# THE IMPACT OF COMMUNITY COLLEGE RETRAINING ON OLDER DISPLACED WORKERS: SHOULD WE TEACH OLD DOGS NEW TRICKS?

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The authors estimate the returns to retraining for older displaced workers—those 35 or older—by estimating the impact of community college schooling on earnings. The analysis relies on longitudinal administrative records covering workers displaced from jobs in Washington State during the early 1990s. The authors find that older displaced workers participated in community college schooling at lower rates than younger workers. Among those who participated, however, the impact on quarterly earnings was similar across the two age groups. One academic year of community college schooling is estimated to have increased long-term earnings by about 7% for older men and by about 10% for older women. Although these percentages are consistent with those reported in the schooling literature, estimates of the social internal rates of return from this retraining may differ substantially among older and younger workers because of differences in their work lives and their opportunity costs of retraining.

During the past decade there has been rising interest in policies that foster human capital investment in young children.[1] Proponents of these policies point to evidence that such investments produce impressive returns, even though much of the social benefit is not apparent until adolescence or young adulthood. Even as this evidence has been accumulating, policymakers have directed more of their work force development expenditures toward

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The data for this project and permissions to use it must be obtained from authorities in the State of Washington. The authors will make available on request the computer programs used to merge the three administrative data bases and generate the results. Contact the second author at 1155 East 60th Street, Room 145, The University of Chicago, Chicago, IL 60637.

[1]These studies include Heckman (2000), Carneiro and Heckman (2003), Barnett (1995), Currie (2001), Currie, Garces, and Thomas (2002), Karoly et al. (1998, 2002), and Olds (1997).

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older, more established workers.[2] Not only are prime-age workers increasingly being served by formal government-sponsored employment and training programs, but large numbers of them also have been seeking retraining on their own in the nation's two-year community colleges (Kane and Rouse 1999).

Despite increased public subsidies for retraining older workers, there is currently little evidence on the returns to these investments (see, for example, Leigh 1990; Corson et al. 1993). This paper provides evidence on the returns from retraining for older workers by estimating the impact of community college schooling on the earnings of displaced workers who sought retraining around the time of their job losses.[3] We define older workers as those who are 35 and older, and we compare their outcomes to the outcomes for younger displaced workers.

Our analysis relies on an administrative longitudinal data base from Washington State consisting of 14 years of quarterly earnings records matched to the records of 25 community colleges. The resulting sample contains over 65,000 workers who lost jobs during the first half of the 1990s, filed a valid claim for unemployment insurance, and remained consistently attached to Washington State's work force throughout the 14-year period studied. Fifteen percent of these workers enrolled in and completed community college courses around the time of their job loss. About one-half of these trainees were 35 or older.

In this paper we focus on four questions. First, how do the effects of community college schooling differ between older and younger workers, and are these effects consistent with the returns to schooling literature? Second, do these effects vary depending on the type of courses completed by older and younger workers? Third, how confident can we be in our non-experimental estimates? And finally, what do our estimated effects imply about the social net benefits and internal rates of return (IRR) of investments in displaced workers' retraining?

## 1. A Model of Community College Participation

Displaced workers may enroll in retraining for several reasons. First, they may enroll to enhance their skills. In this case their decisions depend on schooling's impact on future earnings, their rate of time preference, their remaining work lives, and the direct and indirect costs of going to school. Alternatively, individuals may enroll in school to facilitate their job search or to signal their motivation and skills to prospective employers (Heckman, LaLonde, and Smith 1999). Finally, some schooling may constitute consumption that during a period of prolonged unemployment may be acquired at especially low cost.

The human capital framework implies that if the distribution of per-period effects is the same for younger and older displaced workers, and the cost of participating in retraining is comparable or higher for older persons, then because they have shorter remaining work lives, older displaced workers should be less likely to seek training following the loss of a job. However, among those who do enroll, the per-period impact of training is likely to be larger for the older trainees in order to offset the effects of shorter remaining work lives and possibly higher training costs. This is all the more true if older workers do not learn as effectively as younger workers. Differences in the distributions of training effects for older and younger displaced workers should

[2] An appreciable portion of public expenditures on classroom training in these programs subsidizes classroom training in community colleges (LaLonde 2003). Over time, community colleges have shifted their emphasis away from academic courses toward providing vocational education to their students (Freeman 1974; Grubb 1993; Kane and Rouse 1999).

[3] This paper studies the returns to community college schooling for students who are on average 43 years old. They are much older than community college students studied elsewhere. See Grubb (1993a,b); Kane and Rouse (1995, 1999); Leigh and Gill (1997).

manifest themselves in differences in participation rates in retraining rather than differences in the mean impact among the trained (Heckman and Honoré 1990).

## 2. Administrative Earnings and Community College Data

### The Benefits of Administrative Data in Studies of Retraining

Orley Ashenfelter's study of the 1964 MDTA cohort began a long tradition of using longitudinal administrative data to evaluate employment and training programs (Ashenfelter 1975, 1978; Ashenfelter and Card 1985; Heckman, LaLonde, and Smith 1999). Ashenfelter observed that such data addressed three key problems that arose when estimating the effect of training and informing public policy discussions of the merits of these programs (Ashenfelter 1978). First, training effects tend to be small, because public investments are usually relatively small on a per-person basis. Second, it is difficult to measure these effects precisely, because of the high population variance of earnings. Third, the benefits of successful training programs should accumulate over a long period of time. Administrative data provide evaluators with a relatively inexpensive way to address these problems, because they make it possible to follow very large samples of trainees and non-trainees for relatively long periods.

### The Washington State Administrative Data

To evaluate retraining for displaced workers, we merge three large administrative data sets: unemployment insurance claims records from 1990 to 1994; quarterly wage records covering 1987 to 2000; and community college transcript records covering 1989 to 1996. More details about these data are described in the appendix.

In our analysis we limited our merged sample in two important ways. First, we studied UI claimants who had three or more years of job tenure when they were permanently laid off. We excluded "low-tenure" displaced workers because public policy has been most concerned about the long-term consequences of job loss for experienced workers (Jacobson, LaLonde, and Sullivan 1994b). Second, we studied only workers who had a history of continuous attachment to Washington State's work force.[4] We defined such attached workers as those who between 1987 and 2000 never experienced more than eight consecutive quarters in which they neither had earnings nor were enrolled in community college courses. We restrict our attention to continuously attached workers because many UI claimants, including those enrolling in community college courses, had few quarters of UI-covered earnings after they lost their jobs (Jacobson, LaLonde, and Sullivan 2000).

Our resulting sample contains more than 65,000 displaced workers. Approximately 15% of them enrolled in and completed at least one community college course around the time of their job loss. About 50% of these enrollees were 35 or older. This group constitutes our sample of older trainees. Our comparison group consists of both older and younger displaced workers who lost jobs during the same period, but never completed and community college courses for credit.

### Characteristics of the Trainees and Comparison Group Members

Panel A of Table 1 reveals that displaced workers who were retrained differed in sev-

[4]See the appendix for discussion of how we limited our samples to individuals who remained attached to the state's work force. These data differ from those used in an earlier paper (Jacobson, LaLonde, and Sullivan 2005). For this paper, we have obtained an additional five years of quarterly earnings histories. Because we study only individuals who remain attached to the state's wage and salary work force throughout the sample period, the longer sampling frame implies that here we study a smaller number of displaced workers.

*Table 1.* Characteristics of and Community College Participation by Displaced Workers in Washington State.

**A. Characteristics of Younger and Older Workers in Our Sample of Washington State Displaced Workers**

| | *Men* | | | | *Women* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Under 35* | | *35 and Over* | | *Under 35* | | *35 and Over* | |
| *Characteristic* | $T^a$ *(1)* | $C^b$ *(2)* | $T^a$ *(3)* | $C^b$ *(4)* | $T^a$ *(5)* | $C^b$ *(6)* | $T^a$ *(7)* | $C^b$ *(8)* |
| Age at Job Loss | 28.70 | 29.63 | 43.06 | 43.97 | 28.92 | 28.82 | 43.62 | 44.45 |
| | (3.62) | (3.45) | (5.92) | (6.28) | (3.70) | (3.44) | (5.76) | (6.15) |
| Minority | .12 | .17 | .10 | .13 | .11 | .17 | .09 | .14 |
| Greater Than 6 Years' Prior Tenure | .12 | .13 | .25 | .23 | .16 | .15 | .28 | .27 |
| Less Than a H.S. Degree | .09 | .18 | .06 | .12 | .06 | .12 | .04 | .12 |
| More Than a H.S. Degree | .43 | .28 | .55 | .43 | .49 | .38 | .53 | .41 |
| Aerospace | .19 | .11 | .18 | .10 | .13 | .09 | .11 | .07 |
| Wood Products | .09 | .08 | .16 | .07 | .02 | .02 | .04 | .02 |
| Other Manufacturing | .24 | .24 | .34 | .23 | .14 | .14 | .15 | .15 |
| Seattle-Tacoma MSA | .55 | .55 | .51 | .57 | .59 | .60 | .53 | .58 |
| Other Counties with MSA's | .13 | .12 | .13 | .11 | .12 | .11 | .13 | .12 |
| Rural Counties | .32 | .33 | .37 | .31 | .29 | .29 | .33 | .30 |
| *Labor Market Conditions at Job Loss:* | | | | | | | | |
| County Unemployment Rate (%) | 7.04 | 7.20 | 7.31 | 7.06 | 6.94 | 7.00 | 7.09 | 7.04 |
| County Employment Growth (%) | 1.50 | 1.54 | 1.13 | 1.47 | 1.44 | 1.45 | 1.45 | 1.48 |
| Job Growth in 2-Digit Industry (%) | 0.41 | 1.08 | –0.12 | 1.17 | 1.31 | 1.72 | 1.51 | 2.02 |
| *Mean Earnings Prior to Job Loss:* | | | | | | | | |
| 1–4 Quarters before (in 000s) | $26.5 | $25.7 | $34.5 | $33.3 | $21.1 | $20.5 | $24.5 | $23.4 |
| | (11.6) | (12.1) | (15.3) | (17.6) | (9.7) | (10.0) | (11.8) | (13.2) |
| 5–8 Quarters before (in 000s) | $26.7 | $26.2 | $35.8 | $34.5 | $21.1 | $20.6 | $24.7 | $23.5 |
| | (11.7) | (12.4) | (14.8) | (17.5) | (9.2) | (10.2) | (11.4) | (12.6) |
| Number of Observations | 2,936 | 14,560 | 2,371 | 19,342 | 2,291 | 7,462 | 2,809 | 13,552 |

*Continued*

eral ways from comparison group members. Among both older and younger displaced workers, community college participants were better educated, more likely to be white, and more likely to be displaced from the aerospace industry. Among the older men we see that community college participants also were more likely to be displaced from the state's wood products industries. Despite these differences, however, we still find that the average predisplacement earnings of both the older and younger trainees were similar to the earnings of their counterparts in the comparison group.

Our measure of labor market conditions in displaced workers' prior (2-digit SIC) industry also is different for trainees and comparisons. Those who got training tended to be displaced from industries that had had slower employment growth. This difference suggests that the trainees may have been more likely to change industries as a result of their job losses and as a result expected larger earnings losses from displacement (Jacobson, LaLonde, and Sullivan 1993a; Neal 1995). We explicitly account for this possibility in our empirical work below. By contrast, our two measures of labor market conditions in workers' counties, the county unemployment rate and rate of employment growth, do not reveal any differences between trainees and comparison group members.

*Table 1.* Continued

**B. Participation Rates and Community College Credits Completed by Displaced Workers (credits accumulated in Washington State community colleges by workers displaced between fall 1989 and 1995)**

| | | | | *Number of Completed Community College Credits (Fraction)* | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *All Credits:* | *Rate*[c] | *Mean*[d] | *Std. Dev.*[e] | *1–5* | *6–10* | *11–20* | *21–40* | *41–75* | *75+* |
| Men under 35 | .168 | 29.5 | 33.3 | .27 | .16 | .16 | .15 | .13 | .13 |
| Men 35 and over | .109 | 27.4 | 34.0 | .33 | .16 | .16 | .12 | .11 | .12 |
| Women under 35 | .235 | 27.3 | 32.3 | .32 | .17 | .15 | .14 | .12 | .12 |
| Women 35 and over | .172 | 23.5 | 30.8 | .39 | .16 | .14 | .11 | .10 | .10 |

| | | | *Number of Completed Community College Credits* | | | |
|---|---|---|---|---|---|---|
| *By Group* | *Mean*[d] | *Std. Dev.*[e] | *0* | *1–5* | *6–20* | *21+* |
| *Group 1 Credits:* | | | | | | |
| Men under 35 | 15.2 | 24.3 | .34 | .21 | .23 | .22 |
| Men 35 and over | 15.3 | 24.9 | .29 | .28 | .21 | .21 |
| Women under 35 | 8.8 | 16.8 | .46 | .24 | .18 | .12 |
| Women 35 and over | 8.4 | 16.0 | .41 | .29 | .19 | .11 |
| *Group 2 Credits:* | | | | | | |
| Men under 35 | 14.3 | 20.9 | .29 | .23 | .26 | .22 |
| Men 35 and over | 12.2 | 19.8 | .33 | .24 | .26 | .18 |
| Women under 35 | 18.5 | 23.5 | .15 | .27 | .30 | .28 |
| Women 35 and over | 15.1 | 22.4 | .21 | .31 | .27 | .21 |

[a]T denotes the trainee groups. We define displaced workers as trainees or community college participants if they complete at least one credit.

[b]C denotes the comparison groups. The comparison group consists of displaced workers who either never enrolled in community college or who enrolled but dropped out before completing one course. The numbers in parentheses are the standard deviations.

[c]"Rate" is the participation rate in community college schooling around the time of workers' job losses. This fraction is the ratio of displaced workers who complete at least one credit to all displaced workers in the indicated demographic group.

[d]"Mean" is the mean number of credits completed among those who completed at least one community college credit.

[e]"Std. Dev." denotes the sample standard deviation.

See the appendix for definitions of Group 1 and Group 2 courses.

## Differences between Older and Younger Displaced Workers' Characteristics

The characteristics of older displaced workers suggest that they were more skilled than their younger counterparts, and thus may have had differing incentives to invest in new skills. By construction, the older displaced workers had more labor market experience. In our sample, however, they also were better educated and had accumulated more tenure with their prior employers than younger displaced workers had. This evidence on skill is consistent with the differences between older and younger displaced workers' pre-displacement earnings. The higher skill levels of the older displaced workers suggest that they may have been more effective learners than our sample of younger displaced workers.

## Participation Patterns in Community College

As expected from the framework discussed in Section 1, older displaced workers participated in retraining at lower rates

than did their younger counterparts.[5] As shown by Panel B of Table 1, about 11% of older male workers enrolled in community college and completed at least one community college course around the time of their job loss, compared with nearly 17% of younger male workers. The gap between the participation rates of older and younger women is similar, although both groups participated in retraining at higher rates than the men. Furthermore, in work reported elsewhere we find that the number of community college credits completed by male and female displaced workers declines nearly monotonically with age even after we account for the demographic characteristics reported in Table 1 (Jacobson, LaLonde, and Sullivan 2004).

Despite marked differences in retraining participation rates between older and younger displaced workers, older and younger training participants completed similar amounts of schooling. As shown in Panel B, older male trainees completed about 27 credits. Under the Washington State quarter system each class is worth five credits and one academic year consists of 45 credits. Therefore, on average, older male trainees completed a little less than 2/3 of an academic year of schooling. Younger male trainees completed only 8% more schooling, and older female trainees completed about 17% less schooling than older male trainees. If community college schooling has the same impact as is reported in the voluminous literature on the returns to schooling, these participation patterns suggest that trainees' earnings should rise by about 5–7% (Card 1999; Heckman, Lochner, and Todd 2003).

Our administrative data also reveal the content of displaced workers' course work. These data indicate not only that older and younger trainees were completing the same amount of training, but also that the content of this training was broadly similar across the two groups. As shown by Panel B, somewhat more than half of the credits completed by both older and younger men were in academic and vocational courses teaching more quantitatively oriented material or in courses in health occupations or the trades. We refer to these classes as Group 1 courses. All other community college courses we refer to as Group 2 courses. Among women the pattern of completed courses was different, with only about one-third of the completed credits being in classes teaching Group 1 subject matter. This pattern is identical for older and younger female participants.

### 3. Econometric Model

To estimate the effects of community college schooling on the quarterly earnings of displaced workers, we use an econometric model developed in another paper (Jacobson, Sullivan, and LaLonde 2005). In the next section of this paper, we report impact estimates based on a statistical model of the following general form:

$$(1) \qquad y_{it} = \tau_{it}(c_i, f_i, m_i, z_i) + \mathbf{X}_{it}\boldsymbol{\beta} + \delta_{it}(s_i, z_i) + \alpha_i + g_{it} + \gamma_t + \varepsilon_{it}.$$

According to (1), workers' quarterly earnings, $y_{it}$, depend (a) on the community college schooling they obtain, $\tau_{it}(c_i, f_i, m_i, z_i)$, which depends on the number of credits completed, $c_i$, the first and last quarters individuals are enrolled in school, $f_i$ and $m_i$, and personal characteristics, $z_i$;[6] (b) on observed characteristics that vary with time,

[5] This pattern of participation by age is consistent with statistics from the Current Population Survey (U.S. Census 2001).

[6] Some researchers argue that community college training has important payoffs only if participants complete programs or receive degrees (Hollenbeck 1992, 2002). Since most trainees in our sample complete relatively few courses, in order for community college retraining to be beneficial, on average, it must be the case that trainees' earnings improve even if they complete only a few classes. Otherwise the returns to completing a large number of credits must be exceptionally large. Because we find no evidence of such a correspondence, we focus on the relationship between community college credits and earnings (Jacobson, LaLonde, and Sullivan 2004). This approach is similar to that in Kane and Rouse's (1995)

which in this paper are county unemployment rate, county employment growth, age, age squared, and interactions of age and age squared with race and gender;[7] (c) on the temporal pattern of the effects of displacement $\delta_{it}(s_i, z_i)$, which depends on the time elapsed between the current quarter $t$ and the quarter of displacement $s$, on personal characteristics, on region of the state, on county unemployment rates and employment growth at the time of job loss, and on changes in statewide employment in workers' (2-digit) industry during the predisplacement year; (d) on unobserved individual fixed effects and worker-specific time trends;[8] (e) on time effects, which we specify as a vector of quarterly dummy variables for each quarter covered by our data; and (f) on other time-varying unobserved characteristics marked by an independent and identically distributed disturbance.[9]

The effect of community college schooling, $\tau_{it}(c_i, f_i, m_i, z_i)$, includes parameters that measure how schooling affects earnings when individuals are in school and after they leave school. When displaced workers enroll in community college courses, we expect that schooling may cause them to forgo earnings, and that these losses from forgone earnings are proportional to the number of credits completed. We also allow for economies of scale in classes taken. After displaced workers leave school, we allow the impact of retraining to vary with time since leaving school.

To capture the temporal pattern of these effects after workers leave school, we considered several specifications.[10] Some experimentation led us to the following parsimonious specification, which captures the temporal pattern of the impact of community college credits with four parameters:

$$\tau_{it}(c_i, f_i, m_i, z_i) = \tau_0 + \tau_1 c_i + \tau_2 [1/(t-m_i)] + \tau_3[1/(t-m_i)]\, c_i, \text{ if } m_i < t. \quad (2)$$

In (2), the parameters $\tau_0$ and $\tau_2$ measure systematic earnings differences between displaced workers who complete at least one community college credit and their counterparts who either do not enroll or enroll but do not complete any courses. One interpretation of these parameters is that they are the impact of "just showing up" and enrolling in courses. These effects could be important if retraining facilitates productive job search. Because the term $[1/(t-m_i)]$ gets smaller with the passage of time, the long-term "just showing up" impact is given by $\tau_0$. In our empirical work, we show that our results are sensitive to the interpretation given these parameters.

The impact of completing additional community college credits during post-schooling quarter $t$ is given by $\{\tau_1 + \tau_3[1/(t-m_i)]\}c_i$. During the first full quarter after leaving school, the earnings impact of completing additional credits is given by $\tau_1 + \tau_3$. The long-term impact of completing an additional credit is given by $\tau_1$. If the "just showing up" effects are important, the long-term impact of completing $c_i$ Community College credits is given by $\tau_0 + \tau_1 \cdot c_i$.

## 4. The Impact of Community College Schooling on Earnings

In this section, we begin by presenting results based on our parsimonious specifi-

study of the impact of community college courses and in studies examining the returns to different types of high school courses. (See Altonji 1995; Levine and Zimmerman 1995; Betts and Rose 2001.)

[7]The recent program evaluation literature indicates that it is important to compare trainees and comparison group members from the same or similar labor markets (Heckman, Ichimura, Smith, and Todd 1998; Heckman, LaLonde, and Smith 1999; Smith and Todd 2005).

[8]In Jacobson, LaLonde, and Sullivan (2005) we presented impact estimates based on a specification that controlled only for fixed effects. These effects tend to be smaller than ones generated from a specification that also includes worker-specific time trends. The effects from Group 2 courses are affected by controls for these trends, whereas the effects for Group 1 courses are not. This evidence suggests to us that the processes affecting participation differ for Group 1 and Group 2 courses.

[9]We report robust standard errors for all of our estimates.

[10]See Jacobson, LaLonde, and Sullivan (2004) for estimates based on alternative specifications.

*Table 2.* Impact of Community College Schooling on Displaced Workers' Earnings.

| | *Men* | | *Women* | |
|---|---|---|---|---|
| *Model*[a] | *Under 35* *(1)* | *35 and Older* *(2)* | *Under 35* *(3)* | *35 and Older* *(4)* |
| In College[b] | $417.19 | $12.60 | $263.59 | $232.30 |
| | (81.60) | (108.84) | (79.83) | (70.33) |
| In College*Credits/Qtr. | –242.64 | –275.10 | –171.64 | –200.02 |
| | (11.05) | (12.93) | (11.27) | (10.77) |
| Post-College[c] | 109.04 | 148.10 | –76.46 | 72.13 |
| | (100.85) | (126.77) | (88.94) | (82.65) |
| Post-College*1/k[d] | –310.05 | –524.29 | –33.86 | –182.55 |
| | (122.26) | (83.77) | (86.89) | (103.09) |
| Post-College*Credits | 9.09 | 8.94 | 12.13 | 9.56 |
| | (2.23) | (2.63) | (2.36) | (2.23) |
| Post-College*Credits*1/k | –22.92 | –30.98 | –24.97 | –25.60 |
| | (2.80) | (3.28) | (2.03) | (2.61) |

[a]The dependent variable is quarterly earnings. All models are based on (1) and (2) in the text and include demographic, heterogeneous cost of displacement, and labor market controls as well as individual- and period-specific fixed effects and worker-specific time trends. Robust standard errors are in parentheses.

[b]In-College is an indicator variable for whether the current quarter is during the period when the trainee is enrolled in community college courses.

[c]Post-College is an indicator variable for whether the current quarter occurred after the training participant left Community College.

[d]1/k denotes the reciprocal of the number of quarters after the trainee left school. As time since completing the last community college class increases, 1/k becomes small.

cation (2). We then show how estimates differ by type of course. Finally, we discuss the results of specification tests based on the notion of "backcasting."

### Parsimonious Specification

As shown in Table 2, we estimate that for older male workers, completing community college courses is associated with an effect of $148.10 for "just showing up" plus an additional $8.93 per credit completed. Because older male trainees completed an average of 27.3 credits, our estimates imply that they typically increased their quarterly earnings by $393, or about 7% of post-displacement earnings.[11] A full academic year of schooling would imply a gain of about 11% of post-displacement earnings.

Although statistically insignificant, our point estimate of the "just showing up" effect is large, being equivalent to the completion of nearly three courses. This suggests that despite our rich controls for unobserved heterogeneity and the cost of worker displacement, unobserved differences between trainees and comparison group members may bias our estimates.

Ignoring the "just showing up" effect reduces our estimate of the quarterly gain from community college retraining for the typical older male worker to $244 (or $8.93 × 27.3), while the estimated quarterly gain from one academic year of retraining falls to about $400, or 7% of post-displacement earnings. Although smaller without the "just showing up" effect, this estimate of the impact of community college retraining is still in line with conventional esti-

[11]We arrive at this figure by multiplying the per credit impact of $8.93 times 27.4 credits, the average number of credits completed by older male trainees (see Panel B, Table 1), and then adding the "just showing up" effect of $148.01.

mates of the impact of formal schooling on earnings.[12]

The estimated effects of community college schooling for younger men and older women are close to those just discussed for older men. For young women, completing an additional credit is estimated to increase quarterly earnings by a somewhat higher figure of $12.13, or about 14% of post-displacement earnings. However, the difference between this estimate and the $9.56 per credit impact that we report for older women is not statistically significant. Therefore, it is reasonable to conclude that at least among those who participate in retraining, older workers acquire new skills about as effectively as do younger workers.

Table 2 also reports estimates of the impact of retraining on workers' earnings while they are in school. One interpretation of these results is that they measure trainees' opportunity costs of enrolling in and completing courses. The estimated coefficients associated with the "In-College * Credits per Quarter" variables in Table 2 imply that earnings are significantly lower while workers are enrolled, and that this effect increases with the number of courses completed. Consistent with the opportunity-cost interpretation, we find that these effects are largest for older men and smallest for younger women.

### Effects by Type of Course

By extending specification (2) we can also explore whether returns to retraining differ by course type.[13] As shown in Table 3, Group 1 courses are associated with much larger long-term earnings gains than are Group 2 courses. Within both categories of courses, however, schooling effects are again similar for older and younger displaced workers. Completing a Group 1 credit increased the long-term quarterly earnings of both older and younger men by approximately $12. This estimate implies that an older worker who completed one academic year of such schooling experienced about a 10% increase in post-displacement earnings. Among women, especially younger women, the gains were larger. For them, our estimates suggest that one academic year of Group 1 schooling could eliminate much of the earnings losses associated with displacement (Ruhm 1991; Jacobson, LaLonde, and Sullivan 1993a; Farber 1993, 2003).

In contrast, we find that completing Group 2 courses had a much smaller impact on long-term earnings. As shown in Table 3, the long-term effects of Group 2 courses are estimated to have been about $4 to $5 per credit for all groups of displaced workers, or about 3–5% of post-displacement earnings for those who completed one academic year of such schooling.[14] These effects are smaller than those usually reported in the schooling literature.

### Backcasting and Interpreting Evidence of Specification Error

In his seminal evaluation of the Manpower Development and Training Act (MDTA) program, Orley Ashenfelter introduced "backcasting," the specification testing procedure based on examining whether training appears to have effects before it actually occurs (Ashenfelter 1978; LaLonde 1986; Heckman and Hotz 1989; Angrist and Newey 1991; Heckman, LaLonde, and Smith 1999). Although

[12]In the schooling literature, measures of the impact of one year of schooling usually hold potential experience constant. In our analysis we hold age constant. Therefore, we expect our estimates of the impact of one year of community college schooling to be somewhat smaller than they would be if we controlled for potential experience.

[13]See the appendix for discussion of how we classified courses as Group 1 and Group 2 courses.

[14]We also have found that this relation between Group 1 and Group 2 courses holds among displaced workers who tend to take a majority of their courses in Group 1 subjects. Therefore, we do not believe our Group 1 and Group 2 findings resulted from different types of workers concentrating in these different subject areas.

*Table 3.* Impact of Community College Schooling by Type of Credits. (Short- and Long-Run Effects of Group 1 and Group 2 Courses)

| | *Men* | | *Women* | |
|---|---|---|---|---|
| *Model* | *Under 35 (1)* | *35 and Older (2)* | *Under 35 (3)* | *35 and Older (4)* |
| In College | $488.41 | $20.45 | $262.36 | $236.57 |
| | (81.88) | (109.39) | (79.76) | (70.14) |
| In College*Group 1 Credits/Quarter | –209.68 | –256.41 | –165.51 | –198.15 |
| | (13.34) | (15.43) | (20.94) | (19.79) |
| In College*Group 2 Credits/ Quarter | –288.70 | –302.33 | –174.05 | –202.06 |
| | (15.16) | (19.59) | (12.80) | (13.24) |
| Post-College | 107.89 | 151.00 | –56.10 | 77.07 |
| | (101.08) | (126.99) | (88.46) | (82.64) |
| Post-College*1/k | –275.65 | –508.65 | –33.59 | –183.03 |
| | (122.64) | (157.97) | (109.45) | (103.08) |
| Post-College*Group 1 Credits | 12.05 | 12.39 | 23.72 | 18.48 |
| | (3.14) | (3.77) | (6.29) | (5.33) |
| Post-College*Group 1 Credits*1/k | –15.93 | –27.28 | –25.84 | –26.85 |
| | (3.81) | (4.46) | (6.58) | (5.46) |
| Post-College*Group 2 Credits | 5.82 | 4.16 | 5.47 | 4.29 |
| | (3.74) | (4.43) | (2.99) | (3.10) |
| Post-College*Group 2 Credits*1/k | –32.58 | –36.85 | –24.61 | –24.89 |
| | (4.45) | (5.47) | (3.45) | (3.56) |

*Notes:* The dependent variable is quarterly earnings. See notes to Table 2. See the appendix and text for the definition of more quantitatively orientated technical and vocational Group 1 courses and Group 2 courses. Robust standard errors are in parentheses.

backcasting cannot indicate conclusively whether non-experimental estimates replicate those from true randomized trials, Ashenfelter argued that this exercise "may serve as a signal of serious problems with the maintained hypotheses [associated with the underlying econometric model]" (Ashenfelter 1978:51). Because our Washington State sample of displaced workers contains large numbers of both trainees and comparison group members and covers many quarters both before and after training, we can perform similar checks with our data.

Specifically, we examine whether training affected earnings during two particular pre-training periods: the year prior to displacement, and the period after displacement but before entering school. To accomplish this, we further extend (2) by including dummy variables that equal one in the two pre-training periods if the individual subsequently completed community college credits (see the "Pre-College" variables in Table 4). We also include the interactions between these two dummy variables and the number of Group 1 and Group 2 credits the individual subsequently completed. Together, these variables capture the association of community college attendance and credit completion with earnings during the two pre-schooling periods.

As shown in Table 4, participation in community college retraining predicts earnings prior to enrolling in school. Workers who subsequently completed more Group 1 and Group 2 credits tended to have earnings that were above expected levels during the year prior to displacement. This finding suggests that our earlier results might overstate the effects of retraining. In contrast, the results for the period between displacement and training suggest that the bias may be in the opposite direction. These

*Table 4.* Does Community College Participation Predict Earnings Prior to Retraining? (Predicted "Effect" of Community College Participation and Completed Credits on Pre-Enrollment Earnings)

| | *Men* | | *Women* | |
|---|---|---|---|---|
| *Model*[a] | *Under 35* (1) | *35 and Older* (2) | *Under 35* (3) | *35 and Older* (4) |
| **One Year Prior to Displacement:** | | | | |
| Pre-College[b] | $89.59 | –$53.98 | –$56.04 | $39.50 |
| | (43.30) | (59.36) | (39.22) | (39.83) |
| Pre-College*Group 1 Credits | 5.15 | 9.29 | 6.72 | 6.85 |
| | (1.38) | (1.70) | (2.28) | (2.50) |
| Pre-College*Group 2 Credits | 3.27 | 12.68 | 6.34 | 4.01 |
| | (1.60) | (2.01) | (1.21) | (1.39) |
| **Post-Displacement/Prior to Enrollment:** | | | | |
| Pre-College[b] | 3.54 | –470.19 | 44.22 | –223.93 |
| | (142.14) | (176.28) | (108.96) | (107.42) |
| Pre-College*Group 1 Credits | –11.41 | –11.99 | –13.05 | –10.16 |
| | (4.81) | (5.71) | (6.07) | (6.15) |
| Pre-College*Group 2 Credits | –18.28 | –12.89 | –13.01 | –13.71 |
| | (5.54) | (6.02) | (3.71) | (3.91) |

[a]The dependent variable is quarterly earnings. See notes to Table 2. See the appendix for definitions of Group 1 and Group 2 courses. Robust standard errors are in parentheses.

[b]Pre-College is an indicator variable for whether the current period is during the period indicated in the table and the individual subsequently enrolled in community college schooling.

estimates indicate that during the period between displacement and training, workers who subsequently completed many credits had earnings below expected levels. This second set of results suggests that individuals who did worse than expected after losing a job acquired more training. If our displacement costs specification (see the appendix) fails to capture this variation among displaced workers, then our estimates of community college schooling effects are likely too low.

Despite our rich econometric specification, the results reported in Table 4 may signal that our impact estimates are biased. Participation in retraining was especially high among displaced workers whose earnings were above expected levels prior to their job losses and were below expected levels just after their job losses. Therefore, workers who experienced particularly large unexplained drops in earnings between the pre- and post-displacement periods tended to enroll in and complete more community college schooling than other workers did. Whether these drops reflect the phenomenon known as Ashenfelter's dip depends on whether they were permanent or temporary. If they reflect the permanent cost of job loss, then our estimated effects of community college credits are likely too small. If they were temporary, our estimated effects are likely too large.

If we could better control for these earnings drops, we might be able to reduce the magnitude of the estimates reported in Table 4, increasing our confidence in the non-experimental estimates. To explore this possibility, we examined the sensitivity of the backcasting tests to our displacement cost specification. In results reported elsewhere, we find that backcasting results change little as we refine our specification of displacement costs (Jacobson, LaLonde, and Sullivan 2004). Because our displacement effect specification already includes

more than 130 parameters, it seems unlikely that adding further controls would improve the results of our backcasting tests or alter our results on the impact of community college schooling. If biases do remain in our impact estimates, more work is needed to model what must be a complicated selection process.[15]

## 5. Should We Teach Old Dogs New Tricks?

Although older and younger displaced workers experienced similar gains from community college retraining, our results do not necessarily imply that society should subsidize or even encourage the retraining of older displaced workers. To examine this question, we use our impact estimates to compute the private and social net benefits and the IRR of community college schooling. In Panel A of Table 5, we present the net benefit of retraining from the perspective of the participant and of society. We assume that the opportunity cost of retraining is equal to one-half the cost implied by the "In-College" effects. In Panel B, we present alternative IRR calculations from the perspective of society. We examine how sensitive our calculations are to alternative interpretations of the "just showing up" and the "In-College" effects.[16]

As shown by Panel A of Table 5, our calculations indicate that our sample of displaced workers likely experienced substantial net benefits from their investments in community college schooling.[17] But the private net benefits for younger trainees were roughly double those for the older trainees. For both groups of trainees, however, retraining seems likely to have been a sound investment. Nonetheless, the differences between older and younger trainees' net benefits may provide a reason for why we find substantially lower participation rates in retraining among older displaced workers.

The results of our cost-benefit analysis of retraining are less impressive from the perspective of society, but the net benefits are still positive. The difference between private and social computations results because community college schooling is heavily subsidized by taxpayers.[18] Our more conservative calculations, in which we exclude the "just showing up" effect, suggest that society gained only modestly when older displaced workers were retrained. In contrast, the benefit-to-cost ratios are markedly larger for younger displaced workers, especially for younger women.

The IRR figures in Panel B help to underscore the policy importance of correctly interpreting the "just showing up" and the "In-College" effects. If we assume that the opportunity cost of schooling is zero and we include the "just showing up" effect as part of the impact of retraining, we find

[15]Recent findings from research on this problem in other training settings underscore the difficulty of this task. See Heckman, Ichimura, Smith, and Todd (1998); Smith and Todd (2005).

[16]Our "In-College" estimates may not measure the opportunity cost of schooling. Instead, they could reflect individuals' unsuccessful job search. As a result, they simply tell us that those who did not find new jobs right away enrolled in community college courses and the least successful job searchers completed the most classes. Under this interpretation, our "In-College" estimates overstate the opportunity cost of completing retraining, and thus any net benefit or IRR figures based on them are too small.

[17]We have standardized our net benefit calculations for one academic year of schooling. Because the trainees in our sample acquired, on average, a little less than two-thirds of a year of schooling, the average net benefit of retaining for the trainees studied here is approximately one-third less than the figures in Table 5.

[18]Kane and Rouse (1999) reported that the cost of providing a student with one academic year of community college schooling was about $8,000, about one-fifth of which individuals paid through their tuition and fees. Elsewhere we also report net benefits when we assume that the welfare cost of the taxes used to subsidize retraining equals $0.50 for every dollar raised (Browning 1987; and Heckman, LaLonde, and Smith 1999; Heckman, Lochner, and Todd 2003). In this case the net benefit for society from retaining older men falls to –$300 when we exclude the "just showing up" effect, but equals $5,900 when we include it as part of the training effect (Jacobson, Sullivan, and LaLonde 2004).

*Table 5.* The Net Benefit and Internal Rates of Return from Community College Schooling for Displaced Workers.

**A. Cost-Benefit Analysis of Investments in Displaced Workers' Retraining per Participant**

| | *Exclude "Just Showing Up" Effect* | | | | *Include "Just Showing Up" Effect* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Men* | | *Women* | | *Men* | | *Women* | |
| | *Young/Old* | | *Young/Old* | | *Young/Old* | | *Young/Old* | |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* |
| Participant's Net Benefit (in 000s) | $13.1 | $5.2 | $17.7 | $9.1 | $18.2 | $9.9 | $21.9 | $11.6 |
| Participant's Benefit-to-Cost Ratio | 3.07 | 1.69 | 4.52 | 2.61 | 3.88 | 2.30 | 5.40 | 3.05 |
| Social Net Benefit (in 000s) | $13.1 | $2.8 | $18.4 | $7.5 | $12.8 | $9.1 | $24.3 | $10.8 |
| Social Benefit-to-Cost Ratio | 2.02 | 1.20 | 2.61 | 1.62 | 2.55 | 1.64 | 3.12 | 1.89 |

**B. Alternative Social Internal Rates of Return Calculations for One Academic Year of Retraining**

| | *Exclude "Just Showing Up" Effect* | | | *Include "Just Showing Up" Effect* | | |
|---|---|---|---|---|---|---|
| | *Define Table 2 "In-College Effects" as Opportunity Costs?* | | | | | |
| | *No* | *1/2* | *Yes* | *No* | *1/2* | *Yes* |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* |
| Younger Men | 13.7% | 9.2% | 6.6% | 16.4% | 11.3% | 8.4% |
| Older Men | 10.9% | 5.6% | 2.6% | 14.2% | 8.4% | 5.1% |
| Younger Women | 18.4% | 13.8% | 10.9% | 15.4% | 11.5% | 9.1% |
| Older Women | 13.2% | 8.5% | 5.7% | 15.2% | 10.2% | 7.2% |

*Notes:* Calculations based on estimates in Table 2. We assume that the average remaining work life for older displaced workers is 22 years and for younger displaced workers is 36 years, and that neither type of worker will be displaced again. With these assumptions, we likely overstate the number of years that these individuals will work before retirement and the long-run gains from retraining. In panel A, we discount future per period earnings effects using a real rate of 4%. We also assume that individuals pay 25% of the gains in the form of various taxes. To measure the cost of schooling, we follow Kane and Rouse (1999) and assume the direct costs equal $8,000 per year. This figure includes tuition paid by the students plus the subsidies from state and local government. We assume that students pay about 20%, or $1,500, of this direct cost through their tuition. The remaining amount is defrayed by taxpayers. For the calculations in panel A, we estimate the opportunity cost of schooling to equal 1/2 the costs implied by the "In-College" estimates reported in Table 2. In panel B, we make the indicated assumptions about the opportunity cost of retraining. The 1/2 column heading means that we assume the opportunity costs of retraining equal one-half of the amount implied by the "In-College" estimates for one academic year of schooling. All figures in Panel B are the social internal rates of return. The calculations leave out the welfare cast of the taxes raised to pay for community college retraining. Alternative calculations with these costs included can be found in Jacobson, LaLonde, and Sullivan (2004).

that the social IRR from retraining is impressive for all demographic groups. Our estimates imply an IRR of 14.2% from retraining older men. However, the IRR is not so impressive when we assume that the "In-College" effects measure the opportunity cost of retraining and that the "just showing up" effects are not part of the impact of retraining. Under these assumptions, except for younger women, our IRR estimates are relatively low compared to estimates in the schooling literature (Heckman, Lochner, and Todd 2003). Our calculations now imply that the social IRR from retraining older men is only 2.6%. The sensitivity of our IRR calculations to estimates of the opportunity cost of retraining indicates that more research is needed on whether displaced workers really forgo earnings when they participate in community college schooling.

Finally, our conclusions about the returns to retraining also are sensitive to the type of courses completed by displaced workers. We have based our net benefit and IRR calculations on the assumption

that displaced workers complete the same mix of Group 1 and Group 2 courses observed in our sample. But if an older male worker completes only Group 1 courses, the social IRR from such retraining compares favorably to conventional estimates of IRR to formal schooling. By contrast, our impact estimates imply that the social IRR from investments in Group 2 courses may be negative. This finding is important for retraining policy and raises the question of whether community colleges and operators of Work Force Investment Act or Trade Adjustment Assistance Act programs should steer older displaced workers toward Group 1 subject areas.

## 6. Conclusion

We have used administrative data from Washington State to examine how community college schooling affects the short- and long-term earnings prospects of older displaced workers. We find that older and younger displaced workers experienced similar effects from similar types of community college retraining. Overall, community college schooling raised older displaced workers' long-term quarterly earnings by about $9 per credit. This impact implies that one academic year of community college retraining raised older men's earnings by about 7% and older women's earnings by about 10%. We find considerably larger effects when trainees concentrated on quantitatively oriented vocational or academic subjects than when their emphasis was on other kinds of courses.

Because our impact estimates are consistent with the earnings gains we expect from formal schooling acquired by younger persons, we conclude that "you can teach old dogs new tricks," at least when enrollment in retraining is voluntary. However, the sensitivity of our social net benefit and IRR calculations to alternative interpretations of the "just showing up" effect and alternative estimates of the opportunity cost of retraining makes it less certain whether we *should* teach old dogs new tricks. Resolving these ambiguities requires further research.

Finally, contrary to our prediction in Section 1 that retraining effects would be larger for older trainees than for younger trainees, we found similar effects for the two groups. This finding suggests that the distribution of retraining effects may have both a different mean and a different variance for the population of older displaced workers. Estimating the shape of these impact distributions requires stronger assumptions than are imposed here (Aakvik, Heckman, and Vytlacil 2005). But knowing the shapes of these distributions is important for policy analysis. We also leave this question for future research.

## Appendix

### *A. Notes on Administrative Earnings and Community College Records*

We constructed our sample of Washington State displaced workers from three administrative data bases. We received from the state the UI claims records for every worker who filed a valid unemployment insurance claim between 1990.II and 1994.IV and who had accumulated at least six quarters' job tenure. We matched these data to these workers' quarterly earnings records in UI-covered jobs for the period from 1987 until 2000, and to machine-readable transcripts from 25 of the state's community colleges. State law requires these 25 community colleges to provide academic transfer courses as part of their course offerings. The community college system also operates five public technical schools, each of which at one time was part of a local secondary school district. These schools teach only vocational skills to post-secondary students. We have no data from these technical schools. Some displaced workers, including some comparison group members, may have enrolled in potentially valuable programs operated by these institutions.

We matched the administrative records using individuals' Social Security numbers. From the unemployment insurance claims records, we identified the quarter of each worker's job losses. These records also include a modest set of demographic characteristics taken from individuals' application for unemployment insurance benefits, including birth year, race, gender, and prior education. From the wage records, we obtained information about workers' quarterly earnings in jobs covered by the state UI system, their job tenure at separation, and, for each calendar year, their primary employer's 4-digit SIC code and county. Individuals' earnings when they were self-employed or when they worked outside Washington State are not reflected in these records. The community college records contain information on the credit and noncredit courses displaced workers enrolled in, when and where they enrolled, and the grades they received in courses taken for credit. The community college records begin in the fall term of 1989 and extend through 1995.

To focus our study on the retraining outcomes of displaced workers, we restricted our sample to (a) adults between 22 and 60 years old at the time of their job losses; (b) workers who had accumulated at least 3 years' job tenure with their pre-displacement employer; (c) workers who lost jobs outside the public sector; and (d) workers who remained continuously attached to the state's UI covered work force during the 14-year period covered by our quarterly earnings records. We also excluded from our sample those displaced workers who earned more than three academic years (135 credits) of community college schooling or who transferred from a community college to a four-year institution. We have no records on such students at these four-year institutions.

We defined a displaced worker as being continuously attached to the state's work force if he or she never had more than eight consecutive quarters without UI-covered earnings, except during the period following the job loss and while he or she was enrolled in community college courses. This "continuously attached" criterion eliminated many workers from our sample. Without it, our sample size would have been approximately 167,000 workers. Our review of these excluded individuals indicates that many never had positive wage and salary earnings in Washington State following their job losses or enrollment in the state's community colleges. Although some of these individuals may have moved out of state, we also found that women and older workers were more likely to be in this category than were men and younger workers, respectively. The literature reports that such individuals generally have lower mobility rates or, when they move, are often "tied movers."

The participation rates in community college schooling for the displaced workers who were not continuously attached were similar to the rates we report for our sample in Table 1 (Jacobson, LaLonde, and Sullivan 2000). Because of the large numbers of individuals involved, we deem it unlikely that all these non-attached displaced workers actually had no earnings. When we restore them to our sample, our estimate of the effects of community college schooling, especially from courses teaching less quantitative subject matter, becomes smaller for both older and younger displaced workers.

The Washington State sample used in our analysis in this paper contains 65,321 displaced workers. During the period around these workers' displacements, 10,405 completed at least one community college course. Of these participants in community college schooling, 5,180, or about 50%, were 35 or older when they lost their jobs. This sample is smaller than the one used in an earlier paper that followed displaced workers for fewer years, because here we apply the continuously attached criterion for a longer time period (Jacobson, LaLonde, and Sullivan 2005).

### *B. Classifications of Washington State Community College Courses*

The community college transcript database included information on the types of courses completed by students. Below is a list of ten major categories of for-credit community college courses. To examine how effects varied by courses, we extended equation (2) in the text to account for the categories of courses listed below

(Jacobson, LaLonde, and Sullivan 1997). After reviewing the results, we found it helpful for expositional purposes to aggregate these categories into two groupings. The first group consists of academic courses in the sciences and mathematics as well as courses teaching more technically oriented vocational subject matter, including courses in the health occupations or Group 1 courses. We assign all other courses to the Group 2 category. The ten major categories are as follow:

| *Group 1: Quantitative or Technically Oriented Vocational Courses* | *Group 2: Less Quantitative Courses* |
|---|---|
| Health-related courses | Sales/service courses |
| Technical/professional courses | Vocational courses (not in Group 1) |
| Technical trades | Social science/humanities academic courses |
| College-level science and math academic courses | Health/PE/consumer-oriented courses |
| | Basic skills education |
| | Other courses |

We also experimented with aggregating courses into three groupings. The third group consisted of the Health/PE/consumer-oriented course, the basic skills education course, and "other" courses. Our results were unaffected by this alternative classification.

### *C. Specification of the Displacement Parameters*

Previous research has documented the temporal pattern of the impact of displacement on workers' earnings (Jacobson, LaLonde, and Sullivan 1993a,b). Displaced workers' earnings tend to decline during the period prior to displacement; drop sharply following the quarter of their job loss; and then rise relatively rapidly during the next few quarters, before increasing at a slower rate in subsequent periods. In Jacobson, LaLonde, and Sullivan (2004, 2005) we found that the specification described below was sufficiently rich to allow for differences in the temporal pattern of displacement among Washington State's displaced workers.

To control for the average pattern of displacement, we defined the impact of being displaced in period $s$ on earnings during quarter $t$ as

$$\delta_{it}(s_i, z_i) = \delta_{t-s} = \delta_k,$$

where $k = t - s_i$. Letting $D_{it}^k = 1$ if worker $i$ was displaced at time $t-k$, we write the displacement effect as

$$\delta_{it}(s_i, z_i) = \Sigma \delta_k D_{it}^k.$$

In our empirical work, we allow $k$ to range from –12, the twelfth quarter prior to job loss, to the end of the sample period, which is more than 40 quarters after displacement for some individuals. We allow displacement effects to vary by workers' characteristics and labor market conditions. We found that a parsimonious specification adequately accounts for differences between the average pattern of displacement effects, $\delta_k$, and the pattern for workers with characteristics $z_i$. We summarize this departure from the average patterns using four variables defined as follows:

$F_{it}^1 = t-(s-12)$ if $s-12 \le t \le s$, and = 0 otherwise;

$F_{it}^2 = (F_{it}^1)^2$;

$F_{it}^3 = 1$ if $s < t$, and = 0 otherwise;

$F_{it}^4 = 1/(t-s)$ if $s < t$, and = 0 otherwise.

This specification allows the displacement effects for workers with characteristics $z_i$ to differ from the average effect. After some experimentation, we found that we could summarize these differences by a quadratic function during the twelve quarters prior to displacement, and by the inverse of time since displacement during the post-displacement period. The coefficient associated with the $F_{it}^3$ term indicates the departure from the average long-term impact of displacement for workers with characteristics $z_i$. Therefore, the displacement effect in our econometric model becomes

$$\delta_{it}(s_i, z_i) = \Sigma \delta_k D_{it}^k + F_{it}^1 z_i \phi_1 + F_{it}^2 z_i \phi_2 + F_{it}^3 z_i \phi_3 + F_{it}^4 z_i \phi_4.$$

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