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ABSTRACT

A study described the effects of minimum wages on teenagers by using individual-level panel data on school and work transitions of teenagers. Panel data from 1979-92 measuring transitions among alternative employment and enrollment activities of teenagers were obtained from matched Current Population Surveys data sets. Findings indicated that higher minimum wages had significant negative effects on the employment prospects of less skilled teens. In addition, increases in the minimum wage were associated with an earlier age for leaving school. These employment changes were not evenly distributed across all youth, but were concentrated among those youths with the worst employment prospects. Younger idle youths (ages 16-17) had an almost 6 percentage point increase in their changes of continued idleness compared to older idle youths (ages 18-19). The effect of higher minimum wages was even stronger for minority youths. If they were idle before the minimum wage was raised, they would have a higher probability of continuing to be idle. The relationship between a teen worker's wage and the new minimum markedly affected the employment outcomes. Teens employed with wages below the new minimum showed a higher probability of becoming unemployed. (Appendixes include previous research on substitution hypothesis, the data set, the econometric framework and estimation, additional evidence on queuing, information on the robustness of the results, and a list of 32 references.) (YLB)

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Executive Summary

To assess the desirability of higher minimum wages we typically focus on aggregate employment effects — how much a particular increase would lower *overall* employment. The current views on this question range from no job loss (according to the Clinton Administration) to a loss perhaps as high as 3 percent for teens (the workers most affected by the minimum wage) for every 10 percent increase in the minimum wage.

As David Neumark shows in this paper, however, a focus on the employment effect of a minimum wage increase on broad population groups presents a distorted view of its impact. Subsumed in that aggregate is a shift in the *composition* of the work force. Less skilled teens are displaced from the job market, while more highly skilled teens are lured in by higher wages (even at the expense of cutbacks in their educational attainment). The conventional measures of job loss, by ignoring flows of young workers in and out of employment, can result in a measure of *net* job changes that markedly understates the true magnitude of the employment effect for the lowest-wage workers whom minimum wages are intended to help.

Dr. Neumark goes beyond simple aggregate measures by focusing on the changes in the work and education status of individual teenagers aged 16-19 following an increase in the minimum wage. He finds that higher minimum wages have significant negative effects on the employment prospects of less skilled teens, losses which are masked by their replacement in the work force by more highly skilled teens. In addition, increases in the minimum wage are associated with an earlier age for leaving school. The well-documented earnings premium associated with continued education makes this a potentially troublesome source of long-run earnings loss.

Employment and Schooling Effects

Using state-level data spanning 1979-1992, Dr. Neumark is able to estimate the impact of a higher minimum wage — $5.15 an hour, as proposed by the President — on today's young workers. He finds that the least skilled of these workers would suffer employment losses while the better skilled members of the cohort could enjoy employment gains.

Overall, the increase in the minimum wage proposed by President Clinton would increase, by about 2 percentage points, the number of youths aged 16-19 who are neither in school nor at work. This 2 percentage point increase in the probability of idleness in the entire teen population generates an approximately 20 percent increase in the number of idle youths. At the same time, the probability of being employed while in school falls by as much as 4 percentage points, decreasing the overall number of teens working while in school by 8 to 15 percent.

These employment changes are not distributed evenly across all youths, but rather are concentrated among those youths with the worst employment prospects. For example, youths already out of school but not employed -- whether they left school prior or subsequent to graduation -- experience a 4.4 percentage point increase in the probability that they will continue to be idle (neither in school nor at work) after a minimum wage increase. In contrast, young people initially working while in school are more likely to be employed upon leaving school after a minimum wage increase. In fact, the evidence shows they may actually be leaving school earlier in response to the higher wage.

Dividing teens into younger (16-17) and older (18-19) groups provides further evidence on the sorting process in the labor market. Younger idle youths have an almost 6 percentage point increase in their chances of continued idleness. In contrast, no significant effects are found for

Effect of Minimum Wage Increases on Future Employment and Schooling Status of 16-19 Year Olds

If This Was Your Initial Activity...		...an increase in the minimum wage would have this effect on your activity one year later.			
		In School		Not in School	
		Not Employed	Employed	Not Employed	Employed
In School	Not Employed	—	Lower Probability	Higher Probability	—
	Employed	—	Lower Probability	Higher Probability	Higher Probability
Not in School	Not Employed	Lower Probability	Lower Probability	Higher Probability	—
	Employed	—	Lower Probability	Higher Probability	—

Note: Findings reported in this table are significant at either the 5 or 10 percent level. See table 3 in the paper.

older teens. Idle youths aged 16-17 are highly likely to have left school prior to graduation and hence to have lower skills than either the larger universe of teens or even of older teens who are neither in school nor at work. The reduction in favorable labor market outcomes for this group is consistent with an increased demand for higher skilled workers following a minimum wage increase.

The effect of higher minimum wages is even stronger for minority youths. If these youths are idle — neither at work nor in school — before the minimum wage is raised, they have a 7.3 percentage point increase in their chance of continuing to be idle afterwards. If they had a job before the minimum wage rose, they face a 4.6 percentage point higher probability of becoming idle. A higher minimum wage also increases the probability, by 2.6 percentage points, that these youths will stop mixing work with education; they are more likely to leave school only to find themselves without employment.

Finally, Neumark finds that the relationship between a teen worker's wage and the new minimum markedly affects the employment outcome. Those teens who were out of school and employed with wages below the new minimum showed a 4.5 percentage point increase in the probability that they would be subsequently non-employed. Notably, teens who already earned above the new minimum (and who probably hold higher skills) showed no increase in the probability that they would become non-employed.

Conclusion

Changes in the minimum wage, often thought to affect only aggregate employment levels, are now known to have impacts both in and outside the labor market. Inside the labor market, higher minimum wages affect the composition of the minimum wage work force, reducing the employability of less skilled workers. At the same time, higher minimum wages may accelerate the rate at which youths terminate their formal schooling. Limitations of the data preclude this study from following individual workers for more than two years, so we do not know if they ultimately acquire additional education. We do know, however, that declines in the level of educational attainment are associated with declines in lifetime earnings.

Introduction

The recent debate about the impact of minimum wages on the labor market has focused on aggregate net employment effects of raising the minimum wage — for example, the effect on the employment rate of all teenagers. Some studies have challenged the conventional view that minimum wages reduce employment among youths[1], while other studies have confirmed the conventional wisdom.[2]

The attention given to *aggregate* net employment effects is perhaps a natural one, given the political attractiveness of simple or straightforward answers to economic questions. However, this narrow focus is also subject to the criticism — originally made by Abowd and Killingsworth (1981) — that estimates of minimum wage effects computed for aggregate demographic groups, such as all teenagers, are inadequate for understanding the workings of low-wage labor markets. As Abowd and Killingsworth point out, a focus on net effects for an aggregate demographic group such as teenagers may mask important effects within the group: "For example, a rise in the minimum wage may have sharp negative effects on some teenagers; sharp positive effects on other teenager subgroups; and, overall, a relatively small net effect ..." (p. 144). Despite the potential importance of this warning, the same aggregation is used in much of the recent research on minimum wages.

Evidence that small net effects of minimum wages for teenagers as a whole may mask important effects for subgroups of teenagers is presented in Neumark and Wascher (1994b and 1995c). Using state-level data for teenagers, they find that while the net disemployment effect of minimum wages is relatively small, a higher minimum tends to decrease school enrollment and increase the proportion of "idle" teenagers, those neither enrolled nor employed. Why might this happen? One hypothesis is that, just as the neoclassical economic model would predict, a higher minimum increases the relative demand for enrolled (higher-quality or more-skilled) teenagers, bidding up their market wages and inducing some of them to leave school for employment. As employers substitute toward these higher-skilled teenagers, lower-skilled teenagers — those not in school but employed at or near the old minimum, are displaced from the labor market. It is curious that this hypothesis has not been raised in the recent minimum wage debate. The evidence compiled in Card and Krueger (1995) showing largely no disemployment effect of minimum wages has been interpreted as inconsistent with the competitive model of labor markets. However, a finding of no initial aggregate disemployment effect can be entirely consistent with the competitive labor market model's prediction of job displacement, as long as it is recognized that teenage workers are not all identical and that they may possess heterogeneous skillss, so that a minimum wage increase may increase the demand for some teenagers, and reduce the demand for others.[3]

1 Card, 1992a and 1992b; Katz and Krueger, 1992; Card and Krueger, 1994.

2 Neumark and Wascher, 1992, 1994b, and 1995c; Williams, 1993; Kim and Taylor, 1995; Deere, et. al., 1995.

An alternative to this "substitution" hypothesis — equally consistent with the results from the aggregate data — is that minimum wage increases reduce school enrollment as teens leave school and queue for jobs at the higher minimum, without any displacement of teenagers already employed. From a policy perspective, the alternative explanations may appear not to matter. The "queuing" hypothesis also implies decreased enrollment of teenagers, and increased idleness. One difference, though, is that under the substitution hypothesis, the lowest-wage teenagers may lose their jobs following a minimum wage increase.

Aggregate state-level data are not rich enough to distinguish between these competing hypotheses about the relationship between minimum wages and school/work transitions. For example, we can see the *net* change in the proportion of teenagers who are not-enrolled and employed. However, we cannot observe whether there is an inflow of previously in-school teenagers into this category (from the previously enrolled), and an outflow of teenagers from this category to idleness, both of which are predicted by the substitution hypothesis.

The research described in this paper therefore attempts to provide a fuller description of the effects of minimum wages on teenagers by using individual-level panel data on school and work transitions of teenagers. The panels are created by matching individuals across Current Population Surveys (CPS). These data provide two important advantages relative to the existing research. First, data on transitions among school and work activities allow us to test the alternative substitution and queuing interpretations of the school/work transitions caused by minimum wages, by allowing us to observe minimum wage effects on these transitions. Second, the individual-level data enable us to estimate minimum wage effects on school and work for various subgroups of teenagers distinguished by skill-related characteristics. This is important because the substitution hypothesis suggests that it is precisely the least-skilled, lowest-wage teenagers who will be displaced from employment as a result of minimum wage increases.[4]

The results can best be summarized with reference to the two central questions raised by the recent debate over minimum wages. First, should policy makers no longer believe that minimum wages entail negative consequences for teenagers? Second, should economists discard the competitive labor market model? The evidence for teenagers, using matched CPSs, suggests that the answer to both of these questions is "No." Although increases in minimum wages may have small net effects on overall teen employment rates, such increases raise the probability that more-skilled teenagers leave school and displace lower-skilled workers from their jobs; the effects on each of these subgroups are considerably larger than the effect on overall teen employment. These findings are consistent with the predictions of a competitive labor market model that recognizes skill differences among workers. In addition, we find that the displaced lower-skilled workers are more likely to end neither enrolled in school nor employed. Thus, despite the small net disemployment effects for teenagers as a group, there are significant enrollment and employment shifts associated with minimum wage changes that should be of concern to policy makers.

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3 Only one of the Card and Krueger papers (1994) presents evidence that minimum wages raise employment. Morover, Neumark and Wascher (1995d) show that this evidence is generated by flawed data.

4 Earlier research focused on some components of the substitution hypothesis, but never addressed the hypothesis explicitly. See Appendix A for details.

The Empirical Approach

Panel data measuring transitions among alternative employment and enrollment activities of teenagers are obtained from matched CPS data sets. Teenagers are classified among four alternative activities:

- In school and not employed (SNE)
- In school and employed (SE)
- Not in school but employed (NSE)
- Not in school and not employed (NSNE)

Employment is defined from the CPS employment status recode, while enrollment is defined from the major activity in the survey week.[5] It is assumed that a teenager's activity in each year is influenced by a set of state-level variables (including the state unemployment rate for males aged 25-64, as an indicator of aggregate labor demand, and the minimum wage variable), individual-level variables (including age, race, and sex), and fixed state and year effects to account for unobserved variables that are constant across years or states.[6] In addition, an individual's school/work activity in the current year is sometimes allowed to depend on their activity in the previous year, to attempt to account for unobserved characteristics of individuals, such as a taste for work or schooling. (The data are described in detail in Appendix B. Some of the formal details of the estimation procedures are discussed in Appendix C.)

Two additional types of specifications are estimated. First, one specification asks whether there are more direct effects of the minimum wage on the relative probabilities of alternative school/work transitions, by introducing a set of interactions between the dummy variables for lagged activities and the minimum wage variable.[7] Second, specifications are estimated that allow different effects of minimum wages for various subgroups of teenagers. For example, to test the prediction that disemployment effects of minimum wages should be stronger for individuals initially paid below the new minimum wage, a model is estimated that allows separate effects for these individuals.

Results

Simple Comparisons

Before turning to the multinomial logit estimates, Table 1 reports some simple comparisons across states of rates of transition between alternative school/work activities, distinguished by whether the minimum wage increased in the previous year. Panel A reports results for all observations. The first matrix shows the proportions making each transition in states/years with no

5 Below (in Appendix E),we also consider evidence when we define enrollment based on a measure that does not require schooling to be the major activity, for the more limited sample period for which this alternative measure is available.

6 Two other variables were included in initial estimations of the models: the proportion of teenagers in the population, and an urban/rural dummy variable. The estimated minimum wage effects were unaffected by the exclusion of these variables in all of the specifications reported in this paper.

7 In principle it is possible to introduce a larger set of interactions of all of the variables with the lagged activity. The most flexible such specification is to estimate a separate multinomial logit model for individuals in each initial activity. When this specification was estimated, the estimates were extremely imprecise.

Table 1

Probabilities of Transition: Minimum Wage Increases

A. All Observations (Lagged Minimum Wage Increases)

Year 2	Year 1	No Increase in Minimum SNE	SE	NSE	NSNE	Increase in Minimum ≥$.10 SNE	SE	NSE	NSNE	Difference (Increase-No Increase) SNE	SE	NSE	NSNE
SNE		.58	.25	.12	.17	.58	.26	.13	.17	.01	.01	.01**	.00
SE		.18	.43	.12	.05	.16	.40	.10	.05	-.02**	-.03**	-.02**	.00
NSE		.15	.27	.66	.31	.16	.30	.64	.29	.01*	.02**	-.02*	-.03*
NSNE		.09	.05	.11	.46	.10	.05	.13	.49	.01*	.01	.02**	.03**
N		9,450	4,656	3,547	1,584	7,714	3,973	3,500	1,453				

B. Wage in Year 1 Above Year 2 Minimum Wage (Current Minimum Wage Increases)

Year 2	Year 1	SE	NSE	SE	NSE	SE	NSE
SNE		.25	.09	.23	.08	-.02	-.01
SE		.39	.09	.46	.09	.07**	-.01
NSE		.30	.71	.27	.73	-.03	.02
NSNE		.05	.11	.04	.11	-.02	.00
N		655	804	265	444		

C. Wage in Year 1 At or Below Year 2 Minimum Wage (Current Minimum Wage Increases)

Year 2	Year 1	SE	NSE	SE	NSE	SE	NSE
SNE		.28	.19	.24	.14	-.05**	-0.5**
SE		.43	.15	.44	.14	.01	-0.1
NSE		.24	.55	.28	.56	.03	.00
NSNE		.04	.10	.05	.16	.00*	.05**
N		649	363	642	341		

SNE: In School/Not Employed
SE: In School/Employed
NSE: Not in School/Employed
NSNE: Not in School/Not Employed

Note: In this table, observations with minimum wage increases less than $.10 were discarded. Many of the small increases came from Washington, D.C., for which the minimum wage is an employment-weighted average of minimum wages for different occupations. In Panels B and C wage are required, so only observations from the outgoing rotation groups are used. Differences significant at the 10% level are indicated with a *, and those significant at the 5% level are indicated with a **.

minimum wage increase, while the second shows the same proportions for states/years with a minimum wage increase. The third matrix reports the differences between these proportions, and indicates whether these differences are statistically significant.

The *substitution* hypothesis predicts that we should see more of at least some of the following transitions in states that have raised their minimum wage:

- From in school and not employed, to in school and employed (SNE to SE)
- From in school not employed, to not in school and not employed (SNE to NSE)
- From in school and employed, to not in school and employed (SE to NSE)
- From not in school and employed, to not in school and not employed (NSE to NSNE).

The first three of these transitions represent individuals enrolled in school increasing their labor force attachment, either by leaving school in order to work (SNE to NSE) or to work more

(SE to NSE), or by taking a job while remaining in school (SNE to SE). The last of these (NSE to NSNE) represents employed individuals who are displaced from employment and become non-enrolled and non-employed. In addition, we would expect to see fewer transitions from NSNE to NSE and more individuals remaining NSNE as employment opportunities for non-employed less-skilled individuals decline.

Of these six predictions, one is rejected and five are confirmed in Panel A. The proportion moving from SNE to SE is significantly lower (by .02), rather than higher, following minimum wage increases. But the proportions moving from SE to NSE and from NSE to NSNE are significantly higher following minimum wage increases, as is the proportion moving from SNE to NSE (although only at the ten-percent significance level). Moreover, the proportion moving from NSNE to NSE is lower in states/years with minimum wage increases, while the proportion remaining NSNE is higher.

The *queuing* hypothesis predicts that the proportions moving from in school/not employed to not in school/not employed (SNE to NSNE) as well as from in school/employed to not in school/not employed (SE to NSNE) should be higher following minimum wage increases. Both of these proportions are higher by .01, although only the first is significant (at the ten-percent level).[8]

Although minimum wages appear to be associated with transitions from SE to NSE and transitions from NSE to NSNE, those who make the first transition are likely to displace those originally NSE only if their hours increase when they leave school (since those individuals who are SE are already working). This is in fact the case. In our sample, average weekly hours of individuals who switched from SE to NSE increased by 11.8, from 19.0 to 30.8, whereas average weekly hours of those who remained SE increased only from 16.3 to 17.6.

The substitution hypothesis implies that the disemployment effects of minimum wages should be concentrated among low-wage workers who are more likely to be priced out of the market by minimum wage increases. On the other hand, the hypothesis also suggests that higher-wage workers, who are more productive and earn more than the minimum, may experience relative demand increases and would therefore be more likely to increase their hours of work. Therefore, Table 1 next reports some simple comparisons for high- and low-wage workers considered separately. For this analysis, the sample has to be restricted to individuals working for a wage in their first year (either SE or NSE), and for whom wages are reported in the outgoing rotation groups of the CPS. This reduces the sample to approximately one-ninth of its original size. In particular, Panels B and C distinguish workers based on whether their wage in year 1 was above or below the minimum wage in year 2. In order to make this comparison, only current minimum wage increases can be considered, since only two years of data on each individual are available. Some of these results also support the substitution hypothesis. The proportion moving from NSE to NSNE is significantly higher (by .05) in states with minimum wage increases for those whose initial wage is below the new minimum, while among those workers with initial wages above the new minimum, there is no difference in the proportion making this transition. On the other hand, among high-wage workers the proportion making the transition from SE to NSE is lower, rather than higher, for states that increased their minimum, which is inconsistent with the substitution hypothesis. However, in the multivariate models that follow, this result is reversed, and the findings are more thoroughly consistent with the substitution hypothesis.

8 For similar transition matrices using current rather than lagged minimum wage increases, the estimated differences in the proportions making each transition are smaller and are more likely to be significant only at the ten-percent level. However, the sign pattern is very similar to that in Panel A.

Table 2

Multinomial Logit Estimates of Minimum Wage Effects on Probabilities of School/Work Activities

A. Effects of 21% Increase in Minimum Wage (Absolute/Percent)

	(1)		(2)		(3)		(4)	
SNE	-.013	(-2.8%)**	-.004	(-0.7%)	-.010	(-2.1%)	.007	(1.5%)
SE	-.020	(-8.3%)**	-.037	(-15.4%)**	-.035	(-14.6%)**	-0.27	(-11.6%)**
NSE	.014	(6.8%)**	.021	(10.4%)	.023	(11.7%)	.018	(9.0%)
NSNE	.019	(23.6%)**	.019	(23.6%)**	.021	(25.9%)**	.018	(22.5%)**

B. Variables Included in Model

	(1)	(2)	(3)	(4)
Prime-age male unemployment rate	No	Yes	Yes	Yes
Age, race and sex dummies	No	Yes	Yes	Yes
Year dummies	No	Yes	Yes	Yes
State dummies	No	Yes	Yes	Yes
Lagged activity	No	No	Yes	Yes
Minimum (lagged)x lagged activity	No	No	No	Yes

SNE: In School/Not Employed
SE: In School/Employed
NSE: Not in School/Employed
NSNE: Not in School/Not Employed

Note: Relative minimum wage variable is not adjusted for coverage. Lagged minimum wage variable is used in all specifications. Differences significant at the 10% level are indicated with a *, and those significant at the 5% level are indicated with a **.

On balance, these simple comparisons provide some evidence that minimum wages induce some individuals to leave school for employment or perhaps to increase their hours, and reduce employment among the lowest-wage workers. Next, results from the multivariate analysis are presented and discussed.

Estimates of Minimum Wage Effects on School/Work Activities

In Table 2, we report multinomial logit estimates of minimum wage effects on the probability that an individual is in each of the four school/work activities. In each case, we report the implied effects on the probability of being in each of these four activities of a 21% increase in the minimum wage, the size of the increase proposed by the Clinton Administration. We report these results for four different specifications, adding progressively more control variables to account for characteristics of individuals or labor markets.

There are two results that are consistently statistically significant across all four of the specifications. First, the minimum wage has a significant negative effect on the probability of being in school and employed. For the proposed 21 percent increase in the minimum, the estimated absolute size of the effect ranges from a decrease in this probability of .02 to .037, or a percentage decline ranging from 8.3 to 15.4 percent. Second, the minimum wage has a significant positive effect on the probability of being non-enrolled and non-employed, or idle. For the proposed 21 percent increase in the minimum, the estimated absolute increase in the probability of being idle ranges from 1.8 to 2.1 percent. However, because the proportion in this category is relatively low to begin with — about 8 percent — these absolute increases represent large percentage increases, between 22.5 to 25.9 percent, in the idle population. The results in Table 2 are consistent with the results obtained by Neumark and Wascher (1995c) using state-level aggregate data.

With the individual-level panel data, however, the analysis can be taken one step further, using the multinomial logit estimates to calculate the implied minimum wage effect on the probability of each possibl school/work transition. Thus, 16 effects (four initial activities four final activities) rather than c .'y four are calculated. Table 3 reports these, based on the multinomial logit model used in column (3) of Table 2; that model was preferred based on likelihood-ratio tests of the significance of the variables added in each column. These estimated effects on transition probabilities are the ingredients necessary to test the substitution and queuing hypotheses.

Column (1) of Table 3 reports effects for those in school/not employed (SNE) in year 1. The 21 percent minimum wage increase is estimated to significantly decrease the probability of a transition to in school/employed status (SE) by .026. This finding is inconsistent with the substitution hypothesis: if the potentially most productive workers are those in full-time schooling (SNE), they should be drawn into the market by a minimum wage increase, becoming either SE or NSE. At a minimum, the finding implies that if substitution of higher-skilled for lower-skilled teenagers occurs, it is not those who are originally in school/not employed (SNE) who displace lower-skilled teenagers.

Table 3

Minimum Wage Effects on Transistion Probabilities

	Absolute Effects of 21% Increase in Minimum Wage			
Year 2 / Year 1	(1) SNE	(2) SE	(3) NSE	(4) NSNE
SNE	-.008	.005	-.011	-.025**
SE	-.026**	-.050**	-.030**	-.017**
NSE	.015	.035*	.023	-.002
NSNE	.019**	.011**	.017**	.044**

SNE: In School/Not Employed
SE: In School/Employed
NSE: Not in School/Employed
NSNE: Not in School/Not Employed

Note: Differences significant at the 10% level are indicated with a *, and those significant at the 5% level are indicated with a **.

In addition, the minimum wage increase is estimated to increase the proportion who go from in school/not employed to not in school/not employed (SNE to NSNE); this latter effect is consistent with individuals leaving school to queue for minimum wage jobs. Alternatively, the increased probability of becoming not in school/not employed (NSNE) for those originally in school/not employed (SNE) may reflect individuals who leave school to look for work, irrespective of minimum wage changes (the same occurs for those originally in school and employed (SE)). However, if jobs are harder to find in states in which the minimum wage has gone up, the proportion not in school/not employed (NSNE) may be higher.[9]

For those originally in school/employed (SE), column (2) shows that the probability of remaining in this activity is significantly reduced by an increase in the minimum wage (i.e., the probability of being SE in both years falls by .05). There is a large and significant (at the 10% level) positive effect of the minimum wage on the probability of becoming not in school/employed (NSE), with the probability rising by .035, suggesting that such individuals displace less-skilled workers. There is a smaller significant positive effect on the probability of becoming not in school/not employed (NSNE), consistent with queuing for full-time jobs or, as just discussed, greater difficulty in going from school to work. Finally, the estimates imply that a higher minimum reduces the overall probability of enrollment.

For those originally not in school/employed (NSE), reported in column (3), there is a positive and significant effect of the minimum wage on the probability of becoming not in school/not employed (NSNE), which increases by .017. This effect is consistent with the hypothesis that some previously-employed workers are displaced as a result of a minimum wage increase. In addition, a higher minimum wage discourages these individuals from returning to school, significantly so in the case of the SE (in school and employed) activity; the estimated decrease in the probability of going from not in school but employed to in school with no change in work status (NSNE to SE) is .03.

Finally, for those originally not in school and not employed (NSNE), reported in column (4), the proposed minimum wage increase is estimated to significantly increase the probability that they remain in this activity (the probability of being NSNE in both years rises by .044). This again is consistent with the displacement hypothesis, although in this case individuals face a lack of job opportunities rather than direct job loss.[10]

The minimum wage effects documented in Table 3 are consistent with displacement of lower-quality workers by higher-quality workers. This type of displacement may help to explain the relatively low net disemployment effects for teenagers in standard employment regressions. For teenagers, there appears to be a relatively strong supply response of higher-quality workers to higher wages. These findings may also explain why, for young adults (aged 16-24) as a whole, disemployment effects are stronger in standard employment regressions (Neumark and Wascher, 1992 and 1994b). Among the older individuals in this age group, the potential for a supply response among higher-quality individuals is probably lower; with the initial employment rate considerably higher (and the initial school enrollment rate lower), there is probably a smaller pool of higher-skilled or higher-quality workers who might enter the labor market in response to higher wages. This smaller supply response would imply (by Marshall's laws) a larger reduction in the employment of 20-24 year-olds.

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9 For additional evidence on queuing versus this alternative explanation, see Appendix D.

10 These effects were also estimated for the more flexible specification in column (4) of Table 2, which includes the minimum wage variable interacted with lagged school/work activity. The qualitative conclusions were very similar to those in Table 3. These effects were also estimated for some other specifications. First, using the coverage-adjusted relative minimum wage variable, the point estimates and statistical inferences were virtually unchanged. Second, when both the current and lagged values of the relative minimum wage variable were included, none of the contemporaneous effects were significant. On the other hand, nearly all of the lagged effects that were significant when only the lagged minimum wage was included continued to be significant when both the lagged and contemporaneous minimum wage were included, and the implied minimum wage effects were similar.

Minimum Wage Effects on School/Work Transitions, Disaggregated by Skill Levels

To this point, the multinomial logit framework has not been used to estimate minimum wage effects on subgroups of teenagers differentiated by skill or wages; the latter type of estimation, however, is one of the advantages offered by the matched CPS data. This subsection reports on a number of such experiments. Table 4 reports the results for the important transitions for testing the substitution and queuing hypotheses, and, more generally, for documenting the more important effects of minimum wages.

Table 4

Minimum Wage Effects on Transition Probabilities, Disaggregated by Skill Levels, Absolute Effects of 21% Increase in Minimum Wage

A. 16-17 Year-Olds vs. 18-19 Year-Olds

	SNE to SE (1)	SNE to NSE (2)	SNE to NSNE (3)	SE to NSE (4)	SE to NSNE (5)	NSE to NSNE (6)	NSNE to NSNE (7)
16-17 Year-Olds	-.015	.006	.014**	.014	.007**	.022**	.057**
18-19 Year-Olds	-.041**	.023	.026*	.058**	.017**	.014	.037

B. Blacks and Hispanics vs. Non-Blacks, Non-Hispanics

	SNE to SE (1)	SNE to NSE (2)	SNE to NSNE (3)	SE to NSE (4)	SE to NSNE (5)	NSE to NSNE (6)	NSNE to NSNE (7)
Black and Hispanics	-.031**	-.005	.040	.025	.026**	.046**	.073**
Non-blacks, Non-Hispanics	-.021**	.021	.012*	.038*	.007**	.009	.029*

C. Below New Minimum vs. At or Above New Minimum

	SNE to SE (1)	SNE to NSE (2)	SNE to NSNE (3)	SE to NSE (4)	SE to NSNE (5)	NSE to NSNE (6)	NSNE to NSNE (7)
Below year 2 min. in year 1	—	—	—	-.012	.020**	.045*	—
At or above year 2 min. in year 1	—	—	—	.040	.005	.006	—

SNE: In School/Not Employed
SE: In School/Employed
NSE: Not in School/Employed
NSNE: Not in School/Not Employed

Note: Estimates are based on specification used in column (3) of Table 2, with the models estimated separately for each group. Differences significant at the 10% level are indicated with a *, and those significant at the 5% level are indicated with a **. The sample size in Panel C is about one-ninth the size of the earlier samples, because of the requirement that individuals be working in year 1, and in the outgoing rotation group. The requirement that they be working in year 1 also explains why the effects can only be estimated for columns (4)-(6)

Because age may be a proxy for quality, estimates are first reported for 16-17 year-olds and 18-19 year-olds. These results, which are based on separate estimates of the multinomial logit model for each age group, are reported in Panel A of Table 4. There are considerably smaller effects of minimum wages on the probability of leaving school for employment for 16-17 year-olds than for 18-19 year-olds. For the 16-17 year-olds, none of the estimated effects on the probability of moving from in school/not employed (SNE) to either in school/employed (SE) or not in school/employed (NSE), or from in school/employed (SE) to not in school/employed

(NSE), are significant. For 18-19 year-olds, in contrast, the 21 percent minimum wage increase is estimated to have a (significant) positive effect on the probability of moving from school/employed to not in school/employed (SE to NSE), raising it by .058. On the other hand, the effect on the probability of moving from not in school/employed to not in school/not employed status (NSE to NSNE) is significant only for 16-17 year-olds (and larger for this age group), with a rise of .022 in this probability. Assuming that age is an indicator of skill level, these results are consistent with the hypothesis that more-skilled workers displace less-skilled workers following a minimum wage increase. In particular, some 18-19 year-olds leave school and become employed full-time, while some 16-17 year-olds who were initially NSE become disemployed, and apparently choose not to return to school.[11]

A similar experiment in which minimum wage effects are disaggregated by race or ethnicity is of interest, because for a number of reasons (including lower-quality schools or discrimination), employers might regard blacks and Hispanics as less-skilled workers than non-black, non-Hispanic workers. Thus, Panel B of Table 4 reports estimates of minimum wage effects on transitions among school/work activities from separate estimates of the multinomial logit model by race.

The effect of minimum wages on the transition from not in school/employed to not employed (NSE to NSNE) is significant for blacks and Hispanics, and is five times as large for this group compared to the rest of the population (for whom the estimate is insignificant). In particular, the estimated effect of a 21 percent minimum wage increase on the probability of making this transition is .046 for black and Hispanic teenagers, but only .009 for non-black, non-Hispanic teenagers. In addition, minimum wages have a significant positive effect on the probability (.038) that employed non-black, non-Hispanic teenagers will go from an in-school to out-of-school status (from SE to NSE), but a smaller and insignificant effect for black and Hispanic teenagers (.025). Thus, these results suggest that minimum wage increases result in non-black, non-Hispanic teenagers leaving school to work full-time, displacing black or Hispanic teenagers who were previously employed full-time, and who subsequently become neither enrolled nor employed. These results also suggest that blacks or Hispanics are most likely to become disemployed following a minimum wage increase. If black or Hispanic teenagers also are less skilled, on average, than non-black, non-Hispanic teenagers, or are perceived as such by employers, then this evidence provides further corroboration of the substitution hypothesis.

Finally, as in Table 1, for a subset of the sample the wage level in year 1 can be used as a proxy for skill, in particular by distinguishing the effects of minimum wages for individuals whose year 1 wages are originally above or below the minimum wage in year 2. Because the displacement suggested by the preceding results should be concentrated among low-wage workers who are effectively priced out of the market by minimum wage increases, distinguishing the effects for workers above and below the new minimum should give us more reliable estimates of such effects. In addition, this exercise provides a separate test of whether we are actually detecting minimum wage effects by focusing on the group directly affected by minimum wage laws. The effects reported in Panel C of Table 4 come from estimates of the multinomial logit model including a dummy variable for individuals whose wage in year 1 is below the current minimum, and an interaction of this variable with the minimum wage variable.

As reported in Panel C, for workers below the new minimum, minimum wages increase the probability of becoming NSNE for workers initially in either school/work activity. The large

11 Consistent with this hypothesis, the average weekly hours of those 18-19 year-olds who go from SE to NSE increase from 20.1 to 32.8.

(.045) increase in the probability that a not in school/employed (NSE) individual becomes not in school/not employed (NSNE) (significant at the 10% level) is consistent with displacement of lower-quality workers. A similar but smaller (.020) effect for those originally SE is more difficult to explain as displacement, since it is not obvious why these individuals leave school. One possibility is that they leave school to queue for full-time minimum wage jobs, assuming that the switch to full time will raise their productivity and make them employable at the new minimum. Another possibility is that they would have left school in any case, but because of the minimum wage increase, are more likely to end up not employed (NSNE).

In contrast, for those earning at or above the new minimum wage, there are no significant effects of minimum wages on the probability of becoming not in school/not employed (NSNE). This is as expected. These workers should not be displaced by minimum wage increases, nor should they leave school to queue for minimum wage jobs, since they already earn more than the minimum. However, the substitution hypothesis predicts that these workers leave school (SE) to become full-time workers, as labor demand shifts toward higher-skilled workers. The estimated effect on the probability of this transition is sizable and positive (.04), but not significant.[12]

Conclusions

The recent debate over minimum wages raises two questions. First, should policy makers no longer believe that minimum wages entail negative consequences for teenagers? Second, should economists discard the competitive labor market model? The evidence described in this paper suggests that the answer to both of these questions is "No."

The results can be summarized as follows. First, an increase in the minimum wage increases the probability that teenagers leave school. Some of these teens do not become employed, which may be consistent with queuing for minimum wage jobs. Others do find employment, but apparently at the expense of less-skilled workers — such as minorities, 16-17 year-olds, and the lowest-wage teenagers — who are displaced from their jobs. In addition, the evidence indicates that an increase in the minimum wage raises the probability that these less-skilled employed teenagers become non-enrolled and non-employed, and raises the probability that less-skilled, non-employed teenagers remain out of the work force.

Thus, although minimum wage increases may lead to small net disemployment effects for teenagers as a whole, there are significant enrollment and employment shifts associated with minimum wage changes that should be of concern to policy makers. The evidence also suggests that the conventional view of minimum wage effects is largely correct. The standard textbook model refers to homogeneous workers initially earning less than the minimum. But in a model with heterogeneous workers, only those with a market wage at or near the minimum should become disemployed because of a higher minimum wage. Moreover, the net disemployment effect

12 A potential problem with the estimates in Panel C of Table 4 is that some workers whose wages are below the new minimum may also earn less than the old minimum, because they are not covered by minimum wage laws (or their employers do not comply), or they are waitpersons for whom a tip credit can be applied toward the minimum wage. In either case, changes in minimum wages may affect these workers differently. To examine this issue, a specification of the multinomial logit model was also estimated that allows separate effects for those below the old minimum, at the old minimum, and between the old and the new minimum. For those at the old minimum, the estimated minimum wage effects on the probability of becoming NSNE were very similar to those in Panel C of Table 4. At the same time, the estimates of these effects for those below the old minimum are not significant, nor are the estimates for those above the old but below the new minimum.

for all teenagers may be small if there is substitution toward more-skilled workers. The evidence is consistent with this model.

Finally, the evidence supports the view that the disemployment effects of minimum wages fall largely on less-skilled workers. In this sense, the conventional findings of an employment elasticity with respect to minimum wages of -.1 to -.2 (as in Brown, et al., 1983) are somewhat misleading. An elasticity of -.1 is generally interpreted to mean that a ten-percent increase in the minimum wage reduces the employment rate of teenagers by 1 percent. While strictly correct, there is a sense in which this compares apples to oranges. For the most part, a minimum wage increase raises the wages only of lower-wage workers; however, this same group experiences the largest employment declines. The conventional elasticity, then, is effectively the ratio of the employment decline averaged across all workers to the wage increase among lower-wage workers. A more relevant measure would be the ratio of the employment decline among lower-wage workers to the wage increase among lower-wage workers (i.e., the minimum wage increase). Or, one could compute the ratio of the employment decline averaged across all workers to the wage increase averaged across all workers. The first calculation entails a larger negative number in the numerator, while the second entails a smaller positive number in the denominator. Either calculation, however, suggests that the commonly reported elasticities mask stronger disemployment effects for those workers whom minimum wages are intended to help.

Appendix A: Previous Research on the Substitution Hypothesis

Although most of the previous research on minimum wages has focused on relationships between overall teen or young adult employment rates and the minimum wage, there has been some attention paid to three points especially relevant to the research described in this paper. First, a few papers have considered empirical evidence on the possibility that minimum wage increases affect the wages other workers may earn. This is potentially important, because substitution may entail some bidding up of wages for above-minimum-wage workers.[13] Second, some papers have focused on minimum wage effects for those earning wages at or near the minimum. Third, some previous research has examined the effects of minimum wages on schooling.

Spillover Effects

Gramlich (1976) considered the possibility that minimum wage increases lead to wage increases for other, higher-paid workers "through a ... traditional demand-supply route following substitution by employers away from low-wage labor toward skilled labor" (p. 427). Gramlich provides some evidence that wages for higher-quality workers rise in response to minimum wage increases, showing that in aggregate Phillips curve estimates, overall hourly wages increase significantly in response to minimum wage increases, by a factor twice as large as would be expected based on the higher wage paid to minimum wage workers (pp. 427-9).

Grossman (1983) presents a model in which workers' productivity is positively related to their relative wage, leading employers to bump up the wages of higher-skilled workers in response to a minimum wage increase. Using Area Wage Surveys, she presents evidence on occupations for which all sampled wages exceeded the minimum wage in the state (the higher of the state or federal level). Her findings indicate that for some of these occupations, especially white-collar jobs, wages respond to minimum wage increases.

Effects on Low-Wage Workers

There have also been some attempts to estimate minimum wage effects for those most likely to be affected by the minimum. For example, Neumark and Wascher (1994a) use a disequilibrium endogenous switching model of the labor market to estimate minimum wage effects at the state level for those states and years in which minimum wages are relatively more likely to be binding. The results indicate that the effects of binding minimum wages for workers aged 16-24 are significantly larger than the estimates obtained from single-equation methods that do not differentiate the effects of a minimum wage increase based on the level of the minimum wage relative to the equilibrium wage.

Currie and Fallick (1993) use the National Longtitudinal Survey of Youth (NLSY) to study the 1980 and 1981 increases in the federal minimum. They define workers as bound by the minimum wage if their wage in a base year is less than the minimum wage in the following year, but

13 This is not required. Even teenagers who would have earned less than the new minimum prior to the wage increase (but more than the old minimum) may now be able to earn the new minimum, as the increase in demand for their labor may raise their equilibrium wage to the new minimum wage (or higher).

no less than the minimum wage in the base year. They then define the "wage gap" as the difference between workers' base-year wages and the new minimum, setting it to zero for those not bound by the minimum. Currie and Fallick find that the wage gap is significantly negatively related to employment, and that, at the mean wage gap, being bound by the minimum wage reduces the probability of employment by .03-.04. The research described in the present paper differs in two important ways. First, owing to the limited age cohorts and early starting year of the NLSY, Currie and Fallick were restricted to looking only at the effects of the 1980 and 1981 federal minimum wage increases on teen employment. In contrast, the matched CPSs make it possible to study the effects of state and federal minimum wage increases through 1992. Second, it looks at effects on employment and enrollment, and on the transitions between these activities. This is of particular interest in light of findings in state-level data that minimum wage increases appear to result in enrollment declines and increases in the proportion of teenagers both out of school and out of work.

The studies reviewed above estimate the effects of minimum wages on low-wage workers via refinements of regressions of employment rates on minimum wages. In contrast, Meyer and Wise (1983) estimate the disemployment effect by parameterizing the market wage distribution, taking account of the possibility that minimum wages may either bump up the market wage of those below the minimum or cause them to be non-employed. This procedure enables them to estimate the proportion that would be working in the absence of the minimum. Simulations based on their estimates imply that minimum wage effects on employment of teenagers are somewhat larger in absolute value than the -.1 to -.2 elasticities associated with time-series studies (see, e.g., Brown, et al., 1983). The Meyer and Wise results emphasize, however, that disemployment effects among the lowest-wage workers may be quite severe.

Schooling Effects

A smaller body of research has addressed the relationship between minimum wages, school enrollment, and employment. Neumark and Wascher (1995c) describe results from state-level data indicating that minimum wages decrease enrollments of teenagers and increase the proportion of teenagers neither enrolled nor employed. The substitution and queuing explanations are observationally equivalent in the state-level data, but Neumark and Wascher argue that the substitution hypothesis is more consistent with other previous research.[14]

In contrast to these results, Mattila (1978), using time-series data, finds that enrollment rates of teenagers are positively associated with minimum wages. He also finds that the employment rate of enrolled teenagers is not significantly related to minimum wages, but that the employment rate of non-enrolled teenagers is negatively associated with minimum wages. He interprets these results as suggesting that non-enrolled teenagers experience relatively large disemployment effects from minimum wages. This result is consistent with the interpretation that a higher minimum wage leads to some displacement of lower-quality workers. In contrast to the findings in Neumark and Wascher (1995c), however, Mattila's results suggest that these workers tend to go back to school when this displacement occurs.

Ehrenberg and Marcus (1980 and 1982) take a somewhat different approach to this question. They conclude from other research that minimum wage increases eliminate part-time, low-wage

14 Evans and Turner (1995), in a comment on these state-level findings, have suggested that these resultsare partly attributable to the definition of enrollment Neumark and Wascher use. However,their tables indicate that they obtain different results not from defining enrollment differently, but from combining CPS data from different months.

employment opportunities. They hypothesize that minimum wage increases will then reduce enrollment and increase full-time employment of teenagers from poorer families, because these teenagers use part-time employment to finance their education. On the other hand, by eliminating part-time, low-wage jobs, teenagers from higher-income families, who can afford to remain in school without a job, should be more likely to remain in school (and be non-employed). Using cross-section data for white teenagers, grouped by state, from the 1970 Census of Population, they obtain results counter to their expectations. They find that minimum wages are positively associated with employment of teenagers from higher-income families and negatively associated with employment of teenagers from poor families. They interpret this result as consistent with substitution of higher-quality for lower-quality labor. Ehrenberg and Marcus do not find declines in enrollment for those who are apparently disemployed as a result of minimum wage increases, as neither group's enrollment rate appears to be affected by minimum wages. However, these results are largely reversed in individual-level data from the 1966 National Longitudinal Survey of Young Men. In these data, Ehrenberg and Marcus find that minimum wages result in white male teenagers from higher-income families shifting from enrolled/employed to enrolled/non-employed, and white male teenagers from poor families shifting from enrolled/employed to non-enrolled/employed. For nonwhite teenagers from higher-income families in the NLS, there are no effects of minimum wages on employment or enrollment outcomes, while for those from poor families, minimum wages appear to induce a switch from enrolled/non-employed to non-enrolled/employed, hence reducing enrollment rates and increasing employment rates.

Cunningham (1981) builds on this research by analyzing state-level panel data using the 1960 and 1970 U.S. Censuses. Cunningham also provides a useful additional theoretical perspective on employment and enrollment transitions. Positing that the same worker is more productive in full-time than in part-time work, he argues that minimum wage increases will increase the demand for full-time workers and reduce the demand for part-time workers. This may help to explain some of the declines in enrollment that have been noted, particularly among those who are originally enrolled and employed (presumably part-time), and switch to non-enrolled and employed (presumably full-time). The increase in demand for full-time labor may act as a further incentive to leave school, apart from the increase in demand for higher-quality labor. Cunningham finds that minimum wages reduce covered sector employment of white teenagers. For males, the reduction in covered sector employment is largely matched by an increase in uncovered sector employment. For females, there are increases in both uncovered sector employment and non-employment. He also finds that minimum wages reduce part-time employment and increase full-time employment of white teenagers of both sexes, with the reduction in part-time employment outweighing the increase in full-time employment. Finally, minimum wages reduce school enrollment of white male and female teenagers.[15]

The research in Neumark and Wascher (1995c) is most closely related to Cunningham's paper, in that both papers use panel data on states. In that sense, both papers probably provide more reliable estimates of minimum wage effects on employment and enrollment than do the other studies. However, none of these papers permits the observation of actual individual-level transitions among alternative employment and enrollment activities in response to minimum wage increases, as does the research described in this paper.

15 Similarly, Card (1992b) finds that enrollments declined with the 1988 minimum wage increase in California, relative to other labor markets that did not experience a minimum wage increase.

Appendix B: The Data Set

The data are taken from the May Current Population Surveys for the period 1979 through 1992. As is well known, the sample design of the CPS permits a match of some individuals for the same months across two consecutive years (Welch, 1993). This match was performed for all rotation groups (1, 2, 3, and 4 matched with 5, 6, 7, and 8 respectively), using the household number, line number, age, sex, and race to identify individuals within the household. The sample is limited to individuals who were between 16 and 19 years old in the first year of the matched records. The resulting data set contains 36,021 matched records, with observations in each state for the periods 1979-1980 through 1991-1992.[16] The records include employment and enrollment status, with the former taken from the employment status recode, and the latter from the major activity in the survey week. The matched records were then merged with state-year data on minimum wage levels and state economic characteristics. A list of the variables used in the paper, along with a brief description of each, is given in Table B.1.

Table B.1
Variable Definitions

Variable	Definition/construction	Source
1. SNE: in school, not employed	Employment status from employment status recode, school enrollment from major activity survey week	CPS
2. SE: in school, employed	"	CPS
3. NSE: Not in School, Employed	"	CPS
4. NSNE: Not in School, Not Employed	"	CPS
5. Relative Minimum Wage	Higher of state or federal minimum wage level as of May 1 of each year, divided by average wage in the state	State labor departments, BNA Compensation Primer, Daily Labor Reports, CPS
6. Coverage-Adjusted Relative Minimum Wage	Relative minimum wage multiplied by percentage of workers in state covered by FLSA	Department of Labor
7. Prime-age male unemployment rate	Unemployment rate for men aged 25-64	CPS
8. Age dummy variables	Dummy variables for single-year age categories, ages 16-19	CPS
9. Sex dummy variable	Dummy variable for individual's sex	CPS
10. Race dummy variables	Dummy variables for black, Hispanic, and non-black/non-Hispanic	CPS

The minimum wage variable used is the higher of the state or federal minimum wage level, divided by the mean wage in the state. Although it is common in the literature to multiply this minimum wage variable by the coverage rate, reliable estimates of coverage of teenagers by state and federal minimum wage laws are problematic (see Neumark and Wascher, 1992). Thus, while some results are presented using the coverage-adjusted variable, results using the minimum wage variable without this additional adjustment are highlighted. Finally, given evidence from the U.S. and Canada that minimum wage effects occur with a lag (Baker, et al., 1994;

16 1985-1986 is excluded because the household identifier changed from 1985 to 1986, making it impossible to match records across these years.

Mincer, 1976; Neumark and Wascher, 1992), most specifications substitute the lagged for the contemporaneous minimum wage variable.

One reservation regarding the data is that not all individuals are successfully matched across the CPS surveys. About 65 percent of the eligible teenagers in each year could be matched to a record in the following year, with the match rate slightly higher for the younger ages (Welch, 1993). This raises the possibility of sample selection biases, if unobservable characteristics associated with both successful matches and particular school/work outcomes are correlated with the independent variables. Such correlations cannot be assumed away, because the probability of match is related to employment and labor force status (Flaim and Hogue, 1985), and these, in turn, may be influenced by minimum wages.

To consider the influence of sample selection biases that arise from the inability to match all individuals in consecutive years of the CPS, a parallel sample of non-matched individuals in each year was constructed, being careful to keep the characteristics of the sample the same as in the matched data set. The top panel of Table B.2 provides descriptive statistics for the matched and unmatched samples. The matched individuals are more likely to be in school (SNE or SE), and less likely to be NSE or NSNE. In addition, of those who are out of school, individuals in the matched sample are relatively more likely to be working (NSE) than not (NSNE).

Table B.2

Desriptive Statistics and Model Estimates for Matched and Unmatched Samples

A. Sample Means

	Matched (1)	Non-Matched (2)
SNE	.43	.36
SE	.22	.15
NSE	.25	.33
NSNE	.10	.17

B. Effects of a 21% Increase in Minimum Wage (Absolute/Percent)

	Matched		Non-Matched	
SNE	.010	(2.3%)	-.023	(-6.4%)*
SE	-.027	(-12.3%)**	-.014	(-9.3%)**
NSE	.005	(2.0%)	.020	(6.1%)*
NSNE	.012	(12.0%)**	.019	(10.0%)**

SNE: In School/Not Employed
SE: In School/Employed
NSE: Not in School/Employed
NSNE: Not in School/Not Employed

Note: The data include year 1 and year 2 observations on matched individuals, and all observations on non-matched individuals. The multinomial logit specification i sthe same as in column (2) of Table 2. Differences significant at the 10% level are indicated with a *, and those significant at the 5% level are indicated with a **.

Estimates of the multinomial logit model for the alternative school/work activities — discussed in Appendix C — can also be compared, using the matched and non-matched samples. Because the model with lagged activities cannot be estimated for the non-matched sample, we make this comparison using the specification in column (2) of Table 2, and pool the data across both years for the matched sample. The bottom panel reports estimates of the effects of a 21% increase in the minimum wage on the proportion of teenagers in each activity (in absolute and percentage terms). The estimated minimum wage effects on the SNE and SE probabilities differ across the two samples. Overall, the sum of the two effects, which is the overall effect on the probability of being in school, is larger for the non-matched sample. The estimated absolute effects for the NSE and NSNE activities are also larger for the non-matched sample. Thus, these results suggest that the estimated minimum wage effects from the matched sample tend to be biased towards zero, relative to the population parameters. This attentuation may occur because individuals who change school/work activities are more likely to change addresses, and therefore less likely to be matched. These findings suggest that the estimated minimum wage effects for the matched sample probably understate the true effects, strengthening the evidence for the effects that are found in the matched data.

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Appendix C: The Econometric Framework and Estimation

A teenager's choice among the competing school/work activities is assumed to arise from utility maximization, and to depend on state-level variables (X), individual-level variables (Z_k), state (S) and year dummy variables (Y), the lagged school/work activity (J), and a person-specific random component (ε_k). The utility from each activity (indexed by j) for individual k in state i and period t is

$$(1) U_{kjit} = X_{it}\beta_j + Z_{kit}\gamma_j + J_{kit-1}\pi_j + S_i\delta_j + Y_\tau\theta_j + \varepsilon_{ki} \ .$$

Assuming that ε_k has an extreme-value distribution, this leads to a multinomial logit model.

The results for equation (1) are typically reported after transforming the estimates into derivatives of the probability of each activity with respect to the minimum wage variable, after which the effect on the proportion in each school/work activity of a minimum wage change of any particular magnitude can be calculated. Expressing equation (1) in general form as

$$(2) U_{kj} = W\alpha_j + \varepsilon_k \ ,$$

with a normalized to zero for one of the activities, the derivative of the probability of activity j with respect to the mth element of W is calculated as

$$(3) \partial P_j/\partial W_m = P_j\{\alpha_{mj} - \Sigma_j(P_j\alpha_{mj})\} \ ,$$

where P_j is the probability of activity j, defined as

$$(4) P_j = \exp(W\alpha_j)/\{1 + \Sigma_j \exp(W\alpha_j)\} \ .$$

Standard errors for these derivatives are calculated based on a first-order Taylor series approximation of equation (3) around the true values of the α's (see, e.g., Greene, 1993). It is normally sufficient to evaluate the derivatives and standard errors at the sample means (treating these means as fixed). However, because this paper focuses on minimum wage effects on transitions among school/work activities, it is sometimes more useful to evaluate these derivatives conditional on the initial activity. This is done by setting the dummy variable (i.e., the element of J) corresponding to the initial activity to one, and the others to zero, in equation (4). As the equation shows, in such calculations the effect of the minimum wage on the probability of any particular transition is influenced by the level of the minimum wage variable.

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Appendix D: Additional Evidence on Queuing

There is some evidence in Table 3 of both a queuing response and a substitution response to minimum wages. One possible interpretation of queuing is that in response to a minimum wage increase, teenagers leave school, and possibly even leave the in-school, employed activity, to queue for (presumably full-time) jobs. An alternative explanation is that some individuals leave school in any event, but those in states where minimum wages have risen find it harder to obtain a job, and are therefore more likely to be observed in the NSNE category. However, this cannot be the whole story, since this interpretation cannot explain why enrollment rates decline in response to minimum wage increases. There is no way to assess, using the CPS data, whether minimum wage increases actually changed individuals' schooling plans. However, some light can be shed on these alternative interpretations by examining whether the in-school (SNE or SE) to NSNE transition is more likely to occur among those with less than 12 years of schooling in year 1, than among those with 12 or more years of schooling. It seems plausible that those who make this transition prior to completing high school are more likely to have dropped out of school in response to minimum wage increases.

Table D.1

Transitions Out of School by Schooling Level

A. Transitions to NSNE (Proportions of Those in Same Year 1 Activity)

Year 1 Schooling	Year 1	No Increase in Minimum SNE	No Increase in Minimum SE	Increase in Minimum ≥$.10 SNE	Increase in Minimum ≥$.10 SE	Difference (Increase-No Increase) SNE	Difference (Increase-No Increase) SE
<12		.36	.16	.38	.23	.02	.07 **
=12		.50	.68	.46	.64	-.04 *	-.04
>12		.15	.16	.16	.13	.02	-.03

B. Transitions to NSE or NSNE (Proportions of Those in Same Year 1 Activity)

Year 1 Schooling	Year 1	SNE or SE	SNE or SE	SNE or SE
<12		.31	.34	-.03 **
=12		.52	.50	-.02 *
>12		.17	.16	-.01 *

SNE: In School/Not Employed
SE: In School/Employed
NSE: Not in School/Employed
NSNE: Not in School/Not Employed

Note: In this table, observations with minimum wage increases less than $.10 were discarded. Many of the small increases came from Washington, D.C., for which the minimum wage is an employment-weighted average of minimum wages for different occupations. Differences significant at the 10% level are indicated with a *, and those significant at the 5% level are indicated with a **.

Panel A of Table D.1 shows the distribution by years of schooling in year 1 for those making the transition from either SNE or SE to NSNE. The first two columns show these distributions for states/years with no minimum wage increase, while the second two columns show these distributions for states/years in which minimum wages increased; the final two columns show the differences. The results indicate that in states/years in which minimum wages increased, a larger proportion of individuals leaving school and becoming NSNE had less than 12 years of schooling. The difference is positive both for those originally SNE and those originally SE, although significant only for the latter. These results suggest that the higher flow from SNE or SE to

NSNE in the wake of minimum wage increases may stem from individuals dropping out of high school. But they do not demonstrate this conclusively. We may also be observing that high-school dropouts have a relatively harder time finding jobs after minimum wage increases, with the decision to drop out not influenced by minimum wages.

As additional evidence, Panel B of the table focuses on individuals leaving school regardless of their year 2 activity (i.e., moving from SNE or SE to NSE or NSNE). In states/years with minimum wage increases, the proportion of those leaving school with less than 12 years of education is significantly higher than in states/years without minimum wage increases (.34 vs. .31), and the proportions with 12 or more years of schooling are correspondingly lower. This provides more direct evidence that individuals are actually leaving school to queue for minimum wage jobs, because, unlike in Panel A, the differences cannot be attributed to a differential distribution of those with more or less schooling among the NSE and NSNE activities (in year 2).

But even the evidence in Table D.1 is not conclusive. It does give some credence to the queuing hypothesis, since those making the transition from school to NSNE are weighted slightly toward those with less than 12 years of schooling. At the same time, however, individuals with more than 12 years of schooling also appear to move from school to NSNE in response to minimum wage increases. Of course, these individuals could also be reducing their schooling relative to the amount they would have gotten in the absence of a minimum wage increase. Ultimately, in the absence of data on schooling plans and realizations, it is difficult to determine decisively whether individuals leaving school to become NSNE are literally leaving school to queue for minimum wage jobs, or instead entering the labor market according to plans, and finding it more difficult to obtain employment.

Appendix E: Robustness of the Results to Changes in the Definition of Enrollment and the Sample Period

Recently, some of the state-level results reported in Neumark and Wascher (1992, 1994b, 1995c) have been criticized for using an enrollment rate based on major activity in the survey week (Evans and Turner, 1995). Evans and Turner recompute some state-level results using enrollment rates defined from the October CPSs, which have contained an independent enrollment measure (i.e., one that does not come from the major activity question) since 1978. They claim that many of the state-level results weaken considerably once this alternative enrollment measure is used. It is, however, far from ideal to use — as Evans and Turner do — enrollment and employment measures from October coupled with minimum wage measures from May. In fact, the evidence that they report suggests that many of the differences between their results and those of Neumark and Wascher can be attributed to precisely this problem.

To examine the robustness of the individual-level results described in this paper to the definition of the enrollment rate — without combining data from October and May — Neumark and Wascher (1995a) use May CPSs from 1984 on, when an independent enrollment question was added. The estimated minimum wage effects are somewhat different. In particular, the effects on transitions to NSNE are smaller and no longer statistically significant. However, this is true *regardless* of whether enrollment is defined from the major activity question, or from the independent enrollment question. Thus, it is only because the sample period is considerably shorter that the effects weaken.

While this implies that the alternative definitions of enrollment have no bearing on the results described in this paper, it is nonetheless useful information, because it suggests that the results are not entirely robust to different sample periods. On the other hand, relative minimum wages were relatively lower in this later period, which may explain the smaller effects.[17]

To examine this question, using the original enrollment measure, similar effects to those in Panel C of Table 4 were estimated, to focus on those teenagers whose wages were sufficiently low that minimum wage increases may have led to their displacement from the labor market. These estimates were similar to those in Panel C of Table 4, although in large part because of the smaller sample size, the estimates were no longer statistically significant. In particular, the estimated minimum wage effects on transitions from NSE to NSNE were much larger for those whose wages were originally below the new minimum wage, and the estimated effects for those originally at or above the new minimum were very close to zero.

These results indicate that our findings are in fact not robust to shorten the sample period. This is reinforced by estimates?? of the earlier subperiod. For this subperiod, the estimated minimum wage effect on the NSB to NSNB transition is large and significant for those originally below the new minimum wage. The larger percentage of teenagers below the year 2 minimum in the 1980-84 period (42 percent, vs. 24 percent in the 1985-1992 period) may imply that minimum wage increases necessitated larger wage increases for teenagers in this period, and that the employers were less able to substitute away from teenagers initially below the minimum. Both of these may help explain the differences in the results for different subperiods. Alternatively,

17 The mean of the relative minimum wage variable was .46 in 1980-84, and .38 in 1985-92.

there may be differences because most of the minimum wage increases in the earlier period were federal increases, whereas a larger proportion of the increases in the later period stemmed from state minimum wage increases. Resolving these questions requires further research. At this point, we base on our conclusions on the more precise full sample period, but not with respect to the definitions of enrollment.

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