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The Impact of Economic Conditions on Participation in Disability Programs: Evidence from the Coal Boom and Bust

By DAN BLACK, KERMIT DANIEL, AND SETH SANDERS*

We examine the impact of the coal boom of the 1970's and the coal bust of the 1980's on disability program participation. These shocks provide clear evidence that as the value of labor-market participation increases, disability program participation falls. For the Disability Insurance program, the elasticity of payments with respect to local earnings is between -0.3 and -0.4 and for Supplemental Security Income the elasticity is between -0.4 and -0.7. Consistent with a model where qualifying for disability programs is costly, the relationship between economic conditions and program participation is much stronger for permanent than for transitory economic shocks. (JEL J0, H0)

In 1993, 3.7 million former workers in the United States were receiving Disability Insurance (DI) payments from Social Security. At the

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same time, 4.4 million disabled Americans were receiving income from Supplemental Security Income (SSI). These two programs accounted for payments to the disabled of nearly \$51 billion. Expenditures for disability programs far exceed expenditures on other cash assistance programs. For example, despite the attention it received from politicians and the media, Aid to Families with Dependent Children (AFDC) accounted for payments of less than \$23 billion to about 14 million recipients in 1993.

These high levels of disability payments are the result of a 30-year expansion of disability programs expenditures in the United States. Together SSI and DI real expenditures increased 400 percent from 1970 to 1993, and the number of recipients increased 400 percent as well. By comparison, during the same period AFDC payments increased only 50 percent in real dollar terms, and the number of welfare recipients doubled. Because of the enormous growth in disability programs over the last 30 years and their current importance as a source of public aid, understanding why these programs have grown so rapidly is an important public policy question.¹

¹ *Statistical Abstract of the United States*, Tables 582, 597, and 598 (U.S. Department of Commerce, Bureau of the Census, 1996), provide the DI and (1980 and 1990) SSI expenditures and recipient counts. Committee on Ways and Means (1994) Table 8.1 provides the AFDC expenditures, and we use Tables 4-20 and 4-24 to impute the approximate

The rise in expenditures on DI and SSI coincided with a sharp reduction in the relative earnings of low-skilled men. McKinley L. Blackburn et al. (1990), John Bound and George Johnson (1992), Lawrence F. Katz and Kevin M. Murphy (1992), Murphy and Finis Welch (1992), and Chinhui Juhn et al. (1993), to name but a few, examine the fall in earnings of low-skilled workers during the 1970's and 1980's. A decline in the labor-force participation of low-skilled men accompanied their decline in wages. Juhn (1992), analyzing Current Population Survey (CPS) March Supplement data from 1968 to 1988, finds the decline in labor-force participation particularly severe among less educated men. To what extent has the decline in the earnings of low-skilled men contributed to the increase in disability payments? We address this question in our paper.

Donald O. Parsons (1980, 1982) addresses a related but distinct issue. He argues that growth in disability programs accounts for a large share of the post-World War II decline in labor-force participation. His central piece of evidence is that labor-market dropout appears larger for individuals who face more generous DI payments.² Specifically, the larger the replacement rate—the fraction of pre-disability earnings replaced by the DI program—the lower is the probability of working among prime-aged men. Parsons' work, however, has been vigorously challenged. Robert H. Haveman and Barbara L. Wolfe (1984a, b), Bound (1989), and Bound and Timothy Waidmann (1992), while not denying that disability programs have had some impact on labor-force participation, dispute the magnitude of the impact. They point out the potential endogeneity of Parsons's measure of

DI generosity.³ Specifically, because the DI system is progressive, workers with chronic health problems might have lower earnings that would qualify them to have a higher fraction of their earnings replaced by the DI system. In this case, a high replacement rate may simply reflect a worker's chronic health problems and it is not surprising that dropping out of the labor market is positively correlated with health problems (and hence the replacement rate). Bound and Waidmann (1992) suggest that early diagnosis and treatment now allow many men who would have died to survive, but not to recover enough to work. They argue that this accounts for up to 80 percent of the decline in labor-force participation for men aged 45 to 54 during the 1970's.

Instead of relying on the replacement rate, and the problems involved with its use, we use variation in local earnings growth within states to see how changes in the local economy affect participation in the DI program. We use this approach because, for a specific geographic region in the United States, there is an exogenous shock to the value of labor-force participation. Because of regulatory changes and the OPEC oil embargo there were a series of sharp increases in the price of coal during the 1970's. The Appalachian regions of Kentucky, Ohio, Pennsylvania, and West Virginia, in addition to other areas with coal, experienced rising employment and earnings while other areas within relatively short distances suffered the declines in economic activity experienced by the overall American economy. A subsequent bust in the coal market in the 1980's reversed these gains. We use this variation in local economic conditions to identify the impact of labor-market conditions on DI program participation. Moreover, because the coal boom persisted for a long period, and the

payments and number of disabled recipients for 1970 SSI. In 1970, the DI program paid \$2.4 billion to 1.3 million recipients. Because SSI was not a federal program in 1970, corresponding estimates for the disability portion of SSI are not available. Approximately 1 million of the 3.1 million SSI recipients in 1970, however, were blind or disabled, and total expenditures were about \$2.9 billion, which provides us with approximate expenditures of \$1 billion.

² Similarly, Frederic P. Slade (1984), using data from the 1969 Longitudinal Retirement History Survey, estimates that a 10-percent increase in the generosity of DI payments would reduce labor-force participation of men between the ages of 58 and 63 by 8.1 percent.

³ Haveman and Wolfe (1984a, b) note the potential endogeneity of the replacement rate and correct for this endogeneity by predicting DI income. As Bound (1991) argues, however, exclusion restrictions of questionable legitimacy are required in order to generate the instruments required for this strategy. See Parsons (1984) for his defense to these challenges. Bound's (1989) approach is to use DI applicants who are denied disability insurance as a control group for those who received disability insurance. See Parsons (1991) for a critique of Bound's approach and Bound (1991) for his reply. Gruber (2000), using a 36-percent increase in disability payments in Quebec, finds an estimated labor-force nonparticipation elasticity of about 0.3.

subsequent coal bust persists through today, these economic shocks represent long-term changes in local labor-market conditions rather than transitory ones. Our results suggest that permanent job creation or destruction has a much larger effect on disability program use than more transitory changes in local labor markets.

Establishing the relationship between local economic conditions and DI program participation may help inform the debate between Parsons and Bound as well. The central issue in both our question and theirs is the degree to which disability participation and labor-force participation are substitutes. A finding, for example, of no relationship between economic opportunities and disability program use would support the contention that the effects of the rise of disability programs on labor-force participation are small. Furthermore, the larger the effects of economic opportunities on disability program enrollment, the larger is the substitution potential between work and disability. This suggests a larger role for disability insurance in explaining the decline in prime-aged male labor-force participation.

The remainder of the paper is structured as follows. In the next section, we describe features of the two major U.S. disability programs. In Section II we describe the coal boom and bust, documenting the impact that this cycle had on local economic conditions and on the use of disability programs. In Section III we discuss our econometric specification, and in Section IV we present the results of our estimation. In Section V we offer some concluding comments. The Appendix describes the data we use.

I. Program Description⁴

The DI program covers all participants in the Social Security system. In order to qualify for DI benefits an individual must be deemed disabled by the Social Security Administration (SSA). According to SSA rules, an individual is deemed disabled if he is unable "to engage in substantial gainful activity by reason of a physical or mental impairment." The impairment must last for at least 12 months (or be expected

to result in death). The SSA maintains a list of impairments that, if diagnosed by a physician, qualify individuals for benefits. If individuals have conditions not on this list, however, they may still qualify for benefits if physicians determine that the conditions result in sufficient impairment. In making the determination of impairment, the applicant's age, education, and work experience are considered when determining whether an applicant might still work. The work need not exist in the immediate area in which the claimant lives, nor must a specific job vacancy exist for the individual.

There are no other requirements for participation such as income or asset tests. DI payments are based on past earnings. High-income individuals receive more benefits from DI than low-income individuals. Caps on the amount that individuals can receive from (or pay into) the DI system make the system progressive, and the replacement rate is higher for low-income individuals than for high-income individuals.

The Social Security Act of 1935 established federal grants to states that were to be used for the care of the aged, blind, and disabled. In 1974, the federal SSI program replaced these grants with a federal income-maintenance program to be administered by the SSA. Nationally, about 74 percent of the nearly 6 million SSI recipients qualify for benefits because of a disability. For the purpose of eligibility for SSI benefits, the SSA defines disabled individuals as those "unable to engage in any substantial gainful activity by reason of a medically determined physical or mental impairment expected to result in death or that has lasted, or can be expected to last, for a continuous period of at least 12 months." Gainful activity is operationally defined as earning \$500 a month after impairment-related expenses have been deducted; L. Scott Muller et al. (1996) find that 13 percent of recipients report some labor income while receiving SSI.

The SSI program is designed to be a welfare program. In the words of the Committee on Ways and Means (1994), "Since its inception SSI has been viewed as the 'program of last resort.'" Because of this, individuals deemed disabled must additionally meet strict asset tests to qualify for SSI and can have no more than \$470 per month in earnings or in income from all other assistance programs combined. The SSI application is considered only after the

⁴ Unless we otherwise indicate, this discussion follows Committee on Ways and Means (1994, 1996).

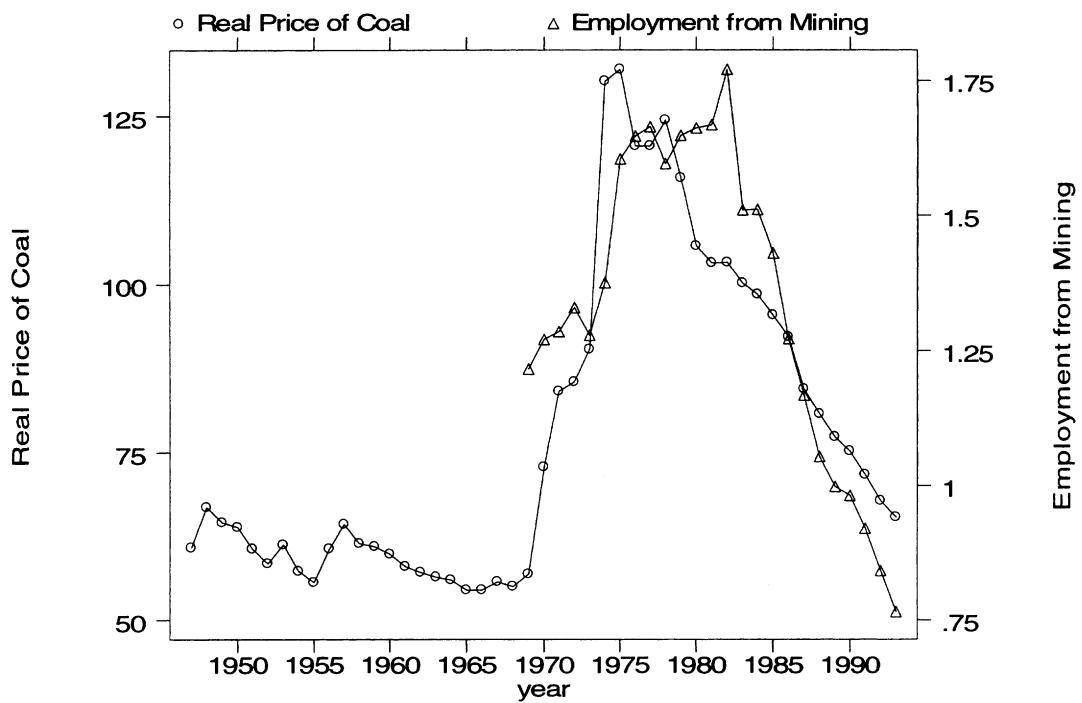


FIGURE 1. THE REAL PRICE OF COAL, 1946–1993, AND MINING EMPLOYMENT AS A PERCENT OF TOTAL EMPLOYMENT, 1969–1993

applicant has applied to all other assistance programs for which he qualifies. In 1995, the average monthly payment to a SSI recipient was \$348 while the average payment to a DI recipient was \$682. Like other Social Security benefits, benefits from both programs are indexed to the Consumer Price Index.

Taken together, the benefit structure of the SSI and DI programs are quite progressive. Because SSI payments are available only to poor individuals, this makes SSI and DI together more progressive than the DI program is alone. Put differently, the replacement rate is larger for low-wage workers than for high-wage workers, and hence the relative reduction in income from withdrawal from the labor market is smaller for disabled, low-wage workers.

II. The Impact of the Coal Boom and Bust on Local Economies

The increases in coal prices in the 1970's were large by any standard. Figure 1 displays

the real price of coal from 1946 to 1993 and the percentage of total employment from the mining industry in the four-state region for 1969 to 1993. A 28.2-percent increase in coal prices between July 1969 and July 1970 brought coal prices to a post-World War II high, but the price increase associated with the 1973 oil embargo was even larger. The real price of coal increased 44 percent between July 1973 and July 1974, and then remained relatively stable until about 1978, when it began a steady decline that continued through the 1980's and 1990's. Indeed, between 1983 and 1993, the real price of coal declined in each year. The large changes in coal prices had a major impact on coal economies. The fraction of total employment from the mining industry for the four-state region tracks the price movement relatively well. It increased from about 1.22 percent in 1969 to a high of 1.77 percent in 1982 and then fell to 0.77 percent in 1993.

The coal boom and bust had a fundamental impact on these local economies. We classify

counties into one of three groups by their coal reserves. Counties with at least a billion tons of coal reserves are defined as large coal-reserve counties. Counties with more than 100 million, but less than a billion, tons of coal reserves are defined as moderate coal-reserve counties. Counties with less than 100 million tons of coal reserves are considered outside the coal regions.⁵ Counties with moderate coal reserves had per capita income grow 1.5 percent faster in the boom and shrink 1.4 percent slower in the bust than areas with little or no coal. Similarly, regions with large coal reserves had per capita income grow at a 3.4-percent faster rate in the boom and a 2.3-percent slower rate during the bust than areas with little or no coal. This increase in per capita income during the coal boom was accomplished as population increased. In both the moderate and large coal-reserve areas, population grew during the boom and contracted during the bust; see Black et al. (2000).

Ascertaining precisely how these economic shocks affected the residents of the coal-producing areas is difficult. Because these areas are small, residents are not identified in the data sets that labor economists have traditionally used. Indeed, even the Decennial Censuses do not reveal individual county-level data from these areas because the counties are too small. It is possible to use the 1970, 1980, and 1990 Decennial Censuses Public Use Micro Samples to obtain some information about the earnings and labor supply of the individuals in the coal region. The Public Use Micro Samples identifies the location of respondents only at the county-group level (less elegantly termed a PUMA in the 1990 Census). In 1970, county groups were collections of "counties" in which at least 250,000 people resided. For the 1980 and 1990 Censuses, county groups or PUMAs were collections of counties in which at least 100,000 people resided. Thus, in large metropolitan areas, a "county group" will be only a portion of a county, but in rural areas county groups will encompass several counties. Moreover, the groupings of counties are not consistent across

⁵ There is nothing special about these cutoffs. We observed those counties with more than a billion tons of coal reserves are invariably large coal producers. Those with less than 100 million tons were usually not large producers of coal.

Censuses, and the groupings are often unrelated to the coal seams.

With these caveats, however, we can identify county groups that contain a relatively large number of workers employed in the coal industry. We define a coal area as any area in which more than 0.5 percent of employment is in the coal industry. A noncoal area is any area that had 0.5 percent or less employment in the coal industry. The timing of the Census is particularly fortunate for us. The 1970 Census, which asks about labor-market information for 1969, is before the beginning of the coal boom. The 1980 Census, which asks about labor-market information for 1979, is roughly at the peak of coal boom, and the 1990 Census, which asks about labor-market information about 1989, is in the coal bust.

In Panel A of Table 1, we provide simple differences-in-differences estimates of changes in various measures of labor supply and earnings for men and women. We compare the percentage change in labor-market outcomes of those who reside in coal areas relative to those in noncoal areas. The labor-market outcomes we use are real annual earnings, annual hours worked, annual weeks worked, hours per week, whether the respondent is in the labor force, and average real wage.

The differences are stark. Real, annual earnings of men in coal areas grew 13 percent faster between 1969 and 1979 than in noncoal areas. Yet, changes in annual hours worked were virtually identical to those in noncoal areas. Labor-force participation for both men and women grew modestly faster in coal areas than in noncoal areas (about 3 percent faster). The average real wage, however, increased 17 percent faster for men and 10 percent faster for women in coal areas than in noncoal areas. Thus, during the coal boom, the increased earnings in the coal areas resulted largely from increases in hourly compensation rather than labor supply.

Wages also change dramatically between 1979 and 1989 although in the opposite direction of the coal boom. Wages declined about 8 percent in coal areas relative to noncoal areas. There is more evidence, however, that the coal bust affected labor supply. The relative decline in earnings among working men and women was larger than the change in wages. Labor-force participation declined for men and weeks

TABLE 1—CHANGES IN EARNINGS, HOURS WORKED, WEEKS WORKED, WAGES, AND LABOR-FORCE STATUS: KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA 1969 TO 1979 AND 1979 TO 1989 (IN PERCENTS)

	Differences-in-differences, coal and noncoal areas, 1969 to 1979		Differences-in-differences, coal and noncoal areas, 1979 to 1989	
Panel A: By Gender				
Population aged 25 to 64	Men	Women	Men	Women
Average real annual earnings	13.0	15.9	-13.5	-11.7
Average hours per year	-0.2	-0.3	-4.9	-1.6
Average weeks worked per year	-0.8	1.8	-4.1	0.4
Average hours per week	1.6	0.2	-3.7	-0.9
In labor force	2.9	2.7	-2.9	1.4
Conditional on working, aged 26 to 64				
Average real annual earnings	11.9	9.5	-11.1	-10.9
Average hours per year	-2.8	-2.0	-2.0	-2.6
Average weeks worked per year	-1.7	-0.7	-1.3	-0.9
Average hours per week	-1.1	-0.7	-0.8	-1.9
Average real wage	17.2	10.2	-8.6	-7.9
Panel B: By Coal and Noncoal Workers	Differences-in-differences, coal and noncoal areas, 1969 to 1979		Differences-in-differences, coal and noncoal areas, 1979 to 1989	
Population of men, aged 25 to 64	Coal workers	Noncoal workers	Coal workers	Noncoal workers
Average real annual earnings	47.7	9.3	-8.5	-13.3
Average hours per year	14.6	-1.5	-1.5	-5.0
Average weeks worked per year	11.9	-1.9	-4.5	-3.9
Average hours per week	17.0	0.3	-0.6	-3.7
In labor force	16.2	1.7	-3.9	-2.5
Men, aged 25 to 64, conditional on working				
Average real annual earnings	29.7	9.5	-4.9	-11.1
Average hours per year	-0.9	-2.9	2.6	-2.5
Average weeks worked per year	-1.4	-1.6	-0.7	-1.4
Average hours per week	0.7	-1.3	3.6	-1.2
Average real wage	30.8	14.8	-8.1	-8.0

Notes: Authors' calculations are from the Public Use Micro Samples of the 1970, 1980, and 1990 Decennial Censuses. Coal areas are defined as PUMAs or county groups with over 0.5 percent of the workforce employed in the coal area. We impute real average wages per hour by taking the sum of total wage and salary earnings, self-employment earnings, and farm earnings, and dividing by annual hours. Annual hours are the product of the respondent's weeks worked last year and average hours worked last year.

worked declined for both men and women in coal areas relative to noncoal areas.

In Panel B of Table 1, we divide the men in the coal areas by whether they work in the coal industry.⁶ We again use all workers in noncoal areas as our comparison group. Not surprisingly, the earnings of coal workers increased

much faster than the earnings of noncoal workers during the boom. Wages grew nearly 31 percent for coal workers and 15 percent for noncoal workers relative to those in noncoal areas. Thus, the coal boom clearly affected the wages of both coal miners as well as other workers in coal areas. As one would suspect, the labor-supply responses of coal workers increased relative to those of workers in the noncoal industries. In the bust, the decline in real average wages was 8.1 percent for workers in

⁶ Virtually no women are employed in the coal industry so we do not repeat this exercise for women.

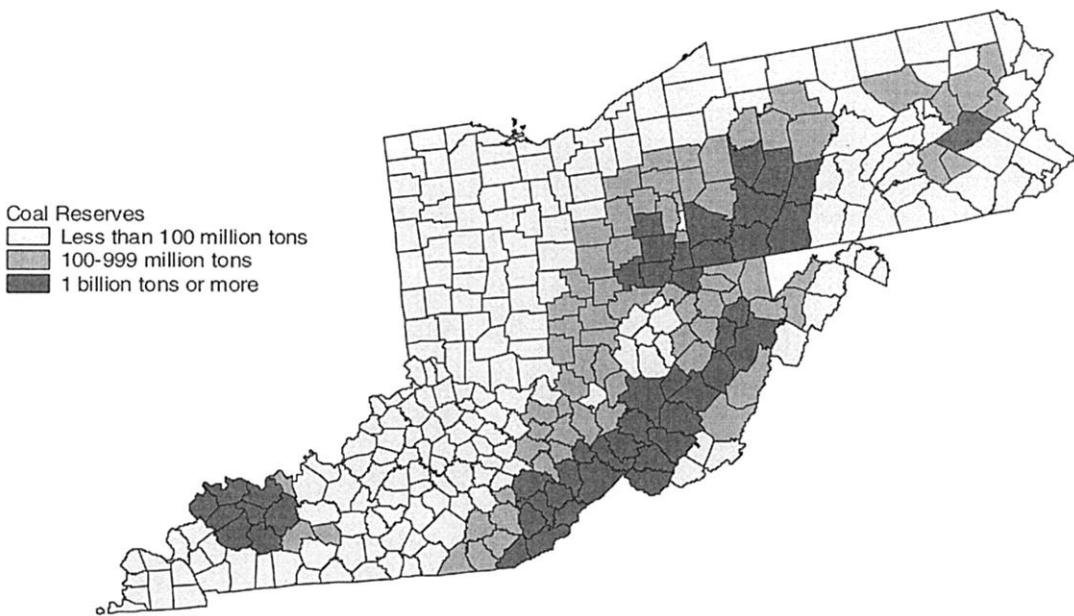


FIGURE 2. COAL RESERVES: KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA

the coal industry and 8.0 percent for those not in the coal industry.

While the coal boom substantially increased earnings in coal-producing areas within Kentucky, Ohio, Pennsylvania, and West Virginia, the economic benefits of the coal boom were not spread evenly across the region. Even in the Appalachian areas of these four states, 53 of the 186 counties have little or no coal reserves, and most of the remaining 144 counties outside Appalachia have no coal. Among those counties with reserves there are great differences in coal endowments. In Figure 2, we map the endowment of coal within the region. We divide the counties into three groups: counties with little or no coal (less than 100 million tons of coal), counties with at least 100 million tons of coal but less than a billion tons of coal, and counties with at least a billion tons of coal. Figure 2 shows three major coal seams. The first major seam lies in western Kentucky, a part of the Illinois coal basin. The second major seam—the Appalachian Basin—runs through eastern Kentucky, West Virginia, western Pennsylvania, and eastern Ohio. Finally, eastern Pennsylvania contains a major seam that is largely anthracite, or hard coal.

In Figure 3, we provide a map of the region's economic growth from 1983 to 1993. This is a period of declining coal prices. We divide counties into quartiles based on the average growth of county earnings. A comparison of Figures 2 and 3 shows how strongly the endowment of coal is correlated with limited economic growth during the coal bust. In Figure 4, we repeat the exercise for the growth of SSI payments during the coal bust. Comparing Figures 2 and 4 it is clear that the endowment of coal is strongly correlated with growth in SSI payments during the coal bust.

III. Econometric Specifications

Figures 2 through 4 visually display our econometric strategy. We wish to correlate intrastate variation in earnings that arises from the coal boom and bust to intrastate variation in SSI and DI payments. The use of intrastate variation allows us to control for interstate differences in policies that affect SSI and DI expenditures. As Gruber and Jeffrey D. Kubik (1997) emphasize, applications for DI and SSI are made to state-appointed boards that differ from state to state. Kubik (1999) and Black et al. (1997) document

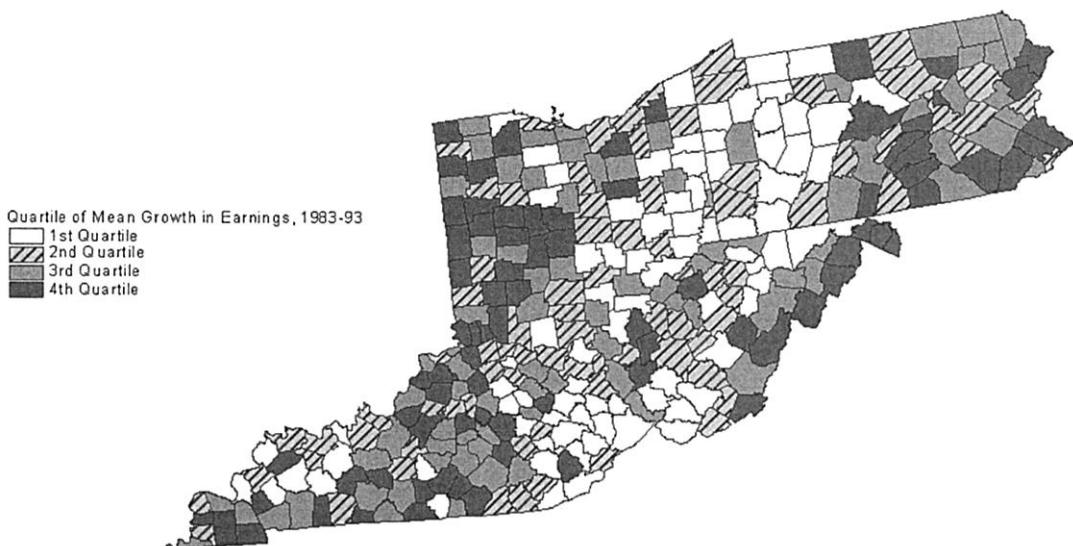


FIGURE 3. QUARTILE OF MEAN GROWTH IN EARNINGS:
KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA 1983-1993

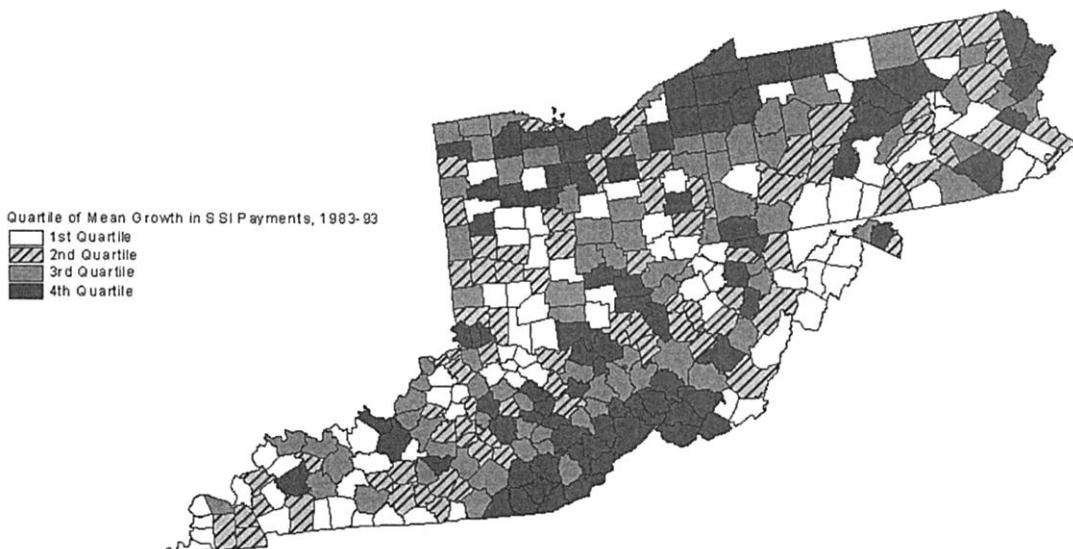


FIGURE 4. QUARTILE OF MEAN GROWTH IN SSI:
KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA, 1983-1993

that SSI rolls are sensitive to the level of AFDC benefits paid in the state, presumably as potential recipients react to the relative benefits of applying to either the AFDC or the SSI program.

Unfortunately, the coal-producing areas of the four-state regions have modest populations, making it impractical to obtain individual-level data for the analysis. As a result, we rely on county-level data, and we estimate regressions

of the form:

$$(1) \quad \Delta y_{ist} = \beta_0 + \text{year}_{st}\beta_{1st} + \mathbf{x}_{ist}\beta_2 \\ + \beta_3 \Delta(\text{earnings}_{ist}) + \varepsilon_{ist},$$

where Δ indicates a first difference in logarithms; Δy_{ist} is the logarithmic difference in the real SSI or DI payments for county i in state s between time t and $t - 1$; year_{st} is a state-year dummy variable for state s in year t ; $\Delta(\text{earnings}_{ist})$ is the difference in the logarithm of real earnings in county i ; ε_{ist} is an error term capturing unmeasured factors; and \mathbf{x}_{ist} is a vector of control variables.⁷ The difference approach of equation (1) will purge the data of any fixed effects. Our use of state-year dummy variables to control for programmatic changes purges the dependent variable of its time-series variations. Similarly, this year fixed-effect approach purges the growth in earnings of all state-specific time-series variations as well. Identification of the effect of county earnings growth on disability caseloads comes from the annual deviations from a state's averages.

Neither coal prices nor coal endowments plays any role in equation (1). This equation simply models the correlation between changes in a county's wage bill and changes in its disability role regardless of the source of the change in the wage bill. The price of coal alters the wage bill through increasing the demand for labor. To capture this econometrically we use a two-stage model. The first stage models the relationship between the wage bill and the value of coal reserves in a county (a function of the

coal price and the county's endowment of coal). The second stage then models how these coal price-induced movements in the wage bill affected disability program participation.

The first-stage equation for the change in (log) earnings is

$$(2) \quad \Delta(\text{earnings}_{ist}) \\ = \alpha_0 + \text{year}_{st}\alpha_{1st} + \mathbf{x}_{ist}\alpha_{ist} \\ + \Delta(\text{value of reserves}_{ist})\alpha_s + u_{ist}$$

where $\Delta(\text{value of reserves}_{ist})$ is some measure of the change in the real value of the county's coal reserves, and u_{ist} is an error term with the usual properties. The second-stage regression model is

$$(3) \quad \Delta y_{ist} = \beta_0 + \text{year}_{st}\beta_{1st} + \mathbf{x}_{ist}\beta_2 \\ + \beta_3 \Delta(\hat{\text{earnings}}_{ist}) + \varepsilon_{ist}$$

where $\Delta(\hat{\text{earnings}}_{ist})$ is the change in earnings due to the coal-price induced value of reserves.

The commitment to enter the DI program is largely permanent. An individual must be out of work for a minimum of five months and the typical time to receiving benefits is two years. Few workers ever leave the DI program before their cases are automatically transferred to Social Security retirement at age 65.⁸ Therefore, in choosing to pursue DI benefits, individuals are more concerned with their long-term earnings prospects than with immediate earnings prospects. Coal price-induced changes in employment, which are often associated with the opening of new mines or the closing of older mines, likely reflect the long-term earnings prospects in Appalachia better than the transitory annual changes in a county's employment. If annual changes in earnings are a more error-ridden measure of economic opportunities than the changes induced by coal prices, then we expect the magnitude of the instrumental variables estimate to exceed the magnitude of the ordinary least-squares (OLS) estimate.

⁷ We control for whether or not the county is in a Metropolitan Statistical Area for the 1990 Census, the logarithm of the county's population, the log difference in the county's population, and the fraction of earnings in 1969 from manufacturing industries. We control for metropolitan status because of our concern that persons with disabilities may move to a metropolitan area for better access to health care. Similarly, we control for population to proxy, in part, for access to medical care and the provision of public services such as transportation that may attract individuals with disabilities. The change in population obviously may have a mechanical relationship with disability payments if persons with disabilities are represented among migrants. Finally, we use the fraction of earnings from manufacturing industries in 1969 to control for any impact of industry structure on disability. Eliminating these controls has little impact on the results discussed below.

⁸ Burkhauser and Haveman (1982) report that 1.6 percent of the caseload exited in 1976. They suggest that this rate has also been falling over time.

TABLE 2—SUMMARY STATISTICS OF SAMPLE BY COAL PRICE PERIOD:
KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA, 1970–1977 AND 1982–1993

Variables	All Counties	Large Coal Counties	Moderate Coal Counties	No Coal Counties
Coal Boom (1970–1977)				
Logarithmic difference in SSI payments	0.063 (0.217)	0.061 (0.189)	0.071 (0.212)	0.060 (0.225)
Logarithmic difference in DI payments	0.127 (0.089)	0.102 (0.080)	0.119 (0.079)	0.136 (0.090)
Logarithmic difference in county earnings	0.030 (0.081)	0.058 (0.078)	0.034 (0.079)	0.022 (0.080)
Logarithmic difference in population	0.013 (0.018)	0.015 (0.018)	0.011 (0.020)	0.012 (0.018)
Logarithmic difference in real price of coal	0.094 (0.140)	—	—	—
Logarithmic difference in coal value instrument	0.253 (0.649)	0.721 (1.080)	0.547 (0.824)	0.050 (0.226)
Mean coal reserves	461 (1,110)	2,562 (1,779)	412 (257)	6.45 (19.5)
Fraction of economy in manufacturing (1969)	0.267 (0.160)	0.158 (0.147)	0.284 (0.167)	0.285 (0.151)
Fraction of counties with an MSA	0.262 (0.440)	0.191 (0.394)	0.296 (0.457)	0.267 (0.442)
Population	84.8 (194)	59.1 (71.6)	80.4 (191)	92.1 (213)
Coal Bust (1983–1993)				
Logarithmic difference in SSI payments	0.062 (0.073)	0.067 (0.070)	0.063 (0.068)	0.061 (0.075)
Logarithmic difference in DI payments	0.033 (0.090)	0.030 (0.090)	0.028 (0.099)	0.035 (0.086)
Logarithmic difference in county earnings	0.018 (0.077)	-0.009 (0.086)	0.008 (0.058)	0.027 (0.079)
Logarithmic difference in population	0.002 (0.013)	-0.007 (0.012)	-0.002 (0.012)	0.005 (0.013)
Logarithmic difference in coal value instrument	-0.112 (0.149)	-0.318 (0.137)	-0.241 (0.106)	-0.022 (0.057)
Logarithmic difference in real price of coal	-0.041 (0.018)	—	—	—
Population	85.7 (179)	58.5 (68.6)	78.3 (170)	94.2 (197)
Number of counties	330	47	71	212

Notes: Authors' calculations are from data sources given in the Appendix. Standard errors are in parentheses.

IV. Results

In what follows we estimate the impact of earnings growth on SSI and DI program expenditures for counties in Kentucky, Ohio, Pennsylvania, and West Virginia. Table 2 presents summary statistics of the sample and mixed evidence on the relationship between earnings growth and program participation. On the average, coal prices increased 9.4 percent per year during the coal boom and decreased 4.1 percent

per year during the coal bust. The average coal reserves in counties in the large seam areas is 2.5 billion tons, in the moderate seam areas it is 412 million tons, and reserves outside of the coal regions are less than 7 million tons. When coal prices were rising, average growth in county earnings was much higher inside the coal regions than outside. During the coal boom, the growth in average county earnings was 5.8 percent for counties with large coal reserves, 3.4 percent for counties with moderate

coal reserves, and 2.2 percent for counties without coal. During the bust, noncoal counties grew 2.7 percent annually while coal counties had essentially no earnings growth. Also, counties in the seam differ from other counties in several ways. Compared to the noncoal counties, counties with large coal reserves have fewer residents, are less likely to be in a metropolitan area, and have less manufacturing. The moderate coal counties are remarkably similar to the noncoal counties in these dimensions.

A. Semiparametric Estimates

We estimate four different models for SSI and DI program payments. First, we estimate the OLS model using year fixed effects, the log difference in earnings, and other covariates. We refer to this as the change in earnings and will, casually, interpret this variable as the percentage change in real earnings. In the next specifications, we use two-stage least squares (2SLS), with the change in the value of coal reserves and two of its lags as instruments. For all estimates, *t*-statistics are reported using Huber-White standard errors.⁹ Because the functional form is a double-log model, the parameter estimate for the change in earnings can be interpreted as an elasticity of the change in payments for a change in the level of the county's real earnings. We then repeat the estimation excluding the control variables.

We begin our analysis with the OLS estimates of equation (1) for DI payments. The OLS estimates indicate an extremely weak link between earnings growth and the growth in DI payments. In column (1) of Panel A of Table 3, we present the OLS estimate for the model with all covariates. Earnings growth appears to have no effect on the growth of DI payments.

⁹ In the tables below we do not correct for possible spatial autocorrelation. Timothy G. Conley (1999) suggests a Generalized Method of Moments (GMM) model that allows nonparametric estimation of the covariance matrix with spatial correlation across observations within a given distance, using a method similar to Whitney K. Newey and Kenneth D. West's (1987) technique for autocorrelation. In the Appendix, available from the authors on request, we reestimate our models using the method that Conley (1999) proposes. The results are robust to corrections for spatial autocorrelation.

These estimates, however, do not focus on the coal price-induced changes in county earnings. In order to implement our two-stage model [equations (2) and (3)] we first must specify a measure for the value of a county's coal reserves. We use the log differences in the real price as the measure of price changes. This measure of the change in coal prices is multiplied by the log of coal reserves. Because new mines require some setup time, we use two lags of this variable as well.

In column (2) of Panel A, we provide the 2SLS estimates of equation (3) using the measures of the change in the value of the coal reserve. The 2SLS estimate suggests a strong and statistically significant impact of earnings growth on DI expenditures. A 10-percent increase in earnings within the county would reduce the amount of DI payments by about 3.5 percent. Thus, increases in earnings seem to reduce DI payments. In columns (3) and (4) of Panel A, we repeat the estimation excluding the other covariates. The OLS estimate indicates essentially no relationship between DI payments and local earnings growth, but the 2SLS estimate suggests a strong and statistically significant impact of earnings growth on DI expenditures. Interestingly, the exclusions of the other covariates leave the point estimates for the earnings growth coefficients essentially unchanged.

DI caseloads change largely by changing the rate of new cases. We may use these estimates to make a back-of-the-envelope calculation about the magnitude of the rate of reduction in the number of new cases. Suppose that initially the DI program has a constant growth rate. If each case has the same expenditures, changes in expenditures are

$$\Delta E_t = N_t - \gamma_1 E_{t-1}$$

where ΔE_t is the change in real expenditures, N_t is the expenditures resulting from new cases (number of "inflows"), γ_1 is the rate at which old cases leave the DI rolls, and E_{t-1} is the level of expenditure last period ($\gamma_1 E_{t-1}$ is the number "outflows"). Dividing both sides by E_{t-1} we obtain

$$\Delta E_{\text{percent}} = (N_t/E_{t-1}) - \gamma_1.$$

TABLE 3—THE IMPACT OF EARNINGS GROWTH ON THE CHANGE IN DISABILITY INSURANCE AND SUPPLEMENTAL SECURITY INCOME PAYMENTS: KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA, 1970–1993

	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Controls:				
State-year dummies	Yes	Yes	Yes	Yes
County is in MSA (1990)	Yes	Yes	No	No
County's population	Yes	Yes	No	No
Change in county's population	Yes	Yes	No	No
Fraction of earnings from manufacturing, 1969	Yes	Yes	No	No
Instruments: Change in value of coal reserves and two lagged values	No	Yes	No	Yes
Panel A: Disability Insurance Payments				
Change in county's earnings	−0.002 (0.11)	−0.345 (3.95)	0.002 (0.10)	−0.347 (4.24)
First-stage F-statistic on excluded instruments	—	26.7	—	28.0
N	7,260	7,260	7,260	7,260
Panel B: Supplemental Security Income Payments				
Change in county's earnings	−0.023 (1.58)	−0.713 (5.33)	−0.020 (1.40)	−0.639 (5.48)
First-stage F-statistic on excluded instruments	—	26.5	—	27.9
N	7,904	7,904	7,904	7,904

Notes: Authors' calculations are from data sources given in the Appendix. Dependent variables are the log differences in real DI payments and the log differences in real SSI payments. We give absolute values of *t*-statistics in parentheses. We use Huber-White robust variances to estimate *t*-statistics, and we adjust standard errors to account for possible nonindependence using Stata's cluster command. There are 330 counties in the four-state region. No data on DI payments are available for 1981 so no observations are available for 1981 or 1982. SSI payments data for ten observations are suppressed to preserve confidentiality.

The rate of change in expenditures is just the difference between the rate of inflows and outflows. Combining information from Burkhauser and Haveman (1982) and from the SSA Annual Statistical Supplement (1981), γ_1 , the annual rate of outflows, appears to be approximately 0.089.¹⁰ Between 1970 and 1995, the real expenditures of the DI system grew at annual rate of 7.9 percent. As ΔE percent = 0.079, the rate of inflows must have been 16.8 percent ($N_t/E_{t-1} = 0.168$). Now suppose the impact of the coal boom reduces DI expenditures solely through changes in the inflow of new cases. For the coal areas we have

¹⁰ There are two components to γ_1 (the outflow rate): the rate at which people "recover" from their disability and the rate at which the caseload population "ages out" of DI. Using 1978 data, Burkhauser and Haveman (1982) estimate that a very small fraction (1.6 percent) of the caseload "recovers" each year. Recipients also leave the DI program at age 65 when the SSA transfers the recipient to old-age retirement. In 1978, according to the SSA Annual Statistical Supplement (1980), 7.3 percent of the DI caseload was 64 years of age and would age out.

$$\Delta E^c \text{percent} = (1 - \alpha)(N_t/E_{t-1}) - \gamma_1$$

where $\alpha < 1$ denotes the rate of reduction of new cases arising from the coal boom. Differentiating the two percentage growth equations, we have

$$\Delta E \text{percent} - \Delta E^c \text{percent} = \alpha 0.168.$$

Over the boom, large coal counties grew 3.6 percent faster than counties with little or no coal. The point estimate in Table 3 suggest this 3.6-percent increase in earnings reduces DI expenditures 1.26 percent so that $\alpha \approx 0.0126/0.168 \approx 0.075$. Thus, the 3.6-percent increase in earnings reduced the number of new entrants by 7.5 percent. If some of the stock of recipients did return to work, this calculation overestimates the responsiveness of the new entrants.

In Panel B of Table 3, we repeat the analysis for SSI payments. Again, the OLS estimates, reported in columns (1) and (3), indicate only an

extremely weak link between earnings growth and the growth in SSI payments. While the estimated coefficient on earnings growth is negative, it is statistically insignificant and economically inconsequential. A 10-percent increase in earnings in a county would reduce SSI payments by only 0.2 percent.

In columns (2) and (4) of Panel A, we provide the 2SLS estimates of equation (3) with and without the other covariates. Both of the 2SLS estimates imply a much larger impact of earnings growth on SSI expenditures. A 10-percent increase in earnings in a county would reduce SSI payments by more than 6 percent. Thus, there is a substantial and statistically significant inverse relationship between growth of earnings and SSI payments within the county.

As Orley Ashenfelter (1983) notes, means testing, such as is done in the SSI program, adds an additional complication to the model. Because the SSI program is means tested, financially ineligible workers have an incentive to work less, thus reducing family income, if doing so allows a disabled family member to collect SSI. A positive shock to earnings, therefore, reduces participation in SSI in two ways. First, as before, it increases the value of labor-force participation for a potential participant. Second, some workers will have family members who are potential participants. Higher earnings for these workers may preclude benefits for disabled family members as the workers' higher earnings may push the entire family above the maximum allowable income. Thus, both of these factors contribute to the correlation between local economic conditions and SSI participation.

We have shown that for the four states the energy boom of the 1970's and the subsequent economic collapse of the coal fields significantly affected disability program participation. Do the large impacts of local economic conditions on disability program participation generalize to other regions? There are at least two distinct issues. First, we have identified the impact of earnings growth on changes in disability payments using movements in coal prices, and coal is mined predominately in rural areas. It is possible that the relationship between earnings growth and disability payments is intrinsically different in rural areas than in urban areas. Because coal areas are rural, physicians are

likely to know their patients more intimately than do physicians in cities. Although SSA rules forbid physicians from taking into account the state of the local economy, physicians may be more willing to certify a patient as disabled when they know that the patient is unlikely to be able to find alternative employment and are familiar with the economic dislocation that the patient's family is experiencing. If this is so, then the applicability of this study to large urban areas may be limited.

On the other hand, the impact of changes in county earnings on changes in SSI and DI receipt are remarkably similar between counties with moderate coal reserves and counties with large coal reserves. Counties with large coal reserves are more rural, are smaller, and have a structure of employment very different from moderate coal areas. Counties with moderate coal reserves are as urban, have a similar employment structure, and are almost as populous as noncoal areas. Thus, the impact of earnings growth on SSI and DI payments was very similar across two areas that are quite different.

A second possible issue is perhaps more important. The coal industry employs a much different set of workers than the economy as a whole. In Table 4, we describe the workers employed in the coal-mining industry in the four-state region in the 1970, 1980, and 1990 Census years. Regardless of the year, coal mining is a male-dominated industry, with males comprising 95 percent of the industry even in 1990. The data also demonstrate that the coal boom had a dramatic effect on the age structure of the industry. Between the 1970 and 1980 Censuses, the industry became much younger as it expanded and older miners retired. Similarly, between the 1980 and 1990 Censuses, we see evidence of the industry aging somewhat. The data also document that coal mining is an industry in which workers have very limited education. Even in 1990, 30 percent of the industry was comprised of workers without a high-school diploma.¹¹ Thus, the coal industry employs a disproportionate number of low-skilled workers.

¹¹ While Table 4 shows a dramatic drop in the percentage of workers with an eighth-grade education or less, the prevalence of individuals in this region with an eighth-grade education or less fell by the 1980 Census.

TABLE 4—CHARACTERISTICS OF WORKERS IN THE COAL-MINING INDUSTRY IN KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA: 1970, 1980, AND 1990 CENSUS DATA (IN PERCENTS)

	All Workers			Coal-Mining Industry Workers		
	1970	1980	1990	1970	1980	1990
Age						
Less than 25	20.5	22.4	16.7	10.4	16.2	4.8
25 to 34	19.5	26.7	26.9	18.7	19.8	25.2
35 to 44	20.1	18.7	25.8	22.5	20.8	40.2
45 to 55	21.3	16.8	17.1	29.9	15.0	20.4
55 to 64	14.5	12.5	10.4	16.8	9.3	8.5
65 and over	4.0	3.0	3.0	1.7	0.9	0.9
Years of schooling						
Less than 8 years	16.5	7.1	3.5	44.4	17.5	9.8
9 to 12 years, no diploma	20.9	14.9	14.1	23.4	20.7	20.0
High-school graduate	40.2	45.0	39.6	27.0	46.9	49.8
Some college	11.0	16.5	24.4	3.8	9.8	15.3
College graduate	11.4	16.5	18.4	1.5	5.2	5.1
Gender						
Male	63.3	58.9	54.8	97.3	95.8	95.2
Female	36.7	41.1	45.2	3.7	4.2	4.8

Notes: Authors' compilations are from the 1970, 1980, and 1990 Public Use Micro Sample of the Decennial Censuses. Data includes all workers in the coal-mining industry regardless of occupation.

To get a feel for how these results might generalize, we consider the impact of the decline in the primary metals industry on DI and SSI payments. Between 1982 and 1987, earnings in the primary metals industry declined from 1.5 percent to 1.0 percent of total U.S. earnings. We collected DI payments by county in 1982 and 1987 for six large steel-producing states: Alabama, California, Illinois, Indiana, Michigan, and New York. These six states, along with Pennsylvania and Ohio, comprised the eight states with the largest employment in primary metals. (We exclude Pennsylvania and Ohio to avoid having to control for the decline in mining as well.) Like coal, primary metals employed large numbers of low-educated men at very high wages, and the decline of the primary metals industry displaced many highly paid, low-skill men.

In Panel A of Table 5, we consider how the decline in the primary metals industry affected DI payments in the six-state region from 1982 to 1987. In column (1) we present the OLS estimates. As in the coal-producing states, the OLS estimate suggests no relationship between earnings and DI payments. Again, the 2SLS

results suggest a much different outcome. For an instrument, we use the county's fraction of male employment in primary metals from the 1970 Census. The results indicate that a 10-percent decline in earnings is associated with a 3.6-percent increase in DI payments, a result that is quite similar to our estimates from the coal-producing regions. In column (3), we provide estimates for the first-stage regression, documenting that earnings within the county are highly correlated with the fraction of male employment in primary metals in 1970. Finally, in column (4), we present the reduced-form regression results, which suggest that during the period of massive closing of steel plants, areas with a historically large fraction of workers in the primary metals industries had DI payments grow faster than elsewhere. Thus, results from both the coal and primary metals industries suggest that declines in these industries are associated with growth in disability payments.

In Panel B of Table 5, we present similar evidence for SSI payments. Again, the OLS estimates indicate no statistically significant relationship between local labor-market earnings and SSI payments. The 2SLS results, however,

TABLE 5—IMPACT OF EARNINGS GROWTH ON THE CHANGE IN DISABILITY INSURANCE AND SUPPLEMENTAL SECURITY INCOME PAYMENTS FROM 1982 TO 1987: ALABAMA, CALIFORNIA, ILLINOIS, INDIANA, MICHIGAN, AND NEW YORK

Panel A: Disability Insurance	(1) OLS	(2) 2SLS	(3) First stage	(4) Reduced form
Controls:				
State dummies	Yes	Yes	Yes	Yes
Fraction of male employment in primary metals, 1970	No	Yes	—	—
Change in earnings	-0.010 (0.28)	-0.361 (2.50)	—	—
Fraction of male employment in primary metals, 1970	—	—	-0.691 (4.78)	0.249 (2.99)
<hr/>				
Panel B: Supplemental Security Income	(1) OLS	(2) 2SLS	(3) First stage	(4) Reduced form
Controls:				
State dummies	Yes	Yes	Yes	Yes
Fraction of male employment in primary metals, 1970	No	Yes	—	—
Change in earnings	-0.042 (0.81)	-1.049 (3.06)	—	—
Fraction of male employment in primary metals, 1970	—	—	-0.691 (4.78)	0.729 (4.77)
N	464	464	464	464

Notes: Authors' calculations are from data sources given in the Appendix. The dependent variables in columns (1), (2), and (4) are the log differences in real DI and SSI payments in 1987 and 1982 and the log differences in earnings in column (3). We give absolute values of *t*-statistics in parentheses. We use Huber-White robust variances to estimate *t*-statistics.

suggest that a 10-percent decline in earnings is associated with a 10-percent increase in payments. Thus, we again find that the decline in SSI payments exceeds the decline in DI payments.

If low-skilled workers are more likely to pursue disability benefits when displaced from their jobs, this suggests that other sources of economic growth are likely to lead to more modest declines in disability program participation. This said, the decline in the economic opportunities of low-skilled workers is well documented. For this reason, we believe that this study has much to say about the increase in disability program participation among men, particularly among low-skilled men.

B. Nonparametric Estimates

In this section, we began to explore why the magnitude of instrumental variables estimates are so much larger than the magnitude of the OLS estimates. In this subsection, we construct nonparametric estimates that allow us to examine more closely the variation that produces the large instrumental variables estimates. These nonparametric estimates better identify the impact of the coal price-induced

earnings growth on the growth in disability payments.

As the controls have little impact on the estimated coefficient on county earnings growth, we exclude them from our nonparametric analysis. As before, we classify counties into one of three coal regions. Counties with at least a billion tons of coal reserves are defined as large coal-reserve counties. Counties with more than 100 million, but less than a billion, tons of coal reserves are defined as moderate coal-reserve counties. Counties with less than 100 million tons of coal reserves are considered outside the coal region. We refer to these categories as the "region" of the county. We also divide the data into three periods: the boom years between 1970 and 1977 (Boom), the peak years between 1978 and 1982 (Peak), and the bust years between 1983 and 1993 (Bust). The first-stage equation for the change in (log) earnings is

$$(2') \quad \Delta(\text{earnings}_{ist}) = \alpha_0 + \text{year}_{st}\alpha_{1st} \\ + \mathbf{C}_{ist}\gamma + u_{ist}$$

where \mathbf{C}_{ist} is a vector that indicates whether *i*th county in the *s*th state has large coal reserves or moderate coal reserves and whether the time

TABLE 6—ALTERNATIVE ESTIMATES OF THE IMPACT OF THE COAL SHOCKS ON DISABILITY INSURANCE AND SUPPLEMENTAL SECURITY INCOME PAYMENTS: KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA, 1970–1993

Period	Difference in the logarithm of real earnings		Difference in the logarithm of real Disability Insurance payments		Difference in the logarithm of real Supplemental Security Income payments	
	Counties with moderate coal reserves compared to counties with little or no reserves	Counties with large coal reserves compared to counties with little or no reserves	Counties with moderate coal reserves compared to counties with little or no reserves	Counties with large coal reserves compared to counties with little or no reserves	Counties with moderate coal reserves compared to counties with little or no reserves	Counties with large coal reserves compared to counties with little or no reserves
	(1)	(2)	(3)	(4)	(5)	(6)
1970–1977	0.014 (3.96)	0.035 (6.48)	-0.016 (5.47)	-0.030 (7.67)	-0.004 (0.85)	-0.017 (3.56)
1978–1982	0.004 (1.00)	0.002 (0.30)	-0.010 (3.36)	-0.024 (6.56)	0.007 (1.93)	0.001 (0.18)
1983–1993	-0.018 (6.58)	-0.034 (8.19)	-0.003 (1.60)	-0.004 (1.31)	0.004 (1.69)	0.014 (4.28)

Notes: Authors' calculations are from data sources given in the Appendix. All regressions contain state-year fixed effects. We report absolute values of *t*-statistics in parentheses calculated using Huber-White standard errors, and we adjust standard errors to account for possible nonindependence using Stata's cluster command.

period lies in the boom, peak, or bust. The coefficients, γ , are the average growth in earnings for counties with large coal and with moderate coal reserves relative to counties with little or no coal for each of the three time periods. The resulting 2SLS regression model is

$$(3') \quad \Delta y_{ist} = \beta_0 + \text{year}_{st}\beta_{st} \\ + \beta_3 \Delta(\hat{\text{earnings}}_{ist}) + \varepsilon_{ist}.$$

For a given state in a given year, $\Delta(\hat{\text{earnings}}_{ist})$ takes on only three values. Moreover, for a given state in a given period, the difference between any two regions' value of $\Delta(\hat{\text{earnings}}_{ist})$ is a constant for all years. Thus, the use of region and time indicators for our instrument series insures that we use only long-term differences in growth rates to identify the impact of earnings on disability payments.

To investigate the relationship among a county's earnings growth, its endowment of coal, and the coal price cycle, the average growth in county earnings is presented for the coal boom, peak, and bust, which are estimated from equation (2'). Columns (1) and (2) of Table 6 report the average economic performance of counties with large and moderate coal reserves relative to counties with small or no reserves of coal. Consistent with Figure 3, counties with moderate

coal reserves did modestly better during the boom period, averaging about 1.4 percent more growth in earnings than counties with little or no coal. Counties with large reserves of coal grew much faster, averaging a growth rate of 3.5 percent more than the growth rate of counties with little or no coal. During the bust, coal counties had much slower growth in county earnings relative to noncoal counties.

A similar exercise is conducted to investigate the relationship between a county's DI payment growth and its geographic location relative to the coal regions and period of the coal price cycle. We estimate

$$(4) \quad \Delta y_{ist} = \theta_0 + \text{year}_{st}\theta_{st} + C_{ist}\tau + u_{ist},$$

where in this model Δy_{ist} is the log difference in county DI payments. The coefficients, τ , are simply the average growth in DI payments for counties with large coal and with moderate coal reserves relative to counties with little or no coal for each of the three time periods. We report these in columns (3) and (4) of Table 6. During the coal boom, DI payments grew 3.0 percent slower in counties with large coal reserves relative to counties with little or no coal reserves and grew 1.6 percent slower in counties with moderate coal reserves relative to counties with little or no coal reserves.

TABLE 7—WALD ESTIMATES OF THE IMPACT OF THE COAL SHOCKS ON DISABILITY INSURANCE AND SUPPLEMENTAL SECURITY INCOME PAYMENTS: KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA, 1970–1993

Panel A: Disability Insurance Payments				
Period	Counties with little or no coal compared to counties with large reserves	Counties with moderate coal reserves compared to counties with large reserves	Counties with little or no coal compared to counties with moderate reserves	Three-region comparison
1970–1977	−0.828 (4.56) N = 2,072	−0.852 (2.45) N = 944	−1.296 (3.08) N = 2,264	−0.887 (5.13) N = 2,640
1978–1982	−2.128 (1.13) N = 777	−5.574 (0.22) N = 354	−2.120 (0.89) N = 849	−2.075 (1.30) N = 990
1983–1993	0.112 (1.26) N = 2,849	0.053 (0.28) N = 1,298	0.198 (1.60) N = 3,113	0.124 (1.62) N = 3,630
1970–1993	−0.333 (4.37) N = 5,698	−0.353 (2.12) N = 2,596	−0.234 (2.29) N = 6,226	−0.324 (4.85) N = 7,260

Panel B: Supplemental Security Income Payments				
Period	Counties with little or no coal compared to counties with large reserves (1)	Counties with moderate coal reserves compared to counties with large reserves (2)	Counties with little or no coal compared to counties with moderate reserves (3)	Three-region comparison (4)
1970–1977	−0.479 (2.94) N = 2,056	−0.704 (1.78) N = 944	−0.241 (0.66) N = 2,248	−0.460 (3.05) N = 2,624
1978–1982	−0.267 (0.11) N = 1,295	3.014 (0.47) N = 590	1.921 (1.02) N = 1,415	1.733 (0.93) N = 1,650
1983–1993	−0.382 (3.94) N = 2,849	−0.453 (2.03) N = 1,298	−0.257 (1.86) N = 3,113	−0.371 (4.36) N = 3,630
1970–1993	−0.424 (5.47) N = 6,200	−0.532 (2.64) N = 2,832	−0.209 (1.53) N = 6,776	−0.398 (5.60) N = 7,904

Notes: Authors' calculations are from data sources given in the Appendix. All regressions contain state-year fixed effects. We report absolute values of *t*-statistics in parentheses calculated using Huber-White standard errors, and we adjust standard errors to account for possible nonindependence using Stata's cluster command.

In columns (5) and (6) of Table 6, we present the average county growth in SSI payments for counties with large coal reserves and with moderate coal reserves relative to counties with little or no coal. We see that during the coal boom, counties with moderate coal reserves had SSI payments grow 0.4 percent slower and counties with large coal reserves had SSI payments grow 1.7 percent slower than noncoal counties. During the coal bust, SSI grew much faster in the coal areas than in the noncoal areas. Relative to noncoal areas, the SSI payments grew 0.4 per-

cent faster in the counties with moderate coal reserves and 1.4 percent faster in the counties with large coal reserves.

In the spirit of Abraham Wald (1940) and Joshua D. Angrist (1990), we may exploit this variation in region and coal prices to form several nonparametric instrumental variables estimators of the impact of earnings on DI and SSI payments. We report the estimates in Table 7, providing the DI estimates in Panel A and the SSI estimates in Panel B. Consider first the SSI estimates. Using data for the boom period

alone, we obtain an elasticity estimate of -0.46 ; using data from the bust period alone, we obtain an elasticity estimate of -0.37 , which we view as quite similar. Similarly, when we use two-way comparisons between the region with large coal reserves and one of the other regions, we get reasonably similar elasticity estimates.

In contrast, we find a great deal of instability in our DI estimates. For example, we find estimates from the boom period suggest an estimate of -0.89 . This elasticity is very large, and, in our view, implausibly large. Moreover, the estimated elasticity is even more negative in the peak, albeit statistically insignificant, and in the bust the estimated elasticity is actually positive, although again insignificant. Obviously, the intertemporal volatility of the elasticity estimates calls into question the point estimates that we presented in Tables 2 and 3.

A closer examination of Table 6, however, suggests a reason for the strong correlation between local economic conditions and DI program payments during the boom yet no correlation during the bust. While not statistically significant, when coal and noncoal areas are experiencing the same growth in their local economies (1978–1982), coal counties appear to have DI payments expanding much more slowly than noncoal areas. It may be that there is a permanently lower growth rate of DI payments in areas with coal. If this is true, then this difference in the baseline growth rate of DI payments exacerbates the negative correlation between local economic conditions and DI growth rates during the boom while reducing the measured effect during the bust.

In order to test our contention that growth rates in DI payments vary by region, we reestimate our nonparametric model including region fixed effects. Table 8 presents the results from this model. In row (1), we report the nonparametric estimates with fixed effects for whether the county has little or no coal, moderate coal reserves, or large coal reserves. As we expected, given Table 6, the fixed effects indicate that DI payment growth is slower in areas with moderate coal reserves than in areas with little or no coal and even slower in areas with large endowments of coal. Controlling for this, the estimated impact of earnings growth on DI payments increases somewhat. We estimate that

a 10-percent increase in earnings would decrease DI payments about 3.9 percent.

In the next three rows, we reestimate the model using only two of three regions—counties with little or no coal and moderate coal reserves in row (2), counties with little or no coal and large reserves in row (3), and counties with moderate reserves and large reserves in row (4). Each of these two-way comparisons provides similar estimates of the magnitude of the impact of earnings on DI payments, with the estimates ranging from -0.37 to -0.41 , and each is statistically significant. In the next three rows, we reestimate the model using only two of the three periods: the peak and bust in row (5), the boom and bust in row (6), and the boom and peak in row (7). For the peak and bust sample and the boom and bust sample, the estimated coefficients are again quite similar, -0.41 and -0.39 , respectively, and both are statistically significant. For the boom and peak sample, the point estimate is -0.30 , but it is imprecisely estimated.

The presence of the region fixed effects suggests that the semiparametric estimates in Table 3 may be biased as well. In the last two rows, we reestimate the semiparametric 2SLS models using a specification similar to that in column (4) of Table 3. In row (8), we reestimate including region fixed effects for the model, and in row (9), we estimate the model with county fixed effects, with both models providing very similar estimates. The estimates imply that a 10-percent increase in county earnings would reduce DI payments about 2.7 percent. Finally, in row (10), we reestimate the nonparametric model with county fixed effects. The results imply that a 10-percent increase in county earnings would reduce DI payments about 3.9 percent.¹² Again, the nonparametric instrumental variable estimate is larger than the 2SLS estimate.

For both programs and for both the coal and steel industries, the magnitudes of the instrumental variables estimates are several times the

¹² The permanently lower growth rate in the coal areas results from the higher rates of DI prior to the coal boom. If we condition on the 1969 per capita level of DI payments and its square, the estimated seam fixed effect drops dramatically in magnitude and is generally insignificant. The results are available on request from the authors.

TABLE 8—ESTIMATES OF THE IMPACT OF THE COAL BOOM AND BUST ON DISABILITY INSURANCE PAYMENTS WITH FIXED EFFECTS FOR GROWTH RATES

	(1) Coefficient on difference of log earnings	(2) Moderate coal region fixed effect	(3) Large coal region fixed effect
(1) Full sample (N = 7,260)	-0.386 (5.42)	-0.010 (5.20)	-0.017 (6.35)
Two-way comparisons by seam:			
(2) Counties with little or no coal and counties with moderate reserves only (N = 6,226)	-0.408 (3.57)	-0.011 (5.24)	—
(3) Counties with little or no coal and counties with large reserves only (N = 5,698)	-0.374 (4.71)	—	-0.017 (6.05)
(4) Counties with moderate coal reserves and counties with large reserves only (N = 2,596)	-0.413 (2.36)	0.008 (2.91)	—
Two-way comparison by time period:			
(5) Peak and bust only (N = 4,620)	-0.408 (3.52)	-0.010 (3.94)	-0.018 (4.19)
(6) Boom and bust only (N = 6,270)	-0.385 (5.25)	-0.010 (4.93)	-0.017 (6.05)
(7) Boom and peak only (N = 3,630)	-0.295 (1.29)	-0.011 (3.18)	-0.020 (2.97)
Alternative 2SLS estimates:			
(8) 2SLS with change in value of coal reserves and two lagged values as instruments and fixed effect for large and moderate coal reserves (N = 7,260)	-0.275 (3.65)	-0.010 (5.26)	-0.017 (-6.77)
(9) 2SLS with change in value of coal reserves and two lagged values as instruments and county fixed effects (N = 7,260)	-0.271 (3.57)	—	—
(10) 2SLS with seam and time interactions as instruments and county fixed effects (N = 7,260)	-0.386 (5.30)	—	—

Notes: Authors' calculations are from data sources given in the Appendix. All regressions contain state-year fixed effects. We report absolute values of *t*-statistics in parentheses calculated using Huber-White standard errors, and we adjust standard errors to account for possible nonindependence using Stata's cluster command. Dependent variable is the logarithm of real DI payments.

magnitude of the OLS estimates. Traditionally, researchers have sought to explain such differences by suggesting that there is an endogenous relationship between county economic conditions and the growth in disability payments. While we certainly would not deny the potential for such endogeneity, we do not feel this is the major reason for the differences. We believe the instrumental variables estimates are larger than the OLS estimates because estimated growth in earnings from the first-stage regression is much smoother than the actual earnings growth and better captures important variations in local economic conditions.

Consider the two series, actual and instrumented changes in earnings. While the two county earnings series have the same mean

(0.012) by construction and are highly correlated (0.605), the standard deviation of the instrumented earnings growth is only 0.049 compared to 0.082 for the actual earnings growth. To the extent that much of the extra variation in actual earnings growth is the result of transitory shocks, the instrumented series removes much of the "noise" from the earnings data. For instance, we observe that in the coal belt of eastern Kentucky, the earnings in Pike County responded immediately to the 1974 price shock, while in neighboring Martin County they responded continuously over a three-year period. Because both Pike and Martin County, however, have over a billion tons of coal reserves, the instrumented series will underestimate growth in Pike County and overstate

growth in Martin County in the first year of the boom. This smoothing of the Pike and Martin earnings series, however, probably better reflects important aspects of the actual economic prospects of Pike and Martin County residents than the actual series. Moreover, short-term fluctuations from floods, strikes, and temporary plant closings, as well as slower growth because of rapid development in a neighboring county, are smoothed away by use of the stock of coal.¹³

To illustrate this argument, we divided the earnings series into the predicted series and the residual of the series, entering both into a regression otherwise specified as in column (4) of Table 3. Because the predicted series and its residual are orthogonal, this leaves unchanged the coefficient on predicted earnings. If there were a substantial endogeneity problem, however, one would suspect that the residual earnings growth, for instance, might be positively correlated with the growth in SSI payments. This is not the case. The coefficient on residual earnings growth is about -0.004, with a standard error of 0.014. For the DI program, the coefficient on residual earnings is positive, 0.009, but is only about half the size of its standard error, 0.016. In our view, this indicates that the county-level earnings series is excessively volatile rather than, strictly speaking, endogenous. The predicted earnings series seems to better capture the economic opportunity than the much more volatile actual earnings series. This is not surprising. Rational economic agents are forward looking, basing their behavior on current conditions and their forecasts of future conditions. Undoubtedly, their forecasts are smoother than realized economic time series. Our instrumental variables estimates reduce the volatility of earnings growth, which probably better reflects the economic prospects of these agents. This is particularly true when we use the region and period interaction as instruments.

¹³ To get a feel for whether smoothing across time or across space was important for variance reduction, we estimated the SSI model using the county's average earnings growth for the boom, peak, and bust periods. While this resulted in a modest increase in the coefficient on earnings growth compared with the OLS estimate, the coefficient was only about one-sixth the magnitude of the 2SLS estimates. Smoothing across space is the more important component.

TABLE 9—IMPACT OF EARNINGS GROWTH ON THE CHANGE IN UNEMPLOYMENT INSURANCE EXPENDITURES: KENTUCKY, OHIO, PENNSYLVANIA, AND WEST VIRGINIA, 1970–1993

	(1)	(2)
Controls:	OLS	2SLS
State-year dummies	Yes	Yes
Instruments:		
Region and time-period interactions	No	Yes
Change in county's earnings	-0.586 (9.06)	0.031 (0.18)
N	7,867	7,867

Notes: Authors' calculations are from data sources given in the Appendix. Dependent variable is the log of real Unemployment Insurance payments. We give absolute values of *t*-statistics in parentheses. We use Huber-White robust variances to estimate *t*-statistics, and we adjust standard errors to account for possible nonindependence using Stata's cluster command. There are 330 counties in the four-state region.

The variation we use for identification in this specification is simply the mean difference in growth rates across the regions during the boom, peak, and bust. No within-region variation or within-period variation remains in the predicted series. Changes in local economic conditions that are correlated with these long-run changes in the value of coal reflect changes in economic opportunity rather than the year-to-year variation that comes and goes with business cycles. As a test of this argument, we re-ran our analysis on a new dependent variable that should be less responsive to permanent changes in economic conditions and more responsive to transitory changes.

Unemployment insurance is designed to act as a buffer for business-cycle fluctuations. We would therefore expect unemployment insurance expenditures to be quite sensitive to transitory fluctuations in county-level earnings. Because benefits are time limited, it is less obvious that unemployment insurance expenditures should be particularly sensitive to permanent changes in economic conditions. Using information on unemployment insurance expenditures by county from the Bureau of Economic Analysis (BEA) data, we estimate the OLS and instrumental variables models with unemployment insurance expenditures as the dependent variable. The results are reported in Table 9.

We see that the OLS coefficient on earnings is greater than -0.5 and highly significant. Us-

ing our region and time-period indicators as instruments, however, we find that the estimated effect of local economic conditions on unemployment insurance expenditures is near zero. These results are in direct contrast to the results for DI and SSI participation in which using these same instrumental variables increased the magnitude of the coefficient substantially. These results provide some support for our argument that the instruments' role in the SSI and DI participation examples is extracting the variation related to the permanent, and not transitory, component of earnings.

V. Conclusions

In this paper, we used variations in local labor-market conditions to estimate the impact of economic growth on disability program participation. To obtain an exogenous shock to local economies, we used data from four coal-producing states and used the coal boom and bust as a natural experiment to identify the impact of earnings growth on disability program participation. The coal boom substantially increased earnings in coal-producing areas within the region. The economic benefits of the coal boom, however, were not spread evenly across the region. Even in the Appalachian areas of Kentucky, Ohio, Pennsylvania, and West Virginia, 53 of the 186 counties have little or no coal reserves, and among those counties with coal reserves there are great differences in endowments. We used the variation in the price of coal over time combined with the variation in coal reserves across space (together, the value of a county's coal reserve) to investigate the effects of economic growth and decline on disability program participation. We found that for the DI program, the elasticity of program payments with respect to local earnings is about -0.3 or -0.4 . For SSI, the elasticity is somewhat larger, between -0.4 and -0.7 .

Our results suggest that permanent job creation or destruction has a much larger effect on disability program use than more transitory local labor-market changes. This is supported by the lack of correlation between coal price-induced changes in the local economy and the use of the unemployment insurance program, a program with time-limited benefits. It is also supported by nearly identical findings for a dif-

ferent source of permanent job destruction, the collapse of the steel industry on DI and SSI program use.

Given the decline in earnings of low-skilled workers, our findings may help explain the findings of Juhn (1992), who documents that the decline in labor-force participation is particularly severe among less educated men. Our use of coal prices and endowments provides a strategy for examining the impact of local earnings growth on a host of outcomes. For example, economists may be concerned about the impact of local labor-market conditions on high-school and college enrollments, welfare participation, crime, out-of-wedlock births, and household formation. In each case, the energy boom and bust may provide important evidence about the impact of local labor-market shocks on these outcomes.

Bound and Waidmann (1992) note that there are potentially important policy implications about the responsiveness of disability program participation to economic incentives. If the availability and generosity of disability programs has reduced labor-force attachment because of "malingering," if those receiving disability payments are "perfectly capable of working," then the "social costs of the disability transfers have been high and the target efficiency low" (p. 1417). An immediate question arises: Do our results provide evidence of this malingering?

The idea that potential claimants are guilty of malingering if they respond to economic incentives appears predicated on a notion of disability as a dichotomous state. In this view, people with disabilities are incapable of working so those who respond to economic incentives must not be disabled. This view, however, is most certainly incorrect. Professional athletes often participate in their sports with injuries that would render most of us disabled. Presumably, the outstanding remuneration associated with participating renders the undeniable pain associated with their injuries endurable. One could interpret the results that we present as evidence of the disabled workers' commitment to the labor market. Individuals who would otherwise qualify for disability programs work when provided with the opportunity. When disabilities are viewed as a continuum, little is learned about whether the existing programs are

targeting the "truly needy" by examining the responsiveness of those with disabilities to economic shocks. Rather, their responsiveness to economic shocks informs us about the number of individuals for whom participation in disability programs is a marginal decision. Whether these recipients should be admitted to disability programs cannot be answered by looking at their responses to economic shocks.

Our analysis can provide, however, insight into why disability program participation has increased. Because the disability system in the United States is relatively more generous for low-wage workers, the disincentive effects of the program are necessarily greatest for these workers. Thus, one suspects that the decline in labor-force opportunities for low-skilled workers affected the rate of participation in disability programs, but the magnitude of this effect is an open question. For two industries that employ low-skilled workers, our analysis suggests the changes in the economic opportunities had sizeable impacts on disability caseloads and expenditures.

APPENDIX: DATA DESCRIPTION

All dollar values are deflated by the CPIU with the base year index as 1983. The July index values of each year are used. We use the Producer Price Index (PPI) for coal divided by the Consumer Price Index of Urban wage earners (CPIU) as a measure of coal prices. We use the Bureau of Economic Analysis' (BEA) Regional Economic Information System (REIS) for our measures of annual county earnings, population, the fraction of earnings from manufacturing in 1969, and SSI payments.

County-level data for DI expenditures was obtained from published and unpublished reports from the SSA. We obtained the data for 1978 to 1980 and 1982 to 1993 from the American Statistical Index (ASI). The Office of Research and Statistics of the Social Security Administration provided the data for 1969–1979. No county-level data are available for 1981.

For information on the reserves of coal located in Kentucky counties, we obtained the Kentucky Geological Survey's (KGS) Kentucky Coal Resources Information Database (Kentucky Coal Marketing and Export Council,

1993). The KGS divides coal reserves into those with seams between 14" to 28", which cannot be efficiently mined, and those with seams of 28" or greater, which we treat as a proxy for coal that could be mined. For Pennsylvania, we obtained estimates of 28" seams from William E. Edmunds (1972), Table 3. Unfortunately, we have no measures of 28" reserves for either Ohio or West Virginia. For Ohio, however, we have estimates of 14" and greater reserves; this data can be accessed over the Internet at http://www.dnr.state.oh.us/odnr/geo_survey/ogcim/coalgpr/counres.htm. For West Virginia, we obtained estimates of 12" and greater reserves from Stephen F. Webber (1996). Robert Andrews (Kentucky), Doug Crowell (Ohio), and Steve McClelland (West Virginia) of each state's Geological Survey answered numerous inquiries and provided help in interpreting the geological data. Because Ohio and West Virginia coal reserves are for 14" and 12" reserves, we adjusted their reserves estimates by two-thirds, which is roughly the ratio of 28" reserves to total reserves in Kentucky.

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