UNIVERSITY OF CALIFORNIA,
IRVINE

Essays in Labor and Transportation Economics

DISSERTATION

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for the degree of

DOCTOR OF PHILOSOPHY

in Economics

by

Irina Zotova

Dissertation Committee:
Professor Michael McBride, Chair
Chancellor's Professor Jan Brueckner
Professor John Duffy

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DEDICATION

To my parents, for their endless love and support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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CURRICULUM VITAE

Irina Zotova

EDUCATION

Doctor of Philosophy in Economics **2018**
University of California, Irvine *Irvine, CA*

Master of Arts in Economics **2014**
University of California, Irvine *Irvine, CA*

Bachelor of Science in Economics/Mathematics, *Cum Laude* **2013**
University of California, San Diego *La Jolla, CA*

FIELDS

Experimental Economics, Applied Microeconomics, Industrial Organization, Labor Economics

PUBLICATIONS

Zotova I., 2017. "Post-Crash Airline Pricing: A Case Study of Alaska Airlines Flight 261." Economics of Transportation 10, 18-22.

RESEARCH PAPERS

"Worker History and Labor Markets: The Role of Costly Information"

"References in the Labor Market: An Experimental Study"

TEACHING EXPERIENCE

Teaching Assistant **2013-2018**
University of California, Irvine *Irvine, CA*

Probability & Statistics I, Basic Economics: Microeconomics, Intermediate Economics I, II, & III, Asymmetric Information, Applied Econometrics I, Computer Based Research in the Social Sciences

RESEARCH EXPERIENCE

Graduate Student Researcher **2013**
University of California, Irvine *Irvine, CA*

PRESENTATIONS

Global Economics and Management Seminar Series, UCLA	2018
Experimental Social Science Laboratory Lunch Workshop, UC Irvine	2016, 2017, 2018
Economics Seminar Series, CSU Long Beach	2017
Department of Economics Labor-Public Seminar Series, UC Irvine	2017
Department of Economics Transportation, Urban and Environmental Seminar Series, UC Irvine	2017
Department of Economics Graduate Student Poster Session, UC Irvine	2016, 2017
Summer Research Symposium, UC Irvine	2013

AWARDS

Summer Research Fellowship, Economics Department, UC Irvine	2016, 2017
Competitive Edge Summer Research Program, UC Irvine	2013
Merit Fellowship in Economics, UC Irvine	2013-2018

ABSTRACT OF THE DISSERTATION

Essays in Labor and Transportation Economics

By

Irina Zotova

Doctor of Philosophy in Economics

University of California, Irvine, 2018

Professor Michael McBride, Chair

The study of pricing is a fundamental topic in economics. This dissertation analyzes pricing strategies in labor and transportation markets.

Chapter 1 examines the impact of the crash of Alaska Airlines Flight 261 on the domestic fares and passenger traffic of the crash carrier, using a difference-in-difference approach. The results show that that the crash reduced fares of Alaska Airlines relative to those of its competitors only in the months right after the crash, indicating that the financial ramifications are not persistent, a finding that justifies the temporary drop in stock prices found in earlier literature.

Chapter 2 investigates the factors that contribute to wage selection in the labor market. When employers consider a job candidate, character assessment about the applicant is gathered from a variety of sources, impartial and subjective, ranging from academic merits to reviews by coworkers. The information is collected in order to make an appropriate wage offer. Existing experimental literature in agency theory provides employers with their employees' work records at no cost. I extend this research by placing a price on the information to develop a more realistic case. Through experimental evidence, I find employers absorb the cost of obtaining history, and do not shift the burden of the fee onto the employees in the form of lower wages. If employers have access to employees' history, they offer wages

that are positively correlated with the employees' work ethic. However, when they are not presented with a history, the employers base wages on their own experiences.

The last chapter studies a different source an employer can use to determine wages. In past labor market experimental literature, an employee's work history was information the employer received from the employee. Chapter 3 of my dissertation modifies the agency problem by introducing a noisy signal from a third party, specifically the employee's past employer. The results of this experimental study show that cooperation is more prominent when employee references are accessible, even if the evaluations are imprecise.

Chapter 1

Post-Crash Airline Pricing: The Crash of Alaska Airlines Flight 261

1.1 Introduction

Though rare, the crash of an airline flight is a disastrous event that brings with it significant economic and emotional consequences. The few major commercial airline crashes that have occurred have received wide media attention, despite the high safety standards of the airline industry and its low fatality rate when compared to other sources of risk. The isolated air crashes, from what is considered the safest mode of transportation, may impose financial ramifications on the carrier involved and the entire aviation industry.

Much of the research regarding the impact of airline crashes has investigated the stock prices of airlines. But no research has previously been conducted on changes in fares following a crash, a significant omission in the literature. Since stock value is derived from profits, which are established by fares and passenger count, this paper can offer a detailed explanation for the stock price effect by examining its determinants.

The paper estimates the impact of one crash, that of Alaska Airlines flight 261, on the carrier's fares on its domestic routes, with a goal of determining how much the accident decreased the fares and passenger count of the crash airline in the months following the event. It could be expected that after a fatal airline disaster, people would be wary of flying, and this fear would either reduce the frequency of their airline use (which would cause traffic for all carriers to drop), or that they would switch to a competing carrier. In both scenarios, the drop in demand would negatively impact Alaska Airlines and could force its fares to decrease following the crash in order to retain business.

Currently, all research agrees that crash airlines lose market value post-crash. Ho et al. [2013] study the consequences of a crash for stock prices as the number of fatalities is varied. They show that, if fatalities are few, crash airlines suffer immediately and non-crash airlines benefit consistently due to the effect of passengers switching away from the crash airline. If fatalities are high, all airlines suffer due to a contagion effect, which results in a drop in the firms' equity values due to heightened fears about the safety of air travel. This outcome is likely due to the media attention large disasters receive, which creates panic among the public.

Bosch et al. [1998] provide additional evidence on the switching and contagion effects. Their results show that as crash airlines lose value, non-crash airlines with greater market overlap with the crash airlines benefit due to the switching effect, while airlines with less or no overlap with the crash airline lose value due to the contagion effect, where overlap is defined as shared routes between airlines.

Similarly to this paper, Nethercutt and Pruitt [1997] also study the effects of a single crash. As in the other papers, their focus is the stock value of airlines, particularly those of rival airlines when the crash airline is a low-cost carrier (LCC). They examine the crash of ValuJet Flight 592, after which the airline was shut down for several months. Analysis showed that the contagion effect of this LCC crash overshadows the switching effect for other low-cost airlines, driving down the stock values of both crash and non-crash LCCs, while owners of major airline stocks gain from the tragedy.

The financial impact of a crash has additionally been studied through factors other than stock prices. Rose [1992] found a negative correlation between profit margins and a carrier's safety performance. Barnett et al. [1992] and Borenstein and Zimmerman [1988] analyzed the effect of a crash on passenger traffic.

The present study differs from the prior work by being the first to look at air fares as opposed to stock prices, as well as focusing on only one crash event. The change of fares and passenger counts post-crash directly lead to an impact on airline profits, and thus, stock value, drawing a link to previous studies. The empirical model controls for typical fluctuations in airline markets in order to observe the effects on fares of Alaska Airlines exclusively due to the crash of its Flight 261. A difference-in-difference approach is used to isolate the fare effects.

The chapter is organized as follows. The crash of Flight 261 is described in Section 1.2. Section 1.3 presents the data and variables that are used in the empirical model. The results of the regression are provided in Section 1.4. Section 1.5 summarizes the conclusions.

1.2 Crash

Flight 261 was scheduled for January 31, 2000, from Puerto Vallarta, Mexico, to Seattle, Washington, with a layover in San Francisco, California. During the flight, the tail jackscrew, which adjusts the position of the tail control surfaces, separated from the acme nut holding it in place, causing the pilots to lose pitch control of the aircraft. With the aircraft no longer able to maintain horizontal stability, it nosedived into the ocean. All 88 passengers and crew on board died from blunt-force impact trauma.

An investigation by the National Aviation Safety Board determined that the crash resulted from poor maintenance (National Transportation Safety Board [2002]). The jackscrew was excessively worn due to poor lubrication, a lapse that was not caught earlier because the FAA allowed Alaska Airlines to extend the time intervals between maintenance events. Another cause of the crash was the absence on the aircraft, the McDonnell Douglas MD-80, of a fail-safe mechanism to prevent the effects of total acme nut thread loss. Altogether, the crash was due to poor maintenance on the airline's part and a manufacturing defect.

1.3 Model

The data are collected from the DB1B database, a 10 percent quarterly sample of all domestic airline tickets provided by the U.S. Department of Transportation. In order to observe the change in prices on the routes of the crash airline, only airport-pairs served by Alaska Airlines are used in the analysis. The sample spans eight quarters: the second quarter of 1999 to the first quarter of 2001. As the Alaska Airlines crash took place in January of 2000, the sample considers ticket prices before and after the crash.[1] Only round-trip flights are included. Itineraries with more than 4 ticket coupons (flight segments) are excluded, as are those with fares of zero. Fares are divided in half so as to count each direction of round-trip itineraries separately. Additionally, directionality is suppressed, with each observation recorded as a one-way trip within an airport-pair (i.e., a flight from San Francisco to Los Angeles is considered to be in the same market as a flight from Los Angeles to San Francisco). Both direct and connecting flights are included, using a dummy variable *connect* to represent a connecting flight. After aggregating and filtering for unusable data, 31,553 observations remain.[2]

The data set provides the number of passengers who paid the same fare for a specific market

[1] Previous research on the effect on stock prices suggests that a market reaction to a crash is not prolonged.
[2] The dataset initially contained 37,930,172 observations.

and carrier during a given quarter. Therefore, different fares on the same flight will generate separate observations. The fares are aggregated for each market i, carrier c, quarter t, also separating non-stop and connecting flights, with the fares weighted by the number of associated passengers. The log of the resulting passenger-weighted average fare is denoted *lfare*.

To separate the ramifications of the crash on fares from market variations unrelated to the accident, three variables to distinguish market characteristics are created. The first is population, collected from the 2000 U.S. Census. The variable, denoted pop_i, is calculated as the geometric mean of the populations of the endpoint cities in each market. Higher demand on a route may raise fares but it may also tend to reduce them via economies of traffic density (which reduces airline costs as traffic rises).

The second control variable is distance for the market, denoted $dist_i$, which is also provided by the DB1B data bank. The variable takes the same value for all direct flights, but may vary across connecting flights, based on location of the layover. Therefore, a passenger-weighted average value is computed for connecting flights when the data is aggregated to the market-carrier-quarter-connect level. As distance increases, passengers are faced with fewer substitutes to flying, which could raise fares. Higher airline costs for longer flights would have the same effect.

A third characteristic is the market temperature differential ($temp_i$), representing the absolute value of the difference between the average January temperatures at the endpoints of the market. Since a large value signifies a leisure market, where consumers would travel to a location whose temperature is different from their origin, a negative fare effect of $temp_i$ is expected.

Competition variables capture how many other carriers are offering service in the market each quarter. The variables capture two types of competition: nonstop competition ($nscomp_{it}$)

and connecting competition ($concomp_{it}$). The goal is to provide more insight into which kind of competition has a larger effect on fares. An increase in the number of competitors is expected to decrease prices.

Quarter dummies, denoted δ_t, are included to capture temporal effects, one for each of the eight quarters in the sample. $Post_{1t}$ is a dummy that accounts for the crash. It is activated post crash, being assigned a value of 0 in the pre-crash quarter (quarters 2 through 4 of 1999), $\frac{2}{3}$ during the crash quarter, and 1 in the post-crash quarter. The reasoning for the $\frac{2}{3}$ value during the crash quarter is that the crash occurred $\frac{1}{3}$ of the way into this second quarter, so two-thirds of the ticket data are from after the crash. Since, as mentioned earlier, the ticket data are provided quarterly, there is no way to separate tickets into those right before or right after the crash.[3]

A drawback of using this data set is it does not provide the ticket purchase date. It is therefore unknown how far in advance passengers purchased their tickets, so that whether the purchase date is during the quarter of the scheduled flight or in the previous quarter is unknown. This lack of information means that some tickets used during the last part of the first quarter or during the second quarter of 2000 could have been purchased prior to the crash. Nevertheless, using the dummy $post_t$ is the best way to capture the effect of the crash, given the available data.

The dummy variable AS_c indicates that the reporting carrier is Alaska Airlines. Multiplying AS_c and the variable $post_{1t}$ creates an interaction variable that captures the change in fares of Alaska Airlines following its crash, and it is the variable of interest in this study. The resulting framework thus embodies a difference-in-difference approach.

In addition to the way of defining the variable $post_{1t}$ described above, the paper considers four modifications of that variable. The first approach creates a second variable $post_{2t}$ that

[3]Since the crash could affect fares for only $\frac{2}{3}$ of the quarter, failure to use $\frac{2}{3}$ rather than 1 as the dummy value would lead to a coefficient that misstates the percentage fare impact on post-crash fares.

equals two-thirds for observations in the crash quarter (the first quarter of 2000), and 0 otherwise. Under this approach, fare impacts are expected only during the crash quarter, dissipating in the following quarter. Another approach creates a third variable $post_{3t}$ that equals 1 for observations in the second quarter of 2000 (the quarter after the crash), and 0 otherwise. This approach assumes that, with advance purchase of tickets, fare effects would not materialize in the weeks following the crash, showing up only in the subsequent quarter. The remaining adaptations of the variable test for extended effects. $Post_{4t}$ and $post_{5t}$ are activated in the third and fourth quarters of 2000, respectively. The values of the variations of the *post* variable are summarized in Table 1.1.

Table 1.1: Values of *Post*

Post	1999 Q2	1999 Q3	1999 Q4	2000 Q1	2000 Q2	2000 Q3	2000 Q4
$post_1$	0	0	0	2/3	1	0	0
$post_2$	0	0	0	2/3	0	0	0
$post_3$	0	0	0	0	1	0	0
$post_4$	0	0	0	0	0	1	0
$post_5$	0	0	0	0	0	0	1

Lastly, AS_c is included by itself to capture general fare differences between Alaska and other carriers. In contrast to a typical airline study, where each carrier would be represented by its own dummy variable, individual carrier dummies are suppressed to facilitate a difference-in-difference approach, with all carriers that are not Alaska Airlines being lumped together.

The regression used in this study then takes the following form:

$$\begin{aligned} Lfare_{ict} = \alpha + \beta\, connect_{ict} + \gamma\, pop_i + \zeta\, dist_i + \iota\, temp_i + \\ \mu\, nscomp_{it} + \phi\, concomp_{it} + \sigma\, \delta_t + \lambda\, post_t AS_c + \theta\, AS_c \end{aligned} \tag{1.1}$$

Table 1.2 provides the unweighted summary statistics for the variables of interest. These averages are computed when the data is aggregated to the market-carrier-quarter-connect

Table 1.2: Summary Statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
weighted_fare	217.05	127.34	3	3279.5
connect	0.871	0.335	0	1
pop	385060.698	407199.012	0	3271113
tdist	1549.949	899.177	16	5097.619
nscomp	0.206	0.773	0	7
concomp	3.466	3.433	0	15

Table 1.3: Weighted Summary Statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
weighted_fare	166.38	101.264	3	3279.5
connect	0.268	0.443	0	1
pop	756077.743	534768.241	0	3271113
tdist	1171.123	810.268	16	5097.619
nscomp	1.556	1.569	0	7
concomp	1.7	3.292	0	15

level.[4] From this table, it is seen that the average fare is $217 (on a one-way basis). Most of the competition that carriers face is from connecting flights (with an average of 3.47 connecting competitors per market, as opposed to an average of 0.21 competing nonstop carriers). These results partly reflect the fact that most flights are connecting flights, making up 87 percent of the sample.

The summary statistics provided in Table 1.3 are instead weighted by passenger count. With the added weights, the mean fare is now $166, and 26.8 percent of the weighted observations represent connecting flights. Since thicker routes with more nonstop competition receive more weight, it is no surprise that the average weighted number of connecting competitors also decreases. The average amount of both types of competition, non-stop and connecting, is approximately 1.7 carriers per weighted observation.

[4]When data is aggregated to the market-carrier-quarter-connect level, one observation is created for each market, carrier, in each quarter, and separated into connecting and nonstop flights.

1.4 Results

1.4.1 Effects on Fares

The first column of Table 1.4 displays regression results from a weighted model using the $post_1$ variable, where each observation is weighted by passenger count. Fares of Alaska Airlines do not show a significant change following the crash. The $post_1$*AS coefficient shows a statistically insignificant decrease in Alaska's fares, implying that the crash had no impact on the fares of the crash airline relative to those of its competitors. The first column of Table 1.5 shows the results from an unweighted regression, where the change in fares of Alaska Airlines following the crash is once again not significant.

The second columns of Tables 1.4 and 1.5 present results of the modified regression where $post_2$ is used. The two columns again represent results from weighted and unweighted regressions, respectively. The weighted regression shows a significant decrease of 5.8 percent in Alaska's fares relative to those of its competitors after its crash. Since the $post_2$ variable is non-zero only in the crash quarter, this finding suggests that the change in fares takes place immediately after the crash.

The third columns of Tables 1.4 and 1.5 present results using the $post_3$ variable, again providing weighted and unweighted regression results. The $post_3$*AS coefficient is not significant in either regression, implying that Alaska fares are not affected relative to those of its competitors in the quarter following the crash, which starts two months after the incident. This result is consistent with the studies on stock prices that found crash ramifications to not be prolonged. The estimates of the other coefficients in Table 1.5 are similar to those in Table 1.4.

Columns 4 to 6 of Tables 1.4 and 1.5 increase the number of quarters used in the regression to determine the persistence of the effect of the crash. In these regressions, each post-crash quarter is provided its own dummy variable. The results show a lack of a significant difference in the fares of Alaska Airlines compared to its competitors in all the quarters after the crash quarter.

The results from Tables 1.4 and 1.5 show that, when the post-crash period is defined to include the quarters following the crash (as with $post_1$ and $post_3$), fare effects do not emerge. However, when the post-crash period is restricted to the two months following the crash through the use of $post_2$, fare effects are present. The finding of contemporaneous effects matches the stock price results, which show an immediate crash effect that soon dissipates.

Other factors that influence fares can also be seen from the regression results. Population increases fares in the weighted model, implying that demand effects dominate any cost reduction in larger markets. Distance has a positive impact on fares, as expected.

Both types of competition, nonstop and connecting, have a negative impact on fares. An additional nonstop competitor reduces fares by 7 percent, and another connecting competitor has a smaller negative fare impact of 3 percent. Lastly, the temperature differential has a slightly positive effect on fares, but it is only significant in the weighted model. This finding shows that prices of traveling are higher in leisure markets, contrary to expectations.

While most of the results are similar in the two models, the effect on fares of a connection varies by model. In the unweighted regression, connecting fares are 14 percent higher than the fares of direct flights, while fares of connecting flights in the weighted model are insignificantly lower than the fares of direct flights, the expected relationship given that passengers are willing to pay more to save time.

1.4.2 Effects on Traffic

It is also of interest to see if passenger traffic is affected by a crash. Squalli and Saad [2006] test the theory that the public's response to a crash is reflected in the quantity of tickets sold. They show that public concern regarding air safety following a high-fatality crash results in a decrease in traffic for the crash carrier, while accidents with only minor injuries are not followed by a statistically significant impact on passenger traffic. Barnett, Menighetti, and Prete's [1992] investigation of the case study of a 1989 crash of the McDonnell Douglas DC-10 showed that passenger traffic on DC-10s industry-wide decreased for only the 8 weeks following the crash. Borenstein and Zimmerman's [1988] study of 13 accidents between 1978 and 1985 finds passenger traffic effects consistent with the DC-10 study: the effect is limited to two months after a crash.

Whether this pattern of a temporary drop in demand exists in the Alaska case can be tested by modifying the current regression, with the difference-in-difference approach now used to ask whether there was a change in Alaska Airlines' passenger traffic after the crash. All observations are again aggregated to the market-quarter-carrier-connect level, and weighting is absent. The log of the passenger count becomes the dependent variable in the new regression. Results are presented in Table 1.6, whose columns vary by the way the $post_t$ variable is defined. In the first column of Table 1.6, which uses $post_1$, the $post_1*AS$ coefficient is not significant, showing no change in Alaska passenger traffic relative to traffic on non-crash carriers in the months following the crash. The $post_2*AS$ coefficient is significant in the second column of Table 1.5, showing that Alaska Airlines experienced a 26 percent decrease in passenger traffic relative to its competitors after the crash during the first quarter of 2000 (which is the immediate effect), results that are consistent with Squalli and Saad [2006]. Together, the results of Table 1.4 and the second column of Table 1.6 show that the immediate effects of the crash are both a decrease in fares and passenger traffic for the crash airline.

The results displayed in the third column of Table 1.6 show that Alaska did not experience a significant change in passenger traffic relative to its competitors during the second quarter of 2000, months after its crash. Investigation into the further quarters, presented in columns 4 to 6, shows no lasting changes to the passenger traffic of the crash airline. This finding is consistent with the results of the literature on stock market effects: the public regains confidence in a carrier shortly after its crash. A decrease in both passenger traffic and fares only occurs immediately after a crash and is not prolonged. Those factors cause a decrease in revenue, and therefore account for the stock price effects found in the previous literature.

Past research on the aviation industry has achieved more significant results when data were separated into categories. Squalli and Saad [2006] did not find a significant impact on passenger traffic following a crash until they ranked the crashes in their data set by severity. Similarly, modifying the regression in this paper by looking at shorter time periods helps to find a significant impact that otherwise is not apparent.

The other results in Table 1.6 show that passenger traffic for connecting flights is lower than for direct flights, as expected. Population and both types of competition have positive effects on passenger traffic.[5]

1.5 Conclusion

This study evaluates the effect of the crash of Alaska Airlines Flight 261 on fares of the crash airline in the months following the accident. Past studies have found that stock prices of crash airlines drop following a crash, while competitors may benefit with an increase in stock prices. The current regressions show that the accident resulted in a statistically significant drop in the fares of Alaska Airlines relative to its competitors only in the few months after

[5]The latter results contradict expectations, which would predict a negative traffic effect from an increase in competition. The estimated positive effect may reflect the influence of omitted variables, which raise traffic for both Alaska and its competitors, thus yielding a biased competition effect.

the crash. The effect of the crash, however, is not prolonged, as there was no change in fares in the quarter after the crash. Alaska also experienced a decrease in passenger traffic immediately following the crash, with a rebound in the subsequent quarter. The results are consistent with those of Squalli and Saad [2006], who found evidence of a decrease in passenger traffic after a high-fatality crash. A decrease in both passenger count and fares justifies the stock price effect found in the earlier literature.

With this study having established the existence of a fare effect for the Alaska Airlines crash, a broader study that looks at fare effects from a variety of crashes might be worthwhile. If such a study were to allow a separate effect for each crash, it would simply be equivalent to a collection of individual crash studies like the current one. However, if the specification were to require common post-crash fare effects across different crashes, the approach would differ from a collection of case studies. The right approach, however, is unclear. Allowing fare effects to differ across crashes may be desirable, but evidence of a common fare effect under the second approach might be more compelling.

Table 1.4: Crash Effects on Alaska Fares (Weighted)

	(1)	(2)	(3)	(4)	(5)	(6)
	lfare	lfare	lfare	lfare	lfare	lfare
connect	-0.00568	-0.00603	-0.00567	-0.00605	-0.00625	-0.00626
	(-0.70)	(-0.74)	(-0.70)	(-0.74)	(-0.77)	(-0.77)
pop	9.14e-08***	9.14e-08***	9.17e-08***	9.14e-08***	9.14e-08***	9.14e-08***
	(24.81)	(24.82)	(24.92)	(24.82)	(24.80)	(24.82)
tdist	0.000542***	0.000542***	0.000542***	0.000542***	0.000542***	0.000542***
	(186.26)	(186.29)	(186.29)	(186.28)	(186.28)	(186.27)
nscomp	-0.0711***	-0.0711***	-0.0712***	-0.0711***	-0.0711***	-0.0711***
	(-46.02)	(-46.06)	(-46.10)	(-46.04)	(-46.04)	(-46.05)
concomp	-0.0309***	-0.0309***	-0.0310***	-0.0309***	-0.0309***	-0.0309***
	(-28.26)	(-28.23)	(-28.31)	(-28.23)	(-28.20)	(-28.21)
quarter2	-0.00978	-0.00977	-0.00977	-0.00977	-0.00978	-0.00977
	(-1.46)	(-1.46)	(-1.46)	(-1.46)	(-1.46)	(-1.46)
quarter3	-0.0400***	-0.0400***	-0.0399***	-0.0400***	-0.0399***	-0.0400***
	(-5.74)	(-5.74)	(-5.73)	(-5.74)	(-5.73)	(-5.74)
quarter4	0.0230**	0.0276***	0.0201**	0.0274***	0.0269***	0.0274***
	(3.06)	(3.55)	(2.78)	(3.53)	(3.45)	(3.51)
quarter5	0.0557***	0.0529***	0.0511***	0.0520***	0.0514***	0.0519***
	(7.75)	(7.65)	(6.95)	(7.07)	(6.98)	(7.03)
quarter6	0.0867***	0.0867***	0.0867***	0.0867***	0.0834***	0.0839***
	(12.96)	(12.96)	(12.96)	(12.96)	(11.80)	(11.84)
quarter7	0.0832***	0.0831***	0.0832***	0.0831***	0.0832***	0.0856***
	(12.30)	(12.30)	(12.30)	(12.30)	(12.30)	(11.91)
quarter8	0.0857***	0.0856***	0.0858***	0.0857***	0.0857***	0.0857***
	(12.29)	(12.29)	(12.30)	(12.29)	(12.30)	(12.29)
temp	0.00843***	0.00843***	0.00842***	0.00843***	0.00842***	0.00842***
	(41.41)	(41.41)	(41.40)	(41.41)	(41.41)	(41.40)
AS	0.0210***	0.0217***	0.0164**	0.0211***	0.0177**	0.0206**
	(3.97)	(4.38)	(3.29)	(3.98)	(3.06)	(3.19)
$post_1$*AS	-0.0152					
	(-1.43)					
$post_2$*AS		-0.0580**		-0.0570**	-0.0520*	-0.0563*
		(-2.68)		(-2.61)	(-2.35)	(-2.50)
$post_3$*AS			0.00932	0.00454	0.00790	0.00506
			(0.69)	(0.33)	(0.57)	(0.36)
$post_4$*AS					0.0200	0.0171
					(1.46)	(1.22)
$post_5$*AS						-0.0140
						(-1.00)
Constant	4.250***	4.250***	4.250***	4.250***	4.250***	4.250***
	(645.48)	(646.21)	(646.06)	(645.53)	(644.28)	(642.47)
Observations	31553	31553	31553	31553	31553	31553
Adjusted R^2	0.690	0.690	0.690	0.690	0.690	0.690

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.5: Crash Effects on Alaska Fares (Unweighted)

	(1) lfare	(2) lfare	(3) lfare	(4) lfare	(5) lfare	(6) lfare
connect	0.145***	0.145***	0.145***	0.145***	0.145***	0.145***
	(13.82)	(13.83)	(13.83)	(13.83)	(13.83)	(13.84)
pop	3.10e-08***	3.11e-08***	3.11e-08***	3.11e-08***	3.11e-08***	3.13e-08***
	(4.22)	(4.23)	(4.23)	(4.22)	(4.22)	(4.25)
tdist	0.000323***	0.000323***	0.000323***	0.000323***	0.000323***	0.000323***
	(108.25)	(108.25)	(108.25)	(108.25)	(108.25)	(108.32)
nscomp	-0.0612***	-0.0612***	-0.0612***	-0.0612***	-0.0612***	-0.0613***
	(-14.09)	(-14.09)	(-14.09)	(-14.09)	(-14.09)	(-14.11)
concomp	-0.0271***	-0.0271***	-0.0271***	-0.0271***	-0.0271***	-0.0272***
	(-26.60)	(-26.61)	(-26.62)	(-26.61)	(-26.60)	(-26.67)
quarter2	-0.0256**	-0.0256**	-0.0256**	-0.0256**	-0.0256**	-0.0256**
	(-2.83)	(-2.83)	(-2.83)	(-2.83)	(-2.83)	(-2.83)
quarter3	-0.0340***	-0.0339***	-0.0340***	-0.0340***	-0.0340***	-0.0345***
	(-3.57)	(-3.56)	(-3.57)	(-3.57)	(-3.57)	(-3.62)
quarter4	-0.00313	-0.00617	-0.00671	-0.00547	-0.00562	-0.00269
	(-0.30)	(-0.57)	(-0.69)	(-0.50)	(-0.51)	(-0.24)
quarter5	0.0274**	0.0238*	0.0293**	0.0294**	0.0293**	0.0322**
	(2.73)	(2.54)	(2.80)	(2.81)	(2.79)	(3.06)
quarter6	0.0343***	0.0343***	0.0343***	0.0343***	0.0334***	0.0363***
	(3.81)	(3.81)	(3.81)	(3.81)	(3.38)	(3.66)
quarter7	-0.0111	-0.0110	-0.0110	-0.0111	-0.0110	0.00371
	(-1.21)	(-1.21)	(-1.21)	(-1.21)	(-1.21)	(0.37)
quarter8	-0.00283	-0.00283	-0.00283	-0.00283	-0.00283	-0.00281
	(-0.31)	(-0.31)	(-0.31)	(-0.31)	(-0.31)	(-0.31)
temp	0.0000733	0.0000723	0.0000736	0.0000737	0.0000733	0.0000692
	(0.36)	(0.36)	(0.36)	(0.36)	(0.36)	(0.34)
AS	0.134***	0.131***	0.133***	0.134***	0.133***	0.144***
	(20.37)	(21.21)	(21.44)	(20.37)	(18.74)	(18.36)
$post_1$*AS	-0.0125					
	(-1.00)					
$post_2$*AS		-0.00253		-0.00654	-0.00565	-0.0223
		(-0.10)		(-0.25)	(-0.22)	(-0.84)
$post_3$*AS			-0.0189	-0.0194	-0.0188	-0.0300
			(-1.18)	(-1.21)	(-1.15)	(-1.80)
$post_4$*AS					0.00346	-0.00768
					(0.22)	(-0.47)
$post_5$*AS						-0.0535***
						(-3.30)
Constant	4.684***	4.685***	4.684***	4.684***	4.684***	4.681***
	(383.88)	(384.37)	(384.21)	(383.87)	(383.23)	(381.85)
Observations	31553	31553	31553	31553	31553	31553
Adjusted R^2	0.317	0.317	0.317	0.317	0.316	0.317

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.6: Crash Effects on Alaska Passenger Volume

	(1) lpass	(2) lpass	(3) lpass	(4) lpass	(5) lpass	(6) lpass
connect	-2.493***	-2.494***	-2.492***	-2.493***	-2.493***	-2.493***
	(-57.64)	(-57.67)	(-57.64)	(-57.67)	(-57.67)	(-57.67)
pop	0.000000626***	0.000000625***	0.000000626***	0.000000625***	0.000000625***	0.000000625***
	(20.61)	(20.59)	(20.63)	(20.59)	(20.59)	(20.59)
tdist	-0.000358***	-0.000358***	-0.000358***	-0.000358***	-0.000358***	-0.000358***
	(-29.12)	(-29.12)	(-29.13)	(-29.13)	(-29.12)	(-29.09)
nscomp	0.152***	0.152***	0.152***	0.152***	0.152***	0.152***
	(8.46)	(8.47)	(8.46)	(8.47)	(8.47)	(8.46)
concomp	0.164***	0.164***	0.164***	0.164***	0.164***	0.164***
	(39.10)	(39.14)	(39.10)	(39.14)	(39.14)	(39.12)
quarter2	0.103**	0.103**	0.103**	0.103**	0.103**	0.103**
	(2.75)	(2.75)	(2.75)	(2.75)	(2.75)	(2.75)
quarter3	0.0439	0.0433	0.0448	0.0439	0.0444	0.0440
	(1.12)	(1.10)	(1.14)	(1.12)	(1.13)	(1.12)
quarter4	0.0503	0.0918*	0.0426	0.0887*	0.0861	0.0881
	(1.18)	(2.05)	(1.06)	(1.97)	(1.91)	(1.95)
quarter5	0.0427	0.0340	0.00399	0.00907	0.00650	0.00853
	(1.03)	(0.88)	(0.09)	(0.21)	(0.15)	(0.20)
quarter6	0.128***	0.127***	0.127***	0.127***	0.113**	0.115**
	(3.43)	(3.43)	(3.43)	(3.43)	(2.76)	(2.80)
quarter7	0.0839*	0.0837*	0.0843*	0.0839*	0.0840*	0.0943*
	(2.23)	(2.23)	(2.24)	(2.23)	(2.24)	(2.25)
quarter8	-0.00233	-0.00237	-0.00232	-0.00237	-0.00236	-0.00235
	(-0.06)	(-0.06)	(-0.06)	(-0.06)	(-0.06)	(-0.06)
temp	0.00640***	0.00640***	0.00639***	0.00639***	0.00638***	0.00638***
	(7.68)	(7.69)	(7.67)	(7.68)	(7.67)	(7.67)
AS	-0.552***	-0.540***	-0.572***	-0.552***	-0.562***	-0.554***
	(-20.42)	(-21.21)	(-22.34)	(-20.41)	(-19.20)	(-17.11)
$post_1$*AS	-0.0282					
	(-0.55)					
$post_2$*AS		-0.260*		-0.242*	-0.227*	-0.239*
		(-2.46)		(-2.28)	(-2.11)	(-2.18)
$post_3$*AS			0.106	0.0866	0.0964	0.0887
			(1.61)	(1.30)	(1.43)	(1.29)
$post_4$*AS					0.0569	0.0492
					(0.87)	(0.74)
$post_5$*AS						-0.0370
						(-0.55)
Constant	5.221***	5.219***	5.226***	5.222***	5.224***	5.222***
	(103.82)	(103.89)	(104.01)	(103.84)	(103.71)	(103.35)
Observations	31553	31553	31553	31553	31553	31553
Adjusted R^2	0.298	0.299	0.298	0.299	0.299	0.299

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Chapter 2

Worker History and Labor Markets: The Role of Costly Information

2.1 Introduction

Before an employer offers a job to a potential employee, he attempts to obtain information about the candidate. This could involve requesting reference letters, conducting background checks, or administering tests during an interview. With the acquired information, an employer can infer the level of work the employee is willing to provide and offer an appropriate wage.

This chapter describes a laboratory experiment to study the role of information about workers' past employment history in wage determination. Past experimental research has treated the work history of employees as an exogenous variable, providing the material to employers at no cost. I construct an experiment which makes employee work history (consisting of past wages and effort levels) endogenous by giving employers the option of paying to receive such information, in order to build a more realistic case. Information rarely comes at no cost, and subjects can choose the price to pay for the amount of information they wish to receive. The aim of this study is to determine when employers will choose to pay to receive their employee's work history, how employee effort will change with the availability of costly employment information, and how employers choose wages when the employee's history is not available. Furthermore, this experiment also asks whether social efficiency is higher under costly or costless history.

The existing labor market experimental literature gathered that regardless of the clarity of the employee's past effort, the threat of knowledge will benefit both employees and employers. However, these results operate under the assumption that information is freely available. Letting the information be accessible only at a cost, a narrative closer to realism, may modify these results.

Bartling et al. [2012] and Douthit et al. [2012] both offer costless screening to employers, the latter with noise and the former without. Bartling et al. [2012] question when it is profitable to offer high discretion jobs (higher wages, less monitoring). Through an experiment that supplied employers with perfect information of an employee's history at no cost, it was discovered that high-paying, high-discretion jobs are only profitable if employees can be screened. The introduction of screening generates incentives for the employees to increase effort in order to improve their reputations, leading to a higher salary.

Douthit et al. [2012] consider cheap talk. In a repeating single-period experimental setting where production is observable but is a noisy indicator of effort, communication of a promised level of effort results in higher pay for the agent, higher effort, and higher expected profit for the principal than the control group with no communication. When the principal and agent interact over multiple periods, reputation building is ineffective, but cheap talk continues to yield superior outcomes. The results of the above two experimental papers support the principal-agent model in Stevens and Thevaranjan [2010], which incorporates some level of moral sensitivity on the part of the agent that allows the principal to rely on a previously agreed-upon level of effort.

Similar experimental research on the inclusion of the history of players has been conducted in other settings, most commonly the prisoner's dilemma. Duffy and Ochs' [2009] experiment shows that cooperation only appears in fixed-pairing treatments; in random-matching treatments a cooperative norm does not form. Duffy et al. [2013] corroborate the conclusion that history influences cooperation, finding that cooperation is more prominent with a longer available history. Camera and Casari's [2009] experimental results deduce that collaboration in an anonymous environment can be increased with monitoring and punishment. Therefore, regardless of the setting studied (simultaneous or sequential, prisoner's dilemma or principal-agent), contribution increases with monitoring.

The findings of this experiment, which determine the way the cost of information impacts cooperation and profits, are relevant for public policy. If costless information results in the highest productivity, then it would be profitable for an institution, like the government or a private firm, to subsidize the distribution of employment history to decrease the individual cost all employers currently have to pay when searching for new workers.

The chapter is organized as follows. A theoretical model is presented in Section 2.2. Section 2.3 describes the experimental set-up, followed by its hypotheses in Section 2.4. The analysis of the data is provided in Section 2.5. Section 2.6 concludes.

2.2 Model

In this standard moral hazard scenario, there are two types of players: employees and employers. An employer can offer two types of wages, ($\underline{w}$ and $\bar{w}$, where $\underline{w} < \bar{w}$) and an employee can exert two levels of effort ($\underline{e}$ and $\bar{e}$).

In each period, the utility functions take the following form:

$$\begin{aligned} u_{employer} &= K + B(e) - w - s\mathbb{1}_{\text{CostlyHist}} \\ u_{employee} &= w - c(e). \end{aligned} \tag{2.1}$$

K is the endowment an employer receives at the beginning of each period. A wage offer to the employee cannot exceed the endowment. $B(e)$ is a concave revenue function of the employer, which is based on the employee's effort level. The employee history is costly only in one treatment (CostlyHist), where it is denoted by the exogenous variable s. $c(e)$ is a convex cost function an agent faces with a chosen effort level.

The game consists of m players, who are randomly and anonymously rematched in every period.[1] Subjects complete a total of n periods. The total utility received by the players is the sum of their payoffs from n periods:

$$\begin{aligned} U_{employer} &= \sum_{i=1}^{n}(K + B(e_i) - w_i - s\mathbb{1}_{\text{CostlyHist}}) \\ U_{employee} &= \sum_{i=1}^{n}(w_i - c(e_i)). \end{aligned} \tag{2.2}$$

Table 2.1 displays the payoff matrix for one period of the binary game.

Table 2.1: Payoff Matrix

		Employer	
		$\bar{w}$	$\underline{w}$
Employee	$\bar{e}$	$K + B(\bar{e}) - \bar{w} - s\mathbb{1}_{\text{CostlyHist}}$ $\bar{w} - c(\bar{e})$	$K + B(\bar{e}) - \underline{w} - s\mathbb{1}_{\text{CostlyHist}}$ $\underline{w} - c(\bar{e})$
	$\underline{e}$	$K + B(\underline{e}) - \bar{w} - s\mathbb{1}_{\text{CostlyHist}}$ $\bar{w} - c(\underline{e})$	$K + B(\underline{e}) - \underline{w} - s\mathbb{1}_{\text{CostlyHist}}$ $\underline{w} - c(\underline{e})$

[1] In order to simulate an interaction with a new opponent, players are randomly assigned to a new pair. The identity of the new match is kept anonymous, to eliminate any bias unrelated to the information provided in the game.

Both the employer and employee can choose which level of wage and effort to employ in this sequential-move game. Each period consists of the following stages. In the first stage (which only applies to the treatment with costly history), the employer chooses whether to pay to obtain an employee's work history (which consists of the employee's past effort and wages). In stage 2, the employer offers a wage. The employee will learn the wage offer, and in the third stage choose an effort level based on the provided information. Lastly, both sides are shown their payoffs for the period. In this binary scenario, the model reduces to a sequential Prisoner's Dilemma.

2.2.1 Finite Game

I will first examine a finite game. In a one period game, the bottom right cell $(\underline{e}, \underline{w})$ is the Nash Equilibrium. Both parties will enjoy higher profits if they play the top left strategy $(\bar{e}, \bar{w})$, but by backwards induction, that allocation cannot be obtained by rational players, because each player can benefit from a unilateral deviation to lower inputs.

Next, consider a finite, two-period game where players are matched with new partners after each period. The equilibrium in the two-period game has the stage game Nash equilibrium repeated in each period. Rational players will use backward induction and will select the $(\underline{e}, \underline{w})$ equilibrium. I will explain the reasoning under different treatments.

Consider three scenarios with the following variable: the employer is offered no employment history of the employee, the employer is able to observe the employee's history at no cost, and the employee's history can be viewed at a cost to the employer. If the employer is provided with no employee history, a backward induction solution is to for the participants to choose $(\underline{e}, \underline{w})$ in every period, since every period can be thought of as a one-shot game.

A scenario with costless history yields the same result. In the second stage of the second period, the employee will always select low effort; there is no punishment for not contributing the higher effort. Knowing this, the employer will offer a low wage in the first stage of period two. This is the optimal solution despite the employee's choice of effort in the first period. If the employee knows his goodwill gesture of a high effort in period one will not be rewarded by a high wage in period two, he will not elect to provide a high effort. Lastly, by this predicted chain of events, the employer will offer a low wage to the employee in period one.

Since the employer knows the employee's dominant strategy is to select $\underline{e}$ in the second period, he has no reason to pay a cost to purchase the employee's history before making a wage offer in period two, which leads to the same solution to the game with costly history as that in the above scenario with costless history. This result will apply to all finite games, regardless of the number of periods.

2.2.2 Indefinite Game

This paper next considers an indefinitely-repeated game, where players participate in an unknown number of rounds. A scenario where an employee's history is not shown to the employer has the same outcome as the finite game. Due to random pairing, no history is formed, therefore each period can be treated as a one-shot game, with a strategy of $(\underline{e}, \underline{w})$ being the equilibrium.

When the employers are provided the employee's history at no cost, the Pareto efficient strategy $(\bar{e}, \bar{w})$ can be maintained in each round under specific conditions. The effort the employees exert in the present round impacts their future payoffs because they are screened by their future employers. Since, in each round, their wage is given to them before they decide on their choice of effort, the only incentive to provide anything other than low effort is to increase their future earnings. Due to information being freely provided to all employers, the result would be the same for cases of paired or random matching.

Consider the following grim trigger strategy. Employees and employers choose $\bar{e}$ and $\bar{w}$, respectively, assuming that this has happened in every preceding period. If either player deviates, then players choose $\underline{e}$ and $\underline{w}$ forever.

On the equilibrium path, an employee obtains the following payoff:

$$\sum_{t=0}^{\infty} \delta^t (\bar{w} - c(\bar{e})) = \frac{(\bar{w} - c(\bar{e}))}{1-\delta} \tag{2.3}$$

Future payoffs are discounted by a factor of δ to express traditional time preference or uncertainty about the length of the game. A deviating employee obtains the following payoff:

$$(\bar{w} - c(\underline{e})) + \sum_{t=1}^{\infty} \delta^t (\underline{w} - c(\underline{e})) = (\bar{w} - c(\underline{e})) + \frac{\delta(\underline{w} - c(\underline{e}))}{1-\delta} \tag{2.4}$$

Hence, a cooperating equilibrium can be maintained if the payoff from cooperating is greater than the payoff from defecting:

$$\begin{aligned} \frac{(\bar{w} - c(\bar{e}))}{1-\delta} \geq (\bar{w} - c(\underline{e})) + \frac{\delta(\underline{w} - c(\underline{e}))}{1-\delta} \Leftrightarrow \\ \delta \geq \frac{(\bar{w} - c(\underline{e})) - (\bar{w} - c(\bar{e}))}{(\bar{w} - c(\underline{e})) - (\underline{w} - c(\underline{e}))} = \frac{c(\bar{e}) - c(\underline{e})}{\bar{w} - \underline{w}} > 0 \end{aligned} \tag{2.5}$$

As long as the discount factor is above that threshold, the employees will benefit in offering a high effort level.

Unlike the employee, the employer does not need to consider his future payoffs when choosing a wage. The employee he is matched with in each period will only see the wage selection of the current period. If the game is sequential and repeated, and it is assumed a grim-trigger strategy will be implemented in the case of deviation, it is not rational for an employee to offer a high effort in return for a low wage; therefore, if cooperation has been upheld up to that point, the employer will not be able to receive high effort if he deviates first. If he wants to maintain the Pareto efficient equilibrium, he will always offer a high wage. However, the employer should only offer a high wage if he believes he can receive a high effort in return. The employer will be able to form his belief about the employee after viewing the employee's history. Therefore, the employer's strategy will be to offer a high wage if he sees high effort in the employee's history, and a low wage if the employee is seen to have exerted low effort in the past.

The above model can be used to determine the equilibrium in the treatment that provides an employee's work history at no cost. With costly history, the indicator variable is activated and the utility function of the employer becomes $U_p = K + B(e) - w - s$. The introduction of costly history does not enter the utility function of the employee, so it will not affect the employee's threshold value of δ to maintain cooperation.

I modify the model by making costly information mandatory for the employer. Costly history will decrease all the payoffs of the employer by the cost of purchasing the history, which is be denoted s.[2] The uniform decrease in utility will not change the employer's optimal strategy in a sequential move game. The employer will maintain the same strategy to only offer a high wage if he sees his employee has reciprocated with high effort in the past.

The experiment conducted for this paper gives employers the option of paying to obtain the work history of their employees. Consider another scenario, where the employer is not always required to pay to receive information, and can opt out of receiving an employee's history. If his future employers cannot see his effort history, the employee has no incentive to exert $\bar{e}$. By backwards induction, the employer is best off not providing $\bar{w}$, leading to an equilibrium strategy of $(\underline{w}, \underline{e})$. With history, as provided in the proof above, $(\bar{w}, \bar{e})$ can be sustained if the players value their future earnings.

Past experiments have found that when history is not available, each round is played like a

[2]For mathematical simplicity, I assume a boundary on the cost of history such that the utility of the employer is always non-negative.

one-shot game, where players defect and cooperation is not built up over time. That is due to the lack of a need to create a reputation. Duffy et al. [2013] find that with the choice of costly screening, cooperation between players increases, even if screening is not implemented in every round.

I will determine the conditions under which the employer will choose to pay the cost to receive an employee's history. Consider the following utilities:

$$p(K + B(\bar{e}) - \bar{w}) + (1 - p)(K + B(\underline{e}) - \underline{w}) - s \geq K + B(\underline{e}) - \underline{w} \tag{2.6}$$

The left side of the above inequality is the expected utility the employer will receive if he chooses to purchase access to the employee's history in a given period. Employers believe the proportion of employees willing to cooperate is p, and the proportion of defecting employees (those who exert low effort regardless of wage) is $(1 - p)$. If the employer chooses to pay to receive the history, with probability p he will see that he is matched with who he believes is a reciprocating employee, will offer him a high wage, and receive high effort in return.[3] With probability $(1 - p)$, the employer is matched with an uncooperative employee, for whom he will offer a low wage in return for a low effort. In addition, he will need to pay the cost to obtain the history. If the employer does not pay for the information, he will offer a low wage and receive low effort; without the availability of history, it is optimal to offer a low wage.

I solve the above equation for the condition under which the expected utility of the employer is higher when he pays for the information than when he does not.

$$p[(B(\bar{e}) - \bar{w}) - (B(\underline{e}) - \underline{w})] \geq s \tag{2.7}$$

As long as the cost of obtaining history is below this value, employers will always pay to

[3] I am assuming that employees are maintaining the behavior consistent with their history.

obtain the history. And given that the employees value the future enough (based on their δ), they will always exert high effort in return for a high wage, setting the value of p to 1. According to this model, effort, wage, and utilities of both employees and employers will increase with the offers of both both costless and costly history, in comparison to a lack of history.

I have proven that in theory, cooperation can be achieved in an indefinitely repeated game. In the finitely repeated agency problem, defection in every subgame is the dominant strategy of rational players, based on backward induction. However, that solution has been found to not always apply, specifically if the players' assumptions are altered.

Andreoni and Miller [1993] conducted an experiment testing the model of Kreps and Wilson [1982], and found that cooperation can be achieved in finitely repeated games if players believe there is a chance their opponents may be altruistic. If a player is altruistic, he may receive extra utility (that is labeled as 'warm glow') from cooperating, or may play a tit-for-tat strategy. Due to this belief, players can cooperate for some time in the finite game, in order to build reputations before the game resorts to mutual defection.

When an employee's history is not present, and players have no information about their opponents, in both the finite and indefinitely repeated games the optimal strategy is to always defect, since no reputations can be constructed. However, in scenarios that provide players' histories, altruism can be signaled, and it is possible to sustain cooperation in finite games. The tit-for-tat strategy that was discussed in Andreoni and Miller's (1993) paper that makes cooperation possible is similar to the grim trigger strategy assumed in the model of this paper. Therefore, if players believe their opponents are willing to cooperate for some time, then the finite game can be played as the indefinitely repeated game for a period before it unravels. Providing employee history is the signal that can uphold collaboration. In that case, the decisions based in the indefinitely repeated game are mirrored in the decisions of the finite game.

2.3 Experiment

This experiment was conducted in a computer lab, using the ZTree software (Fischbacher [2007]). Subjects were recruited via an email sent to the undergraduate students at UC Irvine. Participants were randomly split into two groups: employees and employers.

The revenue and cost functions of both types of players, presented in Table 2.2, are obtained from Charness and Kuhn [2007].[4] The players' utility functions in each period are the following:

$$\begin{aligned} u_{employer} &= 4.5 + B(e) - w + s\mathbb{1}_{\text{CostlyHist}} \\ u_{employee} &= w - c(e) \end{aligned} \tag{2.8}$$

The participants are informed that the experiment consists of three treatments, ten periods each. Employers are given 4.5 lab dollars in each period, and decide how much to pay their employee. In each period, the employer moves first by offering his employee a wage. After seeing their wage offer, the employee then decides how much effort to supply to the job. The cost to the employee to provide each amount of effort and the revenue it generates for the employer is provided in Table 2.2. The table is set up such that high effort is efficient, as it maximizes the sum of utilities.

In an attempt to equate average earnings between the two roles, the conversion rate is different between the types of players; employers are paid $1 for 15 lab dollar earned, and employees are paid $1 for 6 lab dollar. The players are aware of the conversion rate for their type, but not that of their opponents.

[4] The cost of history, s, is only included in the treatment with Costly History.

Table 2.2: Effort Costs and Revenues

Effort Level	Cost to Employee	Revenue Produced by Employee
Zero (0)	0	0
Low (1)	0.10	2.80
Medium (2)	0.30	4.20
High (3)	0.60	5.40

The players are told that in every period of every treatment, each employer is randomly matched with an employee. The experiment follows a within-subject design, with all subjects in each session participating in three treatments:[5]

1. No History: No employee history offered.

2. Costly History: Employer is offered the opportunity to purchase costly history of the employee before making a wage offer.

3. Costless History: Employee's history is provided to the employer at no cost.

The variable in the treatments is the availability of employee history. The NoHist treatment offers the employer no prior information about the employee he is matched with. In the CostlyHist treatment, the employer has the option to pay to screen each new employee before presenting him with a wage offer. The employer will need to pay 0.5 lab dollars in each period that he chooses to request a new employee's history. The CostlessHist treatment provides that information freely to the employers.

The information regarding the employee's past work history consists of the employee's past effort levels, along with the wages he was offered, in an an attempt to mimic a résumé. This material helps the employer assess what level of effort to expect, so he can offer an

[5] A within-subject design was chosen instead of a between-subject design because the treatments are relatively short.

appropriate wage and maximize his own utility.

After seeing the offered wage, the employee will choose a nonnegative effort level to contribute to the job. Payoffs are then computed based on the linear utility functions of the employer and employee. Each treatment lasts 10 periods to set a clear time limit on the experiment. This means that each player is randomly paired ten times in each treatment. The subjects are paid for each period based on the conversion rate for their role.

In addition to the three treatments, this experiment includes a risk-aversion assessment question (administered at the beginning of each session), and finishes with a questionnaire. The results of the risk assessment question are not shown to the subject until the end of the session, when the participants are shown their payoffs for all parts of the experiments. Subjects are paid based on their risk elicitation choice. Altogether, subjects' payoffs were composed of five parts: $7 show-up payment, an amount based on their risk preference, and a payment for each of the three treatments.

Five sessions were conducted at the Experimental Social Science Laboratory at University of California, Irvine, with a total of 68 participants. A brief summary of subject demographics is provided in Table 2.3. The average earnings were $19.44, which included the $7 show-up payment, and 55 percent of the subjects were female.

Table 2.3: Summary Statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Age	20.20	1.34	18	23
Gender = F	0.55	0.5	0	1
Payoff	19.44	1.92	15.9	25.1

2.4 Hypotheses

The focus of this paper is to examine the differences in wages, effort levels, and utilities across the three treatments. Based on the model and previous studies, it is expected that the availability of history moves the players to the Pareto efficient equilibrium of higher wages and efforts. Therefore, I formulate the following hypotheses:

Hypothesis 1: $e_{NoHist} < e_{CostlyHist} = e_{CostlessHist}$

Hypothesis 2: $w_{NoHist} < w_{CostlyHist} = w_{CostlessHist}$

Hypothesis 3: $u_{NoHist} < u_{CostlyHist} = u_{CostlessHist}$ for employee

Hypothesis 4: $u_{NoHist} < u_{CostlyHist} < u_{CostlessHist}$ for employer

I predict that when employers do not view the history of employees, both types of players will defect to offering low wages and efforts, as they are not working on building reputations. With history, employees will be incentivized to produce more effort, and since the cost of obtaining the worker history does not fall on the employee, their efforts should be consistent in the two treatments with costly and costless screening.

I expected the employers to absorb the cost of history and not transfer it to employees in the form of a decrease in wages. The cost of history is not large enough in this experiment to dispute this hypothesis; if the history cost is increased, that may be reflected in wages. Finally, the hypothesis for the profits follows the hypotheses for the efforts and wages.

To establish a prediction for when employers will pay to obtain employee history, I will use the highest and lowest wages and efforts to plug in to the threshold equation for purchasing history:

$$
\begin{aligned}
& p[(B(\bar{e}) - \bar{w}) - (B(\underline{e}) - \underline{w})] \geq s \\
& \Leftrightarrow p[5.4 - 4 - 0 + 0 \geq 0.5] \Leftrightarrow p \geq 0.357
\end{aligned}
\tag{2.9}
$$

Employers will pay to view employee history if they think at least 35.7 percent of the employees are willing to cooperate.

2.5 Experimental Results

The results are presented in the order of the hypotheses listed above.[6]

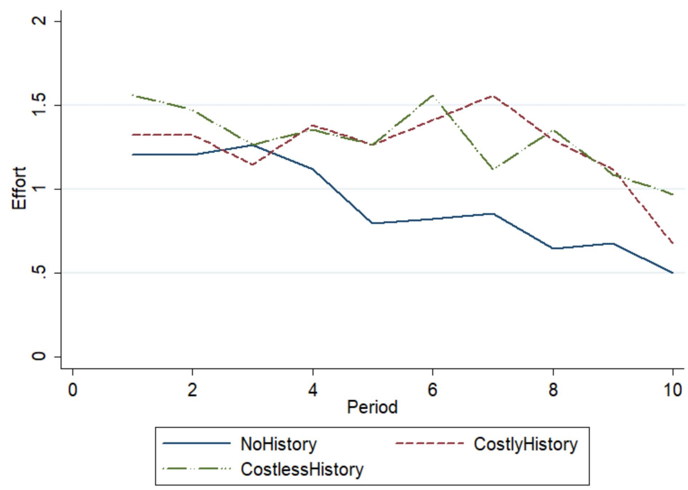
Result 1: Effort levels are higher in the treatments with history (both costly and costless) than in the treatment without employee history.

I begin my analysis with the first hypothesis by examining the difference in effort levels across the three treatments. Figure 2.1 displays the progression of the average effort levels chosen in each period, graphing each treatment separately. All lines follow a similar decreasing trend; this pattern is believed to be tied to the wages, and is further described under the results of hypothesis 2. The average efforts in CostlyHist and CostlessHist appear to be higher than the effort levels in NoHist. Effort levels in CostlyHist and CostlessHist cross, and when the average is computed, the difference between them is not significant. After approximately the first three periods, average efforts in CostlyHist and CostlessHist separate from and are consistently higher than NoHist. There are two possible explanations for the paths of the effort levels. First, it takes a few rounds for subjects to get accustomed to a treatment.

[6] Treatments shall be referred to by the variable condition: NoHist, CostlyHist, and CostlessHist.

After they do, they put in more effort in the treatments with employee history. Second, the effort levels follow the wage offers, as the curves of the effort levels form a similar shape to the wages of the corresponding treatment.

Figure 2.1: Average Effort Levels, by Period and Treatment



To verify the above observations, I run an ordered probit regression of efforts on wages and dummy variables for the three treatments. The results are presented in Table 2.4. All regressions cluster on the 34 employees (half of the subject pool, since subjects were assigned to one of two roles) to generate robust standard errors.[7] Columns 1 and 2 use CostlyHist as a default variable, and vary by the period fixed effects used in the regressions. Column 1 clusters on the ten periods of each treatment, while column 2 takes order effect of treatments into consideration and clusters on the thirty total periods in each session.

Table 2.4 displays the finding that wage has a significantly positive impact on the effort level. This is explained by reciprocity; employees respond in kind to their employers if they receive fair wages. Since employees are second movers, they are not taking on risk when they contribute high effort.

The next variables of interest are the treatment dummies; the regressions show that effort

[7]All regressions include subject fixed effects.

Table 2.4: Efforts Across Treatments

	(1) Effort	(2) Effort	(3) Effort	(4) Effort	(5) Effort
NoHist	-0.394*	-0.424		-1.131*	-0.394*
	(0.167)	(0.246)		(0.526)	(0.167)
CostlessHist	0.0735	0.0402	0.467*	-0.0492	0.0735
	(0.106)	(0.158)	(0.187)	(0.427)	(0.106)
CostlyHist			0.394*		
			(0.167)		
Wage	0.774***	0.802***	0.774***	0.775***	0.774***
	(0.141)	(0.144)	(0.141)	(0.144)	(0.141)
NoHist_first				0.632	
				(0.368)	
CostlyHist_second				-0.444	
				(0.424)	
CostlessHist_first				-0.616**	
				(0.235)	
CostlessHist_second				0.0987	
				(0.465)	
RiskSeeking					-0.507***
					(0.0885)
RiskAverse					-0.903***
					(0.0918)
Constant	2.251***	2.182***	2.645***	2.024***	2.251***
	(0.369)	(0.456)	(0.426)	(0.488)	(0.369)
Session Period Effects	No	Yes	No	No	No
Observations	1020	1020	1020	1020	1020

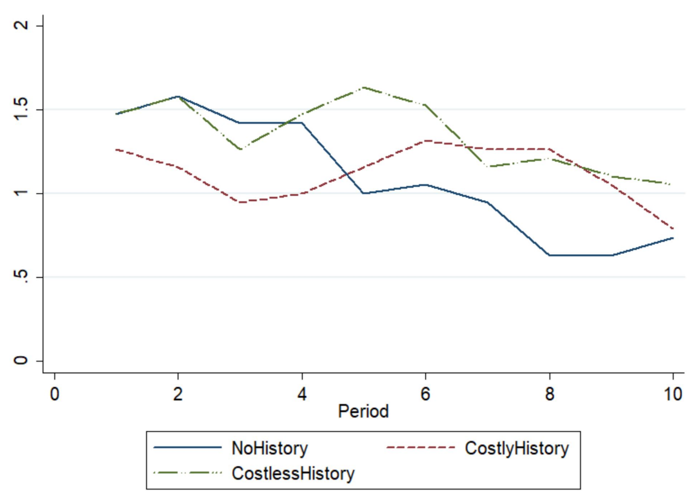
Note: Robust standard errors, adjusted for clustering on 34 individual employees, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

levels in CostlessHist do not significantly differ from CostlyHist. This can be explained by the threat of exposure. In CostlyHist, employees do not know when their history is observed, but the possibility is always present. When faced with the risk of their actions being revealed, people lean towards observing rules.

Compared to CostlyHist, effort in NoHist shows a significant decrease, but only in column 1. This result follows the theory, because NoHist can be treated as a one-shot game where reputation-building is not a necessity. Therefore, shirking does not have costly consequences.

Column 3 differs by setting NoHist as the default treatment to differentiate NoHist from CostlessHist. As a result, effort levels in CostlessHist are higher than in NoHist. This is consistent with the theory and the above explanation that history encourages cooperation.

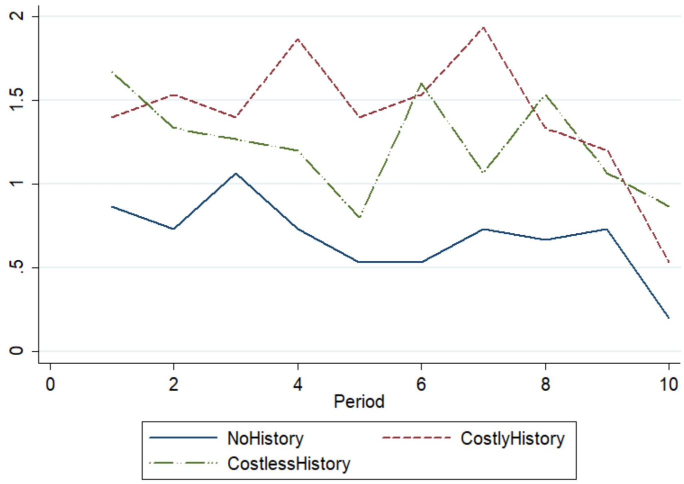
Figure 2.2: Average Effort Levels, by Period and Treatment, with No Hist First



Column 4 adds dummy variables to extract an order effect. Figures 2.2 and 2.3 separate the data by the order of the treatments. In the sessions presented in Figure 2.2, NoHist was completed first by the subjects, and CostlyHist and CostlessHist alternated in order; in Figure 2.3, NoHist was executed last. Based on the difference in these graphs, an order effect appears to develop, which I attempt to capture in column 4.

The effort level of NoHist was significantly higher at the 10% level when NoHist was com-

Figure 2.3: Average Effort Levels, by Period and Treatment, with No Hist Last



pleted first, versus last. The opposite holds true for CostlessHist, which showed lower effort levels as a first treatment than as a last treatment. Lastly, there is no significant change between treatments performed in the second or third place.

I hypothesize that effort in NoHist was smallest when it was completed last (Figure 2.3) due to the subjects learning the game. When the subjects played NoHist first, the efforts were initially higher than in the other two, latter treatments, which is inconsistent with theory. Not only do the effort level decrease with each period, the negative effect carries over to the next treatments. This implies that regardless of the treatment, altruism is present at the start of the game, and decreases with time.

I use the similar explanation of subjects taking some time to become acquainted with the game to explain the increase in effort in CostlessHist when it is a played last. It is possible that subjects did not fully comprehend the game when they began the session.

The remainder of Table 2.4, column 5, adds the subjects' risk assessment to the regression. This regression shows that risk-seeking and risk-averse subjects chose lower effort levels than risk-neutral players. Across the three sessions, only one employee was risk-seeking, so I am hesitant to believe the coefficient associated with risk-seeking subjects due to its small sample size. I will acknowledge the coefficient identified with risk-averse players, because the number of those individuals is a respectable proportion of the subject pool. The result that risk-averse employees exert less effort than risk-neutral employees is puzzling, since the employees are the second movers. They have the advantage of having no uncertainty in their payoffs after they make their move. It could be that risk-averse players are more passive and are trying to maximize the payoff of the present periods by minimizing their contribution.

Another caveat to consider is the validity of the risk assessment. Due to budget constraints, only a small amount of funding could be allocated to extract the risk factor of the subjects.[8] To more accurately elicit the risk behavior a subject, the stakes would need to be higher.

Result 2: No difference in wages is found between any of the treatments. However, the ordering of the treatments affects wages, prompting employers to make higher offers in the beginning of the session.

Hypothesis 2 compares wages between the three treatments. Figure 2.4 graphs the average wages by period, separated by treatment. Like the graph of the effort levels, there is a decline in wages as each treatment progresses. Contrary to theory, a distinct differentiation of wages between the treatments cannot be confirmed. Wages in NoHist are the highest initially, but wages for all three treatments converge as the game progresses. An OLS regression of the wages can be found in Table 2.5.

Similarly to Table 2.4, columns 1 and 2 of Table 2.5 vary by the period fixed effects included in the regressions, and column 3 sets NoHist as the default variable. In these first three regressions, the wages do not diverge across the treatments.

Since there is no significant difference between wages of CostlyHist and CostlessHist, the

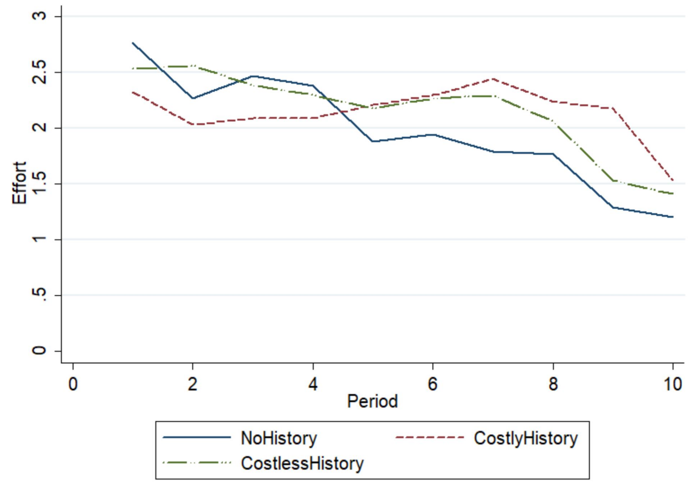
[8] Earnings from the risk assessment ranged from \$0.80 to \$5.00.

Table 2.5: Wages Across Treatments

	(1) Wage	(2) Wage	(3) Wage	(4) Wage	(5) Wage
NoHist	-0.165	0.115		-0.112	-0.165
	(0.215)	(0.289)		(0.673)	(0.214)
CostlessHist	0.00882	0.201	0.174	0.351	0.00882
	(0.149)	(0.231)	(0.217)	(0.649)	(0.148)
CostlyHist			0.165		
			(0.215)		
NoHist_first				0.855*	
				(0.376)	
CostlyHist_second				0.668	
				(0.626)	
CostlessHist_first				0.157	
				(0.225)	
CostlessHist_second				0.577	
				(0.636)	
RiskSeeking					-0.133***
					(6.18e-15)
RiskAverse					0.600***
					(5.76e-15)
Constant	2.935***	3.044***	2.771***	2.296***	1.885***
	(0.142)	(0.324)	(0.164)	(0.635)	(0.0992)
Session Period Effects	No	Yes	No	No	No
Observations	1020	1020	1020	1020	1020
Adjusted R^2	0.318	0.357	0.318	0.353	0.281

Note: Robust standard errors, adjusted for clustering on 34 individual employers, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 2.4: Average Wages, by Period and Treatment



cost to obtain history does not compress the wages. This implies that the employers absorb the cost of obtaining history, subtracting it from their profits.

Akin to the effort levels, I believe the ordering of the treatments impacts wages as well, so I separate the wages by the treatment order in Figures 2.5 and 2.6. In Figure 2.5, NoHist was always presented first to the subjects, and the ordering of CostlyHist and CostlessHist alternated in sessions. It is possible that the subjects started off offering high, generous wages, but the offers decreased with time when they were not reciprocated with high efforts. In Figure 2.6, NoHist was played last, and its wages are the lowest, as predicted by theory.

Like Table 2.4, Table 2.5 includes treatment order dummies. The regression supports the findings from Figures 2.5 and 2.6: NoHist resulted in higher wages when it was performed first, confirming an order effect.

The last column of Table 2.5 includes the risk assessment of the players. Only two employers self-selected into the risk-seeking category. The regression results tell us that higher risk aversion leads to higher wages. Since employers make the first move in this sequential-move game, they stand to lose more.

Figure 2.5: Average Wages, by Period and Treatment, with No Hist First

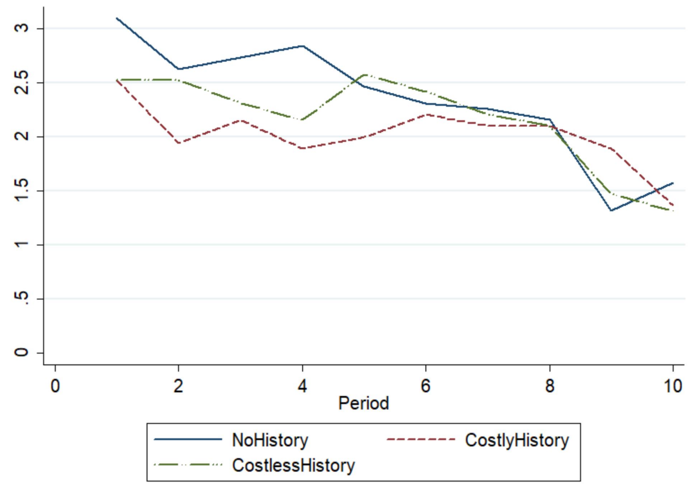
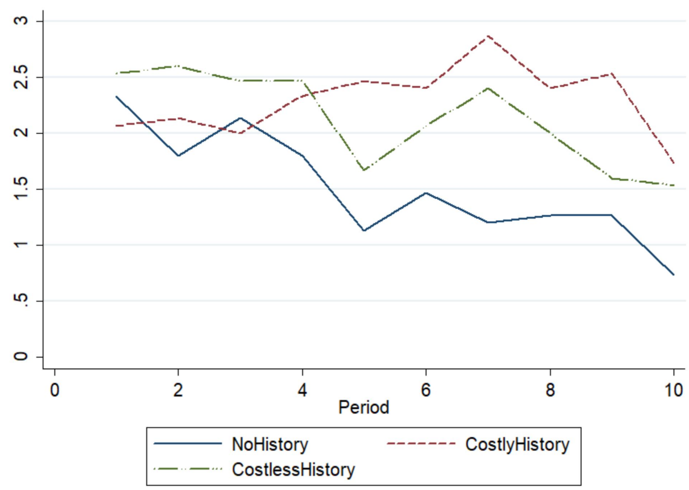


Figure 2.6: Average Wages, by Period and Treatment, with No Hist Last



Result 3: When presented with employee history, employers use the information to adjust their wage offers. If they do not have access to an employee's records, employers base wage offers on their own experience with past employees.

The investigation further explores the effect of placing a cost on employee history. As predicted, employers did not always purchase history of their employees when provided with the opportunity; in this data, employers chose to buy history 37 percent of the time in CostlyHist. The data did not appear to show any pattern for purchasing history.

Figure 2.7: Frequency of Employers Paying for Employee History

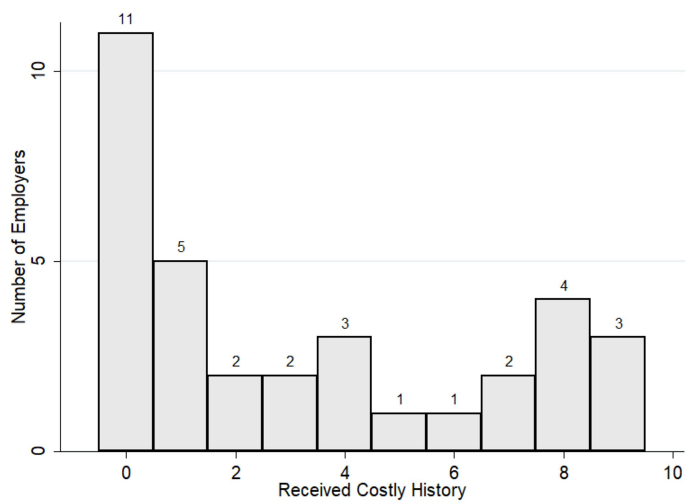


Figure 2.7 summarizes the number of times the employers chose to pay to receive history in CostlyHist. For example, eleven employers chose to never pay to receive history, five employers only paid to receive history one time, and another two employers only chose to pay twice. On the other end of the table, seven employers paid 8 or 9 times for information. In all, there does not appear to be a pattern for the number of times employers chose to pay to receive information.

In CostlyHist, employees chose an effort level of zero 32 percent of the time. If I assume cooperation is returning an effort level greater than zero, then employees cooperated 68 percent of the time, which exceeds the requirement of 35.7 determined by the model. This makes purchasing employee history the optimal action for the employers.

Table 2.6 provides an examination of the impact of purchasing employee history on wages of the employers in CostlyHist.[9] I include a dummy variable that is called 'purchase history', which takes a value of 1 if an employer chose to pay to receive the employee's history and 0 otherwise. In CostlyHist, the employer's choice to purchase history had no significant impact on the wage offered to the employee. This implies that the cost to purchase history was deducted from the employer's profit, and not the wage, an explanation consistent with Table 2.5.

Table 2.6: Impact of Costly History on Wages in CostlyHist

	Wage
Purchase History	0.0559
	(0.308)
Constant	2.581***
	(0.140)
Observations	306
Adjusted R^2	0.452

Note: Robust standard errors, adjusted for clustering on 34 individual employers are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To delve further into the effects that work history has on wage and employer profits, I filter the data to only include observations where employee history was observed, and present the results in Table 2.7. I keep all the data from CostlessHist, and the periods from CostlyHist in which employers chose to pay for history. Period 1 is omitted in both treatments due to it lacking access to employee history.

Columns 1 to 3 regress wages on a treatment dummy (only one is included, since NoHist is omitted), and the lagged effort variables. These columns differ by the number of lagged variables that are included in each regression. Column 1 only takes into consideration the

[9]Table 2.6 includes subject and period fixed effects.

Table 2.7: Wages and Profits With History

	(1) Wage	(2) Wage	(3) Wage	(4) Profit	(5) NewProfit
CostlyHist	0.0268	0.114	0.127	-0.381*	0.1187
	(0.184)	(0.174)	(0.191)	(0.1688)	(0.1688)
EffortLag1	0.543***	0.445***	0.404***		
	(0.0746)	(0.0802)	(0.0891)		
EffortLag2		0.350***	0.380***		
		(0.0616)	(0.0625)		
EffortLag3			0.0848		
			(0.0727)		
Constant	1.429***	0.999***	0.681**	5.123***	5.123***
	(0.177)	(0.226)	(0.237)	(0.0713)	(0.0713)
Observations	417	374	328	417	417
Adjusted R^2	0.435	0.482	0.498	0.937	0.937

Note: Robust standard errors, adjusted for clustering on 34 individual employers, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

lagged effort from one previous period. Column 2 takes into account the lagged efforts from the last two periods, and column 3 from the last 3 periods. In all three scenarios, there is significant change to wages based on the past effort; the better the work ethic of the employee, the higher the wage offer he will receive. Only the most recent past work matters, as the significance disappears by the third lagged period. As I found earlier in Table 2.4, there is no significant difference between wages of CostlyHist and CostlessHist, meaning there exists a lack of a distinction between the wage offers of periods where employers pay to receive employee history versus where they are supplied with the history for free.

Column 4 analyzes the difference in profits between the two treatments, conditional on only using observations which include employee history. Profits in CostlyHist are lower than in CostlessHist by 0.38 lab dollars. The screening cost is 0.50 lab dollars, so the similar magnitude implies that the difference in profits could be due to that cost of history.

Column 5 creates a new dependent variable for profit. It adds a constant 0.50 to all observations where the employer paid to screen, to compensate for the cost. The objective is to compare the profits between the two treatments while adjusting for the cost of history. It is shown that with this modification, a difference in profits between CostlyHist and CostlessHist cannot be confirmed. Therefore, by elimination, the difference in non-adjusted profits may be due to the screening cost, as the wages and effort levels do not differ.

The discovery that employee history impacts future wages is consistent with previous findings. At the end of the experiments, subjects were asked to fill out a questionnaire. One of the questions asked the students to describe their strategy. The hypothesis that the ordering of the treatment matters is consistent with the free response answers of the employers. Several subjects who were assigned to play employers wrote that they started off paying high wages, but when employees did not reciprocate, they deviated to lower wages.

From Table 2.7, Graph 2.2, and the survey results gathered from the subjects, I find that wages decreased with time when the employers thought they were not being compensated enough by their employees. Even though there was no history available in NoHist, the wage offers declined with each period. Why would wages decrease if the employers did not have employee history to reference? My conjecture is that employers base their wages on their own history.

To test this question, I regress wages in periods where no employee history was provided (NoHist and the observations in CostlyHist where employers chose not to obtain history) on the employers' own prior round history, and present the outcome in Table 2.8. The results found were curiously significant; the efforts the employer received in the past periods influenced his wage offer to his new employee. So the new employee was rewarded or punished not based on his own record, but on the experience of the employer. This means that employers form assumptions about new employees, whether that information is correct or not.

Table 2.9 regresses the wages of employers who viewed employee records (CostlyHist and

Table 2.8: Employers' Own Prior Round History in NoHist and CostlyHist

	(1) Wage	(2) Wage	(3) Wage
CostlyHist	0.170	0.0865	0.108
	(0.212)	(0.188)	(0.186)
EffortLag1	0.506***	0.480***	0.423***
	(0.0963)	(0.0886)	(0.0759)
EffortLag2		0.278***	0.271***
		(0.0669)	(0.0715)
EffortLag3			0.175**
			(0.0527)
Constant	2.399***	2.134***	1.969***
	(0.146)	(0.164)	(0.181)
Observations	501	442	386
Adjusted R^2	0.559	0.602	0.620

Note: Robust standard errors, adjusted for clustering on 34 individual employers, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

CostlessHist) on the employers' own prior round history. No significance was found, meaning that when employers were given correct information, they utilized it properly. But when they were not provided with information, they did not update their beliefs, keeping them based on their own history.

This finding explains why the graphs are all downward sloping. In NoHist, wages were the highest in the beginning, employers were optimistic. But when they experienced low efforts in return, they chose to decrease their wage offers in the future rounds, even though they had no information on the new employee. Due to random matching, once an employee deviates, it contaminates the subject pool, causing the choices of all participants to spiral down. Since wages decrease, efforts decrease as well, and the population gets trapped in a downward spiral.

When given the past history of an employee, employers correctly used the information to offer wages that reflect an employee's work ethic. They did not make incorrect decisions based on their own experience. But when they had nothing to change their beliefs, they

Table 2.9: Employers' Own Prior Round History in CostlyHist and CostlessHist

	(1) Wage	(2) Wage	(3) Wage
CostlyHist	0.0594	0.140	0.202
	(0.203)	(0.191)	(0.216)
EffortLag1	0.0342	0.0176	0.0230
	(0.0850)	(0.0787)	(0.0848)
EffortLag2		0.152*	0.156
		(0.0744)	(0.0865)
EffortLag3			-0.00913
			(0.0571)
Constant	2.023***	1.695***	1.571***
	(0.195)	(0.267)	(0.245)
Observations	417	374	328
Adjusted R^2	0.283	0.276	0.277

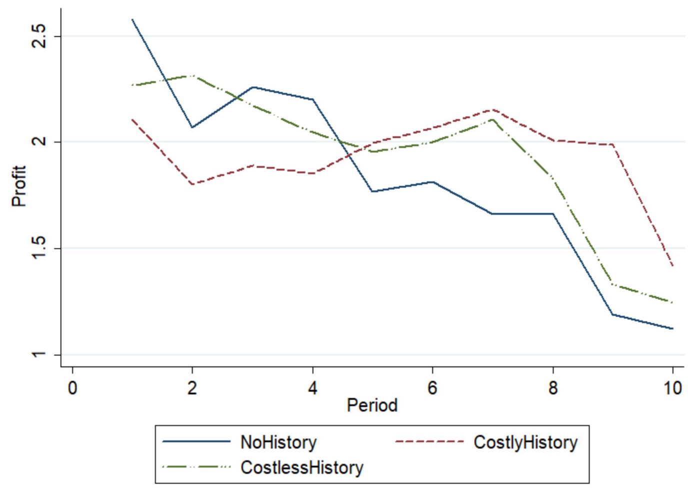
Note: Robust standard errors, adjusted for clustering on 34 individual employers, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

created their own priors, and made wage offers based on that knowledge. This means that subjects always attempt to use the information they have, even if its application is inaccurate.

Result 4: I do not observe a significant difference between any of the treatments in the profits of the employees.

The third hypothesis I am testing is ranking the employees' profits in the different treatments. Figure 2.8 displays the graph of the average employee profits, each treatment demonstrated by a separate line. Initially, profits from NoHist seem to be the highest, and CostlyHist the lowest, but mid-way through the treatment, the profits blend together. This is remarkably consistent with the graph of the wages. Wages were considered the lowest in CostlyHist (though there is no significance), and the employee profits closely followed them. Since wages make up a larger portion of the employees' profits than the cost of their work, this result is expected. The lack of variation in wages across the treatments leads to the absence of diversity in profits. Despite the high effort levels in CostlyHist and CostlessHist, the employees' selections of effort contributions were not large enough to overcome the magnitude of wages.

Figure 2.8: Employee Profits, by Treatment and Period



The regressions of employee profits are presented in Table 2.10. Columns 1 and 2 vary by the default treatment in the regressions. The results do not show significant variation in employee profits between any treatments, a finding which does not support the theory.

Figure 2.9: Employer Profits, by Treatment and Period

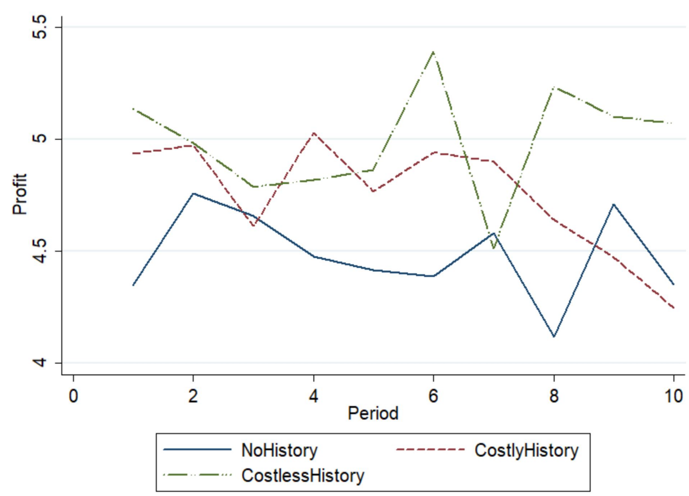


Table 2.10: Employee Profits Across Treatments

	(1) Profit	(2) Profit
NoHist	-0.0953	
	(0.151)	
CostlessHist	-0.00147	0.0938
	(0.143)	(0.157)
CostlyHist		0.0953
		(0.151)
Constant	2.350***	2.254***
	(0.137)	(0.140)
Observations	1020	1020
Adjusted R^2	0.131	0.131

Note: Robust standard errors, adjusted for clustering on 34 individual employers, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2.11: Employer Profits Across Treatments

	(1) Profit	(2) Profit
NoHist	-0.161	
	(0.148)	
CostlessHist	0.485**	0.646**
	(0.144)	(0.169)
CostlyHist		0.161
		(0.148)
Constant	4.633***	4.472***
	(0.219)	(0.170)
Observations	570	570
Adjusted R^2	0.036	0.036

Note: Robust standard errors, adjusted for clustering on 34 individual employers, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Result 5: Employers receive the highest profits in the treatment with costless history. Since wages do not experience a significant difference between treatments, that means that employers absorb the cost to receive costly information.

Table 2.11 (supplemented by Figure 2.9) examines employer profits to test the last hypothesis. The columns once again differ by the default treatment dummy. CostlessHist is found to produce the highest profit. Because wages do not greatly differ across the treatments, I am confident that profits in CostlyHist are lower than CostlessHist due to the price of work history. No significant difference is found between NoHist and CostlyHist, which I justify by the order effect (referenced in Tables 2.4 and 2.5).

Like hypotheses 2 and 4 predicted, the wages do not change with the addition of a fee on work history, as the employers absorb that cost, which decreases their profits. If employers could be subsidized for the fee when searching for new employees, their profits would be the same as in the case with costless history, which is an incentive for a new policy to store employment information in one database. Time spent collecting information would be decreased if it was kept in one virtual location. Websites like LinkedIn and Job Openings for Economists are examples of the trend.

2.6 Conclusion

In this chapter, I study the how placing a cost on the employee's work history affects wages, efforts, and profits, in order to add realism to current experimental literature. The addition of the fee, like predicted by theory, did not affect wages; employers absorbed the cost, which decreased their profits. With time, the employees put in more effort into the treatments where their employment history was available, as opposed to the treatment where their history was unobserved, in an attempt to build favorable reputations. Because employees were second movers, the fluctuations in their decisions closely followed the wages they were offered.

Employers used the employees' work history when it was provided, to offer appropriate wages based on their past performance. However, when employers did not have a history, they offered wages based on their own prior round interactions; employers rewarded or penalized their new employees based on their old employees' work ethic. In both scenarios, with or without history, employers formed assumptions about their employees, whether they were correct or not. Wages declined in all treatments due to employers not receiving fair efforts in return for their wages. Once subjects started defecting, it caused a downward trend in both wages and efforts that affected the entire subject pool.

The take-away from this experimental study is that subjects benefit when history of an opponent is provided, so that people are not paying for the mistakes of others, and a socially efficient outcome can be achieved if the cost of acquiring history is subsidized.

Chapter 3

References in the Labor Market: An Experimental Study

3.1 Introduction

When employers consider a job candidate, character assessment about the applicant is gathered from a variety of sources, impartial and subjective, ranging from academic merits to reviews by coworkers. Current labor market experimental literature has studied the agency problem (a game in which an employer provides a wage, in return for an uncertain amount of effort) by providing employers with information (varying in noise) sent by the employees about their employment history. This chapter modifies the source of information, implementing reports from an outside source into the interaction between an employer and employee. Since job candidates attempt to display their best characteristics before they are hired, to obtain a more thorough image of the employee, employers need to contact their past employers for references.

Agency theory has built models to explain this interaction between employers and employees.

It predicts that in one-shot interactions, it is rational for employees (the second movers) to shirk due to a lack of punishment in the future (Stevens and Thevaranjan [2010]). This assumption of defection is relaxed in repeated games, which economists are more interested in investigating to establish the factors that draw out reciprocation. Variations of models include incorporating the benefit players receive from complying with social norms (Fisher and Huddart [2008]) or the addition of moral sensitivity (Stevens and Thevaranjan [2010]) into the utility of players. One of the ways these games have been approached is by varying a player's access to information about their opponent. Studies in which an employer receives performance records directly from their employee have concluded that monitoring increases efforts, wages, and profits of all parties involved in the transaction, as opposed to when work history is not available (Bartling et al. [2012]).

This experimental chapter examines the influence of a third party on the choice of wages and effort levels of the employer and employee. Instead of handing over an employee's unbiased history, a past employer can send an evaluation of the employee to the new employer. This is done in an attempt to emulate reference letters that are often used when searching for employment.

To investigate the role of references, I design an experiment to analyze the wages offered by employers by varying their capabilities of sending reports to new employers. I include a baseline treatment of no prior references, as well as providing the information for free and at a cost, the latter to create the most realistic scenario. The cost of sending a reference includes the time and mental energy spent in writing the assessment. I find that even though the employers are aware the provided messages do not indicate a clear transmission of employee behavior, the signals are used to influence wages. In addition, the data show that employers exhibit reciprocating behavior by being more likely to send references after they have received them.

Receiving references from a past employer can be thought of as a form of cheap talk. Unenforceable commitments have been found to have a similar positive effect on the payoffs of players as when the communication was concrete (Kessler and Leider [2012]). Douthit et al. [2012] study cheap talk from employees through an experiment. Their construction consists of visible production, but a noisy reading of effort. To compensate, employees could send a message with a promised effort level, which resulted in greater cooperation (and thus, profits) for both the principal and agent, despite theory suggesting that signaling should be valued only when the preferences of the players are aligned (Crawford and Sobel [1982]).

The above results apply to other types of games as well, such as the prisoner's dilemma (Duffy and Ochs [2009], Camera and Casari [2009]), which also find that visible history developed through fixed pairing brings cooperation with it. Overall, monitoring promotes collusion, regardless of the set-up of the interaction.

The structure of this paper is as follows. Section 3.2 discusses multiple cases of a theoretical model by varying the length of the repeated interactions between employees and employers, as well as the availability and cost of employment history. Based on the theory, Section 3.3 formulates hypotheses for the experiment, which is described in Section 3.4. The results of the experiment are examined in Section 3.5. Section 3.6 provides the summary.

3.2 Model

Consider two types of players: employees and employers. An employer is randomly matched to a new employee in every period.[1] In the treatment with costless employer references, the following are the steps in each period:

- Stage 1: Each employer is matched to a new employee. The employer views reference

[1] In order to retain control over the history, this model will assume a finite and very large number of players, to eliminate the chance of future interactions.

r_{t-1}.

- Stage 2: Employer selects a wage w_t.
- Stage 3: Employee sees the wage offer and chooses e_t.
- Stage 4: Both players see their payoffs U_t.
- Stage 5: Employer leaves a binary reference $r_t \in \{good, bad\}$ at cost $k \geq 0$.

In each period, the utility functions are the following:[2]

$$\begin{aligned} u_P &= B(e) - w(r_{t-1}) \\ u_A &= w - c(e(w)) \end{aligned} \tag{3.1}$$

$B(e)$ is a revenue function, determined by the amount of effort the employee provides for the job. $C(e)$ is a convex cost function an employee faces, increasing in the amount of employee effort.

This model and experiment consider three treatments:

- Treatment 1: No Reference (NoRef)
- Treatment 2: Reference is costless, $k = 0$ (CostlessRef)
- Treatment 3: Reference is costly to employer, $k > 0$ (CostlyRef)

Treatment 1 lacks the first and fifth stages listed above, and treatment 3 places a cost to supply the reference in stage five.

[2]P stands for principal, and A for agent.

3.2.1 Finite Game

I will start with a basic scenario of a two period game. Without recommendations, each period will be played like a one-shot game, leading all parties to defect to the lowest contributions. The same result will be found in finite games with endorsements. By backward induction, it is most profitable for employees to defect in period 2.[3] In expectation of this, employers will defect in their wage offers in period 2. In period 1, since employees know the employers in period 2 will give them a low wage, they have no incentive to perform well in period 1, which will result in a low wage in the first period.

The same reasoning will apply to any finitely-repeating game: both types of players will defect (in other words, select low wage and low effort).[4] Since it is not more costly to be honest, a truth-telling equilibrium exists, where all past employers will tell the current employers that employees do not cooperate (as long as sending a signal is costless).

3.2.2 Indefinite Game

No Reference Treatment

Next, I examine the threshold required for a truth-telling equilibrium in indefinitely repeated games. It is rational for the NoRef Treatment to be played like a finitely repeated game: players will defect because there are no consequences past the current period, due to a lack of access to employee references.

[3] I will use the term 'defection' or 'deviation' to mean employees (employers) contributing the lowest effort (wage). 'Cooperation' refers to players offering a high wage or effort level.

[4] While defecting is the rational solution, experiments by Andreoni and Miller [1993] based on the model by Kreps and Wilson [1982] find that cooperation can be achieved in finitely repeated games if players believe their opponents may be altruistic. So even though the model predicts defection, I believe experiments will have a different outcome.

Costless Reference Treatment $(k = 0)$

A cooperating equilibrium can be established in treatments which provide references. Since I am considering a binary evaluation from the employer, a possible equilibrium is a threshold $\bar{e}$. Effort above this threshold will elicit a good evaluation, and effort below $\bar{e}$ a bad one. The equilibrium value of $\bar{e}$ will be discussed further in the paper.

$$r_t^* = \begin{cases} good, & \text{if } e_t \geq \bar{e} \\ bad, & \text{if } e_t < \bar{e} \end{cases} \tag{3.2}$$

The proposed equilibrium begins with the employer offering a high wage, w^*, in period one. In periods two and greater, after seeing an evaluation, an employer would choose the following wages: he will offer w^* in response to a good review, and w_0 for a bad review. In the equilibrium, w^* is the minimum payment an employee requires in order to exert high effort. The equilibrium value of w^* will be derived on the next page.

$$w_t^* = \begin{cases} w^*, & \text{if } r_{t-1} = \text{good} \\ w_0, & \text{if } r_{t-1} = \text{bad} \end{cases} \tag{3.3}$$

The subgame perfect equilibrium in this set-up is for employees to choose some threshold value of effort $\bar{e}_t$, which is the minimum effort required for employers to provide a good evaluation, and employers choose w_t^*, r_t^*. Next, I will solve for the condition on $\bar{e}_t$ to maintain this equilibrium.

When the game is played indefinitely, the total payoffs earned from cooperating in the

CostlessRef Treatment are the following:[5]

$$
\begin{aligned}
U_A &= \frac{1}{1-\delta}(w^* - c(\bar{e})) \\
U_P &= \frac{1}{1-\delta}(B(\bar{e}) - w^*)
\end{aligned} \tag{3.4}
$$

Because effort is costly, the employee will never contribute more effort than necessary, which would require the effort $\bar{e}_{t-1}$ to receive a high wage in period t, and an effort of 0 for a low wage. It would be irrational to select an effort level greater than 0 and less than $\bar{e}_{t-1}$, because by this equilibrium it would result in a low wage, and the employee can increase his utility by providing 0 effort.

The employee's payoff from a deviation in one period is the following:

$$
U_A = (w^* - 0) + \delta(w_0 - c(\bar{e})) + \frac{\delta^2}{1-\delta}((w^* - c(\bar{e})) \tag{3.5}
$$

If he deviates and produces 0 effort in one period, his profit would be the entire wage. But the cost to slacking would be receiving a low wage in the next period, due to a bad review from the employer. To fix his reputation, the employee would need to exert high effort, even after receiving a low wage. Since, in this model, the evaluation is only from one previous period, the employee's bad reputation would be restored after one round of high effort.

To solve for the condition to keep an employee from deviating, I compare the employee's

[5] All future earnings are discounted by δ. This variable symbolizes either the discounted value of future payoffs or the continuation probability. Both definitions have the same mathematical representations.

payoffs from cooperating versus deviating.

$$\begin{aligned}&\frac{1}{1-\delta}(w^{*}-c(\bar{e}))\geq w^{*}+\delta(w_{0}-c(\bar{e}))+\frac{\delta^{2}}{1-\delta}((w^{*}-c(\bar{e}))\\&\Rightarrow c(\bar{e})\leq\frac{\delta(w_{0}(\delta-1)+w^{*})}{1-\delta}\end{aligned}\tag{3.6}$$

Equation 3.6 provides the threshold of $\bar{e}$ below which the employee will be willing to provide a high effort. The more the employee values the future, the more of a cost he's willing to pay in the present.

Next, I will look at the employer's utility. The employer does not face repercussions in future periods, his wage only affects the current employee. He does not need to build a reputation. If he sees the employee received a good review, his incentive to provide him with a high wage is the following:

$$B(\bar{e})-w^{*}\geq -w_{0}\tag{3.7}$$

Combining the constraints of equations 3.6 and 3.7, the following boundaries on w^{*} are formed to maintain a cooperative equilibrium:

$$\frac{(1-\delta)}{\delta}c(\bar{e})-w_{0}\delta\leq w^{*}\leq B(\bar{e})\tag{3.8}$$

Costly Reference Treatment ($k>0$)

Next, I will charge the employer a fee if he chooses to send a reference (CostlyRef Treatment). I provide examples of several equilibria, to show that cooperation from both the employer and employee is a possibility. In this scenario, the utility function of the employee does not change, since the cost only applies to the employer. As previously mentioned, the employer does not need to build a reputation, since his future payoffs are not directly affected by his current moves. One possible question this could answer is if employers value a reference more when they know it was supplied at a cost.

If the employer is mandated to provide a costly reference to an employee, then the condition for him to cooperate remains the same, since the cost applies to both sides of the inequality of equation 3.7.

A more interesting instance would be with optional costly references. In this set up, employers do not directly receive a benefit from paying to send an evaluation. The next part of this model presents several different scenarios in an attempt to explain why employers would pay this cost.

Scenario 1: Grim Trigger Strategy First, I consider a grim trigger strategy. The game begins with the employer offering a high wage, w^*. In a cooperative state, employers would send accurate reports, and would base wages accordingly. In return, employees would exert high effort. If an employer defects and does not send a report, then the next employer, who does not see a reference, also defects. He will give the employee a low wage, and not send a report as well. As subjects are randomly rematched, this contagion would diffuse to the whole population at an exponential rate, leading to a population-wide defection. This equilibrium is meant not only to encourage employees to cooperate (which is the goal in most sequential move coordination games), but to also provide an incentive for employers to supply information to the population.

The amount of employers defecting (giving a low wage and not sending a reference) spreads at a rate of 2^t, where t is the number of periods since the initial deviation. Assuming there are n employers, a large but finite number, at any given period past initial defection, the proportion of employers deviating is $\frac{2^t}{n}$. This means, on average, it would take $\frac{log(0.5n)}{log(2)}$ periods to have an interaction where the defecting player does not receive an evaluation, and has to defect from then on. I will label that value as τ.[6]

Let us look at the consequences of the employer not sending a report in one period. If the employer stays on the equilibrium path, his payoff for the duration of the game will be

$$\frac{B(\bar{e}) - w^* - k}{1 - \delta} \tag{3.9}$$

where k is the cost to send an employee evaluation to the next employer. If the employer does not send a report, his payoff in the period of defection will be $B(\bar{e}) - w^*$, and $B(\bar{e}) - w^* - k$ until he does not see an evaluation (from the 'contagion' finally coming back to him), in some period τ. His lifetime payoff will then be

$$(B(\bar{e}) - w^*) + \sum_{m=1}^{\tau-1} \delta^m (B(\bar{e}) - w^* - k) + \sum_{m=\tau}^{\infty} \delta^m (-w_0) \tag{3.10}$$

Period 2 to Period $\tau - 1$ are the same in both scenarios (equations 3.9 and 3.10), so I can exclude those when I compare the payoffs. The employer's payoffs from cooperating versus defecting in one period are as follows:

$$B(\bar{e}) - w^* - k + \frac{\delta^\tau}{1-\delta}(B(\bar{e}) - w^* - k) \geq B(\bar{e}) - w^* + \frac{\delta^\tau}{1-\delta}(-w_0) \tag{3.11}$$

Just as stated earlier, the average number of periods until the employer does not receive an evaluation after defecting is $\frac{log(0.5n)}{log(2)}$, which is the expected value of τ. Solving for the condition to get a higher expected utility under cooperation, I arrive at the following constraint:

[6] I calculate the average value of the CDF. $\frac{2^t}{n} = 0.5 \Rightarrow t * log(2) = log(0.5n)$

$$\frac{\delta^\tau}{1-\delta}(B(\bar{e}) - w^* + w_0) \geq k \tag{3.12}$$

As long as the cost to send a report is below this threshold, the employers will cooperate. Since the employers are always sending reports, the condition for the employee is the same as in the costless reporting, which is provided in equation 3.6. Given the fraction, the value of k must be quite small in order for this condition to hold, meaning that employers will not maintain a cooperating equilibrium at a significant cost to them.

Scenario 2: Mixed Strategies For a second scenario, I examine a mixed-strategy equilibrium based on beliefs. It decreases the total cost employers pay for history over the duration of an indefinitely repeated game compared to a pure strategy (since the cost is not paid every period), yet is superior to a defecting equilibrium.

Failure to supply a reference does not harm the employer directly, but it has an indirect effect on future earnings. If employers do not see a reference, they cannot update their prior, so they are not sure what level of wage to offer. It will lead to a decrease in wages, and therefore lower efforts, which will cause the entire system to eventually diffuse to defection.

Each period starts with the employer either seeing or not seeing a reference. If he sees a reference, his strategy will remain the same as before: offer w^* if $r_{t-1} = good$, and offer w_0 if $r_{t-1} = bad$.

If he does not see a reference, he will rely on his belief of the distribution of the population to make a wage offer. Assume the following prior for an employer's beliefs regarding types of employees:[7] a proportion p are risk-averse and play a tit-for-tat strategy, and a proportion

[7] Other possible equilibria exist. This is solely one example to show that cooperation under a mixed strategy is a possibility.

$1-p$ are risk-takers and defect, hoping that the current employer will not pay the cost to send an evaluation. In this scenario, if the employer pays a high wage, his expected utility (before paying the cost to send a report) is

$$p(B(\bar{e})-w^*)+(1-p)(-w^*) \tag{3.13}$$

If he offers a low wage, both types of employees will respond in kind, and the employer's utility in that period will be $-w_0$. Therefore, given he does not see a reference, the employer's expected utility from offering a high wage is greater than the utility from selecting a low wage if

$$p \geq \frac{w^*-w_0}{B(\bar{e})} \tag{3.14}$$

Now I will inspect the payoffs of the employees. Assume the employees believe employers send references with probability q. The payoffs the employees will receive from always cooperating versus always defecting are

$$w^*-c(\bar{e}) \geq w^*-0+\frac{\delta}{1-\delta}(qw_0+(1-q)w^*) \tag{3.15}$$

Which means the utility is higher under cooperation when

$$q \geq c(\bar{e})\delta(w^*-w_0) \tag{3.16}$$

The lower q is, the lower the cost of effort must be to induce employees to put in effort. The above inequalities show the beliefs the players must have in order to play a mixed equilibrium. Next, I will check if players are willing to play those strategies, to determine when this equilibrium will hold.

Given their belief that employers send references with probability q, the employees will receive the same expected payoff from always cooperating versus always defecting if $q = c(\bar{e})\delta(w^* - w_0)$, meaning they would be willing to mix over the two strategies.

If employers believe employees are cooperating with probability p, they will offer a high wage when they do not see a report under the condition on p provided in equation 3.14. This is a requirement for employees to be indifferent between cooperating and defecting.

I then need to confirm that sending a report with a mixed probability is an optimal strategy for employers. Employees believe they send reports with probability q. If employers always send reports, their payoffs in each period will be $B(\bar{e}) - w^* - k$. If they never send reports, their payoffs will be $-w_0$. These payoffs assume employees are aware of the employers' strategies. Employers will be indifferent between the two strategies when their expected values are equivalent.

$$B(\bar{e}) - w^* - k = -w_0 \Rightarrow k = B(\bar{e}) - w^* + w_0 \tag{3.17}$$

Therefore, they would be able to mix over sending a report and not sending when the cost of the report is that of equation 3.17.

To confirm that the equilibrium is feasible, I compare equations 3.16 and 3.17, to get the following constraint on the cost of a report:

$$k = B(\bar{e}) - \frac{q}{c(\bar{e})\delta} \tag{3.18}$$

I also verify the condition on the wages given by equations 3.14 and 3.17, to get

$$k \geq B(\bar{e})(1-p). \tag{3.19}$$

Combining equations 3.18 and 3.19 gives the following condition:

$$q \leq B(\bar{e})pc(\bar{e})\delta \tag{3.20}$$

Equations 3.18 through 3.20 confirm that the proposed equilibrium is feasible.

The perfect Bayesian equilibrium is as follows. Employers will offer a high wage when they see no reference; if they do see a reference, they will offer a wage appropriate to the employee's past behavior. Employers will mix strategies with probability $q = c(\bar{e})\delta(w^* - w_0)$ over sending and not sending a reference when the cost of sending a report is $k = B(\bar{e}) - w^* + w_0$. Employees will mix strategies (exerting high or low effort in response to a high wage, and a low effort in response to a low wage) with probability $p = \frac{w^* - w_0}{B(\bar{e})}$ because they believe proportion q of employers pays to send a report. Hence, an equilibrium with partial cooperation can be sustained.

Scenario 3: Inefficient Equilibrium Another example of an (inefficient) equilibrium is when employers offer low wages, employees reciprocate with low effort, and employers do not send a report. Unilaterally offering a higher wage or higher effort results in a lower utility, and is not profitable for either party.

Scenario 4: Incorrect Beliefs A fourth possible equilibrium is playing $(w^*, \bar{e}, none)$. The condition here is that the employees have the wrong belief that employers are sending reports every period. That way, they will believe there are consequences to them defecting, even if that belief is incorrect.

3.3 Hypotheses

- Hypothesis 1: $E_{NoRef} < E_{CostlyRef} \leq E_{CostlessRef}$
- Hypothesis 2: $W_{NoRef} < W_{CostlyRef} \leq W_{CostlessRef}$
- Hypothesis 3: $U_{NoRef} < U_{CostlyRef} \leq U_{CostlessRef}$ for employees
- Hypothesis 4: $U_{NoRef} < U_{CostlyRef} < U_{CostlessRef}$ for employers
- Hypothesis 5: In both CostlyRef and CostlessRef employers will always send references.

I hypothesize that NoRef will have the lowest cooperation, and free information in CostlessRef will have the highest. If employers set wages according to the references they receive, it is optimal for employees to play a tit-for-tat strategy in CostlyRef. That is because they do not know when the employer will provide a reference, and the threat of the possibility of feedback being passed on is enough to keep them from defecting every time. The equilibrium values of wages and efforts in CostlyRef are based on which equilibrium the players will select.

The profits will follow from the wages and efforts. Since the employees do not pay to relay the references, I do not expect their actions or profits to diverge in CostlyRef and CostlessRef. Since that fee falls on the employers, I expect their profits to be smaller in CostlyRef than CostlessRef, even if the wages assigned in the two treatments are predicted to be similar. I also anticipate that references will be sent in most periods in CostlyRef and CostlessRef, based on the grim trigger strategy.

A follow-up question I am asking is if a lack of a reference has the same impact as a poor reference, which will be captured by CostlyRef.

3.4 Experiment

This experiment was conducted in a computer lab, using the ZTree software (Fischbacher [2007]). Subjects were recruited via an email sent to the undergraduate students at UC Irvine. Participants were randomly split into two groups: the employees and the employers.

The utility functions of the players are the following:[8]

$$U_{employer} = 4.5 + B(e) - w - k\mathbb{1}_{\text{CostlyRef}}$$

$$U_{employee} = w - c(e)$$

The participants were informed that the experiment consisted of three parts. Each treatment lasted 10 periods with certainty, and starting from the 11th period the continuation probability was set at 0.6. This was done to collect enough data with confidence, and to eliminate end-game effects. Subjects were paid for one randomly chosen round from each treatment.

The players were told that in every period of every treatment, each employer would be randomly matched with an employee. In each period, employers were given 4.5 lab dollars, and could decide how much to pay their employee. The employer moved first by offering their employee a wage. After seeing their wage offer, the employee then decided how much effort to supply to the job. The cost to the employee to provide each amount of effort and the revenue it generated for the employer is provided in Table 3.1, which is based on the values created by Charness and Kuhn [2007].

The experiment follows a within-subject design, with all subjects in each session participating in three treatments:

[8]The cost of references, k, is only included in the CostlyRef treatment.

Table 3.1: Effort Costs and Revenues

Effort Level	Cost to Employee	Revenue Produced by Employee
Zero (0)	0	0
Low (1)	0.10	2.80
Medium (2)	0.30	4.20
High (3)	0.60	5.40

1. No Reference: Employer cannot send an evaluation.

2. Costly Reference: Employer is able to send an evaluation to the employee's future employer at a cost of 0.5 lab dollars.

3. Costless Reference: Employer sends a reference to the next employer at no cost.

The treatments in which the employer could send a reference required the employer to indicate a threshold at the start of the treatments. If their employee provided an effort level below the indicated threshold, they would be given a "Bad" evaluation; an effort level at or above the threshold resulted in a "Good" evaluation sent to the next employer.

The experiment was comprised of four sessions that alternated the order of the treatments, to eliminate order effects in the analysis. Eighty eight subjects participated in total, and earned $14.70 on average for an hour of their time.

3.5 Results

Results are reported in the order of the hypotheses, starting with the employees and moving to the employers. Most of the analysis is spent exploring the behavior of the employers, as the focus of this paper is the employers' access to employment history with noise.

Result 1: Consistent with Hypothesis 1, employees exert the lowest amount of effort when the employers are not provided with information.[9]

To explore the behavior of the employees, Figure 3.1 graphs their average effort levels, separated by period and treatment. NoRef is clearly separated from the treatments that provide references, which supports this paper's theory that messages promote cooperation. However, the effort levels in NoRef are positive and higher than the theoretical prediction of Section 2.2.1 and the hypothesis, which found an equilibrium in players defecting to the lowest contribution. This behavior implies that factors other than direct monetary utility influence the decisions of the players.

Figure 3.1: Average Effort Levels, by Period and Treatment

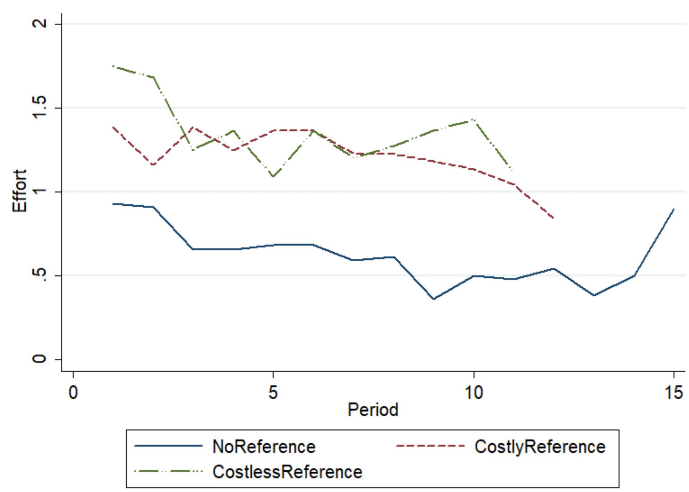


Table 3.2 presents the coefficients of an ordered probit regression on the effort choices of employees.[10] Its columns differ by the selection of the default treatment: CostlessRef is the baseline in column one, and NoRef in column one. Predictably, wage is shown to have a

[9]For simplification, the treatments will be called NoRef, CostlyRef, and CostlessRef.

[10]All regressions in this paper cluster on the subjects and include fixed effects for the subjects and periods.

Table 3.2: Efforts Across Treatments

	(1) Effort	(2) Effort
Wage	0.774***	0.774***
	(0.0863)	(0.0863)
NoRef	-0.983***	
	(0.171)	
CostlyRef	-0.192**	0.791***
	(0.0727)	(0.158)
CostlessRef		0.983***
		(0.171)
cut1		
Constant	1.496***	2.479***
	(0.229)	(0.258)
cut2		
Constant	2.595***	3.578***
	(0.283)	(0.312)
cut3		
Constant	3.943***	4.925***
	(0.365)	(0.400)
Observations	1624	1624

Robust standard errors, adjusted for clustering on 44 individual employees, are in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

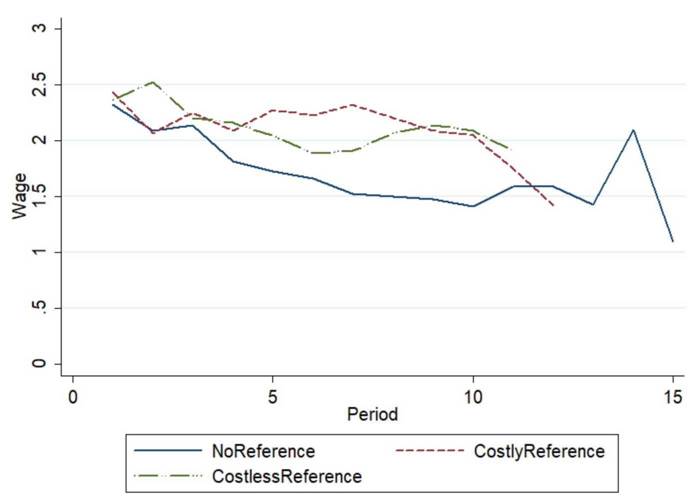
positive correlation with effort: employees respond in kind to a higher offer.

This regression confirms the graphical interpretation that effort in NoRef is significantly lower than in treatments with history. We also see that CostlyRef presents with lower effort than CostlessRef. A possible explanation is that employees thought employers would not pay to send references as often as they would when the information was free, so the employees contributed less when the probability of their behavior being reported was smaller.

Result 2: Consistent with Hypothesis 2, wage offers are lowest in the treatment with no references.

Next, I will move to dissecting the decisions of the employers. The average wages, separated by period and treatment, can be found in Figure 3.2. Akin to the decisions of the employees, employers also contributed the least amount to their opponents in NoRef, a result consistent with the theoretical prediction and hypothesis.

Figure 3.2: Average Wage Levels, by Period and Treatment



The OLS regressions of the wages employers selected are included in Table 3.3. Similarly to Table 3.2, columns one and two of Table 3.3 vary by the baseline variable used in the

Table 3.3: Wages Across Treatments

	(1) Wage	(2) Wage
NoRef	-0.359**	
	(0.131)	
CostlyRef	0.0375	0.397**
	(0.0957)	(0.125)
CostlessRef		0.359**
		(0.131)
Constant	1.532***	1.173***
	(0.117)	(0.0922)
Observations	1624	1624
Adjusted R^2	0.360	0.360

Robust standard errors, adjusted for clustering on 44 individual employees, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

regression. Table 3.3 supports the findings of Figure 3.2, confirming the wages in NoRef are lower than CostlyRef and CostlessRef. It also does not find a significant difference in wages between the treatments with references, supporting Hypothesis 2 by indicating that employers assume the cost of sending a reference by not decreasing employee wages when the cost of sending an evaluation is deducted from their profits.

Result 3: Contrary to Hypothesis 5, employers send fewer references when the report is costly.

Table 3.4 employs a probit model to narrow down the factors that impact an employer's decision to send a reference. It includes all the observations where an employer was given the chance to send a report, in both the CostlessRef and CostlyRef treatments, excluding period one.[11]

[11] Because the analysis considers the impact of a received reference on the choice to send a report, Period one is omitted because employers had not received references at that point.

Table 3.4: Choice to Send Reference

	(1) Send	(2) Send	(3) Send
ReceivedRef	0.313*	0.313*	0.313*
	(0.134)	(0.134)	(0.134)
Wage	0.175*	0.175*	0.175*
	(0.0729)	(0.0729)	(0.0729)
CostlyRef	-1.522***	-1.522***	-1.522***
	(0.185)	(0.185)	(0.185)
Effort	-0.0247	-0.0247	-0.0247
	(0.0949)	(0.0949)	(0.0949)
QuantMajor		-0.171	
		(0.150)	
EconMajor			1.070***
			(0.0521)
Constant	0.00362	0.00362	0.00362
	(0.230)	(0.230)	(0.230)
Observations	967	967	967

Robust standard errors, adjusted for clustering on 44 individual employers, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

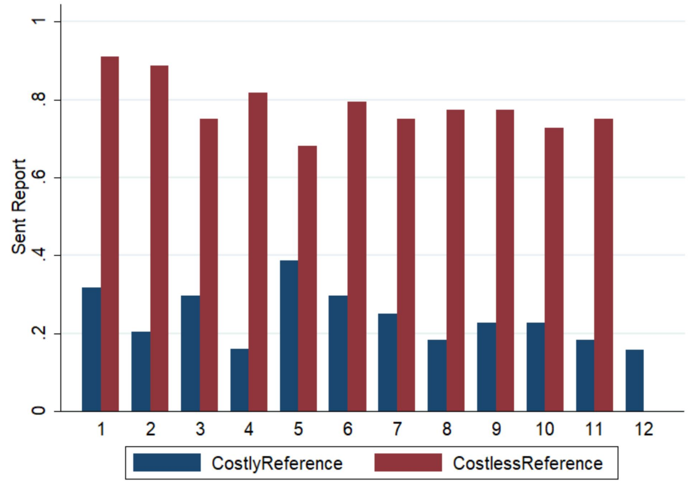
One of the factors that may contribute to the choice of sending an evaluation would be the act of receiving it. Table 3.4 includes the binary variable ReceivedRef, designating whether an employer received a reference in a given period. ReceivedRef displays a positive coefficient in the regression, which means that employers are more likely to send a reference if they have received one previously. Therefore, even if employers know the information is noisy, they will take it into consideration.

In the second row of Table 3.4, we see that employers who offer a higher wage are more likely to send an evaluation of the employee. Since there is no direct monetary benefit to the employer from contributing more money, this implies that a generous player will be more giving in all aspects. Surprisingly, an employee's effort level does not influence the distribution of reports, suggesting that dispersing information is an innate trait of the employers.

The third row of Table 3.4 compares the behavior of the employers between the treatments CostlyRef and CostlessRef, and it reveals that employers send less references when they have to pay a fee. This finding is also supported visually in Figure 3.3, which separates the choices by treatment and graphs the percentage of employers who sent references in each period. Contrary to the hypothesis, references are not sent in every period, even in CostlessRef, suggesting that subjects do not play a full grim trigger strategy. It can clearly be seen that references are consistently (and without significant variation between periods) sent by a fewer proportion of the employers when the act requires payment. Employees might have foreseen this behavior, as previously discussed, which is displayed by their decrease in cooperation in CostlyRef.

Columns two and three of Table 3.4 incorporate two variables to examine the innate characteristics of the employers by separating subjects by their majors. QuantMajor is a binary variable that takes a value of 1 for subjects who are studying a quantitative field (such as economics, math, science, etc.), and 0 otherwise. EconMajor is similar, but only takes a value

Figure 3.3: Percentage of Employers That Have Sent References, by Period and Treatment



of 1 for economics majors. There does not appear to be a difference in behavior between subjects who study a quantitative field versus non-quantitative, based on the insignificance of the coefficient of QuantMajor. However, when that distribution singles out economics majors, they have shown to be more likely to send references than subjects who do not major in economics. This discrepancy in behavior could be due to economics students' exposure to game theory.

Result 4: Information, even if imprecise, influences actions. Employers base wage offers on the reference they received. If they do not receive a reference, they base wages on their own past experiences.

One of the main questions of this study is to determine the effectiveness of references. The difference between this study and other experimental research that had studied access to information is that the messages in this study are noisy and subjective. Employers do not know with certainty how to interpret the evaluations they receive.

Table 3.5 aims to answer this question. It considers factors that could contribute to an employer's choice of wage. Columns one and two include only those observations in which employers received a reference, and columns three and four are the opposite, consisting of the observations without a reference. The first period of each treatment is excluded due to not having a history.

Table 3.5: Wages With/Without References

	(1) Wage	(2) Wage	(3) Wage	(4) Wage
CostlyRef	0.103	0.104	-0.141	0.198
	(0.134)	(0.132)	(0.135)	(0.105)
NoRef			-0.623**	
			(0.179)	
Evaluation	1.253***	1.253***		
	(0.203)	(0.203)		
EffortLag		0.00386		0.362***
		(0.0652)		(0.0493)
Constant	0.590***	0.587***	1.656***	0.783***
	(0.127)	(0.132)	(0.199)	(0.114)
Observations	499	499	993	993
Adjusted R^2	0.502	0.501	0.434	0.480

Robust standard errors, adjusted for clustering on 44 individual employers, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This table shows a positive correlation between the evaluation an employer receives and the wage he offers. This means that employers trust the third-party signal and give higher wages to employees they think were trustworthy. I include the variable EffortLag in the regressions of Columns two and four, which is the effort contribution the employer received in a previous period. Column two tells us that when an employer is provided with an evaluation, his own experience has no influence on the wage. However, when an employer has to decide on a wage without any information about a new employee, he relies on his own experience, as shown by the correlation between the employer's effort from the previous period and the wage offer. This means that wages are always based on some prior information, regardless whether it is correctly applied.

Despite their benefit, obtaining references may come as a challenge, and a candidate's inability to produce references could be inferred to be a bad signal. Some employers follow a social norm of not providing a reference when they do not feel positively about an employee, in order to avoid a conflict (Acoff [1994]). These experimental results convey that an omission of a reference does not have the same effect on wages as a poor report. With an unfavorable evaluation, employers are able to update their prior about the employees and offer a lower wage, while the absence of a reference leaves the employers without a way to update their prior, resulting in a wage offer based on the work ethic of the previous employees.

Table 3.6: Profits of Employers and Employees

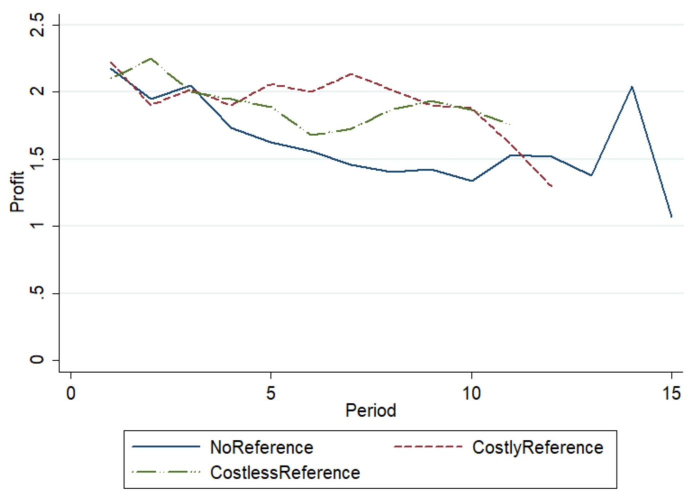
	(1) Profit	(2) Profit	(3) Profit	(4) Profit
NoRef	-1.038***		-0.243*	
	(0.0961)		(0.0937)	
CostlyRef	-0.353***	0.685***	0.0530	0.296**
	(0.0874)	(0.107)	(0.0760)	(0.102)
CostlessRef		1.038***		0.243*
		(0.0961)		(0.0937)
Constant	5.701***	4.663***	1.987***	1.743***
	(0.150)	(0.157)	(0.0888)	(0.0927)
Observations	1624	1624	1624	1624
Adjusted R^2	0.115	0.115	0.058	0.058

Robust standard errors, adjusted for clustering
on 44 individual employers and 44 employees, are in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Result 5: Consistent with Hypotheses 3 and 4, both employers and employees receive the lowest profits in the treatment with no references.

The last information we will look at are the profits of the employers and employees, presented in Table 3.6 and supplemented by Figures 3.4 and 3.5. The first two columns refer to the profits of the employers, and the last two to the employees. For both types of players, NoRef displays the lowest profits, supporting the hypotheses. This result understandably follows from Tables 3.2 and 3.3 and supports the theory, which also finds the wages and efforts to be the lowest in NoRef. The regression results for CostlyRef and CostlessRef uphold the hypotheses, which predicted that employees would receive similar profits in the two treatments with history, while employers would receive more in CostlessRef than CostlyRef due to the higher cost of evaluations. Not surprisingly, decreasing the contributions left both players at a Pareto-inefficient equilibrium.

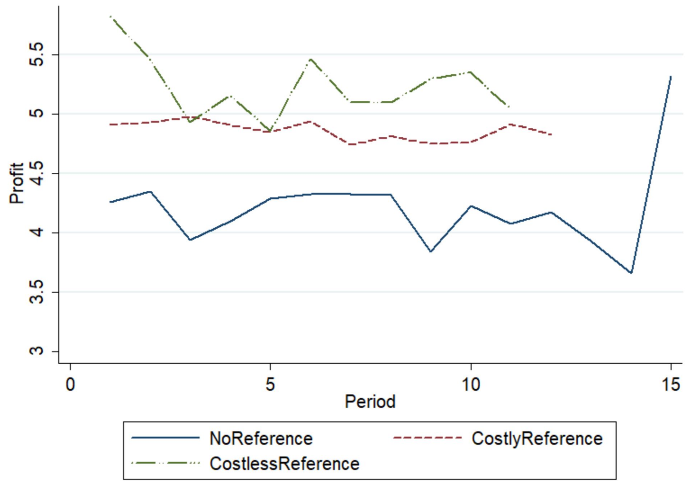
Figure 3.4: Average Employee Profits, by Period and Treatment



3.6 Conclusion

This experimental study aims to examine the influence references from a third party bear on an employer's wage offers. I find that these imprecise signals are of great significance. When employers are provided this information, they correlate wages with the signals. However, employers base wages on their own history with past workers when not provided with new

Figure 3.5: Average Employer Profits, by Period and Treatment



information, because they are unable to update their prior belief.

In addition, I discover that employers will send references, even if the action is costly and does not directly benefit their profits. Employers engage in reciprocating behavior and are more likely to provide them after they have received the information, which supports the long-standing workplace equilibrium of providing references to past employees. This behavior leads to a Pareto-efficient equilibrium, with higher cooperation from both employers and employees.

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