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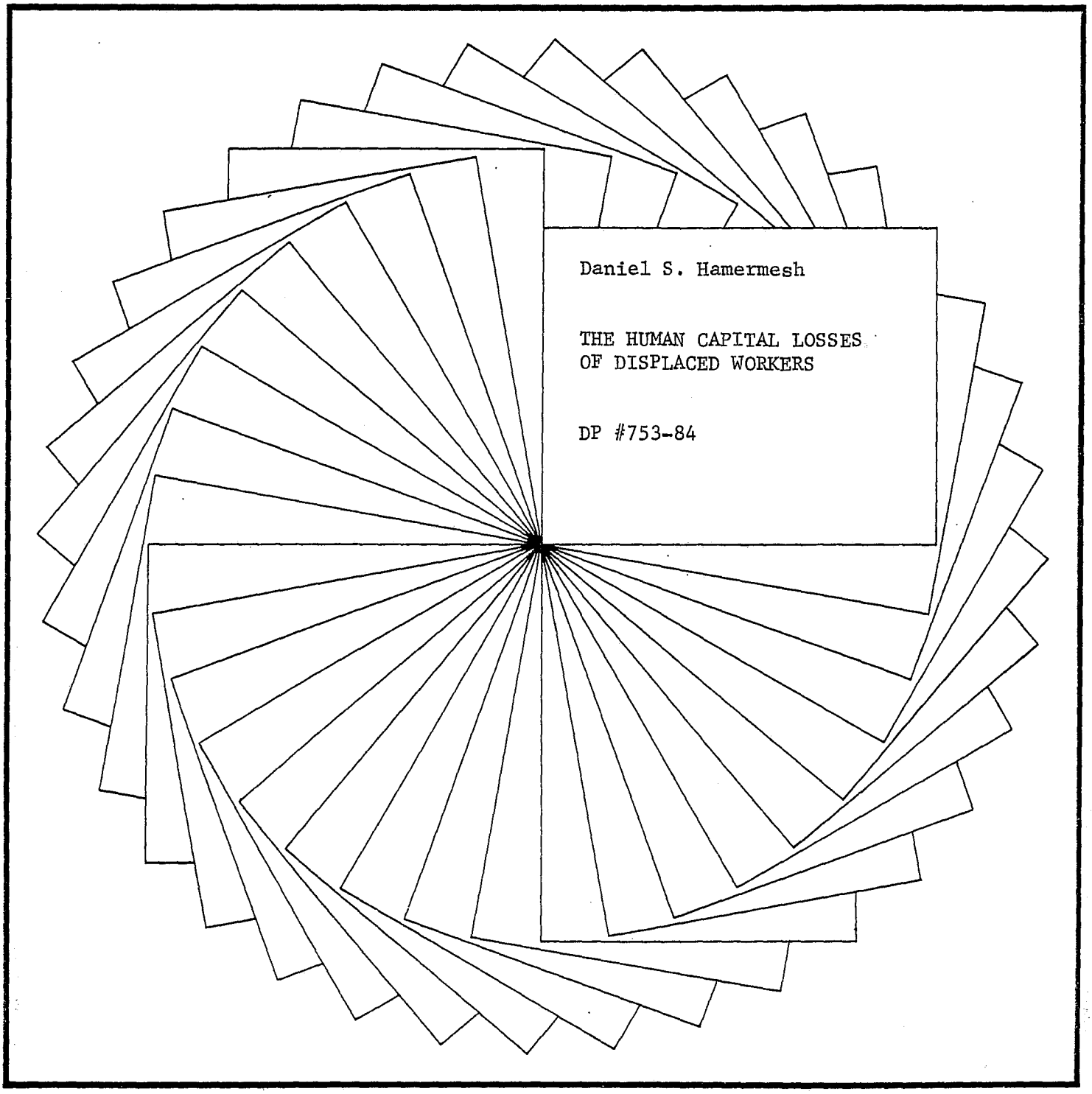

THE HUMAN CAPITAL LOSSES OF DISPLACED WORKERS

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July 1984

Helpful comments on an earlier version of this paper were received from Carl Davidson and participants at seminars at Cornell University and the Universities of Delaware, Pennsylvania and Toronto. This research was supported in part by a contract to the Institute for Research on Poverty of the University of Wisconsin from the U.S. Department of Health and Human Services. The views expressed in this paper are those of the author and do not necessarily reflect the views of either DHHS or the Institute for Research on Poverty.

Abstract

The characteristics of a sample of workers from the Panel Study of Income Dynamics who were laid off permanently or whose plants closed between 1968 and 1981 are examined. The displaced workers are found to have roughly the same characteristics as the typical labor-force participant, while those laid off are somewhat younger and less educated. A theoretical model of the losses resulting from displacement is put forth, in which the main loss is the value of the remaining firm-specific investment embodied in the worker. The size of this loss depends on the ability of firms and workers to foresee the impending end of the job, and on how their ability translates to the outcome of the bargaining over the burden and size of the firm-specific investment that is made. In general, the side that has a longer horizon will bear more of the costs and reap more of the returns to this shared investment.

The theory is linked to empirical work on earnings equations by means of the observation that the wage-tenure profile will reflect the amount of specific training embodied in workers. If workers have good information about impending displacement, the expected diminution in such investment will be reflected in a flattening of the wage-tenure profile as the date of displacement nears. In a sample of workers laid off or displaced between 1977 and 1981, we find that no such flattening is apparent. This suggests either that the worker has little information about impending displacement, or that both workers and firms have little information.

The wage-tenure profile in the year before displacement is used, along with a series of projected quit rates based on several studies of

the quit-tenure relation, to measure the present value (to the worker) of the lost firm-specific training. Using best guesses about the rate of depreciation of human capital and the real rate of interest, the losses average around $6000 for workers in the sample.

I. INTRODUCTION

Perhaps the liveliest new topic in the debate over labor-market policy has been the treatment of declining industries and the workers attached to them. Calls for inchoate "industrial policy," proposals to aid "displaced workers," and attempts to prevent future losses to other workers are all responses to this perceived problem.[1] In this study I examine the meaning of the notion "displaced worker" and attempt to evaluate the magnitude and burden of the losses produced by displacement.

The term "displaced worker" is not well specified.[2] Workers may lose their jobs without any loss other than the time spent searching for new work. Conversely, workers may not experience spells of unemployment after losing jobs, yet may experience large, involuntary losses in earning power.

In this study I use a national sample of workers to identify the characteristics of those who might be classified as displaced. Although many of these job losers experience reductions in earnings, the entire reduction need not be a loss that should be compensated according to some welfare criteria. Thus proposals for measuring the losses using the time the worker spends unemployed or the decline in the wage rate from the previous job may reflect the true loss only loosely.[3] Accordingly, I discuss the nature of the resources lost to society. Most important, the study devises a method for determining whether such losses exist and how large they are. The output of this approach is an answer to the question, Do workers experience a loss in human capital upon losing their jobs, or is the loss solely a reduction in the rents (to characteristics such as sex, race, union status, etc.) that accrued on their previous jobs?

II. WHO ARE DISPLACED WORKERS?

In order of increasing breadth, three definitions of a "displaced worker" can be applied to existing data. The narrowest definition includes only those workers whose job losses result from competition from imports. The difficulty with this definition results from our inability to identify exactly which job losers are unemployed because of import competition.[4] Indeed, empirically it is difficult to distinguish these job losses from those that result from high costs induced by wage rates in excess of those paid to otherwise identical workers.

A broader definition would include all workers whose jobs disappeared because their employer closed the plant or business. The difficulty with this definition is that it creates an artificial distinction between workers, depending on whether the employer closed or merely curtailed operations. Thus a third, and still wider, definition would add to these workers all others who lost their jobs through layoffs that were not part of the closing of an entire plant. In this section I use both these definitions to examine the characteristics of workers who might be classified as displaced. One should note that both definitions relate to the nature of the workers' separation from their previous jobs; neither depends upon the workers' current labor-force status. This obviates the need to examine reservation wages as they affect the time workers spend in unemployment. A loss could have occurred as long as workers left their jobs involuntarily.

While other studies have attempted to measure the number of workers who might be categorized as "displaced," none has been able to distinguish between workers who are involuntarily separated from their

jobs because of plant closings and those who are on permanent layoff.[5] I use the Panel Study of Income Dynamics (PSID) to identify workers who left their jobs either because they were laid off or because the employer's business closed.[6] I thus distinguish between workers identified as "laid-off" and those called "displaced," even though both can be classified as displaced according to the third definition above. Among national samples the PSID is unique in allowing one to distinguish between job losers according to this characteristic.

Appendix Tables A.1-A.6 present estimates of the extent of displacement, and the characteristics of displaced workers, based on the PSID for the years 1969 through 1981. All the information is calculated using the survey's sampling weights (so that the characteristics are comparable to national averages). The information is based only on heads of households (since the data are available only for them); some involuntary separations are missing, and the data may be overstating or understating national average displacement rates, depending on whether household heads are more or less likely to be subject to displacement. As Table A.1 shows, the rate of "displacement" is roughly half that of the layoff rate. Both rates move in the expected direction with the business cycle. It is noteworthy, comparing 1975 and 1981, that even though the aggregate unemployment rate was lower in 1981, the rate of layoff and "displacement" in this sample was higher in 1981. Moreover, the "displacement" rate is higher relative to the layoff rate in the last five years of the sample than it was in 1971-1976.

Table A.2 shows that "displaced" job losers are older than those who were laid off. This may result from the requirement or custom that layoffs follow inverse seniority, a stipulation that is not so important

when an entire plant closes. Despite this difference the workers in our sample are about the same age on average as the typical employee: In 1976 the average wage and salary worker in the United States was 37 years old. There is no noticeable difference between "displaced" and laid-off workers in the fraction who are male (see Table A.3).[7] Both groups of workers are less well educated than the labor force generally (Table A.4): Less than 25 percent have gone beyond high school, and even by 1981 over one-third had not completed high school.

In 1976 only 9.3 percent of all employees were black, and only 4.2 percent classified themselves as Hispanic. Comparing these data to Table A.5, workers in our subsample are disproportionately minority, especially black employees. This is particularly the case for laid-off workers; "displaced" workers are more likely to be white, though less so than the entire labor force. Workers in our subsample are less likely to be married than the typical employee. In March 1976 70 percent of employees were married.[8] Yet in the subsamples of household heads (Table A.6) the percentage was less than this in most years. There was little difference in the fraction married between laid-off and "displaced" workers.

Household heads who are unemployed or have changed jobs because their employers ceased doing business or closed their plants are disproportionately unmarried minority workers with below-average educational attainment. That they are no different in age from the average employee belies the notion that the displacement problem, at least in terms of the workers who might be classified as such, is especially a problem facing older workers. It is worth noting, though, that workers who have lost

their jobs for this reason have different characteristics, particularly age and race, than do workers who were laid off permanently.

III. THE EFFECTS OF IMPENDING DISPLACEMENT ON INVESTMENT IN HUMAN CAPITAL

Consider what kinds of losses would be occasioned by the displacement of workers from their jobs. Rather than defining losses in terms of variables that are observed after the jobs are lost, I propose to measure the costs of displacement by examining workers before the displacement occurs. This contrasts with all previous work, which has attempted to infer the losses from displacement from workers' post-displacement experience, either the duration of their unemployment or the wage reduction they suffer when they become reemployed. The approach proposed here concentrates on examining workers' and firms' behavior during that period of time when the effects of an impending job loss may be developing. Moreover, this approach avoids introducing issues of job search, which are logically separate from measuring the loss from displacement, but that are necessarily introduced when the duration of unemployment or the wage change between jobs is studied.

A worker who is displaced from a firm may experience two kinds of wage loss. Rent that had accrued because some factor that protected the worker from competition may be lost if a new job is not similarly protected. Thus, for example, if the job from which the worker is displaced is unionized, but the job subsequently obtained is not, the worker suffers a loss in wages, ceteris paribus (see Wachter, 1983). However, the loss is a reduction in rent received, and its loss should not affect the ability of employers in the union sector to fill jobs in the future.[9] As

another example, a white male worker may have received large rents for these ascriptive characteristics on the job from which he was displaced, rents that are reduced on his subsequent job. Here too, this loss will not affect employers' ability to fill jobs of the kind that disappeared.

The second type of loss is a reduction in human capital. Workers and firms invest in human capital expecting some horizon over which the returns to the investment will be reaped. Impending displacement may represent a shortening of the horizon and perhaps a capital loss to the worker and/or the firm. Here the distinction between general and specific training is crucial. Displacement cannot affect the value of general training, for such training is by definition as applicable in any subsequent job as in the job that disappeared.[10] Thus the loss resulting from displacement cannot be a loss in the value of general human capital. Firm-specific human capital, however, is by definition lost when the worker leaves the firm. This investment may have been made with the expectation of a longer payout period than in fact occurred. Both the firm and the worker may suffer a capital loss because of the separation, with the size of each party's loss dependent upon the length of the payout period that was expected, the amount invested, and the share of the investment costs borne by each party.

These considerations suggest that an examination of the losses arising from displacement should be based only on the lost firm-specific human capital. This is not an easy task, insofar as the stock of human capital must be inferred from wages, and as the costs of investment in firm-specific human capital are shared by workers and firms. Nonetheless, we can use data on wage-tenure profiles along with some consideration about the efficient split of investment costs between workers

and firms to answer the questions: (1) Is there any loss? That is, are firm-specific investments being made that have a payout period that extends beyond the date of displacement? and (2) If so, which party, the worker or the firm, bears the costs of these ex post poor investments?

Consider the following technology for producing firm-specific training:

$$(1) \qquad B = B(t),$$

where t is the fraction of the initial period of employment that is spent in training. (All firm-specific training is assumed to take place during this first period.) B is the amount that the training adds to the worker's productivity each period; it is assumed to be constant over the entire life of the investment. I assume that production of specific training is characterized by diminishing returns, i.e., $B'>0$, $B''<0$, and that $B(0)=0$. The costs of producing the training are also a function of t, with C(t) described by C', $C''>0$, and $C(0)=0$. There is little evidence either way on the assumptions describing the shapes of B and C; I have merely made standard assumptions about production and cost technologies.[11] In making these assumptions I also ignore for simplicity any costs of training other than the value of trainees' time.

The worker and the firm are assumed to have identical discount rates and have utility functions U, $U'>0$, $U''<0$, defined over the benefits and costs of firm-specific training.[12] Let T_i be each party's horizon, the length of time it expects to reap returns on the investment in specific training, where i refers to the firm (F) or the worker (W). The worker bears some fraction s of the cost of the investment and reaps that same

fraction of the expected returns. The worker's expected utility stream is thus defined as

$$(2) \quad Z_W = U(sB(t)) \sum_{k=1}^{T_W} D^k + U(-sC(t)),$$

where D is the discounting factor 1/[1+r]. Z_F is identical to Z_W except 1-s replaces s, and T_F replaces T_W. Because this is a shared investment in which each side has monopoly power, the outcomes, t*, the optimal fraction of the initial period spent investing, and s*, the optimal fraction of the benefits and costs accruing to the worker, are subject to bargaining between the firm and the worker. The Nash equilibrium solution to this bargaining problem is the pair (t*,s*) that maximizes:

$$(3) \quad Z = Z_F Z_W.$$

If $T_F = T_W$, the assumption of identical discount rates and utility functions produces the standard Nash result that s*=.5.

The displacement problem seems logically based in the parties' expectations about the nature of the shortened horizon over which the shared returns to the investment in firm-specific training will be reaped. Thus the nature of the information available to both sides about the continued existence of the job in which the investment has been made will determine t* and s*. I examine cases in which the information available to each party is identical (symmetric), and in which the firm has better information about the job's impending demise (asymmetric). Asymmetry in the opposite direction, with the worker better able to foresee the job's disappearance, seems unlikely given the firm's control over decisions about operating its plant.

Case I.A. Symmetric Lack of Information

In this case neither party is aware that the job will disappear until the day the firm discovers that its profit-maximizing conditions dictate that the worker be laid off permanently (or the plant closed). Thus at all times up to the date of layoff the horizon seen by workers and the firm is unchanged at $T_F = T_W$, both greater than the ex post payout period of the benefits from the investment. Since in this case the information is identical to what it was in the absence of any discussion of the job's disappearance, the outcome of the bargaining problem that determines t* and s* will be unchanged. Both parties will experience a capital loss when the displacement occurs.

Case I.B. Symmetric Information about Impending Displacement

Assume in this case that the worker and the firm realize that, because of an exogenous drop in product demand, the worker's expected tenure in the firm has dropped to $T'_W < T_W$. Because information is symmetric, $T'_F = T'_W$. This change reduces both parties' perceived utility from investing in specific training. If training is still profitable at some $t^*>0$, it will be undertaken. And, since the Z_i remain symmetric, s* remains at .5. Given the assumptions about the shapes of B and C, though, $t^{*\prime}<t^*$: With a shorter horizon over which to reap the returns to firm-specific training, a smaller investment in such training will be made. The size of the profit over which the parties bargain will be smaller. For some T* the investment will no longer be profitable and t* will be zero.

Case II. Asymmetric Information

Asymmetric information about an impending job loss presumably means that both the worker and the employer realize the horizon has shortened, but the firm acquires this information first. However, the general nature of the problem can be analyzed just as well if we assume that the worker has no knowledge that the layoff is imminent until it actually occurs, while the firm knows the horizon has shortened. Thus

$$T_W = T'_W > T'_F > 0.$$

This means that the stream of returns seen by the firm is lower for every t at s*=.5 than that perceived (incorrectly) by the worker.

In this case two solutions to the bargaining problem implicit in (3) are possible, depending on how short the firm's horizon has become. If it is so short that there is no s*<1 that would make Z_F positive, the solution to the game will be s* = 1. If T'_F is sufficiently positive that $Z_F>0$ for some combination of t* and s*, then s*<1; but s*>.5, because

$$\partial Z_W/\partial s > -\partial Z_F/\partial s, \quad s = .5.$$

In both cases t* will decrease due to the shape of the worker's utility function.[13]

The general solution to the bargaining problem in (3) is shown in Figure 1 as a function of T_F and T_W. The greater the divergence between the parties' horizons, the more the split in the benefits and costs of

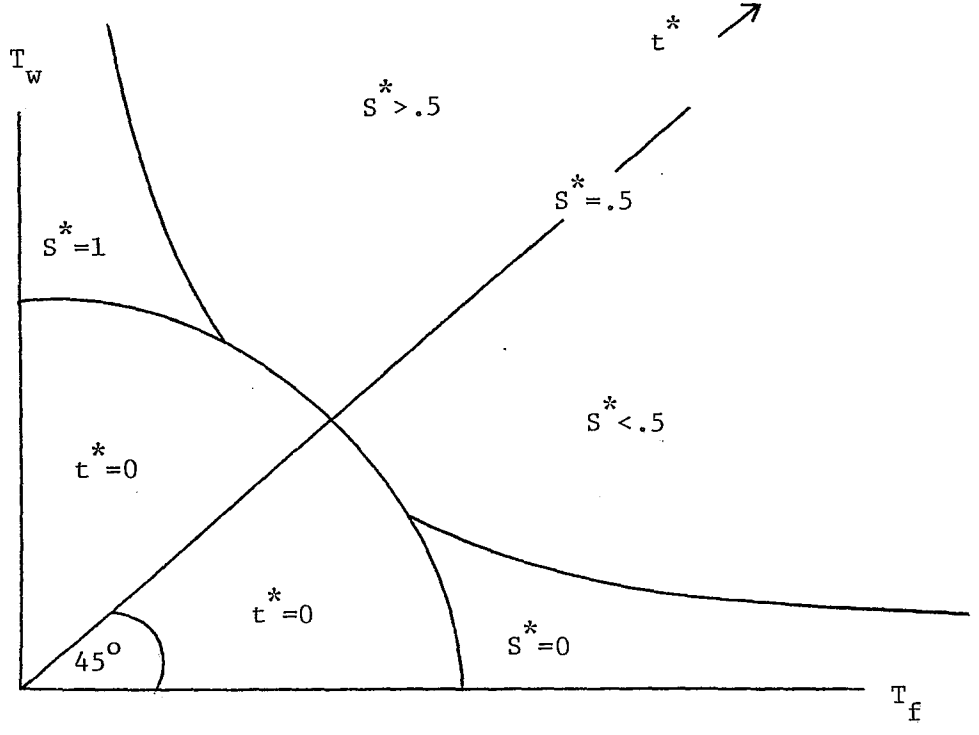

Figure 1. Optimal Sharing of Firm-Specific Training

the investment differs from .5. The shorter the horizons become, the smaller the investment will be.

One might ask why workers do not recognize that an increase in s* signals that T_F has decreased and reduce their T_W too. This question is equivalent to viewing the bargaining process over s and t as a supergame, in which each party learns from the outcome of a particular solution (t*, s*) something about the other party's horizon, and modifies its own behavior accordingly on the next round. Indeed, if there were sufficient rounds in such a supergame, there would be no loss from displacement: Workers and firms would repeatedly modify the amount and sharing of investment based on each other's changing horizons, as revealed by the outcomes of the previous stage. Investment would occur along a path such that the value of firm-specific training was zero at the date of displacement. In effect, what the empirical work in this study does is test whether in fact information is sufficient and the parties are clever enough bargainers to avoid making investments that do not pay off.

One might also ask why employers fail to share their information with workers on a voluntary basis.[14] Among the possible reasons for this failure are fears of worker slacking, of quits by those with smaller amounts of firm-specific capital, and even of sabotage. In what is clearly a bargaining game, information that affects the outcome may be kept secret to the profit of the party that possesses the information.

This discussion allows us to use observed wage-tenure profiles to infer the information available to workers who are displaced and to their employers. Such profiles have been used for some years to examine patterns of investment in firm-specific training. (See, for example,

Mincer and Jovanovic, 1981.) (1) If the profile does not differ among workers whose eventual displacement is nearer in time, this implies either that Case I.A. is correct, or that Case II is valid, but workers' horizons have decreased somewhat. (2) If the profile becomes flatter as the date of displacement draws nearer, either Case I.B. is correct, and both firm and worker have the same, fairly good information about the displacement; or the asymmetric case, II, is correct, but the worker's information is sufficiently good that the total amount invested is reduced sufficiently to offset the worker's increased share of the costs of training. (3) If the profile becomes steeper as the date of displacement approaches, we may infer that the asymmetric case is correct and that the total amount invested (t^*) does not decrease greatly. (If it did, the wage-tenure profile would be unchanged or flattened.[15])

IV. MEASUREMENT AND ESTIMATION

The basic equation to be estimated is of the form

$$(4) \quad \ln w = \beta Z + \gamma Z',$$

where w is the wage on the worker's main job, Z is a vector of control variables, and Z' is a vector containing measures of total experience and tenure. The data used are from the PSID. While this source of data has the virtue of providing a long, continuous panel, it has one severe drawback for our purpose: Tenure with the employer, as opposed to tenure on the particular job, is reported only in the interviews of 1976 and 1977. Since the main purpose is to observe the wage-tenure relationship among workers who are later displaced, this lack greatly restricts the

number of observations from the PSID that can be used. (Since no information on the tenure of people who report themselves displaced in 1976 or earlier is available, only people displaced between 1977 through 1981 have the required information.) The paucity of information on tenure with the employer combines with workers' mobility to limit the sample still further: Many of the workers displaced in, e.g., 1980 or 1981 changed jobs several times between 1977, when their tenure was reported, and the time of their displacement. Yet another problem limiting the sample size is the restriction of the data to household heads. Since some small fraction (around 10 percent) of the households change heads each year, and since the data of interest are reported for household heads, observations must be discarded because the information on tenure and other variables cannot be linked to the date of displacement.

Equation (4) is estimated using observations for years T-1, T-2, T-3, and T-4, where, as before, T is the date of displacement.[16] Starting with 1421 household heads who were displaced, i.e., who left their jobs because of a permanent layoff or a plant closing, in 1977-1981, the exclusions reduce the sample sizes in the estimates of (4) in years T-i, i=1,...,4, to 362, 305, 246, and 200 observations respectively.

The variables included in Z are standard in equations like (4). Among them are years of formal education, or a vector of dummy variables for completion of college, some college, or completion of high school; whether the worker is a union member, white, married, or male; whether the worker resides in the South or in an SMSA in which the largest city has a population above 500,000; the worker's occupation in the job that disappeared (professional or manager, craft, or operative or laborer); and the industry of that job (manufacturing, wholesale and retail trade,

or finance and services). The means of these variables in the four samples are shown in Table 1. They are not typical of the U.S. labor force: There are fewer whites, more Southerners, and more manufacturing workers. These differences are consistent with the PSID's oversampling of low-income households and with the greater propensity of manufacturing employers to lay off workers.

The variables included in Z' are tenure with the employer, TN, and years of actual full-time labor-market experience since age 18, X. A quadratic term in experience is also included in the equations, as is a quadratic term in tenure in some of the estimates that are presented. As Table 1 shows, the average tenure prior to displacement is quite low (though it is consistent with data describing the entire sample of displaced workers). A large fraction of displaced workers have not been on the job very long. Nonetheless, between 33 and 37 percent of the workers in the four samples had more than five years' tenure with their employer, and between 17 and 20 percent had at least ten years of tenure. The average total experience in the samples implies a mean age in the middle thirties, roughly what is implied by a weighted average of the mean ages listed in Table A.2 for 1977-1981.

V. ESTIMATES OF WAGE PROFILES AMONG DISPLACED WORKERS

The estimates of β in (4) for those variables not in Z' are shown in Table A.7. The results are quite standard among estimates of wage equations using micro data and merit little comment here. Suffice it to note that their very routineness suggests that, along most dimensions

Table 1

Sample Means and Standard Deviations

Variable	Years before Displacement 1	2	3	4
Log (Wage) (1980 dollars)	$6.32 (.50)	$6.37 (.50)	$6.33 (.46)	$6.36 (.47)
Experience (years)	16.45 (12.17)	17.00 (12.35)	16.28 (11.62)	16.58 (12.13)
Tenure (years)	5.11 (5.95)	5.63 (6.57)	5.24 (6.18)	5.43 (6.78)
Education (years or fraction with ≥ 12 years)	11.15 (3.04)	11.08 (3.13)	.55	.51
Union Member	.27	.32	.37	.35
White	.53	.53	.48	.48
Married	.65	.73	.70	.69
Male	.80	.84	.83	.82
South	.48	.45	.50	.49
SMSA with City >500,000	.36	.36	.38	.36
Industry				
Manufacturing	.28	.26	.29	.28
Trade	.20	.16	.16	.15
Finance and Services	.24	.15	.15	.16
Occupation				
Professionals and Managers	.19	.19	.13	.12
Craft Workers	.25	.19	.20	.20
Operatives and Laborers	.32	.41	.46	.47
Laid Off	.67	.64	.64	.64
N	362	305	246	200

that produce wage differentials, the particular samples selected from the PSID are not unusual.

Table 2 presents the estimates of the parameters on the experience and tenure variables from (4), including only a linear term in tenure. The wage-experience profiles have shapes that have generally been found in research in this area (e.g., Mincer and Jovanovic, 1981). However, a comparison of the results in Table 2 to those in Table 3, which are based on equations that include a quadratic term in tenure, shows only slight evidence of the usual concavity in the wage-tenure profile. This may result from the peculiar nature of the sample, from the use of tenure with the employer instead of the less appropriate tenure in the job that has been used in many studies, or from the relatively small samples that the focus on displaced workers produces.

The major issue of interest in this study is the pattern of effects of tenure with the firm. As a comparison of the coefficients in Table 2 on this variable makes clear, there may be some flattening of the wage-tenure profile, but it is not very pronounced. The profile is still far from flat even in the year immediately preceding displacement.[17]

Before examining the patterns of variation of the wage-tenure and wage-experience profiles more explicitly, let us consider whether these patterns vary with the worker's union status. Trade-union wage-setting differs from that in nonunion plants in the effects of experience on wage rates (see Johnson and Youmans, 1971) and in how workers process information about the workplace (see Freeman, 1980). It may be that unionized workers, merely because the union provides a means of gathering information about the employer's plans, avoid some of the loss of specific

Table 2

Tenure and Experience Variables, Wage Regressions

	Years before Displacement			
	1	2	3	4
X	.0119	.0209	.0181	.0167
	(2.36)	(3.55)	(2.60)	(2.75)
X^2	-.00026	-.00037	-.00045	-.00042
	(-2.48)	(-3.09)	(-2.83)	(-3.38)
TN	.00896	.00619	.01049	.01070
	(2.40)	(1.59)	(2.42)	(2.62)
$\bar{R}^2$	.54	.50	.45	.59

Note: t-statistics in parentheses here and in Tables 3 to 5. The estimates are from equations in which the full vector of variables Z is included.

Table 3

Tenure and Experience Variables,
Expanded Wage Regressions

	Years before Displacement			
	1	2	3	4
X	.0107	.0212	.0193	.0164
	(2.09)	(3.49)	(2.71)	(2.65)
X^2	-.00024	-.0038	-.00048	-.00042
	(-2.24)	(-3.05)	(-2.93)	(-3.29)
TN	.01748	.00427	.00235	.01389
	(1.99)	(.42)	(.21)	(1.25)
TN^2	-.00037	.00008	.00038	-.00014
	(-1.07)	(.20)	(.81)	(-.31)
$\bar{R}^2$	.54	.50	.45	.59

human capital that is implicit in the lack of flattening of wage-tenure profiles observed in Table 2.

The results of estimating (4) including interaction terms of experience and tenure with union membership are shown in Table 4. While the vector of interaction terms is not jointly significantly different from zero, the results are nonetheless suggestive. The use of a quadratic in X makes it difficult to infer the effect of unionism on changes in the wage-experience profile simply by inspection, and I defer the discussion of that issue. However, inspection of the interaction terms with tenure suggests a striking pattern: The wage-tenure profiles for union workers are much steeper in the third and fourth years before displacement than they are in the first and second years: Among union workers the slopes are .015 and .013 in years T-3 and T-4, and .006 and 0 in years T-1 and T-2. Among nonunion workers there is essentially no change in the steepness of the wage-tenure profile as displacement nears. This difference is consistent with the interpretation of the role of unions in providing information that protects workers from management discretion, in this case, information about impending displacement.

Another possible difference in behavior may arise in those plants that experience closings. In such cases the employer may make more of an effort to hide information than in cases when an isolated worker, or group of workers, is to be laid off. To examine this possibility, equations (4) were reestimated including interaction terms of the tenure and experience variables with the reason for involuntary separation. The results are shown in Table 5. The vector of interaction terms is jointly significant in the equations for year T-4, though not in the other equations. Most interesting, the implied slopes of the wage-tenure

Table 4

Tenure and Experience Variables,
Including Interactions with Union Status

	Years before Displacement			
	1	2	3	4
X	.0096	.0175	.0186	.0144
	(1.75)	(2.70)	(2.38)	(2.08)
X^2	-.00024	-.00033	-.00046	-.00037
	(-2.08)	(-2.55)	(-2.61)	(-2.72)
X•UN	.0040	.0070	-.0002	.0173
	(.26)	(.02)	(-.01)	(1.08)
X^2•UN	.00008	.00004	.00003	-.00047
	(.21)	(.11)	(.08)	(-1.12)
TN	.00873	.00821	.00223	.00916
	(1.81)	(1.62)	(.35)	(1.64)
TN•UN	-.00304	-.00822	.01322	.00416
	(-.40)	(-1.04)	(1.49)	(.47)

Table 5

Tenure and Experience Variables,
Including Interactions with Causes of Displacement

	Years before Displacement			
	1	2	3	4
X	.0134	.0264	.0159	.0197
	(1.74)	(3.02)	(1.48)	(2.08)
X^2	-.00032	-.00048	-.00043	-.00048
	(-2.24)	(-3.05)	(-1.94)	(-2.83)
X·LAIDOFF	-.0045	-.0143	-.0014	-.00169
	(-.43)	(-1.14)	(-.10)	(-.13)
X^2·LAIDOFF	.00015	.00031	.00006	-.00006
	(.68)	(1.10)	(.17)	(-.22)
TN	.01019	.00406	.00658	.00124
	(2.07)	(.83)	(1.20)	(.24)
TN·LAIDOFF	-.00473	.00343	.00851	.02010
	(-.63)	(.43)	(.96)	(2.41)

profiles decline steadily from .0213 to .0054 as the date of layoff approaches. Apparently, workers facing layoff obtain enough information about it to reduce their firm-specific investment. This is not the case among the one-third of the sample who lose their jobs because of plant closings: The coefficients on TN alone in Table 5 show that the slope of the wage-tenure profile increases steadily as the date of closing nears.[18]

The constancy of the slope of the wage-tenure profile with impending displacement suggests either that there is an asymmetry in the information available to workers and their employers about the timing of the displacement, or that neither has any information about it. Let us assume that the latter interpretation is incorrect in light of employers' knowledge of the firm's financial status. If so, that the profiles do not vary greatly with time remaining until displacement shows that this asymmetry is compounded by a rather high degree of ignorance on the part of the workers. If workers' knowledge of the impending displacement were less than employers', but still substantial, total firm-specific investment would drop so much that workers' costs of an increased share of the investment would fall.

Because the quadratic terms in experience make it difficult to infer any changes in the pattern of investment in general training as the date of displacement approaches, Table 6 shows the average wage in the samples as a function of experience, evaluated at the means of the other variables. The clearest result is the lack of change in the wage-experience profile as displacement approaches. Even among union workers, whose wage-tenure profiles indicated they had fairly good information about the displacement, the wage-experience profile changes little. Only

Table 6

Wage Rates by Experience and Time Remaining until Displacement

Years before Displacement	Years of Experience				
	5	10	15	20	25
			All Workers		
1	$5.36	$5.58	$5.73	$5.81	$5.82
2	5.33	5.76	6.10	6.34	6.47
3	5.40	5.71	5.91	5.98	5.91
4	5.65	5.95	6.14	6.20	6.13
			Displaced		
1	5.63	5.88	6.04	6.11	6.08
2	5.43	5.97	6.42	6.73	6.89
3	5.83	6.11	6.27	6.30	6.19
4	6.29	6.70	6.96	7.07	7.01
			Laid-Off		
1	5.24	5.41	5.54	5.62	5.66
2	5.35	5.60	5.83	6.00	6.13
3	5.34	5.58	5.73	5.77	5.71
4	5.57	5.86	5.99	5.97	5.79
			Nonunion		
1	5.03	5.19	5.29	5.33	5.32
2	5.09	5.41	5.67	5.84	5.92
3	4.99	5.29	5.49	5.56	5.50
4	5.08	5.31	5.45	5.48	5.42
			Union		
1	6.30	6.66	7.00	7.30	7.55
2	5.86	6.48	7.07	7.59	8.04
3	5.90	6.27	6.52	6.64	6.62
4	6.74	7.42	7.83	7.92	7.68

when the profiles are calculated for laid-off workers separately is there a noticeable steepening of the profile, while among workers affected by plant closings the profile flattens out.

At first consideration the results for the subgroups, and for the entire sample, are surprising. If workers were fully rational, had perfect information about the impending displacement, and did not face any liquidity constraints, they would invest more in firm-general training, the nearer the time when they will need such training to obtain a job in another firm. I have shown, though, that workers do not have good information about the approaching displacement. The results for the entire sample can be rationalized by noting that workers who face liquidity constraints must trade off investment in general training for investment in firm-specific training. Since they do not change the pattern of investment in specific training, they are unable to change that in general training. Undoubtedly other explanations can be offered, but this one is at least consistent with utility-maximizing behavior, the inferences I have made about the theory of investment in firm-specific training, and the evidence for the entire sample. This view also explains the differences in the changing wage-experience profiles between laid-off and displaced workers: The former exhibit a steepening wage-experience profile along with a flattening wage-tenure profile, while the opposite pattern exists for workers who face plant closings.

VI. ESTIMATING THE LOSS

The value of lost firm-specific investment can be estimated using the results from Section V along with assumptions about workers' quit

behavior. The present value of the loss for the typical worker with TN years of tenure in the firm is

$$(5) \qquad L = H[w^*(TN) - w(0)] \sum_{t=0}^{68-A} \frac{P(TN + t)}{[(t+r)(1+\delta)]^t},$$

where L is the loss; P is the probability the worker would otherwise have been employed in the firm t years after displacement; A is the worker's age; H is hours worked per year; $w^*(TN)$ is the wage rate gross of the cost of investment in specific training for a worker with TN years of tenure, and $w(0)$ is the wage rate the same person would get with tenure of zero years; r is the discount rate, and δ is the rate of depreciation of firm-specific investment. Throughout I assume H = 2000; L is calculated over the range of values of r and δ on the intervals [0,.10] and [.05,.15] respectively.[19]

The wage loss is estimated using the quadratic wage-tenure profile for T-1 that is presented in Table 3. The effect of tenure on the worker's net wage is calculated using the coefficients on TN and TN^2 from that regression. The gross wage loss, however, is the appropriate measure to use in estimating the value of lost firm-specific investment, since it measures the current return on the stock of past firm-specific investment without subtracting any current investment. It is calculated using the coefficients from this same regression under the assumptions that the rates of return to education and firm-specific training are equal, and that the ratio of investment in firm-specific training declines linearly with years of tenure (see Mincer, 1974). As such, the loss in (5) is only the private loss incurred by the worker. One cannot determine how large a share of the investment is being borne by the

worker. However, insofar as the theory in Section III describes the process well, the constancy of the slope of the wage-tenure profile and the assumption that employers have some knowledge of impending displacement imply that the worker's share of the investment is increasing as displacement approaches. If so, the loss calculated in (5) is not far below the total value of the lost firm-specific investment.

I assume that workers would have remained in the firm unless they quit voluntarily. Thus P is calculated as

$$(6) \qquad P(TN + t) + \prod_{k=0}^{t} [1-q_{TN}(k)].$$

where q_{TN} is the voluntary quit rate of a worker with TN years of tenure. Obviously, q cannot be calculated for the workers on whom the estimates in Section V are based. Instead, I use available estimates of quit rates as functions of workers' characteristics based on micro data sets with broad coverage. Three of the available studies--Freeman (1980); Mincer and Jovanovic (1981), and Viscusi (1980)--are based on estimates using the PSID.[20] The other, Mitchell (1982), uses the Quality of Employment Surveys for 1973 and 1977.

The loss in (5) is calculated for each of the 362 displaced workers included in the sample over which equation (4) was estimated for the year before displacement. The average loss in the sample is presented in Table 7 for each of the four quit functions and for various pairs of r and δ. The estimated losses are quite large, even when high values of the discount and depreciation rates are assumed. The failure of workers who are later displaced to adjust the path of investment in firm-specific training generates large losses for them when the displacement occurs.

Table 7

Average Present Value of Lost Specific Training
(in thousands)

Quit Function	r, δ (0, .05)	(0, .10)	(.05, .10)	(10, .10)	(.10, .15)
Freeman (1980) PSID 1968-74, logit, all workers	$11.5	$8.3	$6.5	$5.4	$4.7
Mincer and Jovanovic (1981) PSID 1975-76, OLS, men	10.6	7.9	6.2	5.2	4.6
Mitchell (1982) QES 1973, 1977, probit, men and women separately	15.7	10.5	7.8	6.2	5.3
Viscusi (1980) PSID 1975-76, logit, men and women separately	12.1	8.8	6.8	5.7	4.9

The estimates in Table 7 exceed those based on the change in the wage and the time spent unemployed among workers who eventually find jobs (Glenday and Jenkins, 1984, and Jenkins and Montmarquette, 1979), and also exceed the value of the time the displaced worker spends unemployed (Neumann, 1978). Despite the substantial differences there are two reasons to believe the estimates presented here: (1) Studies that examine pre- and post-displacement wages exclude from the sample those workers who never find employment and instead leave the labor force. Since these people experience the largest losses among the group of displaced workers, ignoring them biases down any estimates of the average loss; and (2) Even if workers obtain the same wage after reemployment, the firm-specific investment that was not fully depreciated and was lost when the displacement occurred must be included in estimates of the loss.

VII. CONCLUSIONS

In this study I have shown how changes in the horizon for a shared investment like that in firm-specific training affect the amount and burden of that investment. I have used the predictions of that demonstration to analyze how the wage-tenure profile changes in a particular sample of workers as they approach the date of their displacement. The estimates indicate that displaced workers do incur a cost in the form of an unexpected depreciation in the firm-specific human capital in which they have invested.

The evidence in this study merely documents the existence of losses of firm-specific human capital by displaced workers. To the extent that information about the risk of incurring such losses is sufficient to

engender compensating wage differentials, there is no justification for compensating ex post those who are displaced. If the information is not sufficient, though, policies that compensate for the loss or provide information that helps minimize the loss may be desirable. Programs that offer retraining allowances, such as Trade Readjustment Assistance, are examples of the first approach. Programs that offer workers information about the likely duration of their jobs, such as requirements of prior notification of plant closings, are examples of the second approach.[21]

Notes

[1]One specific example of this kind of response is the introduction of bills requiring prior notification of a plant closing. The National Employment Priorities Act, 98:1, H.R. 2847, mandates at least one year's prior notification of a permanent layoff or a plant closing involving more than 100 workers. Such legislation is similar to existing laws in many other developed countries.

[2]See Congressional Budget Office, "Dislocated Workers: Issues and Federal Options," July 1982, Chapter 3, for discussion of the various approaches to defining the issue.

[3]These methods are proposed in Jenkins and Montmarquette (1979) and Neumann (1978), respectively.

[4]In the 1960s this difficulty coupled with politics to prevent any payments to workers under the Trade Adjustment Assistance Act of 1962. Beginning in 1969 the pendulum swung in the opposite direction, with payments being made increasingly to workers whose employer's product market merely contained foreign competitors.

[5]Congressional Budget Office, op. cit., uses the Current Population Survey to classify unemployed workers, but does not define displacement on the basis of the reason for job loss. Sandell and Shapiro (1983) estimate the economic and demographic characteristics of job losers, not classified by reason for loss, in a sample of older workers only.

[6]Among currently employed workers, individuals were counted as laid-off or displaced if they involuntarily changed employers within the past year. Among unemployed or retired workers individuals were counted as

laid-off or displaced in that year in which they first reported an involuntary separation.

[7]No comparison to the entire labor force is possible, since the household heads who form the population from which this subsample is drawn are predominantly male.

[8]Bureau of Labor Statistics, Special Labor Force Report No. 206.

[9]I assume, following Farber (1983), that such jobs must be rationed because of their high wages.

[10]Here I implicitly assume that an increase in embodied general training is neutral with respect to the time the worker spends searching for a job after the displacement. It shifts the wage-offer distribution to the right by as much as it raises the reservation wage.

[11]All that is required for the results to go through is that $B'' < C''$.

[12]This too is a simplifying assumption designed to ease the exposition; the results do not depend on it.

[13]The assumption that each party's subjective probability density on the length of the relationship has all its mass at one point is, of course, merely simplifying. The more appropriate assumption would be that each has a probability density defined from zero to infinity, and that the asymmetric case involves a reduction in the mean of the firm's probability density. While more complex and realistic, this modification does not change the conclusion that asymmetric information leads the more optimistic party to bear a greater fraction of the cost of the shared investment.

[14]That they do not and will not do so unless compelled is suggested by the vehement opposition of employer groups to proposed legislation requiring prior notification of plant closings.

[15]In some ways these implications parallel those of Bartel and Borjas (1981). That study, though, did not develop a theoretical structure that allowed inferences about the meaning of changes in the wage-tenure profile to be made; nor did it distinguish how a discrepancy between the workers' and firm's horizons will affect the profile. Finally, it did not examine how that profile, rather than merely general wage growth, varies with time remaining on the job.

[16]Since people displaced in 1977-1981 are included in the sample, wage rates are made comparable across calendar time for T-i, i=1,..,4, by inflating using the growth in private nonfarm hourly earnings between the time the worker's wage is observed and 1980.

[17]One possibility that might explain the apparent lack of flattening is that the linear, and even the quadratic forms of TN misspecify the equation, and that newer workers must be treated separately. To examine this I reestimated (4) for each of the four samples, first adding a dummy variable for workers with at most 1 year of tenure, then adding a dummy variable for those with at most 2 years of tenure. Only one of these eight variables added significantly to the equations' explanatory power, and in no case did their addition change the inference that there is little flattening of the profile as displacement approaches.

[18]Equations (4) were also estimated separately for years T-1...T-4 for the samples disaggregated by union status, and disaggregated by reason of involuntary separation. Only for year T-4 was the hypothesis that the subsamples could be pooled rejected at the 5-percent level of confidence, and only for T-1 for the union-nonunion disaggregation was the hypothesis rejected even at the 10-percent level.

[19]This range brackets the estimates of the rate of depreciation of on-the-job training in Johnson (1970).

[20]Because Mincer and Jovanovic use OLS estimation, the simulated quit rate becomes negative for high values of tenure in the firm. I arbitrarily restricted q to be nonnegative in the simulations.

[21]They may also improve labor-market-wide outcomes, as Folbre et al. (1984) indicate.

Table A.1

Displacement and Layoff Rates, and Numbers in Each Category, PSID 1969-1981

Year	Displaced		Laid Off	
	Rate	N	Rate	N
1969	1.1	92	1.7	154
1970	1.5	93	2.3	146
1971	1.7	100	4.0	252
1972	1.7	111	3.9	262
1973	1.5	93	2.6	188
1974	1.4	78	2.8	192
1975	1.8	114	5.3	341
1976	1.7	98	4.5	324
1977	2.3	115	4.0	277
1978	2.3	100	3.8	248
1979	1.7	114	3.3	215
1980	2.1	114	3.9	313
1981	2.8	139	5.5	368

Note: Rates and averages in this and succeeding tables are weighted by sampling weights in the PSID.

Table A.2

Mean Age of Displaced and Laid-off Workers

Year	Displaced	Laid Off
1969	40.5	39.2
1970	39.7	35.3
1971	37.8	35.2
1972	40.3	35.4
1973	45.4	33.4
1974	38.9	34.5
1975	38.1	34.0
1976	41.3	33.0
1977	39.7	32.8
1978	42.8	35.5
1979	40.2	30.4
1980	39.6	30.7
1981	39.2	32.8

Table A.3

Percentage of Males among Displaced and Laid-Off Workers

Year	Displaced	Laid Off
1969	78.1	94.2
1970	69.4	77.8
1971	72.2	92.4
1972	79.1	78.4
1973	76.1	76.5
1974	95.7	81.6
1975	75.5	84.4
1976	77.4	83.8
1977	84.6	77.4
1978	74.6	71.5
1979	80.5	73.9
1980	73.8	71.6
1981	70.6	71.9

Table A.4

Education (Years of Schooling) of Displaced and Laid-Off Workers
(Percentage Distributions)

Year	Displaced					Laid Off				
	0-8	9-11	12	13-15	≥ 16	0-8	9-11	12	13-15	≥ 16
1969	28.6	37.7	12.8	7.8	13.2	26.2	29.2	29.6	6.3	8.6
1970	18.3	41.5	21.2	5.7	13.3	13.1	43.0	22.9	9.2	11.7
1971	15.9	24.5	36.1	17.5	3.7	18.7	21.9	28.0	20.3	12.1
1972	16.4	13.1	41.1	23.3	3.3	10.1	35.7	29.6	12.4	12.3
1973	16.4	12.6	35.9	2.6	30.1	16.2	26.5	33.4	7.4	8.4
1974	20.7	30.1	24.6	4.9	19.6	22.4	31.0	22.4	12.7	8.1
1975	10.9	21.0	30.5	26.6	9.3	9.5	28.0	42.3	6.7	7.4
1976	9.5	24.6	40.8	18.3	6.7	9.9	22.1	41.1	15.6	8.8
1977	15.7	17.7	45.1	12.3	7.0	10.3	33.8	41.7	11.7	12.4
1978	11.6	14.4	47.5	13.2	13.1	12.6	20.3	42.8	15.9	8.0
1979	8.1	31.8	38.5	12.2	9.4	3.8	28.6	42.0	17.7	6.8
1980	13.1	31.7	34.6	5.5	15.0	7.9	28.1	51.8	10.3	1.3
1981	7.8	25.9	42.3	16.4	7.6	8.1	21.9	42.7	16.5	10.3

Table A.5

Racial Make-up of Displaced and Laid-Off Workers
(Percentage Distributions)

Year	White	Black	Hispanic and Other	White	Black	Hispanic and Other
1969	87.8	12.2	0	77.4	17.3	5.3
1970	89.5	10.0	.5	79.6	18.3	2.1
1971	85.4	10.5	4.1	88.2	7.2	4.6
1972	75.8	13.4	10.8	82.4	12.8	4.7
1973	81.7	18.1	.2	71.7	13.7	14.6
1974	87.7	9.1	3.1	75.5	13.6	10.9
1975	80.0	14.1	5.9	80.2	13.6	6.1
1976	87.4	8.2	4.3	76.9	16.4	6.7
1977	85.0	10.6	4.4	83.6	13.8	2.6
1978	92.7	5.6	1.6	76.2	16.8	7.0
1979	86.9	11.2	1.9	79.8	16.7	3.5
1980	54.2	43.0	2.7	37.6	58.7	3.6
1981	84.5	13.3	2.1	81.7	16.1	2.1

Table A.6

Marital Status of Displaced and Laid-off Workers
(Percentage Distributions)

Year	Displaced			Laid Off		
	Married	Single or Widowed	Divorced or Separated	Married	Single or Widowed	Divorced or Separated
1969	78.0	6.5	15.5	88.8	2.9	8.4
1970	65.3	13.7	20.9	71.8	12.8	15.3
1971	68.0	10.1	21.8	83.6	6.7	9.8
1972	74.3	13.9	11.8	67.5	18.9	13.5
1973	72.5	19.3	8.2	65.2	18.1	16.8
1974	85.9	12.1	2.0	73.1	13.3	13.5
1975	67.0	13.6	19.3	71.3	19.1	9.6
1976	69.2	13.8	17.0	70.4	19.7	10.0
1977	74.1	15.6	10.2	61.4	21.6	17.0
1978	65.4	18.2	16.5	52.5	29.0	18.5
1979	64.5	25.3	10.2	50.2	33.3	16.5
1980	57.0	27.1	15.9	51.2	29.1	19.8
1981	52.7	26.0	21.3	51.7	30.9	17.4

Table A.7

Estimates of Other Coefficients in the Regression in Table 2

Variable	Years before Displacement 1	2	3	4
Education	.0358	.0400	—[a]	—[a]
	(4.75)	(4.80)		
Union Member	.288	.230	.176	.313
	(6.01)	(4.43)	(3.36)	(5.62)
White	.128	.047	.092	.171
	(2.98)	(.90)	(1.71)	(3.34)
Married	.050	.052	.095	-.073
	(.92)	(.77)	(1.37)	(-1.04)
Male	.317	.303	.301	.454
	(4.77)	(3.80)	(3.66)	(5.75)
South	-.182	-.139	-.035	.025
	(-4.36)	(-2.79)	(-.63)	(.45)
SMSA with city > 500,000	.026	.099	0.97	.128
	(.60)	(2.05)	(1.80)	(2.39)
Industry				
Manufacturing	- .126	-.064	-.028	-.082
	(-2.48)	(-1.23)	(-.51)	(-1.47)
Trade	-.269	-.127	.018	-.068
	(-4.73)	(-2.11)	(.27)	(-1.00)
Finance and Services	-.172	-.116	-.041	-.073
	(-2.97)	(-1.78)	(-.57)	(-1.05)
Occupation				
Professionals and Managers	.332	.502	.471	.466
	(5.08)	(7.02)	(5.20)	(4.71)
Craft Workers	.182	.308	.304	.234
	(2.81)	(4.16)	(3.91)	(2.91)
Operatives and Laborers	.044	.144	.043	.071
	(.72)	(2.30)	(.64)	(1.06)

Note: t-statistics in parentheses.

[a]A vector of three dummy variables indicating schooling attainment was included.

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