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Minimum Wage Effects on Hours, Employment and Number of Firms: The Iowa Case

Research on Iowa low-wage retail and service industries supports the long-standing view that minimum wages lower employment opportunities for workers. The sample period includes three successive changes in the Iowa minimum wage in 1990, 1991, and 1992, during which time the Iowa rate exceeded the federal minimum wage and that of its surrounding states. Firm level longitudinal data which separated sub- from superminimum workers yielded employment demand elasticities ranging from -0.3 to -0.7. Hours elasticities were even larger, implying that the increases in minimum wages lowered earnings for subminimum workers. These findings are corroborated by analysis of county-level two-digit industry data. Minimum wages also reduced the number of firms, but increased average firm size in these industries.

I. Introduction

Until recently, economists were uniquely united in the opinion that increases in the minimum wage reduced employment. Frey, Pommerehne, Schneider and Gilbert (1984) reported that almost nine of ten U.S. economists agreed with the statement "A minimum wage increases unemployment among young and unskilled workers." The consensus empirical result, as summarized by Brown et al. (1982) was that a 10% increase in the minimum wage reduced teenage employment by 1-3 percent. The least skilled segments of the population (especially school dropouts) appear to have been most adversely affected.

This consensus was challenged in highly publicized studies by David Card, Alan Krueger and Lawrence Katz. These findings, as summarized in Card and Krueger (1995: p. 1), constitute "a new body of evidence showing that recent minimum-wage increases have not had the negative employment effects predicted by the textbook model." In fact, "some of the new evidence points toward a *positive* effect of the minimum wage on employment; most shows no effect at all." Their research was used to buttress arguments for increasing the federal minimum wage in 1996.

The most prominent of these studies focuses on the employment effects of the 1992 increase in the New Jersey state minimum wage rate. Because neighboring Pennsylvania did not change its minimum wage, the contrast in employment growth between New Jersey and Pennsylvania provided a "natural experiment" to test the minimum wage effects. Card and Krueger (1994) report that employment in restaurants of four national fast-food chains on the urban New Jersey side of the border actually expanded or, at least, didn't decline relative to similar restaurants on the Pennsylvania side. They collected their own data using telephone surveys of about 400 restaurants before and after the minimum wage change. Earlier studies,

published by Katz and Krueger (1992) for fast food restaurants in Texas and by Card (1992) for teenage employment in California report similar results, although they lack the natural experiment features of the New Jersey study.

While several leading economists have praised their work for challenging conventional wisdom and believe that it will have a major influence on policy and future research, others have pointed to potential problems which might weaken or reverse the new empirical findings.[1] Four types of criticism have been raised. First, minimum wages directly raise pay for the subminimum group (those whose wages were below the new minimum) which lowers the demand for subminimum workers according to neoclassical theory. For those paid above the new minimum (the superminimum group), minimum wages raise labor demand if, as is likely, superminimum and subminimum workers are gross substitutes. These studies have used changes in total employment that understate the reduction in demand for subminimum workers.

Second, the New Jersey minimum wage became effective two years after the legislation was passed. Although Card and Krueger suggested that political maneuvering created uncertainty about the actual implementation date, it is possible that some of the reaction to the legislation occurred before the new minimum wage came into effect. If true, the measured change in employment may have missed some of the employment adjustments to the law.

A third potential problem is the concentration on nationally known fast food enterprises rather than a representative sample of eating establishments. It is possible that such fast food restaurants can better absorb wage increases than can eating establishments generally.[2] If so, they may gain market share or expand, even as the industry as a whole is losing employment.

A fourth criticism of the Card-Krueger methodology is that their survey may have noisy measures of the dependent variable of interest. Because the consensus view is that changes in employment resulting from the minimum wage are likely to be small, measurement errors in employment can easily swamp true changes in labor demand. First, their questionnaire did not measure hours worked, making it difficult to interpret the reported change in full- and part-time employment. Second, David Neumark and William Wascher (1995) compared payroll record data with Card and Krueger's survey data and found much higher variation in employment in the survey data. What impact this measurement error might have on the results is unclear.

Our study is in the spirit of the Card-Krueger (1994) longitudinal methodology. However, our data has some significant advantages over the information available in previous studies. The most important is that our data are taken from firm quarterly payroll records provided to the Iowa Department of Employment Services as required by Iowa's unemployment insurance system. As legal documents, these records should minimize problems of measurement errors in employment or numbers of firms. The county-level aggregates include all firms, so we avoid problems of including only a subset of firms in the industry. The firm-level data is based on a random sample of firms in each industry, also insuring a broadly representative sample. Our firm level data set allows identification of superminimum and subminimum workers. Such disaggregation is important since we need to distinguish between minimum wage effects on the targeted low wage workers versus those who are more highly paid. The lag between legislation and initial implementation in Iowa was under one year, so problems of firm response in advance of the analysis was minimized.

Minimum wages are likely to have larger effects in markets with lower relative wages. Thus, minimum wages would be expected to have larger adverse effects in low wage states such as Iowa than in higher wage states such as New Jersey.[3] Despite being a relatively low wage state, Iowa established a state minimum wage on January 1, 1990, which, at $3.85, exceeded the federal minimum. Iowa's minimum wage rose to $4.25 on January 1, 1991, and to $4.65 on January 1, 1992. The state minimum exceeded the federal minimum and exceeded minimum wages in all the surrounding states after January 1990. At the same time, Iowa expanded coverage to small retail and service firms with annual sales as low as 60 percent of the federal threshold.[4] Therefore, the Iowa case presents a useful counterpoint to the previously published work on high-wage states.

II. County-Level Analysis

The Iowa Department of Employment Services (IDES) compiles quarterly data on the number of firms, number of employees and quarterly earnings by county and two-digit SIC industry. The information is from legally mandated quarterly unemployment insurance payment forms. Data were aggregated across all employers in each county and industry. The analysis includes the industries with the highest proportion of low-wage workers, those being Retail Trade (SIC 52-57, 59) and Nonprofessional Services (SIC 70-79). We excluded eating and drinking establishments (SIC 58) to avoid complications of unmeasured earnings from tips.

The minimum wage, MW_t, raises the average price of labor relative to the average wage in county i and industry j in the previous period. The change in labor costs alters firm profitability or derived labor demand according to the regression model

$$\ln Y_{ijt} / Y_{ijt-1} = \alpha_0 + (\alpha_1 + \alpha_2 C_{ij} + \alpha_3 R_i + \alpha_4 C_{ij} * R_i) \ln \left(\frac{MW_t}{\hat{W}_{ijt-1}} \right)$$
$$+ \alpha_5 \ln (E^N_{jt} / E^N_{jt-1}) + \alpha_6 \ln (W^N_{jt} / W^N_{jt-1}) + \alpha_7 \ln (l_{it} / l_{it-1}) + u_{ijt},$$

where Y is alternatively number of firms, number of employees, or quarterly earnings in the county/industry cell, C is the proportion of firms covered by the Fair Labor Standards Act in the country-industry cell, R is a dummy variable if the county is rural, E^N_t is national employment in the industry at time t, W^N_t is the national average hourly wage in the industry at time t, and l_t is per capita income in the county in period t. Changes in national industry employment and wages control for exogenous shifts in industry demand, while changes in county income control for localized demand shifts. The national data came from Employment and Earnings. By law, Iowa firms must comply with the minimum wage if their sales exceed $300,000 per year. Data on the proportion of firms by county and industry with sales above $300,000 were obtained from the Iowa Department of Revenue and Finance.[5] County per capita income was obtained from tapes provided by the Bureau of Economic Analysis. Counties were classified as rural if county population in the 1990 Census of Population was greater than 38% rural. The specification allows for the minimum wage effect to differ between rural and urban markets and between covered and uncovered markets.

IDES does not require that firms report average hourly wages. However, IDES conducts a "shuttle" survey of firms which provides information on hourly wages.[6] Its main advantage for our purposes is that it offers the largest sample of hourly wages in Iowa for the quarters of interest. This "shuttle" survey provided 15 quarters of data from 1989:2 through 1992:4, a cumulative total of 171,947 observations on Iowa workers.

Because it is not a random sample of workers, average wages from this shuttle survey will differ from true county/industry cell means. In order to predict these cell means, we regressed log hourly wages by worker on individual, county and national variables. The individual attributes included dummy variables for female and production workers and the proportion of overtime to total hours worked in the quarter. County-level variables included the proportion rural, proportion female in the labor force, and the proportions with high school and with college degrees. The national variables included employment and wages in the two digit industry. In addition, the regressors included industry dummy variables and the current minimum wage entered alone and interacted with county and individual variables.[7]

Predicted wages in year t for each county/industry cell, $\hat{W}_{ijt}$, were computed by setting the individual attribute variables "female" and "production worker" to their state averages and setting overtime hours to zero. Cross-sectional variation in $\hat{W}_{ijt}$ is attributable to differences in mean wages across industries and differences in county attributes. Temporal variation occurs because of changes in the national variables and changes in the minimum wage.

Results for one-quarter and four-quarter changes in the dependent variables are reported in Table 1. The measured employment changes include both workers whose wages in t-1 were below the new minimum wage (the subminimum group) and those whose wages in t-1 exceeded MW_t. Consequently, the measured wage effects should understate the true effects if sub- and superminimum workers are gross substitutes. The minimum wage will lower demand for subminimum workers, but raise demand for superminimum workers. This problem does not exist for measured numbers of firms, so there should be no downward bias in the elasticity of firm numbers with respect to the minimum wage.

The estimates are sensible. County-level industry employment, earnings and the number of firms respond positively to nationwide sector-specific shocks, as measured by changes in national employment in the industry. National movements in wages may have an impact within a quarter, but these effects dissipate within a year. Improvements to the local economy, as captured by positive changes to local per capita income, also affect employment, earnings and firm numbers positively. Holding constant these changes in county/industry business conditions, minimum wages decrease firm, employment and earnings growth.

The estimates imply that a ten percent increase in the minimum wage relative to the previous wage causes a decrease in the number of firms of 1.7 percent in one quarter and 2.5 percent over four quarters. The effect on firm numbers is only marginally larger in the covered sector and does not differ much between urban and rural counties. Quarterly employment also falls in response to the minimum wage increase. The effect is larger in the covered than in the uncovered sector, and is larger after four quarters than after one quarter. The employment elasticity of around -.1 is consistent with the lower end of the consensus estimates in Brown et al. (1982). Taken together, the more elastic response of firm numbers than of employees to the minimum wage increase implies that average firm size rises with the minimum wage.

Quarterly earnings fall in all sectors in response to the minimum wage increase. The covered sector earning's elasticity is approximately -.12 over one quarter and -.15 over four quarters. The earnings elasticities are greater in magnitude than are the employment elasticities, implying that average hours per worker fall in response to the increased minimum wage. In fact, negative earnings elasticities require that the hours elasticity with respect to the minimum wage must be in the elastic range.[8]

The results from Table 1 strongly conform to the consensus estimates for employment responses to the minimum wage. Hours elasticities are infrequently reported in the literature, although our findings of elastic hours responses are consistent with those reported by Linneman (1982). To our knowledge, there are no recent studies of the response of firm numbers to the minimum wage increases, but neoclassical theory predicts that an increase in input prices will reduce firm numbers, other things equal. To the extent that larger firms have higher wages and more capital-intensive production processes, their costs will rise by a smaller proportion than will the costs of small firms. This accords well with our finding that firm size rises in response to the minimum wage.

III. Firm-level Analysis: Data and Stylized Facts

The county-level analysis strongly confirms the predictions of the theory of derived input demand in response to an input price increase. Nevertheless, the data have a serious limitation in that they aggregate sub- and superminimum workers. This should bias downward the estimated employment and earnings responses to the minimum wage increase. To examine this possibility, we collected data on wages and employment for a subsample of firms in these retail and service industries.

Multi-establishment firms were excluded to avoid confusion of respondent location with establishment location. The exclusion of multi-establishment firms effectively excluded general merchandise firms (SIC 53), although the exclusion was not by design. Because the minimum wage was raised in the first quarter of 1990, after remaining constant at $3.35 since 1982, the universe of retail and service sector firms was taken to be those firms in business in fourth quarter

1989. Sampled firms were followed longitudinally from 1989:4 through 1992:1, a period which contained the successive minimum wage increases in 1990:1, 1991:1, and 1992:1.

A. *Selection of Firms*

IDES records of firms paying into Unemployment Insurance contained 17,362 single establishment retail and nonprofessional service firms in 1989:4. A random sample of 1,201 firms (roughly 7 percent of the universe) was selected for inclusion in the study. Of these, 329 had changed owners, merged, eliminated all employees (which halted reporting to IDES), or closed by 1992:3. These firms were excluded. Thirty-seven firms did not have telephone numbers. This left 835 firms still in existence in 1992 which had the same owner, still had employees and were sending quarterly reports to IDES.

Because of confidentiality rules, firms were first contacted by IDES for permission to participate in the survey and for the release of their unemployment insurance records. These initial phone contacts were made in March, 1993. Of the 835 existing firms with phone numbers, 55 percent agreed to release their records, 25 percent refused to release their records, and 20 percent could not be contacted for various reasons (disconnected phones, unavailable owners, or no answer). The majority of those refusing said they had no records or records were difficult to locate. Others didn't have the time to participate or were reluctant to disclose wage rates.

Unemployment insurance records included information on quarterly employment and earnings for individual employees. Driver's license records were merged by social security number to get the sex and age of each worker. A survey was sent to the 460 firms which agreed to participate. The 460 cooperating firms were distributed across industries and urban and rural counties in roughly equal proportions to the distribution in the universe of firms. In addition to

other questions, firms were asked to list hourly wage rates for each of their workers in 1989:4, 1990:1, 1990:4, 1991:1, 1991:4 and 1992:1. Ultimately, 212 firms returned the survey, 139 of which supplied useable hourly wage data on an average of 772 workers per quarter. All 460 firms are incorporated into the analysis below.

For the 460 firms that agreed to release their records, the Iowa Department of Revenue and Finance (IDRF) released sales tax records for 1990, 1991 and 1992. Firms with reported sales of $300,000 or more were considered covered and those below $300,000 were considered uncovered in the analysis below. About one-quarter of retail employees and one-third of service sector workers in the 460 firms fell into the uncovered sector.[9] Our minimum wage coverage variable has some inherent ambiguities and must be interpreted with caution. First, the $300,000 annual minimum sales criterion is a moving test, the results of which may change each quarter. A firm with $320,000 sales prior to the first quarter would legally be required to pay minimum wages but would later be exempt if its annual sales fell to $295,000 prior to the fourth quarter. Since we only have calendar year sales data, our coverage variable won't capture switching of this nature. On the other hand, it is questionable whether such a firm would actually change its pay practices in such circumstances. More likely, they would either continue to pay the minimum wage in both quarters or to ignore the law in both quarters. Since the law is enforced on a complaint basis, it is plausible that some firms may claim (believe) and inform their employees that they are exempt even though they aren't exempt. Other firms may believe that they are covered even when they aren't.

Second, the law provides exemptions and special cases which our data aren't sufficiently detailed to handle. For instance, individual workers engaged in interstate transactions such as

credit card sales or shipping/receiving are subject (as individuals) to the Federal minimum wage even though their firm is exempt from both the state and Federal minimum wage laws. Seasonal amusement and recreation firms may be exempt from both the state and Federal rates, even though their total revenues exceed $300,000. Full-time students, learners, teenagers (during their first 90 days of employment), and the handicapped may also be paid less than the minimum wage under certain conditions. Given these complications, it is appropriate to regard our coverage variable with some caution. Our coverage variable might alternatively be interpreted as measuring firm sales rather than legal obligations concerning wage rates.

B. *Wage Estimation*

While direct information on hourly wages was available for an average of 772 individuals, relying on observed wages could cause significant biases in the estimation. Minimum wage changes could alter the skill composition of the labor force. Consequently, changes in average wages will partially reflect changes in average skills and not the desired change in the wage per unit of skill. Our estimate of the fixed-skill wage change is based on an earnings function of the

$$\ln W_{it} = \gamma_1 F_i + \gamma_2 A_{it} + \gamma_3 A_{it}^2 + \gamma_4 A_{it} * F_i + \gamma_5 A_{it}^2 * F_i + \gamma_6 C_{it} + \gamma_7 NEMP_{it} + \sum_{j=1}^{n} \delta_j SIC_{ijt} + \sum_{j=1}^{m} \mu_j M_{ijt} + \nu_{it}$$

form

where F is a female dummy variable; A is individual age; C is firm coverage status; NEMP is the number of employees in the firm; the M are county labor market variables (including per capita

income, proportion rural, proportion of women in the labor force and the proportion with either high school or college degrees); and the SIC are industry dummy variables.

C. *Sample Selection Bias Adjustment*

Firms which reported wage data are not likely to be distributed randomly from the sample of surveyed firms. Incentives to respond would be expected to vary with firm profitability, but also with the costs and/or returns to participation. Fortunately, some clearly exogenous identifiers of non-response were available. Our survey coincided with major flooding and property loss in parts of Iowa during the late spring and summer of 1993. Some counties were affected more severely than others. Cumulative rainfall by county grouping from January through August of 1993 was assumed to increase the cost of participating. Because floods typically result from heavy rains upstream that eventually overwhelm a downstream county, this rainfall measure was supplemented by information on emergency flood assistance in the county. We expect that rain and flood reimbursements should reduce survey response rates.

Firms would be less likely to provide wage information for workers employed in the earliest periods in the sample. Records would be harder to find and memories would be more hazy for the earlier quarters. Firm size may also be negatively related to probability of response since cost of response increases as the number of employees increases, although they may also have more resources for providing responses. A county's political leanings may influence the response rate to our survey. More heavily Republican counties (as indicated by the Republican voters in recent presidential elections) might include higher proportions of firm owners and managers who are cautious about revealing proprietary firm information and thus refuse to participate.

$$y_{it} = X_{it}\,b_X + Z_i\,b_R + T_{it}\,b_T + e_{it}$$

The net return to providing wage information on worker i in year t is of the form where X_{it} is the vector of regressors in the earnings function (equation 1); Z_i is a vector of response instruments including rainfall, flood reimbursements, and the proportion voting Republican; and T_{it} is a vector of quarterly dummy variables. The variable y_{it} is the unobservable net return from responding to the survey. However, we observe whether the survey was returned

$$I_{it} = 1 \text{ if } y_{it} > 0$$
$$= 0 \text{ otherwise}$$

(I_{it}), which is defined as follows:

If e_{it} and v_{it} are distributed bivariate normal, a selection corrected form of (1) would replace the conditional error v_{it} with $r\,[f(y_{it} - e_{it})/F(y_{it} - e_{it})] + \hat{n}_{it}$, where ? is a coefficient to be estimated, f is the normal density function, F is the normal cumulative distribution function, and $\hat{n}_{it}$ is a random error with zero mean. The coefficients in (3) were estimated by probit, using the sample of 21,277 employees (aggregated over six quarters) in the 460 firms who received the survey instrument. The results (available on request) were consistent with expectations. County rainfall, flood reimbursements, and Republican votes in the previous three presidential elections all reduced the probability of firm response. As expected, response rates were 8 to 10% lower for the earliest quarters requested. Larger firms were less likely to respond.

D. *Decomposition into Subminimum and Superminimum Groups*

Estimates of equation (2) with the selection correction based on (3) are reported in Appendix Table A1 for all first and fourth quarters in the sample period. By holding fixed the earnings function coefficients in a given quarter (hereafter, the quarter's earnings structure), we can predict period t hourly wage rates for workers employed in all other periods. The result is a generated wage rate distribution for each period which holds the time t earnings structure fixed, but allows the worker attributes to reflect those of the workers actually employed in each period.

$$\ln W_t = X_t \gamma_t + \rho_t \lambda_t + \hat{v}_t$$

To make this explicit, let the earnings structure at time t be given by the equation where λ_t is the inverse Mill's ratio based on the probit model (3); X_t is the vector of individual, firm, and local labor market characteristics in (2); γ_t and ρ_t are parameters; and $\hat{v}_t$ is a random error term. Equation (4) was used to predict the wage for all those employed in period t as $\ln \hat{W}_t^t = X_t \gamma_t$. It also allows those employed in period t to be decomposed into two groups. The subminimum group is defined as those for whom $\ln(MW_{t+1} / \hat{W}_t^t) > 0$ and the superminimum group is those for whom $\ln(MW_{t+1} / \hat{W}_t^t) \leq 0$,[10] where MW_{t+1} is the minimum wage implemented one quarter after period t.

The estimated parameters in (4) enable us to predict what workers in a different period, t′, would have been paid at time t. The predicted time t log wages for time t′ employees are of the form $\ln \hat{W}_t^{t'} = X_{t'} \gamma_t$. This procedure has the advantage that we can include newly hired employees at t′, even though they weren't employed at time t. We derive the subminimum

population at time t′ as all employees for whom $\ln(MW_{t+1} / \hat{W}_t^{t'}) > 0$, holding the time t earnings structure constant.

In Table 2, this strategy was employed three different ways. The first two columns present the predicted subminimum group, using the 1989:4 wage structure and the 1990:1 implemented minimum wage of $3.85. The two middle columns use the 1990:4 earnings structure and the 1991:1 implemented minimum wage of $4.25. The final two columns use the 1991:4 wage structure and the 1992:1 implemented minimum wage of $4.65. This strategy holds returns to firm and individual attributes (the earnings structure) fixed over time, so the simulated changes in employment shares are due to changes in the distribution of attributes of the 460 firms' employees. Whatever the possible biases in the assignment into super- and subminimum groups, those biases are fixed over time.

The simulated subminimum employment shares were generated for all employees in the 460 firms, and aggregated separately for urban, rural, covered and not covered employees. The three simulations yield similar implied changes in subminimum employment shares. Comparing common quarters to avoid seasonal biases, simulations in Table 2 show that the employment share for those with predicted pay below $3.85 in 1989:4 fell by .4 to 1.0 percentage points. Those with predicted pay below $4.65 in 1991:4 lost from 1.3 to 2.2 percentage points. The implication across all simulations is that the subminimum group, however defined, lost progressively larger employment share as the minimum wage increased.[11]

There is some evidence that rural subminimum workers fared better than their urban counterparts, with those paid below the minimum actually gaining employment share when we compare 89:4 to 91:4. However, urban and rural subminimum groups each lose 2.4 percentage

points of employment share when $4.65 is used as the minimum wage and we compare 90:1 to 92:1.

There are also pronounced differences between the covered and uncovered sectors. In the covered sector, the subminimum group loses about two percentage points of employment share regardless of which reference wage structure is used. However, in the uncovered sector, the subminimum employment share remains steady or increases. At least for the rural, uncovered sector this can be traced, in part, to an increase in the proportion of employees who were teenagers. Whereas the proportion of teenagers declined in other sectors by 5% to 22%, the proportion increased by at least 17% in the rural, uncovered sector.[12]

The increasing share of teenagers in uncovered rural employment corresponds to an increased share of workers in uncovered firms paid below the minimum wage. This is consistent with the standard prediction that minimum wages create employment spillovers from covered to uncovered firms. However, the distinction between covered and uncovered sectors was insignificant in the comparative static analysis conducted at the county-level (in Table 1) and in the firm-level analysis reported below. It is likely that covered and uncovered firms are not behaviorally distinct, given ambiguities in coverage status and our findings that many uncovered firms pay minimum wages, and that many employees in covered firms are paid below the minimum wage.[13]

IV. Firm-level Analysis: Comparative Statics

Using our individual-level predicted wage data, firm employment at time t can be decomposed into two groups, the group paid below the minimum wage (to be changed at time t+1) and the group paid above the t+1 minimum wage. Analysis of how two inputs respond to a minimum wage change is most conveniently addressed by considering changes in factor shares.

A. *Methodology*

Designate total subminimum hours for firm i as H_t^B (for below), superminimum hours as H_t^A (for above) and wages paid to these groups as W_t^B and W_t^A, respectively. The short-run derived

$$S_{it}^B = \alpha_0 + \alpha_1 \ln W_{it}^B + \alpha_2 \ln W_{it}^A + e_{it}$$

demand for factor inputs, assuming neutral technical change, can be expressed as

where S_{it}^B is the subminimum group's share of total earnings. The use of factor shares is convenient because it holds constant output changes that alter the overall level of demand for

$$S_{it+1}^B = \alpha_0 + \alpha_1 \ln MW_{t+1} + \alpha_2 \ln W_{it+1}^A + e_{it+1}$$

labor. When the minimum wage changes at time t+1, the short-run share equation is

under the assumption that the subminimum group is brought up to the minimum wage level.

Over short time intervals, changes in the wage for the superminimum group can be

$$\ln W_{it+1}^A - \ln W_{it}^A = x_{it+1}$$

characterized by a random error term,[14] so that

First differencing the subminimum share equations and imposing the random walk

$$S^B_{it+1} - S^B_{it} = a_1 \ln (MW_{t+1} / W^B_{it}) + a_2 x_{it+1} + e_{it+1} - e_{it}$$

assumption on the superminimum wage series, we get

Demand elasticities can be reclaimed from the share equation by taking the derivative of the share with respect to the own wage. Dropping subscripts for simplicity, and noting that $S^B = (W^B H^B)/C$, where C is total labor cost:

$$\frac{dS^B}{d \ln W^B} = \frac{W^B}{dW^B}\left[\frac{H^B}{C} dW^B + \frac{W^B}{C} dH^B - \frac{H^B W^B}{C^2} dC\right]$$
$$= \frac{W^B H^B}{C} + \frac{(W^B)^2}{C}\frac{dH^B}{dW^B} - \frac{H^B (W^B)^2}{C^2}\frac{dC}{dW^B}$$

$$\frac{dS^B}{d \ln W^B} = S^B + S^B h_{BB} - (S^B)^2 = a_1$$

so

where $?_{BB}$ is the elasticity of demand for hours of subminimum group employment with respect to its wage and a_1 is estimated from (8) as the elasticity of the subminimum earnings share with respect to the wage change.

Alternatively, the subminimum group share can be measured as the employment share, $L^B = N^B / \sum_j N^j$. Equation (8) could be estimated using changes in these employment shares as the dependent variable. The derivative of the employment share with respect to the subminimum group wage is

$$\frac{dL^B}{d \ln W^B} = \frac{W^B}{dW^B}\left[\frac{dN^B}{\sum_j N^j} - \frac{N^B \sum_j dN^j}{(\sum_j N^j)^2}\right]$$
$$= L^B q_{BB} - L^B \sum_j q_{jB} L^j = a_1^L$$

where $?_{BB}$ is the elasticity of subminimum employment with respect to its wage and

a_1^L is the coefficient on $\ln (MW_{t+1}/W_t^B)$ in (8) when L^B is used as the dependent variable.

Equations (9) and (10) allow us to derive alternative estimates of demand elasticities.

$$h_{BB} = [a_1 - S^B + (S^B)^2]/S^B$$

From equation (9) the hours elasticity is[15]

$$q_{BB} = \frac{a_1^L + L^B \sum_{j\_B} q_{jB} L^j}{L^B (1 - L^B)}$$

From equation (10) the employment elasticity, in general, is

Given our special case of two labor types, A and B, the theory of derived demand requires that

$$S_B q_{BB} + S_A q_{AB} = 0$$

$$q_{AB} = \frac{-S_B}{S_A} q_{BB}$$

so that

$$a_1^L = L^B \, q_{BB} - L^B q_{BB} L^B + L^B \frac{S_B}{S_A} L^A q_{BB}$$

Substituting (14) into (10), one obtains

$$q_{BB} = \frac{a_1^L}{L^B(1 - L^B + \frac{S_B}{S_A} L^A)} = \frac{a_1^L}{L^B L^A (1 + \frac{S_B}{S_A})}$$

so that the employment elasticity is

The elasticity in (15) reflects adjustments of numbers of employees. The elasticity in (11) reflects adjustments of total hours of employment. Hours are less costly to adjust than are numbers of employees. Consequently, demand for labor hours should be more elastic than demand for labor numbers, implying $?_{BB} < ?_{BB}$.

B. *Constructing the Variables*

The firm earnings and employment shares were estimated using the earnings structures reported in Appendix Table A1. The 1989:4 earnings structure was used to estimate hourly wage rates for all those employed in the 460 firms in 1989:4, 1990:1, and 1990:4. All workers in these periods whose predicted wage in 1989:4 is less than 3.85, the minimum wage implemented in 1990, are considered subminimum workers. In quarter t (where t = 89:4, 90:1, or 90:4) the subminimum group are those for whom $\ln(3.85 / \hat{W}_{89}^{t}) > 0$. This methodology allows us to assign workers to sub- or superminimum groups, even if they were not employed in 1989:4. The employment share for subminimum workers is the ratio of predicted subminimum workers to all workers. The earnings share of subminimum workers is the quarterly earnings for those identified as subminimum workers relative to total quarterly earnings. One quarter changes (89:4 to 90:1) and four quarter changes (89:4 to 90:4) in these shares provide the dependent variables for equation (8). By using the wage structure that existed before the minimum wage increase to assign workers to sub- and superminimum groups, we prevent the assignment to be biased by changes in returns to skill that occurred as a result of the minimum wage increase. The method is repeated for the 1991 minimum wage of $4.25, using the 1990:4 earnings structure. In this context, we define the subminimum group as those for whom $\ln(4.25 / \hat{W}_{90}^{t}) > 0$ where t = 90:4, 91:1, or 91:4. Likewise for the 1992 minimum wage increase to $4.65, the 1991:4 earnings structure identifies subminimum groups using $\ln(4.65 / \hat{W}_{91}^{t}) > 0$ for t = 91:4 or 92:1.

The key independent variable in (7) is the ratio of the minimum wage relative to the average predicted wage of the subminimum group in the period before the minimum wage increase. This ratio was set to one if the firm employed no subminimum workers. In log form,

the variable takes a minimum value of zero for firms employing only superminimum workers in both periods (and hence face zero effective change in the subminimum wage), and takes on positive values for employers having subminimum workers. The log ratio of minimum wage to average previous subminimum wage is interacted with a coverage dummy variable (C), a rural dummy variable (R), and the product (CR). The specification allows estimation of several potential differences in responses to the minimum wage: impacts on subminimum versus superminimum workers, on rural versus urban workers, and on covered versus uncovered workers.

C. *Results*

The regressions of changes in subminimum employment shares and of changes in subminimum quarterly earnings shares are reported in Tables 3 and 4, respectively. In each table, estimates for one-quarter and four-quarter changes are shown separately to allow for possible lagged adjustments by firms. Joint F-tests of significance of all coefficients involving $(MW_t / \hat{W}_{t-1})$ variables were computed to determine whether minimum wages had neutral effects on superminimum and subminimum employment. The neutrality hypothesis is rejected in every specification. While the R^2 are small, the coefficients are quite stable across dependent variables, specifications and time intervals.

The coefficients are not directly interpretable, but can generate demand elasticities (reported in Table 5) using equations (11) and (15). The findings are striking. Minimum wages lower subminimum employment in every sector. The effects are larger in urban than in rural markets, but differ little between the covered and uncovered sectors. Apparently, low wage firms in the uncovered sector raise wages in response to the imposition of higher wage minimums, even

if not required to do so by law. The employment elasticities are in the range of -.2 to -.85 depending on sector and specification. The magnitudes are larger than those obtained using the county-level data in Table 1, and are at the upper end of typical demand elasticities with respect to the minimum wage.[16] All eight estimated employment share elasticities from our preferred specification (including industry controls) were negative and significantly different from zero.

It is rare to estimate minimum wage responses which incorporate hours responses rather than the cruder adjustment in number of employees. One would expect that hours are easier to adjust than employees because of costs associated with hiring and firing. As such, one would expect a more sensitive response to minimum wage changes in the earnings share equations since earnings shares incorporate adjustments in both hours and numbers of workers. These expectations are strongly supported in the bottom half of Table 5. As with our county-level estimates in Table 1, all estimated hours elasticities in our preferred specification are in the elastic range, implying that earnings for subminimum workers as a group fell when the minimum wage was increased.[17]

The finding of such elastic demand responses to the minimum wage may be surprising when compared to earlier minimum wage studies. On the other hand, studies of the derived demand for teenage or young adult labor routinely find highly elastic demand.[18] The real mystery is why minimum wage studies have yielded such small elasticities when more fully specified input demand studies yield such large elasticities. Our presumption is that the more closely a minimum wage demand analysis fits the specifications utilized in the derived input demand analyses, the more comparable the estimated elasticities will become.

The implication of the firm-level demand elasticities is clear. In Iowa retail and service sector firms, an increase in the minimum wage reduces earnings for subminimum workers. The primary mechanism of the demand adjustment is through reduced hours and not reduced employment. When we control for industry, a 10 percent increase of the minimum wage relative to previous wage will cause about a 6 percent reduction of subminimum employment in urban firms one year later, but a 13-15 percent reduction in hours per quarter. In rural firms, the comparable reductions in subminimum employment and hours after four quarters are a 3-6 percent loss of employment and an 11-14 percent respectively. We note that these estimates are short-run elasticities taken over a time period over which capital substitution for labor may be constrained. Employment may adjust even more over a longer time period. This concern is somewhat allayed by the fact that small retail and service sector firms are not capital intensive and may have limited capital-labor substitution possibilities.

One surprise is that we fail to find significant differences between the covered and uncovered sector demand elasticities with respect to the minimum wage. Mincer's (1976) model accommodates an employment decrease in the uncovered sector if uncovered sector workers leave their jobs to queue for potential openings in the covered sector, but the very elastic negative demand response in this sector seems implausible. As discussed above, our coverage variable is an imperfect measure of the legal obligation to pay the minimum wage, so that covered and uncovered firms may not be behaviorally distinct. Since the main distinguishing feature of uncovered firms is that they are small, our results may simply mean that small and larger firms respond in similar ways to higher minimum wage rates.

VI. Conclusions

Our results strongly support the long-standing view among economists that minimum wages lower employment opportunities for employees of firms covered by the law. Before the publication of studies by Card, Krueger and Katz, the consensus estimated elasticity of employment with respect to the minimum wage was -0.1 to -0.3. Our county-level employment elasticity estimates are very consistent with this earlier consensus. Our firm-level analysis which distinguishes between sub- and superminimum wage workers found even larger employment elasticities, ranging from -0.3 to -.85 for the impact on employment. Our results suggest that the earlier consensus may have understated the impact of minimum wages on low wage, subminimum employees. With few exceptions, the earlier consensus was based on studies that aggregated sub- and superminimum workers. Our results imply that this biased downward the elasticity estimates.

Hours worked are more sensitive than employment to changes in minimum wages. Both the firm and county-level estimates imply elastic demand responses to minimum wage increases so that earnings for subminimum workers fall. We also find evidence that higher minimum wages caused a net destruction of firms. Furthermore, elasticities are more negative for the number of firms than for employment, so that firm size increases when the minimum wage increases.

We were surprised by the lack of significant differences in minimum wage impacts between the covered (larger) and uncovered (smaller) firms. Since few studies have even attempted to make this distinction, we cannot tell if our findings hold more generally. However, it is likely that firm uncertainty about their own coverage status, incomplete compliance by covered firms, and de facto compliance by some uncovered firms make it difficult to distinguish between the responses of uncovered and covered firms.

Our results are in marked contrast to the widely publicized conclusions of Card, Krueger and Katz that minimum wages do not reduce employment. Therefore, it is important to identify why this study might have led to such different conclusions. First, Iowa is a relatively low-wage state so that its high minimum wage may have represented a larger shock to firms than in New Jersey or California. Second, we look at a broader set of firms in an industry rather than a subset of potentially atypical firms with a single industry. Indeed, our finding that the average size of firms increases with increasing minimum wages suggests that large fast food restaurants might be unaffected by minimum wages, even as their smaller competitors may have to cut hours or even exit. Third, we rely on payroll data which enables us to measure employment and earnings more exactly, rather than relying exclusively on respondent opinions which may be subject to error. Fourth, we distinguish between subminimum and superminimum workers as suggested by theory rather than aggregating the two groups. Whether these changes would be sufficient to modify or reverse the conclusions from the New Jersey, Texas or California studies is uncertain. Nevertheless, we can conclude that, at least in Iowa, low-skill labor demand curves slope downward and consequently, minimum wages have adverse effects on employment.

Table 1. County-level One- and Four-quarter Changes in Firms, Employment and Earnings in Response to Changes in the Minimum

	One-Quarter			Four-Qu	
	FIRMS	EMPLOYMENT	EARNINGS	FIRMS	EMPLOYM
$\ln(MW_t / W_{t-1})$	-.167**	-.060	-.081	-.255**	
	(5.90)	(1.41)	(1.41)	(6.17)	
$C^* \ln(MW_t / W_{t-1})$	-.003	-.027	-.037	.007	
	(.21)	(1.51)	(1.52)	(.47)	
$R^* \ln(MW_t / W_{t-1})$	.0004	-.0008	.005	.002	
	(.18)	(.27)	(1.16)	(.55)	
$C^* R^* \ln(MW_t / W_{t-1})$	-.004	.008	-.006	-.009	
	(.58)	(.74)	(.40)	(.92)	
$\ln(E_t^N / E_{t-1}^N)$	1.460**	1.421**	2.314**	1.130**	
	(7.28)	(4.71)	(5.71)	(5.92)	
$\ln(W_t^N / W_{t-1}^N)$	.502**	1.227**	1.103**	-.194*	
	(3.94)	(6.41)	(3.91)	(1.90)	

$\ln(I_t / I_{t-1})$	.088	.281**	.308**	.330**	
	(1.11)	(2.36)	(1.93)	(3.19)	
SIC dummies	✓	✓	✓	✓	✓
R^2	.045	.042	.030	.038	
N	3654	3651	3651	3653	3652
Minimum Wage Elasticities	Firms	Employment	Earnings	Hours	Firms	Employme
Urban						
Covered	-.170**	-.087**	-.108**	-1.11**	-.248**	
Uncovered	-.167**	-.060	-.081	-1.06	-.255**	
Rural						
Covered	-.173**	-.080*	-.119**	-1.11**	-.255**	-.
Uncovered	-.166**	-.061	-.076	-1.07	-.253**	-

t-statistics in parentheses. * indicates significance at the .10 level and ** indicates significance at the .05 level. The slight variation nonreported quarterly data for a few county-industry cells.

Table 2. Simulated Subminimum Employment Shares, Based on Currently Employed Workers in 460 Firms, Holding Wage Structures Fixed at the 1989:4, 1990:4, and 1991:4 Levels.

Year and	1989:4 Coefficients		1990:4 Coefficients		1991:4 Coefficients	
Quarter	Subminimum[a]	Superminimum	Subminimum[b]	Superminimum	Subminimum[c]	Superminimum
			All Employed			
89:4	27.4%	72.6%	18.6%	81.4%	29.0%	71.0%
90:1	22.5	77.5	14.2	85.8	26.0	74.0
90:4	27.8	72.2	18.1	81.9	28.9	71.1
91:1	22.9	77.1	14.5	85.5	25.5	74.5
91:4	27.0	73.0	17.3	82.7	27.7	72.3
92:1	21.5	78.5	13.4	86.6	23.8	76.2
			Rural Counties Only			
89:4	29.7%	70.3%	21.5%	78.5%	36.1%	63.9%
90:1	28.8	71.8	19.7	80.3	35.7	64.3
90:4	31.8	68.2	22.9	77.1	37.1	62.9
91:1	30.2	69.8	21.4	78.6	36.3	63.7
91:4	29.9	70.1	22.5	77.5	36.4	63.6
92:1	27.0	73.0	20.0	80.0	33.3	66.7
			Urban Counties Only			
89:4	26.2%	73.8%	17.1%	82.7%	25.3%	74.7%
90:1	18.8	81.2	11.0	89.0	20.4	79.6
90:4	25.5	74.5	15.4	84.6	24.3	75.7
91:1	18.3	81.7	10.2	89.8	18.8	81.3
91:4	25.3	74.7	14.3	85.7	22.7	77.3
92:1	18.1	81.9	9.3	90.7	18.0	82.0
			Not Covered Firms Only			
89:4	28.1%	71.9%	21.1%	78.9%	36.3%	63.7%
90:1	26.9	73.1	19.7	80.3	35.2	64.8
90:4	28.9	71.1	21.9	78.1	36.3	63.7
91:1	28.8	71.2	21.3	78.7	35.3	64.7
91:4	30.0	70.0	21.3	78.7	36.4	63.6
92:1	28.8	71.2	20.8	79.2	35.0	65.0
			Covered Firms Only			
89:4	27.8%	72.8%	17.7%	82.3%	26.4%	73.6%
90:1	20.8	79.2	12.1	87.9	22.5	77.5
90:4	27.4	72.6	16.7	83.3	26.2	73.8
91:1	20.6	79.4	11.9	88.1	21.8	78.2
91:4	25.9	74.1	15.8	84.2	24.5	75.5
92:1	18.9	81.1	10.8	89.2	19.9	80.1

[a]Proportion of workers employed in the year and quarter with predicted pay below $3.85 in 1989:4.
[b]Proportion of workers employed in the year and quarter with predicted pay below $4.25 in 1990:4.
[c]Proportion of workers employed in the year and quarter with predicted pay below $4.65 in 1991:4.

Table 3. Iowa Firm-level Estimation of Changes in Subminimum Employment Shares as a Function of the Minimum Wage

	1	2	3	4
<u>One Quarter Change</u>				
$\ln(MW_t/W_{t-1})$		-.072**		-.088**
		(6.13)		(7.06)
$C*\ln(MW_t/W_{t-1})$	-.062**	.004	-.086**	-.019
	(4.65)	(.26)	(5.72)	(1.07)
$R*\ln(MW_t/W_{t-1})$	-.025**	.041**	-.032**	.041**
	(2.98)	(2.99)	(3.61)	(3.03)
$C*R*\ln(MW_t/W_{t-1})$	.044**	-.022	.072**	.008
	(2.53)	(1.09)	(3.73)	(.38)
SIC dummies included[c]			✓	✓
R^2	.034[a]	.062[a]	.052[a]	.088[a]
N	1274	1274	1274	1274
<u>Four Quarter Change</u>				
$\ln(MW_t/W_{t-1})$		-.065**		-.079**
		(3.63)		(4.22)
$C*\ln(MW_t/W_{t-1})$	-.031*	.029	-.054**	.010
	(1.64)	(1.18)	(2.53)	(.40)
$R*\ln(MW_t/W_{t-1})$	-.053**	.007	-.063**	.006
	(4.19)	(.35)	(4.71)	(.30)
$C*R*\ln(MW_t/W_{t-1})$	.061**	.001	.086**	.024
	(2.42)	(.02)	(3.09)	(.75)
SIC dummies included[c]			✓	✓
R^2	.024[a]	.039[a]	.035[a]	.055[a]
N	845	845	845	845

t-statistics in parentheses. * indicates significance at the .10 level and ** indicates significance at the .05 level.

[a]F-test of the joint hypothesis that all coefficients except the constant term are equal to zero is rejected at the .01 level.

[b]F-test of the joint hypothesis that all coefficients except the constant term are equal to zero is rejected at the .05 level.

[c]A constant term was also included in the specifications that excluded industry dummy variables.

Table 4. Iowa Firm-level Estimation of Changes in Subminimum Quarterly Earnings Shares as a Function of the Minimum Wage

	1	2	3	4
<u>One Quarter Change</u>				
$\ln(MW_t/W_{t-1})$		-.028**		-.036**
		(2.49)		(3.03)
$C*\ln(MW_t/W_{t-1})$	-.032**	-.007	-.048**	-.021
	(2.61)	(.43)	(3.43)	(1.25)
$R*\ln(MW_t/W_{t-1})$	-.014*	.012	-.019**	.011
	(1.72)	(.91)	(2.25)	(.86)
$C*R*\ln(MW_t/W_{t-1})$	.023	-.002	.041**	.014
	(1.42)	(.13)	(2.24)	(.71)
Industry dummies included[c]			✓	✓
R^2	.011[a]	.016[a]	.022[a]	.029[a]
N	1274	1274	1274	1274
<u>Four Quarter Change</u>				
$\ln(MW_t/W_{t-1})$		-.029*		-.036**
		(1.91)		(2.30)
$C*\ln(MW_t/W_{t-1})$	-.030*	-.004	-.050**	-.020
	(1.93)	(.17)	(2.81)	(.94)
$R*\ln(MW_t/W_{t-1})$	-.037**	-.010	-.046**	-.015
	(3.50)	(1.28)	(4.18)	(.85)
$C*R*\ln(MW_t/W_{t-1})$	.059**	.008	.080	.052**
	(2.80)	(1.78)	(3.48)	(1.98)
Industry dummies included[c]			✓	✓
R^2	.017[a]	.022[a]	.038[b]	.044[a]
N	845	845	845	845

t-statistics in parentheses. * indicates significance at the .10 level and ** indicates significance at the .05 level.

[a]F-test of the joint hypothesis that all coefficients except the constant term are equal to zero is rejected at the .01 level.

[b]F-test of the joint hypothesis that all coefficients except the constant term are equal to zero is rejected at the .05 level.

[c]A constant term was also included in the specifications that excluded industry dummy variables.

Table 5. Demand Elasticities Implied by the Firm-level Demand Regressions

		No Industry Controls		Industry Controls	
		Share Elasticity	Demand Elasticity	Share Elasticity	Demand Elasticity
Employment					
Urban			Employment		Employment
Covered	1 quarter changes	-.068**	-.54	-.106**	-.85
	4 quarter changes	-.035	-.28	-.069**	-.55
Uncovered	1 quarter changes	-.072**	-.58	-.088**	-.70
	4 quarter changes	-.065**	-.52	-.079**	-.63
Rural					
Covered	1 quarter changes	-.049**	-.39	-.057**	-.46
	4 quarter changes	-.028*	-.22	-.039**	-.31
Uncovered	1 quarter changes	-.032**	-.26	-.046**	-.37
	4 quarter changes	-.058**	-.46	-.073**	-.58
Earnings					
Urban			Hours		Hours
Covered	1 quarter changes	-.035**	-1.27	-.057**	-1.50
	4 quarter changes	-.032*	-1.24	-.056**	-1.49
Uncovered	1 quarter changes	-.028**	-1.20	-.036**	-1.28
	4 quarter changes	-.029*	-1.21	-.036**	-1.28
Rural					
Covered	1 quarter changes	-.026**	-1.17	-.031**	-1.23
	4 quarter changes	-.010	-1.01	-.019	-1.10
Uncovered	1 quarter changes	-.016*	-1.07	-.025**	-1.16
	4 quarter changes	-.034**	-1.26	-.051**	-1.44

The employment based demand elasticities are computed using equation (15), and the earnings based demand elasticities are computed using equation (11). Parameter values are taken from columns 2 and 4 of Tables 3 and 4. Top number is the one-quarter elasticity. The bottom number is the four quarter elasticity.

*represents a value of a significantly different from zero at the .10 level. **represents a value of a significantly different from zero at the .05 level.

Over the period, those predicted to be in the subminimum group have average employment share of .130 and average earning share of .096.

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Appendix Table A1. Log Hourly Wage Rate Equations

	1989:4	1990:1	1990:4	1991:1	1991:4	1992:1
Intercept	-1.71	-.24	-1.43	-1.48	-.17	-.10
	(1.61)	(.23)	(1.35)	(1.40)	(.18)	(.11)
F (FEMALE)	.51	.27	.38	.24	.23	.17
	(3.20)**	(1.70)	(2.62)**	(1.57)	(1.70)	(1.15)
A (AGE)	.07	.05	.06	.06	.05	.05
	(11.3)**	(8.78)**	(9.85)**	(9.65)**	(9.41)**	(8.05)**
A^2	-.001	-.001	-.001	-.001	-.001	-.0005
	(9.75)**	(7.38)**	(8.61)**	(8.54)**	(8.24)**	(6.91)**
A * F	-.037	-.022	-.028	-.022	-.019	-.016
	(4.33)**	(2.60)**	(3.60)**	(2.65)**	(2.62)**	(2.03)**
A^2 * F	.0004	.0002	.0003	.0002	.0002	.0001
	(3.65)**	(2.05)*	(3.06)**	(2.30)*	(2.03)*	(1.49)
NEMP (SIZE)	-.002	-.002	-.001	-.0002	-.0007	-.0002
	(2.04)*	(2.03)*	(1.05)	(.30)	(1.11)	(.32)
C (COVERED)	.125	.142	.098	.119	.107	.161
	(3.70)**	(4.60)**	(3.29)**	(4.06)**	(3.68)**	(5.71)**
SIC's Included	✓	✓	✓	✓	✓	✓
% Rural	-.37	-.45	-.28	-.36	-.35	-.35
	(3.38)**	(4.15)**	(2.53)**	(3.24)**	(3.28)**	(3.24)**
Per Capital Income	-.0001	-.0001	-.0001	-.0001	-.0001	-.0001
	(3.67)**	(4.53)**	(1.88)	(2.99)**	(1.86)	(3.84)**
% H.S. Grads	-.008	-.011	.005	.010	-.002	-.004
	(.61)	(.86)	(.40)	(.76)	(.17)	(.29)
% College Grads	.004	.009	-.001	-.003	.001	.004
	(.50)	(1.29)	(.21)	(.42)	(.13)	(.66)
% FEM in L.F.	8.80	6.57	5.28	5.38	3.87	5.02
	(4.63)**	(3.61)**	(2.87)**	(2.97)**	(2.29)*	(3.06)**
?	.05	.13	-.01	-.02	.06	.12
	(.46)	(1.28)	(.08)	(.20)	(.55)	(1.22)
R^2	.508	.492	.445	.460	.410	.449
N	733	713	788	776	867	756

t-ratios in parentheses
*Significant at 5% level.
**Significant at 1% level.

Appendix Table A2. Comparison of Predicted and Actual Hourly Wage Rates

	Correctly Predicted	Incorrectly Predicted to be		Correctly Predicted
	Below MW	Below MW	Above MW	Above MW
1989:4				
Number	95	77	62	505
(% correct)	(60.5%)			(86.8%)
1990:1				
Number	29	118	16	476
(% correct)	(64.4%)			(80.1%)
1990:4				
Number	85	54	114	519
(% correct)	(42.7%)			(90.6%)
1991:1				
Number	19	46	42	573
(% correct)	(31.1%)			(92.6%)
1991:4				
Number	114	87	106	534
(% correct)	(57.6%)			(86.0%)
1992:1				
Number	45	178	15	438
(% correct)	(75.0%)			(71.1%)
Total	**417**	**560**	**355**	**3045**
(% correct)	(54.0%)			(84.5%)

1. For examples of reactions, see Kennan (1995) and the "Review Symposium: Myth and Measurement" (1995).

2. There are many reasons why fast food restaurants might gain market share. Finis Welch, in "Review Symposium" (1995: p. 847) suggests that national chains may be less low-skill labor intensive than other restaurants. It is also possible that national chains have less elastic output demands due to brand loyalty, allowing them to pass on costs to consumers more easily.

3. In 1993, Iowa ranked 42 out of 50 states in average annual income for unemployment insurance covered wage and salary workers. In contrast, New Jersey ranked third (Statistical Abstract of the United States, 1995).

4. Apparently, Iowa legislators thought these would be the mandated minimum wage levels in federal legislation which was under consideration and expected to pass. After the Iowa legislation was passed, U.S. Congress passed an amended bill with a lower level. Therefore, the higher minimum

wage in Iowa was probably an accident, but Iowa legislators are hesitant to admit that on the record.

5. To test for sensitivity, coverage was also measured by proportion of total sales in the county-industry cell made by covered firms. The results were not changed appreciably. A better coverage measure might be the proportion of workers covered per county/industry cell, but that measure was not available.

6. The Iowa shuttle survey data is combined with comparable data from other states to form the U.S. Bureau of Labor Statistics' Employment and Earnings Establishment data for the nation.

7. The results of this regression are available on request.

8. Let quarterly earnings be W·H. The elasticity of quarterly earnings with respect to wages is Install Equation Editor and double-click here to view equation. where Install Equation Editor and double-click here to view equation. is the hours elasticity of demand for all workers. Install Equation Editor and double-click here to view equation. implies that Install Equation Editor and double-click here to view equation.

9. The 460 cooperating firms were distributed across industries and urban and rural counties in roughly equal proportions to the distribution in the universe of firms.

10. Predicted subminimum and superminimum status was compared to the actual hourly wage rate for the subset of workers for whom data was supplied by our surveyed firms. These predictions were correctly classified 79 percent of the time, aggregating over all 6 quarters. The wage equation generated smaller subminimum groups (by 11 percent) and larger superminimum groups (by 4 percent) than did the reported wages. Appendix Table A2 summarizes the actual versus predicted sub- and superminimum groups by quarter.

11. These results are not due solely to the use of wage structures. As shown in Orazem and Mattila (1995), covered sector employment shares for teenagers fell sharply in Iowa over the period while increasing for those aged 20-24.

12. See Orazem and Mattila (1995), Table 1.11.

13. The proportions of workers paid below the current minimum based on reported wages top number) or predicted wages (bottom number in parentheses) are reported for the first quarters of 1990 and 1992. Generally, uncovered or rural firms are more likely than covered or urban firms to pay wages below the minimum. However, there are large numbers of employees paid below the minimum wage in all sectors.

	Urban		Rural	
	Covered	Uncovered	Covered	Uncovered
1990:1	3.5	5.5	4.9	15.5
	(33.1)	(24.7)	(39.9)	(53.5)
1990:2	5.8	6.7	4.6	17.0
	(23.1)	(48.8)	(30.4)	(61.6)

14. Ashenfelter and Card (1982) found that quarterly wage series were well represented by an AR(1) process with a coefficient insignificantly different from 1. Analysis which relaxed this restriction by incorporating predicted changes in superminimum wages in response to the minimum wage yielded results similar to those reported in this study.

15. Note that equation (11) is the standard elasticity formulation derived from a translog cost function. See Hamermesh (1986), Table 8.1.

16. Because the dependent variable distinguishes between subminimum and superminimum workers, one would expect the elasticities to be more negative than those obtained in typical studies which aggregate across superminimum and subminimum workers.

17. Linneman (1982) also found that earnings for subminimum workers fell in response to minimum wage increases.

18. See Table 3.9 in Hamermesh (1993) for a summary of results of demand studies disaggregated by age. Elasticities for teenage workers are generally above .5 in absolute value with some estimates well into the elastic range.