polarization and asymmetry in the legislature.

The two papers most closely related to this work are Morelli (1999) and Jackson and Moselle (2002). Morelli (1999) introduced the demand bargaining game as a new model of legislative bargaining that predicts very different outcomes than the alternating offer game, such as a more equalized distribution of the budget and a less polarized policy outcome. In his model, though, he does not consider the choice of the first mover to separate or bundle issues. In addition, he uses a different utility function that proves unsuitable for the question of bundling versus separating. While I use a quadratic loss function, he uses an absolute distance function to represent the loss a legislator experiences from a move of the policy position away from her ideal point. The crucial difference between these two functions is that with a quadratic loss function, legislators have different marginal rates of substitution in the policy
dimension, while with a linear loss function, the marginal rate of substitution is the same for all legislators and policy positions. The question of separating and bundling issues is equivalent to the question of whether legislators prefer to make trades across dimensions on the basis of these differences in the marginal rates of substitution or not. With an absolute distance function, legislators have no incentive to trade, even when they bundle issues.

The second paper, Jackson and Moselle (2002) examine an environment very similar to mine, but use the alternating offers game. As to be expected with the strong first mover advantage in such a game, the issues are always bundled together in their model.

My basic model is a relatively simple model of legislative bargaining. It allows me to focus exclusively on the influence of the bargaining rules and legislators’ preferences on the preference over separating and bundling. It should be understood as a first look at some of the forces that drive these preferences. I extend the model to a case in which the more extreme legislators care more about the policy dimension than the median. Intuitively, this should increase the occurrence of bundling because this allows the extreme legislators to tilt the policy position toward their ideal point. However, the equilibrium choices stay qualitatively the same. Separating as an optimal choice proves to be a relatively robust outcome of this type of model of legislative multi-issue bargaining.

1.2 The Model

Consider a legislature with three members. Each legislator has a distinct policy ideal point \( \hat{y}_i, \ i = 1, 2, 3, \ \hat{y}_1 < \hat{y}_2 < \hat{y}_3 \). Let \( Y = [\hat{y}_1, \hat{y}_3] \) be the policy space. Legislator
1 is the extreme left, legislator 3 is the extreme right, and legislator 2 is the median. Without loss of generality, I assume that \( \hat{y}_2 - \hat{y}_1 \leq \hat{y}_3 - \hat{y}_2 \), so that legislator 3 is weakly more extreme in terms of distance from the median. The legislators have to approve a policy position \( y \in Y \) and distribute a monetary budget \( X \) among themselves. A decision is a pair \( (y, (x_1, x_2, x_3)) \in Y \times \mathbb{R}^3_+ \) such that \( \sum_i x_i \leq X \). The following represents a legislator’s utility from a decision \( (y, (x_1, x_2, x_3)) \):

\[
\begin{align*}
 u_i(y) &= -b(y - \hat{y}_i)^2 \\
 U_i(y, x_i) &= u_i(y) + x_i, \ i = 1, 2, 3
\end{align*}
\]

The parameter \( b > 0 \) captures how much the legislators care about the policy dimension relative to the budget dimension and is called ‘policy intensity’.

The bargaining game that I use is a modified version of the demand bargaining game presented in Morelli (1999). This is a bargaining game with nearly unrestricted amendment possibilities because it is modeled as a game of consecutive demands. Legislators sequentially ask for their respective share of the budget and a policy agreement. The first mover is randomly chosen by Nature.\(^3\) The first mover decides whether issues are bundled together in one bill or approved in two separate bills. Then she fixes the order of play of the remaining legislators.\(^4\)

\(^3\)I do not try to determine endogenously the first mover in this model because I want to focus on the legislative bargaining and the effect of the identity of the first mover on the bargaining outcome. One could easily extend this model to include a prior stage, e.g. letting the Head of State choose the first mover.

\(^4\)This assumption seems restrictive at first, but the results show that it is not. In a modified model with random order of play, the results would remain qualitatively unchanged.
**Bundled issues.** When issues are bundled, the first mover specifies her demand for a budget share as well as a policy position, \((x^1, y^1)\).\(^5\) The second mover can now form a majority coalition with the first mover by making the demand \((X-x^1, y^1)\), i.e. the same policy and the rest of the budget. In this case, the game is over. Alternatively, the second mover can announce another demand, such as \((x^2, y^2)\), i.e. a different policy position and a share different from \(X-x^1\). This move can be interpreted as the disapproval of the first mover’s demand by proposing an amendment. In this case, the third mover can form a coalition with either one of the preceding legislators (a coalition with the first mover by demanding \((X-x^1, y^1)\), or a coalition with the second mover by demanding \((X-x^2, y^2)\)). Or she can decide that the game should go on to the next round. If the game goes to the next round, the process restarts and simply repeats itself.

**Separated issues.** When issues are separated, the first mover has to decide which issue should be the first. The bargaining proceeds as above, but with one dimension at a time. The first mover can make a demand only on one issue and the second mover can propose an amendment only to the same issue. Once a decision on the first issue is reached, a new first mover is randomly chosen, each legislator with the same probability, for the decision process on the next issue. The two dimensions are treated separately. No commitment to trades between issues is possible.

I assume that there is no discounting of the future, i.e. the same decision in different rounds yields the same payoff to the legislators This allows me to focus exclusively

\(^5\)Note that superscripts denote the position in the order of play, while subscripts indicate the position of the legislator on the ideological dimension. \(y^1\) is the policy position demanded by the first mover, and \(x^1\) is her share of the budget.
on preferences over separating and bundling.\\(^6\) I also assume that legislators who are indifferent between ending the game in two different rounds will end it in the earlier one, consistent with the potential introduction of discounting.

The size of the budget $X$ plays an important role. To stack the deck against myself, I assume that the budget is very large, so that any sidepayment necessary for trades are possible and the trade-offs are completely unconstrained. Thus, I create the most favorable conditions for bundling ceteris paribus.

The appropriate equilibrium concept is subgame perfect equilibrium. The demand bargaining game is inherently sequential and there is always perfect information about prior moves, such as the order of play and demands on the table.

### 1.3 Equilibrium

The demand bargaining game can be interpreted as a game of competing demands or unrestricted amendments. The second mover can propose any feasible amendment to the demand of the first mover, as long as the amendment is in the same dimension(s). In the eyes of the third mover, these two demands compete for her support to form a majority coalition. The competition between the two demands on the table weakens the bargaining power of the first mover and constraints the amount of benefits she can extract for herself. If she demands too much, the second mover will make a demand that is more favorable for the third mover. In the demand bargaining game, it is possible to pass a bill without the support of the first mover. A majority coalition between any two of the three legislators is possible, independent of the order of play. Either the second mover agrees with the first; or the third mover has

\(^6\)The results can be extended to $\delta < 1$ by adding a positive constant to the utility function, such that $u_i(y) = k - b(y - \hat{y}_i)^2 \geq 0$.\)
the choice to agree with either of them (or with none). This negatively affects the equilibrium share of the first mover. Proposition 1 establishes an upper bound on the budget share of the first mover and shows that she can even have an absolute disadvantage relative to the second mover.

**Proposition 1** In the demand bargaining game defined above, the first mover cannot obtain an equilibrium share larger than \( X/2 \). When issues are bundled, the first mover’s share has to be strictly less than \( X/2 \).\(^7\)

If the legislators only have to divide a budget among themselves, the first mover receives half of the budget and the second mover agrees to take the rest (see Morelli 1999).\(^8\) When a policy dimension is added to the same bill, the first mover has a strict disadvantage in budget shares.

When issues are bundled, the second mover can threaten to form a majority coalition with the third mover and approve a bill that allocates no shares to the first mover and contains a policy position less favorable for her. The threat of being excluded from the minimal winning coalition induces the first mover to compensate the second mover greatly for her supporting vote. The demand bargaining mechanism makes it very expensive for the first mover to get support for a bundled bill. In the following subsection, I show how this influences the equilibrium choice of the first mover and her preference for separating or bundling.

\(^7\)Proofs can be found in Appendix A.

\(^8\)In the alternating offers version of the budget dividing game, the first mover extract a share that is disproportionately larger than the share of any other legislator (see Baron and Ferejohn (1989)). This reflects her large bargaining power in the alternating offers game.
1.3.1 Bundling Issues

Assume that the first mover has decided to bundle issues. In the following subgame, she has to fix the order of play and make a demand on both dimensions. Lemma 1 characterizes the equilibrium policy demands for both the first and second mover in this subgame.

**Lemma 1** In any subgame perfect continuation equilibrium of the game when bundling has been chosen and the order of play has been fixed, the first mover $j$ demands a policy $y$ such that $\left| \frac{\partial u_j}{\partial y} \right| = \left| \frac{\partial u_k}{\partial y} \right|$, where $k$ is the subsequent mover.\(^9\)

Given that the first mover has decided to bundle both issues together in one bill, legislators make trade-offs between the two dimensions. This is not very surprising. While legislators disagree in the policy dimension, they can use budget shares to buy support of other legislators and pass a bill that is as favorable to them as possible. Trades are possible as long as one legislator cares less about a marginal move of the policy position than does another. Budget shares can be used to compensate for moves in the policy dimension. Legislators engage in trade-offs up to the point at which both care equally about a marginal change and no beneficial trades are possible any more. This is the condition established by Lemma 1.

The size of the budget has no bearing on the policy decisions, nor has the specific order of legislators. Important is only the identity of the two legislators that engage in the trade. The policy decision depends on their ideal points and loss functions. Here, it is exactly the midpoint between their ideal points.

---

\(^9\)Lemma 1 does not depend on the specific loss function $u_i(y)$. Most of my qualitative analysis should also be true for a more general quasi-linear utility function $U_i(y, x_i) = \tilde{u}_i(y) + x_i$, with $\tilde{u}_i(y)$ a concave loss function.
With regard to the policy dimension, the first mover j has neither a disadvantage nor an advantage over the second mover k in either of the two subgames. However, combined with Proposition 1, I can establish the second-mover advantage that proves so crucial for the results of this paper.

Proposition 2 Conditional on bundling, there is a second-mover advantage in terms of payoffs. The second-mover advantage is increasing in \( b \), the intensity of policy preferences.

A complete description of equilibrium choices for all possible orders of play can be found in the proof of Proposition 2.

The second-mover advantage implies a first-mover disadvantage. Trading comes at a cost for the first mover. She has to give up a portion of her share, expressed in a discount from \( \frac{X}{2} \), to buy the support of the second mover. The second mover is the one that can extract rent due to her position in the order of play. In the demand bargaining game, the second, not the first, mover has the advantageous position. She can exclude the first mover from a winning coalition and from any budget shares. This is a credible threat and gives her a powerful position, expressed in an additional amount of shares in excess of \( \frac{X}{2} \). The credible threat by the second mover of making a counter-proposal is off the equilibrium path. Therefore, in equilibrium, the third mover is never part of the winning coalition and always receives a share of zero.

The second mover advantage increases, in relative terms, both with the disparity in ideal points and with the policy intensity \( b \). The farther apart are the ideal points, the more costly it is to find support for a policy position. The value of the policy loss for the coalition partner increases with larger distance of ideal points, and she
requires more compensation for forming a coalition with the first mover. Increasing $b$ implies that the legislators care more about the policy dimension. This also increases the loss of a legislator and so the cost of her vote.

While I assume in this model that the first mover has to fix the order of the remaining legislators, this assumption turns out not to be crucial. The first mover is indifferent between the two possible orders of the remaining legislators. She receives the same utility for both.

1.3.2 Comparing Bundling and Separating

Assume that the first mover has decided to separate issues. In the subsequent game, she has to decide which issue should be the first and order the remaining legislators. Then she has to make a demand on the first issue. Once a decision on this issue is reached, a new first mover is randomly chosen to make the same choices for the bargaining process on the second issue.

We can use the results of Morelli (1999), applied to this model, to characterize the equilibrium choices in the subgame in which issues are separated.

**Lemma 2** *If issues are separated, independent of players’ ideal points and the size of $X$, the monetary dimension is always decided on first. The policy outcome is always the median ideal point, and the money is always distributed evenly among the first and second mover in the majority that approves the budget distribution.*

When issues are separated, they are treated completely independent of each other. Legislators cannot commit to trades unless both issues are part of the same bill, so there are no trade-offs between issues here. Instead of trading, majorities have to be built by policy compromises between the legislators in two separate dimensions.
The demand bargaining game is similar to an open rule mechanism, so the median legislator’s ideal point is the only policy position that can find majority support. When issues are separated, the outcome of the policy dimension is independent of the order of play or the identity of the first mover. The first mover wants to assure herself a positive share of the budget and decides that the budget distribution should be the first issue. Here, for the first time, the position of the first mover is advantageous due to her agenda setting power. By choosing the budget dimension to be the first issue, she can assure herself a positive budget share.

After characterizing the choices when issues are bundled and separated, I can now turn to the preference of the first mover over separating and bundling. Define

\[ r_3 \equiv \frac{\hat{y}_3 - \hat{y}_1}{\hat{y}_3 - \hat{y}_2} \]

**Proposition 3** The median legislator always prefers separating, independent of any of the parameters of the model. With \( \hat{y}_3 - \hat{y}_2 \geq \hat{y}_2 - \hat{y}_1 \), legislator 1 always wants to separate issues as well. Only with sufficient asymmetry in the location of ideal points, i.e. \( r_3 < \sqrt{3} \), legislator 3 prefers to bundle.

In the demand bargaining game, separating is preferred more often than is bundling. Bundling can indeed only be found in the rare case in which the more extreme legislator is very far away from the median and is chosen to be the agenda setter.

It is not very surprising that legislator 2 prefers separating, given her dominant position in the equilibrium in which issues are separated.

But also legislator 1 never wants to bundle issues. She finds it unfavorable to trade even if that resulted in a policy position closer to her ideal point. Buying support for the bundled bill is too expensive because of her disadvantageous position in the
competition of demands. The second mover wants to be compensated for not carrying out the threat of excluding her from the winning coalition. The compensation proves to be too expensive, so that legislator 1 always prefers to separate issues.

The logic is the same for the cases in which legislator 3 does not want to bundle. There is, however, a threshold of asymmetry, or polarization, such that legislator 3 now wants to bundle. The second mover still requires a compensation for supporting the bundled bill, but when legislator 3 is far enough from the median, in relative terms, her loss from implementing the median ideal point becomes so large that it exceeds the monetary loss from buying support.

In the basic model, there are many cases in which all three legislators prefer separating and only some in which one of them does not. I now extend the model to one with more heterogeneity in legislators’ preferences to check the robustness of this result.

1.4 Extension to Heterogeneous Policy Intensity

In the basic model, I have assumed that all legislators care the same way about the policy dimension, i.e. that they all have the same policy intensity $b$. Now I want to relax this assumption. Assume now that the two extreme legislators care more about the policy dimension and have a policy intensity of $b_1 = b_3 = b > 1$, while the median legislator has a policy intensity of 1. Every other assumption of the original model still holds.

Lemmata 1 and 2 are unaffected by the change in the model. So there is still a second-mover advantage. The only change is the additional loss that legislators 1 and 3 experience from implementing the median ideal point. Their loss is now larger.
One may be tempted to conjecture that this increases the occurrence of bundling because the legislators experience a larger loss from the median policy than before. But Proposition 4 shows that this is not the case.

**Proposition 4** Assume for simplicity and without loss of generality that \( \hat{y}_1 = -1 \) and \( \hat{y}_3 = 1 \). Even if the intensity of policy preferences differs between the median legislator and the extreme ones, legislators 1 and 2 always prefer separating.

For each \( b \), there is a unique \( \hat{y}^*_2(b) \leq 0 \) such that for \( \hat{y}_2 \geq \hat{y}^*_2(b) \) legislator 3 prefers separating, and for \( \hat{y}_2 < \hat{y}^*_2(b) \) legislator 3 prefers bundling. \( \hat{y}^*_2(b) \) is strictly decreasing in \( b \).

The first mover’s preference over separating and bundling remains qualitatively the same. Only the most extreme legislator prefers bundling in some cases. Now, though, her preference not only depends on the level of asymmetry but also on the policy intensity \( b \). The level of asymmetry such that bundling is the optimal choice is increasing in \( b \). Figure A.2 in the proof of Proposition 4 shows how the threshold of asymmetry changes with \( b \). It seems quite counterintuitive at first that the more legislator 3 cares about the policy dimension the more she prefers to approve two separate bills. But for any level of asymmetry such that legislator 3 chose to bundle in the basic model, there is a range of values of \( b \) with some upper bound such that she chooses to separate issues now. Note that if \( b \) increases beyond this upper bound, she prefers to bundle. This is quite intuitive because increasing \( b \) implies indeed that implementing the median ideal point becomes more and more costly.

But for some intermediate values of \( b \), there is a disadvantage to bundling that is larger than the cost of implementing the median ideal point. Notice that in the
extended model, legislator 3 prefers to buy the support of legislator 1 rather then legislator 2 for a bundled bill. The policy that legislator 1 and 3 implement in a bundled bill is the midpoint between their ideal points. For low levels of asymmetry this is close to the median, so that the loss of separated issues is not very large. But there is a cost of bundling that increases with $b$: To buy legislator 1’s support, legislator 3 has to compensate her for not forming a coalition with legislator 2. This compensation is increasing with $b$ because the policy decision in a bundled bill with legislator 2 is closer to legislator 1’s ideal point than the policy decision in a bundled bill with legislator 3. The more legislator 1 cares about the policy dimension, the more she cares about this difference and wants to be paid a higher compensation. The loss of a worse policy position (median ideal point) is smaller than the additional compensation required by her coalition partner for an intermediate range of $b$, so that I find separating as legislator 3’s optimal choice.

1.5 A Remark on the Robustness of Separating as the Optimal Choice

In this section, I want to comment briefly on one assumption that might seem crucial for my results: the composition of winning majorities. In my model, I assume that in the subgame in which issues are separated, the winning majority that approves the first bill can consist of different legislators than the one that approves the second. There are circumstances, such as a model of government formation, in which this does not seem a realistic assumption. In a coalitional government, bargaining partners can certainly not change for every issue. Once two parties enter a coalition to form a government, they will be bargaining partners for some time and will need to bargain over issues with each other for sure. The question is whether this is an environment, in
which legislators would prefer to make a contract over all issues right at the beginning of the legislative term, i.e. in which bundling might arise as the optimal choice? It turns out that this is not the case.

Assume that a government formateur (the first mover) has decided to separate issues. Intuitively, and also consistent with a theory of government formation, budget shares (such as ministerial payoffs) are distributed first. For the second issue, the bargaining reduces to a game between two parties. In the policy dimension, this will lead to exactly the same policy decision as in Lemma 1. By separating issues, the first mover can assure herself half of the budget shares and the favorable policy position of Lemma 1. Therefore, no government formateur would ever choose to bundle all the issues together in one bill or contract.

1.6 Concluding Remarks and Directions for Future Research

In this paper, I have proposed a new model of legislative multi-issue bargaining. Three legislators with distinct ideological ideal points bargain over a policy position and a distribution of a budget. I have investigated in particular whether issues are optimally bundled together in one bill or approved as two separate bills. I show that in contrast to the previous literature on legislative bargaining, separate bills can be the optimal choice for the agenda setter.

My model is a modified version of the Morelli (1999) demand bargaining game. I show that this bargaining process leads to a second-mover advantage when issues are bundled. This makes bundling issues in one bill a suboptimal choice for the first mover in many cases. Only the most extreme legislator prefers to bundle issues in some circumstances: With large enough asymmetry in ideal points of the three
legislators she finds it optimal to bundle. When the first mover decides to bundle issues, the decisions reflect trade-offs between dimensions. The first mover buys support for a more favorable policy decision by allocating a large share of the budget to the second mover. Because of the second-mover advantage, the share of the second mover is always larger than half of the budget in a bundled bill. When issues are separated, they are treated completely independent of each other. In this case, the median legislator’s ideal point is always the approved policy decision and the budget is divided evenly over the members of the winning coalition.

Since this is the first model to deliver predictions about the likelihood of both separating and bundling of issues, it will be important to revisit the empirical work on bundled versus separate bills. The first prediction is that whenever there is large agenda setting power in a legislature, we should observe more bundled bills. But notice also that the demand bargaining game is an extreme case of an open rule institution, while the "always bundle" result was obtained with the closed rule alternating offer game. So, the more the bargaining is open to amendments, the less bundling we should observe.

While there is evidence of both omnibus legislation and separate bills in the United States (e.g. appropriations legislation), a more suitable environment to test the predictions of my model seems to be European parliaments with more than two parties. There, the additional predictions about the relationship between asymmetry and polarization in the legislature and the likelihood of bundled or separated bills should clearly be tested for empirical bite.

There are several avenues for future research on the more theoretical level. First of all, some of the results rely on the assumption that the budget is large enough
to cover all sidepayments of the trades. When the budget shrinks below a certain threshold, the policy decisions of Lemma 1 will not be possible any more and the size of the budget will have an influence on the decisions. It will be interesting to investigate whether the preference for separation is robust to a shrinking budget.

I also plan to apply this work to the context of public good provision. In this case, the ideological dimension (public good provision) and the distributive dimension (particularistic good) are additionally interlinked by coming from the same budget. Volden and Wiseman (2005) use alternating offers in their one-shot model of public good provision, and it would be interesting to compare a demand bargaining mechanism to their results.

In general, one could conjecture that in the cases in which the policy dimension is a public good coming from a common budget, bundling should be optimal more often than in the model of this paper. Leblanc, Snyder, and Tripathi (2000) and Battaglini and Coate (2005) both present a repeated alternating offers game in the same context of public good provision. Here, investment in the public good yields benefits for later periods. Interestingly, they come to quite different results regarding the efficiency of public good provision. Leblanc et al. (2000) find that alternating offers bargaining leads to inefficient public good provision, except for the case in which legislators are forced to separate issues.

Battaglini and Coate (2005) come to the opposite result. In their model, that differs from Leblanc et al. (2000) in having an infinite horizon and investment benefits that last longer than only the next period, they find that public good provision can be efficient. With alternating offers, slight changes in the environment can lead to
dramatically different results. Both of these models offer an interesting point of comparison for an extended demand bargaining game. It is also not clear how interlinking periods through investment that yields benefits in future periods would influence the choices and dynamics in a demand bargaining game.
CHAPTER 2

MULTI-ISSUE LEGISLATIVE DEMAND BARGAINING: A PILOT EXPERIMENT

2.1 Introduction

This chapter is closely connected to the first chapter in that it presents an experimental study based on the model developed therein. In the previous chapter, I present a new model of legislative multi-issue bargaining, in which legislators have to approve decisions on several dimensions: a budget-distribution and a policy position. I use a modified version of the demand bargaining game, introduced by Morelli (1999), to model the legislative bargaining process as a non-cooperative game in which legislators can make proposals sequentially, and a minimum coalition of 2 legislators is needed to approve decisions. The question that I specifically investigate is whether legislators in this setting prefer to bundle both issues in the same proposal and approve them at the same time, or whether they prefer to bargain over the issues separately. The main finding is that the demand bargaining game leads to a second-mover advantage when issues are bundled, and that this induces the first mover to separate issues in most cases. In this chapter, I present an experiment that is designed to test whether this also holds in reality. It is a first step toward testing whether a multi-dimensional demand bargaining model describes real-world behavior sufficiently well.
The literature on non-cooperative legislative bargaining is divided between using demand bargaining games and alternating offer games (introduced by Baron and Ferejohn 1989) to model the legislative decision process. The question of which bargaining game is most likely used by legislators remains open, and there are still ways to be found to find the answer in field data, especially since the existing empirical literature comes to inconclusive results. Warwick and Druckman (2001) for example investigate the relationship between a party’s bargaining power (measured in terms of its share of cabinet posts in a government coalition) and the share of seats it brings to the coalition. They find a linear relationship between the two variables, and in addition, they do not find a formateur advantage. Therefore, they favor the demand game as a theoretical model for legislative bargaining. Ansolabehere, Snyder, Strauss, and Ting (2003), on the other hand, find that a party’s share of seats in the legislature as a whole and being the government formateur are powerful explanatory variables of bargaining power. In conclusion, they favor alternating-offer games as the underlying model.

There is a growing literature on the experimental testing of legislative bargaining models, especially alternating-offer and demand bargaining models (see e.g. McKelvey 1991, Frechette, Kagel, and Lehrer 2003, Diermeier and Morton 2004, Frechette, Kagel, and Morelli 2005b, and Diermeier and Gailmard 2004 for studies on alternating-offer games and Frechette, Kagel, and Morelli 2005a for the demand game). Frechette et al. (2005c) directly contrast alternating offer and demand bargaining models and compare their results to the empirical studies done before. They use a one-dimensional policy space, a budget distribution between the legislators. For this case, the theory predicts a strong first mover advantage in alternating-offer
games and an equal distribution of benefits among coalition partners in the demand game. While this is a strong difference in predictions, these differences in payoffs fail to materialize in the data. Frechette et al. find a small first mover advantage in both models. It is smaller than predicted for the alternating offer games, and larger than predicted for the demand games, so that, behaviorally, the two models are almost identical. This is the reason that it is very difficult to distinguish these two models in field data as well.

Based on the theoretical work presented in the previous chapter, the predicted difference between alternating-offer and demand games is of a different nature for a multi-dimensional policy than for only a budget distribution. Instead of only a difference in point predictions of shares, there is also a qualitative difference in whether issues are separated or bundled. This is a much more useful hypothesis for experimental data, as point predictions are always never met anyway. This chapter describes a first attempt to show that using a multi-dimensional policy space to compare the two prominent bargaining models might be a way out of the inconclusiveness of previous work.

I present an experiment in which subjects use the demand bargaining game to approve issues in two dimensions: a budget distribution and a policy position. I use two treatments, one with bundled issues and one with separated issues. I test whether subjects recognize the strategic implications of the difference between issue bundling and issue separating in a demand game and whether they behave significantly different in the two treatments. Secondly, I investigate whether they meet theoretical predictions for separating and bundling. I find that subjects indeed behave differently in the two treatments. In the separating treatment, they meet the predictions of the
theory in over 80% of the decisions. In the bundling treatment, they do not match point predictions for payoffs very closely. Qualitatively, though, the data matches the theory, and there is evidence of strategic play.

2.2 Theoretical Background and Hypotheses

The theoretical background for the experiment is the model presented in the previous chapter. I will briefly describe it here. Notice that some of the parameters now take on specific values to derive point predictions for the experiment.

Consider a legislature with three members. Each legislator has a distinct policy ideal point $\hat{y}_i$, $i = L, C, R$, $\hat{y}_L = 0, \hat{y}_C = 0.5 \times \sqrt{20}, \hat{y}_R = \sqrt{20}$. Let $Y = [\hat{y}_L, \hat{y}_R]$ be the space of potential policy decisions. Legislator 1 is the extreme left, legislator 3 is the extreme right, and legislator 2 is the median, and $\hat{y}_2 - \hat{y}_1 = \hat{y}_3 - \hat{y}_2$, so that legislators' ideal points are symmetrically located. The legislators have to approve a policy position $y \in Y$ and distribute a monetary budget $X = $12 among themselves. A decision is a pair $(y, (x_L, x_C, x_R)) \in Y \times \mathbb{R}_+^3$ such that $\sum_i x_i \leq $12. The following represents a legislator’s utility from a decision $(y, (x_L, x_C, x_R))$:

$$u_i(y) = 20 - (y - \hat{y}_i)^2$$
$$U_i(y, x_i) = u_i(y) + x_i, \ i = 1, 2, 3$$

The parameters for the model, i.e. the size of the budget, the degree of polarization, and the policy loss function, were chosen so that the difference between first and second mover payoffs in the bundling case are as large as possible.

The bargaining game I use is a modified version of the demand game, introduced by Morelli (1999). Legislators move consecutively. The order of play is exogenous, i.e.
it is decided before the game starts and legislators know about the order of play when they move. Possible orders are LCR, LRC, CLR, CRL, RCL, and RLC, indicating the identity of the first, second, and third mover.

**Bundled issues.** When issues are bundled, the first mover specifies her demand for a budget share as well as a policy position, \((x^1, y^1)\).\(^{10}\) The second mover can now form a majority coalition with the first mover by making the demand \((X-x^1, y^1)\), i.e. the same policy and the rest of the budget. In this case, the game is over. Alternatively, the second mover can announce another demand, such as \((x^2, y^2)\), i.e. a different policy position and/or a share different from \(X-x^1\). This move can be interpreted as the disapproval of the first mover’s demand and proposing an amendment. In this case, the third mover can form a coalition with either one of the preceding legislators (a coalition with the first mover by demanding \((X-x^1, y^1)\), or a coalition with the second mover by demanding \((X-x^2, y^2)\)). Or she can decide that the game should go on to the next round. If the game goes to the next round, the process simply repeats itself with the same order of play.

**Separated issues.** When issues are separated, the two issues are approved in two different rounds. Once a decision on the first issue is reached, a new first mover is randomly chosen, each legislator with the same probability, for the decision on the next issue. Bargaining proceeds as above, but on one dimension at a time. The first mover can only make a demand on the first issue and the second mover can propose an amendment only to the same issue. Once a majority coalition for the first issue is formed, the game proceeds to the next issue with a new first mover. In the experimental treatment with separated issues, there are some periods with

\(^{10}\)Note that superscripts denote the position in the order of play.
exogenously given order of issues, and some periods, in which the first first mover, i.e. the first mover for the first issue, can choose the order of the issues, i.e. she can decide which issue should be the first and which the second.

Table 2.1 presents the equilibrium predictions for the policy and the final payoffs for the first mover (FM), second mover (SM), and third mover (TM) in the bundling treatment. They are derived from Proposition 2 of the previous chapter. Notice that the proof of the Proposition shows that the budget share of the first mover is $x^1 = \frac{12}{3} - \frac{1}{7}(\hat{y}^1 - \hat{y}^3)^2$, the share of the second mover is $x^2 = \frac{12}{2} + \frac{1}{7}(\hat{y}^1 - \hat{y}^3)^2$. The third mover receives no budget share in the equilibrium. In addition, each legislator receives a payoff from the policy. In the table, LC denotes the midpoint between legislator L’s and legislator C’s policy ideal point. RC is defined accordingly.

For the case of separated issues, the equilibrium predictions are given in Table 2.2. They are derived in Lemma 2 of the previous chapter. The Lemma states that when issues are separated, the approved policy is always the median ideal point, and the budget is always distributed evenly between the first and second mover.
Table 2.2: Equilibrium Predictions for the Separating Treatment

The experimental data will be evaluated according to a set of hypotheses that are based on the theoretical predictions of the previous chapter.

**Hypothesis 1:** In the separating treatment, the approved policy position is C (Lemma 2).

**Hypothesis 2:** In the separating treatment, the budget is divided equally between the first and second mover (Lemma 2).

**Hypothesis 3:** In the separating treatment, the first mover of the first issue prefers the budget as the first issue (Lemma 2).

A possible outcome of the experiment is that subjects do not recognize the differences in strategic behavior between the separating and the bundling treatment. A natural focal point in the policy dimension is C, while a natural focal point in the budget distribution is equal division between two committee members (notice that positive shares for three committee members are excluded as a possibility due to my design). While these focal points are also the equilibrium predictions for the separating treatment, they are not for the bundling treatment. One focus of the experiment is therefore whether subjects choose differently from these focal points in the bundling
treatment and whether we can observe a significant difference in behavior between the two treatments because that would imply that subjects understand that there is a strategic difference between bundled and separated issues.

**Hypothesis 4:** The outcome in the bundling treatment is different from equal division of the budget and policy position C.

Since the equilibrium predictions for the separating treatment are also quite intuitive choices for the subjects, hypotheses for the separating treatment involve point predictions. However, I do not expect the behavior in the bundling treatment to exactly meet the point predictions for the payoffs, so the following hypothesis is a qualitative one:

**Hypothesis 5:** There is a second-mover advantage in the payoffs of the bundling treatment.

### 2.3 Experimental Design

The experiment is designed to compare subject behavior when issues are bundled and when issues are separated. Two different treatments are conducted, one with bundled issues and one with separated issues. The only difference between the two treatments is whether the issues are decided in the same round of a voting period (bundled issues) or in different rounds (separated issues). The two issues are the distribution of a budget between the members of a committee and the decision on a hospital location. The hospital location represents the policy issue of the theoretical model in the following way: Subjects are assigned a type at the beginning of the experiment. They are either type L, or type C, or type R. Each committee consists of one L member, one C member, and one R member. Each committee member prefers
Table 2.3: Payoffs in Dollar from Hospital Location

<table>
<thead>
<tr>
<th>Location</th>
<th>Member L</th>
<th>Member C</th>
<th>Member R</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>20</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>LC</td>
<td>18.75</td>
<td>18.75</td>
<td>8.75</td>
</tr>
<tr>
<td>C</td>
<td>15</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>RC</td>
<td>8.75</td>
<td>18.75</td>
<td>18.75</td>
</tr>
<tr>
<td>R</td>
<td>0</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>

a different location for the hospital and suffers a loss when the hospital location is different from her preferred location. There were five possible locations for the hospital that the committee could choose from: L, LC, C, RC, and R. Each subject is given a table (see Table 2.3), indicating her own payoff from each hospital location and the payoff that each other committee member gets from each location. Subjects’ types remain the same throughout the entire experiment. Committee members are randomly re-matched after each voting period, but each committee always has one L member, one C member, and one R member.

To avoid bankruptcy issues, I choose a loss function with a positive constant, so that the lowest payoff a subject could receive from the hospital location was 0. This, however, does not change the theoretical prediction.

**Bundling Treatment.** In the bundling treatment, both issues have to be approved in the same round of a voting period, i.e. in the same proposal. The order of play, i.e. the identity of the first, second, and third mover, is randomly determined.

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11 Notice that the continuous policy space from the theoretical model is broken down into a discrete choice. There are several reasons for this. First of all, it is nearly impossible to have a continuous choice space for an experiment run on paper. Second, this makes the choice easier for subjects and this pilot study is designed to test whether subjects realize the differences in the strategic implications between the separating and bundling treatment, and not whether they meet point predictions exactly. For this purpose, adding a continuous choice space does not help, and rather confuses the subjects.
for each voting period. The first mover is given a form, a piece of paper, on which the following information is given: The current voting period, round, and group number, and the order of play of the three committee members L, C, and R (there is no way of identifying the actual subjects in a group). There are three copies of this form, all identical and attached to each other. The first mover is asked to request a share of the budget for herself and a location of the hospital by indicating both on the form. The form is then presented to the second mover. The second mover can either decide to accept the first mover’s proposal. In this case, the voting period is over and the first mover receives her budget share, the second receives the rest of the budget, and each committee member also receives the payoff associated with the hospital location. Or the second mover can decide to announce an alternative proposal (budget share and location) on the form. In this case, the form goes to the third mover. The third mover can decide to form a winning coalition with either one of the previous movers. If the third mover agrees with the first (second) mover, the first (second) mover receives her budget share, and the third mover receives the rest of the budget. The hospital location is the one indicated by the winning proposal. Or the third mover can decide that there should be a new round. In this case, the process repeats itself with the same order of play. There is no limit to the number of rounds a voting period can have. Whenever a proposal is accepted or the voting period goes into a new round, the three copies of the form are distributed for feedback to each member of the committee.

\footnote{Notice that I force the formation of minimum winning coalitions in this experiment. It is not an option for subjects to distribute budget shares to all three committee members. This substantially simplifies the procedure of the experiment. Frechette, Kagel, and Morelli (2005c) find a large frequency of minimum winning coalitions in demand games, in which subjects have the choice to form supermajorities.}
**Separating Treatment.** The process of deciding in the separating procedure is the same as in the bundling procedure: The first mover makes a proposal; the second mover either accepts or makes a counterproposal. If the second mover makes a counterproposal, the third mover can either accept one of the previously made proposals or let the voting period go into a new round. The difference is that the proposals can only be made on one issue at a time, either the budget distribution or the hospital location. One of the issues is decided on first. Once the first issue is settled, a new order of play is determined and the second issue is decided. In the first four voting periods of the separating treatment, the order of the issues is predetermined to give subjects an opportunity to get used to the two possible agendas. Two times the budget is the first issue followed by the hospital location, and two times the hospital location is the first issue. In the remaining voting periods, the first mover in the first round can decide which should be the first and which the second issue.

Each treatment starts with the instructions being read aloud by the experimenter, while the subjects can read along on their paper copies.\(^{13}\) Then there is a dry run to familiarize the subjects with the procedure. After the subjects have no more questions, they play several voting periods for cash (the actual number of voting periods for cash differs between treatments due to time constraints). At the end of the session, one of the voting periods played for cash is selected randomly, and the subjects are paid their payoffs for that voting period in cash.

\(^{13}\)Instructions are available from the author upon request.
2.4 Results

The subjects are undergraduate students at The Ohio State University that have taken at least one economics course.

2.4.1 The Separating Treatment

There were nine subjects in the separating treatment with three committees in each voting period. The subjects played nine voting periods for cash. In the first four, the agenda, i.e. the order of the issues, was predetermined: in two periods, the budget distribution was the first issue, and in the remaining two periods, the hospital location was the first issue. In the remaining five periods, the first mover for the first issue was asked which one she preferred as the first. Once this issue was settled, the second issue was bargained over with a new, randomly determined, order of play. Overall, there are 23 final decisions in the policy dimension and 21 decisions in the monetary dimension that are valid for the data analysis. And there are 12 valid decisions over the agenda.\textsuperscript{14}

\textit{Hypothesis 1 (C is the outcome of the policy decision.): }Indeed, the median ideal point is the outcome of the bargaining over the policy in 16 out of 23 cases, which is approximately 70%. Out of the remaining seven cases, in which another policy was approved, four appeared in the first three periods. Taking learning and adjusting of the subjects into account and only looking at periods four to nine, 80% of the policy decisions are the median ideal point.

\textsuperscript{14}In the bundling session, there was a subject that asked to leave early. This is why there are less than 27 observations of final decisions and less than 15 observations of the agenda choice.
Hypothesis 2 (The budget is divided evenly between the first and the second mover): Again, the subjects come very close to the equilibrium predictions. In 16 out of 21 cases, or approximately 76%, the budget is divided evenly between the first and second mover. Out of the five remaining final decisions, four also led to an equal division, but to a different coalition than that of first and second mover: The division is (0,6,6) in three cases, and (6,0,6) in one case. Only in a single case, the division is (7,5,0), different from equal division. Only looking at voting periods three to nine, there is only one decision that is different from (6,6,0), increasing the occurrence of the equilibrium prediction to approximately 93%.

Hypothesis 3 (The agenda setter, prefers the budget distribution to be the first issue.): Out of the 12 valid observations, only in five cases the budget distribution is chosen as the first issue. In seven cases, or more than 50%, the hospital location is chosen as the first issue. Obviously, in the agenda choice, the subjects are rather far away from the equilibrium prediction. It is indeed quite surprising that the subjects did not recognize the strategic element in the agenda choice, while the approved issues are so close to the predictions. However, the number of periods was quite limited. I clearly expect subjects to come closer to the prediction for the agenda choice with more repetitions.

In this treatment, all final decisions are made in the first round of a voting period.

2.4.2 The Bundling Treatment

There were nine subjects in the bundling treatment, with three committees in each voting period. The subjects played ten voting periods for cash. There are 30
Table 2.4: Average Payoffs in the Final Decision

<table>
<thead>
<tr>
<th>Order</th>
<th>FM</th>
<th>SM</th>
<th>TM</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCR, RCL</td>
<td>18.075 (19.76)</td>
<td>24.875 (29.74)</td>
<td>17.175 (8.75)</td>
</tr>
<tr>
<td>LRC, RLC</td>
<td>16.825 (19.75)</td>
<td>19.425 (22.25)</td>
<td>23.125 (20)</td>
</tr>
<tr>
<td>CLR, CRL</td>
<td>21.5 (23.5)</td>
<td>22.7 (26)</td>
<td>13.3 (8.75)</td>
</tr>
</tbody>
</table>

observations of final decisions. In 17 cases, the second mover made an alternative proposal and the third mover was the one to form the coalition.

**Hypothesis 4** (The final decisions in the bundling treatment are different from equal division of the budget and policy position C): In 22 out of 30 cases, or 73.3%, the final outcome is a different combination of policy issue and budget distribution than equal division of the budget and policy C. The first mover asked for (C,6) in only three cases. In two of these, it was approved by the second mover and in one by the third mover. In five cases, the second mover proposed (C,6) as a counter-proposal that was accepted by the third mover. After voting period 3, equal division of the budget and policy C was approved in only four remaining cases.

**Hypothesis 5** (There is a second-mover advantage in terms of final payoffs): There are five observations of final payoffs for each order of play. Averages are summarized in Table 2.4. FM indicates the first mover, SM the second mover, and TM the third mover. Predicted values are given in parentheses.

Clearly, there is a second-mover advantage in terms of payoffs in the bundling treatment. Also as predicted, orders LCR and RCL yield a much larger difference between first and second mover than for the other orders of play.
However, the second-mover advantage in the experimental data, however, is much smaller than predicted. The second movers do not get as much rent as the theory predicts. The third mover gets a much larger payoff than predicted. Several reasons for this can be found in the data. In 13 out of the 30 bargaining rounds, the proposal of the first mover is accepted immediately by the second mover. While this is in line with the theory, in these instances, the first mover, on average, asks for too much for herself ($23.875 instead of predicted $19.76 for orders LCR and RCL, $20.9 instead of predicted $19.75 for orders LRC and RLC, and $24.63 instead of predicted $23.5 for orders CLR and CRL), but the second mover accepts this and gets a payoff smaller than she should have gotten. And in 17 out of 30 voting rounds, the second mover makes an alternative proposal. Generally, she makes herself better off, but offers the third mover more than predicted.

The payoffs in the bundling treatment do not exactly meet the point predictions of the equilibrium, but subjects clearly behave differently than in the separating treatment. Subjects understand many of the strategic implications of bundling two issues together in the demand bargaining game. They behave strategically, as can be inferred from the following observations. In many cases, the first mover recognizes that she has to compromise in at least one of the two dimensions to induce the second mover to form a coalition with her. In 17 out of 30 observations, the first mover makes a proposal that leaves the second mover at least as well off as the first. In 11 cases, the first mover asks for the midpoint between first and second, but in 5 of these she also asks for a budget share less than half. In 10 observations, the first mover asks for her ideal point, but in 5 of these asks for a share substantially smaller than half of the budget. Overall, in 12 out of 30 observations, the first mover asks for strictly less
than half of the budget. And in 6 cases, the first mover asks for a budget share larger than half, but bundled with a policy position that is farther away from her ideal point than the midpoint between her and the second mover. Overall, these observations indicate that the first mover recognizes that her bargaining power is limited in the demand bargaining game, especially when issues are bundled.

The theory predicts that if the first mover asks for too much, the second mover makes a proposal that leaves herself better off and the third indifferent between the two proposals. In this pilot experiment, the second mover attempts to do so in many cases, although the third mover generally receives more than she should. The second mover makes 17 counterproposals, 13 out of which are accepted by the third mover.

The large frequency of winning coalitions between second and third mover contributes to the fact that the third mover share in the data is much larger than what is predicted by the theory. There are also four winning coalitions consisting of first and third mover.

Finally, in the bundling treatment, proposals are always approved in the first round, but often required more than the minimum steps predicted. In more than 50% of the observations, the second mover makes an alternative proposal, and many coalitions involve the second and third mover, and some also the first and third.

2.5 Discussion

In the separating treatment of this pilot experiment, subjects approve the predicted policy and budget allocation in more than 80% of observations. Only the agenda choice does not follow predictions. Play is substantially different in the bundling treatment:. Subjects clearly recognize that issues are now not to be treated
independent of each other, but that trade-offs between dimensions can be made. And they also recognize that these trade-offs between dimensions change real bargaining power of the players. There is a second mover advantage in terms of payoffs.

Many of my findings are in agreement with the previous literature, especially with Frechette et al. (2005a and 2005c). As the theory predicts, and as it was found often in previous studies of legislative demand bargaining, allocations are made in the first round. While there were usually some deviations in previous studies, in my study all allocations were made in the first round an issue was on the table. Often, though, they required more than the minimal steps predicted. More than half of the observations included a proposal by the second mover. This is because the first mover often asked for too much, which was also found in previous studies.

One of the most important findings of this study is the second-mover advantage in the bundling treatment, but not only because it is predicted by the theory. Previous studies on one-dimensional demand bargaining (budget or policy) consistently found a first mover advantage even though this is contrary to the theory. Interestingly, with more dimensions, behavior comes closer to equilibrium predictions. This indicates that subjects recognize the strategic implications of bundled proposals in a demand game. And secondly, this has a very important implication for future empirical research on legislative bargaining. As mentioned in the Introduction, the previous empirical literature on legislative decision making came to inconclusive results regarding the bargaining game actually used by legislators. This pilot study, together with

\[\text{15 I do expect this, however, to slightly change towards more deviations when the experiment will be run on computers. A second round is less costly (in terms of time it takes) in a computer-run experiment. Subjects did, however, indicate that third movers often did not go into a new round out of fear of being excluded from the winning coalition in the future.}\]

\[\text{16 Interestingly, I also do not observe a first mover advantage in the separating treatment.}\]
the theoretical findings of the previous chapter, gives a hint at a possible answer. If subjects realize the strategic implications of bundled proposals in the demand bargaining game, it is clearly worthwhile (and a future project) to study whether they also do so in alternating offer games. And, given the choice between separating and bundling, subjects should then recognize that bundling is better in alternating offer games and separating better in demand bargaining games. This gives a strong qualitative prediction, which might be a way to distinguish the models empirically from each other.

2.6 Conclusion

This chapter presents the first experiment of demand bargaining with a multi-dimensional policy space. The theoretical background for this pilot experiment is the model of multi-dimensional legislative demand bargaining in the previous chapter. Three legislators have to approve a budget distribution and a policy position. The legislators are heterogeneous in their policy ideal points. Legislators can either bundle both issues together in the same proposal, or bargain over them separately, one after the other. The main prediction is that legislators prefer to separate issues when their policy ideal points are symmetrically located. This is due to a second mover advantage in the demand bargaining game when issues are bundled.

This pilot experiment sets out to investigate the hypotheses of this model. There are two treatments, a separating and a bundling treatment. In the separating treatment, subjects bargain over the two issues separately, one after the other. In the bundling treatment, they bargain over bundled proposals containing both issues.
In the separating treatment, subjects largely behave as predicted: The median policy ideal point is approved in the policy dimension, and the budget is divided equally between the first and the second mover. When the first mover can choose the agenda, i.e. which issue she prefers to be the first, subjects choose the policy more often than the predicted budget. But I contribute this failure to the limited number of voting rounds and expect it to disappear when the experiment is run with more than 10.

In the bundling treatment, play is substantially different from the separating treatment. Subjects make trade-offs between dimensions. And there is a second-mover advantage in payoffs, just as predicted. So, the behavior qualitatively matches the theory. Quantitatively, the difference between first mover and second mover payoff is not as large as in theory. The second mover does not extract as much rent as she could. She either approves a proposal of the first mover that allocates too much to the first mover. Or, when she makes a counter-proposal, she allocates too much to the third mover and too little to herself. There are majority coalitions that include the third mover, so that she receives more on average than predicted.

It is an especially important finding that the data shows a second mover advantage in the bundling treatment, even with a limited number of observations. Previous studies on one-dimensional demand bargaining found a slight first mover advantage, completely contrary to the theory. So, adding more dimensions brings behavior closer to the equilibrium predictions.

This pilot experiment is only an initial step. Further experiments planned along these lines will be done on a computer to be able to increase the number of repetitions. Also, it is clearly necessary to investigate how subjects behave when the first mover
can choose between separating and bundling of issues. And, finally, a comparison between demand bargaining and alternating offers, the other predominant game to model legislative bargaining, has to be done in the laboratory. A hypothesis resulting from this pilot experiment is that the prediction of a preference for issue-separating in demand games of for issue-bundling in offer games will show up in the data and help us to finally distinguish these two games also in field data.
CHAPTER 3

LEARNING DIFFERENCES IN MIXED COMMON VALUE AUCTIONS

3.1 Introduction

In this chapter, I present an experiment testing the behavior of experienced and inexperienced bidders in common value auctions with 'mixed' markets. In mixed markets, there are both experienced and inexperienced bidders competing against each other and observing each others bidding behavior. This is the first common value auction experiment with mixed markets, and it turns out that a mixed market environment has a great influence on the bidding behavior of the inexperienced bidders.

A common value auction is an auction, in which the true value of the item is the same for all the bidders. At the time of bidding, though, the bidders are uncertain about this value. Each has a private estimate (her signal) and needs to base her bid primarily on this estimate. Estimates are distributed around the true value, so that the high signal holder likely has an overly optimistic estimate of this value. With unbiased signals and symmetric bidders, rationality requires that bidders discount their estimates. The term 'winner's curse' describes the situation, in which the high bidder does not discount her signal enough and submits a bid higher than the true
value. In this case, the price of the object is higher than the value is worth to the bidder. The literature calls this the 'winner’s curse' because this situation results in negative profits.

The winner’s curse is common in both field settings and experiments (see e.g. Capen et al. 1971, Lorenz and Dougherty 1983 for evidence in field data and Kagel and Levin 2002 for an overview on the experimental literature). Inexperienced bidders are the ones most likely to suffer from it because they! tend to bid too aggressively. Frequently, they earn negative profits on average and go bankrupt. But bidders learn over time how to avoid losing money: Experienced subjects bid much more successfully, making positive average profits.

Behavior of inexperienced and experienced bidders is quite different in common value auctions. This raises the question whether it influences bidding behavior whether bidders in an auction market have the same or different levels of experience. Clearly, in ‘real’ auction markets, experience levels of bidders tend to be heterogeneous. And several experimental studies of common value auctions and other games indicate that behavior of subjects is indeed dependent on the composition of the group they play with.

For example, subjects learn from observation of peers and from imitating the especially successful ones (e.g. Garvin and Kagel 1994, Offerman and Sonnemans 1998, Merlo and Schotter 2003, Armantier 2004 among others). On the other hand, Andreoni and Miller (1995) show that playing against a successful opponent can sometimes hinder learning. And for experienced subjects, Slonim (2005) finds that they condition their behavior on the entry of inexperienced subjects in a beauty contest game.
However, all previous studies on common value auctions have been done with exclusively homogeneous markets of either only experienced or only inexperienced bidders. I design an experiment with both experienced and inexperienced bidders in the same auction market and compare the behavior of both to a benchmark treatment with either only inexperienced or only experienced bidders. Overall, there are three treatments: a mixed treatment with two experienced and two inexperienced bidders in an auction market, an inexperienced treatment with four inexperienced bidders in a market, and an experienced treatment with four experienced bidders in a market.

In each treatment, bidders know the composition of the auction market. After an auction round, they can observe bidding behavior of their opponents, i.e. their bids along with their signals. Bidder identification is suppressed. In the mixed treatment, information about an opponent’s type - I for inexperienced and E for experienced - is also provided with bidding behavior.

The first hypothesis is that the inexperienced bidders in the mixed treatment learn faster than in the inexperienced treatment. The tool of learning, besides own experience, is the observation of the bidding behavior of opponents. In the mixed treatment, the inexperienced subjects have some experienced opponent that are likely to be successful. With good role models to imitate, learning should speed up for the inexperienced bidders in the mixed treatment.

For the experienced bidders, the matter is different. They tend to bid lower than the inexperienced ones because they have gained some understanding of the game. The mixed treatment serves as a test of this understanding. The experienced bidders are faced with overly aggressive inexperienced opponents that are more likely to win the auction. Will this induce the experienced bidders to lower their bids and fall
back to overly aggressive behavior because they want to increase their likelihood of winning? The second hypothesis of this study is that the experienced bidders in the mixed treatment bid more aggressively than the experienced bidders in the experienced treatment.

It turns out that the data can not be organized in a meaningful way without taking gender into account. Casari et al. (2004) as a study on bidding behavior in common value auctions with homogeneous markets finds significant gender effects for inexperienced bidders: Inexperienced females start out bidding much more aggressively than inexperienced males. But they also learn at a faster rate, so that by the end of the session, the gap between males and females disappears. There are no significant gender effects for experienced bidders. I replicate both of these findings in the inexperienced and experienced treatments. In the mixed treatment, however, I find very interesting new gender effects: The inexperienced males in the mixed treatment bid more aggressively than their counterparts in the inexperienced treatment, while inexperienced females in the mixed treatment bid less aggressively than their counterparts in the inexperienced treatment. In fact, in my data, bidding behavior of inexperienced males and females is indistinguishable. These findings have important implications. First, learning and adaptation mechanisms of males and females may be very different. And the finding of a gender difference in previous studies may not be as crucial because it disappears in the more realistic setting of heterogeneous markets.

Experienced bidders do not behave differently in the mixed and experienced treatments. This implies that I have to reject the hypothesis that experienced subjects in the mixed treatment lower their bids and become more aggressive again. This suggests
that their understanding of the structure of the game is relatively deep and that they are not tempted to bid more aggressively even if their opponents, the inexperienced bidders, do.

3.2 Theoretical Background: Risk Neutral Nash Equilibrium Bidding

The symmetric risk neutral Nash equilibrium (RNNE) for first price sealed bid common value auctions can be found in Wilson (1977) and Milgrom and Weber (1982). My experimental design has the following specifications: There are four bidders in each auction market, competing for an item with a common value of $x_0$. The value of $x_0$ is drawn from a uniform distribution on $[50, 950]$. Bidders do not know the value of $x_0$ at the time of bidding, but each receives a private signal drawn from a uniform distribution on $[x_0 - 12, x_0 + 12]$\(^{17}\). Each bidder submits a sealed bid. The high bidder receives the item and pays her bid, so that her profit is the true value $x_0$ minus her bid. The other bidders receive zero profit for this auction period.

I restrict my attention to signals in the region $(62, 938)$. The bulk of the observations lies in this region, and bidders do not have additional end-point information to calculate the expected value of the item. In this region, the risk neutral Nash equilibrium bidding function takes the following form\(^{18}\):

\[
\begin{align*}
  b(s_i) &= s_i - 12 + h(s_i) \\
  h(s_i) &= (24/n + 1) \exp\left(-\left(n/24\right)(s_i - 62)\right)
\end{align*}
\]

\(^{17}\)This information structure is the one of affiliated private values found in Milgrom and Weber (1982).

\(^{18}\)For a complete derivation of the risk neutral Nash equilibrium bidding function, including signals outside the specified region, refer to Kagel and Levin (1986) and Kagel and Richard (2001).
$s_i$ is bidder $i$’s signal and $n$ is the number of bidders in the auction market. The non-linear term $h(s_i)$ approaches zero fast if the signal is larger than 62 and is insignificant in all regressions. I will omit it in further discussions, but include it in all relevant regressions.

Kagel and Richard (2001) show that the function

$$b_i(s_i) = s_i - 12$$

(3)

is a better approximation of observed bidding behavior than (1). They also show that the best response to (3) is to bid according to (3). When bidders bid above (3), it is solely a failure to account for the adverse selection in this bidding environment.

I will generally characterize bidding behavior of subjects by their bid factor:

$$bid factor_i = s_i - b(s_i)$$

(4)

The bid factor is a convenient measure of the aggressiveness of bidding behavior. It indicates the discount from a subject’s signal. According to (3), the Nash equilibrium bid factor for this environment is 12.

3.3 Experimental Design and Data Description

In each treatment, the range of possible common values, the range of the signals conditional on the common value, and the number of bidders in an auction market are the same.
There are 25 auction rounds in each session. In each auction round, subjects are randomly distributed into auction markets of four bidders.\(^{19}\) In each auction period, a new common value \(x_0\) is drawn randomly and independently from previous and future periods. Each bidder receives a signal as an independent draw from the interval \([x_0 - 12, x_0 + 12]\). The experiment is done on computers. The subjects see their signal on the screen, together with the range of possible values of \(x_0\) given their signal \(s_i: [\max(\$50, s_i - 12), \min(\$950, s_i + 12)]\). Each active subject is asked to submit a bid larger than zero. The item is awarded to the high bidder with a profit of \(x_0 - b_i\).\(^{20}\) All other bidders received zero profit for this auction round.

After the high bidder is determined, bidders receive information about the current auction period, including their own profit, bids and signals of their opponents (bidder identification was suppressed), the common value of the item \(x_0\), the price of the item as the bid of the high bidder, and the profit of the high bidder. In the mixed treatment, the type of their opponents - inexperienced or experienced - is given along with their bids and signals.

Each subject is given an initial cash balance of $15, from which negative profits are subtracted and to which positive profits are added. A subject that goes bankrupt before the end of the session, i.e. whose cash balance drops below zero, is no longer permitted to bid.

\(^{19}\)The number of bidders in an auction market is always four. If the total number of bidders is not divisible by four, some subjects were randomly selected to be inactive in that period.

\(^{20}\)There is a hidden reserve price of \(x_0 - 24\) in this experiment. Subjects know that if the high bid turns out to be below the reserve price, the item is not awarded in this period and all bidders receive a profit of zero. The actual reserve price is revealed only after the auction period. The reserve price serves as a means to constrain the possible earnings of subjects. In fact, however, the item was sold in every round of every session.
There are three treatments to compare the mixed market with two relevant benchmark treatments. There is the mixed treatment as the main treatment and the experienced and inexperienced treatments as benchmark treatments.

**Mixed treatment.** In this treatment, there are two inexperienced and two experienced bidders in each auction markets. This is common knowledge. On the feedback screen, subjects can identify experienced and inexperienced opponents.\(^{21}\)

**Inexperienced treatment.** In this benchmark treatment, auction markets consist of four inexperienced bidders. This is common knowledge.

**Experienced treatment.** In this benchmark treatment auction markets consist of four experienced bidders. This is common knowledge. All subjects in this treatment have the same level of experience, because they have all participated in one prior session of the inexperienced treatment.

Table B.1 shows the total number of participants and the number of males and females for each session.\(^{22}\) Participants are undergraduate students from The Ohio State University who were enrolled in economics classes. In week 1, I recruited subjects for two sessions of the inexperienced treatment. In the invitation email, subjects were told that they had to participate in two different sessions, and that after the first session, they would only receive half of their earnings. The remaining half of week 1’s earnings and a $20 participation fee would be paid after the completion of the second session.

\(^{21}\)In fact, whenever the total number of experienced and inexperienced bidder is such that not all can be divided into markets with two experienced and two inexperienced bidders, as many markets as possible with two and two bidders are formed. The (randomly selected) remaining bidders are first divided into markets with four bidders of the same experience level and then, if there are still some left, into markets of four bidders, irrespective of their type. Subjects can identify the composition of the current auction market on the screen, but observations with compositions other than two experienced and two inexperienced bidders are not included in the data analysis.

\(^{22}\)All Tables and Figures for this chapter can be found in Appendix B.
session, along with the earnings for that session. Subjects had strong incentive to return and selection effects for the returning bidders were avoided. All except 1 of 60 initial bidders returned for the second session.

In the inexperienced treatment, instructions were read aloud.\textsuperscript{23} Subjects also had a hard copy to read along. There were two dry-run auctions (not payoff-relevant) to familiarize the subjects with the software and the computer screens. Then there were 25 payoff-relevant auction rounds. At the end of the session, subjects were paid half of their earnings and were told that they would be invited back next week.

In week 2, the subjects from the inexperienced treatment were invited back and randomly divided into one experienced and two mixed treatments. I also recruited new inexperienced subjects for the mixed treatment.

The experienced treatment had the same structure as the inexperienced treatment, but with a short summary-version of instructions. At the end of the session, subjects received the second half of their earnings from week 1, $20 participation fee, and their total earnings from week 2.

For the mixed treatment, the inexperienced subjects were invited at an earlier time than the experienced subjects. Instructions were given as in the inexperienced treatment. A colleague received the experienced subjects and told them to wait for a short while before entering the room. Once the inexperienced subjects had no more questions, the experienced ones were invited in. Summary instructions were read aloud to both experienced and inexperienced. There were two dry runs. After 25 auction rounds, the experienced subjects received their remaining earnings from

\textsuperscript{23}Instructions can be obtained from the author upon request.
week 1, $20 participation fee, and their total earnings from week 2. The inexperienced subjects received their total earnings for the session along with a $6 participation fee.

Notice that by the way the instructions were written and read to the subjects, all experienced and all inexperienced subjects were given exactly the same instructions, independent of the treatment.

3.4 Bidding Behavior

I estimate the bid factor as defined in (4). Theoretically, the bid factor is a constant discount from the signal. Previous studies have shown that subjects’ bidding behavior changes over time, so the regressions also include a learning term as one of the independent variables. I use an adjustment term defined in Casari et al. (2004) because it has proven to be a powerful explanatory variable: \( \text{learn}_t = 1/\ln(t + 1) \), where \( t \) is the actual number of auctions played by a subject, including the current one. This function is convex in the number of rounds and diminishes over time, assuming that the heaviest learning takes place in early rounds.

A dummy male takes the value 1 if the subject is male and 0 otherwise. The female dummy takes the value 1 for female subjects. Since I pool the data for subjects of the same experience level, I also have treatment dummies. The dummy inexperienced (experienced) takes the value 1 for the inexperienced (experienced) treatment, the dummy mixed for the mixed treatment. I use a random-effects estimation for the bid factor of subject \( i \) in round \( t \). The usual assumptions on random-effects estimation apply.
\[ \text{bid factor}_{it} = \beta_0 + \beta_1 \times \text{male}_i + \beta_2 \times \text{inexp}_i + \beta_3 \times \text{male}_i \times \text{inexp}_i + \]
\[+ \beta_4 \times \text{learn}_i \times \text{mixed}_i \times \text{male}_i + \beta_5 \times \text{learn}_i \times \text{mixed}_i \times \text{female}_i + \]
\[+ \beta_6 \times \text{learn}_i \times \text{inexp}_i \times \text{male}_i + \beta_7 \times \text{learn}_i \times \text{inexp}_i \times \text{female}_i + \]
\[+(u_i + \varepsilon_{it}) \]

\( \beta_0 \) is the intercept of the bid factor of a female in the mixed treatment, \((\beta_0 + \beta_1)\) the intercept of a male in the mixed treatment, \((\beta_0 + \beta_2)\) the intercept of a female in the inexperienced treatment, and\((\beta_0 + \beta_1 + \beta_2 + \beta_3)\) the intercept of a male in the inexperienced treatment. \( \beta_4 \) describes the magnitude of adjustment of a male subject in the mixed treatment, and \( \beta_5, \beta_6, \) and \( \beta_7 \) of a female in the mixed treatment and male and female in the inexperienced treatment, respectively. For experienced subjects, similar interpretations of the coefficients apply.

Alternatively, I could have estimated the bid function as in (1), with the bid as the dependent and the signal as an additional independent variable. The coefficients of the independent variables other than the signal would not have changed, and the signal would have a coefficient that is statistically indistinguishable from one.

### 3.4.1 Bidding Behavior of Inexperienced Subjects

Table B.2 gives the estimation results for the inexperienced subjects. All coefficients except \( \beta_1 \) are statistically significant at either the 5% or 10% level. The bidding behavior of both males and females in the mixed and the inexperienced treatments have a significant intercept and adjust over time.

The males in the inexperienced treatment have the highest intercept, and so the least aggressive bidding behavior. At the same time, they have the lowest rate of
adjustment over time. The females in the inexperienced treatment have the lowest intercept, and so the most aggressive bidding behavior. But they also have a relatively high rate of adjustment and change to a less aggressive bidding behavior fast.

The males and females in the mixed treatment are indistinguishable. They have an intermediate bidding behavior, more aggressive than the males in the inexperienced treatment, but less aggressive than the females in the inexperienced treatment.

The data of the benchmark treatment replicates the findings of previous studies, such as Casari et al. (2004): With only inexperienced bidders in an auction market, females start out considerably more aggressive than males, but learn at a faster rate. I use a Mann-Whitney test (see Table B.3) to show that in early rounds, 2-5, there is a significant difference in average bid factors of males and females in the inexperienced treatment that disappears in later rounds, 20-25. Because of a faster rate of adjustment, females catch up with males by the end of the session (see also Figure B.1).

The main treatment is the mixed treatment. The gender dummy in the mixed treatment is not significant, nor is the adjustment over time different for males and females (see Table B.2 and Figure B.2). The Mann-Whitney tests in Table B.3 confirm that average bid factors are not different, neither in early nor in late rounds. The gender difference of the inexperienced treatment does not appear in the mixed treatment.

While across-gender differences appear, interesting within-gender differences appear with the mixed treatment. Inexperienced males bid more aggressively in mixed markets than with only inexperienced opponents. But inexperienced females bid less aggressively in mixed markets than when they only have inexperienced opponents.
More aggressive bidding results in lower, potentially even negative (winner’s curse), profit. Table B.4 gives average profits for inexperienced subjects. As expected, inexperienced subjects in all treatments receive negative average profits, both conditional on winning and overall. While the average profits are not statistically significantly different, they point in the same direction as the bid factors: Lower bid factors lead to larger losses. Conditional on winning, the least aggressive males, the ones in the inexperienced treatment, receive the highest profits, while the females in the inexperienced treatment as the most aggressive ones receive the lowest. Profits of males and females in the mixed treatment are higher than the ones of females in the inexperienced treatment, but lower than the ones of the males in the inexperienced treatment. Notice that it is possible that the ranking of overall profits is reversed because inexperienced subjects in the mixed treatment win more often than subjects in the inexperienced treatment because they face the experienced bidders as less aggressive opponents.

Another characteristic of inexperienced bidding behavior is a high frequency of bankruptcy. A subject is bankrupt as soon as her cash balance drops below zero. Because of frequent overbidding and negative average profit, inexperienced subjects are likely to go bankrupt. As expected, the inexperienced subjects in all treatments have a high frequency of bankruptcy. But again, the ones with higher bid factors have a lower frequency than the ones with lower bid factors. Males in the inexperienced treatment have the lowest rate of bankruptcy, and the females in the inexperienced treatment have the highest. Consistent with their intermediate bid factors, males and females in the mixed treatment have an intermediate bankruptcy rate.
3.4.2 Bidding Behavior of Experienced Subjects

The estimation results are given in Table B.5. Only the coefficient of the intercept is significant. It is similar to the one inexperienced bidders display in later rounds. But it is still below the RNNE bid factor. There is no significant adjustment over time, so I also did the regression without the learning terms. Still, only the intercept is significant. The experienced bidders do not behave differently with mixed opponents than with only experienced opponents (see also Figures B.3 and B.4). They have relatively high bid factors to begin with, do not adjust over time, and also do not condition their bid factors on the composition of the auction market.

3.5 Discussion

The results presented here clearly show the interesting treatment effect of the mixed market, while the results of the benchmark treatments are similar to those found in previous studies, such as Garvin and Kagel (1994) and Casari et al. (2004). In the inexperienced benchmark treatment, subjects start out bidding very aggressively. There is a high frequency of bankruptcies and average negative profits. However, subjects learn to adjust their bids over time, so that by the end of the 25 auction rounds, they have established a relatively high bid factor. There is, in addition, a significant gender difference: Males start out much less aggressively, but also adjust their bidding behavior less over time. Females start out very aggressive, but learn much faster than males, so that by the end of the session, there is no gender difference any more.

In the mixed treatment, experienced and inexperienced subjects compete against each other. The introduction of experienced opponents has a significant effect on
the behavior of both inexperienced males and females. Both behave differently in mixed markets than in those with only experienced opponents. But they change their behavior in the opposite direction.

While there is a the gender difference in the inexperienced treatment, inexperienced males and females in the mixed treatment bid very similar to each other. This suggests that the gender difference found in previous studies might not be of importance in real auction markets because they are usually mixed.

Since the gender difference disappears, the mixed market has the opposite effect on inexperienced males and females: Males bid more aggressively in mixed markets, while females bid less aggressively.

For inexperienced males, having experienced opponents has a negative influence on their bidding behavior, but for the inexperienced females it has a positive effect. So, males and females clearly react different in economic environments. And males and females learn differently and use different stimuli to adjust their behavior.

Not all of the inexperience subjects take advantage of the additional source of learning offered by the observation of experienced opponents. Females do, but males do not. Females seem to understand that there is an opportunity to imitate experienced opponents, and they already start to observe in the dry run.24 Figure B.5 shows that the inexperienced females bid very close to the experienced, and in the last round, their behavior is almost indistinguishable. The males, however, rather become more aggressive in mixed markets.

24Recall that the inexperienced bidders in the mixed treatment are told that they have experienced opponents and that the difference in behavior is already apparent in early rounds. The experienced bidders in the mixed treatment have an average bid factor of 7.155 in the two dry runs, and there is a much lower standard error than for the bid factors of inexperienced bidders in the dry runs.
In a study on gender differences in high ranking positions, Niederle and Vesterlund (2005) conduct an experiment in which males and females perform tasks in both non-competitive and competitive environments. While they find no gender difference in the performance in the competitive task, they find differences in how optimistic males and females are about their performance. And they find differences in how likely males and females are to enter a competitive task. Males are much more optimistic about their future performance than females, and tend to enter competitive tasks much more, and in fact too frequently. This observation can serve as an initial explanation for the gender differences that I find in this experiment. Men prefer competitive environments and are very optimistic about their performance. Bidding against experienced opponents is clearly more competitive than bidding against inexperienced opponents. Males react to this by being overly competitive. They believe that they can do better than the experienced opponents and submit bids that are too high.

Females, on the other hand, are pessimistic about their performance in competitive tasks. So, they are more open to learning from others, in this case the experienced bidders. In the mixed treatment, they know whom to imitate. Experienced bidders can be distinguished as being successful. Characteristics, such as pessimistic expectation about own performance, might be a downside in other environments, but can very well be a force that improves learning behavior in others, such as common value auctions.

The experienced bidders do not behave differently in the two treatments. Especially, they do not become more aggressive in the mixed markets with overly aggressive inexperienced opponents. This indicates that the experienced subjects gained some
understanding of the game and do not revert to unsuccessful behavior. They start out bidding relatively high in both treatments and do not change their behavior too much over time. This finding is reassuring for two reasons: First, it implies that experience indeed lead to a successful adaptation to the environment. And second, the experienced bidders can indeed serve as good role models in mixed markets because they stick to successful bidding behavior.

3.6 Conclusion

I examine the behavior of experienced and inexperienced bidders in mixed common value auctions that have both experienced and inexperienced bidders. I compare the behavior of subjects in the mixed treatment to two benchmark treatments, one with only inexperienced and one with only experienced bidders. In the mixed treatment, there are two experienced and two inexperienced bidders. In the benchmark treatment, all four bidders are either experienced or inexperienced.

The mixed treatment is a bidding environment that has never been studied before. It turns out that inexperienced bidders behave very differently in mixed markets than in markets with only inexperienced bidders. And gender effects are crucial in this study. Males and females behave differently in mixed markets compared with their counterparts in markets with only inexperienced bidders, so that the mixed market has the opposite on males than on females.

Similar to previous studies, I find in the inexperienced treatment, the one with only inexperience subjects, that female bidders start out bidding much more aggressively than males. But they also learn at a faster rate, so that by the end of the session, the gender difference disappears. In this benchmark treatment, inexperienced bidders
make negative profits on average and have a high frequency of bankruptcy. In the experienced treatment, the findings are also similar to previous ones. Experienced bidders bid much less aggressively than inexperienced ones and there is no gender effect.

In the mixed treatment, inexperienced males and females bid very similar to each other: there is virtually no gender difference. But this implies that compared to the inexperienced benchmark treatment, males and females react differently to having some experienced opponents. Inexperienced males bid more aggressively in mixed markets, while females bid less aggressively.

An initial explanation for this gender difference is drawn from Niederle and Vesterlund (2005) who find, in a different experience, gender differences in expectations about performance in competitive tasks. Males are attracted to competitive environments and overestimate their performance. Bidding in a market with successful experienced opponents induces them to become very competitive and, as a result, too aggressive. Niederle and Vesterlund (2005) also find that females underestimate their performance in competitive tasks. This could be the factor that induces them to imitate the experienced opponents. In this case, the mixed markets enhances female learning and hinders male learning.

The experienced bidders do not behave differently in the mixed market and the benchmark treatment. Even when facing overly aggressive opponents, the inexperienced bidders, in the mixed market, they do not become more aggressive. This implies a relatively deep understanding of the bidding environment because they are not tempted to bid more aggressively.
This study shows the interesting effects of the mixed markets and implies very different adaptation behavior of inexperienced males and females to economic environments. It is an interesting avenue for future research to investigate further the differences of males and females in learning and reacting to competitive environments. My design only allows me to draw some initial hypotheses that are clearly worthwhile to be investigated deeper.
BIBLIOGRAPHY


APPENDIX A

APPENDIX TO CHAPTER 1

Proof of Proposition 1 See Morelli (1999) for a proof of the pure budget-dividing game. In the pure budget-dividing game, the budget is distributed evenly over the first and second mover, i.e. the first mover gets exactly $\frac{X}{2}$. When issues are bundled together, assume that the first mover proposes some policy $y^1$ and demands a share larger than $\frac{X}{2}$. Then the second mover can always propose the same policy and demand a share of exactly $\frac{X}{2}$, so that both the second and third mover are better off by forming a majority coalition together rather than with the first mover. Therefore, asking for a share larger than $\frac{X}{2}$ cannot be an equilibrium strategy for the first mover.

Now suppose that issues are bundled together and the first mover asks for a share of exactly $\frac{X}{2}$ and a policy $y^1$. Then the second mover could propose a new $y^2$ and ask for some share $x^2$ such that the third mover would be indifferent. The compensation payment $dx$ between the second and third mover leaves the third mover indifferent between $y^1$ and $y^2$, i.e.

$$dx = -b(y^2 - \hat{y}^3)^2 + b(y^1 - \hat{y}^3)^2$$  \hspace{1cm} (1)

The first mover knows that the second mover can form a coalition with the third. This is a credible threat off the equilibrium path. To receive any budget shares, she
has to convince the second mover to form a coalition with her. So, she has to leave the second mover at least indifferent between a coalition with the first and third mover, i.e.

\[-b(y^1 - \hat{y}^2)^2 + X - x^1 = -b(y^2 - \hat{y}^2)^2 + x^1 + dx\]  

\[X - x^1 = x^1 = X/2 \Rightarrow dx = -b(y^1 - \hat{y}^2)^2 + b(y^2 - \hat{y}^2)^2\]

Notice that with \(x^1 < X\) and \(\hat{y}^2 \neq \hat{y}^3\), it follows that \(y^1 \neq y^2\). There is no \(dx\) that satisfies both (1) and (3). So, it is not possible that \(x^1 = X/2\). \(x^1\) has to be less than \(X/2\) when issues are bundled. \(q.e.d\)

**Proof of Lemma 1** Suppose not. Suppose instead that the proposed \(y\) is such that \(\left| \frac{\partial u_j}{\partial y} \right| > \left| \frac{\partial u_k}{\partial y} \right|\). Then the gain to \(j\) of moving \(y\) closer to \(\hat{y}_j\) is larger than the loss to \(k\), and \(j\) can compensate \(k\) with money and both are better off. Suppose now that \(y\) is such that \(\left| \frac{\partial u_j}{\partial y} \right| < \left| \frac{\partial u_k}{\partial y} \right|\). The same logic as above applies. In equilibrium with large \(X\), \(y\) has to be such that \(\left| \frac{\partial u_j}{\partial y} \right| = \left| \frac{\partial u_k}{\partial y} \right|\). \(q.e.d\)

**Proof of Proposition 2** Proposition 1 follows directly from Lemmata 1 and 2. I will, however, include a complete description of equilibrium choices for all orders of play.

Order 123

For a given \((y_1, x_1)\), 2 makes the following proposition that leaves 3 as well off as by forming a coalition with 1: \((y_2, x_2 = x_1 + dx)\)

\[dx = -b(y_2 - \hat{y}_3)^2 + b(y_1 - \hat{y}_3)^2\]

\[y_1 = \frac{\hat{y}_1 + \hat{y}_2}{2}, \quad y_2 = \frac{\hat{y}_2 + \hat{y}_3}{2}\]

\[\Rightarrow dx = -\frac{b}{4}(\hat{y}_2 - \hat{y}_3)^2 + \frac{b}{4}(\hat{y}_1 + \hat{y}_2 - 2\hat{y}_3)^2 = -\frac{b}{4}(\hat{y}_2 - \hat{y}_3)^2 + \frac{b}{4}(\hat{y}_2 - \hat{y}_3 + \hat{y}_1 - \hat{y}_3)^2\]

1 has to make 2 at least as well off as by going with 3:
\[-b(y_1 - \hat{y}_2)^2 + X - x_1 = -b(y_2 - \hat{y}_2)^2 + x_1 + dx\]

\[\Rightarrow x_1 = \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2\]

Order 132

With the same logic as above:

\[y_1 = \frac{\hat{y}_1 + \hat{y}_2}{2}, y_3 = \frac{\hat{y}_1 + \hat{y}_3}{2}\]

\[dx = -b(y_3 - \hat{y}_2)^2 + b(y_1 - \hat{y}_2)^2 = -\frac{b}{4}(\hat{y}_3 - \hat{y}_2)^2 + \frac{b}{4}(\hat{y}_1 + \hat{y}_3 - 2\hat{y}_2)^2\]

\[x_1 = \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_2)^2\]

Order 213

\[y_1 = \frac{\hat{y}_1 + \hat{y}_2}{2}, y_2 = \frac{\hat{y}_1 + \hat{y}_2}{2}\]

\[dx = -\frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2 + \frac{b}{4}(\hat{y}_1 + \hat{y}_2 - 2\hat{y}_3)^2\]

\[x_2 = \frac{X}{2} - \frac{b}{4}(\hat{y}_2 - \hat{y}_3)^2\]

Order 231

\[y_2 = \frac{\hat{y}_1 + \hat{y}_3}{2}, y_3 = \frac{\hat{y}_1 + \hat{y}_3}{2}\]

\[dx = -b(y_3 - \hat{y}_1)^2 + b(y_2 - \hat{y}_1)^2 = -\frac{b}{4}(\hat{y}_3 - \hat{y}_1)^2 - (y_3 - y_1 + y_2 - y_1)^2\]

\[x_2 = \frac{X}{2} - \frac{b}{4}(\hat{y}_2 - \hat{y}_3)^2\]

Order 321

\[y_3 = \frac{\hat{y}_2 + \hat{y}_3}{2}, y_2 = \frac{\hat{y}_1 + \hat{y}_2}{2}\]

\[dx = -b(y_2 - \hat{y}_1)^2 + b(y_3 - \hat{y}_1)^2 = -\frac{b}{4}(\hat{y}_2 - \hat{y}_1)^2 - (\hat{y}_3 + \hat{y}_2 - 2\hat{y}_1)^2\]

\[x_3 = \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2\]

Order 312

\[y_3 = \frac{\hat{y}_1 + \hat{y}_3}{2}, y_1 = \frac{\hat{y}_1 + \hat{y}_2}{2}\]

\[dx = -b(y_1 - \hat{y}_2)^2 + b(y_3 - \hat{y}_2)^2 = -\frac{b}{4}(\hat{y}_1 - \hat{y}_2)^2 + \frac{b}{4}(\hat{y}_1 + \hat{y}_3 - 2\hat{y}_2)^2\]

\[x_3 = \frac{X}{2} - \frac{b}{4}(\hat{y}_2 - \hat{y}_3)^2\]
Comparing orders of play for the first mover

Case 1: 1 is the first mover

\[ U_1(123) = -\frac{b}{4}(\hat{y}_2 - \hat{y}_1)^2 + \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2 = \]

\[ = U_1(132) = -\frac{b}{4}(\hat{y}_3 - \hat{y}_1)^2 + \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_2)^2 \]

Case 2: 2 is the first mover

\[ U_2(213) = -\frac{b}{4}(\hat{y}_1 - \hat{y}_2)^2 + \frac{X}{2} - \frac{b}{4}(\hat{y}_2 - \hat{y}_3)^2 = \]

\[ = U_2(231) = -\frac{b}{4}(\hat{y}_3 - \hat{y}_2)^2 + \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_2)^2 \]

Case 3: 3 is the first mover

\[ U_3(321) = -\frac{b}{4}(\hat{y}_2 - \hat{y}_3)^2 + \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2 = \]

\[ = U_3(312) = -\frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2 + \frac{X}{2} - \frac{b}{4}(\hat{y}_2 - \hat{y}_3)^2 \]

Proof of Lemma 2 Assume that issues are separated. When issues are separated, they are treated independent of each other. By Morelli (1999), the decision on the budget will be \((\frac{X}{2}, \frac{X}{2})\) for the first and second mover in this dimension. Also by Morelli (1999), the policy decision is \(\hat{y}_2\), independent of the identity of the first mover and the order of play.

The first mover can set the agenda and knows that she has no influence on the policy position. But if she decides that the budget should be the first issue, she can assure herself a share of \(\frac{X}{2}\), while it is uncertain if she will be part of the majority coalition if the budget distribution is the second issue. Therefore, the budget will always be decided on first. qed

Proof of Proposition 3 If legislator 2 (the median) decides to separate issues, she gets \(\frac{X}{2} - b(\hat{y}_2 - \hat{y}_2)^2 = \frac{X}{2}\). If she prefers to bundle, she gets \(-\frac{b}{4}(\hat{y}_3 - \hat{y}_2)^2 + \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_1)^2\). Separating always gives her a larger utility.
Assume that legislator 1 is the first mover. With earlier results, 1 prefers separating issues if and only if separating gives her at least the same utility as bundling, i.e.

\[
\frac{X}{2} - b(\hat{y}_2 - \hat{y}_1)^2 \geq -\frac{b}{4}(\hat{y}_2 - \hat{y}_1)^2 + \frac{X}{2} - \frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2
\]

\[
\iff b(\hat{y}_2 - \hat{y}_1)^2 \leq \frac{b}{4}(\hat{y}_2 - \hat{y}_1)^2 + \frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2
\]

\[
\iff (\hat{y}_2 - \hat{y}_1)^2 (b - \frac{b}{4}) \leq \frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2
\]

\[
\iff 3(\hat{y}_2 - \hat{y}_1) \leq (\hat{y}_3 - \hat{y}_1)\sqrt{3} \leq \frac{(\hat{y}_3 - \hat{y}_1)}{(\hat{y}_2 - \hat{y}_1)} = r_1
\]

Similarly, legislator 3 prefers separating, i.e.

\[
\sqrt{3} \leq \frac{(\hat{y}_3 - \hat{y}_1)}{(\hat{y}_3 - \hat{y}_2)} = r_3
\]

With \(r_1\) and \(r_3\), there are three possible cases:

Case 1: Both 1 and 3 prefer bundling. Then \(\sqrt{3} > \frac{(\hat{y}_3 - \hat{y}_1)}{(\hat{y}_2 - \hat{y}_1)}\) and \(\sqrt{3} > \frac{(\hat{y}_3 - \hat{y}_1)}{(\hat{y}_3 - \hat{y}_2)}\) \iff \(\sqrt{3}(\hat{y}_2 - \hat{y}_1) + \sqrt{3}(\hat{y}_3 - \hat{y}_2) > 2(\hat{y}_3 - \hat{y}_1)\) \iff \(\sqrt{3} > 2\), which is not true. Therefore, it is not possible that both 1 and 3 prefer bundling.

Case 2: 1 prefers separating and 3 prefers bundling. Then it has to be true that \(\sqrt{3}(\hat{y}_2 - \hat{y}_1) \leq \sqrt{3}(\hat{y}_3 - \hat{y}_2)\).

Case 3: 3 prefers separating and 1 prefers bundling. Then it has to be true that \(\sqrt{3}(\hat{y}_3 - \hat{y}_2) \leq \sqrt{3}(\hat{y}_2 - \hat{y}_1)\).

But \((\hat{y}_2 - \hat{y}_1) \leq (\hat{y}_3 - \hat{y}_2)\), 1 always prefers separating because \(\sqrt{3} \leq \frac{(\hat{y}_3 - \hat{y}_1)}{(\hat{y}_3 - \hat{y}_2)}\). For 3, either \(\sqrt{3} \leq \frac{(\hat{y}_3 - \hat{y}_1)}{(\hat{y}_3 - \hat{y}_2)}\), or \(\sqrt{3} > \frac{(\hat{y}_3 - \hat{y}_1)}{(\hat{y}_3 - \hat{y}_2)}\). \(q.e.d\)

67
**Proof of Proposition 4:** For the median legislator, the same logic applies as in the homogeneous case, so she will always prefer to separate issues.

**Legislator 1 is the first mover.** Recall that in case of separating, legislators always prefer to approve the budget distribution first. Separating will yield $U_1(separating) = \frac{X}{2} - b(\hat{y}_2 - \hat{y}_1)^2$ to legislator 1. Note that the legislators 1 and 3 are assumed to have the same policy sensitivity, so if issues are bundled, the policy position is $\frac{\hat{y}_3 + \hat{y}_3}{2} \geq \hat{y}_2$. From Proposition 1, the first mover can never get a share larger than $\frac{X}{2}$. So, legislator 1 prefers separating to bundling when the order is 132.

**Order 123**

$$y_1 = \frac{b\hat{y}_3 + \hat{y}_2}{b+1}, y_2 = \frac{b\hat{y}_3 + \hat{y}_2}{b+1}$$ from Lemma 1.

2 has to make 3 as well off as by going with 1, so

$$dx = -b\left(\frac{b\hat{y}_3 + \hat{y}_2}{b+1} - \hat{y}_3\right)^2 + b\left(\frac{b\hat{y}_3 + \hat{y}_2}{b+1} - \hat{y}_3\right)^2 =$$

$$= -\frac{b}{(b+1)^2}(\hat{y}_2 - \hat{y}_3)^2 + \frac{b}{(b+1)^2}(b\hat{y}_1 + \hat{y}_2 - b\hat{y}_3 - \hat{y}_3)^2.$$  

1 has to make 2 at least as well off as by going with 3:

$$-\frac{b}{(b+1)^2}(\hat{y}_2 - \hat{y}_3)^2 + X - x_1 =$$

$$= -\left(\frac{b\hat{y}_3 + \hat{y}_2}{b+1} - \hat{y}_2\right)^2 + x_1 - \frac{b}{(b+1)^2}(\hat{y}_2 - \hat{y}_3)^2 + \frac{b}{(b+1)^2}(b\hat{y}_1 + \hat{y}_2 - b\hat{y}_3 - \hat{y}_3)^2 \Leftrightarrow$$

$$\Leftrightarrow -\frac{b}{(b+1)^2}(\hat{y}_1 - \hat{y}_2)^2 + X - x_1 =$$

$$= -\frac{b^2}{(b+1)^2}(\hat{y}_3 - \hat{y}_2)^2 - \frac{b}{(b+1)^2}(\hat{y}_2 - \hat{y}_3)^2 + \frac{b}{(b+1)^2}(b(\hat{y}_1 - \hat{y}_3) + (\hat{y}_2 - \hat{y}_3))^2 \Leftrightarrow$$

$$\Leftrightarrow 2x_1 = X - \frac{b^2}{(b+1)^2}(-\hat{y}_3 - \hat{y}_2)^2 + b(\hat{y}_1 - \hat{y}_3)^2 + 2(\hat{y}_1 - \hat{y}_3)(\hat{y}_2 - \hat{y}_3) + (\hat{y}_1 - \hat{y}_2)^2.$$  

$$U_1(123) = \frac{X}{2} + \frac{b}{2(b+1)^2}(b\hat{y}_3 - \hat{y}_2)^2 - b(\hat{y}_1 - \hat{y}_3)^2 - 2b(\hat{y}_1 - \hat{y}_3)(\hat{y}_2 - \hat{y}_3) - b(\hat{y}_1 - \hat{y}_2)^2 - 2(\hat{y}_1 - \hat{y}_2)^2$$

Assume that $\hat{y}_1 = -1, \hat{y}_3 = 1$

$$U_1(123) = \frac{X}{2} + \frac{b}{2(b+1)^2}(b(-1 - \hat{y}_2)^2 - b^2(-2)^2 - 2b(-2)(\hat{y}_2 - 1) - b(1 + \hat{y}_2)^2 - 2(1 + \hat{y}_2)^2) =$$
\[
\frac{X}{2} + \frac{b}{2(b+1)^2} (b - 2b\hat{y}_2 + b\hat{y}_2^2 - 4b^2 + 4b\hat{y}_2 - 4b - b - 2b\hat{y}_2 - b\hat{y}_2^2 - 2 - 4\hat{y}_2 - 2\hat{y}_2^2) = \\
\frac{X}{2} + \frac{b}{2(b+1)^2} (-4b^2 - 4b - 4\hat{y}_2 - 2 - 2\hat{y}_2^2) =
\]

The first legislator prefers separating over bundling if and only if \(U_1(123) \leq U_1(\text{separating})\) \iff

\[
\frac{X}{2} + \frac{b}{2(b+1)^2} (-4b^2 - 4b - 4\hat{y}_2 - 2 - 2\hat{y}_2^2) \leq \frac{X}{2} - b(\hat{y}_2^2 + 2\hat{y}_2 + 1) \iff \\
\frac{1}{(b+1)^2} (-4b^2 - 4b - 4\hat{y}_2 - 2 - 2\hat{y}_2^2) \leq -(\hat{y}_2^2 + 2\hat{y}_2 + 1) \iff \\
-4b^2 - 4b - 4\hat{y}_2 - 2 - 2\hat{y}_2^2 \leq -(b + 1)^2(\hat{y}_2^2 + 2\hat{y}_2 + 1) \iff \\
-4b^2 - 4b - 2(\hat{y}_2 + 1)^2 \leq -(b + 1)^2(\hat{y}_2 + 1)^2 \iff \\
-4b^2 - 4b \leq -(b^2 + 2b - 1)(\hat{y}_2 + 1)^2 \iff \\
4b^2 + 4b \geq (b^2 + 2b - 1)(\hat{y}_2 + 1)^2 \iff \frac{4b^2 + 4b}{b^2 + 2b - 1} \geq (\hat{y}_2 + 1)^2.
\]

Since \((\hat{y}_2 + 1)^2 \leq 1\) and \(\frac{4b^2 + 4b}{b^2 + 2b - 1} > 1\forall b \geq 1\), legislator 1 always prefers to separate.

**Legislator 3 is the first mover.**

**Order 321**

\[
y_{23} = \frac{\hat{y}_2 + b\hat{y}_3}{b+1}, \ y_{12} = \frac{\hat{y}_2 + b\hat{y}_1}{b+1}
\]

2 has to make 1 at least as well off as by going with 3:

\[
dx = -b(\frac{\hat{y}_2 + b\hat{y}_1}{b+1} - \hat{y}_1)^2 + b(\frac{\hat{y}_2 + b\hat{y}_3}{b+1} - \hat{y}_1)^2 = \\
= -\frac{b}{(b+1)^2} (\hat{y}_2 - \hat{y}_1)^2 + \frac{b}{(b+1)^2} (b(\hat{y}_3 - \hat{y}_1) + (\hat{y}_2 - \hat{y}_1))^2
\]

3 has to make 2 at least as well off as by going with 1:

\[
-b(\frac{\hat{y}_2 + b\hat{y}_3}{b+1} - \hat{y}_2)^2 + X - x_3 = \\
= -b(\frac{\hat{y}_2 + b\hat{y}_1}{b+1} - \hat{y}_2)^2 + x_3 - \frac{b}{(b+1)^2} (\hat{y}_2 - \hat{y}_1)^2 + \frac{b}{(b+1)^2} (b(\hat{y}_3 - \hat{y}_1) + (\hat{y}_2 - \hat{y}_1))^2 \iff \\
\iff -\frac{b^2}{(b+1)^2} (\hat{y}_2 - \hat{y}_3)^2 + X - x_3 = \\
= -\frac{b^2}{(b+1)^2} (\hat{y}_1 - \hat{y}_3)^2 + x_3 - \frac{b}{(b+1)^2} (\hat{y}_2 - \hat{y}_1)^2 + \frac{b}{(b+1)^2} (\hat{y}_3 - \hat{y}_1)^2 + \frac{b^2}{(b+1)^2} (\hat{y}_3 - \hat{y}_1)(\hat{y}_2 - \hat{y}_1) \iff
\]

69
\[ \Leftrightarrow -\frac{b^2}{(b+1)^2}(\dot{y}_2 - \dot{y}_3)^2 + X - x_3 = -\frac{b^2}{(b+1)^2}(\ddot{y}_1 - \dot{y}_2)^2 + x_3 + \frac{b^3}{(b+1)^2}(\dot{y}_3 - \dot{y}_1)^2 + \frac{2b^2}{(b+1)^2}(\dot{y}_3 - \dot{y}_1)(\ddot{y}_2 - \ddot{y}_1) \Leftrightarrow \]

\[ \Leftrightarrow 2x_3 = X - \frac{b^2}{(b+1)^2}(\ddot{y}_2 - \ddot{y}_3)^2 + \frac{b^2}{(b+1)^2}(\dot{y}_1 - \dot{y}_2)^2 - \frac{b^3}{(b+1)^2}(\dot{y}_3 - \dot{y}_1)^2 - \frac{2b^2}{(b+1)^2}(\dot{y}_3 - \dot{y}_1)(\ddot{y}_2 - \ddot{y}_1) \Leftrightarrow \]

\[ \Leftrightarrow x_3 = \frac{X}{2} - \frac{b^2}{2(b+1)^2}(\ddot{y}_2 - \ddot{y}_3)^2 + \frac{b^2}{2(b+1)^2}(\dot{y}_1 - \dot{y}_2)^2 - \frac{b^3}{2(b+1)^2}(\dot{y}_3 - \dot{y}_1)^2 - \frac{2b^2}{2(b+1)^2}(\dot{y}_3 - \dot{y}_1)(\ddot{y}_2 - \ddot{y}_1). \]

\[ U_3(321) = -b\left(\frac{\ddot{y}_2 + \ddot{y}_3}{b+1} - \ddot{y}_3\right)^2 + x_3 = -\frac{b}{(b+1)^2}(\ddot{y}_2 - \ddot{y}_3)^2 + x_3 \]

Assume now that \( \dot{y}_1 = -1, \dot{y}_3 = 1 \)

\[ U_3(321) = -\frac{b}{(b+1)^2}(\ddot{y}_2 - \ddot{y}_3)^2 + x_3, \]

\[ x_3 = \frac{X}{2} - \frac{b^2}{2(b+1)^2}(\ddot{y}_2 - \ddot{y}_3)^2 + \frac{b^2}{2(b+1)^2}(\dot{y}_1 - \dot{y}_2)^2 - \frac{b^3}{2(b+1)^2}(\dot{y}_3 - \dot{y}_1)^2 - \frac{2b^2}{2(b+1)^2}(\dot{y}_3 - \dot{y}_1)(\ddot{y}_2 - \ddot{y}_1) = \]

\[ = \frac{X}{2} - \frac{b^3}{2(b+1)^2} - 2b^2 \frac{b+1}{2(b+1)^2} \]

\[ U_3(321) = -\frac{b}{(b+1)^2}(\ddot{y}_2 - \ddot{y}_3)^2 + x_1 = -\frac{b}{(b+1)^2}(\ddot{y}_2 - 1)^2 + \frac{X}{2} - \frac{b^3}{2(b+1)^2} - \frac{2b^2}{2(b+1)^2}. \]

**Order 312**

\[ y_{13} = \frac{\dot{y}_1 + \dot{y}_3}{2}, \quad y_{12} = \frac{\dot{y}_2 + \dot{y}_1}{b+1} \]

1 has to make 2 at least as well off as by going with 3:

\[ dx = -\left(\frac{\ddot{y}_2 + \ddot{y}_1}{b+1} - \frac{\ddot{y}_1 + \ddot{y}_3}{2}\right)^2 = \]

\[ = -\frac{b^2}{(b+1)^2}(\ddot{y}_1 - \ddot{y}_2)^2 + \frac{1}{4}((\ddot{y}_1 - \ddot{y}_3) + (\ddot{y}_3 - \ddot{y}_2))^2 \]

3 has to make 1 at least as well off as by going with 2:

\[ -b\left(\frac{\ddot{y}_1 + \ddot{y}_3}{2} - \ddot{y}_1\right)^2 + X - x_3 = \]

\[ = -b\left(\frac{\ddot{y}_1 + \ddot{y}_3}{b+1} - \ddot{y}_1\right)^2 + x_3 - \frac{b^2}{(b+1)^2}(\ddot{y}_1 - \ddot{y}_2)^2 + \frac{1}{4}((\ddot{y}_1 - \ddot{y}_3) + (\ddot{y}_3 - \ddot{y}_2))^2 \Leftrightarrow \]

\[ \Leftrightarrow -\frac{b}{4}(\ddot{y}_3 - \ddot{y}_1)^2 + X - x_3 = \]

70
\[-\frac{b}{(b+1)^2}(\hat{y}_2 - \hat{y}_1)^2 + x_3 - \frac{b^2}{2(b+1)^2}(\hat{y}_1 - \hat{y}_2)^2 + \frac{1}{4}(\hat{y}_1 - \hat{y}_2)^2 + \frac{1}{4}2(\hat{y}_1 - \hat{y}_2)(\hat{y}_3 - \hat{y}_2) + \frac{1}{4}(\hat{y}_3 - \hat{y}_2)^2 \iff
\]
\[\iff 2x_3 = X - \frac{b}{4}(\hat{y}_3 - \hat{y}_1)^2 + \frac{b}{2(b+1)^2}(\hat{y}_2 - \hat{y}_1)^2 + \frac{b^2}{2(b+1)^4}(\hat{y}_1 - \hat{y}_2)^2 - \frac{1}{4}(\hat{y}_1 - \hat{y}_2)^2 - \frac{1}{4}2(\hat{y}_1 - \hat{y}_2) + \frac{1}{4}(\hat{y}_3 - \hat{y}_2)^2 \iff
\]
\[\iff x_3 = \frac{X}{2} - \frac{b}{8}(\hat{y}_3 - \hat{y}_1)^2 + \frac{b}{2(b+1)^2}(\hat{y}_2 - \hat{y}_1)^2 + \frac{b^2}{2(b+1)^4}(\hat{y}_1 - \hat{y}_2)^2 - \frac{1}{8}(\hat{y}_1 - \hat{y}_2)^2 - \frac{1}{8}2(\hat{y}_1 - \hat{y}_2)(\hat{y}_3 - \hat{y}_2) - \frac{1}{8}(\hat{y}_3 - \hat{y}_2)^2
\]

Assume now that \(\hat{y}_1 = -1, \hat{y}_3 = 1\)

\[x_3 = \frac{X}{2} - \frac{b}{8}(2)^2 + \frac{b}{2(b+1)^2}(\hat{y}_2 + 1)^2 + \frac{b^2}{2(b+1)^4}(1 + \hat{y}_2)^2 - \frac{1}{8}(1 + \hat{y}_2)^2 + \frac{1}{8}2(1 + \hat{y}_2)(1 - \hat{y}_2) - \frac{1}{8}(1 - \hat{y}_2)^2 = \frac{X}{2} - \frac{b}{2} + \frac{b}{2(b+1)^2}(\hat{y}_2 + 2\hat{y}_2 + 1) + \frac{b^2}{2(b+1)^4}(\hat{y}_2 + 2\hat{y}_2 + 1) - \frac{1}{8}(\hat{y}_2 + 2\hat{y}_2 + 1) + \frac{1}{8} - \frac{1}{8}\hat{y}_2 - \frac{1}{8}(\hat{y}_2 - 2\hat{y}_2 + 1) = \frac{X}{2} - \frac{b}{2} + \frac{b}{2(b+1)^2}(\hat{y}_2 + 2\hat{y}_2 + 1) + \frac{b^2}{2(b+1)^4}(\hat{y}_2 + 2\hat{y}_2 + 1) - \frac{1}{2}\hat{y}_2^2.
\]

\[U_3(312) = -\frac{b}{4}(\hat{y}_1 - \hat{y}_3)^2 + x_3 = \]

\[-b + \frac{X}{2} - \frac{b}{2} + \frac{b}{2(b+1)^2}(\hat{y}_2 + 2\hat{y}_2 + 1) + \frac{b^2}{2(b+1)^4}(\hat{y}_2 + 2\hat{y}_2 + 1) - \frac{1}{2}\hat{y}_2^2 = \frac{X}{2} - \frac{3b}{2} + \frac{b}{2(b+1)^2}(\hat{y}_2 + 1)^2 + \frac{b^2}{2(b+1)^4}(\hat{y}_2 + 2\hat{y}_2 + 1) - \frac{1}{2}\hat{y}_2^2
\]

Legislator 3 prefers order 321 if

\[-\frac{b}{(b+1)^2}(\hat{y}_2 - 1)^2 + \frac{X}{2} - \frac{4b^3}{2(b+1)^2} - \frac{4b^2}{2(b+1)^4} \geq
\]

\[\geq \frac{X}{2} - \frac{3b}{2} + \frac{b}{2(b+1)^2}(\hat{y}_2 + 1)^2 + \frac{b^2}{2(b+1)^4}(\hat{y}_2 + 1)^2 - \frac{1}{2}\hat{y}_2^2 \iff
\]

\[\iff -\frac{b}{(b+1)^2}(\hat{y}_2 - 1)^2 - \frac{4b^3}{2(b+1)^2} - \frac{4b^2}{2(b+1)^4} \geq -\frac{3b}{2} + \frac{b}{2(b+1)^2}(\hat{y}_2 + 1)^2 + \frac{b^2}{2(b+1)^4}(\hat{y}_2 + 1)^2 - \frac{1}{2}\hat{y}_2^2 \iff
\]

\[\iff -2b(\hat{y}_2 - 1)^2 - 4b^3 - 4b^2 \geq -3b(b+1)^2 + b(\hat{y}_2 + 1)^2 + b^2(\hat{y}_2 + 1)^2 - (b+1)^2\hat{y}_2^2 \iff
\]

\[\iff -2b\hat{y}_2^2 + 4b\hat{y}_2 - 2b - 4b^3 - 4b^2 \geq -3b^3 - 6b^2 - 3b + b\hat{y}_2^2 + 2b\hat{y}_2 + b + 2b^2\hat{y}_2 + b^2 - 2b\hat{y}_2^2 - \hat{y}_2^2 \iff
\]

\[\iff -b^3 + b^2 + 2b\hat{y}_2 - b\hat{y}_2^2 - 2b^2\hat{y}_2 + \hat{y}_2^2 \geq 0
\]

\[\iff \hat{y}_2^2(1 - b) + 2b\hat{y}_2(1 - b) + b^2(1 - b) \geq 0
\]
But with $b > 1$, $\hat{y}_2^2 + 2b\hat{y}_2 + b^2 \leq 0 \iff (\hat{y}_2 + b)^2 \leq 0$. This is never true. Legislator 3 always prefers a coalition with the other extreme legislator 1.

Compare separating and bundling:

$U_3(\text{separating}) = \frac{X}{2} - b(\hat{y}_2 - \hat{y}_3)^2 = \frac{X}{2} - b(\hat{y}_2 - 1)^2$

Legislator 3 prefers separating if

$$\frac{X}{2} - b(\hat{y}_2 - 1)^2 \geq \frac{X}{2} - \frac{3b}{2} + b(\hat{y}_2 + 1)^2 + \frac{b^2}{2(b + 1)}(\hat{y}_2 + 1)^2 - \frac{1}{2}b\hat{y}_2^2 \iff$$

$$-b(\hat{y}_2 - 1)^2 \geq -\frac{3b}{2} + b(\hat{y}_2 + 1)^2 + \frac{b^2}{2(b + 1)}(\hat{y}_2 + 1)^2 - \frac{1}{2}b\hat{y}_2^2 \iff$$

$$-b(\hat{y}_2 - 1)^2 \geq -\frac{3b}{2} + \frac{b(b + 1)}{2(b + 1)}(\hat{y}_2 + 1)^2 - \frac{1}{2}b\hat{y}_2^2 \iff$$

$$-b(\hat{y}_2 - 1)^2 \geq -\frac{3b}{2} + \frac{b}{2(b + 1)}(\hat{y}_2 + 1)^2 - \frac{1}{2}b\hat{y}_2^2 \iff$$

$$-2b(b + 1)(\hat{y}_2 - 1)^2 \geq -3b(b + 1) + b(\hat{y}_2 + 1)^2 - (b + 1)\hat{y}_2^2 \iff$$

$$b(b + 1)(-2(\hat{y}_2 - 1)^2 + 3) - b(\hat{y}_2 + 1)^2 + (b + 1)\hat{y}_2^2 = D^*_b(\hat{y}_2) \geq 0.$$

$$\frac{\partial D^*_b(\hat{y}_2)}{\partial \hat{y}_2} = -4b^2\hat{y}_2 + 2b + 4b^2 - 8b\hat{y}_2 - 2\hat{y}_2$$

and $\frac{\partial}{\partial b} \left( \frac{\partial D^*_b(\hat{y}_2)}{\partial \hat{y}_2} \right) = 8(b - (b + 1)\hat{y}_2) + 2 > 0 \forall -1 \leq \hat{y}_2 \leq 0$.

Figure A.1 depicts $D^*_b(\hat{y}_2)$ for different $b$. The higher $b$, the higher the slope of $D^*_b(\hat{y}_2)$.

For each $b$, there is a range of median ideal points for which legislator 3 prefers separating. As in the homogeneous case: For each $b$, there is a threshold $\hat{y}^*_2(b)$ for which the following is true: As long as $\hat{y}_2 \geq \hat{y}^*_2(b)$, legislator 3 prefers separating, and bundling otherwise. Only with sufficient asymmetry in ideal points, legislator 3 prefers bundling.

Define $\hat{y}^*_2(b) = (\hat{y}_2(b) \mid D^*_b(\hat{y}_2) = 0, \hat{y}_2(b) \leq 0) = \hat{y}^*_2(b)_1 = \frac{1}{2b^2 + 2b^2 - 1} \left( \sqrt{6b^3(b + 1) - 2b^2 - b} \right).$
Figures A.2 and A.3 depict $\hat{y}_2^*(b)$ and $\frac{\partial}{\partial b}(\hat{y}_2^*(b))$. They show that $\hat{y}_2^*(1) < \hat{y}_2^*(b), b > 1$ and that the threshold is increasing in $b$. Notice that $\hat{y}_2^*(1)$ is the same as in the homogeneous $b$ case.
Figure A.2: $\hat{y}_2^*(b)\big|_1$ for $b \geq 1$.

Figure A.3: $\frac{\partial}{\partial b}(\hat{y}_2^*(b))$ for $b \geq 1$. 
APPENDIX B

APPENDIX TO CHAPTER 3

<table>
<thead>
<tr>
<th>Session</th>
<th>Treatment</th>
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<th>Gender</th>
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Table B.1: Data Description
<table>
<thead>
<tr>
<th>Bid Factor</th>
<th>Coefficient</th>
</tr>
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<tbody>
<tr>
<td>Male (β₁)</td>
<td>-.3941 (1.2123)</td>
</tr>
<tr>
<td>Inexp. (β₂)</td>
<td>-1.995* (1.0813)</td>
</tr>
<tr>
<td>Male*Inexp. (β₃)</td>
<td>2.9437** (1.4831)</td>
</tr>
<tr>
<td>Learn<em>Male</em>Inexp. (β₆)</td>
<td>-2.1275*** (.5315)</td>
</tr>
<tr>
<td>Learn<em>Male</em>Mixed (β₄)</td>
<td>-4.2407*** (.8441)</td>
</tr>
<tr>
<td>Learn<em>Female</em>Inexp. (β₇)</td>
<td>-4.8442*** (.6475)</td>
</tr>
<tr>
<td>Learn<em>Female</em>Mixed (β₅)</td>
<td>-4.4788*** (.8249)</td>
</tr>
<tr>
<td>Intercept (β₀)</td>
<td>8.4845*** (.8511)</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses.
*** significant at 1% level.
** significant at 5% level.
* significant at 10% level.

Table B.2: Bid Factor Regression for Inexperienced Subjects

![Figure B.1: Average Bid Factors of Inexperienced Subjects in Inexperienced Treatment](image-url)

Figure B.1: Average Bid Factors of Inexperienced Subjects in Inexperienced Treatment
<table>
<thead>
<tr>
<th>Bid Factor</th>
<th>Males</th>
<th>Females</th>
<th>Mann-Whitney</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, M = F, 2-5</td>
<td>6.9428 (.6581)</td>
<td>2.8251 (.8157)</td>
<td>z = -3.579</td>
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<tr>
<td>I, M = F, 20-25</td>
<td>9.1766 (.6996)</td>
<td>8.2084 (1.284)</td>
<td>z = -0.849</td>
</tr>
<tr>
<td>Mi, M = F, 2-5</td>
<td>3.9096 (1.4694)</td>
<td>6.4015 (1.0729)</td>
<td>z = 0.979</td>
</tr>
<tr>
<td>Mi, M = F, 20-25</td>
<td>7.5849 (1.1709)</td>
<td>9.3324 (.9199)</td>
<td>z = 1.015</td>
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<tr>
<td>I M = Mi M, 2-5</td>
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<td>z = -1.761</td>
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<td>I M = Mi M, 10-15</td>
<td></td>
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<td>z = -1.925</td>
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<tr>
<td>I M = Mi M, 20-25</td>
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<td>z = -1.285</td>
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<td>I F = Mi F, 2-5</td>
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<td>z = 2.469</td>
</tr>
<tr>
<td>I F = Mi F, 10-15</td>
<td></td>
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<td>z = 1.073</td>
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<tr>
<td>I F = Mi F, 20-25</td>
<td></td>
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<td>z = 0.646</td>
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Table B.3: Average Bid Factors of Inexperienced Subjects, I=Inexp., Mi=Mixed, M=Male, F=Female (SE in parentheses.)

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<th>Profit</th>
<th>Mean if High Bid</th>
<th>Mean of Mean Predicted Av. Bankrupt</th>
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<td>RNNE Profit</td>
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<tr>
<td>M, I</td>
<td>-0.4759 (.7007)</td>
<td>-.4549 (.33)</td>
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<tr>
<td>F, I</td>
<td>-5.4828 (1.1271)</td>
<td>-2.6052 (.6919)</td>
</tr>
<tr>
<td>M, Mi</td>
<td>-1.6273 (1.1024)</td>
<td>-1.1004 (.6976)</td>
</tr>
<tr>
<td>F, Mi</td>
<td>-4.9108 (2.1405)</td>
<td>-3.9889 (1.9546)</td>
</tr>
</tbody>
</table>

Table B.4: Average Profits by Subject and Bankruptcies for Inexperienced, I=Inexp., Mi=Mixed, M=Male, F=Female (SE in parentheses.)
### Table B.5: Bid Factor Regression for Experienced Subjects

<table>
<thead>
<tr>
<th>Bid Factor</th>
<th>Coefficient</th>
<th>Coefficient</th>
</tr>
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<tbody>
<tr>
<td>Male ((\beta_1))</td>
<td>.7998 (.9219)</td>
<td>.8426 (1.2044)</td>
</tr>
<tr>
<td>Exp. ((\beta_2))</td>
<td>-1.5829 (1.0319)</td>
<td>-1.28 (1.3117)</td>
</tr>
<tr>
<td>Male*Exp. ((\beta_3))</td>
<td>1.2927 (1.3627)</td>
<td>1.3593 (1.7545)</td>
</tr>
<tr>
<td>Learn<em>Male</em>Exp. ((\beta_6))</td>
<td>.2834 (.5028)</td>
<td>-</td>
</tr>
<tr>
<td>Learn<em>Male</em>Mixed ((\beta_4))</td>
<td>-.5836 (.51)</td>
<td>-</td>
</tr>
<tr>
<td>Learn<em>Female</em>Exp. ((\beta_7))</td>
<td>.1837 (.6655)</td>
<td>-</td>
</tr>
<tr>
<td>Learn<em>Female</em>Mixed ((\beta_5))</td>
<td>-.5855 (.5294)</td>
<td>-</td>
</tr>
<tr>
<td>Intercept ((\beta_0))</td>
<td>9.0937*** (.6678)</td>
<td>8.7717*** (.8671)</td>
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</table>

Note: Standard errors in parentheses.
*** significant at 1% level.

Figure B.2: Average Bid Factors of Inexperienced Subjects in the Mixed Treatment
Figure B.3: Average Bid Factors of Experienced Subjects in Experienced Treatment

Figure B.4: Average Bid Factors of Experienced Subjects in Mixed Treatment
Figure B.5: Inexperienced Males and Females and their Experienced Opponents