A Reassessment of the New Economics of the Minimum Wage Literature with Monthly Data from the Current Population Survey

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We estimate the employment effects of federal minimum wage increases using monthly Current Population Survey (CPS) data from 1979 through 1997. We find that the empirical differences in the new minimum wage literature based on CPS data primarily can be traced to alternative methods of controlling for macroeconomic conditions. We argue that the macroeconomic controls commonly included in models where no employment impact is found are inappropriate. We consistently find a significant but modest negative relationship between minimum wage increases and teenage employment using alternative controls or allowing employer responses to the policy to occur with some delay.

The authors thank Charles Brown, Donald Deere, Douglas Holtz-Eakin, Marvin Kosters, Alan Krueger, David Neumark, William Rodgers, Steve Ross, Scott Scrivner, David Stapleton, and William Wascher, as well as seminar participants at Cornell University, Georgia Tech University, Syracuse University, the Bureau of Labor Statistics, Queens College, the American Economic Association, and the Urban Institute.

[*Journal of Labor Economics*, 2000, vol. 18, no. 4]

0734-306X/2000/1804-0005$02.50

Introduction

Economists have long been interested in the economic consequences of minimum wage legislation.[1] Stigler (1946) provides the first complete neoclassical statement of the behavioral and income distributional consequences of minimum wage increases. While his model and the conclusions drawn from it were challenged at the time (Lester 1946), by the 1980s a clear consensus had developed (Brown, Gilroy, and Kohen 1982; Brown 1988) that increases in the minimum wage rate had significant but modest negative impacts on the employment of teenagers.

Research since then has provided conflicting evidence of the effect of minimum wage increases on teenage employment. Neumark and Wascher (1992) and Deere, Murphy, and Welch (1995) find that the effects of minimum wage increases are consistent with neoclassical predictions. Card, Katz, and Krueger (1994) and Card and Krueger (1995), however, challenge the standard neoclassical predictions primarily on empirical grounds. They demonstrate the sensitivity of past empirical evidence to specification changes and introduce new evidence that increases in the minimum wage over the last quarter of the twentieth century have had no significant effects on employment.[2] For some, this assault on conventional wisdom constitutes "a devastating critique both of economic the-

[1] One of the earliest and most comprehensive proposals for a government-enforced minimum wage was made by Ryan (1906). He argued that "whole classes of laborers, for example those employed in sweat shops, are underpaid, underfed, and under supplied with everything which contributes to civilized life" (Ryan 1906, p. 18). This important book, whose introduction was written by Richard Ely, the founder of the University of Wisconsin economics department and the first president of the American Economic Association, helped popularize a living wage as a social goal. The concept of a living wage was based on the ideas of a broad spectrum of social reformers of the day, from Pope Leo XIII, who argued in *Rerum Novarum* (1891) that "there is a dictate of nature more imperious and more ancient than any bargain between man and man, that the remuneration must be enough to support the wage earner in *reasonable and frugal comfort*" (Ryan's emphasis; as quoted in Ryan 1906, p. 33), to Sidney and Beatrice Webb, who in *Industrial Democracy* (1897) called for state-enforced national minimum wages that would provide laborers "with the food, clothing and shelter physiologically necessary, according to national habit and custom to prevent bodily deterioration" (as quoted in Ryan 1906, p. 82). While minimum wage policy may have been an appropriate method for raising the income of the working poor at the turn of the twentieth century, it is much less so as we begin a new century. See Burkhauser and Finegan (1989), Burkhauser, Couch, and Wittenburg (1996), and Burkhauser, Couch, and Glenn (1996). Today, the vast majority of minimum wage workers do not live in poor families and the vast majority of the working poor earns wages above the minimum wage. We argue that the Earned Income Tax Credit is a much more effective method of transferring income to the working poor.

[2] Several reviews of this new literature have been published (Ehrenberg 1995; Kosters 1995; Burkhauser et al. 1996; Burkhauser and Harrison 2000).

ory and of empirical research methods in economics" (Ehrenberg 1995, p. 827). We agree with Ehrenberg that this new body of work on the minimum wage, if credible, challenges both the empirical evidence underlying the conventional view of the minimum wage's negative employment effects as well as neoclassical theory's explanation of this relationship.

While our primary interest in this article is to estimate the employment effects of the minimum wage increases in the 1990s, this inquiry is performed in the shadow of the controversy surrounding the new literature on the minimum wage. Additional empirical work demands that some perspective be drawn regarding how one can reasonably proceed in a body of literature in which consensus has evaporated. This article serves the dual purposes of interpreting the new empirical literature that uses Current Population Survey (CPS) data to test the importance of minimum wage increases on teenage employment and providing our own estimates of the effects of the most recent increases in the federal minimum wage on employment.

We first review the new minimum wage literature based on annual state-level observations constructed from repeated cross sections of May CPS data. We reestimate the empirical specifications most widely associated with the findings that minimum wage increases do not adversely affect employment (Card et al. 1994; Neumark and Wascher 1994; Card and Krueger 1995) using monthly CPS data from January 1979 through December 1992. We then present estimates based on data from both the May CPS and from every other month of the CPS. These data roughly cover the period examined by prior researchers. We find that the effect of the minimum wage on employment is only insignificant when year effects are included in the specification.

We investigate why the inclusion of year specific effects has such a dramatic effect on the estimation results. We show that because federal minimum wage increases occur in discrete steps and typically do not change more than once over a calendar year, controlling for year-specific effects in this type of model eliminates virtually all of the variation in the constructed variable used to represent the discrete levels of the statutory minimum wage.

The CPS-based papers that found no employment effect of minimum wage increases used only one observation (in May) from each year of data and included year dummies in their estimations. This effectively removed all variation in their constructed minimum wage variable due to federal minimum wage increases. Hence, when time-specific effects are included in the specification, the minimum wage effects can be identified only by using the relatively small number of observations in which the state minimum wage is higher than the federal minimum wage. It is not surprising that under these circumstances, no impact is found when all variation in the federal minimum wage is removed from the variable intended to measure the effect of a minimum wage increase. Once the variation due to federal policies is removed, little information remains in the constructed minimum wage variable.

Because the dimension of time appears to be critical to these estimates, we allow employer adjustments in response to changes in the minimum wage to occur with a lag. In that model, we find that regardless of how one controls for time, minimum wage increases have a consistent, negative impact on teenage employment.

We also provide estimates from a specification similar to that of Deere et al. (1995). In their model, they use dummy variables in the years in which federal minimum wage increases occur to capture the employment effects of this policy change. One way of viewing their findings is that they capture the effect of the federal minimum wage with what Card and Krueger (1995) might interpret as a year effect. We will argue that the parameter estimates obtained by Deere et al. (1995) may be influenced by uncontrolled macroeconomic effects, but that they still capture the impact of statutory changes in policy. Like Deere et al., we find that our specification consistently yields estimates that indicate that raising the minimum wage reduces teenage employment.

We further explore the dimension of time by extending our sample through December 1997. This allows us to examine the effects of the most recent increases in the federal minimum wage to $4.75 in October 1996 and to $5.15 in October 1997 and to see if the fact that they occurred in a strong macroeconomic climate diminishes their effects on employment. We find that even during the recent period of robust economic growth, minimum wage increases had a statistically significant but modest negative effect on teenage employment.

On the basis of these results we question the findings that minimum wage increases do not create employment losses. The theoretical and empirical considerations we detail raise serious concerns regarding conclusions drawn from the sole model that yields that result. We conclude that, much like in previous decades, minimum wage increases in the 1990s had significant but modest negative effects on teenage employment.

Recent Evidence on Minimum Wage Outcomes with CPS Data

Like other aspects of the new minimum wage literature, the central papers using CPS data to test the effect of minimum wages on teenage employment (Neumark and Wascher 1992, 1994; Card et al. 1994; Deere et al. 1995) draw conflicting conclusions. Neumark and Wascher (1992) were the first to exploit the cross-state variation in minimum wage rates to evaluate the impact of the policy on employment. Standard neoclassical theory argues that state increases in the minimum wage above the federal rate, as well as any federal increases, should be associated with lower employment in those states. Neumark and Wascher (1992) create a variable that includes the higher of the state or federal minimum wage for each state in each period of their data to capture the variation in policies across political jurisdictions.[3] They use repeated May CPS surveys from 1973 through 1989 to calculate state-level observations of the other variables used in their analysis.

In an interchange with Neumark and Wascher (1994), Card et al. (1994) (and later, Card and Krueger 1995) argue that the variable set employed by Neumark and Wascher (1992) is inappropriate and drives their results.[4] Neumark and Wascher (1994) verify that when they conduct estimates like those of Card and Krueger (1995), they obtain the same result: namely, minimum wage increases over that period had no significant impact on teenage employment. Card and Krueger (1995) expand this argument regarding the misspecification of the model estimated by Neumark and Wascher (1992) and provide additional empirical analyses. The Card and Krueger (1995) results based on pooled repeated cross-sectional May CPS data are in part a replication of those found in Card et al. (1994) and in Neumark and Wascher (1994). Card and Krueger (1995) find no evidence that increases in the minimum wage reduced employment; in some specifications, employment actually increased.

[3] The variable they used to capture variation in the minimum wage was the Kaitz index. The Kaitz index was used in many previous studies of the minimum wage. The Kaitz index is the ratio of the minimum wage to the average adult wage multiplied by the percent of persons covered by the minimum wage.

[4] Among other criticisms, Card et al. (1994) show that the estimation results are sensitive to the use of two variables. First, the construction of the variable Neumark and Wascher (1992) use to control for schooling in the CPS includes only teenagers in school and not working. This control variable for schooling not only underestimates the number of teenagers in school by excluding the intersection of teenagers in school and working, but its construction is systematically related to the dependent variable measuring teenage employment. When the schooling variable is dropped from the estimates, the parameter used to measure the impact of the minimum wage, the Kaitz index, is no longer statistically significant. A second important criticism of Card et al. (1994) is over the use of the Kaitz index as a measure of minimum wage impact. They argue that the inclusion of adult wages as a function of the Kaitz index is problematic because adult wages, which are included in the denominator of the Kaitz index, are correlated with economic activity and hence should be correlated with the teenage wage rate. Factors that lead to an increase in adult wages, however, will lead to a decline in the Kaitz index. Therefore, the Kaitz index may be negatively correlated with teenage wages and a poor measure of how the minimum wage increase affects teenagers. They demonstrate this point by regressing teenage wages on the Kaitz index. They find a negative relationship between the Kaitz index and teenage wages. However, when teenage wages are regressed on a more direct measure of the minimum wage, the larger of the natural log state or federal minimum wage, the expected positive and significant relationship is found. Using this direct measure of the minimum wage and dropping the problematic schooling variable, their estimates indicate that the effect of raising the minimum wage on employment is positive and statistically significant at the 0.05 level.

The preferred model from Card and Krueger (1995) is constructed as follows:

$$E_{it} = \alpha_0 + MW_{it}\beta + X_{it}\chi_n + T_t\tau_t + S_i\delta_i + \varepsilon_{it}, \tag{1}$$

where E_{it} is the ratio of teenage employment to teenage population; MW_{it} is a variable representing the log of the larger of the state or federal minimum wage; X_{it} is a set of explanatory variables; T_t is a set of year dummy variables; and S_i is a set of state dummy variables. The key coefficient of interest is β, which represents the effect of minimum wage increases on employment.

Deere et al. (1995) also use pooled repeated cross-sectional data from the CPS to estimate the impact of minimum wage increases. They construct intervals of monthly data from 1985 through 1993 that begin on the first day of April of each year and end on the last day of March during the following year. For each interval, they create annual averages of variables. They create these intervals to correspond with federal minimum wage increases that occurred in April 1990 and April 1991. Unlike the studies mentioned above, Deere et al.'s (1995) study ignores the effects of state minimum wage increases and only focus on federal changes.

Unlike Card and Krueger (1995), Deere et al. (1995) use two dummy variables to capture the effect of minimum wage increases. The first dummy variable equals one in the period in which the minimum wage was $3.80 (from April 1990 to March 1991). The second dummy variable equals one in the period in which the minimum wage was $4.25 in their data (April 1991–March 1993). Over the remaining periods in their data, the minimum wage was $3.35 (from April 1985 through March 1990). Because they do not include a dummy variable for the period when the federal minimum wage was $3.35, the two key dummy variables of interest measure the effect of raising the minimum wage relative to $3.35.[5]

Deere et al. (1995) estimate a series of equations for male, female, and black teenagers (ages 15–19) and for male, female, and black high school dropouts (ages 20–54). They report declines in employment of −4.8%, −6.6%, and −7.5% for male, female, and black teenagers and −1.5%, −2.5%, and −4.4% for male, female, and black high school dropouts as a result of the 1990 increase in the minimum wage. Although they do not calculate elasticities in their work, the implied elasticities given the 13.4% minimum wage increase from $3.35 to $3.80 in 1991 are −0.36, −0.49, and −0.56 among male, female, and black teenagers and −0.11, −0.19, and −0.33 among male, female, and black high school dropouts.

The Deere et al. (1995) model is specified as follows:

[5] Deere, Murphy, and Welch (1995) used an F-test to show that individual year dummies should not be included.

$$E_{it} = \alpha_0 + MW_1\beta_1 + MW_2\beta_2 + X_{it}\chi_p + S_i\delta_i + \varepsilon_{it}, \tag{2}$$

where E_{it} is the ratio of teenage employment to teenage population; MW_1 is a dummy variable equaling one when the federal minimum wage is \$3.80; MW_2 is a dummy variable equaling one when the federal minimum wage is \$4.25; X_{it} is a set of explanatory variables; and S_i is a set of state dummy variables. The subscripts i and t denote the relevant state and time period. The key coefficients of interest are β_1 and β_2, which represent the affect of minimum wage increases on employment.

The main difference between the Card and Krueger (1995) and the Deere et al. (1995) specifications is in the interpretation of the year effects. Deere et al. use the 1990 year dummy to capture the effect of the level of the minimum wage at \$3.80 and use a grouped year dummy for 1991 and 1992 to capture the effect of the level of the minimum wage at \$4.25. In contrast, Card and Krueger include a minimum wage variable and individual year controls in their analysis. Conceptually, Card and Krueger attempt to distinguish between individual year effects and minimum wage increases, whereas Deere et al. directly interpret the year variables as the federal minimum wage effect. We discuss this difference and its implications in the empirical section of the article.

Data

We use monthly data from the outgoing rotation groups of the 1979–97 CPS. This differs from Card and Krueger (1995), who used information from the May CPS from 1973 through 1989, and Deere et al. (1995), who used annual averages of months from the 1985 through 1993 CPS.[6] The advantage of using data for all months from the CPS rather than one annual observation from the month of May or one annualized observation is that the amount of information is increased.

We create state-month observations based on individual-level information provided in each of the monthly CPS data sets. In each month, approximately 22,500 observations of working-age individuals are available for use in construction of the state-month observations. Weights are used to make the sample nationally representative.

We initially only use the data from January 1979 through December 1992. We do this because these data cover a time period similar to that used in the new minimum wage literature.[7] This sample contains 8,568

[6] While wage information is available for the month of May back to 1973 in the CPS, the same information that was collected in May only became available on a monthly basis for each outgoing rotation group in 1979. This explains the use of the May observations from 1973 through 1989 in the work of Neumark and Wascher (1992) and our use of the data beginning in 1979 here.

[7] Card and Krueger (1995) use data from 1973 to 1989, and Deere et al. (1995) use data from 1979 through 1993.

state-month observations. This compares to the sample of 751 state-month observations, for example, employed by Card et al. (1994), Card and Krueger (1995), and Neumark and Wascher (1994).[8] Later, we add monthly CPS data through December 1997 to our original data set to capture the most recent minimum wage increases in October 1996 and October 1997 and to see if the more robust economic climate during these years affect our results. This sample contains 11,628 state-month observations.

In all of our estimates, we include a set of control variables that are identical to those in Card and Krueger (1995, table 7.1). These variables include the log of the average adult wage in the state, the proportion of teenagers in each state's population, and the prime-age male unemployment rate in each state. When we estimate equation (1), the minimum wage variable is constructed as the log of the higher of the state or federal minimum. The log state minimum variable is replaced by a set of dichotomous variables for each individual level of the state or federal minimum wage when estimating equation (2). Much of the discussion in the article revolves around the issue of the consequences of including various combinations of sets of dummy variables in equations (1) and (2) to control for state, seasonal, yearly, and recessionary effects. Table 1 provides definitions of all the variables used in our analysis as well as their weighted means and standard deviations. Column 1 provides statistics for CPS data from 1979 to 1992, and column 2 provides statistics from 1979 to 1997.

Empirical Evidence

We begin our empirical analyses using monthly CPS data from January 1979 through December 1992. All estimates in the article are weighted by the underlying state population in each survey.[9]

The Effect of the Minimum Wage on Average Teenage Wage Rates

If changes in the minimum wage are to affect teenage employment, they must first have an impact on teenage wage rates. In table 2, we show that minimum wage increases significantly increase the hourly wage rate of

[8] The 751 observations were derived from 50 states plus the District of Columbia multiplied by the 13 years for which complete data were available in the CPS (1977–89) plus an additional 4 years of data for the 22 larger states identified in the May CPS from 1973 to 1976.

[9] Alternative estimates were made using the number of observations available for constructing the state-month observations as a weight. Unweighted estimates were also calculated. These alternative estimates produced no substantive differences in our results.

Table 1
Definitions of Variables Used in the Econometric Analysis

		1979–92	1979–97
Dependent variable	Ratio of teenage (ages 16–19) employment to teenage population in a given state	.42 (.11)	.44 (.14)
Log teenage wage	The natural log of the wage of teenagers (ages 16–19)	1.411 (.198)	1.48 (.23)
Log state minimum[a]	The natural log of the greater of the state or federal minimum wage	1.23 (.10)	1.31 (.15)
Log difference[b]	Natural log of the state minimum wage minus the natural log of the federal minimum wage. If the federal minimum wage exceeds the state minimum wage, the log difference equals zero.	. . .	.013 (.041)
Log adult wage	The natural log of the wages of prime age adults	2.21 (.21)	2.28 (.24)
Share of teenagers	The share of teenagers in the overall state population	.11 (.02)	.10 (.02)
Unemployment rate	The prime-age male unemployment rate in the state	.05 (.03)	.05 (.03)
State effects	A dummy variable with a value of one for each state	. . .	. . .
Seasonal adjustments	A dummy variable with a value of one for each month of the year	. . .	. . .
Recession dummy	A dummy variable with a value of one when the economy was officially in a recession	. . .	. . .
Year dummies	A dummy variable with a value of one for each year in the analysis	. . .	. . .
Number of states[c]		51	51
N		8,568	11,628

SOURCE.—Computed by the authors.
NOTE.—Weighted means of all variables using underlying state populations in each CPS survey. Standard deviations are in parentheses.
[a] In the Deere, Murphy, and Welch (1995) specification, this variable is replaced by a set of dummy variables that take on a value of one in states where the minimum wage level is greater then the federal minimum.
[b] This variable is only used in specifications using data from the month of May.
[c] Includes the District of Columbia.

teenagers.[10] Column 1 contains estimates obtained by regressing the natural log of the average hourly wage for teenagers (ages 16–19) on the log state minimum wage variable through the use of monthly CPS data

[10] Here and in the remainder of the article, we use the words "insignificant" and "significant" to denote a statistical test at the 5% level. The results from this specification also appear in Card and Krueger (1995), table 7.1. They used these estimates to show that their measure of the minimum wage, the log state minimum, is superior to the Kaitz index used in the previous literature.

Table 2
Effect of Minimum Wage Increases on the Log Wage Rate of Teenagers (Ages 16–19) from 1979 through 1997

	1979–92		1979–97	
Variables	(1)	(2)	(3)	(4)
Log state minimum	.338*	.388*	.322*	.481*
	(.042)	(.021)	(.035)	(.017)
Log adult wage	.281*	.442*	.213*	.417*
Share of teenagers	−.156	−2.43*	.007	−.058
Unemployment rate	−.218*	−.510*	−.288*	−.582*
Seasonal adjustments	Yes	Yes	Yes	Yes
State effects	Yes	Yes	Yes	Yes
Year dummies	Yes	No	Yes	No
R^2	.560	.549	.660	.650
N	8,568	8,568	11,628	11,628

SOURCE.—Computed by the authors.
NOTE.—In each data set, the dependent variable is the log of the average wage of teenagers. Standard errors are in parentheses.
* Indicates statistical significance at the 5% level.

from 1979 through 1992. The estimates contained in column 2 are similar, except that the individual year dummies are excluded. In both specifications, minimum wage increases have a significant positive effect on the average hourly wages of teenagers who work. The last two columns provide estimates based on data for a slightly longer time period—January 1979 to December 1997—that also will be used in the analysis below. As was the case in the previous columns, the results indicated that minimum wage increases over this period had a positive and significant effect on the hourly wage rate of teenagers.

Estimates Based on the Equation (1) Model

Having established that increases in the minimum wage increase the wages of teenagers, we estimate a series of models closely related to equation (1). We examine the robustness of the results from these models with respect to the effects of raising the minimum wage by varying the controls used to capture state- and time-specific effects.

Column 1 of table 3 contains results from regressing the teenage employment to population ratio on the set of variables preferred by Card and Krueger (1995) with no controls for state or time effects. The parameter associated with the minimum wage variable in this specification captures all variation in the ratio of employment to population for a given change of the minimum wage controlling for the other variables in the equation. The minimum wage coefficient is negative and statistically significant. Minimum wage increases result in decreases in teenage employment. The elasticity of teenage employment with respect to the log of the minimum wage (calculated at the mean of the teenage employment to the teenage population ratio) is −0.450.

Table 3
Effects of the Minimum Wage on the Ratio of Teenage (Ages 16–19) Employment to Teenage Population (January 1979–December 1992)

Variables	(1)	(2)	(3)	(4)	(5)
Log state minimum	−.190*	−.175*	−.186*	−.028	−.189*
	(.017)	(.016)	(.014)	(.028)	(.015)
Log adult wage	.065*	.051*	.050*	.018	.055*
	(.009)	(.010)	(.008)	(.015)	(.009)
Share of teenagers	−.020	.004	−.016	.008	−.017
	(.075)	(.066)	(.057)	(.058)	(.057)
Unemployment rate	−1.026*	−.908*	−.773*	−.573*	−.757*
	(.042)	(.039)	(.034)	(.040)	(.035)
State effects	No	Yes	Yes	Yes	Yes
Seasonal adjustment	No	No	Yes	Yes	Yes
Year dummies	No	No	No	Yes	No
Recessionary dummy	No	No	No	No	Yes
R^2	.079	.345	.520	.528	.521
Auxiliary $R^{2\,a}$	...	.017	.000	.895	.136
					−.447
Elasticity	−.450	−.413	−.440	−.065	

SOURCE.—Computed by the authors.

NOTE.—Column headings are (1) variables preferred by Card and Krueger (1995) with no controls for state or time effects; (2) same as (1), but a set of dummies for state effects is added; (3) same as (2) but a set of controls that seasonably adjust the data on a monthly basis is added; (4) same as (3) but a set of year dummies is added; (5) same as (3) but recession dummy is added for months in which a recession occurred. Standard errors are in parentheses. $N = 8{,}568$ for all columns.

[a] Represents the R^2 from a second regression using the log state minimum as the dependent variable. The explanatory variables vary by column and include state effects (col. 2), seasonal effects (col. 3), year effects (col. 4), and recession dummies (col. 5).

* Indicates statistical significance at the 5% level.

In the next three columns, we sequentially add additional sets of variables to the specification to control for state, seasonal, and year effects. The conceptual argument is that each of these sets of control variables captures unmeasured variation in a given dimension. In column 2, we add a set of dummies to capture state effects. The estimated coefficient on the minimum wage remains negative and significant, although the magnitude of the elasticity falls in comparison to column 1 from −0.450 to −0.413. These results indicate that the state-specific component of the change in the ratio of employment to population with respect to the minimum wage is relatively small. In column 3, we add a set of controls to column 2 that seasonally adjust the data on a monthly basis.[11] The estimated minimum wage effect remains negative and significant, and the elasticity relative to column 2 rises slightly to −0.440. Column 4, which contains the set of controls most similar to those used by Card and Krueger (1995), adds a set of individual year dummies to column 3. Like them, we find an insignificant minimum wage effect.

The coefficient on the minimum wage variable becomes insignificant

[11] Card and Krueger (1995) did not need to control for seasonal effects since their data was for the month of May in each year.

when individual year effects are included because those year variables capture most of the variation in the minimum wage variable. The reason for this is that federal minimum wage increases occur once in a given year in our data and those changes make up the greatest part of the variation in the minimum wage variable used here and by prior researchers.

To demonstrate the relationship between the minimum wage variable and the year effects, we provide auxiliary regression results in each column of table 3 to show how much variation is lost in the minimum wage variable as other controls are included in the regression. In our auxiliary regressions, the log state minimum is regressed on the additional dummy variables that are included in each successive column of table 3. When this auxiliary R^2 is larger than the R^2 from the primary regression, it is indicative of a high degree of collinearity.[12] Another interpretation is that the auxiliary R^2 shows how much of the variation in the minimum wage variable is removed by including a particular set of controls.

In column 2 we regress the log state minimum on the state dummy variables. The auxiliary R^2 is 0.017, which indicates that state effects capture less than 2% of the total variation in the log state minimum. In column 3, we regress the log state minimum on the seasonal dummy variables. We find little relationship between the seasonal effects and the log state minimum, as the auxiliary R^2 is less than 0.01. In column 4, we regress the log state minimum on individual year dummies. The auxiliary R^2 is 0.895. This indicates that approximately 90% of the variation in the constructed minimum wage variable is captured by the individual year dummies. The auxiliary R^2 in column 4 is higher than the R^2 value from the primary regression, which is indicative of a problem with collinearity. Column 4 is the only set of estimates in which this occurs and is the only specification in which minimum wage increases are found to have no effect on employment.

The Relationship between the Minimum Wage and Year Dummies

We have demonstrated empirically that the inclusion of individual year dummies in a model similar to that estimated in prior research removes the majority of the variation in the minimum wage variable. Here, because we use monthly data, some year-specific variation due to changes in the federal policy remains. In prior studies, however, where only one observation from a particular year was used, the inclusion of year dummies had the effect of removing all variation in the minimum wage variable due to changes in the federal minimum wage. This point is important enough that we digress here to provide a simple derivation that identifies the effect of including the year dummies in equation (1). We also discuss the

[12] See Greene (1997) for fuller discussion.

implied change in the appropriate interpretation of the results of the model when the year dummies are included. The point is also demonstrated empirically.

Recall that the measure used in equation (1) to capture the effect of the minimum wage on employment is the higher of the state or federal minimum wage in the month of May in each state. Hence, MW_{it} can be rewritten as

$$MW_{it} = (FED_t + DIFF_{it}), \tag{3}$$

where FED_t represents the federal level of the minimum wage during time period t and $DIFF_{it}$ represents the difference between the state and federal minimum wage for state i during period t. Assuming that the federal minimum wage can only take one value per year because only one observation per year is used, we can rewrite the federal minimum wage as a linear function of the individual year dummies:[13]

$$FED_t = T_t\sigma_t, \tag{4}$$

where σ_t represents the observed natural log of the federal minimum wage in each year. By substituting (3) and (4) into equation (1), we derive the following equation:

$$E_{it} = \alpha_0 + [(T_t\sigma_t) + DIFF_{it}]\beta + X_{it}\chi_n + T_t\tau_t + S_i\delta_i + \varepsilon_{it}. \tag{5}$$

Because of the inclusion of the year dummies, equation (5) can be rewritten as

$$E_{it} = \alpha_0 + DIFF_{it}\beta + X_{it}\chi_n + T_t z_t + S_i\delta_i + \varepsilon_{it}, \tag{6}$$

where $z_t = (\sigma_t\beta + \tau_t)$. That is, z_t represents the estimated effects of changes in federal policy plus any year specific effects.

As equation (6) shows, the parameter β, interpreted by previous authors as capturing the impact of federal minimum wage increases on employment, captures only the effect of deviations between state and federal levels of the minimum wage. Hence, all observations of the minimum wage variable are effectively zero for states that never change their minimum wage relative to the federal level, even in the specific years

[13] The federal minimum wage can have two values when monthly data are used. For example, in 1990, the federal minimum wage was raised in April from \$3.35 to \$3.80. Hence, from January to March 1990, the federal minimum wage equals \$3.35, and from April to December it equals \$3.80. When annual data are used, as in Card and Krueger (1995), the federal minimum wage will have only one value.

when the federal minimum wage increases.[14] Thus, the correct interpretation of β is that it measures the effect of state increases in the minimum wage relative to the federal minimum rather than the effect of federal increases in the minimum wage.

Conceptually, it is possible that one can gauge the effect of a federal policy by looking at the relative experiences of states that decide to pursue their own policies. However, even if the experiences of those states are similar to what happens when a federal minimum wage is increased, it is unclear why one would want to use a model that excludes any variation in the federal minimum wage over time when it is the effect of that specific policy that is of most interest to policy makers. Moreover, unless there are substantial deviations in time and space across political jurisdictions, one is unlikely to obtain precise estimates of the impact of state policies.

We demonstrate the empirical relationship between *DIFF* and the log state minimum variable in table 4. In column 1, we provide estimates of equation (1) that are the same as those discussed as in column 4 of table 3, except that we only use CPS observations from the month of May. This is the same method of data usage employed by Card and Krueger (1995). In column (2), we estimate the same equation, except that we use the difference in the logs of the state and federal minimum wages as the measure of the minimum wage. This construction corresponds to the variable *DIFF* in equation (6). Both estimates contain year dummies. The estimated coefficients on the minimum wage variables are identical, although in one, by construction, we have removed all of the variation in the variable due to the federal minimum wage. These results show that the coefficient for the minimum wage variable in estimates such as those reported by Card and Krueger (1995) capture none of the federal variation in the minimum wage. Thus, the appropriate interpretation of the resulting parameter estimate for β is that it measures the incremental effect of raising state specific minimum wages relative to the federal level.

As we did in table 3, we use auxiliary regression results in table 4 specifications to show how much variation is lost in the minimum wage variable when we use year dummies. As can be seen in column 1, the year dummies capture 93% of the variation in the minimum wage variable. Put in a different way, the remaining variation in the minimum wage variable due to state policies is only 7% of the total. With so little independent variation in state policies, it is not surprising that a precise estimate of the effect of those policies on employment is difficult to obtain.

[14] For example, assume that a state had a minimum wage that was always 10 cents above the federal minimum wage. For this particular state, the value of the log difference would always be 10 cents, even if there were several increases in the state's minimum wage level. Hence, Card and Krueger's (1995) log state minimum variable would not capture any of the changes in the level of this state's minimum wage.

Table 4
Effects of the Minimum Wage on the Ratio of Teenage (Ages 16–19) Employment to Teenage Population (Annual Data, May 1979–May 1992)

Variables	(1)	(2)	(3)	(4)
Log state minimum	−.067	. . .	−.204*	. . .
	(.112)		(.046)	
Log difference[a]	. . .	−.067	. . .	.026
		(.112)		(.106)
Log adult wage	.064	.064	.052	−.040*
	(.056)	(.056)	(.028)	(.020)
Share of teenagers	−.393	−.393	−.362	−.304
	(.203)	(.203)	(.198)	(.200)
Unemployment rate	−.653*	−.653*	−.803*	−.848*
	(.145)	(.145)	(.117)	(.118)
State effects	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	No	No
Auxiliary R^2	.932	.140	.017	.149
R^2	.484	.484	.475	.459
Elasticity	−.153	−.153	−.481	.061

SOURCE.—Computed by the authors.
NOTE.—Column headings are (1) variables preferred by Card and Krueger (1995); (2) same as (1), except the minimum wage is measured as the log difference; (3) includes all of the control variables preferred by Card and Krueger except year effects; (4) same as 3 except the minimum wage is measured as the log difference. Standard errors are in parentheses. $N = 714$ for all columns.
[a] Natural log of the state minimum wage minus the natural log of the federal minimum wage. If the federal minimum wage exceeds the state minimum wage, the log difference equals zero.
* Indicates statistical significance at the 5% level.

The final two columns of table 4 show that when year effects are not included, the log difference and the log state minimum variables are quite different. Hence, the relationship between the log difference and the log state minimum wage variable holds only when year effects are included. Also note that the point estimate on the log state minimum variable in column 3 is negative and significant when year effects are excluded.

Alternative Macroeconomic Controls

A potential criticism of the specifications in table 3 that do not control for individual year effects (cols. 1–3) is that they do not include sufficient macroeconomic and policy controls, even though variables for the unemployment rate and adult wage rate are included in the specification.[15] Hence, it could be argued that the minimum wage variable is capturing these effects. For example, in equation (4) we show that the federal minimum wage, which makes up much of the variation in the log state minimum variable, could be written as a function of individual year effects. Therefore, it could be argued that

[15] Another possible criticism is that the variables are not cointegrated and that the results are spurious. We performed appropriate panel tests of cointegration and found that all of the models in table 3 are cointegrated.

it is difficult to differentiate the effect of a minimum wage increase from the effect of other unobserved macroeconomic factors in a given year.

In column 5 of table 3 we more fully account for macroeconomic factors by including a dummy variable equal to one for each month in which the economy was officially in recession to our column 3 specification.[16] Presumably, the state of the business cycle was one of the initial concerns that prompted the inclusion of controls for every time period in the data. We find that the estimated minimum wage coefficient is negative and significant with an estimated elasticity of −0.447. This value is slightly larger than that estimated in column 3.

In summary, using a framework similar to Card and Krueger (1995), we find that the minimum wage has a negative and significant effect on teenage employment across all our specifications except one. Only when individual year effects are included is the estimated effect of the minimum wage insignificant. We show theoretically and empirically, however, that it is reasonable to discount that particular specification because it fails to capture variation in the minimum wage variable due to changes in federal policy. The estimated elasticities from the other models range from −0.413 to −0.450, which is somewhat larger than the range reported by Brown et al. (1982) of −0.1 to −0.3.

Lagged Employment Effects

Neumark and Wascher (1994) argue that the employment effects of minimum wage increases do not occur instantaneously. There are many reasons why this seems plausible. Including lagged effects of a minimum wage increase is another method of exploring the robustness of equation (1) in the dimension of time.

In table 5, we estimate all the specifications reported in table 3 but include a 1-year lagged value of the minimum wage in each column. We find that the effect of both the current value of the minimum wage and the lagged value of the minimum wage are negative and significant in the first three columns. We calculate the elasticity as the sum of the employment change when the minimum wage is increased and main-

[16] From January 1979 through December 1998 there were 32 official recessionary months (U.S. Department of Commerce, table 51, various years). We tested alternative specifications that included a dummy variable for each of the 32 months. Based on an F-test, we found that the single dummy variable capturing recessionary period was preferred to the 32 recessionary dummies. In both specifications, the estimated minimum wage elasticities are virtually identical.

Table 5
Effects of the Minimum Wage on the Ratio of Teenage (Ages 16–19) Employment to Teenage Population Initially and after 1 Year (January 1980–December 1992)

Variables	(1)	(2)	(3)	(4)	(5)
Log state minimum	−.101*	−.098*	−.093*	.014	−.070*
	(.027)	(.023)	(.020)	(.031)	(.023)
Log state minimum lagged 1 year	−.112*	−.122*	−.154*	−.106*	−.181*
	(.030)	(.026)	(.023)	(.032)	(.026)
Log adult wage	.068*	.072*	.080*	.016	.089*
	(.010)	(.011)	(.010)	(.016)	(.011)
Share of teenagers	−.132	−.031	−.055	−.004	−.056
	(.079)	(.070)	(.060)	(.061)	(.060)
Unemployment rate	−.974*	−.851*	−.701*	−.583	−.685*
	(.045)	(.044)	(.038)	(.041)	(.039)
State effects	No	Yes	Yes	Yes	Yes
Seasonal adjustment	No	No	Yes	Yes	Yes
Year dummies	No	No	No	Yes	No
Recession dummy	No	No	No	No	Yes
R^2	.076	.343	.516	.523	.518
Elasticity	−.505	−.519	−.584	−.217	−.593

SOURCE.—Computed by the authors.
NOTE.—Column headings are (1) variables preferred by Card and Krueger (1995) with no controls for state or time effects; (2) same as (1) but a set of dummies for state effects is added; (3) same as (2) but a set of controls that seasonably adjust the data on a monthly basis is added; (4) same as (3) but a set of year dummies is added; (5) same as (3) but a recession dummy is added for months in which a recession occurred. Standard errors are in parentheses. $N = 7{,}956$ for all columns.
* Indicates statistical significance at the 5% level.

tained.[17] The estimated elasticities in these columns range from −0.505 to −0.584.

Column 4 adds individual year dummies to the specification. Because the lagged values of the minimum wage have an empirical relationship to the individual year dummies similar to that of the contemporaneous value, the variation in this variable is also reduced greatly by the inclusion of year controls. Nonetheless, the coefficient of the lagged variable is negative and significant with an elasticity of −0.217.

In column 5, the effect of both the current value of the minimum wage and lagged value of the minimum wage are negative and significant with an associated elasticity of −0.593. Since they capture longer-term effects of minimum wage increases, the elasticities in table 5 are somewhat higher relative to those in table 3.

[17] This elasticity measure is calculated as the sum of the coefficients on the log state minimum and lag state minimum divided by the employment to population ratio.

A Reestimation of Deere et al.

In tables 3–5 we used the log state minimum variable in Card and Krueger (1995) to capture the effect of minimum wage increases on employment. Deere et al. (1995) use a more flexible approach that allows the relationship between minimum wage increases and employment to be nonlinear. In this spirit, we construct a set of dummy variables for each value of the minimum wage during the period from January 1980 through December 1992 to estimate equation (2). This is feasible since over this 13-year period there were only five federal minimum wage levels and 26 state minimum wage levels, that exceeded them in any of these years. We exclude the dummy variable representing the level of $3.35 and measure changes in employment relative to that level of minimum wage. One difference between our specifications and those of Deere et al. (1995) is that we also include a dummy variable for each state and federal minimum wage increase.[18] Another difference is that we use monthly data rather than one annualized observation.

Table 6 provides the results from estimates of equation (2). With the exception of the minimum wage variable, the control variables in each of the columns are identical to those used in table 3. The specification that includes individual year effects is not identified because of perfect collinearity.[19] The abbreviated results shown in each column are obtained from estimations that include a set of variables that represent all 31 values of the minimum wage between January 1979 and December 1992. These values include the five federal minimum wage values of $2.90, $3.00, $3.35, $3.80, and $4.25, as well as 26 other values that individual states set over this time period and that exceeded the federal minimum wages. All these minimum wage values are reported in appendix table A1. In table 6, we only report the

[18] We are cautious in interpreting these results relative to individual state minimum wage values, however. By far, the most prevalent values are those associated with the federal minimum wage levels. It is important to note that while there are 26 state and five federal minimum wage values in the data, the prevalence of the values is not uniform in the data. Some state minimum wage values represent relatively rare events that are linked to only one state. See appendix table A1. Further, some values of the state minimum wage levels were higher than the federal level for only a short period of time (e.g., the $3.75 level of the state minimum wage in Vermont was in effect only from January through March 1990, when the federal minimum was increased to $3.75). Finally, some state minimum wage levels are not comparable to $3.35 because their state minimum wage level was always over $3.35 starting in 1979 (e.g., Alaska has never had a state minimum wage lower than $3.40).

[19] This equation could not be identified because the individual year dummies along with the other controls are perfectly collinear with the federal minimum wage increases.

Table 6
Effects of the Minimum Wage on the Ratio of Teenage (Ages 16–19) Employment to Teenage Population (January 1979–December 1992)

Variables	(1)	(2)	(3)	(5)
Minimum wage of $3.80[a]	−.029*	−.024*	−.022*	−.016*
	(.006)	(.005)	(.004)	(.007)
Minimum wage of $4.25[a]	−.042*	−.043*	−.046*	−.048*
	(.004)	(.004)	(.004)	(.004)
Log adult wage	.067*	.065*	.063*	.077**
	(.009)	(.011)	(.010)	(.011)
Share of teenagers	−.077	−.079	−.026	−.038
	(.074)	(.066)	(.057)	(.057)
Unemployment rate	−.928*	−.859*	−.712*	−.681*
	(.044)	(.043)	(.037)	(.038)
State effects	No	Yes	Yes	Yes
Seasonal adjustment	No	No	Yes	Yes
Recession dummy	No	No	No	Yes
R^2	.103	.351	.523	.525
Elasticity $3.80[a]	−.502	−.430	−.396	−.273
Elasticity $4.25[a]	−.375	−.380	−.406	−.426

Source.—Computed by the authors.

Note.—Column headings are (1) variables preferred by Card and Krueger (1995) with no controls for state or time effects; (2) same as (1) but a set of dummies for state effects is added; (3) same as (2) but a set of controls that seasonably adjust the data on a monthly basis is added; and (5) same as (3) but a recession dummy is added for months in which a recession occurred. The column (4) specification could not be estimated because the individual year effects were perfectly collinear with the dummies for the federal minimum wage level variables. Standard errors are in parentheses. N = 8,568 for all columns.

[a] Relative to $3.35. Although only the parameters associated with the levels of $3.80 and $4.25 are reported here, variables representing each level except $3.35 are included in the estimates.

* Indicates statistical significance at the 5% level.

coefficients on the minimum wage at the levels of $3.80 and $4.25. In appendix table A2, we report the coefficients on the 30 individual minimum wage values in the column 3 specification (the $3.35 level is omitted). We interpret these minimum wage coefficients as measuring the effect of a given level of minimum wage on employment relative to $3.35.

Table 6 results are similar to estimates presented in the previous tables. The parameters measuring the increase in the minimum wage from $3.35 to $3.80 and to $4.25 are each negative and significant. The elasticities associated with the increase to $3.80 range from −0.273 to −0.502. The elasticities associated with the increase to $4.25 range from −0.375 to −0.426.[20] The macroeconomic climate when the minimum wage was raised to these levels from 1990 to 1992 was relatively poor in comparison

[20] The coefficients for the other federal minimum wage values coefficients in our data (i.e., for levels at $2.90 and $3.10) are positive and significant (see appendix table A2 for more information). This is expected because the excluded category, $3.35, represents a higher minimum wage level. Hence, at all levels of the federal minimum wage, we find a negative and significant effect of a minimum wage increase on employment.

to other periods, and some of this effect may be captured in the minimum wage coefficient.

State-Level Autocorrelation and Heteroskedasticity Corrections

Table 7 tests the sensitivity of the results of tables 3, 5, and 6 by exploring alternative specifications of the error term. We repeat the specifications contained in columns 3–5 of tables 3, 5, and 6 but now allow for state-specific autocorrelation parameters, state-specific heteroskedasticity, and across-state correlation. In general, the pattern of results is similar to that found in the previous tables. There are some differences. Most notable is the fact that the minimum wage specification of equation (1), which includes year dummies, now has the more conventional negative and significant effect on employment, although its elasticity is smaller than that found in the other columns. In general, these corrections increase the size of the negative estimated effect of the minimum wage with respect to employment. The range of estimated elasticities of teenage employment with respect to the minimum wage across all specifications is -0.204 through -0.569.

Effects of Recent Minimum Wage Increases

The federal minimum wage was increased from $4.25 per hour to $4.75 per hour in October of 1996 and then to $5.15 per hour in October 1997. In table 8, we add monthly data from the outgoing rotation groups of the CPS through December 1997, the most recent months available to us. We do this to test the sensitivity of our results during a period of more robust economic growth. To the degree that parameter estimates obtained during periods of weak growth or recession are likely to overstate the negative employment effects of raising the minimum wage, the complimentary argument is that the estimates presented in this section should understate to some degree the impact of that policy on employment. The natural variation in the growth of the economy thus provides us with an opportunity to see if uncontrolled macroeconomic effects in earlier periods influence the results we have reported.

The specifications estimated are identical to those contained in table 7, except that we do not make any corrections for the error term. In the first three columns, we report the results based on model (1) controlling for contemporaneous effects of the minimum wage on employment. These results correspond to columns 3–5 in table 3. The pattern of results is identical, though the estimated elasticity in each column is lower relative to table 3. This is not surprising given our priors about minimum wage increases in an expanding economy. With the exception of the specification that includes individual year dummies, the estimated coefficients are negative and significant at the 5% level.

Table 7
Effects of the Minimum Wage on the Ratio of Teenage (Ages 16–19) Employment with Controls for State-Level Autocorrelation and Heteroskedasticity Correction to Teenage Population Ratio (January 1979–December 1992)

	Table 3			Table 5			Table 6[a]	
Variables	(3)	(4)	(5)	(3)	(4)	(5)	(3)	(5)
Minimum wage of $3.80[b]	. . .	. . .	. . .	. . .	. . .	. . .	−.018*	−.023*
							(.003)	(.004)
Minimum wage of $4.25[b]	. . .	. . .	. . .	. . .	. . .	. . .	−.046*	−.048*
						(.003)	(.003)	
Log state minimum	−.192*	−.086*	−.197*	−.096*	−.060*	−.090*	. . .	. . .
	(.012)	(.024)	(.013)	(.016)	(.027)	(.019)		
Log state minimum lagged 1 year	. . .	. . .	. . .	−.145*	−.042	−.151*	. . .	. . .
				(.019)	(.028)	(.022)		
Log adult wage	.064*	.023	.070*	.095*	.019	.093*	.081*	.092*
	(.007)	(.013)	(.008)	(.008)	(.013)	(.008)	(.008)	(.009)
Share of teenagers	−.007	.026	−.015	−.058	−.003	−.057	−.008	−.019
	(.045)	(.046)	(.045)	(.046)	(.047)	(.046)	(.045)	(.045)
Unemployment rate	−.596*	−.400*	−.593*	−.522*	−.405*	−.525*	−.525*	−.509*
	(.029)	(.033)	(.029)	(.031)	(.034)	(.031)	(.031)	(.032)
State effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seasonal adjustment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recession dummy	No	No	Yes	No	No	Yes	No	Yes
Year dummies	No	Yes	No	No	Yes	No	No	No
Elasticity	−.454	−.204	−.466	−.389	−.241	−.569	. . .	. . .
Elasticity at $3.80[b]	. . .	. . .	. . .	. . .	. . .	. . .	−.316	−.411
Elasticity at $4.25[b]	. . .	. . .	. . .	. . .	. . .	. . .	−.406	−.426

SOURCE.—Computed by the authors.
NOTE.—Column headings are for the time series cross-sectional estimates from the respective columns in tables 3 and 5. Standard errors are in parentheses.
[a] The column (4) specifications could not be estimated because the individual year effects are perfectly collinear with the federal-minimum-wage-level variables.
[b] Relative to $3.35. Although only the parameters associated with the levels of $3.80 and $4.25 are reported here, variables representing each level except $3.35 are included in the estimates.
* Indicates statistical significance at the 5% level.

Table 8
Effects of the Minimum Wage on the Ratio of Teenage (Ages 16–19) Employment to Teenage Population Ratio using Data from the Most Recent Minimum Wage Increase (January 1979–December 1997)

	Table 3			Table 5			Table 6	
Variables	(3)	(4)	(5)	(3)	(4)	(5)	(3)	(5)
Minimum wage of \$3.80[a]	. . .	. . .	. . .	. . .	. . .	. . .	−.025*	−.027*
							(.004)	(.005)
Minimum wage of \$4.25[a]	. . .	. . .	. . .	. . .	. . .	. . .	−.040*	−.041*
							(.003)	(.003)
Minimum wage of \$4.75[a]	. . .	. . .	. . .	. . .	. . .	. . .	−.049*	−.050*
							(.005)	(.005)
Minimum wage of \$5.15[a]	. . .	. . .	. . .	. . .	. . .	. . .	−.041*	−.042*
							(.008)	(.008)
Log state minimum	−.133*	.013	−.130*	−.078*	.030	−.059*	. . .	. . .
	(.011)	(.024)	(.011)	(.018)	(.028)	(.019)		
Log state minimum lagged 1 year	. . .	. . .	. . .	−.079*	−.029	−.096*	. . .	. . .
				(.019)	(.029)	(.020)		
Log adult wage	.037*	.029*	.034*	.056*	.030*	.051*	.062*	.065*
	(.008)	(.013)	(.008)	(.009)	(.014)	(.009)	(.009)	(.010)
Share of teenagers	.010	−.028	.014	−.012	−.038	−.006	−.038	−.042
	(.050)	(.051)	(.050)	(.052)	(.054)	(.052)	(.050)	(.051)
Unemployment rate	−.829*	−.646*	−.830*	−.791*	−.661*	−.796*	−.754*	−.751*
	(.032)	(.037)	(.032)	(.034)	(.038)	(.034)	(.034)	(.035)
State effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seasonal adjustment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recession dummy	No	No	Yes	No	No	Yes	No	Yes
Year dummies	No	Yes	No	No	Yes	No	No	No
Elasticity	−.302	.300	−.295	−.356	.002	−.354	. . .	. . .
Elasticity at \$3.80[a]	. . .	. . .	. . .	. . .	. . .	. . .	−.424	−.455
Elasticity at \$4.25[a]	. . .	. . .	. . .	. . .	. . .	. . .	−.339	−.344
Elasticity at \$4.70[a]	. . .	. . .	. . .	. . .	. . .	. . .	−.265	−.269
Elasticity at \$5.15[a]	. . .	. . .	. . .	. . .	. . .	. . .	−.174	−.177

Source.—Calculated by authors.
Note.—Column headings are for the time series cross-sectional estimates from the respective columns in tables 3–5. Standard errors are in parentheses.
[a] Relative to \$3.35. Although only the parameters associated with the levels of \$3.80, \$4.25, \$4.75, and \$5.15 are reported here, variables representing each level except \$3.35 are included in the estimates.
* Indicates statistical significance at the 5% level.

In the next three columns, we report results using the lagged specification of the minimum wage based on model (1). These columns correspond to columns 3–5 in table 5. Again, the pattern of coefficients is similar to that reported in table 5, although the column 4 specification is now insignificant and the magnitude of the estimated elasticities fall. As was the case in the previous tables, the elasticities that capture the lagged effect in table 8 are somewhat higher than for the contemporaneous effects.

In the final two columns, we provide estimates of equation (2) corresponding to columns 3 and 5 in table 6. For these specifications, we continue to use \$3.35 as the excluded category.[21] We report estimated parameters for the four most recent increases in the minimum wage.[22] All of the coefficients are negative and significant. The estimated impacts of raising the minimum wage on employment are negative even during a historically strong period of economic growth. This suggests that any biases due to not including individual macroeconomic controls in equations (1) and (2) are not large enough relative to the impact of the policy to generate misleading estimates with respect to the direction or significance of the results.

Conclusion

We have focused on the impact of statutory changes in the federal minimum wage on teenage employment during the decade of the 1990s. One of the major topics we considered was whether estimates obtained by previous researchers (e.g., Card and Krueger 1995) using CPS data provide credible evidence that minimum wage increases have no measurable effect on the employment of teenagers.

We explain theoretically and demonstrate empirically that models like the ones proposed by Card and Krueger that use pooled repeated

[21] We could have chosen \$4.25 as the excluded category. The \$4.25 minimum wage increase occurred during an economic downturn. For more recent minimum wage increases this specification would likely capture changes in teenage employment from a period of relatively poor economic conditions (\$4.25 in 1992–95) to a period of improved economic conditions (\$4.70 in 1996 and \$5.15 in 1997). The \$3.35 federal minimum wage was in effect during both low and high points of the business cycle. Hence, it seems to be less sensitive than the \$4.25 level to macroeconomic conditions. When \$4.25 is used as the base, we find an insignificant coefficient for the \$4.70 and \$5.15 increases. If there was no minimum wage effect, however, we would have expected to find a positive and significant coefficient on these variables because the economic conditions during this period were relatively better than in other years.

[22] Over this longer period, it is possible that our minimum wage estimates will be sensitive to inflation. In Burkhauser, Couch, and Wittenburg (2000), we test the sensitivity of the results we have reported controlling for inflation. The alternative estimates produced no substantive differences in our results.

cross-sectional CPS data in which only one observation is drawn from each year and that include year dummies in the estimation procedure eliminate all variation in the minimum wage variable due to changes in federal policy. While the resulting parameter estimates from these models may be interpreted as the marginal impact of state minimum wage policies, the direct effect of the federal policy is not captured by that parameter estimate. Furthermore, we conclude that using only state deviations in policy to gauge the effect of federal policy over this time period is not credible even if the two goals were correlated, given the small number of observations in which states set minimum wage standards above the federal level.

By using data from every month of the year rather than from only 1 month, we slightly mitigate the problem of completely excluding variations in federal policy. However, when we do so, we find that including year dummies in the estimation procedure still removes 93% of the variation of the minimum wage variable. We conclude that, even using data from every month, we still imprecisely estimate the impact of the minimum wage when we include year controls. Whether annual or monthly data are used, the important conceptual point is that minimum wage changes occur in discrete steps through time. Hence, including variables in the estimations that have the effect of controlling for any discrete change over time is likely to substantially reduce the likelihood of obtaining a precise estimate of the impact of the policy being examined. While this may not matter in some cases, in this instance, the problem this procedure creates is severe.

We explore alternative methods of controlling for macroeconomic effects and robustness of the model in the dimension of time. We estimate models controlling explicitly for recessions. We estimate models that allow the impacts of the policy to occur with a lag. We allow the error structure of the model to vary over time. We also compare results during the period of recent robust growth to those obtained using data from an earlier part of the decade when the performance of the economy was weaker, to see if unexplained macroeconomic factors are driving our results. The preponderance of the evidence indicates that increases in the minimum wage during the 1990s led to modest but statistically significant declines in teenage employment. We conclude that the elasticity of teenage employment with respect to the minimum wage lies in the range of $-.2$ to $-.6$. On the basis of our findings, it is not yet necessary to abandon neoclassical theory as a method of predicting labor market outcomes.

Appendix

Table A1
State Minimum Wages from 1979 through 1997 That Were Higher than the Federal Minimum on January 1

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Federal minimum[a]	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.80	4.25	4.25	4.25	4.25	4.25	4.75	5.15
Northeast:															
New England:															
Maine	. . .	. . .	3.45	3.55	3.65	3.65	3.75	3.85	. . .	. . .	. . .	. . .	. . .	. . .	. . .
New Hampshire	. . .	. . .	. . .	. . .	3.45	3.55	3.65	3.75	3.85	. . .	. . .	. . .	. . .	. . .	. . .
Vermont	. . .	. . .	. . .	. . .	3.45	3.55	3.65	3.75	3.85	. . .	. . .	. . .	4.75	4.75	5.00
Massachusetts	. . .	. . .	. . .	. . .	3.55	3.65	3.75	3.75	. . .	. . .	. . .	. . .	. . .	. . .	5.25
Rhode Island	. . .	. . .	. . .	. . .	3.55	3.65	4.00	4.25	4.25	4.45	4.45	4.45	4.45	4.45	5.15
Connecticut[b]	3.37	3.37	3.37	3.37	3.37	3.75	4.25	4.25	4.25	4.27	4.27	4.27	4.27	4.27	4.77
Middle Atlantic:															
New Jersey	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	5.05	5.05	5.05	5.05	5.05	5.05
Pennsylvania	. . .	. . .	. . .	. . .	. . .	. . .	3.70	3.80	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Midwest:															
East North Central:															
None	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
West North Central:															
Minnesota	. . .	. . .	. . .	. . .	. . .	3.55	3.85	3.95	4.25	. . .	. . .	. . .	. . .	. . .	. . .
Iowa	. . .	. . .	. . .	. . .	. . .	. . .	. . .	3.85	4.25	4.65	4.65	4.65	4.65	4.65	. . .
South:															
South Atlantic:															
Delaware	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	4.65	5.00
District of Columbia[c]	. . .	3.82	3.82	3.86	4.16	4.33	4.33	4.33	4.33	4.33	4.33	5.25	5.25	5.25	5.75
East South Central:															
None	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
West South:															
None	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

Table A1 (*Continued*)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
West:															
Mountain:															
None	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Pacific:															
Washington	. . .	. . .	. . .	. . .	. . .	. . .	3.85	4.25	4.25	. . .	. . .	4.90	4.90	4.90	4.90
Oregon	. . .	. . .	. . .	. . .	. . .	. . .	. . .	4.25	4.75	4.75	4.75	4.75	4.75	4.75	5.50
California	. . .	. . .	. . .	. . .	. . .	. . .	4.25	4.25	4.25	. . .	. . .	. . .	. . .	. . .	. . .
Pacific (noncontiguous):															
Alaska[d]	. . .	3.85	3.85	3.85	3.85	3.85	3.85	3.85	4.30	4.75	4.75	4.75	4.75	4.75	5.25
Hawaii	. . .	. . .	. . .	. . .	. . .	3.85	3.85	3.85	. . .	4.75	5.25	5.25	5.25	5.25	5.25

SOURCE.—Derived from the Council of State Governments (1998).

NOTE.—Only the states listed in the table had a minimum wage rate that exceeded the federal minimum wage rate in any month from January 1979 through December 1997. In 1990 and 1991, the federal minimum wage was not implemented until April. Therefore, some states listed in the table had a higher state minimum wage than the federal minimum wage from January through March of those years. In 1996 and 1997, the federal minimum wage was not implemental until October. Therefore, some states listed in the table had a higher state minimum wage than the federal minimum wage from January through September of those years.

[a] The federal minimum wage was $2.90 in 1979, $3.10 in 1980, and $3.35 from 1981 to 1983. During this period, minimum wages in all states were the same as the federal level except where noted.

[b] The minimum wage in Connecticut was $2.91 in 1979, $3.12 in 1980, and $3.37 from 1981 to 1983.

[c] The minimum wage in the District of Columbia was $2.95 in 1979, $3.14 in 1980, $3.48 in 1981, $3.62 in 1982, and $3.82 in 1983.

[d] The minimum wage in Alaska was $3.40 in 1979, $3.60 in 1980, and $3.85 from 1981 to 1983.

Table A2
Coefficients for Each Minimum Wage Value Based on Table 6, Column 3, Specification (January 1979–December 1992)

Minimum Wage Value ($)	Coefficient Normed to $3.35	Minimum Wage Value	Coefficient Normed to $3.35
2.90	.040*	3.75	−.001
	(.005)		(.016)
2.91	.020	3.80	−.022*
	(.030)		(.004)
2.95	−.050	3.82	−.019
	(.090)		(.080)
3.10	.026*	3.85	−.000
	(.004)		(.016)
3.12	−.026	3.86	−.018
	(.030		(.096)
3.14	−.008	3.95	−.037
	(.090)		(.027)
3.35	. . .	4.00	.035
			(.053)
3.37	−.029	4.16	.004
	(.019)		(.009)
3.40	.015	4.25	−.046*
	(.080)		(.004)
3.45	.060	4.27	−.055
	(.031)		(.035)
3.48	−.040	4.33	−.001
	(.090)		(.077)
3.55	.030	4.45	−.042
	(.014)		(.061)
3.60	−.013	4.65	.005
	(.077)		(.030)
3.62	−.080	4.75	−.047*
	(.083)		(.021)
3.65	−.004	5.05	−.050*
	(.016)		(.022)
3.70	.016	. . .	. . .
	(.015)		

NOTE.—All values are based on the specification shown in column (3) of table 6. The estimates include controls for seasonal adjustment and state effects along with controls for the adult wage rate, the unemployment rate, and the proportion of teenagers in the population of the state. Standard errors are in parentheses.
* Indicates statistical significance at the 5% level.

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