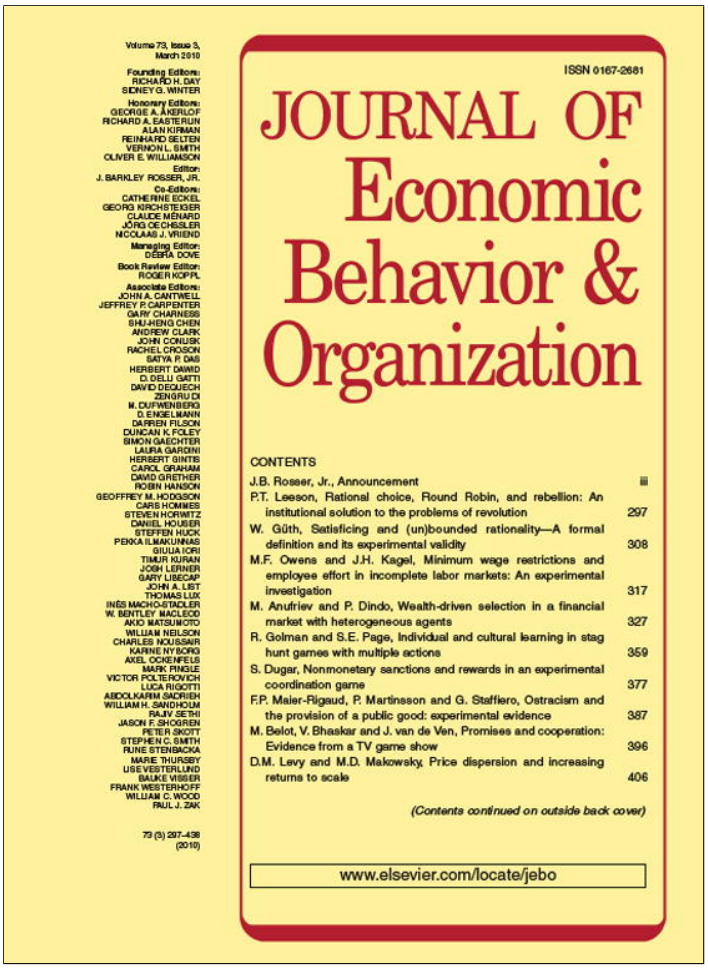

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# Minimum wage restrictions and employee effort in incomplete labor markets: An experimental investigation☆

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ABSTRACT

A minimum wage raises average wages along with modest increases in employees' average effort levels, generating a Pareto improvement in social welfare. The minimum wage reduces effort in the neighborhood of the minimum, but has no systematic effect on effort levels at higher wages. As a consequence average effort increases modestly with a minimum wage as it raises average wages. Similar results are reported within groups, both when introducing and eliminating a minimum wage, although the within group effects of introducing a minimum wage are stronger than dropping it.



## 1. Introduction

Numerous experimental studies of gift exchange in incomplete labor markets have supported Akerlof's (1982) hypothesis that employees consistently provide higher effort levels in response to higher wages independent of any repeated play considerations based on individual reputations (see Gächter and Fehr, 2002, for a survey of laboratory experiments).[1] The existence of a successful laboratory gift exchange paradigm makes possible controlled investigation of a number of interesting issues in labor economics; e.g., the possible benefits of incomplete versus complete contingent contracts (e.g., Brown et al., 2004) and the reasons for sticky downward wages (Hannan, 2005). The present experiment focuses on the effects of minimum wage requirements on effort levels in incomplete labor markets.

There are two motivations for the present study. First, few studies have investigated the effect of labor market policies on gift exchange, in particular the effect of a minimum wage requirement on worker effort. Introduction of a minimum wage

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[1] The identification of gift exchange effects is not limited to experimental labor markets. For example, Campbell and Kamlani (1997) and Bewley (1998) find support for the presence of gift exchange in labor markets from employer surveys and Al-Ubaydli et al. (2008) and Kube et al. (2008) from field experiments.

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into such a market might be expected to reduce worker effort as a result of employees discounting the gift component of the wage payment by the minimum wage requirement.[2] It is extremely difficult to measure effort in field settings, much less the effects of increases in the minimum wage on worker effort.[3] The present paper does this, reporting results from a series of incomplete labor markets both with and without minimum wages.

The second motivation for the present study is to better understand the mechanism underlying greater worker effort in response to higher wages in gift exchange experiments. Charness (2004) looks at this issue, comparing the effects of exogenously determined wages versus employer determined wages in order to tease apart reciprocity considerations from other forms of social preferences. He finds that effort levels are significantly higher at lower wage rates when these are determined exogenously (either randomly or by the experimenter) as opposed to employer determined, but that at higher wages there are no significant differences between the two treatments. He attributes the lower effort with employer determined wage rates (employees provide close to minimum possible effort) to negative reciprocity. However, given the similarity of effort at higher wage rates between random and employer determined wages, and the payoff functions employed, it is not possible to distinguish between reciprocity guided gift exchange or other regarding preferences, such as dislike for unequal payoffs at these higher wages.

We compare the effects of a minimum wage on effort supplied under three different conditions: introducing a minimum wage starting from an economy that has no minimum, starting from an economy that has a minimum wage and then drops it, and comparing between economies with and without a minimum wage. The within group effects are clear and unambiguous: a minimum wage increases wages significantly and results in significant, but smaller, increases in average effort levels. This somewhat counterintuitive effect on effort follows from the fact that at worst minimum wages reduce effort somewhat in the neighborhood of the minimum, but not to the level associated with the lowest pre-minimum wages, along with the overall increase in average wages which increases effort. The net result is that a minimum wage generates a Pareto improving outcome in that employees have higher average incomes and employers have the same, or slightly higher, average earnings. Further, it is those employers offering the lowest wages to begin with whose incomes experience the greatest increases with the minimum wage requirement. This indicates that for one reason or another, these employers failed to maximize income earning opportunities absent the minimum wage.

With respect to better understanding the mechanism underlying greater worker effort in response to higher wages in gift exchange experiments, our results provide clear evidence for positive reciprocity at higher wage rates. This follows from the systematically lower effort provided in the neighborhood of the minimum wage, with the minimum wage than without it, since the same other regarding *income* considerations are at work in both cases. The fact that there are no consistent or statistically significant differences at higher wages suggests that the minimum wage requirement was less salient at these higher wages and/or that employees recognized that wages set a good deal higher than a minimum wage requirement represent just as large a monetary gift as without the requirement.

Our results regarding minimum wage effects on effort levels are quite different from the two existing studies reported in the literature.[4] The experiment that is closest to ours, Brandts and Charness (2004), looks at minimum wage effects as part of a larger experimental investigation of labor supply issues. They report two findings contrary to ours: First, average wages are essentially the same with and without the minimum wage in their study. In ours, average wages increase significantly with a minimum wage than without it. Second, although using non-parametric test statistics they are unable to reject a null hypothesis that average effort levels are the same with and without the minimum wage, the probability of significantly lower effort levels is on the verge of being marginally significant. In contrast, in our experiment we can reject a null hypothesis of no difference in effort levels *in favor of higher effort* under the minimum wage at the 10% level under a two-tailed non-parametric test statistic. Falk et al. (2006) look at the effects of a minimum wage in an economy where workers provide either zero effort by refusing to accept a wage offer, or automatically provide maximum effort when accepting a wage offer. Their minimum wage requirement is set higher than nearly all the pre-minimum wage rates offered, so that between the very high wage requirement and the differences in experimental design it is difficult to compare their results to ours. As such what comparisons can be made are best done after reporting our results.

The paper is organized as follows. Section 2 outlines some theoretical considerations regarding the effects of a minimum wage on effort levels. Section 3 describes the design and procedures. Experimental results are reported in Section 4. Section 5 summarizes our results and provides a more detailed discussion of differences between our experiment and the other two.

[2] In the Akerlof (1982) model firms voluntarily offer a "gift" to workers in the form of a wage that is above the zero unemployment market clearing wage. In return workers voluntarily provide a "gift" to the firm by working in excess of the minimum standard.

[3] Incentive effects of minimum wages are, of course, irrelevant within standard economic theory. The standard economic argument against the minimum wage is that in a perfectly competitive labor market imposing a minimum wage that exceeds the market determined equilibrium wage will lead to increased unemployment. Empirical studies regarding the employment effect of increases in the minimum wage have been subject to some controversy recently. Katz and Krueger (1992) and Card and Krueger (1994), do not find that unemployment increases with minimum wage increases. In contrast, Neumark et al. (2004) find that work hours are reduced.

[4] There is corresponding literature on minimum effort requirements as well which should be noted (see for example Falk and Kosfeld, 2006).

## 2. Theoretical considerations

Implementing a minimum wage within the gift exchange paradigm can help to clarify the true nature of gift exchange in labor markets. The positive relationship between wages and effort levels reported in the typical gift exchange experiment is (potentially) related to two distinct factors: (i) positive (as well as negative) reciprocity in the sense of Akerlof (1982) and (ii) outcome based income inequality (e.g., Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000). The latter relates to the fact that some proportion of the population has been shown to be willing to sacrifice their own income in the presence of strong income inequality. These two factors are likely to work in opposition to each other following the introduction of, or an increase in, a minimum wage.

At one extreme, if reciprocity considerations are the only factor underlying higher effort levels in response to higher wages, employees might be expected to completely recalibrate their effort levels so that they provide the same effort level as prior to the minimum wage at "comparable" wages. By recalibrating at "comparable" wages we mean the following: Let $w_L$ represent the lowest possible wage that can be offered and in response to which employees provide the minimum possible effort level, $e_L$. Using this as a baseline, following the introduction of a mandatory minimum wage, $w_\mu > w_L$, one might expect effort level at the minimum wage, $e_\mu$, to be equal to $e_L$ as employees recalibrate their effort levels to account for the mandatory nature of $w_\mu$. Further, employees continue to fully compensate for the mandatory nature of $w_\mu$ so that at wages $w^* > w_\mu$ they respond with the same effort level as they would under the voluntary wage equal to $(w^* - w_\mu)$. However, there are a number of factors working against these outcomes.

First, at a minimum wage $w_\mu > w_L$, under the typical payoff values employed in gift exchange studies, absent a positive response by employees to $w_\mu$ there is income inequality in favor of the employee that is strongly increasing in $w_\mu$. As such to the extent that some portion of the population is responsive to such outcome based income inequality, effort levels would be expected to exceed the minimum requirement. Further, since the minimum wage is imposed exogenously by a third party, and it is costly to employers regardless of where it came from, a wage rate equal to the minimum will not necessarily be viewed as expressing zero, or negative reciprocity as the wage rate $w_L$ would, as there is clear evidence from past experiments for treating exogenous actions differently than voluntary actions (Charness, 2004; Blount, 1995). In short, to the extent that outcome based income inequality drives some employees' choices, one would not expect that effort levels would be recalibrated according to the extreme scenario described in the previous paragraph either at $w_\mu$ or at wages $w^* > w_\mu$.

## 3. Experimental design and procedures

Subjects were divided into two groups with an equal number of subjects in each group. One group was randomly chosen to be "managers" with the other group serving as "employees" for the entire session.[5] Each session lasted for 10 market periods in which each manager was paired anonymously with exactly one employee in a period. The pairings were reassigned randomly before each market period. Details regarding the random assignment of pairings were explained before the start of each session and were repeated before each of the first several market periods within each session and subjects were periodically reminded of the random nature of the matching process throughout a session. In the sessions with fewer than ten pairs, each employee was matched with each manager no more than twice and never re-matched in two consecutive periods.[6] These procedures create a series of one-shot games so that the only motivation for offering efficiency wages is the potential gain from higher effort. Each participant was given a written copy of the instructions, which were read aloud to all participants.[7]

In each period managers were asked to choose a wage for an employee. Each employee was then given the individual wage that was offered to him/her. Wage offers were written directly on employee record sheets so that only the manager and employee involved in the contract knew the wage offer. One advantage of this procedure is that by not posting wages, any session level effects will be minimized.[8] After receiving the wage, each employee was asked to choose an effort level, which was transmitted back to the manager in question.[9] Thus, both wage offers and effort levels were private information for the manager and worker in each pairing.

The firm's payoff function and employee's effort-cost relationship were provided to both managers and employees so that this information was common knowledge. Participants were provided with calculators and were required to correctly compute the payoffs for both managers and employees in several examples prior to the start of the experiment.

[5] The terms "manager," "employer," and "firm," and "employee" and "worker" are used interchangeably.

[6] There were twelve sessions, four of which had lower than expected show up rates than the 20 subjects desired: one had 18 subjects, two had 16, and one had 14.

[7] A copy of the instructions can be found at http://www.econ.ohio-state.edu/kagel/Owens_Kagel_minWage_Insts.pdf.

[8] There are, in fact, a variety of procedures for matching firms with workers reported in past gift exchange experiments, of which this is one. See Fehr et al. (1998) for a systematic comparison of bilateral gift exchange procedures such as those employed here with a posted price procedure with excess supply of workers, suggesting at best second order differences as a consequence of the procedures employed.

[9] The term "effort" is used throughout this paper but in the experiment "Amount of Work" was used in its place in the instructions.

The payoff functions for managers ($\Pi_M$) and employees ($\Pi_E$) were

$$\Pi_M = 100 - w + 5e$$

$$\Pi_E = 100 - e + 5w$$

with both wages and effort restricted to the interval [0, 100].[10] As such the minimum possible payoffs were zero for both firms and workers. The Nash equilibrium in the absence of any gift exchange motives has employees providing the minimum allowable effort and managers, anticipating this, offering the lowest possible wage. In contrast, with gift exchange exercised, there is the possibility of a substantial increase in earnings for both firms and workers.[11] The fact that the profit functions are linear and symmetric in this design means that the marginal cost of an increase in wages is equal to that of an increase in benefits and holds the costs constant throughout. In addition, the marginal return to firms of an increase in effort is equal to that of workers for an increase in wages, and constant throughout.[12]

Twelve sessions were conducted each having 10 market periods. Six of the sessions started with no minimum wage, which was introduced in market period six, and remained in effect until the session ended. We refer to these as NOtoMW sessions. They provide the basis for our within group comparisons of minimum wage effects. The other six sessions began with a minimum wage for periods 1–5 which was then removed for periods 6–10. These are referred to as MWtoNO sessions. Comparing outcomes in periods 1–5 between the NOtoMW with the MWtoNO sessions provides the basis for our between group comparisons. Comparing behavior between periods 1–5 and 6–10 within the MWtoNO sessions allows us to look at the impact of eliminating a minimum wage in an ongoing labor market.

The minimum wage was set at 40 in all sessions. It was determined endogenously in the first experimental session so that the minimum wage would have impacted 25–30% of all wage offers in periods 1–5, thereby creating a significant minimum wage effect while still providing ample scope to examine the impact of the minimum wage on higher wage earners.[13] Subjects were told the number of market periods in advance but were not informed of any of the planned changes in treatments or how long a given treatment would last.

Sessions were conducted at two locations: Ohio State University and Middle Tennessee State University, with three NOtoMW and three MWtoNO sessions in each location. Tests for session level effects between the two locations showed no significant effects so the data are pooled across locations.

Subjects were paid privately and individually at the end of each session at a rate of 250 experimental dollars to 1 US dollar along with a $6 participation fee. Average earnings were approximately $22.00 for employees and $15.00 for managers. Sessions lasted about one hour and fifteen minutes.

## 4. Experimental results

Results are presented in two parts. First, we report the effects of introducing the minimum wage within an ongoing market (NOtoMW sessions) in some detail. We then go on to briefly report parallel results for dropping the minimum wage in the MWtoNO sessions, comparing between groups in terms of the no minimum wage periods in the NOtoMW sessions with the minimum wage periods of the MWtoNO sessions, and the effects of pooling all the data.

### 4.1. Effect of introducing a minimum wage within an ongoing labor market

Fig. 1 shows average wages and effort over time before and with the minimum wage in the NOtoMW sessions. As in previous gift exchange experiments, wages and effort are significantly different from the minimum levels predicted by the Nash equilibrium (absent any gift exchange motives). The introduction of the minimum wage of 40 resulted in a marked increase in average wages from 59.0 (2.68) before the minimum to 70.4 (2.80) with the minimum and was accompanied by an increase in the average effort level from 29.1 (2.19) to 34.6 (5.86) (standard errors of the mean using session averages as the unit of observation are in parentheses). The wage increases are statistically significant at the 5% level using a two-tailed Wilcoxon signed rank test, but the increase in effort levels are not ($p > 0.10$ two-tailed test). However, as will be shown in

[10] These payoff functions were inspired by the Brandts and Charness (2004) study, as they represent a rescaled version of their payoffs. We had begun our study of minimum wage effects using quite different payoffs prior to becoming aware of the Brandts and Charness paper. Results from far fewer sessions with these different payoffs can be found in our working paper (Owens and Kagel, 2007). Results reported here involve substantially more sessions than in our working paper.

[11] Indeed a necessary condition for above minimum wages appears to be both the possibility of improved earnings on the part of both firms and workers (see Fehr and Falk, 1999 for example) as well as firms and workers recognition this fact (Hennig-Schmidt et al., 2008). Responses on the part of players are sensitive to the magnitude of the potential improvements as well (see Cooper and Kagel's 2009 survey of the other regarding preference literature).

[12] A popular specification of manager profits in past experiments is $\Pi_M = (100 - w) \times e$ with effort from the interval 0.1 to 1 (in increments of 0.1) and wages from 0 to 100. In this case the marginal benefit for any given effort level depends on the wage offered, so that managers receive smaller marginal benefits under a minimum wage requirement unless effort increases more than proportionately to the wage increase. This would tend to inhibit managers from raising wages above the minimum requirement.

[13] After collecting all of the data 82 out of the 290 (28.3%) wages offered in the first five no minimum wage periods were less than or equal to 40.

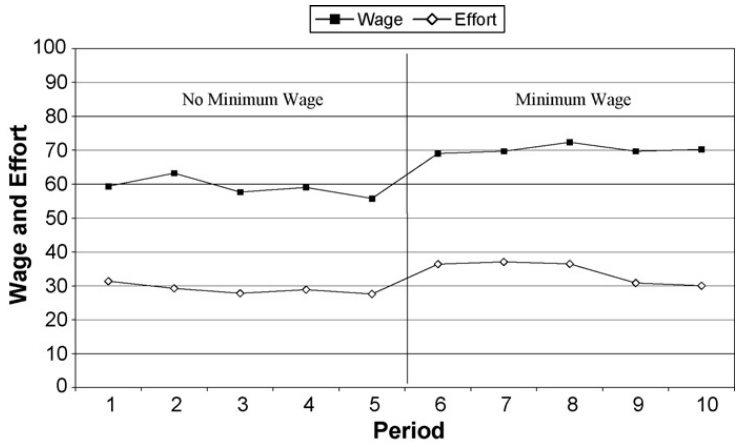


**Fig. 1.** Average wage and effort by period: (NO to MW sessions).

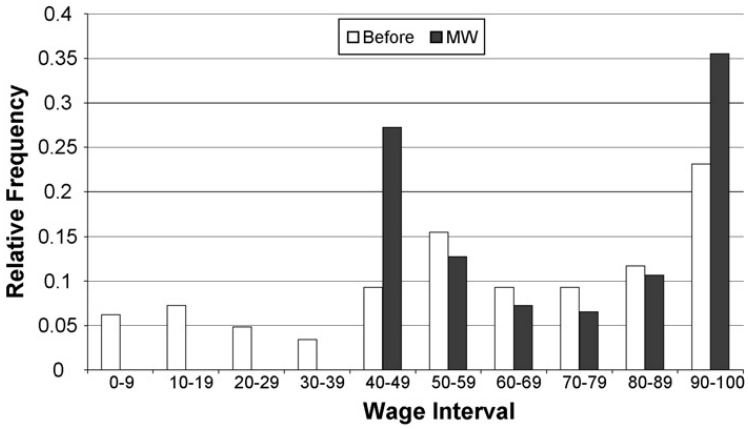


**Fig. 2.** Histogram of wage offers: (NO to MW sessions).

the next section, with the added power of the MWtoNO sessions effort levels are significantly higher with the minimum wage than without it using the two-tailed Wilcoxon signed rank test ($p < 0.10$).

Fig. 2 shows the relative frequency of wage offers before and with the minimum wage. The introduction of the minimum wage forced all employers who were paying below the minimum wage to increase their wages. However, it also influenced the wages paid by employers who were already paying average wages of 40 or above. Of the 47 employers who were paying above minimum wages (on average) to begin with, 36.2% (17 out of 47) increased average wages, 51.1% (24 out of 47) offered the same average wage, and 12.8% (6 out of 47) reduced average wages.[14] Thus, not only did the minimum wage requirement raise wages for those "covered" by it, it also raised average wages for a number of workers who were not "covered."

Fig. 3 shows mean effort over different wage ranges. Bars indicate mean effort with error bands representing the standard error of the mean. The effect of the minimum wage differs depending on the wage rate: At lower wage rates effort is *lower* than it was *at these same wage rates* prior to the introduction of the minimum wage with this decrease, judging from Fig. 3, concentrated at wages in the neighborhood of the minimum wage (40–49). In contrast, at higher wages effort is the same, or in some cases *greater* than it was, *at these same wages*, prior to introducing the minimum.

Of particular note is the fact that effort was substantially higher in the neighborhood of the minimum wage (40–49) than it was at the lowest wage rates (wages of 29 or less) prior to introducing the minimum wage. This is shown more clearly in Fig. 3B, which compares effort levels before the minimum wage to effort levels at comparable wages with the minimum (i.e., after subtracting out the minimum wage requirement of 40). Employees are providing greater average effort in the neighborhood of the minimum wage than in the neighborhood of the zero wage point in the absence of the minimum wage, and the difference between effort levels increases as the wage increases.

These results are more dramatic yet if we look at the detailed data. Of the 18 wage offers in the interval 0–9 before the minimum wage, 72.2% (13 out of 18) were met with zero effort. The other 5 provided average effort of 22.6, but this includes a single outlier who responded with effort of 100 to a wage of 2, so that the average effort for the other 4 cases was 3.3. In contrast, there were 58 wage offers exactly at the minimum (20.0% of all wage offers) in the periods following its introduction. 37.9% of these wage offers were met with zero effort, a substantially smaller percentage than for wage offers

[14] Average wages were calculated for each employer and placed in intervals as follows: less than 40, 40–60, 61–80, and 81–100 to get these percentages.

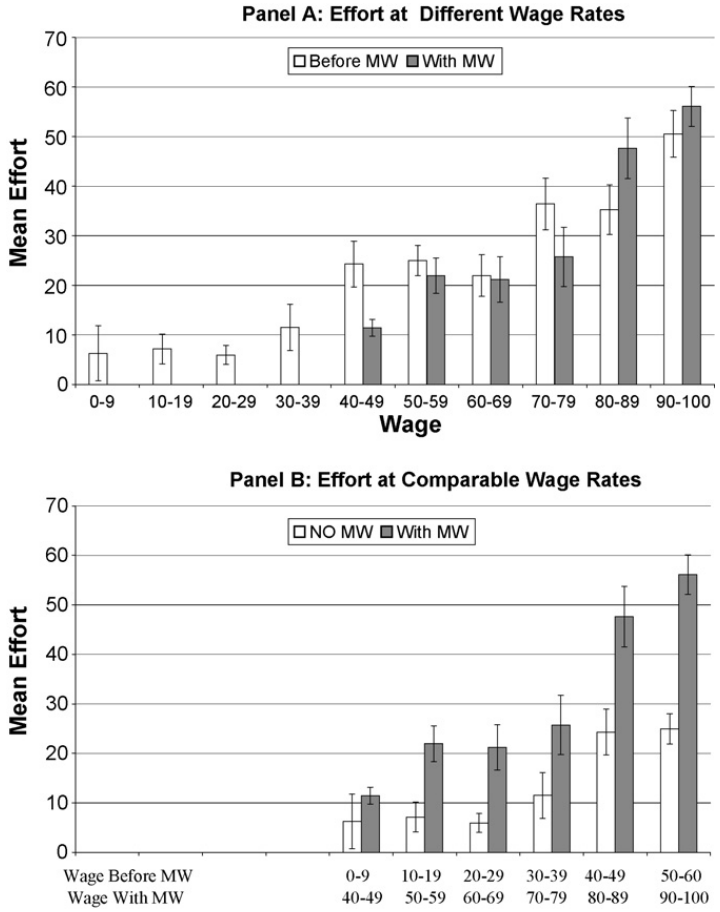


**Fig. 3.** Effort responses no to minimum wage sessions. Panel A: effort at different wage rates. Panel B: effort at comparable wage rates. Bars represent mean effort for the wage range and the error bands are the standard error of the mean.

**Table 1**
Random effects Tobits for the effects on effort of the minimum wage within an ongoing labor market: (NO to MW sessions).

| Dependent variable is effort[a] | (1) | (2) | (3) | Wage | Marginal effect of minimum wage | Effort difference at "comparable" wage (MW – NO) |
|---|---|---|---|---|---|---|
| Constant | −25.7*** (4.94) | −24.9*** (4.97) | −20.62*** (5.33) | 40 | −8.17*** (3.09) | 21.71*** (4.21) |
| Wage | 0.80*** (0.04) | 0.82*** (0.04) | 0.75*** (0.05) | 60 | −4.63** (2.19) | 25.25*** (3.07) |
| MW | – | −3.42 (2.11) | −15.25** (6.03) | 80 | −1.10 (2.37) | 28.79*** (2.41) |
| Wage*MW | – | – | 0.18** (0.08) | 100 | 2.44 (3.50) | 32.33*** (2.82) |
| Log Likelihood | −2131.2 | −2129.9 | −2127.7 | | | |
| Joint test of MW and Wage*MW | – | – | $\chi^2(2) = 7.02$, $p = 0.03$** | | | |

MW = 1 if minimum wage is in effect; 0 otherwise.
[a] Number of observations is 580 in all cases. Session level dummy variables are suppressed as they are not statistically significant.
** Significantly different from 0 at the 5% level, two-tailed test.
*** Significantly different from 0 at the 1% level, two-tailed test. Standard errors are in parentheses.

in the interval 0–9. Further, comparing effort with the minimum wage to pre-minimum effort in the wage interval 40–49, 22.2% of pre-minimum offers were met with zero effort, with average effort conditional on providing some effort 31.2% versus 32.9% zero effort with the minimum and average effort of 17.1 conditional on providing some effort.[15] Thus, effort is substantially greater at the minimum wage than near the pre-minimum zero wage. While the lower effort provided in the neighborhood of the minimum results from an increased frequency of zero effort and lower effort levels conditional on providing some effort.

Formal statistical tests of the effect of the minimum wage on effort levels are reported in Table 1 using random effect Tobits with a white noise error term and an employee specific random error term. The Tobits account for censoring at both the minimum effort level of 0 and the maximum effort level of 100. They employ session level fixed effects to account for

[15] There were 27 wage offers (9.3% of all wage offers) in the interval 40–49 prior to introducing the minimum wage.

potential interdependence of employees' responses within a session.[16] Several specifications are reported. The session level fixed effects showed no significant effects at anything approaching conventional levels in any of the regressions, so they are suppressed.

The most relevant specification is the last one with both a dummy variable for the minimum wage (MW = 1 with a minimum wage, 0 otherwise) and an interaction effect between wage and the minimum wage dummy (Wage*MW). The dummy for the minimum wage effect is negative and statistically significant at the 5% level, while the Wage*MW variable is positive and significant at the 5% level as well. A chi-square test for the joint significance of the minimum wage dummy (MW) and the MW*Wage is reported as well. As the next to last column of Table 1 shows, effort is significantly lower ($p < 0.01$) at the minimum wage than at the same wage without the minimum and at wage 60 as well ($p < 0.05$). In contrast, at wage rates 80 and 100 there are no significant differences in estimated effort levels, with mean effort levels higher at $w = 100$.

The last column of Table 1 evaluates the difference in effort levels under the minimum wage versus "comparable" wages absent the minimum. In all cases effort is substantially, and significantly, higher under the minimum wage, than at comparable wages without it. As such we can definitely reject the complete recalibration of effort hypothesis offered at the beginning of Section 2.

Other regarding income effects can plausibly account for this offsetting effect: as already noted, workers typically respond with very little or zero effort in the interval 0–9 prior to introducing the minimum wage. If workers responded with the same effort level with the minimum wage requirement of 40, earnings for employers would be 65 compared to 299 for employees. In contrast, at the average effort level reported for a wages in the interval 40–49 with the minimum wage requirement (11.4) earnings for employers averaged 115 versus 289 for employees, cutting the difference in earnings by almost a half at relatively little cost to employees.

Introduction of the minimum wage has a distinct *positive* welfare effect here as it creates a Pareto improving outcome: Average employee earnings per period increased by over 10% from 365.8 (12.9) before the minimum to 417.4 (10.5) with it ($p < 0.01$) and employers' earnings increased slightly as well from 186.5 (10.4) to 202.5 (27.3) (standard errors of the mean using session averages as the unit of observation are in parentheses). The increase in worker earnings is statistically significant at the 5% level using a two-tailed Wilcoxon signed rank test, but the increase in employer earnings is not ($p > 0.10$ two-tailed test). The key factor underlying the slight increase in employers' earnings is the increase in average earnings for those employers whose average wages were below the minimum requirement to begin with.[17] Given the marginal response of employees to increased wages, and employers' profit function, these employers were clearly not maximizing earnings prior to the minimum wage mandate. Whether this was a result of risk aversion due to the variability in employee effort responses or a failure to fully explore the wage effort relationship or some other factor is, unfortunately, unknown.

### 4.2. Additional treatment effects

Our data allow us to look at the impact of dropping the minimum wage as well as the between group effects of one group that has no minimum wage versus a group that has a minimum wage to begin with. We simply summarize the impact of these treatment effects here, which yield results quite similar to those reported in the previous section. We focus on what can be learned by employing all the data to obtain more powerful tests of wage and effort effects by doubling the sample size.[18]

Dropping the minimum wage in the MWtoNO sessions generates a mirror image of the NOtoMW sessions: There is a clear decrease in both average wages and average effort after eliminating the minimum wage, with much of the decrease accounted for by the 30% of employers who reduced wages paid to below the old minimum wage requirement.[19] As with the NOtoMW sessions, the wage effects are statistically significant ($p < 0.05$) using session averages as the unit of observation using the Wilcoxon signed rank test, but the effort decreases are not. As with the NOtoMW sessions, here too there is a Pareto improvement in social welfare with the minimum wage as employees incomes are significantly higher (again using the Wilcoxon signed rank test), and employers' earnings increase modestly as well, but this difference is not statistically significant.

Pooling these data with the NOtoMW sessions, we can reject a null hypothesis that effort levels are the same with and without the minimum wage in favor of one where effort levels are *higher with the minimum than without it* ($p < 0.10$ two-tailed Wilcoxon singed rank test). While at first blush this might seem counter intuitive, it reflects the fact that average wages are higher[20] with the minimum than without it, and workers provide greater effort in response to the wage increases than for

[16] These session specific fixed effects are used rather than clustering at the session level due to limitations of existing software. It is not possible to cluster at the session level and still correct for censoring of effort levels and subject random effects within Stata. Only two of these three can be done in a single regression.

[17] This calculation is based on wage categories specified in footnote 14 above. There were 13 such employers, whose average earnings increased by close to 70% ($p < 0.01$). These increased earnings are largely offset by the relatively small number of employers who chose to reduce average wages following the minimum wage requirement which resulted in reducing their incomes.

[18] An online Appendix provides the detailed statistical analysis underlying these results.

[19] The majority of these employers (10 out of 16) were offering relatively low average wages, in the interval 40–60, with the minimum wage requirement.

[20] In fact, session level average wages are higher in all twelve sessions with the minimum wage than without it. This increase is statistically significant at the 1% level using a two-tailed Wilcoxon signed rank test.

**Table 2**
Random effects Tobits for the effects on effort of the minimum wage: all sessions pooled.

| Dependent variable is effort[a] | (1) | (2) | (3) |
|---|---|---|---|
| Constant | −26.11*** (3.55) | −23.19*** (3.79) | −23.27*** (3.79) |
| Wage | 0.83*** (0.031) | 0.79*** (0.05) | 0.79*** (0.04) |
| MW | – | −9.48** (4.52) | – |
| Wage*MW | – | 0.13** (0.06) | 0.13** (0.06) |
| NOtoMW*MW | – | – | −12.27** (4.75) |
| MWtoNO*MW | – | – | −6.72 (4.75) |
| Log Likelihood | −4068.7 | −4066.5 | −4064.7 |
| Joint test of MW and Wage*MW = 0 | – | $\chi^2(2) = 4.41$, $p = 0.11$ | – |
| Joint test of NotoMW*MW = MWtoNO*MW | – | – | $\chi^2(1) = 3.62$, $p = 0.06$* |
| Joint test of NOtoMW*MW and MWtoNO*MW and Wage*MW = 0 | – | – | $\chi^2(3) = 8.04$, $p = 0.05$** |

MW = 1 if minimum wage is in effect; 0 otherwise. NOtoMW = 1 if NOtoMW session; 0 otherwise. MWtoNO = 1 if MWtoNo session; 0 otherwise.
[a] Number of observations is 1120 in all cases. Session level dummy variables are suppressed as they are not statistically significant.
* Significantly different from 0 at the 10% level, two-tailed test.
** Significantly different from 0 at the 5% level, two-tailed test.
*** Significantly different from 0 at the 1% level, two-tailed test. Standard errors are in parentheses.

"comparable" wages without it (recall Fig. 3B). The increase in employers' earnings, even with pooling, is too modest to be able to reject a null hypothesis of no significant effect of the minimum wage on their earnings ($p > 0.10$, two-tailed test).

Regression results for the MWtoNO sessions show no statistically significant effect of the minimum wage on effort levels.[21] This indicates that the impact on effort levels for given wages is stronger going from a no minimum situation to one with a minimum as opposed to the reverse direction. Regression results for the pooled data, including all twelve sessions, shown in Table 2, confirm this. Session level fixed effects, which were once again not statistically significant, have been suppressed. Specification 1 is the same as (3) in Table 1. The second specification introduces dummy variables for order effects with the NOtoMW*MW dummy equal to 1 in the NOtoMW sessions (0 otherwise) and the MWtoNO*MW dummy equal to 1 in the MWtoNO sessions (0 otherwise) (where MW is the minimum wage dummy). The larger absolute value for the NOtoMW*MW dummy, in conjunction with its sign, is reflective of the statistically significant reduction in effort levels in the neighborhood of the minimum wage reported in the previous section.[22]

The data also permit us to do a between group comparison of the effects of the minimum wage, comparing average wages in first 5 periods of the NOtoMW sessions without a minimum wage to the first 5 periods of MWtoNO sessions that start with the minimum wage. Wages average 59.0 (2.69) in the first 5 periods of the NOtoMW sessions versus 69.5 (3.06) in the first 5 periods of the MWtoNO sessions (with standard errors of the mean in parentheses using session level data as the unit of observation). A Mann–Whitney between groups test shows this difference to be statistically significant at the 10% level using the session level data, again using a two-tailed test. Effort averaged 29.1 (2.19) in the first 5 periods of the NOtoMW sessions versus 37.7 (3.83) in the first 5 periods of the MWtoNO sessions (with standard errors of the mean in parentheses using session level data as the unit of observation). A Mann–Whitney between groups test shows these differences to be statistically significant at the 5% level, using a two-tailed test and session level data. Thus, the between group differences yield much the same picture as the within group differences.[23]

## 5. Summary and conclusions

We study gift exchange in incomplete labor markets with and without minimum wage restrictions. Within session effects of a minimum wage are clear and unambiguous: Average wages are significantly higher with the minimum than without, as are average overall effort levels. The latter results from the fact that employees provide greater effort in the neighborhood of the minimum wage than under comparable pre-minimum wages (at the lowest pre-minimum wages) and that any decreases in effort levels compared to pre-minimum wages is restricted to wages in the neighborhood of the minimum wage.

From a labor policy perspective the minimum wage has at worst a modest adverse effect concentrated in the neighborhood of the minimum wage. But taken overall, it results, somewhat surprisingly, in a Pareto improving social welfare effect as employees' incomes are significantly higher with a minimum wage than without it, while there is a modest, but statistically insignificant, increase in employers' earnings. Further, it is exactly those employers who offer low wages before the minimum wage is introduced who have the largest increase in average earnings. Correspondingly, following elimination of a minimum wage, it is those employers who reduce wages to below the old minimum that have the largest decrease in average earnings.

Of course one must exercise extreme caution in any effort to extrapolate these results to a field setting, or even other laboratory studies with other subject populations and other payoff functions, as this remains an open empirical question.

[21] $p > 0.20$ for the chi-square test for the joint significance of a MW dummy and a Wage*MW variable like the ones employed in specification 3 in Table 1.
[22] Similar results are obtained by adding a Wage*NOtoMW*MW dummy to specification 1 as the coefficient value is negative and statistically significant at the 10% level.
[23] This is entirely consistent with the result that session level dummies fail to be significantly different in the regressions reported in Tables 1 and 2 as these regressions condition effort on wages paid, indicating that the response pattern does not differ significantly between sessions.

More importantly, our experimental design eliminates any possible unemployment effects of a minimum wage, an issue that is still hotly debated in field settings (Katz and Krueger, 1992; Card and Krueger, 1994; Neumark et al., 2004). However, what we can say from a labor policy perspective is that our results refute any argument that, in addition to adverse employment effects, a minimum wage will *necessarily* result in lower effort levels to boot. And in fact it suggests the possibility it would actually increase effort levels.

Regarding better understanding of the mechanism underlying gift exchange in experimental labor markets our results, combined with Charness (2004) make it clear that both positive and negative reciprocity is behind employees' effort levels. Charness (2004) experiment makes it clear that low, or zero, effort levels in response to low wages are reflective of negative reciprocity. Our experiment shows that for a moderately low, but far from zero wage, which is what our minimum was set at, positive reciprocity plays a significant role, although it is probably not the only factor at work.

The question remains as to why we do not find systematic effects much beyond the neighborhood of the minimum wage? One plausible explanation would be as follows: First, to the extent that employees are sensitive to the fact that in terms of cost to employers, any wage greater than the minimum represents just as much of a gift with the minimum as without it, one might expect the same effort level as before the minimum wage requirement. This, of course, ignores any kind of reference point effects whereby once the minimum is set at 40 instead of zero, wages in the 40s do not appear nearly as generous as when the minimum requirement is zero, as it was before the minimum. However, as one moves farther away from the minimum wage itself, this recalibrated reference point would tend to become less and less salient. Further clarification of this issue is beyond the scope of the present paper.

Our results show some important differences from the two other experiments investigating minimum wage effects in incomplete labor markets. With respect to Brandts and Charness (2004), the paper that is closest to ours, the key difference is that in their experiment the minimum wage generated a negligible increase in wages, to the point that comparing average wages above the minimum, wages were over 10% *lower* with the minimum that without it. This decrease was primarily driven by a dramatic drop in the frequency with which the maximum possible wage was offered with the minimum compared to without it. In contrast, in our experiment average wages increased significantly with the minimum, and average wages beyond the minimum remained essentially the same with the minimum as without it.[24] This reduction in wages above the minimum no doubt accounts for their finding that average effort was lower with the minimum than without it.

But this begs the question of why the wage differences between the two studies? One possibility is that we use a bilateral gift exchange procedure; they used posted wages with an excess supply of labor. However, Fehr et al. (1998) directly compares these two procedures, albeit with no minimum wage present, and finds essentially the same outcome for both wages offered and effort levels. Another possibility is that we changed the scales for effort and wages from [0, 10] in their study to [0, 100] in ours which may have impacted the results. However, we ran one NOtoMW session with the same scale they did, obtaining average wages and effort levels within the ranges reported here, and nothing like the very high wages they got absent the minimum wage. Of course we cannot rule out subject population or cultural differences as their experiments were conducted in Spain, ours in the US, or some subtle difference in instructions. Thus, these differences remain to be sorted out by additional experiments.

Falk et al. (2006) look at the effects of a minimum wage in an economy where workers provide either zero effort by refusing to accept a wage offer, or automatically provide maximum effort when accepting a wage offer. They find that the introduction of a minimum wage into an ongoing labor market results in substantially higher reservation wages. They go on to argue that the minimum wage affects subjects' fairness perceptions, so that wages that were previously considered to be fair may no longer be perceived as such. We find results consistent with this interpretation at lower wages in that effort levels are significantly less in the neighborhood of the minimum wage in our sessions that start with no minimum wage. However, this does not hold in our experiment for higher wages where there are no significant differences, or even higher effort levels, with the minimum wage than without it. Given the very high minimum wage requirement set in Falk et al., a wage requirement that was higher than nearly all the pre-minimum wage rates offered, they do not have any observations for the effect of their minimum wage requirement on wage rates that were substantially higher than the minimum requirement to begin with. On this interpretation, there is no inconsistency between our results and theirs, with the major difference between the two experiments resting on the much higher minimum wage requirement set in their experiment compared to ours.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jebo.2009.12.002.

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[24] The average wage offer for wages greater than or equal to 40 is 71.3 (2.08) without the minimum versus 70.4 (2.80) with it, with standard errors of the mean using session level data in parentheses. In addition, we observe an increase in the frequency with which the very highest wages were offered with the minimum compared to without it.

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