Online Appendix for "Peer Bargaining and Productivity in Teams: Gender and the Inequitable Division of Pay"

Appendix

A. Robustness of Productivity and Bargaining Fixed Effects

Table A.1 Worker Categorization by Gender for Alternative Specifications

G_i	C_i	Sample A Men	Sample A Women	Sample A P-value	Sample B Men	Sample B Women	Sample B P-value
		Panel (A) Specification with Two-Person Transactions					
Low	Low	80 (23.5%)	88 (38.3%)	< 0.001	116 (23.2%)	162 (37.5%)	< 0.001
Low	High	97 (28.4%)	21 (9.1%)	< 0.001	138 (27.6%)	50 (11.6%)	< 0.001
High	Low	60 (17.6%)	58 (25.2%)	0.036	86 (17.2%)	102 (23.6%)	0.019
High	High	104 (30.5%)	63 (27.4%)	0.480	160 (32%)	118 (27.3%)	0.137
Total Workers			571			932	
		Panel (B) Specification with Total Service Revenue					
Low	Low	45 (13.2%)	96 (41.7%)	< 0.001	60 (12%)	179 (41.4%)	< 0.001
Low	High	136 (39.9%)	9 (3.9%)	< 0.001	199 (39.8%)	28 (6.5%)	< 0.001
High	Low	56 (16.4%)	89 (38.7%)	< 0.001	90 (18%)	137 (31.7%)	< 0.001
High	High	104 (30.5%)	36 (15.7%)	< 0.001	151 (30.2%)	88 (20.4%)	< 0.001
Total Workers			571			932	

Note: This table shows the number of male and female workers who fall in each of four quadrants defined by median productivity and bargaining. Sample A requires a minimum of 30 weeks' service while Sample B requires 10 weeks. P-values based on chi-squared tests.

In this section, we demonstrate that our main result—female workers tend to have similar productivity fixed effects but lower peer bargaining fixed effects compared to male workers—remains robust towards alternative data-sampling rules, model specifications, and variable definitions. In particular, we present two new specifications: one with a different data-sampling rule and data-aggregation level to estimate bargaining fixed effects, and the other with a new definition of service revenue to estimate productivity fixed effects.

The first specification uses the service and card productivity fixed effects estimated from Equations (1) and (2). For bargaining fixed effects, it only uses data from two-person transactions so that the empirical results can be matched with the theoretical bilateral bargaining model in Section 6. It also uses the transaction-level instead of week-level data to achieve more accurate estimates of bargaining fixed effects. The detailed specification is as follows:

$$\begin{aligned}\text{Cut}_{ijt} =& C_i^c + \text{CardTransactionType}_{ijt} + \text{NumDays}_{it} \\ & g(\text{Cumulative Card Transactions}_{it-1}) + g(\text{Cumulative Card Revenue}_{it-1}) + \\ & g(\text{Card Revenue}_{ijt}) + \text{Week}_t + \text{Store}_{it} + \text{Shift}_{it} + \epsilon_{ijt},\end{aligned} \tag{1}$$

where Cut_{ijt} represents the percentage of total commission received by worker i working with coworker j on transaction ijt.

The results of this specification are in Panel (A) of Table A.1. It is clear that under this new specification, there are disproportionally more female workers with high productivity and low bargaining power and disproportionally fewer female workers with low productivity and high bargaining power. In other words, our main results are confirmed.

The second specification uses the same card productivity fixed effects and bargaining fixed effects as the main models in Equations (2) and (3). When estimating the service productivity fixed effects, however, instead of using commission-adjusted service revenue, this specification uses total revenue. In other words, assume that a service transaction has generated USD 100, and two workers who contributed to it have earned USD 3 and USD 7 as commissions. In this case, the service revenue for each worker in the specification is USD 100.

The results of this specification in Panel (B) of Table A.1 confirm that female workers have higher productivity fixed effects but lower bargaining fixed effects compared to male workers.

B. Detailed Regression Results of Productivity and Bargaining Estimates

In this section, we provide the detailed regression results for Equations (1) to (3). These three regressions are used to estimate the service and card productivity fixed effects as well as the bargaining fixed effect. Columns (1) to (3) of Table B.2 and Table B.3 show the results of the original regressions based on Equations (1) to (3). Fixed effects for store ID and week are not reported.

C. Simulation on Bargaining Outcomes

In order to understand what mechanisms drive the results in Figure 6, we conduct a large-scale simulation. In particular, we observe two important moment conditions in Figure 6:

1. Panel (a) shows that in same-gender groups, the average standard deviation of female-to-female splits is much smaller than that of male-to-male splits. In other words, females are more likely to split around 50 percent.

2. Panel (b) shows that in mixed-gender groups, male workers' splits are much larger than those of female workers.

Table B.2 Detailed Regression Results of Equations (1) to (3) (Table 1)

	Dependent Variable:		
	Service Productivity	Card Productivity	Bargaining FE
	(1)	(2)	(3)
Shift Monday 0	1.696***	0.242*	−0.055
	(0.413)	(0.146)	(0.035)
Shift Monday 1	0.074***	0.037***	−0.001
	(0.007)	(0.011)	(0.003)
Shift Tuesday 0	0.099***	0.289***	0.041***
	(0.026)	(0.070)	(0.012)
Shift Tuesday 1	0.073***	0.033***	0.002
	(0.007)	(0.010)	(0.003)
Shift Wednesday 0	0.106***	0.011	−0.041**
	(0.023)	(0.059)	(0.016)
Shift Wednesday 1	0.086***	0.028***	0.0004
	(0.007)	(0.010)	(0.003)
Shift Thursday 0	0.090***	0.127**	0.008
	(0.023)	(0.053)	(0.012)
Shift Thursday 1	0.051***	0.048***	−0.003
	(0.007)	(0.011)	(0.003)
Shift Friday 0	0.134***	0.051	−0.005
	(0.018)	(0.036)	(0.012)
Shift Friday 1	0.089***	0.044***	−0.002
	(0.006)	(0.010)	(0.003)
Shift Saturday 0	0.120***	0.218***	0.002
	(0.019)	(0.049)	(0.011)
Shift Saturday 1	0.099***	0.060***	0.0002
	(0.007)	(0.009)	(0.002)
Shift Sunday 0	0.113***	0.236***	0.012
	(0.019)	(0.052)	(0.011)
Shift Sunday 1	0.114***	0.081***	−0.001
	(0.008)	(0.009)	(0.002)
Service Transaction Type (Other)	2.059***		
	(0.112)		
Service Transaction Type (Style)	0.682***		
	(0.125)		
Service Transaction Type (Stylist Haircut)	0.989***		
	(0.118)		
Service Transaction Type (Hair Care)	2.381***		
	(0.135)		
Service Transaction Type (Hair Dye)	2.278***		
	(0.140)		
Service Transaction Type (Simple Haircut)	0.898***		
	(0.127)		
Card Transaction Type (New Card)		−0.151***	−0.017***
		(0.013)	(0.004)
Observations	58,129	42,574	42,574
Adjusted R^2	0.560	0.245	0.525

Note: Robust standard errors presented in parentheses, *p<0.1; **p<0.05; ***p<0.01. All levels of shifts are identified since the model does not estimate a constant. The omitted category of Transaction Type for service transactions is “Massage,” while the omitted category of Transaction Type for card transactions is “Card Refill.”

Table B.3 Detailed Regression Results of Equations (1) to (3) (Table 2)

	Dependent Variable:		
	Service Productivity	Card Productivity	Bargaining FE
	(1)	(2)	(3)
NumDays	0.050***	0.057***	0.010***
	(0.004)	(0.004)	(0.001)
Avg. Number of Coworkers	−0.424***	0.035**	−0.131***
	(0.057)	(0.018)	(0.005)
Avg. Coworker Age	0.005***	0.001	−0.001***
	(0.002)	(0.001)	(0.0002)
Percent of Coworker Rank (Senior)	−0.052	−0.140***	−0.039***
	(0.054)	(0.029)	(0.008)
Percent of Coworker Rank (Junior)	−0.045	−0.237***	−0.006
	(0.057)	(0.030)	(0.008)
Percent of Coworker Title (Beautician)	0.026	0.183***	0.035***
	(0.034)	(0.016)	(0.005)
Percent of Coworker Title (Stylist)	−0.007***	−0.031***	0.014***
	(0.002)	(0.008)	(0.002)
Percent of Coworker Title (Technician)	0.232***	0.068***	0.082***
	(0.039)	(0.018)	(0.006)
Percent of Coworker Title (Massager)	0.187	0.101**	0.028**
	(0.203)	(0.049)	(0.013)
Card Revenue			0.572
			(0.573)
Card Revenue^2			−0.141
			(0.300)
Card Revenue^3			0.383
			(0.266)
Card Revenue^4			−0.245
			(0.228)
Cumulative Card Revenue			0.453
			(2.251)
Cumulative Card Revenue^2			−0.288
			(1.008)
Cumulative Card Revenue^3			−0.003
			(0.716)
Cumulative Card Revenue^4			−0.452
			(0.465)
Cumulative Card Transactions			2.065
			(1.865)
Cumulative Card Transactions^2			−1.171
			(1.058)
Cumulative Card Transactions^3			1.254**
			(0.517)
Cumulative Card Transactions^4			−0.438
			(0.325)
Observations	58,129	42,574	42,574
Adjusted R^2	0.560	0.245	0.525

Note: Robust standard errors presented in parentheses, $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$. The omitted category of Percent of Coworker Rank is "Intern," while the omitted category of Percent of Coworker Title is "Others." Transaction Types are omitted due to space limitation.

Therefore, we design a simulation method by varying the prosociality of male and female workers (i.e., $\alpha_{male}, \beta_{male}, \alpha_{female}, \beta_{female}$) and the bargaining power of male and female workers (i.e., the proposing probability of male workers).[1] In this simulation, we have five parameters:

1. Prosociality of male workers: $\alpha_{male} = \beta_{male} \sim Uniform(0, x_{male})$
2. Prosociality of female workers: $\alpha_{female} = \beta_{female} \sim Uniform(0, x_{female})$
3. Proposing probability of male workers: $p_{male} = 1 - p_{female}$
4. Outside options of male workers: $r_{male} \sim Uniform(0, \bar{r}_{male})$
5. Outside options of female workers: $r_{female} \sim Uniform(0, \bar{r}_{female})$

In the simulation, we assume that $\bar{r}_{male} = \bar{r}_{female} = 0$ (i.e., both female and male workers have outside options 0) and $x_{male} = 0$ (i.e., male workers are always not prosocial).[2] We vary x_{female} from 0 to 0.5. We also vary p_{male} from 0.5 (i.e., male and female workers have same bargaining power) to 0.9 (i.e., male workers have much higher bargaining power). For each set of parameters (i.e., $(x_{male}, x_{female}, p_{male}, \bar{r}_{male}, \bar{r}_{female})$, we randomly draw $1,000$ samples of $(\alpha_{male}, \alpha_{female}, p_{male}, r_{male}, r_{female})$ and report the average split of male workers in mixed-gender groups and the standard deviations of splits in all-male and all-female groups. Figure C.1 shows the simulation results.

Panel (a) in Figure C.1 shows the difference between male splits and female splits in the mixed-gender groups with respect to female workers' prosociality and male workers' bargaining power (i.e., the probability of proposing for male workers). The upper-left corner of the graph shows that if female and male workers are equally prosocial and they have the same proposing probability, female and male workers' split difference is precisely at zero. The vertical direction of the graph shows that the difference of average splits becomes increasingly larger when male workers have higher proposing probability (i.e., higher bargaining power). However, the horizontal direction of the graph shows that the difference of average splits does not change much if females become more prosocial. This suggests that in order for us to rationalize the data where male workers have higher bargaining outcomes than female workers, we need male workers to have higher bargaining power.

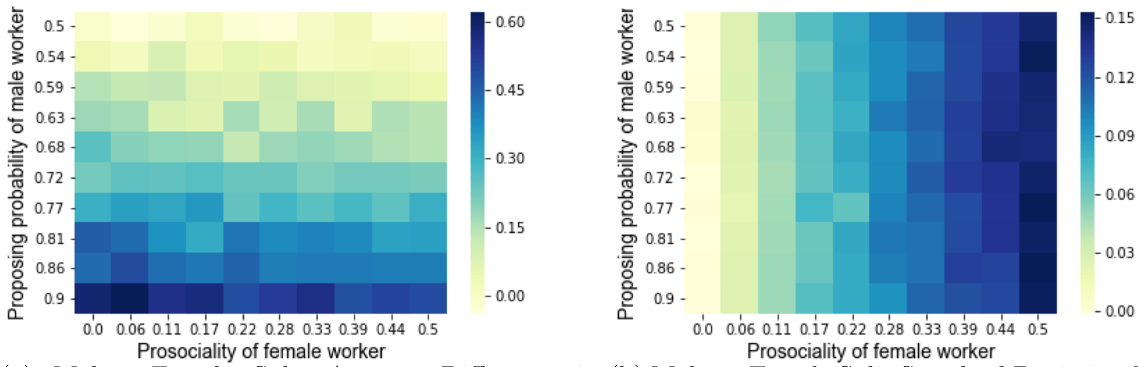
Panel (b) in Figure C.1 shows the difference between the standard deviations of male workers' and female workers' splits in the same-gender groups with respect to female workers' prosociality and male workers' bargaining power. Again, the upper-left corner in the heat map is zero, suggesting that when female and male workers have the same bargaining power and prosociality, they have the same standard deviation of splits in the same-gender groups. The vertical direction of the graph shows that the difference of standard deviations does not change with respect to one gender's bargaining power. However, the horizontal direction of the graph shows that this difference changes dramatically when one gender becomes more prosocial. This suggests that in order to match the data that female workers have much lower standard deviation of splits in same-gender groups, we need female workers to be more prosocial than male workers.

In summary, this simulation numerically shows that female workers need to have lower bargaining power and higher prosociality to rationalize the two aforementioned observations in Figure **??**.

[1] Bargaining power can also be represented by the outside options of female and male workers (r_{male} and r_{female}). Our simulation results hold if we use outside options to represent bargaining power instead of the proposing probability.

[2] Our simulation results hold qualitatively if we use different outside option levels or different prosociality levels for male workers.

Figure C.1 Simulation of Male and Female Bargaining Outcomes



(a) Male-to-Female Split Average Difference in Mixed-Gender Groups

(b) Male-to-Female Split Standard Deviation Difference in Same-Gender Groups

Note: This figure presents simulation results based on our ultimatum game bargaining model. Panel (a) presents the average bargaining split difference between male and female workers in mixed-gender groups, while Panel (b) shows the standard deviations of male and female splits in same-gender groups. The vertical axes represent the bargaining power of the male worker based on the probability of being the proposer. The horizontal axes represent the prosociality of female workers while holding male prosociality constant at zero. Each point represents $1,000$ simulations. Panel (a) shows that male bargaining advantage in mixed-gender teams cannot be achieved without superior male bargaining power. Panel (b) shows that higher standard deviation in same-gender teams cannot be achieved without higher prosociality of female workers.

D. Proof of Proposition 1

Let us first analyze the decision by the responder given an offer s. If $s \geq 0.5$, the utility of accepting s for the responder is $u_r(s) = s - \beta_r(2s-1)$. If $\beta_r < 0.5$, $u_r(s)$ is always greater than or equal to 0.5, which means that $u_r(s)$ is always greater than or equal to r_r. If $\beta_r \geq 0.5$, we need $s \leq \frac{r_r - \beta_r}{1-2\beta_r}$. Since $s \leq \frac{r_r - \beta_r}{1-2\beta_r}$ is bounded above by -0.5 for $\beta_r \in [0.5, 1]$ and $r_r \in [0.0, 0.5]$, there is always no trade when $\beta_r \geq 0.5$.

Similarly, if $s < 0.5$, the utility of the responder is $u_r(s) = s - \alpha_r(1-2s)$, which is greater than the outside option if $s - \alpha_r(1-2s) \geq r_r$, or $s \geq \frac{r_r + \alpha_r}{1+2\alpha_r}$. This means that the responder only accepts the offer if the offer is big enough.

Given the responder's reaction, we can compute the proposer's exact optimal strategy since this is a complete-information game. First, notice the fact that $\beta_s \leq 1$ requires the proposer to offer at most $s = 0.5$. This is because if $\beta_s \leq 1$, the proposer will always benefit by offering $s = 0.5$ instead of $s > 0.5$. Moreover, notice that if $s > 0.5$ will be accepted by one responder, then $s = 0.5$ will always be accepted by the same responder. Therefore, when the proposer is prosocial enough $\beta_s > 0.5$, he prefers offering $s = 0.5$.

If the proposer is not prosocial enough, he will offer $s < 0.5$ and his utility is $u_s = (2\beta_s - 1)s + (1-\beta)$. Since the proposer can only offer when his share from the game is greater than his outside option, he will only offer s if $(2\beta_s - 1)s + (1-\beta_s) \geq r_s$, which is $s \leq \frac{1-\beta_s - r_s}{1-2\beta_s}$. This means the offer has to be small enough for the proposer to benefit from the game. Therefore, combining this with the responder's action, the proposer will always offer the lowest possible offer, which is $\frac{r_r+\alpha_r}{1+2\alpha_r}$ if the offer is lower than the proposer's breakeven point

$\frac{1-\beta_s-r_s}{1-2\beta_s}$. In other words, if $\frac{1-\beta_s-r_s}{1-2\beta_s} \geq \frac{r_r+\alpha_r}{1+2\alpha_r}$, $s = \frac{r_r+\alpha_r}{1+2\alpha_r}$. Note that $\frac{1-\beta_s-r_s}{1-2\beta_s} \geq 0.5$ for $\beta_s < 0.5$ and $\frac{r_r+\alpha_r}{1+2\alpha_r} \leq 0.5$, therefore, the condition is always satisfied.

In summary, since $u_s = (2\beta_s - 1)s + (1-\beta)$ is decreasing in s if $\beta_s < 0.5$. This means the proposer will offer the smallest possible $s < 0.5$ when $\beta_s < 0.5$, which is $\frac{r_r+\alpha_r}{1+2\alpha_r}$. If $\beta_s \geq 0.5$, the proposer will offer $s = 0.5$, and this offer is only accepted by the responder if $\beta_r < 0.5$. ■

E. Proof of Lemma 1

First, we prove that agent i's payoff from the game is weakly increasing in p_i, i.e., his probability of being the proposer. This is intuitive since if an agent is a proposer, he will always get 0.5 ($\beta_s \geq 0.5$) or above ($\beta_s < 0.5$) when there is a trade. This is because $\frac{r_r+\alpha_r}{1+2\alpha_r}$ is bounded above by 0.5 for all feasible primitives. However, if an agent is a responder, when there is a trade he will at most get 0.5. Therefore, an agent's average payoff increases when he is proposer compared to being a responder. The weak increase happens when there is no trade regardless of whether the agent is a proposer or a responder.

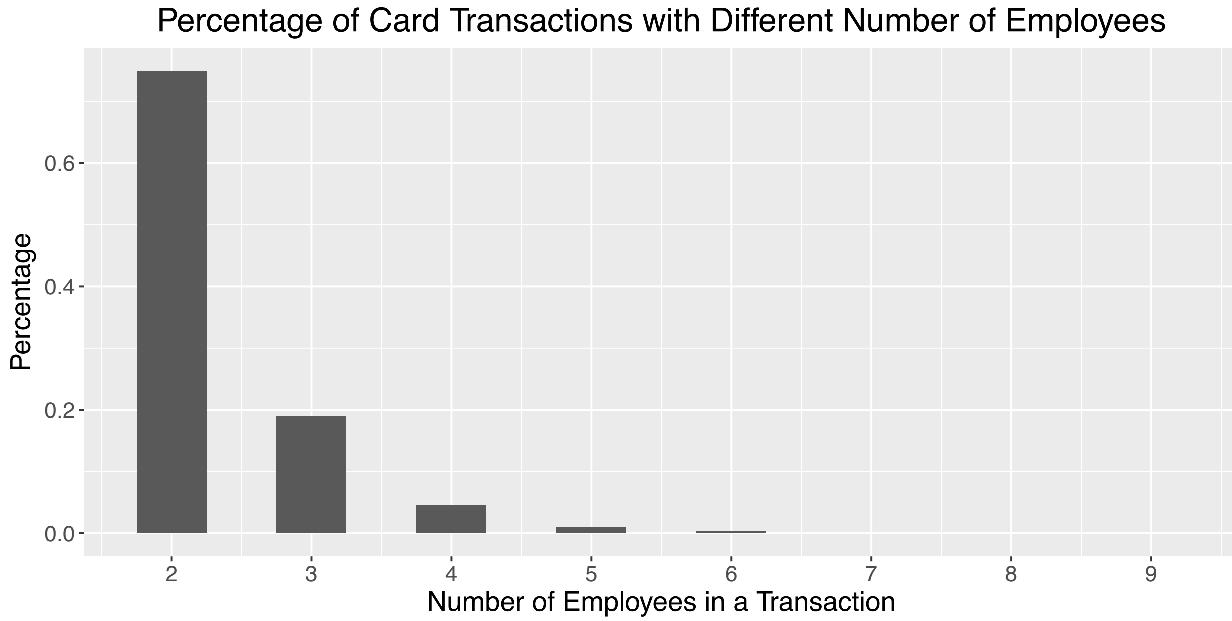
Second, let us prove that if an agent i has higher outside option r_i, he will receive a higher outcome when bargaining with a pool of agents. This is also intuitive. When the agent i is bargaining with other agents, regardless of whether he is a proposer or a responder, his split is bounded below by r_i. Therefore, when r_i increases, the lower bound of the bargaining outcome increases. Since r_i does not change the bargaining outcome except setting the lower bound, the agent will get a higher split when r_i increases.

Third, let us show that the average outcome is weakly increasing in α_i. Notice that when agent i is the proposer, his payoff does not depend on α_i. If the agent is a responder, his average payoff is increasing in α_i since he will be willing to only accept a higher offer when α_i increases.

Last, let us show that the average outcome is weakly decreasing in β_i. Notice that when one agent i is a proposer, he will get on average less of a payoff, if $\beta_i \geq 0.5$ versus $\beta_i < 0.5$. If the person is a responder, he will have some probability to get 0.5 if $\beta_i > 0.5$. And he will not get 0.5 if $\beta_i \geq 0.5$. Since 0.5 dominates all of agent i's payoffs regardless of the opponent when the agent is a responder, the agent's average payoff decreases when β_i increases. ■

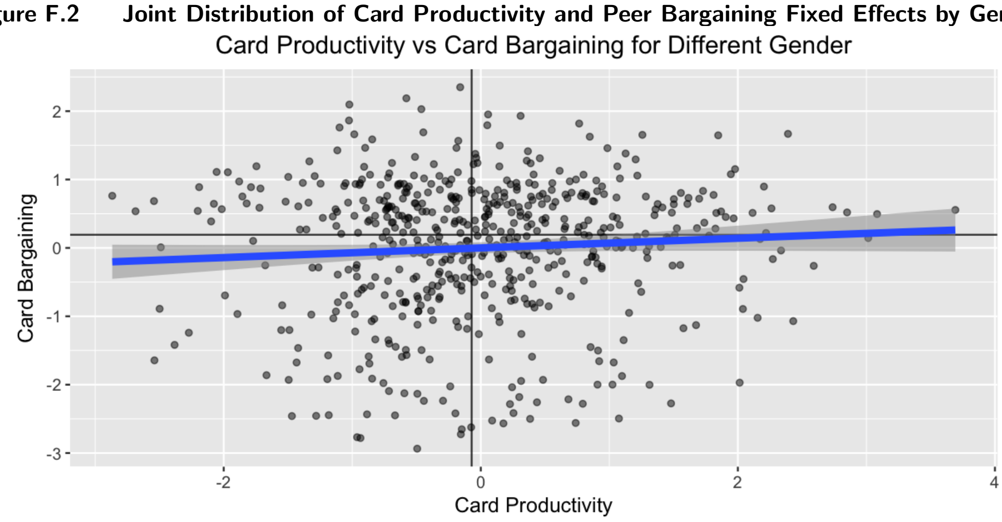
F. Auxiliary Graphs and Tables

Figure F.1 Distribution of Card Team Size



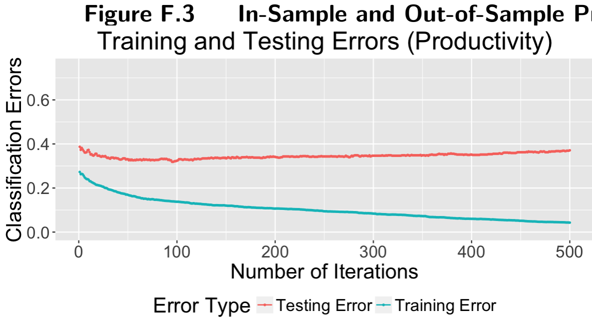
Note: This figure shows the distribution of card team size. As we note in the text, we use only those card teams with two workers.

Figure F.2 Joint Distribution of Card Productivity and Peer Bargaining Fixed Effects by Gender

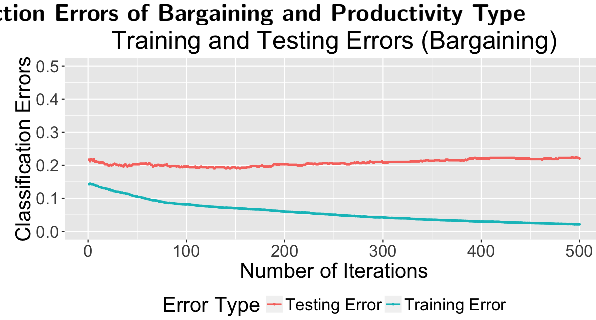


Note: This figure shows the unique bargaining and card productivity estimates for each of the 571 workers with at least 30 weeks of service and 30 card transactions. Vertical and horizontal lines represent medians. Included are linear fits and confidence intervals.

Figure F.3 In-Sample and Out-of-Sample Prediction Errors of Bargaining and Productivity Type



(a) Productivity Type Prediction



(b) Bargaining Type Prediction

Note: This figure presents the errors for extreme gradient boosted trees predicting above-median productivity and bargaining as well as worker classification type. Panels (a) and (b) show prediction errors for productivity and bargaining type versus 50 percent counterfactual respectively.