Firm Specific Investments Based on Trust and Hiring Competition: A Theoretical and Experimental Study of Firm Loyalty*

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Abstract

Two firms, each consisting of a team with the owner and just one employee, compete on the labor market with free labor mobility. After observing the investment decisions by firm owners their employees can engage in costly training, thus increasing their general and firm-specific productivity, which also depends on capital endowment. The trust problem is mutual since firm owners, when investing, do not know employees' willingness to engage in training, while employees must hope that future wage offers will reward training. The experimental results show that higher firm-specificity of human capital makes employees more willing to engage in training, while low specificity triggers over-investment by firm owners. Firm loyalty is found to be usually low.

Keywords: Hold-up problem, human capital, trust and reciprocity, team competition

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1 Introduction

Firms are usually seen as institutions enabling mutually beneficial cooperation via labor division,[1] with employers developing entrepreneural ideas and accepting the risk of capital investments, while employees provide subordinated labor in return for a more or less riskless salary. The world is, however, much richer than suggested by this stylized picture. Often employees provide innovative ideas, and the entrepreneurs are just the venture capitalists. Furthermore, although employees rarely invest in financial or physical capital, they typically invest in human capital by engaging in costly education and training, thus increasing both their general and their firm-specific productivity.

In a world of complete contracts, (firm) surplus maximizing levels of investment could be easily achieved. If actions are, however, non-contractable or non-verifiable,[2] trust problems arise. Principal-agent experiments suggest that trust and reciprocity may allow for successful cooperation even without complete contracts. While such experiments typically rely on a fixed partnership, our model allows partnerships to break up since the employee can be hired by another firm or reject the proposed wage. In our view, this may seriously question the reliability of trust and reciprocity. Our study thus also varies from usual team competition experiments (see Bornstein et al., 2002), which do not allow teams to break up and usually rely on symmetry of team members. The rather robust finding of more intra-team cooperation due to external competition may become less reliable when teams may split up.

As in the experiment, the theoretical model assumes two pre-established firms, each consisting of an employer and her employee. The market decision process starts with the employers choosing their capital investments. Knowing these decisions the employees then decide whether to engage in additional training or not. Whereas capital is completely immobile and thus firm specific, labor's firm specificity is captured by one parameter measuring the extent to which an employee is more productive when staying with her employer. After all investment decisions have been made, employers offer salaries both to the own and to the external employee. The employees finally select their employer, either their former one or the other firm, or remain unemployed.

Our more complex design allows to test whether previous studies have

[1] Coase (1988) confronts labor division within firms with that via trade. Berninghaus and Güth (2002) provide an evolutionary analysis of both institutions.

[2] Modern societies provide commitment power by legal institutions, allowing cooperation where trust in/and reciprocity would fail, or where there is no continuous dealing allowing for self-enforcing arrangements. However, human labor division has developed to such complexity that legal enforcement of all promises and obligations is hardly ever possible. Moreover, legal institutions frequently are not able to solve the mutual trust problem in one shot-interactions.

focused too much on rather special situations. Consider, for instance, an employee deciding whether to invest in further training and let us assume firm loyalty. Since the capital investment of her employer is already known and thus the capital costs are sunk, the training decision of the employee is similar to the well-known hold-up problem (see, for instance, Noldeke and Schmidt, 1995): The employee can increase her productivity but her employer may appropriate a share of the surplus increase due to the employee's training decision. Anticipating such expropriation might induce underinvestment, which in our case takes the form of no additional training. Usually, expropriation is simply assumed in the hold-up literature, whereas in our model the labor market determines endogenously how the gains from a surplus increase are distributed.

More importantly, our model shows that the usual assumption that a surplus increase can be attributed to one party's investment is too simple: The size of the surplus increase due to additional training depends crucially on earlier capital investment by the employer. This reveals that in given employment relationships (like our preestablished firms) the hold-up problem is mutual. Only when considering earlier (capital) investments as sunk (and, in our case, when additionally imposing firm loyalty), the special case of a simple, one sided hold-up problem results. In this regard, firm specificity of human capital is theoretically crucial since it increases the surplus gain from training, but also appropriability of this surplus gain by the employer.

This paper is organized as follows: Section 2 presents the model. The solution, based on commonly known opportunism, is derived in section 3 by backwards induction. After describing the experimental protocol (section 4), the main findings are discussed and statistically analyzed in section 5. The final remarks are in section 6.

2 The model

Two firms interact strategically by investing in technical equipment and hiring workers. Firms have already formed. Thus, there are two established partnerships, each consisting of a firm owner (A or X) and her respective employee (B or Y). The following sequential decision process assumes that all previous decisions are commonly known:

1. Each firm owner $i = A, X$ invests an amount k_i, with $k_i \geq \underline{k} > 0$, to enhance labor productivity.

2. After observing the investment decisions of both firms, each employee/agent $j = B, Y$ decides whether to engage in training, whose positive costs C_j must be paid by j. For $j = B, Y$, denote by

$$\delta_j = \begin{cases} 1 & , \quad \text{in case of additional training} \\ 0 & , \quad \text{otherwise.} \end{cases}$$

3. Both[3] firm owners $i = A, X$ simultaneously offer wages $w_i^j \geq 0$ to both agents $j = B, Y$.

4. Each agent $j = B, Y$ selects an employer (either her former boss or the other firm owner), or remains unemployed. We denote for j

$$\sigma_j^i = \begin{cases} 1 & , \quad \text{if } j \text{ chooses to work in firm } i \\ 0 & , \quad \text{otherwise.} \end{cases}$$

   Of course, $(\sigma_j^A + \sigma_j^X) \in \{0, 1\}$, where $\sigma_j^A + \sigma_j^X = 0$ means that j decides to be unemployed.

Technology is such that the potential contribution of each worker j to firm i's production capacity depends via separable factors on the level k_i of physical capital available at firm i, and on the worker j's human capital (which is increased when worker has engaged in training). Specifically, let the function $f_i(k_i)$ capture the productivity implications of capital investments, with $f_i'(\cdot) > 0$ and $f_i''(\cdot) < 0$ for $i = A, X$, and define similarly $h(\delta_j; c_{ij}) = (1 + c_{ij})(1 + \delta_j)$, where c_{ij} represents the firm-specific effect of j's human capital when she works for owner i (see Kessler and Lülfesmann, 2000).[4] For $i = A, X$ and $j = B, Y$, payoffs depend on decisions via

$$U_j = \sum_i \sigma_j^i w_i^j - \delta_j C_j, \tag{1}$$

and

$$\Pi_i = \sum_j \sigma_j^i \left[f_i(k_i)(1 + c_{ij})(1 + \delta_j) - w_i^j \right] - k_i. \tag{2}$$

In what follows, we shall assume that $c_{AB} = c_{XY} = c > 0$ whereas $c_{AY} = c_{XB} = 0$, i.e., firm-specific productivity is restricted to the existing partnerships AB and XY: Situations with $c_{ij} > 0$ correspond to partnership-specific productivity gains of labor, whereas $c_{ij} = 0$ means that agent j

[3] If a firm owner wants to hire just one employee, e.g., his own apprentice, this can be guaranteed by a sufficiently low wage offer for the other employee.

[4] Kessler and Lülfesmann (2000) discuss firm-specific and general productivity.

has no special skills to offer to owner i. For the sake of simplicity the cost of training is set equal for both agents, i.e., $C_B = C_Y = C$, with $C > f(\underline{k})$, and the production functions[5] are assumed to be symmetric, $f_A(k) = f_B(k) = f(k)$, with $f'(\underline{k}) > 1$. The latter condition guarantees an interior optimal investment in technical equiment[6], if at least one employee can be hired.

Whereas an owner i can vary k_i continuously[7] , the training choice is discrete in nature[8]. The timing of decisions is obvious regarding the two later stages of the game (3 and 4). That firms invest before employees also seems quite natural, since the decision to invest in firm-specific training usually requires that the capital structure of the firm is known.

3 Sequential rationality based on opportunism

Our model involves risky decisions of firm owners and of employees. In particular, firm owners have to choose k_i without knowing either whether the agent will engage in training, or how many agents can be hired (two, one or none?). Similarly, employees have to choose δ_j without knowing the later wage offers. We examine the implications of these uncertainties by applying backward induction based on opportunism (in the sense that all participants are risk-neutral[9] own-payoff maximizers).

A derivation of the subgame perfect equilibria in all technical detail can be found in Appendix 1. Here, we confine ourselves to a brief description of the theoretical analysis. What this implies for the numerical parameters used in the experiment will be said in section 4, which introduces our experimental design.

On stage 4 optimality requires that employees choose the employer offering them the highest wage, or (as a convention) their former employer in case of equal wages. On stage 3, therefore, employers have to offer opportunity-cost wages, which are equal to the productivity of the corresponding agent in the other firm (if her productivity in the own firm is higher) or her productivity in the own firm (if it is lower). This defines the solution wages and employment decisions depending on the investment and training decisions

[5]Throughout the paper, we will also assume that f is homogeneous of degree $\beta \in (0, 1)$.

[6]A simple function satisfying these requirements is $f_i(k) = \alpha_i k^{\beta_i}$, with $\alpha_i > 0$, $0 < \beta_i < 1$ and $\underline{k}_i < (\alpha_i\beta_i)^{\frac{1}{1-\beta_i}}$.

[7]In the experiment this, of course, means that k_i can vary more freely (due to the constraints for choosing numbers in a computerized experiment).

[8]See Spence (1973) for an illustrative, but less realistic exercise based on continuous education choices.

[9]Although in principal-agent theory one typically assumes risk averse employees/agents, this seems a better choice for a benchmark solution since in the experiment participants play the game repeatedly (with changing partners) and not just once. Moreover, there is no a prior reason to assume that owner participants are less risk averse than employee participants when roles are randomly assigned.

made on stages 1 and 2. In particular, equilibrium wage offers depend both on the ratio $f(k_A)/f(k_X)$ and on the vector (δ_B, δ_Y) (see section A.1 of the Appendix).

In stage 2 the agents have to anticipate how training influences the labor market outcome, while taking into account the capital choices that have already been made by the firms at stage 1. If the latter are rather similar for both firms[10], each employer keeps his own employee (i.e., the final teams are AB and XY); otherwise, both employees are hired by the firm that made the highest capital investment (in which case the final teams are either ABY and X, or A and XBY).

Finally, it is possible to show that, on stage 1, "similar-investments equilibria" require (due to the symmetry of the market) equal levels of capital investment, with high specificity of human capital allowing for coordination on both low and large capital investments. In contrast, low specificity of human capital excludes such multiplicity of (symmetric) coordination equilibria in capital investments. Nevertheless, neither low nor high specificity excludes asymmetric equilibria with one of the two employers hiring both employees.

The different (potential) equilibria are exemplified in the $f(k_A) \times f(k_X)$-diagrams of Figure 1, using specificity-parameter values $c = 0.5$ and $c = 1.5$, and fixed training cost, C. The points E_X and E_A correspond to asymmetric equilibria in which one dominant firm invests k^* while other stays out of the market (thus investing $\underline{k}$). On the other hand, $\underline{E}$ and $\overline{E}$ represent symmetric equilibria with, respectively, low and high investment levels. The shaded areas show the training choice of agents as induced by different capital investments. In particular, agent X (resp. B) invests in training only in the subregion $\{(f(k_A), f(k_X)) : f(k_A) \geq C \text{ and } f(k_X) \geq \frac{C}{1+c}\}$ (resp. $\{(f(k_A), f(k_X)) : f(k_X) \geq C \text{ and } f(k_A) \geq \frac{C}{1+c}\}$), since competitive wages will cover training costs only if capital investments endow the agents with high levels of productivity. Note that an interior solution for the symmetric equilibrium with training and high investment levels, $\overline{E}$, is compatible with the participation constraint of the agents only if it lies within the dark shaded area[11].

In the diagrams of Figure 1 it is also possible to identify the employment decision induced by capital investments (through competitive wage offers). The cone defined by $\{(f(k_A), f(k_X)) : \frac{f(k_A)}{f(k_X)} \in [\frac{1}{1+c}, 1 + c]\}$ corresponds to situations in which each employer keeps the own employee. In contrast, the area to the left (resp. right) of that cone corresponds to situations in which firm A (resp. X) hires both agents.

Finally, note that all potential equilibrium points must fulfill the partic-

[10] In Appendix 1, k_A and k_B are considered to be "similar" as long as $\frac{1}{1+c} \leq f(k_A)/f(k_X) \leq 1 + c$. Note that this interval shrinks to just one point as $c \to 0$.

[11] This is the case only in the right diagram of Figure 1.

ipation constraints of the firms, $\Pi_j \geq \underline{k}$, $j = A, X$, which do not appear on the diagrams of Figure 1.

4 Experimental design

Is equilibrium behavior as derived by backward induction a good predictor of actual investment decisions? To test this, six experimental sessions were conducted in Jena, each session involving 24 participants (students of Jena University). At the beginning of each session half of the participants were randomly assigned either to roles A and X (employers/principals) or B and Y (employees/agents). In each period, subsets of four players (two employers and their respective employees) were randomly formed within matching groups of eight participants each. They then played the game described above. This was repeated 14 times. Players kept their roles as owners or trainees during the 15 periods, although the particular labels A or X, resp. B or Y, were randomly allocated to participants of the same kind (employer or employee). Each matching group consisted of four employers and four employees, who were re-matched in each round.

In all experimental sessions we used the production function $f(k) = 10\sqrt{k}$, and the cost of training $C = 200$. In sessions $1, 2$, and 5 the specificity parameter was $c = 1.5$, yielding a symmetric equilibrium investment level at either $k' = 156.25$ or $k'' = 625$, with corresponding wage levels at $w(k') = 125$ or $w(k'') = 500$ (and each employer hiring the own agent). The asymmetric equilibrium in this case was given by one firm investing $k^* = 306.25$ and the other $\underline{k} = 9$, with equilibrium wages at 45 for the external agent and 30 for the own agent in the dominant firm. Symmetric equilibrium profits at low and high investment levels were, respectively, $\Pi(k') = 31.25$ and $\Pi(k'') = 125$, while the asymmetric equilibrium profit of a dominant firm were $\Pi(k^*) = 231.25$.

In sessions $3, 4$, and 6 the value of the specificity parameter was $c = 0.5$. Hence, there was no symmetric equilibrium fulfilling the participation constraint of the firms in this case, and the asymmetric-equilibrium prediction had one firm investing $\underline{k} = 9$ and the other firm choosing $k^* = 156.25$, with equilibrium wages of 45 and 30 paid by the dominant firm. In this low-specificity treatment, equilibrium profits were $\Pi(\underline{k}) = -9$ for the firm staying out of the market, and $\Pi(k^*) = 81.25$ for the firm hiring both trainees.

Since players may incur losses, all participants received an initial endowment of 3,200 tokens. The exchange rate was "100 token = 0,20 Euro" for all participants, except for the firms in the $c = 0,5$ treatment, with "100 token = 0,40 Euro" (since under the $c = 0.5$ treatment one firm should stay out of the market each period).

At each stage of the game, players were informed about all previous decisions, also of their counterparts. So, for example, before making the decision whether to engage in training or not, both trainees were informed about the investment levels of the own and the other firm, and about the productivity with and without training. Similarly, before offering wages, both employers were informed about productivity levels of both agents at their own and at the other firm.

When interpreting the data it may also help to be aware of the efficiency benchmark in the sense of symmetric investments and training decisions due to the symmetry of the two firms. For efficiency with training one has $2f'(k_i^+)(1+c) = 1$, and $f'(k_i^-)(1+c) = 1$ for efficiency without training. This yields $\sqrt{k_i^+} = 10(1+c)$ and $\sqrt{k_i^-} = 5(1+c)$. The condition $20\sqrt{k_i^+}(1+c) - 10\sqrt{k_i^-}(1+c) = 150(1+c)^2 > C = 200$ holds both for $c = 0.5$ and for $c = 1.5$. Thus, the symmetric efficiency benchmark is $k_i^+ = 100(1+c)^2$ for $i = A, X$ and $\delta_j = 1$ for $j = B, Y$. How this compares with the game theoretic benchmark solution, given the experimental parameters, can be easily seen with the help of Table 1, which lists all essential benchmark results.

4.1 Experimental Results

Following the logic of backward induction used to derive the game-theoretic solution of our model, we begin the data analysis by considering the choices at the labor market (stages 3 and 4 of the game). Then we proceed with the analysis of training decision data, and conclude with the investment choices k_A and k_X on the first stage of the game.

4.1.1 Decisions at the labor-market stage

Let us first analyze the employment decision data, both under $c = 1.5$ and $c = 0.5$, which are summarized in Table 2. It is clear that, with the exception of very few cases, employment is always preferred to unemployment. Moreover, "loyalty" to one's former employer does not seem to play a role when deciding which wage offer to accept: under both treatments this decision is usually in favor of the highest wage offer. Indeed, if we disregard the cases in which the agent decided not to accept any job offer (what happens in about 2% of the cases), the Chi-square test for count data allows us to reject the hypothesis of independence between columns and rows for both $c = 1.5$ ($\chi_1^2 = 437.0328$, p-value=0) and $c = 0.5$ ($\chi_1^2 = 416.9358$, p-value=0).

Let us now analyze the choice of wage offers by the firms. According to the theoretical solution, if the productivity of the own agent is higher in the own firm than in the other firm, then the wage offered to the own agent should be equal to her productivity *in the other firm*. Similarly, if the productivity of the external agent is higher in the other firm, the solution wage to the external agent should be her productivity *in the own firm*.

Keeping investment levels k equal for all firms, each agent is by a factor $1 + c$ more productive in her original firm. Thus we should expect the within-matching-group average productivity to be greatest at own firm. As a result, "productivity in the other firm" should be a good predictor of wage offers to own agents, while "productivity at the own firm" should be a good predictor of wage offers to external agents.

Averaging across repetitions and across members of the same matching group, the left panel of Figure 2 plots wage offers to the *own* agents against these agents' average productivity level in the other firms. Similarly, the right panel plots the average wage offers for the *external* agents against their average productivity in the *own* firms. Table 3 provides the OLS estimates of the linear regressions between average wages and average productivities at the two values of the specificity parameter c.

The estimated slope for the data under $c = 1.5$ is very close to 1, both for own and for external agents, meaning that, on average, increasing the value of an agent's outside option increases the wage offer by a similar amount. However, the intercept in case of the external agent is significantly lower than zero, implying that average wage offers to external agents are systematically below the value of their outside option (by approximately 111 tokens). One possible interpretation of this systematic deviation from competitive wage offers to external agents is a tacit agreement among owners not to "steal" the other's agent.

The estimated slope (see Table 3) in case of low specificity $c = 0.5$ are, in contrast, significantly lower than one, meaning that an increase of one unit in the value of the outside option of the agent goes along with a proportionally lower increase in the wage offers. This may be due to the fact that a higher level of productivity under $c = 0.5$ usually results from over-investment in the first stage of the game[12]. Therefore firms may be trying to minimize the negative effects of sunk costs by offering wages below the competitive level.

4.1.2 Training decisions

We now analyze the training decisions of the employees by comparing them to the solution behavior according to which an agent will only engage in training if the resulting wage increase covers the costs of training. This is the case if the increase in the minimum productivity of the agent (in both firms) after training, which we denote by $\min(p)$, is at least $C = 200$. Table 4 shows the two-way classification matrices of individual training decisions, according to the decision itself ($\delta = 0$ or $\delta = 1$) and whether the value of $\min(p)$ was below the threshold $C = 200$ or not. The hold-up hypothesis would predict both matrices to be diagonal, with (almost) no decisions

[12]Recall that, in equilibrium, a firm should either stay out of the market, setting $k = 9$, or invest only $k^* = 156$ tokens. Levels of investment far above this value induce high losses.

in both off-diagonal cells. There are, however, quite a few observations in the off-diagonal cells. In particular, too many employees do not engage in training when its productivity effect would predict otherwise. Nevertheless it is still possible to reject the H_0-hypothesis of independence between rows and columns in both matrices using Pearson's chi-square test for count data. In particular, under $c = 1.5$ we obtain $\chi_1^2 = 5.3879$, rejecting H_0 at p-value= 0.0203, whereas for $c = 0.5$ the test statistic is $\chi_1^2 = 14.3557$, rejecting independence at p-value= 0.0002. This suggests that the decision to engage in training is qualitatively in line with "rational wage expectations", in the sense of competitive wage offers by employers. Moreover, the hold-up problem of employees seems to be more serious in case of low specificity ($c = 0.5$), or, turned around, higher specificity ($c = 1.5$) somehow mitigates the hold-up problem as far as employees are concerned.

4.1.3 Capital investment

To illustrate the overall results on the first stage of the game Figure 3 compares the evolution of the average investments of firms with high specificity, $c = 1.5$, with that for the low specificity, $c = 0.5$. There is an upward trend in the average investment levels for $c = 1.5$, while for $c = 0.5$ the trend is downwards. Nevertheless, as figure 4 demonstrates, on the level of matching groups the dynamics vary a lot.

Figure 5, showing how the frequency distribution of investment decisions changes over time, suggests that for $c = 1.5$ this distribution evolves quite differently from that one in case of $c = 0.5$. Indeed, as can be seen in Figure 6, the distribution of investment choices under high specificity dominates the one under low-specificity.[13] Although this is qualitatively in line with the theoretical prediction, it will be necessary to examine the distribution of k in more detail.[14]

Since our model predicts specific equilibrium investment levels ($k \in \{ 9, 156 \}$ for $c = 0.5$, and $k \in \{9, 156, 306, 625 \}$ for $c = 1.5$), we want to test whether there are significant "bumps" around these values in the population distribution. More specifically, we test statistically whether the experimental data clusters near the two equilibrium predictions. For this purpose, we first use kernel estimation techniques as an exploratory statistical approach (Silverman, 1980). In particular, Figure 7 plots the estimated pdfs of all individual investment decisions k_A and k_B for periods 6 to 15 using a Gaussian kernel with bandwidth $h = 150$. This provides a better approximation than a histogram and reveals important qualitative

[13]The two-sample Kolmogorov-Smirnov test ($ks = 0.2074$, p-value $= 0.0$) rejects the null hypothesis of equal cdf's for both treatments.

[14]Wolf and Sumner (2001) note that "histograms do not provide an objective method to formally test the number of modes in a distribution because the resulting density shape depends critically on window origin and window-width assumptions."

features. In the first place, neglecting the obvious modes that result from censored data at the extremes of the distribution, the fact that the second bump in both pdf occurs between 9 and 200 supports the benchmark solution predicting $k' = 156$ for $c = 1.5$ and $k^* = 156$ for $c = 0.5$. Similarly, the fact that the estimated pdf curve for $c = 1.5$ exhibits a bump around 600 supports the game theoretic prediction $k'' = 625$.

We want to test whether there is, for instance, a couple of bumps near k=156 or k=625 when $c = 1.5$, resp. near of $k = 9$ or $k = 156$ when $c = 0.5$.[15] Paraphrasing Good and Gaskins (1980), our problem is to sort out the components of a mixture of two unimodal distributions. Therefore, an appropriate model should assume that the density $g(k)$ generating the data is the sum of m weighted densities.[16] In particular, we use a censored-normal mixture specification, where each density $g_i(k) = \phi(k; \mu_i, \sigma_i^2)$ is normal censored[17] at values below $\underline{k} = 9$ and above $\underline{k} = 800$. The results obtained from estimation via the Expectations-Maximization (EM) method[18] are presented in Table 5. Both under $c = 0.5$ and $c = 1.5$ the data support the hypothesis of a bimorphic distribution ($m = 2$), with similar weight values for each of the two respective components. However, while the estimated vector of location parameters for $c = 1.5$, $\hat{\mu}_{1.5} = (107.06, 628.30)$, is more or less in line with the bench-mark prediction, the values obtained under $c = 0.5$, $\hat{\mu}_{0.5} = (90.37, 423.16)$, exhibit a significant level of over-investment compared to the equilibrium levels, although the estimated effect of a change in c is in the "right" direction.

5 Conclusions

Our experimental findings can be summarized as follows:

- higher firm specificity encourages capital investments, as revealed by the investment clusters at the predicted levels,

[15] Before estimating the location and size of "bumps" in the distribution, a few words of caution are in order. First, although confirming a mode near an equilibrium value supports the theoretical solution, the absence of bumps does not necessarily question it, since even if players are selecting among two "noisy equilibria", the population distribution of choices may still be unimodal. On the other hand, the true distribution may exhibit more than two modes, even with only two noisy equilibrium choices: If the choice process is noisy, the very fact that decisions are censored at $\underline{k} = 9$ and $\overline{k} = 800$ will generate spurious modes at the extremes.

[16] In other words,

$$g(k) = \sum_{i=1}^{m} w_i g_i(k),$$

where w_i is the weight of the i-th term, with $w_1 + \cdots + w_m = 1$ and $w_i > 0$ (see, e.g., McLachlan and Peel, 2000).

[17] Greene (1997, p.959).

[18] Martínez and Martínez (2002, pp. 196s)

- higher capital investments are often not rewarded by investments in human capital, regardless whether firm specificity of human capital is high or low,
- wage offers are below their predicted level, and (do not) increase by the same amount as minimum productivity when firm specificity of human capital is high (low), and
- quite surprisingly, firm loyalty is low although it is efficiency enhancing due to the firm specificity of labor.

Such results partly question previous findings for simpler situations. So, for instance, the trust in/and reciprocity-hypothesis, confirmed in principal-agent experiments is rejected when employees do not reward previous capital investments although such rewarding is in their own interest (when expecting competitive wage offers). Furthermore, the team competition-effect (e.g., Bornstein et al., 2002) nearly vanishes when members anticipate that teams may break up. Corporate identity seems fragile when the employment relation is rather a one-night stand than a long race.

Labor division in firms typically relies on continuous dealings. But even in such long-term partnerships major investments are the exception rather than a regularity on both sides, i.e., of the firm owner and the employee. Serious efforts to increase the employee's own skills are typically made when starting to work. Similarly, a major capital investment is the decisive step when founding or enlarging a firm. Rewards for such major investments cannot be guaranteed by continuous dealings simply because, by their very definition, they are single events.

There are not only strategic conflicts within firms, as captured by principal-agent models, but also between firms. For the sake of simplicity, especially not to overburden experimental participants, interaction between firms has been restricted to the labor market.[19] Although one starts out with given partnerships or teams, these may split up. Firm loyalty is inspired by firm-specificity of human capital and by feelings of corporate identity. Contrary to team competition experiments (see Bornstein et al. 2002) our data reveal little or no firm loyalty.[20] When employees stay with her employer this is nearly always due to her employer's larger wage offer. There is nearly no evidence of firm loyalty in the sense of staying with the former employer although his wage offer is worse than the one of the competitor.

[19]Typically, a firm faces different competitors when hiring and selling.

[20]Of course, our game model and experimental scenario could be seen as a worst case for firm loyalty since partnerships can extend only over the few stages of the decision process but not over rounds.

A Solution by backwards induction

A.1 The labor market

At the labor market (stages 3 and 4 of the game), both firms have already chosen their respective investment, k_A and k_X, and agents their training decisions, δ_B and δ_Y. Thus, at this point, the potential productivity p_j^i of agent j at firm i is completely determined by equation (2). For instance, for $j = B$, we have

$$p_B^A = \begin{cases} 2f(k_A)(1+c) & \text{if } \delta_B = 1 \\ f(k_A)(1+c) & \text{if } \delta_B = 0, \end{cases}$$

and

$$p_B^X = \begin{cases} 2f(k_X) & \text{if } \delta_B = 1 \\ f(k_X) & \text{if } \delta_B = 0, \end{cases}$$

p_Y^A and p_Y^X determined analogously. Note that an agent's productivity in a particular firm does not depend on whether or not this firm hires the other agent.

In case of equal wage offers, we assume that an agent chooses the firm where her productivity is higher; if both wage offers and productivity levels are the same, we assume that the original employment relationships ((A, B) or (X, Y)) is continued. At stage 4 each agent selects the firm offering the higher wage. Since productivities are commonly known, competition at stage 3 implies that a worker receives as wage her lower productivity level and that a worker is hired by the firm for whom her productivity is larger.

A.1.1 Subgame Type (1,1): Two trained agents

To see how equilibrium wages arise, consider first the wage decision of firm A in some subgame after both workers acquired additional training, i.e., $(\delta_B, \delta_Y) = (1, 1)$. Suppose that firm X is offering wages $\hat{w}_X^B$ and $\hat{w}_X^Y$. For firm A, all wage offers $w_A^B < \hat{w}_X^B$ yield the same payoffs (similarly, all wage offers $w_A^Y \leq \hat{w}_X^Y$), since firm A will not be able to employ the agent. $w_A^B = \hat{w}_X^B$ is strictly better than all wage offers $w_A^B > \hat{w}_X^B$, while setting $w_A^Y = \hat{w}_X^Y + \varepsilon$ is strictly better than $w_A^Y > \hat{w}_X^Y + \varepsilon$, where $\varepsilon > 0$ be the smallest currency unit available[21]. There are four profit levels which firm A can possibly obtain by its wage offers depend on who can be hired:

I.1: If $w_A^B < \hat{w}_X^B$ and $w_A^Y \leq \hat{w}_X^Y$, then $\Pi_A = -k_A$.

I.2: If $w_A^B = \hat{w}_X^B$ and $w_A^Y \leq \hat{w}_X^Y$, then $\Pi_A = 2f(k_A)(1+c) - (k_A + \hat{w}_X^B)$.

I.3: If $w_A^B < \hat{w}_X^B$ and $w_A^Y = \hat{w}_X^Y + \varepsilon$, then $\Pi_A = 2f(k_A) - (k_A + \hat{w}_X^Y + \varepsilon)$.

[21] An alternative interpretation of ε is that of costs for employees when changing their employer.

I.4: If $w_A^B = \hat{w}_X^B$ and $w_A^Y = \hat{w}_X^Y + \varepsilon$, then $\Pi_A = 2f(k_A)(2+c) - (k_A + \hat{w}_X^B + \hat{w}_X^Y + \varepsilon)$.

Comparing case I.2 to I.1, and case I.4 to I.3, it is clear that if

$$2f(k_A)(1+c) - \hat{w}_X^B > 0, \tag{3}$$

then hiring agent B by setting $w_A^B = \hat{w}_X^B$ is strictly better than $w_A^B < \hat{w}_X^B$, irrespective of the wage level offered to agent Y. Similarly, comparing case I.3 to case I.1, and case I.4 to case I.2, one can see that if

$$2f(k_A) - \hat{w}_X^Y > \varepsilon, \tag{4}$$

then hiring agent Y by offering $w_A^Y = \hat{w}_X^Y + \varepsilon$ is better, regardless whether agent B is hired.

If principal $i = A, X$ is not able to hire any worker, then the sunk cost k_i is completely lost. Therefore, given that the most productive employee is the original one, each firm may have an incentive to hire at least the own agent, provided that the capital investment of the competing firm is not substantially higher than the own investment. This can be achieved by offering to the own agent a wage equal to her potential productivity in the competitor's firm. For instance, if principal X offers to agent Y a wage $\hat{w}_X^Y = 2f(k_A)$, then principal A will prefer not to hire agent Y, and will choose some $w_A^Y \leq \hat{w}_X^Y$ instead. However, this last inequality must be binding in equilibrium, since if principal A chooses a strictly lower wage $w_A^Y = \tilde{w}_A^Y < \hat{w}_X^Y$, then principal X has an incentive to deviate and offer $w_X^Y = \tilde{w}_A^Y$ instead. Thus, in equilibrium $w_A^Y = \hat{w}_X^Y$.

Defining the interval $[\frac{1}{1+c}, 1+c]$ as the *similarity range*[22] for capital investments, we obtain one of the following three equilibrium wage offers at the labor market, depending on how close the levels of investment k_A and k_B are:

1. If $1 + c \geq \frac{f(k_A)}{f(k_X)} \geq \frac{1}{1+c}$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (2f(k_X), 2f(k_A)),\\ (w_X^B, w_X^Y) &= (2f(k_X), 2f(k_A)),\end{aligned}$$

   with each agent being hired by her own firm.

2. If $\frac{1}{1+c} > \frac{f(k_A)}{f(k_X)}$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (2f(k_A)(1+c), 2f(k_A)),\\ (w_X^B, w_X^Y) &= (2f(k_A)(1+c) + \varepsilon, 2f(k_A)),\end{aligned}$$

[22] It is interesting to note that the similarity range shrinks for $c \to 0$ and becomes even degenerate for $c = 0$, whereeas for $c \to \infty$ it becomes universal

with both agents hired by firm X.

3. If $\frac{f(k_A)}{f(k_X)} > 1 + c$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (2f(k_X), 2f(k_X)(1+c)+\varepsilon),\\ (w_X^B, w_X^Y) &= (2f(k_X), 2f(k_X)(1+c)),\end{aligned}$$

with both agents hired by firm A.

Thus that if the investment levels of both firms are not too different from each other, each agent will stay at her "home" firm, but will receive a wage that depends on the investment of the "foreign" firm. On the other hand, if one firm invests much more than the other does, then it will be able to hire both agents. Interestingly, wage levels will be determined by the level of investment of the crowded-out firm. In the dominating firm the own worker is more productive but obtains a wage *lower* than the worker who has changed employer. According to the game-theoretic solution of the labor-market subgame, firm loyalty does not play any role at all.

A.1.2 Subgame Type (0,0): Two non-trained agents

Let us now consider the wage offers of firm A in the subgames at which both workers decided not to engage in additional training, i.e., with $(\delta_B, \delta_Y) = (0,0)$. Again, we proceed by deriving A's best-response to firm X's wage offers, $\hat{w}_X^B$ and $\hat{w}_X^Y$. Using the same sort of argument as before, we consider the following four profit levels that firm A can obtain depending its own and its competitor's wage offers:

II.1: If $w_A^B < \hat{w}_X^B$ and $w_A^Y \leq \hat{w}_X^Y$, then $\Pi_A = -k_A$.

II.2: If $w_A^B = \hat{w}_X^B$ and $w_A^Y \leq \hat{w}_X^Y$, then $\Pi_A = f(k_A)(1+c) - (k_A + \hat{w}_X^B)$.

II.3: If $w_A^B < \hat{w}_X^B$ and $w_A^Y = \hat{w}_X^Y + \varepsilon$, then $\Pi_A = f(k_A) - (k_A + \hat{w}_X^Y + \varepsilon)$.

II.4: If $w_A^B = \hat{w}_X^B$ and $w_A^Y = \hat{w}_X^Y + \varepsilon$, then $\Pi_A = f(k_A)(2+c) - (k_A + \hat{w}_X^B + \hat{w}_X^Y + \varepsilon)$.

Comparing case II.2 to II.1, and case II.4 to II.3, $w_A^B = \hat{w}_X^B$ is optimal if

$$f(k_A)(1+c) - \hat{w}_X^B > 0. \tag{5}$$

In a similar fashion, it is straightforward to obtain

$$f(k_A) - \hat{w}_X^Y > \varepsilon, \tag{6}$$

as a sufficient condition for $w_A^Y = \hat{w}_X^Y + \varepsilon$ to be optimal. Thus, competition on the labor market leads to equilibrium wage offers that look very similar to the ones of Subgame Type (1,1), i.e., they are dependent on how much has each firm invested relative to each other:

1. If $1+c \geq \frac{f(k_A)}{f(k_X)} \geq \frac{1}{1+c}$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (f(k_X), f(k_A)),\\ (w_X^B, w_X^Y) &= (f(k_X), f(k_A)).\end{aligned}$$

2. If $\frac{1}{1+c} > \frac{f(k_A)}{f(k_X)}$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (f(k_A)(1+c), f(k_A)),\\ (w_X^B, w_X^Y) &= (f(k_A)(1+c)+\varepsilon, f(k_A)).\end{aligned}$$

3. If $\frac{f(k_A)}{f(k_X)} > 1+c$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (f(k_X), f(k_X)(1+c)+\varepsilon),\\ (w_X^B, w_X^Y) &= (f(k_X), f(k_X)(1+c)).\end{aligned}$$

In equilibrium, again, if only one firm hires both agents (i.e., if one firm has invested much more than the other), the new and thereby less productive worker obtains the higher salary.

A.1.3 Subgame Type (0,1) or (1,0): Only one trained agent

In case that only one worker has obtained training, assume that agent B has engaged in training, while agent Y has not, i.e., $(\delta_B, \delta_Y) = (1, 0)$. The same reasoning as above leads to the following wage offers in equilibrium:

1. If $1+c \geq \frac{f(k_A)}{f(k_X)} \geq \frac{1}{1+c}$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (2f(k_X), f(k_A)),\\ (w_X^B, w_X^Y) &= (2f(k_X), f(k_A)).\end{aligned}$$

2. If $\frac{1}{1+c} > \frac{f(k_A)}{f(k_X)}$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (2f(k_A)(1+c), f(k_A)),\\ (w_X^B, w_X^Y) &= (2f(k_A)(1+c)+\varepsilon, f(k_A)).\end{aligned}$$

3. If $\frac{f(k_A)}{f(k_X)} > 1+c$, then

$$\begin{aligned}(w_A^B, w_A^Y) &= (2f(k_X), f(k_X)(1+c)+\varepsilon),\\ (w_X^B, w_X^Y) &= (2f(k_X), f(k_X)(1+c)).\end{aligned}$$

As before, a newly hired agent can improve her wage due to her firm-specific productivity for her former employer. In contrast, the worker who stays with her initial employer does not get any compensation for her actually realized firm-specific productivity advantage. Nevertheless, in all cases the worker who engaged in training will obtain a higher reward as long as $c < 1 - \varepsilon$, regardless of whether she has changed her employer or not.

A.2 Agents' training decisions

Having solved the different subgames of the labor market stages 3 and 4, we now proceed with stage 2 and examine the agents' decisions to engage in training or not. These decisions are made simultaneously, but after observing the firms' levels of investment, k_A and k_X.

1. If $1+c \geq \frac{f(k_A)}{f(k_X)} \geq \frac{1}{1+c}$, then the payoff that worker B can expect, with and without additional education, is given by

$$u_B = \begin{cases} f(k_X) & \text{if } \delta_B = 0, \\ 2f(k_X) - C & \text{if } \delta_B = 1. \end{cases}$$

   Thus agent B will prefer training if and only if the level of investment of the competing firm is high enough, i.e.,

$$\delta_B = 1 \;\Leftrightarrow\; f(k_X) > C. \tag{7}$$

2. Alternatively, if $\frac{1}{1+c} > \frac{f(k_A)}{f(k_X)}$ (i.e., if the "home" firm has a very small capital level compared to the competitor's investment), worker B will switch to firm X, and her payoff with and without additional education, will be given by

$$u_B = \begin{cases} f(k_A)(1+c) + \varepsilon & \text{if } \delta_B = 0, \\ 2f(k_A)(1+c) + \varepsilon - C & \text{if } \delta_B = 1. \end{cases}$$

   Therefore, in this case agent B will invest in training if and only if the investment of the "home" firm is not too low, i.e.,

$$\delta_B = 1 \;\Leftrightarrow\; f(k_A) > \frac{C}{1+c}. \tag{8}$$

3. Finally, if $\frac{f(k_A)}{f(k_X)} > 1 + c$ (i.e., if the "home" firm has invested much more than the "foreign" firm), worker B will obtain the payoff

$$u_B = \begin{cases} f(k_X) & \text{if } \delta_B = 0, \\ 2f(k_X) - C & \text{if } \delta_B = 1. \end{cases}$$

   Therefore, as was the case when both firms invest similar amounts, agent B will engage in training if and only if the level of investment of the competing firm is high enough, i.e., if (7) holds.

A.3 Owners' investment decisions

We are now ready to derive the optimal investment decisions of the owners A and X, when anticipating the future rational behavior. Optimal behavior at this stage crucially depends on whether or not the specificity of human capital, i.e., the parameter c, is "high enough".[23]

A.3.1 High specificity of human capital

Consider first a hypothetical situation in which owner A believes that, for any investment k_A that she might choose, her competitor will always set some k_X such that $f(k_X) > f(k_A)(1+c)$. In other words, owner A believes that her competitor's level of investment will make it impossible for her to hire any agent. In this case, any level of investment above $\underline{k}$ would be non-optimal for owner A, who thus prefers $k_A = \underline{k}$.

Now, for the sake of the argument, suppose that owner X is aware of A's beliefs. Then, owner X will rationally predict that she will be able to hire both agents at very low cost. In particular, owner X will offer wages

$$w_X^B = \begin{cases} f(\underline{k})(1+c)+\varepsilon & \text{if } \delta_B = 0, \\ 2f(\underline{k})(1+c)+\varepsilon & \text{if } \delta_B = 1, \end{cases}$$

and

$$w_X^Y = \begin{cases} f(\underline{k}) & \text{if } \delta_Y = 0, \\ 2f(\underline{k}) & \text{if } \delta_Y = 1, \end{cases}$$

regardless of her own investment k_X.

If, however, owner A invests only $\underline{k}$, the equilibrium wage levels at the labor market do not justify the costs of training, since by assumption conditions (7) and (8) are not fulfilled.[24] As a consequence, owner X's profit will be only

$$\Pi_X = f(k_X)(2+c) - (k_X + f(\underline{k})(2+c)+\varepsilon),$$

inducing firm X to optimally choose $k_X = k^*$ with $f'(k^*) = \frac{1}{2+c}$. In case of $c = 1.5$ it is further a best response for employer A to choose $k_A = \underline{k}$ when expecting firm X to invest $k_X = k^*$. This gives rise to an asymmetric Nash equilibrium with one firm staying out of the market (in the sense of $k = \underline{k}$) and the other firm hiring both agents.

Now consider the case in which owner A sets k_A such that $f(k_A) \in \left[\frac{1}{1+c} f(k^*), (1+c)f(k^*)\right]$, so that she might be able to hire agent B. In this

[23] What we mean with "high enough" has to do with a threshold level that determines whether the owners' participation constraint $\Pi \geq -\underline{k}$ is satisfied.

[24] Owner X cannot credibly promise a high wage to the workers conditional on training, due to incomplete contracting.

case, A's profits would be given by

$$\Pi_A = \begin{cases} f(k_A)(1+c) - (k_A + f(k^*)) & \text{if } \delta_B = 0, \\ 2f(k_A)(1+c) - (k_A + 2f(k^*)) & \text{if } \delta_B = 1. \end{cases}$$

This implies that A's optimal decision at stage 1 of the game is either $k_A = k'$ or $k_A = k''$ depending on whether she expects B to engage in training or not, with these levels of investment being such that $f'(k'') = \frac{1}{2(1+c)}$ and $f'(k') = \frac{1}{(1+c)}$.[25]

Assumption *Training costs are such that $f(k') < C < f(k'')$.*

Since $k' < k^* < k''$, under this Assumption principal X will also like to deviate to either $k_X = k'$ or $k_X = k''$, and the game becomes a coordination game. In particular, if owner X decides to invest $k_X = k''$, then agent B will engage in training and owner A will invest $k_A = k''$. This, in turn, will induce agent Y to engage in training too, so that owner X's initial decision turns out to be optimal, yielding a symmetric equilibrium with high investment. Nevertheless, $k_A = k_X = k'$ is also an equilibrium: if owner X invests only $k_X = k'$, then agent B would anticipate a lower salary, which would deter her from education. Therefore, it would then be optimal for firm A to restrict its own investment level to $k_A = k'$, so that Y will also anticipate a low salary and will not obtain training. This, in turn, confirms X's choice $k_X = k'$ as optimal, which confirms the existence of a symmetric equilibrium with low investments.

If, contrary to the Assumption, the costs of training do not lie within the interval $[f(k'), f(k'')]$, there is a unique, symmetric equilibrium investment. In case of $C < f(k')$ both agents will engage in training; hence, both firms have an incentive to choose $k = k''$. In contrast, if $f(k'') < C$, equilibrium wages will not cover training costs, and this will be anticipated by both firms, inducing them to invest only $k = k'$.

A.3.2 Low specificity of human capital

The symmetric equilibria $(k_A, k_X) = (k', k')$ and $(k_A, k_X) = (k'', k'')$ were derived under the implicit assumption that the owners' participation constraint $\Pi \geq -\underline{k}$ is fulfilled. Since $f(k)$ is assumed to be homogeneous of degree $\beta \in (0,1)$, this will be the case if both conditions

$$c \geq \frac{k''}{2f(k'')} - \frac{\underline{k}}{2^{\frac{\beta}{\beta-1}} f(k'')} \quad \text{and} \quad c \geq \frac{k''}{2f(k'')} - \frac{\underline{k}}{2f(k'')}$$

[25] We neglect for a while owner A's participation constraint that the profit from choosing k' or k'' has to be greater than the outside option $\Pi_A = -\underline{k}$.

are satisfied. To see this, note that the owner's participation constraint requires that

$$c \geq \frac{k' - \underline{k}}{f(k')} \quad \text{and} \quad c \geq \frac{k'' - \underline{k}}{2f(k'')},$$

and that $f'(k') = \frac{1}{1+c}$ and $f'(k'') = \frac{1}{2(1+c)}$ implies that $k' = 2^{\frac{1}{\beta-1}} k''$.[26] This, in turn, can be used to write

$$f(k') = 2^{\frac{\beta}{\beta-1}} f(k'').$$

Thus, if the value of the specificity-parameter c is less than $\frac{k''}{2f(k'')} - \frac{\underline{k}}{2f(k'')}$, an equilibrium exists in which only one firm invests k^* while the other stays out of the market, provided that

$$f(k^*)(2+c) - k^* - f(\underline{k}(2+c) \geq -\underline{k}$$

or, equivalently, that c satisfies

$$\frac{f(k^*) - f(\underline{k})}{k^* - \underline{k}} \geq \frac{1}{2+c}. \tag{9}$$

In this case, the investment decision stage, anticipating future opportunism, essentially reduces to a *chicken game*.

Finally, if the value of c is so low that not even condition (9) is fulfilled, both firms invest only $\underline{k}$ in equilibrium.

[26] Recall that if $f(\cdot)$ is homogeneous of degree β, then $f'(\cdot)$ is homogeneous of degree $\beta - 1$.

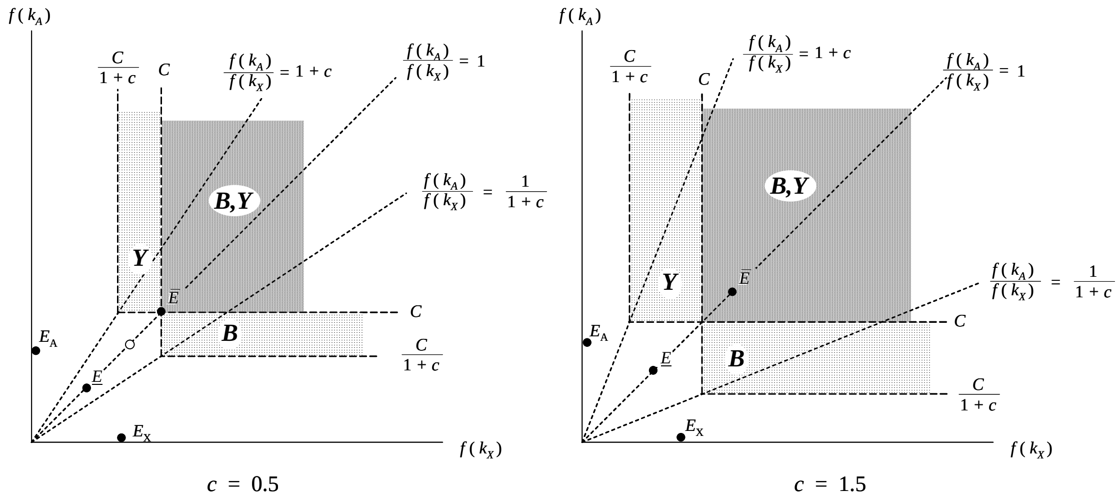

Figure 1: Potential equilibria in the $f(k_A) \times f(k_X)$-diagram for two different values of the specificity parameter c.

NOTE: The left panel illustrates the case where $\overline{E} = (f(k''), f(k''))$ is a (potential) corner solution, i.e., where the participation constraints of the agents (represented by the dotted angles) are binding.

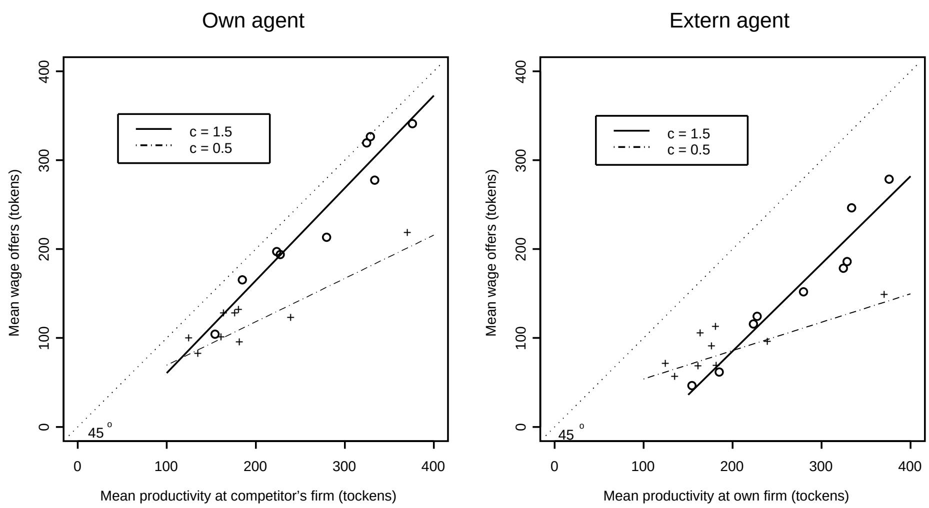

Figure 2: Wage offers and value of the agent's outside option

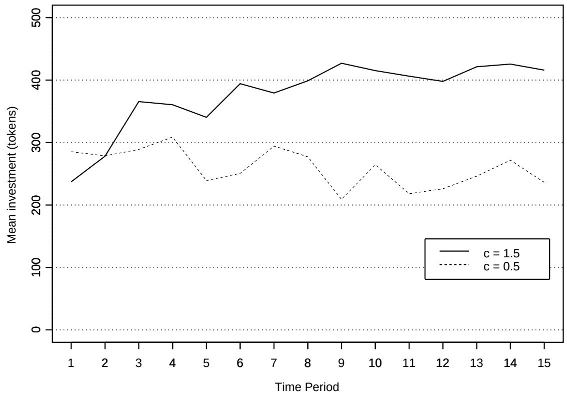

Figure 3: Mean investment decisions by treatment

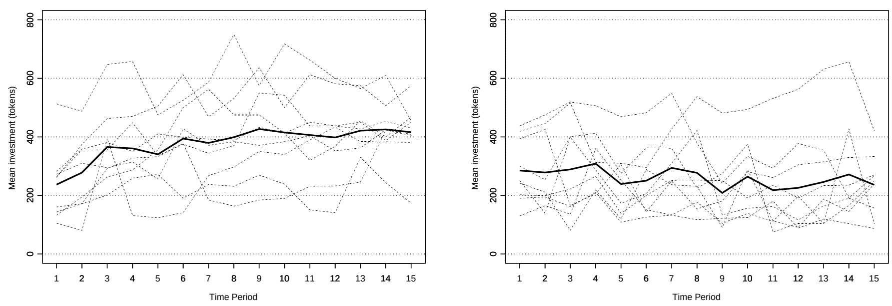

Figure 4: Mean investment decisions by matching group for $c = 1.5$ (left) and $c = 0.5$ (right). The solid line represents the mean investment level across matching groups.

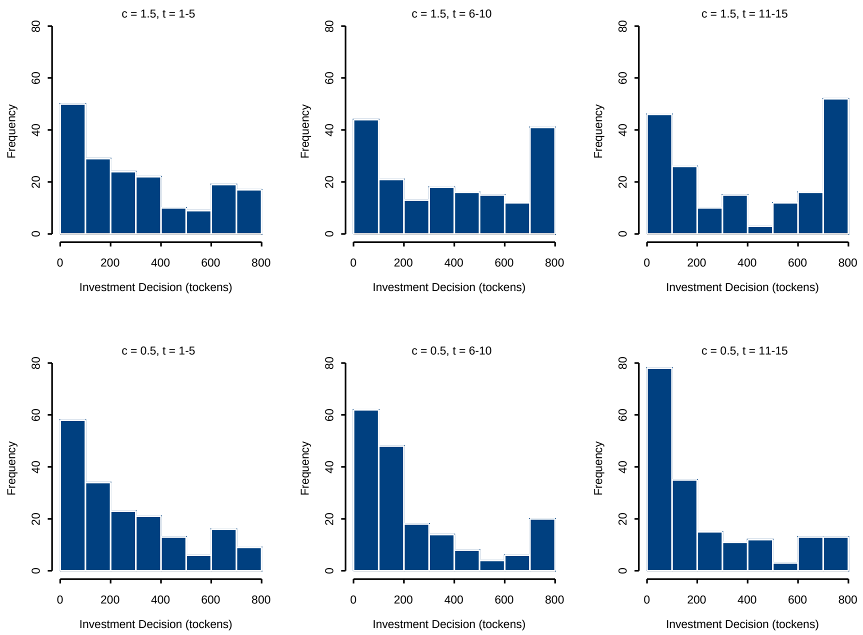

Figure 5: Frequency of investment decision across repetitions.

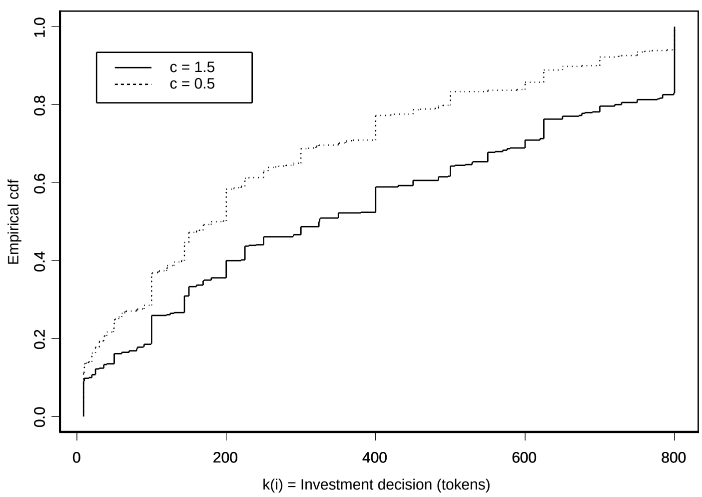

Figure 6: Comparison of empirical cdfs of investment decisions.

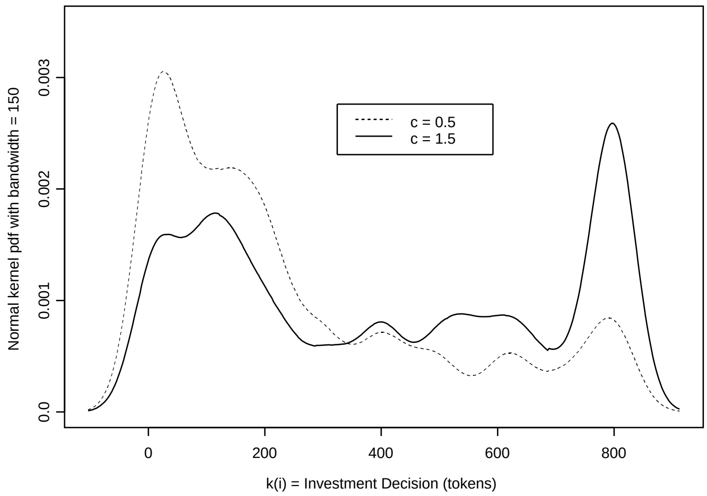

Figure 7: Normal kernel pdf estimate of investment decisions in periods 6 to 15.

c	Benchmark	Play Data (Stages 1 to 3)								Final Teams	Payoffs				Total Surplus
		k_A	k_X	δ_B	δ_Y	w_B^A	w_Y^A	w_B^X	w_Y^X		A	B	X	Y	
0.5	*Rational Play*														
	Asymmetric :	156.25	9	0	0	30	45	30	45	$ABY,\ X$	81.25	30	-9	45	147.25
		9	156.25	0	0	45	30	45	30	$A,\ XBY$	-9	45	81.25	30	147.25
	Efficient Outcome														
	Symmetric :	225	225	1	1					AB, XY					50
	Asymmetric :	625	9	1	1					ABY, X					716
		9	625	1	1					A, XBY					716
1.5	*Rational Play*														
	Symmetric:	156.25	156.25	0	0	125	125	125	125	AB, XY	31.25	125	31.25	125	312.5
		625	625	1	1	500	500	500	500	AB, XY	125	300	125	300	850
	Asymmetric:	306.25	9	0	0	30	45	30	45	$ABY,\ X$	231.25	30	-9	45	297.25
		9	306.25	0	0	45	30	45	30	$A,\ XBY$	-9	45	231.25	30	297.25
	Efficient Outcome														
	Symmetric :	625	625	1	1					AB, XY					850
	Asymmetric* :	800	9	1	1					ABY, X					770.9
		9	800	1	1					A, XBY					770.9

Table 1: Benchmark results for the experimental parameter specifications

*Note: An interior asymmetric efficient solution with $c = 1.5$ requires $k_i = 1225$ and $k_j = 9$; $i \neq j$. In the experiment k could not exceed 800.

	$c = 1.5$		
	$w_o \geq w_c$	$w_o < w_c$	Total
Unemployment	10	1	11
Stay at original firm	364	9	373
Change to competing firm	10	146	156
Total	384	156	540

	$c = 0.5$		
	$w_o \geq w_c$	$w_o < w_c$	Total
Unemployment	6	5	11
Stay at original firm	331	13	344
Change to competing firm	13	172	185
Total	350	190	540

Table 2: Employment decision as a function of relative wage offers

	Own agent		External agent	
	$c = 1.5$	$c = 0.5$	$c = 1.5$	$c = 0.5$
Intercept	-43.52	20.6399	-111.2827^*	21.7178
	(30.2810)	(17.4973)	(28.0884)	(17.4222)
Slope	1.0403^*	0.4876^*	0.9832^*	0.3196^*
	(0.1083)	(0.0832)	(0.1004)	(0.0828)

* Significance at the 0.01% level

Table 3: OLS estimates of the relation between average wage offers and average value of the agent's outside option. In case of $c = 1.5$ the value of the outside option is equal to the productivity at the competitor's firm; in case of $c = 0.5$ it is equal to the productivity at the own firm.

$c = 1.5$

	$\min(p) < 200$	$\min(p) \geq 200$	Total
$\delta = 0$	81	180	261
$\delta = 1$	61	218	279
Total	142	398	540

$c = 0.5$

	$\min(p) < 200$	$\min(p) \geq 200$	Total
$\delta = 0$	180	171	351
$\delta = 1$	64	125	189
Total	244	296	540

Table 4: Decision to engage in training as a function of minimal potential productivity levels

	$\hat{w}$	$\hat{\mu}$	$\hat{\sigma}$	No. of iterations
$c = 0.5$	(0.52, 0.48)	(90.37, 423.26)	(73.08, 253.09)	453
$c = 1.5$	(0.42, 0.58)	(107.06, 628.30)	(79.97, 176.70)	131

Table 5: EM estimates of mixture-parameters for the investment decision.