The Impact of Occupational Injury Reduction on the U.S. Economy

Eduard Zaloshnja, PhD,* Ted R. Miller, PhD, and Geetha Waehrer, PhD

Background *Preventing occupational injuries reduces labor and fringe benefit costs to employers. The related savings filter through the economy, impacting its performance. This study is a first attempt to measure the impact of occupational injury reduction on national economic output, gross domestic product, national income, and employment by using an input–output model of the U.S. economy.*
Methods *Occupational injury costs by industry for 1993 were used as a baseline for an input–output model, and the impact of the 38% injury rate reduction between 1993 and 2002 was measured. All computations are in year 2000 dollars.*
Results *Declining occupational injury between 1993 and 2002 increased employment by an estimated 550,000 jobs. The increase in gross domestic product (GDP) was $25.5 billion or 9% of the average annual GDP increase from 1993 to 2002.*
Conclusions *These estimates represent the benefits of injury rate reduction but ignore associated prevention costs.* Am. J. Ind. Med. 49:719–727, 2006. *© 2006 Wiley-Liss, Inc.*

KEY WORDS: occupational injury; economic impact; input/output model

INTRODUCTION

Preventing occupational injuries reduces labor and fringe benefit costs to employers. Several studies [Neumark et al., 1991; Rossman et al., 1991; Miller and Galbraith, 1995; Leigh et al., 1997, 2004a; Leigh and Miller, 1998] have analyzed the costs associated with these injuries from the employer's perspective and/or society's as a whole.

It is tempting to compare these cost estimates to the gross domestic product (GDP, defined below) or some other measure of economic activity. If one omits the value of household work and quality of life loss, the GDP is a valid yardstick for the size of the injury problem. For example, US highway collision costs were 2.1% of the GDP in 2000 [Blincoe et al., 2002]. However, the cost estimates do not describe injury's impact on the economy. For one thing, when an injured person buys domestic medical care rather than an imported South African diamond or a television set produced in China, that helps the domestic economy. Similarly, when someone dies, in the absence of full employment, someone else gets a job. The victim's wage loss is not a GDP loss. The GDP loss in wages is just the friction cost described by Koopmanschapp et al., 1995; essentially the costs of hiring and training plus the value of unique skills that are lost, plus the opportunity cost of diverting capital from productive investment to compensate surviving family. Computing the impact of injury on the economy requires tracing the waves of expenditure shifts that result from injuries.

The major reduction in occupational injuries between 1993 and 2002 doubtless impacted on national economic output, GDP, national income, and employment. This study is a first attempt to measure these impacts by using an input–output model. Developed in 1951 by Nobel Prize laureate Wassily Leontief, input–output modeling is a standard analytical tool that economists have used for more than

Pacific Institute for Research & Evaluation, Calverton, Maryland
The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the funding agency.
Grant sponsor: National Institute for Occupational Safety and Health of the Centers for Disease Control and Prevention; Grant number: R01 OH03750.
*Correspondence to: Eduard Zaloshnja, Pacific Institute for Research & Evaluation, 11710 Beltsville Drive, Suite 125, Calverton, MD 20705. E-mail: zaloshnja@pire.org

Accepted 2 May 2006
DOI 10.1002/ajim.20353. Published online in Wiley InterScience (www.interscience.wiley.com)

50 years to measure the impacts of changes in inputs on the economy's performance.

The heart of an input–output model is a matrix that describes the inputs and outputs of each sector/industry group in the economy (for example, the inputs to steel-making include labor, coal and iron, among others; the outputs are steel rods, steel bars, etc.). The matrix, thus, describes how industries interrelate. The model allows the analyst to estimate what happens to the economy or its specific sectors when inputs or demand for outputs change. That makes it suitable for modeling the economic impacts of changes in occupational injuries in the short run. The published input–output application most similar to this study assessed the potential impact of reducing tobacco sales on state and regional economies [Warner and Fulton, 1994; Warner et al., 1996].

To use the input–output model, inputs to each sector of the economy are adjusted; the model projects the impact on the economy and affected industries. A change in occupational injury rate affects firms' inputs in the following ways: (a) it reduces medical care costs; (b) it reduces workers' compensation disability costs and reduces sick leave costs for injuries not covered by workers' compensation; and (c) it reduces the labor costs and productivity losses associated with employee turnover. The model can also simulate different scenarios of injury rate reduction, ranging from 1 to 100%.

Conway and Svenson [1998] attribute the 17% decline in occupational injury and illness rate from 1992 to 1996 to the legislative reforms motivated by increases in workers' compensation payments and a growing awareness of workplace hazards by unions, employers, and the insurance industry. Assuming that the same factors that brought about the rate reduction from 1992 to 1996 continued to be the driving force behind it from 1997 to 2003, one could estimate the cost of such factors and compare it to the benefits. However, no economy-wide data on injury prevention costs were available for use in this study. Therefore, this study will focus on the benefits of injury rate reductions. Sensitivity analyses will simulate results for hypothetical values of prevention costs.

METHODS

An input–output analysis software developed by Rutgers University's Center for Urban Policy Research was used for this analysis. The national input–output model underlying this software has 517 sectors. The national input–output accounts currently used in the Rutgers' software are from the 1997 annual accounts produced by the U.S. Bureau of Economic Analysis. These data have been updated using employment, earnings, and GDP data for the year 2000. The accounts include detail added to the official input–output model released by the US Bureau of Economic Analysis. This extra detail is added in the retail trade, agriculture, water transportation, and household consumption sectors. It also comes equipped with 37 construction-related impact vectors. Lahr and Stevens [2002] shows that such extra sector detail is critical to maintaining accuracy in impact estimates. The techniques used to produce Rutgers' software, unlike similar software which often seem ''black box'' in nature, are detailed in Treyz and Stevens [1985] and Lahr [2001].

The software allows the researcher to measure the short-term impacts of a change in inputs by industry on the economy as a whole and on specific sectors, assuming prices and production functions remain constant during the time span that changes take place. Given the inability of input–output models to accommodate changes in relative input costs, it was assumed that employers plowed back all savings from injury reduction into the production process, that is, that employers use these savings to buy extra inputs to increase their output, and employees used the savings to buy extra goods and services.

Various measures were used in this study to indicate the effects of injury reduction on the U.S. economy. These measures include changes in national employment, output, wages, tax revenue, and GDP that result from an occupational injury reduction. Although the meaning of most of these measures, at first glance, may appear obvious, they are discussed here to minimize the possibility of misunderstanding or misinterpretation.

- *Jobs* are a measure of employment at the place of business. The value of this measure depends on the prevailing mix between full- and part-time employment for the industries in the region affected by the economic change because the model does not distinguish between these two categories. The employment levels used are ones reported by the US Bureau of Economic Analysis, which collates numbers from state and local employment offices that do not distinguish between full- and part-time employment. They include all jobs in the nation.
- *Output* is the value of industry production exchanged between firms or other organizations. Except for the construction, wholesale trade and retail trade sectors, it is also the change in sales by the sector. For wholesale and retail trade, output is the ''margin'' added to goods being sold. Thus ''sales'' for these sectors would equal output (margin) plus the cost of goods sold. For construction, change in output is equal to the change in sales of construction contractors. But the value of a construction project will equal the construction change plus the added cost of those materials and outside subcontracts required to carry it out. To get something close to actual business revenues (or sales), one multiplies the numbers for retail trade by about 5.0, for wholesale trade by about 7.5, and for construction by about 2.0.

- *Income* includes wages, salaries, and proprietors' earnings only. It excludes non-wage compensation (such as pensions, insurance, and health benefits); transfer payments (such as welfare or social security benefits); or unearned income (such as dividends, interest, or rent), even if the unearned income is generated in economic activities affected by the economic change entered into the model run. Wages are paid to labor at their place of work and spent at their place of residence, which may be outside the country. Economic modelers often use the terms ''income'' and ''wages, salaries, and proprietors' income'' interchangeably.
- *State taxes* are revenues collected by state governments through personal and corporate income, state property, excise, sales, and other taxes generated by changes in output or wages or by purchases by visitors to the region.
- *Local taxes* are revenues collected by sub-state governments, occurring mainly through property taxes on new worker households and businesses, but including income, sales, and other major local taxes.
- *GDP* is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports.

This study reports the direct effects, indirect effects, and induced effects of changes in injury rates on the above measures. Direct effects represent the sales of extra goods and services produced as a result of the extra inputs employed; indirect effects represent the value of goods and services needed to support the provision of those direct economic effects; and induced effects represent the value of goods and services consumed by households with the income they earned by providing the direct and indirect labor.

The following example demonstrates how an expansion of economic activity can affect the output in different ways. Assume that a company invests in a factory expansion. As a result of the expansion, the company will increase its output and labor force; this is the direct effect. Meanwhile, its suppliers and buyers will increase their output and labor force to respond to its increased demand for inputs; this is the indirect effect. Finally, the increase in labor force at the original company, and at its suppliers and buyers will provide extra income to households, which, in turn, will increase their demand for housing, retail services, etc.; this is the induced effect.

Injury Incidence Estimation

Annual incidence counts are needed to compute annual injury costs. The fatal injury counts in this model come from the 1993 and 2002 Census of Fatal Occupational Injury. Counts of non-fatal injuries are from the 1993 and 2002 Bureau of Labor Statistics (BLS) Annual Surveys of Occupational Injuries and Illnesses (Annual Survey). By industry, the Annual Survey provides count of injuries with days away from work, restricted work days, and no work loss, plus micro-data on the diagnoses and other characteristics of days-away-from-work cases. The Annual Survey only covers workers in private industry. It excludes government workers, the self-employed, workers on small farms (less than 11 employees), and private household workers.

Following Leigh et al. [2004b], incidence of non-fatal injuries in the agriculture sector was adjusted with national agricultural survey estimates that included injuries on small farms. Leigh et al., [2004b] estimated that the Annual Survey under-reports between 33% and 69% of all non-fatal injuries in other covered industries. Their preferred 40% under-reporting rate was used to adjust the Annual Survey counts, but estimates are also presented without this adjustment. Injuries to non-agricultural workers not covered by the Annual Survey and corresponding fatalities were omitted.

Injury Cost Estimation

The costs used in this study are a component of the costs in Leigh et al. [2004a] and are drawn from an unpublished detailed table [Miller et al., 2002]. This subsection briefly describes the methods used by Leigh et al. [2004a]. Thorough descriptions are available in Leigh's Appendices A and B, available at http://www-epm.ucdavis.edu/Fac/Leigh/CostsAcrossIndustries.htm[Leigh et al., 2004c]. The modeling in this study considered two injury cost factors.

Medical Costs

These include payments for hospital, physician, and allied health services, rehabilitation, nursing home care, home health care, and medical equipment. They also include the insurance administrative costs for medical claims compensation. Occupational violence costs also include payments for mental health treatment of victims and their families [Miller, 1995].

Productivity Losses

These include the short-term and discounted long-term productivity losses measured in wage and benefit losses and the time spent by supervisors and co-workers investigating incidents, juggling schedules, recruiting and training temporary or permanent replacements for injured workers, and gossiping about incidents. They also include the cost of administering workers' compensation wage replacement programs, and disability insurance claims processing.

Except for wage losses, these costs are fully borne by employers. From linked studies of the cost of occupational injuries [Miller and Galbraith, 1995] and the portion of those costs paid by employers [Miller, 1997], it was estimated that

83% of wage losses are borne by employers and the rest by employees. When employers compensate work loss, they essentially pay wages and fringe benefits but obtain no productive work. The input–output model estimates what the impact would have been if the hours compensated were productive ones. On the other hand, cost savings to employees were assumed to increase households' demand for goods and services.

For medical costs, the computation is more complicated because medical costs play a dual role in the model. Their reduction provides funds for employers to buy extra inputs but reduces demand for healthcare. The impact of health care demand reduction was subtracted from the total impact of occupational injury reduction. The medical spending attributed to injury reduction was distributed among four healthcare sectors (doctors and dentists, hospitals, nursing and personal care facilities, and other medical and health services) using the most recently published U.S. injury-related spending patterns [Rice et al., 1989].

The costs were incidence-based and included costs over the victim's lifespan. Whenever costs extended more than a year, a discount rate of 2.5% was applied to compute present value. The rationale for this is that once a Workers' Compensation claim has sufficiently progressed, the insurer sets aside a loss reserve fund to cover future disbursements, based on their present value. A self-insured or experience-rated employer will be charged up front for those future disbursements. Indeed, some Workers' Compensation insurers pay at-risk case managers to assume responsibility for these claims.

For days-away-from-work cases, Leigh et al. [2004a] estimated diagnosis-specific medical costs and combined them with the injury diagnosis distribution and work loss information for these cases in the BLS Annual Survey. Average medical costs for non-fatal injuries with no work loss or restricted activity only were computed from diagnosis distributions for workplace injury with restricted activity and with medical costs only from 1987 to 1993 National Health Interview Survey data. For fatalities, average medical cost per case was drawn directly from multi-state Workers' Compensation (WC) data. Table I summarizes the national and state health services data sets used to estimate the non-fatal medical and work losses by factor. Medical costs were estimated separately for hospitalized and non-hospitalized survivors by diagnosis, then averaged based on the probability of admission. The medical costs for hospitalized

TABLE I. National and State Health Services Data Sets Used To Estimate Medical and Work Loss Factors

Data element	Source
Percentage hospitalized by diagnosis, ages 18–64	
Number of admissions	1987–1992 National Hospital Discharge Survey
Number with work loss but not admitted	1987–1993 National Health Interview Survey
Medical costs for hospitalized victims by diagnosis	
Length of stay	1987–1993 National; Hospital Discharge Survey, payer = Workers' compensation
Hospital cost per day	1994 New York and Maryland Hospital Discharge Censuses & associated cost to charge ratios
Ratio of professional fee payments to hospital payments	1992–1994 Civilian Health & Medical Program of the Uniformed Services (CHAMPUS)
Ratio of costs in the first 6 months to costs during the initial admission	1987 National Medical Expenditure Survey; 1994 Missouri Hospital Discharge Census with linked identifiers for readmissions
Ratio of the present value of lifetime medical payments to payments in the first 6 months	1979–1988 Detailed Claims Information (DCI, longitudinal), National Council on Compensation Insurance (NCCI)
Medical costs for non-hospitalized victims by diagnosis	
The probability an injury required medical treatment	National Health Interview Survey
Physician visits/injury, months 0–6	1992–1994 CHAMPUS
Payments per non-hospitalized visit	1992–1994 CHAMPUS
Ratio of prescription and ancillary care payments to payments for medical visits	1987 National Medical Expenditure Survey
Ratio of present value of lifetime medical payments to payments in the first 6 months	1979–1988 DCI
Medical costs for fatalities	
Costs/fatality	NCCI summary of WC claims
Work loss costs	
Number of days away from work	Annual Survey of Occupational Injuries and Illnesses (BLS)
Predicted wage received by a worker	Current Population Survey (BLS)
Permanent disability probabilities & Percentage disabled	1979–1996 DCI

survivors were the product of five diagnosis-specific factors: length of stay; hospital cost per day; ratio of professional fee payments to hospital payments; ratio of costs in the first 6 months to costs during the initial admission; and ratio of the present value of lifetime medical payments to payments in the first 6 months. The medical costs for non-hospitalized survivors were the product of five diagnosis-specific factors: the probability an injury required medical treatment; physician visits per injury during the first 6 months; payments per non-hospitalized visit; ratio of prescription and ancillary payments to payments for medical visits; and ratio of present value of lifetime medical payments to payments in the first 6 months.

Indirect losses for non-fatal cases were divided into short and long-term losses. To account for the censoring, a statistical model was developed to estimate the length of time censored cases would have taken to be resolved (Leigh's Appendix B [Leigh et al., 2004c]). The model predicted durations (length of time away from work) by diagnosis category. The adjustments raised total estimated days away from work by 12%. For short-term wage losses, the number of days away from work was multiplied times the predicted wage received by a worker of the same age group, race, gender, industry, and occupation as the injury victim.

A zero dollar value was placed on productivity losses among persons with restricted work (light duty). This was a conservative assumption since persons working on restricted duty were probably not producing as much as they would be if they were fully recuperated and working at their usual job.

The Annual Survey lacks information on permanent disability, so disability probabilities by diagnosis were drawn from multi-state WC data. Long-term wage losses resulting from permanent total disability were based on estimates of lifetime wage loss calculated using an age-earnings model. For permanent partial disability cases, long-term wage loss was calculated by multiplying WC ratings of the fraction impaired times estimated lifetime wage loss. Work loss compensation by the employer for a fatality was estimated using the methods in Miller [1995] and updated data.

Unit costs from Miller et al. [2002] were inflated to 2000 dollars (to be compatible with the input–output matrix) using medical spending per capita and the Employment Cost Index as price adjusters. Costs of workplace disruption, incident investigation, hiring, and retraining were inflated from Miller [1995]. Following Miller et al. [2002], the unit costs were multiplied by industry-specific incidence to estimate total costs.

Because this study is focused on estimating the effects of injury rate reduction, not the effects of improving medical technology and injury care management, the same cost per case by diagnosis was used for 1993 and 2002. For example, it was assumed that the cost of a broken leg, expressed in year 2000 dollars, was the same in 2002 as in 1993. Shifts in diagnosis mix within industries were ignored since 2002 BLS microdata required to adjust for those shifts was not accessible for this study.

Workers tend to be compensated for taking risky jobs. Leeth and Ruser [2003], for example, estimated that men exposed to the mean fatal injury risk earn from 0.53% to 0.89% more per hour than men exposed to no fatal injury risk, all else equal. It also found that percentage hourly wage compensation for bearing the mean non-fatal injury risk ranged from 0.93% to 1.38%. For women, it found that those exposed to the mean non-fatal injury risk earn an hourly wage from 2.87% to 4.49% higher than women with no chance of injury, all else equal. It found no difference in women's hourly wages due to risk of fatal injury. The gradual decline in injury rates lowers the perceived occupational risk and, as a result, wage premiums. The perception of risk in the workplace, however, does not necessarily closely follow changes in the occupational injury rate. For this reason, this analysis conservatively did not include wage premiums paid to induce workers to take risky jobs.

Input–Output Model Data Preparation

Since sectors in the input–output model are detailed at the four-digit Standard Industrial Classification (SIC) level and Miller et al.'s [2002] costs are reported at the three-digit SIC level, the latter was distributed across sub-sectors of each three-digit SIC level sector, using sub-sector employment patterns as proportioning factors. For example, the total cost of occupational injuries to employers in the poultry and eggs sector is $85,568,556. Around 37% of this cost was assigned to the eggs sub-sector, and 63% to the poultry sub-sector, thus preserving the employment ratio between the two (79,772 vs. 136,387).

Based on occupational injury and illness statistics found on the BLS website [Bureau of Labor Statistics, 2004], the incidence rate decline was estimated for each sector of the economy from 1993 to 2002. To keep costs per case constant, it was assumed that the incidence rate reductions in each sector were followed by a proportionate reduction in injury costs. Entering these savings into the input–output model yielded the injury reduction economic impacts.

RESULTS

Injury incidence rate for the US private sector declined by 38% from 1993 to 2002 indicating that the trend reported in Conway and Svenson [1998] for the period 1992–1996 continued until 2002. The highest reduction was in agriculture, 43%, and the lowest was in the services sector, 31% (Table II). Based on incidence rate reductions by sector, it was estimated that the total cost savings to employers and households from injury reduction was over $31 billion.

Declining occupational injury increased employment in 2002 by almost 550,000 jobs (Table III). Without the decline

TABLE II. Injury Rate Reduction, 1993–2002 and Resulting Cost Reduction

Sector	Incidence rate reduction	Injury cost reduction ($000)
Agriculture, forestry, and fishing	43%	757,352
Mining	41%	891,278
Construction	42%	3,409,151
Manufacturing	40%	8,908,732
Transportation and public utilities	36%	2,841,435
Wholesale trade	32%	1,790,234
Retail trade	35%	3,071,654
Finance, insurance, and real estate	41%	695,893
Services	31%	5,181,456
Households	N/A	3,567,890
Total	38%	31,115,075

in occupational injuries, the unemployment rate in 2002 would have been 6.16% instead of 5.78%. Thus, improved workplace safety reduced the US unemployment rate by 6.6% (0.38/5.78). (According to the 2004 Economic Report of the President [The White House, 2004] in 2002, the total number of employed people in the civilian labor force was 136,485,000 and the unemployed were 8,378,000).

As shown in Tables III and IV, output (sales) rose an estimated $54 billion because occupational injuries declined; income rose almost $17 billion; federal taxes rose $2.9 billion; state and local taxes rose $1.7 billion; and the GDP rose $25.5 billion. The GDP increase equates to 9% of the average annual increase in GDP from 1993 to 2002. (According to the 2004 Economic Report of the President [The White House, 2004] expressed in year 2000 dollars, GDP was $7,533 billion in 1993 and $10,083 billion in 2002). For every $1 million worth of occupational injury cost savings, total output rose by an estimated $1,737,837, the GDP by $819,625, income by $544,654, federal taxes by $93,561, state taxes by $31,093, and local taxes by $25,954; and 17.7 new jobs were created. These estimates are 39% lower when the count of non-fatal injuries is not adjusted for under-reporting.

As shown in Table V, economic gains from the decline in occupational injuries primarily result from indirect and induced effects (defined above). Every dollar increase in output directly resulting from the occupational injury reduction leads to another $1.53 increase from indirect and induced effects.

Being unable to estimate investments required to achieve the observed safety gains, in sensitivity analysis, it was assumed that employers spent $100 per employee, on average, to achieve these gains. The estimated economic impacts of increased safety in this case were reduced. The output (sales) increase was reduced to $35 billion, the income increase was reduced to $11 billion, the creation of new jobs was reduced to 354,000, and the GDP increase was reduced to $16.5 billion.

DISCUSSION

This input–output analysis indicates the recent decline in occupational injuries significantly increased national economic activity. Given the assumptions underlying the input–output model (fixed relative prices and linear production functions), the multipliers provided in this paper (e.g., the number of new jobs per $1 million in occupational injury cost savings, etc.) can be used to estimate the economic impacts of any reduction in occupational injury if the reduction distribution across industries used in this model is assumed. For example, reducing injury costs by $3 billion would create an estimated 53,000 new jobs ($17.7 \times \$3$ billion/$1 million).

The results and multipliers should be used with caution in future studies because they derive from a restrictive short-term general equilibrium model. First, the input–output model represents only input–output relations and prices that existed in year 2000. Second, it does not allow for an interaction between supply and demand, which ultimately determines prices and output, and for changes in technology, which, in turn, determine how much of each input is needed to produce a certain amount of output. Thus, a reduction in occupational injuries today may produce a different economic effect from what this model predicts. This is because technological advances since year 2000 make it possible to produce more output with the same inputs, and changes in demand and supply might have affected input and output prices underlying the model, violating the input–output model's assumption that relative prices are fixed.

A more appropriate model would be a Computable General Equilibrium (CGE) model, in which prices are determined internally by the interaction of supply and demand for outputs and inputs. A CGE model, differently from the input–output model, would allow for non-linear relationships between inputs and outputs. Building a CGE model, however, is a far larger undertaking than tailoring and applying an existing input–output model. This first modeling effort did not attempt to estimate the impact of reductions in insurance claims processing costs, property damage averted, or liability payments for third parties injured in work-related events. Because the perception of risk in the workplace does not necessarily follow closely changes in the occupational injury rate, wage premiums paid to induce workers to take risky jobs were conservatively ignored. In reality, the gradual reduction in injury rates is associated with lower wage premiums (i.e., with lower production costs), all else equal. Modeling the lag between wage premiums and injury reduction, however, would require a major effort.

TABLE III. Impacts of the 38% Decrease in Occupational Injury Rate on the U.S. Economy by Major Industry

	Adjusting for occupational injury under-reporting			
Industries	**Output ($000)**	**Employment (jobs)**	**Income ($000)**	**GDP ($000)**
Private				
Agriculture	1,442,862	11,574	97,132	215,339
Agri. serv., forestry, and fish	658,894	15,307	298,539	368,145
Mining	1,663,864	5,942	388,206	643,861
Construction	4,435,799	65,729	2,483,249	3,060,609
Manufacturing	18,935,118	105,743	4,597,221	6,820,240
Transport and public utilities	6,794,429	46,272	1,865,896	2,911,893
Wholesale	3,581,992	28,363	1,456,625	1,521,917
Retail trade	7,597,244	169,741	2,841,876	4,485,354
Finance, Ins., and real estate	6,274,382	46,245	2,324,932	4,262,044
Services	2,389,722	51,855	502,660	1,071,219
Private subtotal	53,774,305	546,769	16,856,336	25,360,622
Public				
Government	297,767	2,424	90,333	141,661
Total effects (private and public)	54,072,072	549,193	16,946,669	25,502,283
	Results based on unadjusted injury counts			
Private				
Agriculture	898,366	7,635	60,165	134,703
Agri. serv., forestry, and fish	411,192	9,563	186,411	229,520
Mining	1,029,404	3,725	242,015	401,205
Construction	2,696,415	39,937	1,508,381	1,859,490
Manufacturing	11,553,535	64,596	2,808,912	4,163,632
Transport and public utilities	4,130,277	28,137	1,134,612	1,770,164
Wholesale	2,182,950	17,284	887,702	927,492
Retail trade	4,610,794	103,060	1,725,605	2,722,840
Finance, ins., and real estate	3,819,286	28,141	1,415,451	2,593,842
Services	1,461,878	31,679	309,262	654,529
Private subtotal	32,794,097	333,756	10,278,516	15,457,417
Public				
Government	181,366	1,476	55,021	86,286
Total effects (private and public)	32,975,463	335,233	10,333,537	15,543,703

TABLE IV. Components of the Increase in GDP (in Thousands of Year 2000 Dollars)

	Adjusted ($000)	**Unadjusted ($000)**
Wages—net of taxes	14,460,083	8,819,968
Taxes	4,686,104	2,851,028
Local	807,554	491,882
State	967,442	588,488
Federal	2,911,109	1,770,659
General	711,590	433,199
Social security	2,199,519	1,337,459
Profits, dividends, rents, and other	6,356,096	3,872,707
Total GDP (1 + 2 + 3)	25,502,283	15,543,703

A compounding effect was also conservatively ignored because the 38% reduction in occupational injury rate was spread over 10 years. In reality, cost savings during each year would be invested into the economy, creating conditions for a better economic performance in the subsequent year. This model essentially condensed 10 years (from 1993 to 2002) into 1 year—year 2000. The estimated economic impacts ignore the positive long-term effect of those intermediate gains. Input–output models, nevertheless, are prone to overstate impacts, and the unavoidable use of an input–output model from a fixed year rather than a sequential set of (non-existent) models may have accentuated that tendency. Furthermore, input–output models are static. They do not capture changes in the inputs used to produce goods. This analysis uses production functions for 2000, but work became less labor intensive between 1993 and 2000, meaning injury cost savings in the earlier years were underestimated.

TABLE V. Distribution of Economic Effects

Adjusting for occupational injury under-reporting				
	Output ($000)	Employment (jobs)	Income ($000)	GDP ($000)
Direct effects	21,382,917	261,221	7,228,296	10,701,556
Indirect and induced effects	32,689,155	287,972	9,718,373	14,800,728
Total effects	54,072,072	549,193	16,946,669	25,502,283
Multipliers (3/1)	2.53	2.10	2.34	2.38
Results based on unadjusted injury counts				
Direct effects	13,062,903	159,897	4,415,112	6,529,669
Indirect and induced effects	19,912,560	175,335	5,918,425	9,014,034
Total effects	32,975,463	335,233	10,333,537	15,543,703
Multipliers (3/1)	2.53	2.10	2.34	2.38

These choices underestimate the aggregate impact on employment and output. The estimates also ignore the impact of injury reduction in the government sector because the input–output model includes only economic sectors that produce goods and services exchanged in the marketplace.

Following Koopmanschapp et al. [1995], it was assumed that in the short run, which is the horizon of this input–output analysis, the GDP loss in wages due to fatal injury is just the friction cost, essentially the costs of hiring and training plus the value of unique skills that are lost, plus the opportunity cost of diverting capital from productive investment to compensate surviving family. Over a lifetime, however, those avoiding death would make a significant contribution. Such contributions can be estimated only through a long-term dynamic model.

Thus, these estimates are order-of-magnitude bounds. Yet they clearly indicate that occupational injury reductions between 1993 and 2002 boosted the U.S. economy substantially. In the future, research needs to refine the estimates reported here, probe the resulting impacts on international competitiveness and on inflation control, analyze within-industry effects of safety gains by a subset of firms, and incorporate prevention costs. Many of these analyses will require tying in a CGE model of the US or world economy.

ACKNOWLEDGMENTS

This research was supported by grant R01 OH03750 from the National Institute for Occupational Safety and Health of the Centers for Disease Control and Prevention.

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