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The Effects of Occupational Injuries After Returns to Work: Work Absences and Losses of On-the-Job Productivity

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Abstract

We extend the research on postinjury employment by estimating productivity losses for workers with permanent partial disabilities (PPDs) in the first three years after injury. Our method distinguishes between productivity losses attributed to spells of work absence versus reduced earnings during spells of employment. The method is applied to data for 800 Ontario workers with PPDs. The results document large productivity losses persisting at least three years after injury, with different loss patterns for workers returning to stable versus unstable employment. Human capital investments or job accommodations can reduce productivity losses, but the significant determinants of losses differ for the stable versus unstable employment groups.

Introduction

It is commonly believed that a return to work marks a recovery from the disabling effects of an occupational injury and an end to the economic losses associated with the injury, but two recent studies provide evidence that contradicts the common wisdom. Using data for Ontario workers with PPDs, the two studies reveal that nearly two-thirds of injured workers who initially return to work experience subsequent spells of injury-related work absence, and a substantial proportion eventually withdraw from the labor market because of their injuries (Butler, Johnson, and Baldwin, 1995; Johnson, Butler, and Baldwin, 1998). The studies suggest that the productivity

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losses associated with a work-related injury can continue well beyond the first return to work, both because of subsequent injury-related work absences, and because a permanent impairment can reduce on-the-job productivity.

This article estimates, for the first time, the patterns of productivity losses that occur after an injured worker returns to work. We decompose the difference between expected and actual earnings in the postinjury period into two distinct effects: an *absentee effect* associated with spells of work absence; and an *earnings effect* associated with periods of work at reduced capacity, reflected in a lower wage rate, or periods of work at reduced hours. Exploiting the rich data on postinjury employment experiences of Ontario workers that have been used in prior studies, we present estimates of productivity losses for a full three years after the date of injury. We observe distinctly different patterns of losses for workers who return to work and stay (*stable employment*) versus those who experience spells of injury-related work absence after a first return to work (*unstable employment*); so results are stratified by postinjury employment stability.

We also estimate the determinants of productivity losses, focusing on workers' human capital characteristics and employer-provided job accommodations, two sets of modifiable factors that have the potential to minimize the work-related disability associated with a serious occupational injury. Workers' investments in human capital, for example, impart skills that can compensate for the functional limitations associated with permanent impairments, while job accommodations are one of the most effective disability management strategies firms can employ to facilitate returns to work and reduce injury-related losses. The relationships between productivity losses, human capital investments, and job accommodations are estimated in models that treat a return to stable employment, and the probability of receiving job accommodations, as endogenous.

The results reveal large productivity losses for injured workers throughout the three-year postinjury period we study. Losses are greater for workers whose postinjury employment is interrupted by spells of work absence than for workers who return to stable employment, but even workers in stable postinjury employment patterns incur significant productivity losses. The types of human capital investments and job accommodations that are important in reducing productivity losses differ for workers in stable versus unstable employment, suggesting that a change in disability management strategies may be necessary for workers who are unsuccessful in their first postinjury job.

The Ontario survey is now more than fifteen years old and the dollar values of productivity losses are not an accurate measure of the losses that would accrue to a more recent cohort of injured workers. The survey is, however, the only source of data that supports analyses of productivity losses and its component absentee and earnings effects during periods after a first return to work. The patterns of losses and the methods we present are, therefore, useful extensions of our understanding of the effects of permanent impairments on productivity.

Background

Permanent Partial Disability

We focus on the productivity losses associated with PPDs, a relatively small but costly part of the workers' compensation caseload. To define PPDs, it is important to differentiate among three concepts, namely, *impairment*, *functional limitations*, and *disability*, which are often used interchangeably but are not synonymous. *Impairment* refers to an anatomical or physiological abnormality or loss associated with an illness or injury, while *functional limitations* are restrictions of cognitive, physical, or sensory capacities that may result from impairment. A work *disability* occurs when functional limitations restrict a worker's ability to perform the tasks required in the jobs for which the worker is qualified by education and experience (Nagi, 1969). Workers with PPDs have permanent impairments causing functional limitations that restrict their ability to perform some jobs, but do not altogether preclude a return to work.[1]

PPDs represent relatively severe work-related injuries and a challenge to disability management programs. Workers with PPDs represent less than 20 percent of the workers' compensation caseload, but 60–70 percent of costs, in most jurisdictions (NCCI, 1999). Because of the long-term effects and high costs, there are potentially large payoffs to improving postinjury employment outcomes for workers with permanent disabilities. Two of the most common approaches to improving work outcomes are investments in human capital (e.g., education, training, vocational rehabilitation) and on-site disability management (e.g., job accommodations, proactive return-to-work programs). In what follows, we briefly describe the potential impact of each approach on the measurement of postinjury productivity losses.

Disability and Human Capital

Prior to a disabling injury, a worker's productivity in the labor market is determined by his stock of general and specific human capital (Becker, 1975). Investments in general human capital, which increase worker productivity in a variety of jobs, typically take the form of formal or informal education, including vocational training. The costs of acquiring general human capital are borne by the worker (because a firm has no incentive to fund training that increases a worker's productivity at competing firms) and the worker reaps the benefits in terms of higher wages.

Investments in specific human capital, acquired on the job, increase a worker's productivity in the firm in which the training occurs, but not at other firms. Typically, the costs and benefits of firm-specific training are shared between workers and firms. The firm pays the worker part of the increased productivity associated with investments in specific human capital, because it needs to retain the worker to recoup its investments, but not all benefits go to the worker, because his productivity in other firms is based only on his general human capital (Oi, 1962).

Investments in either general or specific human capital can potentially reduce the losses associated with a PPD. General human capital increases a worker's job mobility, making it more likely that functional limitations do not become disabilities, and that job accommodations will permit permanent reemployment. Specific human capital increases a firm's incentives to rehire an injured worker, to minimize the loss of the firm's investment in specific training (provided the firm-specific human capital is not destroyed by the injury). Increases in postinjury productivity associated with investments in general human capital should be observable in the form of higher

[1] Occupational injuries that permanently and totally disable a worker are, fortunately, quite rare, affecting less than 1 percent of injured workers in 1995–1997 (Mont et al., 2001).

wages, whereas productivity increases associated with specific human capital may not be fully observable if the worker shares part of the costs.

Disability and Job Accommodations

Job accommodations are changes to work environments or modifications of job requirements, such as flexible schedules, light work, special training, etc., that offset the functional limitations associated with permanent impairments. The potential of job accommodations to reduce work disability is supported by a growing body of empirical evidence. A recent study using the Ontario data, for example, reports that light work accommodations significantly reduce initial durations of postinjury work absence (Huang, Baldwin, and Conway, 2006). Studies reviewed by Frank et al. (1996) consistently show that job accommodations reduce initial durations of work absence by 30 to 45 percent. Other research finds that job accommodations prolong expected employment durations after a return to work (Burkhauser, Butler, and Kim, 1995; Johnson, Butler, and Baldwin, 1998).

To our knowledge, the effects of job accommodations on postinjury productivity losses have not been measured. Losses of on-the-job productivity are difficult to measure if employers impose part of the costs of accommodations on workers in the form of lower wages. This is a likely scenario because job accommodations, such as altering a workstation, can be viewed as a form of investment in firm-specific human capital for which workers are expected to bear part of the cost.[2] Increases in productivity obtained by providing job accommodations need not be shared completely with the worker, and so the productivity of workers who receive accommodations may not be reflected fully in their postinjury wage stream. Gunderson and Hyatt (1996) find some empirical support for the theory that employers pass on the costs of job accommodations in the form of lower wages to disabled workers, when an injured worker does not return to the time-of-injury employer.

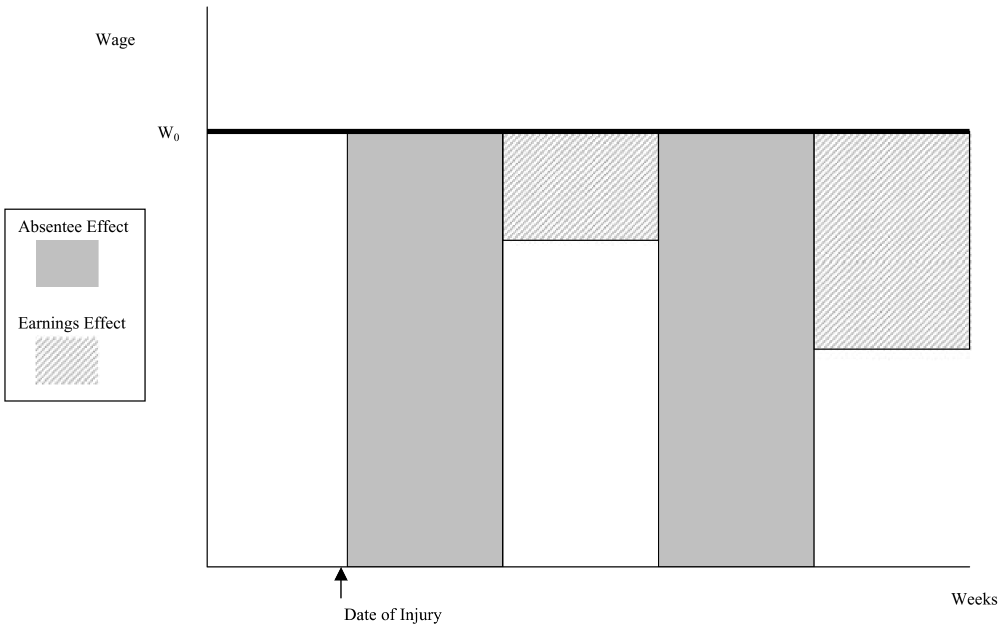
In sum, job accommodations are expected to reduce postinjury productivity losses by increasing the probability that an injured worker returns to work and returns to his preinjury productivity on the job. The former effect (an "absentee" effect) is measurable with the methods we propose; the latter effect (an "earnings" effect) may or may not be measurable depending on what part of the costs of accommodations are passed on to workers in the form of lower wages.

Methods

Our objective is to estimate the productivity losses associated with permanent partial impairments, and the determinants of productivity losses, over a multiyear postinjury period. Preliminary analyses show that the structure of productivity losses is significantly different for workers who return to work and stay (stable employment)

[2] Job accommodations are often provided at little or no direct cost (Granger, Baron, and Robinson, 1997; Collignon, 1986), but even inexpensive accommodations may impose indirect costs on employers. Indirect costs include: costs associated with changes to work schedules or job descriptions of co-workers; supervisory time to implement accommodations; reductions in the morale of co-workers who may resent special treatment for a disabled worker; and so forth.

FIGURE 1
Postinjury Productivity Losses: Absentee and Earnings Effects



versus workers who experience multiple spells of injury-related work absence (unstable employment); so we partition the sample according to postinjury employment stability.[3] We measure productivity losses by comparing workers' expected earnings in the absence of injury to their actual postinjury earnings stream. The estimates of productivity losses become the dependent variables in models that estimate the impact of human capital investments and employer-provided job accommodations on postinjury productivity losses, and its absentee and earnings components.

Dependent Variables: Productivity Losses Associated with Permanent Impairments

We define two components of productivity losses associated with permanent partial impairments. Permanent impairments can lower workers' productivity by: (1) reducing annual hours worked because of periods of injury-related work absence ("absentee effect") or (2) reducing on-the-job productivity, or hours worked, during postinjury spells of employment ("earnings effect"). Figure 1 depicts the two types of productivity losses. The absentee effect (darkly shaded) refers to productivity losses during spells of injury-related work absence, including initial and subsequent work absences, while the earnings effect (lightly shaded) refers to losses of on-the-job productivity, or fewer hours worked per week, associated with functional limitations. The distinction between absentee and earnings effects is important, because the characteristics that

[3] Tests of the hypothesis that the coefficients for the loss regressions are equal for workers in the stable vs. unstable employment groups reject the null hypothesis at better than the 1 percent level.

enable a worker to return to work are often quite different from the characteristics that enable him/her to return to his/her preinjury work capacity.

Our estimate of total productivity losses is defined as the ratio between expected earnings in the absence of injury and actual postinjury earnings. Let M_{it} represent expected real annual income (in 1989 equivalent dollars) for the ith injured worker, in year t after the injury date, if no injury had occurred. Imposing the simplifying assumption that the average annual real wage growth in Ontario from 1970 to 1990 is zero, the expected real wage rate, if no injury had occurred, equals the preinjury wage.[4] Under this assumption, M_{it} equals annual preinjury earnings. Let actual earnings inyear t be denoted by m_{it}. Then, a measure of total productivity losses in year t is defined as $L_{it} = \frac{M_{it}}{m_{it}}$, where L_{it} is the ratio between a worker's expected earnings stream in the absence of injury and actual postinjury earnings.

To define measures of the absentee and earnings effects, note that M_{it} (annual earnings in the year prior to injury) is the product of k_{i0}, the number of weeks worked in the year prior to injury, and $w_{i0,}$ the average preinjury weekly wage (in 1989 dollars). Similarly, m_{it} (actual earnings in year t) is the product of the number of weeks worked in year t, k_{it}, and the reported average weekly wage, w_{it} (in 1989 dollars). Then

$$L_{it} = \frac{M_{it}}{m_{it}} = \frac{(k_{i0}w_{i0})}{(k_{it}w_{it})} = \left(\frac{k_{i0}}{k_{it}}\right)\left(\frac{w_{i0}}{w_{it}}\right). \tag{1}$$

The first term on the right, $K_{it} = k_{i0}/k_{it}$ is the absentee effect, the ratio between expected annual weeks worked with no injury and actual weeks worked. The second term, $W_{it} = w_{i0}/w_{it}$, is the earnings effect, the ratio between expected weekly earnings in the absence of injury and actual weekly earnings. In logarithms, the two components sum to total productivity losses:

$$\ln L_{it} = \ln K_{it} + \ln W_{it}.$$

We compute the estimates of productivity losses, and the absentee and earnings effects, for each worker with complete data on postinjury spells of work and work absence for one, two, and three years after injury. The estimates become the dependent variables in models to analyze the determinants of postinjury productivity losses.

Loss Model with Endogenous Postinjury Employment Stability and Accommodations

Estimating the determinants of productivity losses presents several empirical complexities, because both postinjury employment stability and the probability of receiving job accommodations are endogenous. To address the endogeneity issues,

[4] Identifying the counterfactual wage, that is, the expected wage if no injury had occurred, is the major challenge in estimating postinjury productivity losses. We invoke the simplifying assumption of zero wage growth, which is close to reality, because actual wage growth in Ontario over the study period is slightly negative. However, we conduct sensitivity analyses with a 2-percent growth rate and with occupation-specific growth rates. An alternative approach, proposed by researchers from RAND (Reville, 1999; Reville et al. 2001) is to generate the counterfactual by matching injured workers to similar workers in the same firm who do not experience an injury.

we estimate a three-equation switching regression model. In the first stage, we estimate probit models of the probability of returning to stable employment and the probability of receiving job accommodations, and construct sample selection correction variables (inverse Mills ratios) from the results. In the second stage, we estimate loss models separately for those who return to stable versus unstable employment, with the corresponding sample selection correction variables as additional regressors.

Dependent variables in the first-stage probit models are defined as follows. Let S_i be a binary variable denoting postinjury employment stability. Define $S_i = 1$ for workers who return to work after injury and remain employed; $S_i = 0$ for workers who either return to work, leave the job because of the original injury, and withdraw from the labor force; or return to work, leave the job because of the original injury, and experience subsequent spells of employment and injury-related spells of work absence. Let A_i be a binary variable such that $A_i = 1$ for workers who receive job accommodations on their first postinjury return to work, and 0 otherwise.

Assume the binary variables S_i and A_i have the underlying decision rules:

$$\begin{aligned} S_i &= 1 \quad \text{if } S_i^* = \zeta' h_i + v_i > 0, \\ S_i &= 0 \quad \text{otherwise;} \end{aligned} \tag{2}$$

$$\begin{aligned} A_i &= 1 \quad \text{if } A_i^* = \xi' h_i + u_i > 0, \\ A_i &= 0 \quad \text{otherwise;} \end{aligned} \tag{3}$$

where u_i and v_i are independent error terms with normal distributions. In this specification, job accommodations and employment stability are determined by a common set of variables, h, that include workers' demographic and human capital characteristics, nature of injury, characteristics of the preinjury job, measures of labor demand, and interaction terms. Characteristics of the preinjury job are important determinants of postinjury employment experiences, because an injured worker's best chance to return to work is with his/her preinjury employer, where he/she has accumulated firm-specific human capital. Proxies for labor demand are included in the model, because employers have greater incentives to rehire, retain, and accommodate workers with permanent impairments when labor markets are tight.

In the second stage, we estimate three versions of the loss function, with identical independent variables, for total losses, the absentee effect, and the earnings effect. In what follows, we develop the model for total losses. Assume

$$\ln L_{it} = \alpha_t + \beta_t X_i + \gamma_t A_i + \varepsilon_{it}, \tag{4}$$

where L_{it} represents the ith worker's cumulative productivity losses t years after injury. Productivity losses are determined by variables in the vector X_i, which includes measures of demographic and human capital characteristics, nature of injury, characteristics of the preinjury job, and local labor demand; and A_i, whether or not a worker receives job accommodations. The independent variables X and A are held constant across time periods, but the corresponding coefficients and error terms are allowed to vary with time.

Our intent is to estimate equations for total productivity losses incurred for t equaling one to three years after injury, separately for workers partitioned by the stability of postinjury employment. To account for self-selection into the stable and unstable employment groups, and for the endogeneity of job accommodations, we construct sample selection variables from first-stage probit estimates of the stability (2) and accommodations (3) models (Heckman, 1979). Then, the expected value of $\ln L_{it}$ given that $S_i = 1$, $A_i = 1$, is:

$$
\begin{aligned}
E(\ln L_{it} \mid S_i = 1, A_i = 1) &= \alpha_t + \beta_t X_i + \gamma_t A_i + E(\varepsilon_{it} \mid S_i = 1, A_i = 1) \\
&= \alpha_t + \beta_t X_i + \gamma_t A_i + \kappa_{S1t}\lambda_i^A + \kappa_{S2t}\lambda_i^S
\end{aligned} \tag{5}
$$

and, the expected value of $\ln L_{it}$ given that $S_i = 0$, $A_i = 1$, is:

$$
\begin{aligned}
E(\ln L_{it} \mid S_i = 0, A_i = 1) &= \alpha_t + \beta_t X_i + \gamma_t A_i + E(\varepsilon_{it} \mid S_i = 0, A_i = 1) \\
&= \alpha_t + \beta_t X_i + \gamma_t A_i + \kappa_{U1t}\lambda_i^A + \kappa_{U2t}\lambda_i^U .
\end{aligned} \tag{6}
$$

In Equations (5) and (6), λ_i^S and λ_i^U are the inverse Mills ratios accounting for self-selection into the stable and unstable employment groups, and λ_i^A is the inverse Mills ratio accounting for the endogeneity of job accommodations. We include the observed binary variable for job accommodations in the loss model, because we believe it is the actual receipt of accommodations that matters rather than the estimated probability of it occurring.[5]

We observe four types of job accommodations in our data, namely, light work, flexible schedules, modified equipment, and special training. We analyze each type of accommodation separately, rather than constructing a single binary variable for workers who receive any type of accommodation, because previous research suggests that different accommodations have different effects on postinjury durations of work absence (Butler, Johnson, and Baldwin, 1995). Only two types of accommodations, light work, and flexible scheduling, occur with sufficient frequency to yield stable estimates in the first-stage probit functions. So our empirical loss models include binary variables and associated Mills ratios for these two accommodations.[6]

The three-equation system is identified by including controls for preinjury unemployment and size of the preinjury firm in the probit models, but not in the loss models.[7] We assume the likelihood of postinjury employment and job accommodations are

[5] This is a standard treatment effects approach in which the endogeneity of the observed binary explanatory variable is corrected by including the inverse Mills ratio in the equation (see, e.g., Greene, 2000, pp. 933–934).

[6] Only 1 to 2 percent of workers in our data report modified equipment or special training accommodations in their first postinjury job.

[7] The full set of identifying variables includes: three binary variables for size of preinjury firm (<50, 50–200, >200 workers); interactions between the firm size dummies and the Northeast labor market region; year of injury and year of injury squared (proxies for annual unemployment rates); and interactions between year of injury and two occupation dummies (service, transport). Other specifications of the model had less explanatory power.

strongly influenced by the incidence of unemployment in the worker's occupation at the time of injury, and by the capacity of firms to modify work requirements to the functional limitations of workers with permanent impairments. Once the probabilities of stable employment and accommodations are controlled, however, preinjury unemployment rates and firm size are less important in determining productivity losses.

In sum, our estimation strategy is as follows: (1a) Estimate a probit model for $\Pr(S_i)$ from the full sample and construct the inverse Mills ratios $(\hat{\lambda}_i^S, \hat{\lambda}_i^U)$. (1b) Estimate a probit model for each job accommodation from the full sample and derive the estimated inverse Mills ratios, $\hat{\lambda}_i^{A1}$ and $\hat{\lambda}_i^{A2}$. (2) Estimate the loss equations separately for workers who return to stable and unstable employment, with $\hat{\lambda}_i^{A1}$, $\hat{\lambda}_i^{A2}$, and $\hat{\lambda}_i^S$ or $\hat{\lambda}_i^U$, as additional regressors. The second-stage loss model is estimated with total losses ($\ln L_{it}$), and the absentee ($\ln K_{it}$) and earnings ($\ln W_{it}$) effects as dependent variables.

Data

The data come from the *Survey of Ontario Workers with Permanent Impairments*, the largest survey of injured workers ever conducted. Injured workers were interviewed between June 1989 and June 1990, as they reported to the offices of the Ontario Workers' Compensation Board for PPD assessment, or reassessment, by Board physicians.[8] The survey is a unique source of detailed information on postinjury employment and earnings, obtained from interviews with injured workers, combined with the workers' compensation claims data obtained from administrative records.

Our analysis data are drawn from a sample of workers who returned to work at least once. We exclude observations with missing data on preinjury employment (wages and hours) because we use the preinjury wage to benchmark potential postinjury earnings. After these exclusions, there are 4,406 observations.

We restrict the sample to workers interviewed at least three years after injury, so that we have a minimum three-year period of postinjury work experience to study. For those workers who are reporting for an initial PPD rating, the lag between injury and assessment (minimum three years) is longer than typical in the United States, but not atypical in Ontario. The three-year restriction does not imply that the cases in our sample are unusually difficult, except that they are obviously more severe than cases where temporary disability ends without residual impairment. We also restrict the sample to workers who have no missing data for the independent variables in the loss functions, and who provide complete information to estimate productivity losses for the full three-year postinjury interval. The remaining 800 workers comprise our main analysis sample.

A comparison of means between excluded and included cases (Appendix Table A1) suggests there is little systematic selection into the analysis sample based on key human capital variables. Relative to cases with missing data, included cases are more likely to be male, to work in the high-unemployment Northeast region, and to be union members. Among those who return to stable employment, the included cases appear

[8] The survey instrument was designed by Professor Johnson and administered by the staff of the Ontario Workers' Compensation Board (now the Workplace Safety and Insurance Board).

to have relatively more severe injuries, based on the proxy measures of severity (back strain, duration of first work absence), and are less likely to receive job accommodations. We examine the potential impact of selection bias on our results by reestimating the loss models using all eligible cases with complete data at the one-year ($N = 2{,}919$) and two-year ($N = 1{,}499$) intervals.

The vast majority of injured workers return first to their time-of-injury employer, so one important characteristic that distinguishes workers in stable versus unstable employment patterns is that most of the former group have returned to work and stayed with their time-of-injury employer. Coincidentally, in our main analysis sample, 100 percent of workers make their first return to work to the time-of-injury employer.

The dataset was collected more than ten years ago, but it is the only source of information on postinjury spells of work and work absence that can be used to analyze patterns of productivity losses for several years after injury. Although there are important differences between the workers' compensation systems in Ontario and most states, we believe the concepts and methods that we use to estimate productivity losses can be used to inform disability management decisions in the United States as well as Canada.[9] The industrial structure of Ontario is similar to that of many states, and many of the same firms and unions operate in Ontario and the United States. There are also important similarities in the determinants of postinjury duration of work absence in Ontario and the United States (Butler, Johnson, and Baldwin, 1995; Johnson, Butler, and Baldwin, 1995).

Variable Definitions

The key analysis variables are measures of general and specific human capital, and variables identifying workers who receive job accommodations. The accommodations variables, defined above, are binaries identifying workers who receive light work or flexible schedules on the first return to work.[10] We expect accommodations to reduce postinjury productivity losses associated with the absentee effect, but the effects of accommodations on total productivity losses and the earnings effect are theoretically ambiguous. Our measure of firm-specific human capital is a binary variable identifying workers employed by the time-of-injury firm five or more years prior to injury. Firm-specific human capital is expected to reduce postinjury productivity losses, because it provides incentives to employers to rehire injured workers, and the effect is expected to be greater for workers in stable employment patterns, because these workers return and stay with their time-of-injury employers.

We use four measures of general human capital that indicate the amount of education, training, and work experience acquired in the preinjury period. The first, a binary

[9] In Ontario, workers' compensation is managed by a centralized agency, the Workers' Compensation Board, that collects employer premiums and makes payments to injured workers and health care providers, effectively functioning as an exclusive insurer. In most states, workers' compensation is decentralized and payments are the responsibility of private insurers or self-insured employers. Lawyers are frequently involved in disputes between workers and insurers in the United States, whereas lawyers typically are not involved in the Ontario system.

[10] No measures of job accommodations are available for subsequent returns to work.

variable identifying high school graduates, captures the type of general education most applicable to all types of jobs.[11] The second, a binary variable that identifies workers with vocational training, measures general human capital more applicable to blue-collar, rather than white-collar, occupations. All else equal, we expect workers with more schooling or training to have lower postinjury productivity losses than workers with less. Another variable identifies workers who took time off work in the five years preceding injury to attend school. More recent acquisition of schooling includes more currently relevant job skills and should, therefore, reduce postinjury productivity losses. Finally, we include a variable for sporadic employment, measuring the number of spells of joblessness lasting one month or longer in the five years prior to injury. Sporadic employment, a measure of missing work experience, is expected to increase postinjury productivity losses.

Other variables in the loss models control for worker characteristics (age, sex); nature of injury; characteristics of the preinjury job; and demand in the local labor market (Northeast region).[12] The controls for injury include a binary variable for back sprains or strains (a diagnosis that accounts for a disproportionate share of indemnity costs in workers' compensation) and binary variables identifying duration of initial work absence (less than 120 days, 120–240 days, more than 240 days). The diagnosis and duration variables are included in the loss models as, admittedly weak, proxies for severity of injury.[13]

Characteristics of the preinjury job influence postinjury productivity losses, because an injured worker's best opportunity to return to work is often with his or her time-of-injury employer. Our controls for preinjury job characteristics identify workers who were union members, and workers employed in service or transport occupations, at the time of injury. An interaction term between high school graduation and union

[11] We have more detailed information on education, but there is so little variability in the data that all the important variation is captured by the high school/non-high school distinction.

[12] The specifications began with a more expanded set of characteristics, which proved to be statistically insignificant and are not reported here. These include additional controls for size of the preinjury firm, injury type, industry, and region. The Northeast labor market region had consistently higher unemployment rates than the other regions in Ontario throughout the period in which the injuries in our data occurred.

[13] The use of initial duration of work absence as a proxy for injury severity is potentially problematic, because duration is also a function of many other factors, such as the nature of the employers' return to work programs, workers' attitudes toward return to work, etc. An auxiliary analysis shows, however, that duration is only weakly correlated with other independent variables in the model: when we regress the initial duration of work absence on all other independent variables in the model, the variables are not jointly significant. As a consequence, when we exclude the duration variables from the loss models, there is no substantive change in the results.

An alternative approach to controlling for severity would be to include the International Classification of Disease (ICD9) diagnosis codes in the models, but the codes are also poor measures of severity, primarily because that is not the purpose for which they were designed. The codes are frequently applied incorrectly and there is substantial variation across providers in the assignment of codes for workers' compensation claims (Johnson, Baldwin, and Burton, 1996). Further, many codes are ambiguous, often combining diagnoses that are clinically dissimilar even when they are applied correctly (Romano and Luft, 1992).

membership captures the extent to which union membership protects more or less educated workers from productivity losses following a work-related injury.

RESULTS

Estimates of Productivity Losses

Table 1 reports mean productivity losses, and its component absentee and earnings effects, for workers in stable ($N = 322$) versus unstable ($N = 478$) postinjury patterns of employment. Losses are expressed in log form (e.g., ln projected earnings − ln actual earnings), so the sum of the absentee and earnings effects equals total productivity losses. Results are presented for one to three years after injury.

The results show that permanent partial impairments impose substantial productivity losses over the entire three-year postinjury period we observe. Productivity losses are greater for workers in unstable versus stable employment patterns, and the differences are statistically significant in each year. For both groups, the absentee effect is the most important component of losses in the first year after injury, reflecting the lengthy first spells of work absence characteristic of workers in our sample, all of whom have relatively severe injuries.

The pattern of losses for the stable employment group documents a large loss of productivity in the first year after injury, attributed to lengthy initial spells of work absence, followed by a recovery close to preinjury earnings in the following years. In the first year after injury, actual earnings are 43 percent lower than expected earnings, and the difference is almost entirely explained by the absentee effect. In the second year, mean earnings are only 6 percent less than expected, a considerable improvement, and the reduction in productivity is now almost entirely explained by the earnings effect. Losses increase slightly in the third year, to 16 percent, with one-fourth being attributed to the absentee effect and three-fourths to the earnings effect. Even workers in stable employment patterns can incur losses attributed to the absentee effect, if actual weeks worked are less than the expected weeks based on the preinjury job. Still, we expect these losses to be comparatively small.

For those workers with unstable reemployment histories, productivity losses are substantial throughout the three-year postinjury period. Losses in the first year represent a 58-percent reduction in earnings, almost entirely explained by the absentee effect. In the second year, actual earnings are 29 percent lower than expected, and the absentee effect still accounts for the majority of losses. Losses increase substantially, to 52 percent, in the third year after injury, with approximately two-thirds attributed to the absentee effect and one-third to the earnings effect. Overall, the absentee effect maintains its dominance over the entire period we observe, reflecting the intermittent employment of workers in unstable employment patterns.

Determinants of Productivity Losses

Tables 2–4 report coefficient estimates of the loss functions for one to three years after injury. In each model, the dependent variable is the log of the ratio of an expected to actual value (postinjury earnings, weeks worked, or weekly earnings); so the coefficient estimates represent percentage changes in relative effects. The models control for nonrandom selection into the stable and unstable employment groups, and for the

TABLE 1
Estimates of Productivity Losses for Workers in Stable versus Unstable Postinjury Employment

	First Year After Injury[a]			Second Year After Injury[a]			Third Year After Injury[a]		
	Stable ($N = 322$)	Unstable ($N = 478$)	t-Test	Stable ($N = 322$)	Unstable ($N = 478$)	t-Test	Stable ($N = 322$)	Unstable ($N = 478$)	t-Test
Productivity losses[b]	0.4349 (0.033)	0.5775 (0.032)	3.01***	0.0584 (0.017)	0.2910 (0.027)	6.54***	0.1617 (0.029)	0.5162 (0.040)	6.49***
Absentee effect[c]	0.4278 (0.031)	0.5355 (0.029)	2.46**	0.0005 (0.009)	0.1732 (0.021)	6.55***	0.0409 (0.024)	0.3246 (0.035)	6.02***
Earnings effect[d]	0.0071 (0.012)	0.0420 (0.010)	2.20**	0.0579 (0.014)	0.1178 (0.015)	2.81***	0.1208 (0.017)	0.1915 (0.018)	2.70***

Source: Survey of Ontario Workers with Permanent Impairments (1989–1990).
t-Ratios identify significant differences in losses between workers in stable and unstable employment patterns, where ***1 percent; **5 percent; *10 percent.
[a]Standard error of means in parentheses.
[b]Total productivity losses measured as log(expected earnings/actual earnings).
[c]Absentee effect measured as log(preinjury weeks worked/postinjury weeks worked).
[d]Earnings effect measured as log(preinjury weekly wage/postinjury weekly wage).

TABLE 2
Determinants of Total Productivity Losses: Stable versus Unstable Employment

	First Year Losses[a]		Second Year Losses[a]		Third Year Losses[a]	
	Stable ($N = 322$)	Unstable ($N = 478$)	Stable ($N = 322$)	Unstable ($N = 478$)	Stable ($N = 322$)	Unstable ($N = 478$)
High school	−0.250 (−2.16)	0.112 (0.97)	−0.121 (−1.04)	−0.093 (−0.79)	−0.123 (−0.95)	−0.099 (−0.77)
Union × high school	0.447 (3.53)	−0.107 (−0.85)	0.225 (1.97)	0.035 (0.31)	0.109 (0.76)	0.139 (0.97)
5 years experience	−0.160 (−1.81)	−0.032 (−0.36)	−0.089 (−1.50)	−0.095 (−1.60)	−0.160 (−1.86)	−0.060 (−0.70)
Vocational training	0.063 (1.17)	−0.157 (−2.92)	0.022 (0.50)	−0.152 (−3.36)	0.026 (0.37)	−0.149 (−2.10)
Prior schooling	−0.026 (−0.45)	−0.067 (−1.15)	−0.068 (−0.95)	−0.119 (−1.65)	−0.151 (−2.00)	−0.133 (−1.76)
Sporadic work	−0.057 (−1.59)	−0.023 (−0.63)	−0.039 (−1.28)	−0.039 (−1.29)	−0.064 (−1.77)	−0.012 (−0.35)
Flexible schedule	−0.994 (−3.91)	0.169 (0.66)	−0.462 (−2.78)	0.410 (2.47)	−0.110 (−0.46)	0.108 (0.45)
Light work	0.069 (0.22)	0.434 (1.40)	0.320 (1.25)	0.067 (0.26)	0.164 (0.40)	−0.817 (−2.03)
Age	−0.000 (−0.30)	−0.006 (−2.44)	0.002 (1.05)	−0.010 (−4.08)	0.005 (1.21)	−0.002 (−0.55)
Male	−0.046 (−0.58)	−0.090 (−1.12)	−0.014 (−0.19)	−0.037 (−0.50)	−0.073 (−0.68)	−0.298 (−2.78)
Northeast	0.018 (0.21)	−0.162 (−1.91)	0.061 (0.90)	−0.144 (−2.13)	0.068 (0.60)	−0.176 (−1.54)
Union	−0.223 (−2.40)	0.021 (0.23)	−0.075 (−1.21)	−0.008 (−0.13)	0.033 (0.32)	−0.156 (−1.52)
Back strain	−0.059 (−0.82)	0.015 (0.21)	−0.041 (−0.74)	0.089 (1.59)	−0.032 (−0.33)	0.316 (3.31)
Duration <120	−1.484 (−13.52)	−1.502 (−13.69)	0.075 (1.37)	−0.052 (−0.96)	0.099 (1.24)	−0.093 (−1.16)
Duration 120–240	−0.995 (−8.68)	−0.954 (−8.33)	0.078 (1.13)	−0.043 (−0.61)	0.074 (0.78)	−0.034 (−0.35)
Service	0.055 (0.50)	0.095 (0.86)	0.086 (0.90)	0.208 (2.17)	0.113 (0.68)	−0.251 (−1.52)
Transportation	0.088 (0.55)	0.128 (0.80)	0.118 (1.07)	0.158 (1.43)	0.233 (1.14)	−0.131 (−0.64)
λ-Stable	0.244 (1.10)	−0.145 (−0.65)	0.274 (1.60)	−0.253 (−1.48)	0.207 (0.72)	−0.745 (−2.59)
λ-Flexible schedule	0.501 (3.73)	−0.186 (−1.39)	0.269 (3.26)	−0.225 (−2.72)	0.120 (1.02)	−0.043 (−0.37)
λ-Light work	−0.044 (−0.23)	−0.183 (−0.98)	−0.188 (−1.22)	−0.049 (−0.32)	−0.114 (−0.47)	0.433 (1.80)
R^2	0.670	0.528	0.090	0.073	0.108	0.059
Wald test (HC)[b]	17.545***	10.046	10.351	27.518***	7.413	9.470
Wald test (ACC)[b]	15.390***	2.386	8.919*	6.328**	0.376	4.318
Wald test (**λ**)[b]	16.781***	3.237	15.954***	10.229***	1.950	12.603***

Source: Survey of Ontario Workers with Permanent Impairments (1989–1990).
[a] *t*-Statistics in parentheses.
[b] Statistical significance of the Wald tests indicated by ***1 percent; **5 percent; *10 percent.

TABLE 3
Determinants of the Absentee Effect: Stable versus Unstable Employment

	First Year Losses[a]		Second Year Losses[a]		Third Year Losses[a]	
	Stable ($N = 322$)	Unstable ($N = 478$)	Stable ($N = 322$)	Unstable ($N = 478$)	Stable ($N = 322$)	Unstable ($N = 478$)
High school	−0.113 (−1.32)	0.089 (1.04)	−0.018 (−0.30)	−0.099 (−1.62)	0.001 (0.02)	−0.083 (−1.01)
Union × high school	0.262 (2.67)	−0.116 (−1.18)	0.060 (1.04)	0.010 (0.18)	−0.090 (−0.88)	0.065 (0.64)
5 years experience	−0.121 (−1.69)	−0.065 (−0.91)	−0.043 (−1.65)	−0.079 (−3.01)	−0.113 (−1.64)	0.020 (0.30)
Vocational training	0.031 (0.78)	−0.128 (−3.20)	0.004 (0.16)	−0.120 (−4.94)	0.021 (0.36)	−0.155 (−2.70)
Prior schooling	−0.021 (−0.39)	−0.067 (−1.27)	−0.004 (−0.08)	−0.096 (−1.93)	−0.047 (−1.13)	−0.034 (−0.81)
Sporadic work	−0.055 (−2.26)	−0.035 (−1.45)	−0.032 (−2.72)	−0.038 (−3.27)	−0.059 (−2.65)	0.000 (0.02)
Flexible schedule	−0.661 (−3.98)	0.077 (0.46)	−0.303 (−3.20)	0.242 (2.55)	−0.014 (−0.07)	0.271 (1.42)
Light work	−0.006 (−0.03)	0.362 (1.72)	0.026 (0.29)	0.223 (2.46)	−0.185 (−0.62)	−0.462 (−1.55)
Age	−0.001 (−0.57)	−0.007 (−3.80)	0.000 (0.55)	−0.010 (−8.29)	0.002 (0.69)	−0.001 (−0.32)
Male	0.003 (0.08)	−0.134 (−2.92)	0.014 (0.55)	−0.115 (−4.56)	−0.040 (−0.49)	−0.328 (−4.02)
Northeast	−0.037 (−0.63)	−0.146 (−2.46)	0.014 (0.51)	−0.209 (−7.44)	0.029 (0.33)	−0.294 (−3.33)
Union	−0.112 (−1.44)	0.015 (0.19)	−0.019 (−0.64)	0.027 (0.93)	0.080 (0.99)	−0.106 (−1.31)
Back strain	−0.057 (−1.19)	0.049 (1.01)	0.003 (0.13)	0.074 (3.30)	0.026 (0.35)	0.256 (3.35)
Duration <120	−1.508 (−16.48)	−1.455 (−15.90)	0.010 (0.36)	−0.090 (−3.21)	0.042 (0.71)	−0.127 (−2.16)
Duration 120–240	−1.027 (−10.78)	−0.981 (−10.30)	0.023 (0.62)	−0.113 (−3.07)	0.056 (0.82)	−0.088 (−1.29)
Service	0.049 (0.75)	−0.000 (−0.00)	0.043 (1.26)	0.090 (2.62)	0.067 (0.48)	−0.263 (−1.88)
Transportation	0.039 (0.35)	0.120 (1.06)	0.015 (0.37)	0.200 (4.89)	0.103 (0.61)	−0.151 (−0.90)
λ-Stable	0.119 (0.86)	−0.260 (−1.88)	0.106 (1.41)	−0.376 (−5.01)	0.055 (0.24)	−0.813 (−3.51)
λ-Flexible schedule	0.303 (3.55)	−0.109 (−1.27)	0.146 (3.26)	−0.133 (−2.97)	0.019 (0.21)	−0.138 (−1.49)
λ-Light work	−0.013 (−0.10)	−0.162 (−1.31)	−0.012 (−0.23)	−0.164 (−3.04)	0.102 (0.58)	0.205 (1.15)
R^2	0.763	0.566	0.072	0.111	0.060	0.066
Wald test (HC)[b]	16.242**	17.584***	15.397**	97.964***	11.384*	13.534**
Wald test (ACC)[b]	15.889***	3.164	10.399***	12.345***	0.394	4.471*
Wald test (λ)[b]	14.760***	6.605*	13.347***	38.614***	0.403	19.254***

Source: Survey of Ontario Workers with Permanent Impairments (1989–1990).
[a] *t*-Statistics in parentheses.
[b] Statistical significance of the Wald tests indicated by ***1 percent; **5 percent; *10 percent.

TABLE 4
Determinants of the Earnings Effect: Stable versus Unstable Employment

	First Year Losses[a]		Second Year Losses[a]		Third Year Losses[a]	
	Stable ($N = 322$)	Unstable ($N = 478$)	Stable ($N = 322$)	Unstable ($N = 478$)	Stable ($N = 322$)	Unstable ($N = 478$)
High school	−0.136 (−1.79)	0.023 (0.30)	−0.103 (−1.04)	0.006 (0.06)	−0.124 (−1.12)	−0.016 (−0.14)
Union × high school	0.184 (2.40)	0.008 (0.10)	0.165 (1.69)	0.024 (0.25)	0.199 (1.75)	0.074 (0.65)
5 years experience	−0.038 (−0.76)	0.033 (0.66)	−0.045 (−0.82)	−0.015 (−0.28)	−0.046 (−0.81)	−0.081 (−1.42)
Vocational training	0.031 (0.90)	−0.029 (−0.83)	0.018 (0.48)	−0.032 (−0.84)	0.005 (0.12)	0.006 (0.14)
Prior schooling	−0.005 (−0.25)	0.000 (0.02)	−0.064 (−1.32)	−0.022 (−0.45)	−0.104 (−1.50)	−0.099 (−1.42)
Sporadic work	−0.002 (−0.09)	0.012 (0.45)	−0.007 (−0.23)	−0.000 (−0.02)	−0.005 (−0.19)	−0.013 (−0.44)
Flexible schedule	−0.333 (−1.98)	0.091 (0.54)	−0.159 (−1.04)	0.168 (1.10)	−0.095 (−0.60)	−0.163 (−1.03)
Light work	0.076 (0.32)	0.072 (0.30)	0.293 (1.09)	−0.156 (−0.58)	0.349 (1.17)	−0.355 (−1.20)
Age	0.000 (0.12)	0.000 (0.22)	0.002 (0.96)	−0.000 (−0.19)	0.002 (1.14)	−0.001 (−0.49)
Male	−0.050 (−0.71)	0.043 (0.62)	−0.028 (−0.40)	0.078 (1.11)	−0.032 (−0.45)	0.030 (0.42)
Northeast	0.056 (0.88)	−0.015 (−0.24)	0.046 (0.70)	0.065 (0.98)	0.039 (0.53)	0.118 (1.61)
Union	−0.110 (−2.16)	0.006 (0.11)	−0.056 (−0.87)	−0.035 (−0.55)	−0.047 (−0.67)	−0.050 (−0.72)
Back strain	−0.002 (−0.03)	−0.033 (−0.65)	−0.044 (−0.81)	0.015 (0.27)	−0.059 (−1.02)	0.060 (1.04)
Duration <120	0.024 (0.55)	−0.046 (−1.08)	0.065 (1.34)	0.037 (0.77)	0.057 (1.07)	0.034 (0.64)
Duration 120–240	0.032 (0.65)	0.027 (0.54)	0.055 (0.98)	0.070 (1.24)	0.018 (0.27)	0.054 (0.80)
Service	0.005 (0.06)	0.096 (1.05)	0.042 (0.46)	0.118 (1.27)	0.046 (0.48)	0.012 (0.12)
Transportation	0.048 (0.46)	0.008 (0.07)	0.103 (0.94)	−0.041 (−0.38)	0.129 (1.12)	0.020 (0.17)
λ-Stable	0.125 (0.80)	0.114 (0.73)	0.167 (1.02)	0.122 (0.74)	0.151 (0.87)	0.067 (0.39)
λ-Flexible schedule	0.197 (2.31)	−0.077 (−0.90)	0.123 (1.62)	−0.091 (−1.20)	0.100 (1.28)	0.094 (1.20)
λ-Light work	−0.030 (−0.21)	−0.020 (−0.14)	−0.175 (−1.07)	0.115 (0.70)	−0.217 (−1.21)	0.228 (1.27)
R^2	0.074	0.051	0.093	0.027	0.130	0.052
Wald test (HC)[b]	8.084	2.052	7.020	1.533	6.354	5.472
Wald test (ACC)[b]	4.038	0.391	2.177	1.501	1.715	2.580
Wald test (λ)[b]	6.363*	1.364	5.139	2.303	4.101	3.182

Source: Survey of Ontario Workers with Permanent Impairments (1989–1990).
[a] *t*-Statistics in parentheses.
[b] Statistical significance of the Wald tests indicated by ***1 percent; **5 percent; *10 percent.

endogeneity of job accommodations, by including the inverse Mills ratios (λ-stable, λ-flexible schedule, λ-light work) generated from the first-stage probit estimates (Appendix Table A2) as regressors.

One important difference between the models for year one and the subsequent years is the importance of duration of first work absence as a predictor of total productivity losses (Table 2). Much of the explanatory power of the models representing productivity losses in the first year is embedded in the variables describing duration of first absence from work, but duration of first absence is not a significant predictor of total losses after the first year. The results suggest that losses in the first year are largely determined by the acute or temporarily disabling effects of injuries, including the time required for medical care and rehabilitation, whereas losses in the subsequent years are largely determined by the more permanent effects of the impairment, not necessarily highly correlated with the first spell of work absence. Among workers in unstable employment patterns, however, duration of first absence is significantly correlated with losses attributed to the absentee effect even in the second and third years after injury (Table 3).

Human Capital. Investments in human capital significantly reduce postinjury productivity losses for at least the first two years after injury, but the timing and type of human capital investments that matter are distinctly different for workers who return to stable versus unstable employment. In the total loss models, the human capital variables are jointly significant in the first year for workers in stable employment, and in the second year for workers in unstable employment (see Wald tests in Table 2).

Consistent with theory, investments in specific human capital reduce postinjury productivity losses, and the effects are generally greater for workers in stable versus unstable employment patterns. Workers in stable postinjury employment return and stay with their preinjury employer, where they have acquired specific human capital. Although the coefficient estimates for work experience are generally not significant, the effects tend to be larger in the absentee model than in the earnings model, supporting the notion that specific human capital provides incentives to rehire and retain injured workers, thereby reducing postinjury spells of work absence.

Investments in general human capital reduce postinjury productivity losses, as expected, but the relative importance of the various measures differs for workers in stable versus unstable employment. Among workers in stable employment patterns, high school education reduces total productivity losses by 25 percent in the first year after injury, after which the effect becomes insignificant. The interaction effect between education and union membership is positive and significant, indicating that union status helps protect its less educated members from productivity losses, but not its more educated members. The effect weakens in the second year and becomes statistically insignificant by the third year after injury.

Among workers in unstable reemployment patterns, vocational training reduces productivity losses by approximately 15 percent in each of the three years after injury. Vocational training programs supply a form of general human capital more highly focused than formal schooling, typically providing a self-contained set of skills requiring virtually no other firm-specific knowledge. Electricians working in construction, for example, tend to use universal types of wires, connectors, circuit designs, and so forth. Workers with such training can move easily from one job site to another, diminishing the impact of unstable postinjury employment. There is little synergy between vocational training and firm-specific work experience, and so it is not surprising that vocational training is less important for workers in stable employment patterns, who return to their preinjury employer and stay.

Contrary to our expectations, sporadic work in the preinjury period significantly reduces productivity losses associated with the absentee effect (Table 3) for both the stable (all years) and the unstable (year two) employment groups. The negative coefficient may indicate a pattern of preinjury work experience that reduces a worker's wage expectations, increasing the chances of reemployment after injury. The variable is insignificant in the earnings models, however, showing no consistent pattern of lower postinjury wages among workers with sporadic work histories (Table 4).

Job Accommodations. The results for job accommodations also yield striking differences between the stable versus unstable reemployment groups. The accommodations variables are jointly significant in the total loss and absentee models in years one and two for workers in stable employment, and in years two and three for workers in unstable employment (see Wald tests in Tables 2 and 3).

Among workers in stable reemployment patterns, a flexible schedule on first return to work significantly reduces total productivity losses in the first two years after injury. The impact of a flexible schedule operates primarily through the absentee effect, enabling injured workers to return to work sooner than would have been possible without the accommodation. Flexible scheduling has a negative effect in the earnings model (significant only in year one). So there is no evidence that employers pass on the costs of the accommodation to injured workers.

Among those in unstable reemployment patterns, a light work accommodation significantly reduces total productivity losses in the third year after injury, an effect almost equally attributed to the absentee and earnings effects. Flexible schedules, however, are associated with significant increases in losses attributed to the absentee effect in year two. One possible explanation for this result comes from a previous study of the Ontario workers, which suggests that accommodations for workers who experience postinjury spells of disability represent trial work situations, testing whether the workers are able to perform selected jobs with an accommodation (Butler, Johnson, and Baldwin, 1995). Workers who fail the test may experience additional spells of work absence, incurring subsequent losses attributed to the absentee effect.

Determinants of Postinjury Employment Stability

As shown in Table 1, employment stability is a critical factor in minimizing postinjury productivity losses, particularly as time elapses from the injury date. Although not the primary focus of this article, the determinants of employment stability are important because of the strong correlation between productivity losses and whether or not an injured worker is successful on his/her first return to work.

Estimates of the employment stability model, reported in Appendix Table A2, suggest that characteristics of the injured worker and his/her preinjury job, and the demand for labor, are more important than human capital investments in determining returns to stable employment. Older workers and males are significantly more likely to experience postinjury employment stability than younger workers or females. Duration of first work absence is not a significant determinant of stable work outcomes, but workers with back sprains or strains are less likely to return to stable employment than workers with other injuries, a result that is marginally significant. Transportation workers are less likely to return to stable employment than workers in service or other occupations, while workers in the Northeast region are more likely to experience postinjury employment stability than workers in other regions.

Sensitivity Tests

The potential size of our analysis sample is reduced by restricting it to workers with three full years of postinjury employment and earnings data. To test how the restriction affects the generalizability of our results to the population of interest (workers with permanent disabilities who return to work at least once), we reestimated the loss models using all eligible cases in each period. In other words, first year losses are estimated for all workers with complete data for one year after injury, and second and third year losses in a similar manner. The results for all eligible cases support our qualitative conclusions regarding patterns of productivity losses between the stable and unstable reemployment groups, and the relative importance of the absentee and earnings effects, over the three-year period (Appendix Table A3).

Estimates of the total loss model for all eligible cases (Appendix Table A4) confirm the importance of first duration of work absence as a determinant of losses in the first year and not thereafter, but differ with respect to the importance of human capital characteristics and job accommodations. Nevertheless, we must be cautious in drawing inferences from the differences between the two samples, because the classifications into stable/unstable employment at one or two years may differ from the classifications after three years. In other words, some workers classified as stable after only one or two years' observation may experience subsequent injury-related absences (instability) in later years that we do not observe, creating a misclassification bias in the sample of all eligible cases. Only 40 percent of the analysis sample is classified in the stable group, for example, compared to 47 percent of the full sample. Another reason to emphasize the results for the three-year cohort is that it is impossible to compare productivity losses over time with the sample of all eligible cases, because each cohort includes a different set of workers.

Our estimates of productivity losses are based on the counterfactual assumption that injured workers would have experienced zero growth in real wages in the absence of injury. The real wages of individual workers, however, tend to rise during most of a worker's career. To examine the sensitivity of the results to the zero wage growth assumption, we reestimated the models using a 2-percent growth rate, and introducing heterogeneous growth rates for eleven distinct industry/occupation combinations. In both cases, our qualitative results are robust to changes in the wage growth rate.

An alternate approach to generating expected earnings in the absence of injury has been developed in a series of studies from RAND (Reville et al., 2001; Reville, 1999). The RAND research estimates postinjury earnings losses without imposing an *ex ante* assumption on wage growth rates by comparing actual earnings of injured workers in the postinjury period to earnings of matched employees from the preinjury firm who do not experience an injury. The matching methodology is less desirable for the purposes of our study, because it is more difficult to match workers from smaller firms, introducing a potential selection bias into the estimates of human capital and job accommodations on productivity losses. Despite the differences in methodologies and selection of study populations, however, the RAND studies find large productivity losses that persist up to ten years after the injury date, consistent with our main results.

DISCUSSION

Previous research on the Ontario data demonstrates that a return to work does not necessarily mark the end of the spells of work absence attributable to an occupational injury (Butler, Johnson, and Baldwin, 1995). This article extends the line of research by providing estimates of productivity losses in the postinjury period, including periods after a first return to work. In so doing, we document large productivity losses that persist up to three years after injury, even for a group that returns to stable employment.

There are distinctly different patterns of losses for workers who return to stable reemployment versus those who do not. In the first year after injury, productivity losses are primarily attributed to an absentee effect (losses incurred during spells of work absence) for both groups, because the workers in our sample experience lengthy spells of first work absence, on average. In subsequent years, workers in unstable employment patterns continue to experience losses primarily attributed to the absentee effect, reflecting repeated spells of injury-related work absence. For those in stable employment, losses in the second and third years are primarily attributed to the earnings effect (losses incurred during periods of work at reduced wages or reduced hours), a loss that would be overlooked if one focused solely on returns to work and continued employment as measures of recovery.

The important determinants of postinjury productivity losses also differ for the stable versus unstable reemployment groups. For both groups, the most important determinant of losses in the first year after injury is duration of initial work absence, but initial duration has no significant effect on losses in subsequent years. Investments in human capital mitigate productivity losses to some extent, with specific human capital relatively more important for workers who return to stable employment, and general human capital more important for the unstable group. Job accommodations have a greater impact in reducing losses for those in stable reemployment, underscoring the economic importance of a successful return to the preinjury employer.

Previous research with the Ontario data reveals that many injured workers who initially return to work experience subsequent significant spells of work absence, but workers who return to work and stay appear to have recovered from the limiting effects of their injuries in those analyses. The results reported here show that even workers in stable postinjury employment incur large losses related to their injuries. Taken together, the past and the current research on the Ontario workers suggests that the long-term effects of permanent impairments are both greater and more persistent over time than was previously thought to be the case. The topic is deserving of more attention, with the objective of improving disability management programs and strategies to minimize the adverse effects of permanent impairments.

APPENDIX

TABLE A1
Comparisons of Means for Excluded and Included Cases by Postinjury Employment Stability

	Stable					Unstable				
	(a) In-sample ($N = 322$)	(b) Missing Outcome ($N = 967$)	(c) Missing Controls ($N = 723$)	*t*-Test (a vs. b)	*t*-Test (a vs. c)	(d) In-sample ($N = 478$)	(e) Missing Outcome ($N = 1,152$)	(f) Missing Controls ($N = 764$)	*t*-Test (d vs. e)	*t*-Test (d vs. f)
Preinjury wage	16.1 (5.57)	14.6 (5.37)	15.3 (6.29)	4.42***	1.93*	15.9 (6.18)	13.8 (5.20)	15.6 (8.47)	7.15***	0.84
Preinjury weeks worked	51.3 (3.65)	51.2 (4.30)	50.7 (5.90)	0.024	1.59	51.4 (3.38)	51.5 (3.27)	50.0 (7.15)	0.15	4.05***
High school	0.36 (0.48)	0.40 (0.49)	0.47 (0.50)	1.21	6.65***	0.39 (0.48)	0.39 (0.48)	0.40 (0.49)	0.72	1.81*
5 years experience	0.59 (0.44)	0.59 (0.49)	0.57 (0.50)	0.05	0.56	0.64 (0.49)	0.56 (0.50)	0.43 (0.49)	2.41**	5.79***
Vocational training	0.42 (0.49)	0.40 (0.49)	0.44 (0.50)	0.44	0.59	0.44 (0.49)	0.42 (0.49)	0.43 (0.50)	0.26	1.20
Prior schooling	0.16 (0.81)	0.12 (0.66)	0.17 (0.80)	0.92	0.23	0.26 (0.78)	0.20 (0.71)	0.22 (0.86)	0.86	0.59
Sporadic work	0.71 (1.24)	0.80 (1.34)	0.83 (1.42)	1.04	1.27	0.83 (1.26)	1.00 (1.42)	1.07 (1.59)	2.77***	3.34***
Flexible schedule	0.10 (0.30)	0.18 (0.39)	0.17 (0.30)	3.58***	2.83***	0.14 (0.31)	0.14 (0.32)	0.11 (0.32)	0.63	0.18
Light work	0.32 (0.47)	0.39 (0.49)	0.36 (0.48)	2.08**	0.93	0.36 (0.47)	0.37 (0.47)	0.36 (0.48)	0.74	1.34
Age	40 (11)	42 (12)	41 (11)	2.39**	1.11	40 (11)	41 (11)	40 (12)	2.74***	1.56
Male	0.86 (0.35)	0.82 (0.38)	0.83 (0.38)	1.66*	1.39	0.83 (0.40)	0.66 (0.48)	0.62 (0.48)	6.53***	6.47***
Northeast	0.25 (0.43)	0.12 (0.32)	0.06 (0.24)	5.67***	8.64***	0.17 (0.35)	0.12 (0.30)	0.06 (0.24)	2.02**	4.29***
Union	0.71 (0.45)	0.59 (0.49)	0.65 (0.48)	4.05***	2.09**	0.70 (0.47)	0.64 (0.49)	0.64 (0.48)	1.83*	0.70
Service	0.08 (0.27)	0.06 (0.23)	0.09 (0.27)	1.61	0.48	0.05 (0.23)	0.08 (0.26)	0.08 (0.27)	1.53	1.75*
Transportation	0.09 (0.29)	0.05 (0.22)	0.07 (0.25)	2.57**	1.18	0.05 (0.24)	0.06 (0.22)	0.08 (0.27)	0.92	1.32
Back strain	0.33 (0.47)	0.20 (0.40)	0.25 (0.44)	4.52***	2.39***	0.42 (0.48)	0.45 (0.49)	0.36 (0.48)	1.90*	0.55
Duration <120	0.61 (0.49)	0.50 (0.50)	0.52 (0.50)	3.32***	2.66**	0.70 (0.48)	0.72 (0.46)	0.51 (0.50)	1.55	4.98***
Duration 120–240	0.28 (0.45)	0.31 (0.46)	0.26 (0.44)	1.18	0.66	0.28 (0.43)	0.25 (0.42)	0.19 (0.39)	0.61	2.03**

Note: Standard deviations in parentheses. Statistical significance of the *t*-Tests indicated by ***1 percent; **5 percent; *10 percent
Source: Survey of Ontario Workers with Permanent Impairments (1989–1990).

TABLE A2
Probit Estimates for the First-Stage Sample Selection Models

	Stable Employment ($N = 800$)		Flexible Schedule ($N = 800$)		Light Work ($N = 800$)	
	Coefficient	p-Value	Coefficient	p-Value	Coefficient	p-Value
High school	0.128	0.467	−0.270	0.248	0.050	0.776
Union × high school	0.004	0.982	0.559	0.044	0.043	0.838
5 years experience	−0.049	0.736	0.142	0.480	0.042	0.775
Vocational training	0.082	0.402	0.360	0.006	−0.047	0.640
Prior schooling	0.014	0.838	0.056	0.536	0.015	0.832
Sporadic work	−0.002	0.964	0.096	0.181	0.000	0.995
Age	0.009	0.047	−0.003	0.559	−0.002	0.614
Male	0.280	0.031	−0.503	0.001	0.222	0.094
Northeast	0.505	0.006	0.299	0.277	0.453	0.015
Union	0.138	0.345	−0.116	0.551	−0.241	0.106
Back strain	−0.178	0.070	0.278	0.036	0.228	0.022
Duration <120	−0.082	0.596	−0.362	0.069	−0.199	0.204
Duration 120–240	0.048	0.772	−0.283	0.196	−0.158	0.357
Service	6.022	0.307	−8.506	0.309	9.506	0.074
Transportation	−13.217	0.016	2.982	0.641	−18.651	0.131
Accident year	−0.652	0.123	−0.213	0.652	0.143	0.701
Accident year^2	0.004	0.112	0.001	0.689	−0.000	0.778
Firm size: 1–49	0.069	0.663	0.720	0.000	0.063	0.693
Firm size: 50–199	0.038	0.805	0.253	0.256	−0.016	0.919
Firm size: 200+	−0.056	0.676	0.205	0.292	0.070	0.615
NE * Firm 1–49	−0.543	0.103	−1.255	0.023	−0.978	0.006
NE * Firm 50–199	0.298	0.440	−0.537	0.391	−0.238	0.551
NE * Firm 200+	0.068	0.821	−0.835	0.131	−0.205	0.498
Acc year * Service	−0.067	0.336	0.100	0.309	−0.115	0.070
Acc year * Trans	0.161	0.014	−0.038	0.620	0.212	0.142
Log-likelihood	−510.064		−242.872		−480.726	
χ^2: exclusion restrictions[a]	22.503**		18.308**		21.017**	

Source: Survey of Ontario Workers with Permanent Impairments (1989–1990).
[a]Statistical significance of the exclusion restrictions indicated by ***1 percent; **5 percent; *10 percent.

TABLE A3
Estimates of Productivity Losses for Workers in Stable versus Unstable Postinjury Employment: Cases with Complete Data in Each Year

	First Year After Injury[a]			Second Year After Injury[a]			Third Year After Injury[a]		
	Stable ($N = 1289$)	Unstable ($N = 1630$)	t-Test	Stable ($N = 624$)	Unstable ($N = 875$)	t-Test	Stable ($N = 322$)	Unstable ($N = 478$)	t-Test
Productivity Losses[b]	0.6529 (0.021)	0.9834 (0.022)	10.89***	0.1233 (0.016)	0.6227 (0.032)	12.35***	0.1617 (0.029)	0.5162 (0.040)	6.49***
Absentee Effect[c]	0.5692 (0.018)	0.8894 (0.020)	11.78***	0.0331 (0.011)	0.4819 (0.029)	12.58***	0.0409 (0.024)	0.3246 (0.035)	6.02***
Earnings Effect[d]	0.0837 (0.008)	0.0940 (0.007)	0.95	0.0902 (0.011)	0.1407 (0.013)	2.77***	0.1208 (0.017)	0.1915 (0.018)	2.70***

Source: Survey of Ontario Workers with Permanent Impairments (1989–1990).
[a]Standard error of means in parentheses. t-Ratios identify significant differences in losses between workers in stable and unstable employment patterns, where ***1 percent; **5 percent; *10 percent.
[b]Total productivity losses measured as log(expected earnings/actual earnings).
[c]Absentee effect measured as log(preinjury weeks worked/postinjury weeks worked).
[d]Earnings effect measured as log(preinjury weekly wage/postinjury weekly wage).

TABLE A4
Determinants of Total Productivity Losses: Stable versus Unstable Employment, Cases with Complete Data in Each Year

	First Year Losses[a]		Second Year Losses[a]		Third Year Losses[a]	
	Stable (N = 1,289)	Unstable (N = 1,630)	Stable (N = 624)	Unstable (N = 875)	Stable (N = 322)	Unstable (N = 478)
High school	−0.037 (−0.61)	0.007 (0.11)	−0.109 (−1.27)	−0.196 (−2.27)	−0.123 (−0.95)	−0.099 (−0.77)
Union × high school	0.024 (0.34)	−0.124 (−1.76)	0.119 (1.27)	0.151 (1.61)	0.109 (0.76)	0.139 (0.97)
5 years experience	−0.081 (−1.61)	−0.036 (−0.71)	0.036 (0.65)	0.024 (0.44)	−0.160 (−1.86)	−0.060 (−0.70)
Vocational training	0.017 (0.48)	−0.062 (−1.73)	−0.012 (−0.21)	−0.165 (−2.96)	0.026 (0.37)	−0.149 (−2.10)
Prior schooling	−0.033 (−0.87)	−0.010 (−0.27)	−0.017 (−0.29)	−0.026 (−0.45)	−0.151 (−2.00)	−0.133 (−1.76)
Sporadic work	−0.020 (−1.04)	0.025 (1.31)	0.009 (0.35)	0.025 (0.97)	−0.064 (−1.77)	−0.012 (−0.35)
Flexible schedule	0.099 (0.20)	−1.005 (−2.01)	0.137 (0.29)	−0.332 (−0.70)	−0.110 (−0.46)	0.108 (0.45)
Light work	−0.556 (−1.45)	−0.158 (−0.41)	0.470 (1.15)	1.049 (2.56)	0.164 (0.40)	−0.817 (−2.03)
Age	0.001 (0.33)	−0.004 (−2.19)	0.001 (0.51)	−0.002 (−0.79)	0.005 (1.21)	−0.002 (−0.55)
Male	−0.145 (−2.13)	−0.385 (−5.66)	−0.194 (−1.94)	−0.513 (−5.14)	−0.073 (−0.68)	−0.298 (−2.78)
Northeast	−0.130 (−2.19)	0.094 (1.59)	−0.051 (−0.56)	−0.382 (−4.19)	0.068 (0.60)	−0.176 (−1.54)
Union	−0.112 (−2.12)	0.073 (1.38)	−0.041 (−0.55)	0.134 (1.81)	0.033 (0.32)	−0.156 (−1.52)
Back strain	0.212 (3.14)	0.287 (4.26)	0.021 (0.26)	0.264 (3.27)	−0.032 (−0.33)	0.316 (3.31)
Duration <120	−1.546 (−20.14)	−0.880 (−11.47)	0.048 (0.64)	0.172 (2.30)	0.099 (1.24)	−0.093 (−1.16)
Duration 120–240	−1.092 (−16.92)	−0.736 (−11.41)	0.056 (0.78)	0.072 (1.00)	0.074 (0.78)	−0.034 (−0.35)
Service	−0.012 (−0.15)	−0.015 (−0.19)	0.047 (0.46)	0.326 (3.20)	0.113 (0.68)	−0.251 (−1.52)
Transport	−0.066 (−0.78)	0.122 (1.45)	0.108 (0.89)	0.525 (4.30)	0.233 (1.14)	−0.131 (−0.64)
λ-Stable	−0.289 (−2.82)	−0.687 (−6.70)	−0.050 (−0.26)	−1.137 (−5.98)	0.207 (0.72)	−0.745 (−2.59)
λ-Flexible schedule	−0.045 (−0.17)	0.521 (1.93)	−0.040 (−0.16)	0.147 (0.58)	0.120 (1.02)	−0.043 (−0.37)
λ-Light work	0.361 (1.54)	0.163 (0.70)	−0.249 (−1.00)	−0.695 (−2.78)	−0.114 (−0.47)	0.433 (1.80)
R^2	0.600	0.220	0.053	0.091	0.108	0.059
Wald test (HC)[b]	3.804	26.385***	2.843	23.525***	7.413	9.470
Wald test (ACC)[b]	2.100	4.414*	1.340	7.506**	0.376	4.318
Wald test (λ)[b]	11.050**	50.616***	1.059	45.900***	1.950	12.603***

Source: Survey of Ontario Workers with Permanent Impairments (1989–1990).
[a] *t*-Statistics in parentheses.
[b] Statistical significance of the Wald tests indicated by ***1 percent; **5 percent; *10 percent.

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