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Table of Contents

Minimum Wage Laws Lower Some Agricultural Wages

Minimum wage legislation affects the agricultural sector of the economy differently than other sectors. We show that an increase in the federal minimum wage lowers the wage of some agricultural worker and causes nonagricultural workers to move to agriculture.[1] We believe this study is the first to systematically examine the impact of the minimum wage in the hired agricultural labor market.

According to microeconomic theory, enforcing a minimum wage in a previously unregulated labor market censors the wage distribution, raising the wages of workers who were previously earning below the minimum wage to that threshold. Consequently, the average wage in the market increases.

However, if the coverage of the minimum wage is incomplete, the effects on wage distributions are more complex. Imposing a minimum wage drives up the wage in the covered sector and decreases the average wage and increases employment in the uncovered sector.

The agricultural sector was exempt from the original federal minimum wage legislation. Indeed, when the original federal minimum wage act was enacted in 1938, many economists joked that the purpose of the law was to maintain family farms.

Today, agriculture is covered under the federal minimum wage law, but minimum wage legislation still has a differential effect on this sector. For a variety of reasons, including failure to enforce the law, not all agricultural workers receive as much as the

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[1] In contrast, Card and Krueger, 1995, and DiNardo, Fortin,and Lemieux, 1996, report that an increase in the federal minimum wage raises average wages in nonfarm sectors.

federal minimum wage. We document that a significant number of workers receive less than the minimum wage in agriculture — most of them apparently in violation of the law. Agricultural workers who are paid by the piece are significantly more likely to receive a wage below the minimum wage than are workers who are paid by the hour. Thus, we view agriculture as a whole (workers who receive hourly wages and those who receive piece rates) as being only partially covered by the minimum wage. In contrast, virtually all workers in other sectors receive at least the minimum wage.

We examine the effects of the increase in the federal minimum wage from $3.35 to $3.80 on April 1, 1990 and the increase from $3.80 to $4.25 on April 1, 1991, and various shifts in state minimum wage laws. We find that an increase in the federal minimum wage *lowers* the average wage of piece-rate agricultural workers but raises the average wage of hourly workers, controlling for individuals' characteristics.

Federal minimum wage legislation affects the wage distribution in two ways. First, it changes the nominal level of federal minimum wage during the period under consideration. Second, it changes relative prices and thereby affects real wages.[2]

In the appendix, we use a simple two-sector, general-equilibrium model where only shifts in labor occur to show the effect on the average wage of imposing a minimum wage that affects only some workers. In particular, we demonstrate that raising the minimum wage

[2] An increase in the minimum wage may cause shifts in both supply and demand. For example, a front page story in *The Packer*, September 15, 1997 reports that, in response to the latest minimum wage increase, the food service industry (where many workers are paid the minimum wage) has increased the demand for on-farm processing of fruits and vegetables. Similarly, restaurants have cut kitchen labor and are buying more value-added produce.

may increase or decrease the average wage and the wage bill. Thus, we turn to empirical evidence to determine the effect of the minimum wage on average wages in agriculture.

We start by describing our data and then present summary statistics that illustrate the effects of federal minimum wage increases in agriculture. In the third section, we use multivariate analysis to estimates the effects of changes in minimum wages on wages and on the probability of being paid less than the minimum wage, conditional on individual and local labor market characteristics. In the fourth section, we estimate how days worked outside agriculture or spent outside of the United States in the years before the interview vary with the minimum wage. In the concluding section, we summarize our main findings.

DATA SOURCE

We use data from the National Agricultural Worker Survey (NAWS) from 1989 to 1995. The Immigration Reform and Control Act of 1986 required the Secretaries of Agriculture and Labor to assess annually the quantity and quality of agricultural workers in the United States. In response to IRCA's mandate, the Department of Labor commissioned the NAWS starting in 1988.

The NAWS is an annual survey of a random sample of hired seasonal agricultural services (SAS) workers. Although only SAS workers are interviewed in the NAWS, SAS is defined broadly as most field work in perishable crop agriculture. SAS crops are the vast majority of nursery products, cash grains, field crops, as well as all fruits and vegetables. SAS do not include production of poultry, livestock, silage or other animal fodder (Mines, Gabbard, and Samardick).

A nationally representative cross-section of SAS workers from 72 counties in 25 states representing 12 distinct agricultural regions are sampled. For each of the interviewing cycles, 30 counties are selected randomly as interview sites.[3] The number of interviews conducted during a given cycle is proportional to the share of SAS activity at that time of the year. Interviews are conducted every four months — in January ("winter" in our tables), May ("spring"), and October — to ensure as diverse a representation of workers as possible.

In early years, a one-year follow up survey of interviewed workers was conducted. As this information is not available in later years, we use only a single observation per individual. See Mines, Gabbard, and Boccalandro for complete details on the sampling procedure.

DESCRIPTIVE STATISTICS

Summary statistics for our sample (where the means are calculated using weights reflecting the probability that a respondent would be sampled) are presented in Table 1. We distinguish between worker paid by the hour and those paid by the piece because they differ slightly in terms of characteristics and pay.

Our NAWS sample has 7,145 workers who are paid by the hour and 1,918 workers who are paid by the piece. The mean earnings per hour ("wage") is $6.53 in the piece-rate sector and only $5.48 in the time-rate sector. In both sectors, the typical worker has slightly more than 10 years of U.S. farm work experience.

[3] Our data set does not report the county in which the employee works.

Ninety-five percent of the workers in the piece-rate sector are Hispanics, compared to 84% in the time-rate sector. In each sector, roughly one in five workers is female and a little over a half are white.

Although citizens are a quarter of the workers in the time-rate sector, they are less than a tenth of those in the piece-rate sector. Roughly one in five workers in both sectors are not authorized to work in the United States. [They do not have a work permit and may have entered the country illegally.] The remain group consists of immigrants who may legally work in the United States (permanent residents and those with amnesty under the Immigration Reform and Control Act of 1986).

A minority of employers supplement wages with fringe benefits. Roughly one in five employers provide rent-free housing to workers. Workers receive bonuses from 26% of time-rate employers and 15% of piece-rate employers.

Table 2 indicates how wages, minimum wages, and unemployment rates varied over our sample period. The second and third columns of Table 2 show the real and nominal agricultural mean hourly wages, respectively. The mean wage in agriculture fell in both nominal and real terms for the first five years of the sample period. The average nominal wage was $6.12 in 1989 and $5.99 in 1995. The decrease in real wages ($1991) is even more dramatic, falling from $6.72 in 1989 to $5.35 in 1995.

In contrast, the average nominal wage in manufacturing (fourth column) increased monotonically from $10.61 in 1989 to $12.51 in 1995. The manufacturing wage was 73% higher than the agricultural wage in 1989, but was 108% higher by 1995.

To reflect market conditions, the table also reports the average nonagricultural unemployment rate in the states included in our sample. These averages were calculated by imputing to each worker in the sample the unemployment rate in the state and in the month in which the interview took place.

The last two columns of Table 2 report the federal and state minimum wage rates in nominal terms. The minimum wage was calculated by imputing to each worker in the sample the federal minimum wage in the month in which the interview took place. During the relevant period, the federal minimum wage increased twice: on April 1, 1990 (from $3.35 to $3.80) and on April 1, 1991 (from $3.80 to $4.25).

The state minimum wage was calculated by imputing to each worker in the sample the minimum wage in the state and in the month in which the interview took place. Each state may set its own minimum wage. The binding constraint is the greater of the federal and state minimum wages. Thus, we set the "effective" state minimum wage equal to the federal minimum wage for those states that do not set a state minimum or have one that is lower than the federal regulation.

Subminimum Wages

Agricultural workers may be paid less than the minimum wage because the minimum wage laws are not enforced, because they are not covered by minimum wage laws, or because they receive other offsetting compensation. Table 3 reports the unconditional probabilities that a worker in the sample was paid an hourly wage below or at the relevant minimum wage. For the entire sample, Column 2 shows the percentage of workers who were paid less than the relevant minimum wage and Column 3 lists the percentage paid exactly the minimum

wage. Depending on the year, 3.9% to 13.1% of all agricultural workers were paid less than the minimum wage and between approximately 0.2% and 7.3% were paid exactly the minimum wage.

Some agricultural workers have a higher probability of being paid less than the minimum wage than do others. Unlike most sectors of the economy, a substantial proportion of agricultural workers (one fourth of our sample) are paid by the piece. Federal law requires that piece workers must be paid exactly the hourly minimum wage if their piece earnings fall below that level: "Employers may pay employees on a piece-rate basis, as long as they receive at least the equivalent of the required minimum hourly wage rate."

The fourth and fifth columns of Table 3 show the percentage of time-rate workers who receive less than or exactly equal the federal minimum wage. The last two columns report the comparable numbers for piece-rate workers. In every year except 1991, a larger share of piece-rate workers are paid less than the minimum wage than hourly workers. For example, in 1990, 14% of piece-rate workers but only 7% of hourly workers were paid less than the minimum wage.

This result is particularly striking because piece workers are paid more on average than are hourly workers. One explanation for these results is that the piece-rate labor force is heterogenous. Piece-work employers attract the very best (prime-age workers) using high hourly compensation, but they also hire some of the least productive workers, whose value of their marginal productivity is less than the minimum wage. A second explanation is that it may be easier for an employer to pay less than the minimum and not be caught. As Table 3

shows, virtually no piece-rate workers receive exactly the minimum wage — unlike workers paid by the hour.

Some workers may be paid less than the minimum wage without violating the laws. Not all state laws cover the agricultural sector although federal minimum wage legislation covers this sector. Some state laws (for example, Washington's) exempt small employers or do not cover piece workers.

The federal minimum wage law does not cover farm workers employed on small farms — those that hire fewer than 500 "man-days" of farm labor in any quarter of the preceding calendar year. In addition, youths under 20 years of age may be paid a lower wage than the current federal minimum wage during the first 90 consecutive calendar days of employment with an employer.[4]

Further, federal minimum wage legislation allows the employer to take monetary bonuses and housing benefits into account when calculating the hourly wage. It is unclear how important this type of exemption is. For example, under California law, meals and lodging can be claimed as an in-kind offset only by written agreement with employees (Rosenberg and Egan), which may discourage the use of such offsets.

According to the theory of compensating differentials, an increase in a worker's nonwage compensation (such as monetary bonuses or rent-free housing) lowers the wage, holding all else constant. Therefore, observing a wage below the minimum might reflect that part of a worker's compensation takes the form of a bonus or rent-free housing.

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[4] Some state laws differ. For example, under California law, people younger the 18 may be paid no less than 85% of the adult minimum wage (Rosenberg and Egan).

To examine the importance of this exemption, we calculate how the probability of being paid below the minimum wage varies with housing benefits and bonuses. Table 4 reports the probability that individual is paid less than the minimum wage. These figures provide support for the view that some workers are paid less than the minimum wage legally because they receive rent-free housing. The share of workers paid less than the minimum wage was 9.9% of those who did not receive rent-free housing but 15.2% of those who did receive such housing.

On the other hand, the bonuses probably do not justify wage payment below the legal limits. Only 6.2% of workers who received a bonus were paid less than the minimum wage in contrast to 12.5% of those who did not receive the bonus. Apparently employers who provide bonuses are "good" employers who are less likely to violate the minimum wage law than others.[5] As the table shows, workers who get both a bonus and rent-free housing have only a 8.9% probability of being paid less than the minimum wage, compared to 11.2% of those who get neither.

Thus, housing and bonuses do not fully explain why many agricultural workers receive less than the minimum wage. Either these workers are not covered by the minimum wage law because their employers have few employees or the laws are being violated.

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[5] This apparent rejection of the theory of compensating differentials is consistent with the previous literature on farm workers' earnings. Using the same data set, Hashida (1995) found that wages and fringe benefits including bonuses are positively related with wages after controlling for productivity, skill and other worker characteristics.

Effects of an Increase in the Minimum Wage

Changes in the minimum wage affect the wage distribution and the composition of the labor force. The top panel of Figure 1 illustrates how the wage distribution changed when the federal minimum wage rose from $3.35 to $3.80 on April 1, 1990. The distributions were obtained using kernel estimation. The kernel function is taken to be Gaussian and the smoothing parameter was set at 0.25. The solid line shows the distribution of wages in the year before the increase and the dotted line is the distribution in the year after the increase. The distribution becomes more concentrated around the mode, which is slightly above the new minimum wage of $3.80. The bottom panel shows the difference between the two distributions. It illustrates that the major shift after the law changed was a decrease in weight near the previous minimum wage and an increase in weight immediately to the right of the new minimum wage.

Figure 2 compares distributions the year before (solid line) and the year after (dotted line) the April 1991 minimum wage rose from $3.80 to $4.25. Again, the distribution shifts slightly to the right and becomes more concentrated around the mode, which is slightly above the minimum wage. This shift in the wage distribution is much less dramatic than in the previous figure. In particular, only about two-thirds as much weight is shifted from near the old minimum wage to the new minimum wage, as can be seen by comparing the bottom panels in both figures.

Some characteristics of workers also changed along with the minimum wage. White workers were 40.5% of the sample, but their share grew to 60.7% after the 1990 federal minimum wage increase and to 66.8% after the 1991 change. The share of citizen fell from

23% to 18% after the 1990 federal minimum wage increase and to 15% after the 1991 increase. The share of unauthorized immigrants increased from 3% to 6% to 11%. These changes in the legal status of workers were not necessarily driven by changes in the minimum wage legislation, as number of unauthorized immigrants has risen over the entire period due to the effects of IRCA. On average, the other worker characteristics — gender, ethnicity, age, and farmwork experience — did not change.

The percentage of workers in the piece-rate sector was unchanged in the year before and after the 1990 increase in minimum wage, but decreased from 29% to 18% in the year after the 1991 increase. Whether this latter shift is due to the second minimum wage increase or merely reflects an unrelated secular trend is unclear.

MULTIVARIATE ANALYSES

So far, we have presented unconditional summary statistics and figures reflecting the effects of a change in the minimum wage. We now use multivariate analyses to estimate conditional responses.

We use two econometric methodologies to examine the effects of the minimum wage on wages. First, we estimate how the average agricultural wage changes when the minimum wage rises. To do so, we estimate a wage equation where the minimum wage is included among the regressors. The coefficient on the minimum wage variable reflects the change in the mean wage due to changes in the law. Second, we estimate how the level of the minimum wage affects the probability of being paid less than the minimum wage.

In both analyses, we examine the binding minimum wage: the higher of the federal or the state minimum wages. Seven states in our sample had minimum wages that were higher

than the federal one for at least one season during the period under consideration. Due to changes in both federal and state minimum wages, the group of states that have minimum wage higher than the federal one changes over time. These changes provide useful variation in a state over time that helps identify the effect of a state minimum wage.

Wage Equations

We start with a reduced-form regression of the real hourly earnings on the real minimum wage and various demographic, economic, and regional variables. Age, age squared, U.S. farm-work experience, experience squared, gender, ethnicity (Hispanic, other), race (white, other), and legal status (U.S. citizens, immigrants who are authorized to work here, and immigrants who are not authorized to work here) serve as proxies for relative marginal productivity and possibly of discrimination. The real manufacturing wage and the nonagricultural unemployment rate for the state capture the general economic conditions and hence the worker's reservation wage. Seasonal dummies capture shifts in demand and supply over the year. The regional dummies reflect other demand and supply differences across the country. In addition, we include binary dummies for whether a worker received a cash bonus or rent-free housing, to control for possible compensating wage differentials.

We divide the sample into four groups: workers paid by the hour and those paid by the piece in states where the state minimum wage is higher than the federal rate; and workers paid by the hour and those paid by the piece in other states.

Due to possible differences in enforcement effort between state and federal authorities or other factors, the coefficient on minimum wage may differ in states where the federal minimum wage is binding and in states that have a minimum wage above the federal level.

A likelihood-ratio test strongly rejects the hypothesis that the two groups of states can be aggregated into a single regression.[6]

In estimating the wage equations, we use a Heckman two-step technique to control for possible sample selection in workers' choice of either time-rate or piece-rate jobs.[7] Table 5 reports wage equation estimates for our four subsamples. The coefficient on both the federal and state minimum wage is positive for workers who are paid by the hour.

Controlling for individuals' characteristics, a dollar increase in the federal minimum wage raises the average wage in the hourly sector by 14¢ (which is statistically significantly different from zero at the 0.05 level). A dollar increase in the state minimum wage raises the average wage in this sector by 12¢ (but this coefficient is not precisely estimated). In contrast, a dollar increase in the federal minimum wage causes the real hourly earnings in the piece-rate sector *to fall by 26¢* (a statistically significant effect). An increase in the state minimum wage has essentially no effect: a statistically insignificant increase of 0.2¢. By weighting the estimated coefficients by the number of workers in each group, we can calculate the average effect of a minimum wage change on the entire population of agricultur-

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[6] The likelihood-ratio test statistic for aggregating the federal and state subsamples are 387 for the hourly workers and 101 for the piece-rate workers. We also tested aggregating piece-rate and hourly subsamples. The test statistic was 213 for workers in states with higher state minimum wage laws and 1,117 for workers in other states.

[7] In the logit equation for whether a worker has a piece-rate job, we use the same right-hand side variables as in Table 5 plus four crop dummies. Crop is an important determinant of whether farmers use piece rates. For example, farmers rarely use piece rates for delicate crops. In all four subsamples, the coefficients of at least three dummies are statistically significant in the first stage of the estimation process.

al workers. Averaging across the samples, we find that a one dollar increase in the relevant minimum wage leads to a 6.5¢ increase in hourly earnings.

The other coefficients generally have the expected signs. The coefficient on the state unemployment rate is either negative or insignificant. The coefficient on the manufacturing wage is positive or insignificant. Legal status has a similar but smaller effect on wage than in previous studies (e.g., Isé and Perloff). Wages are a concave function of age and farm experience when age and farmwork experience are statistically significant.

Robustness

We conducted several sets of experiments to examine the robustness of our results. First, we considered the possibility that there is no sample selection problem in the choice of jobs so that we can estimate these wage equations using ordinary least squares. Second, we tested whether the bonus and rent-free housing dummies, which are treated as exogenous in Table 5, were actually endogenous. Third, we examined the role of time trends. Fourth, we considered the effects of the youth exemption of the federal minimum wage law.

If we ignore the possibility of sample-selection problems and estimate the wage equations using ordinary least squares, we obtain coefficients (asymptotic standard errors) on the minimum wage of 0.14 (0.02) in the federal hourly sample, 0.15 (0.06) in the state hourly sample, -0.26 (0.06) in the federal piece-rate sample, and -0.003 (0.17) in the state piece-rate sample. The overall effect of a one dollar increase in the relevant minimum wage is 7¢ across all four of these sectors. Thus, the results are close to those reported in Table 5.

As one might reasonably view the bonus and rent-free housing dummies as endogenous, we considered several approaches to deal with that problem. We performed eight

Hausman tests (four subsamples estimated using either ordinary least squares or the Heckman two-step procedure) of whether these variables are endogenous. In each case except the state piece-rate sample using the Heckman technique we failed to reject the hypothesis of no endogeneity.[8] If we estimate using instrumental variables, we get the same qualitative results but the coefficients are slightly larger in absolute value.[9] The overall effect of a one dollar increase in the minimum wage rises to 7.6¢ when the instrumental variable technique is used.

Alternatively, we could drop the rent-free housing and bonus dummies and use a "reduced-form" specifications. Estimating this reduced-form specification using ordinary least squares, we obtain the following coefficients on the minimum wage: 0.13 (0.02), hourly, federal; 0.16 (0.06) hourly, state; -0.25 (0.06) piece, federal; -0.01 (0.16) piece, state. Again, these estimates of the key coefficients are close to those from the specification that include these dummy variables.

To capture unobserved trend in demand for agricultural products, we added a time trend and its square to the specification in Table 5. The resulting minimum wage coefficients

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[8] The Hausman test statistics (χ^2 with 22 degrees of freedom) are 16.7, 14.3, 2.9, and 3.7 for the four subsamples (in the order presented in Table 5) for ordinary least squares versus instrumental variables and -450.1, 9.59, -21.4, and -44.94 for the Heckman two-stage procedure with and without the use of instruments. The instruments are seasonal worker status, whether an employer provided equipment, whether the employer provided drinking water and toilet facilities in the field, and whether the worker has relatives who have nonagricultural U. S. jobs.

[9] For the subsamples in the order given in Table 5, the estimated coefficients on the minimum wage dummy when we use instrumental variables but ignore possible sample selection are 0.24 (0.06); 0.06 (0.08); -0.46 (0.15); and -0.003 (0.17). For the instrumental variables-Heckman estimates, they are 0.150 (0.055); 0.060 (0.096); -0.320 (0.177); and 0.421 (0.943).

are 0.107 (0.030) for the hourly federal sample; 0.165 (0.077), hourly state; -0.174 (0.075), piece-rate federal; and -0.623 (0.195), piece-rate state. These coefficient estimates are qualitatively similar to those in Table 5, but the asymptotic standard errors tend to be slightly larger because the time trend absorbs some of the variation in minimum wage.

Because youths under 20 years of age may be paid a lower wage than the current federal minimum wage during the first 90 consecutive calendar days of employment with an employer we estimated the same model on a sample that includes only workers who were at least 21 years. Results in the restricted federal samples are qualitatively similar to the ones in the full sample, although less precise. The coefficient on the minimum wage for hourly workers is 0.130 (0.027) and that for piece workers is -0.207 (0.072).

Probability of Being Paid Less than the Minimum Wage

At first glance, the finding that minimum wage lowers the wage in the piece-rate sector is surprising, as previous literature on minimum wage, which studies only nonagricultural workers, finds positive and significant wage effects in other sectors (Card and Krueger, 1995, DiNardo, Fortin, Lemieux, 1996). Card and Krueger found that the 1990 rise in the Federal minimum wage, from $3.35 to $3.80, increased teenage wages by 2% to 6%, depending on the state of residence. DiNardo, Fortin, and Lemieux used a semiparametric procedure to analyze the effects of changes in minimum wage on the entire wage distribution. They found that changes in the minimum wage was an important factor in raising wages of workers at the bottom of the distribution, and hence the minimum wage raised the average

wage.[10] However, because they focused on wage inequality, they do not report the quantitative effect of an increase in the minimum wage on average wages.

We believe our results differ from those of the previous studies of nonagricultural workers because an agricultural worker has a higher probability of being paid below the minimum wage than would a corresponding worker in other sectors. To pursue this issue further, we consider two questions. First, by how much does the probability of being paid less than the minimum wage rise as the legal floor increases? Second, which agricultural workers are likely to be paid less than the minimum wage?

We use a logit model, Table 6, to answer these questions. The left-hand-side variable is a dummy that equals one if an individual's hourly earnings is less than the relevant minimum wage. The right-hand-side variables are the same as in Table 5. However, as we report the marginal effects of a change in a variable in Table 6, the squared age and U.S. farm work experience variables are not explicitly shown. If the variable is a zero-one dummy, we report the marginal effect as the difference in the probability of being paid less than the minimum wage when that dummy is set equal to one instead of zero. For continuous variables, we report the marginal effect of a one percent change in the variable. Asymptotic t-statistics are reported in the parentheses.

An increase in the federal or state minimum wage raises the probability that a farm worker is paid less than the minimum wage. A one percent increase in the minimum wage raises the probability of being paid less than the minimum wage by 0.17 percent in the hourly

[10] In contrast, Horrigan and Mincy reported that the distributional effects of the minimum wage were relatively unimportant.

samples, 0.22 percent in the federal piece-rate sample, and 0.07 percent (not a statistically significant effect) in the state piece-rate sample.

Surprisingly, legal status does not appears to be an important factor in determining who is paid less than the minimum wage. According to our point estimates, unauthorized workers are more likely to receive less than the minimum wage than are citizens or authorized immigrants, but these effects are not significantly different from zero.

In the hourly sector, a worker is 3 to 6 percent more likely to be paid less than the minimum wage if the employer provides rent-free housing, as one might expect. This effect is not statistically significant in the piece-rate sector. Workers who receive a bonus are *less* likely to be paid below the minimum wage. This result is consistent with the view that only "good" employers provide bonuses, and that these employers would not violate the law by paying less than the minimum wage.

As robustness tests in separate specifications, we interacted minimum wage with gender and legal status to examine whether increases in minimum wage make female or unauthorized immigrants more likely to be paid less than minimum wage. The results - not reported here, but available on request - generally reject the hypothesis of a differential effect by gender or legal status.

MIGRATION INTO AGRICULTURE

We conclude that part of the explanation for the perverse wage effect in the piece-rate sector is that an increase in the minimum wage increases the share of piece-rate workers who are paid less than the legal minimum. One possible explanation for this result is that some workers who are driven out of nonfarm and farm sectors where the minimum wage law is

better enforced mover into agriculture putting downward pressure on the agricultural wage and inducing some workers to accept below-minimum wage jobs. Further an increase in the minimum wage may attract extra workers from out of the country who then find only subminimum wage jobs. Thus, flows into piece-rate work and the lack of enforcement of the minimum wage law may be responsible for the perverse wage effect.

Unfortunately, our data do not allow us to directly examine how the minimum wage affects migration in and out of agriculture. However, we can use our data to indirectly examine migration into agriculture from U. S. nonagricultural employment and from outside of the country.

Movements from Nonfarm Employment

Given that a worker is more likely to receive a payment below the minimum wage in agriculture, we would expect workers in nonagricultural sectors who lose their job due to a higher minimum wage to move to the agricultural sector. Such a shift of workers into agriculture may explain why the real (indeed the nominal) agricultural wage has fallen over time.

We indirectly examined this migration hypothesis in Table 7, where we regressed the number of days that each interviewed agricultural worker in the NAWS survey spent working in the nonfarm sector in the year prior to the interview on the same covariates that we used in Tables 5 and 6.[11] The results are consistent with a net migration from the nonagricultural sector into agriculture. We find that, the higher the minimum wage today, the more likely a

[11] The reported coefficients are based on ordinary least squares; however, the Heckman two-stage coefficients are qualitatively similar.

given agricultural worker had a nonagricultural job in the previous year. A dollar increase in the federal minimum wage raises the number of days of nonfarm work in the previous year by 21 days in the hourly sector and 28 days in the piece-rate sector, roughly doubling the amount of nonfarm work experience in the previous year. The effects are qualitatively the same for an increase in the state minimum wage but not statistically significantly different from zero at the 0.05 level. Thus, this evidence is consistent with the view that workers shifted from nonfarm to farm jobs when the minimum wage rose.[12]

Who are the workers who moved from the nonfarm sector into the farm sector as a consequence of minimum wage increases? To address this question, we examine the characteristics of two groups of farm workers — those who worked at least one day at a nonagricultural U. S. job and those who only worked in agriculture — in the year before and after the federal minimum wage increases.

In the year before the 1990 minimum wage increase, workers with some nonfarm work experience in the previous year were younger and less experienced than workers with zero days of nonfarm work. They were also more likely to be male and non-Hispanic. The percentage of unauthorized immigrants was the same in the two groups. In the year after the minimum wage increase, the percentage of unauthorized immigrants increased from 3% to 5% among workers who had worked outside of agriculture in the previous year but remained at 3% for those who only worked in agriculture. Similarly the group who had worked outside of agriculture became whiter and more female relative to the group who only worked in

[12] Alternatively, it is possible that a disproportionate number of workers who had only worked in agriculture shifted out of agriculture when the minimum wage rose. We think this second explanation is very unlikely, but we have no direct way of testing it.

agriculture. There are only minimal differences between the two groups in terms of Hispanic ethnicity, age, and U. S. farm work experience. Moreover, there were no major differences between the two groups after the 1991 federal minimum wage increase.

Workers shifting from outside of agriculture are not necessarily the ones who were paid below the minimum wage in agriculture. These workers may have better language and other skills and may force other workers who were formerly employed in above-minimum wage jobs into below-minimum wage jobs. To examine whether workers who move into agriculture from nonagricultural jobs are more likely to be paid less than the minimum wage, we estimated a logit model with the same explanatory variables as in Table 6 and two additional regressors: the number of days worked outside agriculture in the previous year and the interaction between number of days worked outside agriculture and the minimum wage. Neither of these coefficients are statistically significantly different from zero at the 0.05 level. Thus, we conclude that workers who migrate from nonfarm jobs are not more likely to obtain subminimum wage jobs than other agricultural workers.

International Migration

We have been examining movements in and out of agriculture. Because many farm workers in the sample are immigrants from Mexico and Central American countries, it is also possible that changes in the minimum wage induce movements in and out of the United States.

Some of these workers spend a large fraction of the year outside of the United States. They return to their home countries when work is scarce or for vacations. We tested whether increases in the minimum wage affects international migration decisions by regressing the

number of days that each interviewed agricultural worker spent outside the United States in the year prior to the interview on the same covariate as in Table 5, 6, and 7.

A dollar increase in the federal minimum wage is associated with 27.9 (with a standard error of 7.16) more days spent outside the United States in the previous year in the hourly sector, where this group spent a mean of 34 days outside of the United States. The corresponding numbers for the other groups were: 45.41 (14.31) extra days compared to an average of 45.67 for the state hourly sample; 32.44 (14.61) and 40.88, federal piece; and 21.13 (28.25) and 38.72, state piece. Thus, the higher the minimum wage today, the more like that an agricultural worker was outside the country in the previous year. This result is consistent with the hypothesis that an increase in the minimum wage causes a net migration from outside of the country into agriculture.

CONCLUSIONS

Theoretically, an increase in a minimum wage may cause a drop in the average wage if the coverage of the minimum wage is incomplete. Controlling for workers' characteristics, we estimate that a one dollar increase in a binding state minimum wage causes the average wage to rise by 12¢ in the hourly sector of agriculture and does not have a statistically significant effect in the piece-rate sector. A one dollar increase in the federal minimum wage causes the average wage to rise by 14¢ in the hourly sector and to *drop* by 26¢ in the piece sector. Averaging across the samples, we find that a one dollar increase in the relevant minimum wage leads to a 6.5¢ increase in hourly earnings.

Depending on the year, between 4% and 13% of agricultural workers were paid less than the federal minimum wage. A larger proportion of workers in the piece-rate sector are paid less than the minimum wage than in the time-rate sector.

Controlling for individual characteristics, we find that a one dollar increase in the federal minimum wage raises the probability of being paid less than the minimum wage by 16.7%. This effect does not statistically significantly vary by legal status.

As the federal (but not state) minimum wage increases, the probability rises that a worker was employed in a nonagricultural job within the United States or who was outside of the United States agriculture in the previous year. Thus, the minimum wage may be inducing a net inflow of workers to agriculture, which explains the fall in real (and nominal) wages in agriculture in general and the absolute drop in the average wage in the piece-rate sector.

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Appendix: A Simple General-Equilibrium Model

We illustrate the effect on the average wage of imposing a minimum wage that affects only some workers using a simple two-sector, general-equilibrium model where only shifts in labor occur. Before the imposition of a minimum wage, total market demand for labor, $L(w)$, is a function of the market wage, w. The market demand is the sum of the demand in (what will be) the covered sector, $L_c(w)$, and that in the uncovered sectors, $L_u(w)$. The initial equilibrium wage is determined by equating the total market demand and the supply of labor, $S(w)$:

$$L(w) \equiv L_c(w) + L_u(w) = S(w).$$

Now suppose that a minimum wage $\underline{w}$, is applied to only the covered sector. The new equilibrium condition is

$$L_c(\underline{w}) + L_u(w*) = S(w*), \tag{1}$$

where $w*$ is the new equilibrium wage in the uncovered sector. Totally differentiating Equation 1, we derive the well-known result that raising the minimum wage causes the wage in the uncovered sector to fall if the supply curve of labor is upward sloping, $S' > 0$:

$$\frac{dw*}{d\underline{w}} = -\frac{L_c'}{L_u' - S'} < 0.$$

The new average wage is

$$\bar{w} = \frac{L_u(w*)w* + L_c(\underline{w})\underline{w}}{L_u(w*) + L_c(\underline{w})},$$

so the new wage bill is

$$\bar{w}L = L_u(w*)w* + L_c(\underline{w})\underline{w}. \tag{2}$$

By total differentiating Equation 2, we determine how the minimum wage affects the wage bill:

$$\begin{aligned}\frac{d\bar{w}L}{d\underline{w}} &= \left[w*L_u' + L_u\right]\frac{dw*}{d\underline{w}} + \left[\underline{w}L_c' + L_c\right] \\ &= \left[\varepsilon_u + 1\right]L_u\frac{dw*}{d\underline{w}} + \left[\varepsilon_c + 1\right]L_c.\end{aligned}$$

In general, the sign of $d\bar{w}L/d\underline{w}$ depends on the relative magnitudes of the elasticities of demand and the relative sizes of the two sectors. If the elasticity of demand in the uncovered sector, ε_u, is less than -1 (elastic) and the elasticity of demand in the covered sector, ε_c, is greater than -1 (inelastic), the wage bill rises with the minimum wage, $d\bar{w}L/d\underline{w} > 0$. If the uncovered sector has an inelastic demand and the covered sector has an elastic demand, the wage bill falls as the minimum wage rises.

The direction of the effect that the minimum wage has on the average wage, $d\bar{w}/d\underline{w}$, is the same as it has on the wage bill. Consequently, we cannot determine the effect of the minimum wage on the wage bill or the average wage by theory alone. As a result, we turn to empirical evidence.

Table 1
Summary Statistics for All Years
Means (Standard Deviations)

	Hourly Pay	*Piece Rate*
Real wage ($1991)	5.48 (2.29)	6.53 (3.08)
Age	33.61 (12.13)	32.32 (11.44)
Years of U.S. Farmwork Experience	10.69 (9.34)	10.19 (8.44)
White	.58	.54
Hispanic	.84	.95
Female	.21	.17
U.S. Citizens	.25	.09
Legal Immigrant	.58	.72
Unauthorized Immigrant	.17	.20
Rent-Free Housing	.22	.18
Bonus (money)	.26	.15
Spring	.25	.28
Winter	.27	.39
Summer	.48	.33
West	.43	.46
South East	.13	.22
North West	.10	.09
Western Plains	.12	.10
Midwest	.14	.06

Source: NAWS.

Table 2
Summary Statistics Over Time

	Real Agricultural Wage	*Nominal Agricultural Wage*	*Nominal Manufacturing Wage*	*Nonagricultural Unemployment Rate*	*Federal Minimum Wage*	*Av. State Minimum Wage*
1989	6.72	6.12	10.61	5.51	3.35	3.75
1990	6.36	6.11	10.76	5.58	3.70*	3.99
1991	6.28	6.28	11.09	6.97	4.06**	4.16
1992	5.57	5.74	11.77	8.01	4.25	4.31
1993	5.16	5.48	12.05	7.42	4.25	4.31
1994	5.23	5.69	12.29	6.83	4.25	4.37
1995	5.35	5.99	12.51	6.30	4.25	4.40

* On April 1, 1990, the federal minimum wage creased from $3.35 to $3.80 per hour. The number reported is the average rate over the year.
** On April 1, 1991, the federal minimum wage creased from $3.80 to $4.25 per hour.

Sources: NAWS: Real and nominal agricultural wage; BLS (1996): Nominal manufacturing wage and unemployment rate.

Table 3
Share of Employees Receiving Less than or Equal to the Federal Minimum Wage

	All		*Paid by the Hour*		*Paid by the Piece*	
	Less	*Equal*	*Less*	*Equal*	*Less*	*Equal*
1989	8.8	0.5	6.2	0.8	15.6	0
1990	9.9	0.2	7.2	0.2	13.9	0
1991	13.1	3.4	13.2	4.5	12.8	0.3
1992	9.7	3.6	8.1	4.8	14.6	0
1993	12.2	6.9	11.4	8.5	15.5	0.5
1994	4.8	7.3	4.5	8.3	7.2	0
1995	3.9	2.0	3.0	2.5	7.9	0

Source: NAWS.

Table 4
Percentage Paid Less than the Minimum Wage
(Share of the Entire Sample)

		Rent-Free Housing		
		no	yes	
bonus	no	11.2 (61.0)	17.9 (15.2)	12.5 (76.2)
	yes	5.3 (17.5)	8.9 (6.3)	6.2 (23.8)
		9.9 (78.5)	15.2 (21.5)	

Table 5
Heckman Two-Stage Wage Equations
Regression Coefficient (asymptotic standard error)

	Hourly		*Piece Rate*	
	Federal	*State*	*Federal*	*State*
Constant	0.722	1.315	2.027	2.122
	(0.113)	(0.423)	(0.353)	(1.162)
Minimum Wage	0.141	0.117	-0.264	0.002
	(0.025)	(0.071)	(0.068)	(0.171)
Unemployment Rate	-0.013	-0.025	0.016	0.093
	(0.003)	(0.012)	(0.010)	(0.026)
Manufacturing Wage	0.013	-0.010	0.072	-0.082
	(0.005)	(0.020)	(0.022)	(0.063)
White	0.021	0.003	-0.018	-0.181
	(0.008)	(0.021)	(0.023)	(0.054)
Hispanic	-0.033	-0.034	-0.018	0.011
	(0.012)	(0.038)	(0.044)	(0.221)
Female	-0.052	-0.018	-0.133	-0.055
	(0.009)	(0.023)	(0.027)	(0.055)
Citizen	0.070	-0.026	0.053	-0.098
	(0.014)	(0.035)	(0.048)	(0.111)
Legal Immigrant	0.044	0.024	0.082	-0.031
	(0.011)	(0.030)	(0.029)	(0.062)
Age	0.008	-0.001	-0.0004	0.009
	(0.002)	(0.005)	(0.006)	(0.012)
Age^2	-0.0001	-0.0001	-0.00002	-0.0002
	(0.00002)	(0.0001)	(0.00008)	(0.0002)
U.S. Farm Experience	0.004	0.016	0.013	0.009
	(0.001)	(0.003)	(0.004)	(0.009)
U.S. Farm $Experience^2$	-0.00004	-0.0002	-0.0003	0.00001
	(0.00003)	(0.0001)	(0.0001)	(0.0002)
Rent-Free Housing	-0.038	-0.011	-0.079	-0.034
	(0.009)	(0.027)	(0.030)	(0.076)
Bonus	0.096	0.098	0.040	0.115
	(0.009)	(0.022)	(0.033)	(0.054)
Spring	0.0004	0.072	-0.174	-0.164
	(0.010)	(0.029)	(0.035)	(0.070)
Winter	-0.006	0.092	-0.197	0.011
	(0.009)	(0.023)	(0.033)	(0.087)
West	0.107	0.198	-0.152	0.180

	(0.022)	(0.041)	(0.058)	(0.099)
South East	0.048	-	-0.021	-
	(0.022)	(-)	(0.071)	(-)
North West	0.201	0.139	-0.032	0.219
	(0.026)	(0.038)	(0.078)	(0.096)
Western Plains	0.024	-	-0.039	-
	(0.021)	(-)	(0.064)	(-)
Midwest	0.044	0.139	-0.149	-
	(0.021)	(0.084)	(0.069)	(-)
λ	-0.032	-0.232	0.020	0.004
	(0.019)	(0.051)	(0.043)	(0.153)
Likelihood Ratio Test (all slope coefficients = 0), χ^2_{22}	690	294	216	58
Number of Observations	5,108	1,655	1,438	443

Table 6
Logit: Paid Less than the Minimum Wage
Marginal Effects at the Sample Means (Asymptotic t-statistics)

	Hourly		*Piece Rate*	
	Federal	*State*	*Federal*	*State*
Minimum Wage	0.167	0.171	0.216	0.074
	(6.92)	(2.90)	(3.58)	(0.60)
Unemployment Rate	0.001	-0.004	-0.032	-0.046
	(0.50)	(-0.48)	(-3.89)	(-2.33)
Manufacturing Wage	-0.020	0.009	-0.042	0.002
	(-3.80)	(0.59)	(-2.01)	(0.05)
White	-0.004	0.018	-0.031	0.091
	(-0.64)	(0.98)	(-1.61)	(2.47)
Hispanic	0.0004	0.024	-0.035	0.113
	(0.04)	(0.85)	(-0.95)	(0.05)
Female	0.011	0.030	0.037	0.003
	(1.27)	(1.51)	(1.55)	(0.09)
Citizen	-0.020	0.031	-0.005	0.063
	(-1.64)	(1.29)	(-0.16)	(0.78)
Legal Immigrant	-0.013	0.024	-0.058	-0.010
	(-1.39)	(1.13)	(-2.16)	(-0.24)
Age	0.003	-0.007	0.0001	-0.003
	(0.87)	(-1.73)	(0.03)	(0.39)
U.S. Farmwork Experience	-0.0004	-0.002	-0.002	-0.005
	(0.47)	(-1.83)	(-0.62)	(-1.22)
Rent-Free Housing	0.028	0.059	-0.003	0.067
	(3.08)	(2.66)	(-0.14)	(1.12)
Bonus	-0.058	-0.039	-0.058	-0.070
	(-6.94)	(-2.35)	(-2.55)	(-2.11)
Spring	-0.017	0.009	0.085	0.142
	(-1.83)	(0.44)	(2.85)	(2.09)
Winter	-0.016	-0.036	0.099	0.049
	(-2.07)	(-2.28)	(3.97)	(1.20)
West	-0.002	-0.097	0.160	-0.007
	(-0.14)	(-3.14)	(2.29)	(-0.11)
South East	0.008	-	0.039	-
	(0.41)	-	(0.50)	-
North West	-0.024	-0.062	-0.081	-0.043
	(-0.92)	(-2.63)	(-0.90)	(-0.69)

Western Plains	0.093	-	0.048	-
	(3.49)	-	(0.64)	-
Midwest	0.048	-0.054	0.108	-
	(1.99)	(-1.00)	(1.21)	-
Correctly Predicted	90.5%	87.8%	84.9%	87.0%

Table 7
Ordinary Least Square Regression of Days Worked at a Nonfarm Job in the Previous Year
(Asymptotic standard errors)

	Hourly		*Piece Rate*	
	Federal	*State*	*Federal*	*State*
Constant	-90.539	39.887	-95.508	-226.081
	(29.924)	(71.276)	(62.889)	(147.078)
Minimum Wage	21.500	4.337	28.330	16.872
	(6.785)	(12.373)	(12.031)	(21.881)
Unemployment Rate	-2.174	1.578	-1.404	4.268
	(0.910)	(2.190)	(1.643)	(3.322)
Manufacturing Wage	1.630	-3.790	-0.534	7.903
	(1.350)	(3.390)	(3.788)	(7.121)
White	7.763	1.508	3.274	7.803
	(2.035)	(3.685)	(3.898)	(6.166)
Hispanic	-17.030	-14.352	-13.440	7.532
	(3.202)	(6.453)	(7.474)	(23.378)
Female	-13.798	-5.718	-3.007	10.525
	(2.350)	(4.029)	(4.635)	(7.095)
Citizen	17.781	25.430	23.839	28.832
	(3.769)	(6.051)	(7.759)	(12.230)
Legal Immigrant	8.673	10.383	8.928	21.354
	(2.876)	(5.307)	(5.022)	(7.923)
Age	2.002	0.209	1.608	1.711
	(0.450)	(0.794)	(0.970)	(1.478)
Age^2	-0.025	-0.004	-0.024	-0.029
	(0.005)	(0.009)	(0.012)	(0.020)
U.S. Farmwork Experience	-1.786	-0.414	-1.562	-1.832
	(0.301)	(0.548)	(0.708)	(1.126)
U.S. Farmwork $Experience^2$	0.027	-0.0006	0.027	0.061
	(0.006)	(0.012)	(0.018)	(0.031)
Rent-Free Housing	4.954	-6.127	-2.356	-4.169

	(2.475)	(4.720)	(5.109)	(9.933)
Bonus	-6.735	-1.702	-8.054	-8.184
	(2.167)	(3.861)	(5.066)	(6.829)
Spring	5.260	-3.373	8.100	-3.730
	(2.616)	(5.074)	(5.207)	(8.767)
Winter	8.684	2.322	7.426	-4.965
	(2.326)	(3.731)	(4.438)	(6.714)
West	-5.229	3.272	-2.229	1.663
	(5.731)	(7.190)	(10.012)	(11.968)
South East	5.417	-	7.059	-
	(5.818)	-	(12.600)	-
North West	8.329	6.020	44.589	17.243
	(6.676)	(6.779)	(13.193)	(11.968)
Western Plains	28.362	-	7.253	-
	(5.561)	-	(10.900)	-
Midwest	25.970	4.034	46.485	-
	(5.526)	(14.592)	(11.749)	-
$\bar{R}^2$	0.11	0.03	0.08	0.06
Mean of the dependent variable	27.6	19.6	21.5	15.2

Figure 1: Effect of the April 1990 Minimum Wage Increase on the Wage Distribution

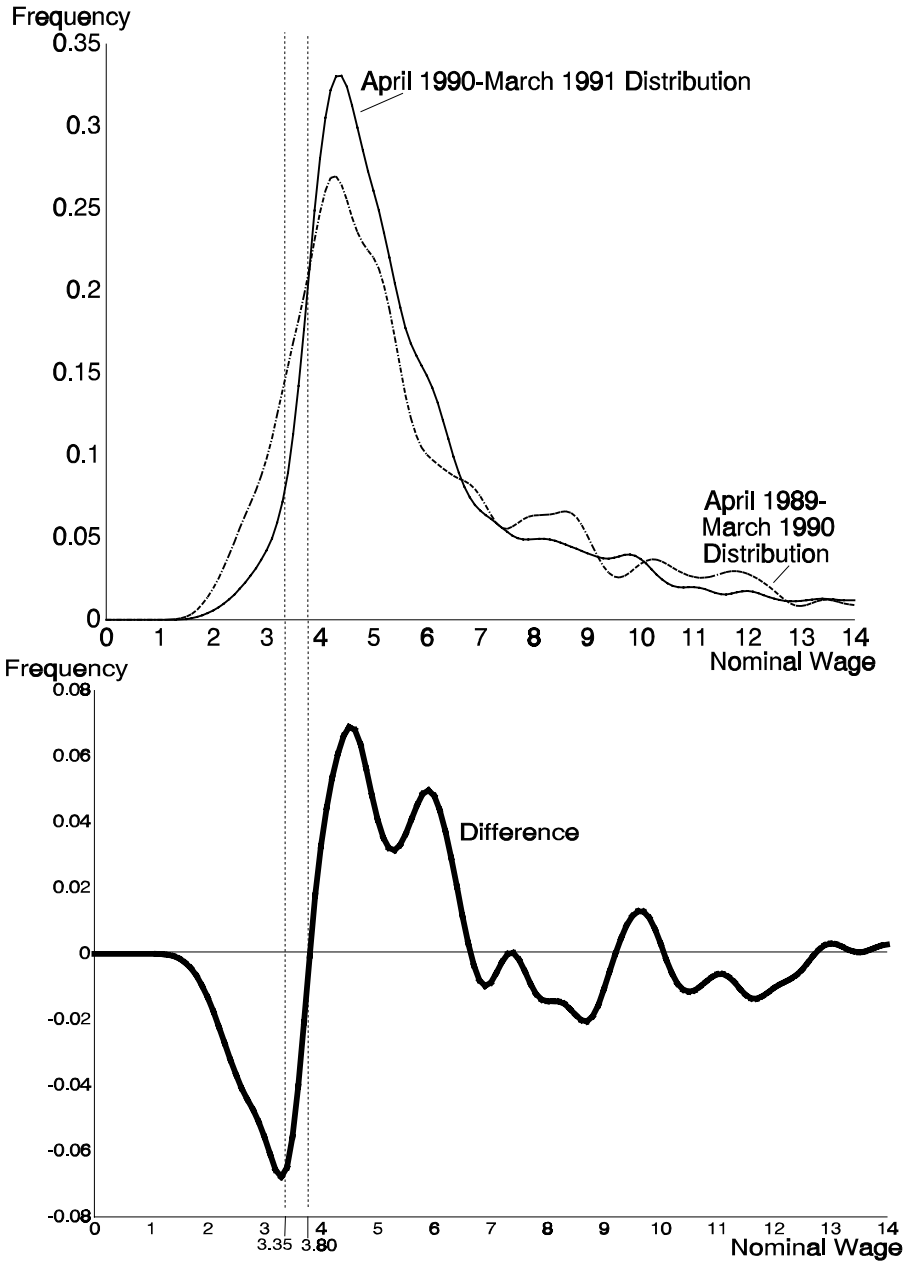

Figure 2: Effect of the April 1991 Minimum Wage Increase on the Wage Distribution