

Examining evidence on whether BLS undercounts workplace injuries and illnesses

The BLS Survey of Occupational Injuries and Illnesses offers many advantages over other data systems, and BLS has been working on improvements to increase its accuracy and scope; nevertheless, there is a debate about whether the survey undercounts injuries and illnesses to any significant extent

John W. Ruser

The BLS Survey of Occupational Injuries and Illnesses (SOII or Survey) has come under criticism for undercounting the number of injury and illness incidents in the workplace. Estimates of the undercount range widely from 20 percent to 70 percent of all cases in some research. However, other research and analysis concludes that the size of the undercount is small. This article summarizes and critiques some of these studies and describes BLS efforts to better understand and address the undercount issue.

SOII produces annual estimates of counts and rates (number of cases per worker) of new workplace injuries and illnesses. The survey data are provided by responding employers, who draw information from Occupational Safety and Health Administration (OSHA) logs and supplementary materials maintained by employers throughout the year. SOII is separate from other systems for recording workplace injuries and illnesses, (hereinafter referred to as “data systems”) including workers’ compensation, trauma registries and other administrative and survey data sources.

Four dimensions of a potential undercount that can be identified are the failure to count

1. most occupational illnesses that have a long latency period;
2. occupational injuries and illnesses

incurred by out-of-scope workers (public-sector workers, the self-employed, and workers in households and on small farms);

3. some occupational injuries and illnesses that are reported in other data systems such as workers’ compensation; and
4. some occupational injuries and illnesses that are not reported in any data system.

The Bureau of Labor Statistics takes the allegations of underreporting seriously and has instituted a number of activities to understand and, where possible, address the issue. First, in 2007 BLS conducted a quality assurance survey which indicated that SOII data collection processes did not result in an undercount along any of the four dimensions listed earlier. Second, BLS is extending the scope of SOII to include all public-sector workers.

Third, BLS has instituted a program of research to examine and extend previous research into the undercount. The aim is to determine whether certain types of cases and respondents display greater evidence of apparent undercounting and to identify the factors that might be responsible for the undercount findings. The latter factors include legitimate differences among data systems and methodological

John W. Ruser is the Assistant Commissioner for Safety, Health, and Working Conditions in the Office of Compensation and Working Conditions, Bureau of Labor Statistics. E-mail: ruser.john@bls.gov

aspects of undercount research that might provide biased estimates of the SOII undercount. Fourth, BLS is undertaking focused interviews of employers to learn about decisions made to report injuries and illnesses on OSHA logs and to other data systems. Finally, BLS is exploring partnerships with other organizations, including the National Institute for Occupational Safety and Health, to research the use of alternative data sources to complement the data available from SOII.

Although BLS will make progress in addressing the undercount issue, it must be conceded that some aspects of this issue cannot be addressed within the framework of the BLS Survey. Estimating the number of long-latent occupational illnesses is not possible with an employer-based recording mechanism. Self-employed, household and small-farm workers remain outside the scope of SOII because they are not part of the SOII sample frame nor are they covered by the Occupational Safety and Health Act of 1970. In addition, there are a variety of incentives that affect the reporting of workplace injuries and illness to SOII and other data systems. These incentives are outside of BLS control. Estimating cases that are outside the scope of SOII (either because they are not OSHA recordable or are incurred by out-of-scope workers) may be feasible using other data sources.

This article discusses the SOII undercount issue. After providing a brief overview of SOII and some alternative data systems, it describes in depth the four different dimensions of the potential undercount. Some of the key papers in the undercount literature are summarized. The article then discusses a variety of possible reasons for the undercount findings, including methodological issues, incentives for reporting, and differences in various data systems. Finally, the article summarizes BLS activities aimed at addressing the undercount issue.

Data collection

SOII is a Federal and State program in which employers' reports are collected annually from about 176,000 private-industry establishments.¹ Data are collected starting in January after the end of the survey reference year. Responding employers provide information on the number of workplace injuries and illnesses by copying the data from their Occupational Safety and Health Administration (OSHA) recordkeeping logs to the SOII questionnaire. Employers also provide the number of employee hours worked (needed in the calculation of incidence rates) as well as the establishments' average employment.

Besides reporting injury and illness counts, survey re-

spondents are asked to provide additional information for a subset of the most serious nonfatal cases logged, namely, those which involved at least 1 day away from work beyond the day of injury or onset of illness. Employers answer several questions about these cases, including the demographics of the worker disabled, the nature of the disabling condition, and the event and source producing the condition.

Most employers use information from supplementary recordkeeping forms and State workers' compensation claims to fill out the Survey's "case form"; some, however, attach those forms when their narratives answer questions on the case form, an option the Bureau offers to help reduce respondent burden. Also, to minimize the burden on many larger employers, sampled establishments that are projected to have numerous cases involving days away from work are instructed to report on a sample of those cases. These employers are assigned a range of dates and are instructed to provide information only on the cases with days away from work for which the date of injury or onset falls within the assigned range of dates.

SOII receives occupational injury and illness data from the U.S. Department of Labor Mine Safety and Health Administration for establishments in the coal, metal, and nonmetal mining industries and data from the U.S. Department of Transportation Federal Railroad Administration for railroad incidents. The Survey excludes all work-related fatalities, as well as nonfatal work injuries and illnesses, to the self-employed; to workers on farms with 10 or fewer employees; to private household workers; and, nationally, to Federal, State, and local government workers.

Injuries and illnesses logged by employers conform to definitions and recordkeeping guidelines set by the Occupational Safety and Health Administration, U.S. Department of Labor (see box). Under these guidelines, nonfatal cases are recordable if they are work-related illnesses or injuries that involve lost worktime, medical treatment other than first aid, the restriction of work, loss of consciousness, a transfer to another job, or other specific conditions. Employers keep counts of injuries separate from counts of illnesses. They also identify whether each injury or illness involved any days away from work, days of restricted work activity, or both that occurred after the day of injury or onset of illness. All employers with 11 or more employees in OSHA-designated high-hazard industries are required by OSHA regulation 29 Code of Federal Regulations (CFR) 1904 to maintain logs throughout the year and to complete a summary based on the log at the end of the year. Other employers also are required to maintain

logs according to OSHA regulation 29 CFR 1904.42 in the event that they are asked to participate in SOII. BLS draws a sample of employers for SOII from both OSHA-designated high hazard industries and other industries.

OSHA case recordability criteria

OSHA guidelines for recording cases are codified in 29 CFR (Code of Federal Regulations) 1904. In general, recordable cases include new work-related cases of injuries and illnesses or the significant work-related aggravation of preexisting non-work-related conditions. Cases are recordable if they result in

- death
- loss of consciousness
- days away from work
- restricted work activity or job transfer
- medical treatment (beyond first aid)
- significant work-related injuries or illnesses that are diagnosed by a physician or other licensed health care professional, including cancer, chronic irreversible disease, a fractured or cracked bone, and a punctured eardrum

Cases also are recordable if they meet additional criteria for special cases; cases that qualify include those involving needlesticks and “sharps” injuries, occupational hearing loss, and tuberculosis. The regulations provide definitions of many key concepts, explaining how to determine whether a case is work related, what is a new case, what is involved in a significant aggravation of a preexisting condition, what is restricted work, and so forth.

Occupational injuries, such as sprains, cuts, and fractures, account for the vast majority of all cases that employers log and report to the BLS survey. Occupational illnesses are new cases recognized, diagnosed, and reported during the year. Overwhelmingly, those cases which are reported are easier to relate directly to workplace activity (for example, contact dermatitis or carpal tunnel syndrome) than are long-latent illnesses, such as cancers.

SOII provides estimates that are based on a scientifically selected sample of establishments, some of which represent only themselves but most of which also represent other employers of like industry and workforce size that were not chosen in a given survey year. For each survey, the sample used is one of many possible samples, each of which could have produced different estimates. The data also are subject to nonsampling errors that are not measured. These errors include the unavailability of characteristic data for some cases, mistakes in recording or coding the data, and definitional difficulties. To minimize nonsampling errors, the Bureau conducts a rigorous train-

ing program for survey coders and continues to encourage survey participants to respond fully and accurately to all survey elements.

There are other data systems that provide estimates of occupational injuries and illnesses. An important advantage of SOII is that it is a large system that affords the most complete occupational injury and illness counts for the Nation and does so consistently across States. While it is beyond the scope of this article to discuss other systems in detail, a brief summary of some of them is necessary, because it is comparisons between SOII and the other systems that provide the basis for the undercount estimates.

Each State has its own workers' compensation system to cover injured and ill workers. The systems vary somewhat but have the same general characteristics. With the exception of Texas, all States mandate coverage of nearly all private-sector workers. Some States exempt from coverage workers in very small companies, certain agricultural workers, and some other categories of workers.² All State laws require that employers cover nearly 100 percent of an injured or ill worker's medical expenses and further require that workers who are off work longer than a specified “waiting period” be paid cash benefits related to lost earnings.³ States differ in the durations of their waiting periods, which range from 2 days to 7 days, and also differ to a small extent regarding which cases are compensable. Recently, for example, a number of States passed legislation requiring that work be a major or predominant cause of the disability or legislation eliminating compensation for the aggravation of a preexisting condition or for a condition related to the aging process.

Despite the fact that there is a workers' compensation system in each State, national estimates of occupational injuries and illnesses are difficult to derive from workers' compensation records because of incomparabilities across States. For example, some workers' compensation databases can provide estimates only of cases for which workers are off work for longer than the particular State's waiting period. There are differences in scope between workers' compensation and SOII data with which researchers must contend in trying to reconcile estimates between the two systems. This issue will be discussed later.

Another data system against which SOII estimates have been compared is the National Health Interview Survey (NHIS), the principal source of information on the health of the civilian noninstitutionalized population of the United States and one of the major data collection programs of the National Center for Health Statistics. The NHIS is an annual cross-sectional household interview survey of about 35,000 households and 87,500 people.⁴

Among many questions it asks are whether an injury occurred while the individual was working at a paid job, what type of medical care was sought, the external cause or nature of the injury, what the person was doing when the injury occurred, the date and place the injury occurred, and whether the person missed days of work.

There are a variety of advantages and disadvantages of the NHIS for estimating workplace injuries and illnesses. An advantage is that the scope of the survey is broader than that of SOII, encompassing all civilian workers, including public-sector workers and the self-employed. Further, Leigh and colleagues argue that economic incentives for workers not to report injuries in the NHIS are weak to nonexistent. (See discussion of reporting incentives in a later section.) However, the sample of injury episodes collected by the NHIS is quite small (fewer than 2,000), so the NHIS cannot publish the amount of detail that SOII can. Further, the NHIS relies on proxy respondents—that is, individuals who respond to questions on behalf of other household members and who may not be aware of some work injuries and illnesses. In addition, workers tend to forget less severe injury episodes, so “recall bias” is a problem for injury cases that occurred further away from the time of the interview. Beginning with 2004, data were collected on injury episodes occurring within 3 months of the interview. However, the National Center for Health Statistics tabulates data only for injury cases that occurred within 5 weeks of the interview.⁵ Finally, any comparison of NHIS and SOII estimates is complicated by the fact that cases in NHIS are not necessarily OSHA recordable (as defined in the box on page 22).

Other data sources used to track workplace injuries and illnesses and to compare against SOII include data from hospital discharges and emergency room visits. Three of the 19 occupational health indicators identified by the Council of State and Territorial Epidemiologists (CSTE) are based on the National Hospital Discharge Survey.⁶ As noted by CSTE,

[S]tate hospital discharge data are useful for surveillance of serious health conditions. While these state data sets do not include explicit information about “work-relatedness” of the health conditions for which a patient is hospitalized, they do include information about the payer for the hospital stay. The designation of workers’ compensation as primary payer is a good proxy for the work-relatedness of hospitalized injuries.⁷

Another source of hospital data that can serve to track workplace injuries and illnesses is the National Electronic Injury Surveillance System (NEISS). Data from this source are collected for the National Institute for Occupational

Safety and Health from a small sample of U.S. hospital emergency departments. In each hospital, a staff member reads the emergency room charts and identifies work-related cases.

An advantage of using data from hospitals is that all workers are potentially in scope, as opposed to the more limited scope of SOII. (See later.) However, the cases that appear in hospitals are typically more severe than a typical OSHA-recordable case. Hospitalizations account for only a small percentage of all workplace injuries and illnesses—3 percent, according to CSTE. Identifying cases by means of the payer implies that the cases counted by hospital discharge data may or may not be OSHA recordable. Indeed, in the case of the CSTE indicators, these cases would be workers’ compensation claims. Similarly, NEISS data pertain only to cases treated in emergency departments, while the scope of the OSHA-recordable cases counted by SOII is both broader and potentially different. Finally, the relatively small sample size of the NEISS limits the availability of detailed estimates. All of the data sources just described should be viewed as providing estimates that are complementary to SOII.

Dimensions of the SOII undercount

Some have viewed SOII with misgivings over its failure to count all workplace injuries and illnesses. Their comments can be classified into four separate categories: underrecording of illnesses, incomplete scope in the coverage of workers, incomplete capture of injury and illness cases that are reported in other systems, and unreported cases.

Underrecording of illnesses. It is well known and acknowledged by BLS that SOII does not capture all occupational illnesses. In its press release for SOII, BLS notes that

The survey measures the number of new work-related illness cases that are recognized, diagnosed, and reported during the year. Some conditions (for example, long-term latent illnesses caused by exposure to carcinogens) often are difficult to relate to the workplace and are not adequately recognized and reported. These long-term latent illnesses are believed to be understated in the survey’s illness measures. In contrast, the overwhelming majority of the reported new illnesses are those that are easier to directly relate to workplace activity (for example, contact dermatitis or carpal tunnel syndrome).⁸

A central problem is that many work-related illnesses take years to develop and may be difficult to attribute to the workplace. Thus, a recording mechanism based on employer records, as is SOII, will generally fail to capture these illnesses.

SOII scope restrictions. Because of restrictions on the scope of the workers covered, SOII does not enumerate all nonfatal workplace injuries and illnesses incurred by U.S. workers. Specifically, SOII excludes the self-employed; farms with fewer than 11 employees; private households; Federal Government agencies; and, for national estimates, employees in State and local government agencies. SOII does collect data on State and local government workers in 27 States.

To address this shortcoming, BLS is expanding the collection of data to all government workers. Starting with the 2008 survey year, BLS has extended the SOII sample to include the 23 States for which State and local government data are not currently collected. Sampled State and local government agencies have been asked to record their workplace injuries and illnesses on OSHA logs, just as the current SOII sample members do. BLS intends to publish data for State and local government workers at the national level and for each State. In addition, together with OSHA, BLS is exploring ways to collect data for Federal agencies. Currently, Federal agencies are required to record their workplace injuries and illnesses on OSHA logs, but they are not required to report these data to OSHA.

Collecting data on other workers who are outside the scope of SOII (the self-employed, private household workers, and workers on small farms) is problematic, because these workers are outside of the scope of the Occupational Safety and Health Act of 1970 and therefore are not required to record injuries and illnesses on the OSHA logs that form the basis for SOII. In addition, sample frames are not available to BLS to capture data on these workers. A couple of different approaches might be pursued to collect such data.

One approach would be to obtain data through a household survey such as the NHIS. Workers in the out-of-scope groups could be asked about their workplace injury and illness experience during a period prior to the interview. To obtain estimates consistent with SOII, questions would need to be structured so that the injuries and illnesses that are identified are OSHA-recordable cases. As with the current NHIS, one potential shortcoming of using household interviews is recall bias. Whereas OSHA instructs employers to record injuries and illnesses on a flow basis throughout the year, a survey questionnaire would elicit information only for a specified period prior to the interview.⁹ Because workers have been found to forget about minor injuries that occurred 6 or more weeks prior to the interview,¹⁰ the period for which injury and illness information would be obtained would need to be kept short. This short retrospective period would limit the

number of cases captured and reduce the reliability of the estimates.

Another approach to estimating injury and illness rates for the self-employed, household workers, and small farms would be to capture data from various other sources, including insurance claims, emergency room visits, and hospital discharges. This multisource approach is employed by the BLS data program for fatal injuries, the Census of Fatal Occupational Injuries (CFOI), though the CFOI sources are not the same as those just listed.¹¹ Nonfatal workplace injuries and illnesses that are captured in these other systems might differ from OSHA-recordable cases. Further, as noted in the previous section, hospital data are likely to include only more severe cases. Utilizing the aforementioned sources to capture data on nongovernmental workers who are currently outside the scope of SOII would be quite resource intensive.

Absent the collection of data through methods such as those just described, some researchers have generated estimates for out-of-scope workers. Estimates for some groups of workers are obtained from alternative data sources that are adjusted to conform to the OSHA-recordability concept underlying SOII. In other cases, estimates are produced by extrapolating from the known injury or fatality data on other groups of workers.

J. Paul Leigh, James P. Marcin, and Ted R. Miller estimated that in 1999 1.76 million injuries were incurred by out-of-scope workers,¹² in addition to 5.335 million injuries reported in SOII. Thus, Leigh and colleagues estimate that, because of restrictions in scope, SOII did not capture 24.8 percent of all workplace injuries and illnesses. For some out-of-scope groups (agricultural and Federal Government workers), Leigh and colleagues were able to obtain other estimates of injuries. For self-employed, State and local government, and “other” workers, they generated injury and illness estimates by multiplying the SOII estimate of injuries by both employment ratios and measures of relative risk. (Details appear in their paper.) The SOII sample expansion to cover public-sector workers will narrow the number of cases incurred by out-of-scope workers.

Incomplete SOII capture of injuries and illnesses that are reported in other systems. Another strand of the undercount literature argues that SOII fails to capture some cases that are within the scope of the survey, but that are captured in other work-related injury and illness data systems. At least three approaches have been taken to establish whether or not SOII and the OSHA logs underlying it are complete: OSHA audits of employer recordkeeping, aggregate com-

parisons of SOII estimates with estimates generated from other data systems, and microlevel matches of cases in SOII with cases in other data systems.

OSHA conducts onsite audits of employer injury and illness records to verify the overall accuracy of source records and to estimate the extent of employer compliance with OSHA recordkeeping requirements. Annually, OSHA draws a small sample of establishments that have responded to its Data Initiative, and within those establishments, OSHA draws a sample of employees.¹³ The sample is restricted to establishments with 40 or more employees in the high-hazard industries (excluding construction) covered by the initiative. Further, the establishments must be located in States under Federal OSHA jurisdiction or in a State Plan State that has decided to participate in the initiative. Auditors compare entries on the OSHA logs with other records in the establishment.

For calendar year 2004, OSHA found that 95.7 percent of establishments had “accurate” recordkeeping (at or above the 95-percent threshold) for total recordable injury and illness cases and that 95.3 percent of establishments had “accurate” recordkeeping for cases with days away from work, work restrictions, or transfers (DART). Among the recordable cases identified by auditors, 10.0 percent were not recorded, 6.4 percent were DART cases recorded as less severe non-DART cases, and 0.9 percent were non-DART cases recorded as more severe DART cases. In 2004, recordkeeping accuracy, according to the 95-percent criterion, was not statistically significantly different from previous years’ accuracy.

One additional issue uncovered by the OSHA audits is overrecording. The audits found instances where employers recorded non-OSHA recordable cases. These were almost exclusively non-DART cases and, as a result, were out of the scope of the microdata studies of underreporting to be discussed subsequently. Overrecording of these minor cases increases the count of total workplace injuries and illnesses and partially compensates for the effects of any undercounting of more severe cases.

Aggregate studies of the undercount involve comparing estimates from SOII with estimates produced from other data systems. To the extent that these other data systems have different scopes from that of SOII, the estimates need to be adjusted to comparable scopes.

As an example of an aggregate comparison, Leigh and colleagues compared SOII estimates with those from the National Health Interview Survey (NHIS).¹⁴ The SOII estimate of 6.3 million injuries and illnesses in 1994 was 28.2 percent below the NHIS estimate of 8.8 million injuries and illnesses. Leigh and colleagues note that economic in-

centives for workers not to report in SOII might be weak or nonexistent in the NHIS, explaining at least part of the estimated undercount.

Not all aggregate comparisons of estimates conclude that SOII undercounts injuries and illnesses. Arthur Oleinick and Brian Zaidman compare counts of workers’ compensation cases with counts of days-away-from-work cases in SOII for Minnesota over the period from 1992 to 2000.¹⁵ For cases lasting 4 or more days away from work—the cases for which data were available in the Minnesota workers’ compensation data set—Oleinick and Zaidman conclude that there is 92- to 97-percent concordance between the two estimates of injury and illness counts and that the BLS survey has “high sensitivity” for workplace injuries with 4 or more days away from work.

There are some limitations of aggregate comparisons. Most fundamentally, even if an estimate from another data system is close to the SOII estimate, it does not mean that underreporting is not present in SOII (or in the other system). It is possible that SOII captures some cases that are not in the other system, while the other system captures some cases that are not in SOII. In such a circumstance, there is underreporting in both SOII and the other system. Indeed, that is what appears to occur in the microlevel studies described shortly. Note, however, that Oleinick and Zaidman, who obtained close concordance between SOII and workers’ compensation counts, dismissed the possibility that offsetting biases resulted in the close concordance that they found.¹⁶

Another limitation of aggregate comparisons is that it may be difficult to ensure that the estimates from SOII and the other data system are for cases within the same scope. The researchers must make careful adjustments to ensure scope comparability. The Oleinick and Zaidman study is an example in which their adjustments draw the SOII and workers’ compensation count estimates together.

To address these purported limitations of aggregate comparisons, recent studies have matched individual cases in SOII with cases in other systems.¹⁷ These studies attempt to restrict the data in SOII and other systems to the same scope and then to match cases on a variety of characteristics, including those of the worker, employer, and case. The studies are able to document the number of cases that are in another system but not in SOII, the number that are in SOII but not in the other system, and the number that are in both SOII and the other system.

Kenneth D. Rosenman and colleagues match case-level SOII data to workers’ compensation cases for the State of Michigan in 1999, 2000, and 2001.¹⁸ Because Michigan has a waiting period of 7 days before workers’ compen-

sation benefits are paid (hence, only cases that surpass the 7-day waiting period are captured in the Michigan database), the scope of the data-set comparison was restricted to cases with more than 7 days away from work. The researchers estimated that, on average each year from 1999 to 2001, a total of 79,379 injury and illness cases was reported in only SOII, in only workers' compensation, or in both systems. Of these more-than 79,000 cases, SOII captured 30,800, or 38.8 percent, whereas workers' compensation captured 62,264, or 78.4 percent. Focusing on specific types of injuries, the researchers found that SOII was more likely to capture certain types of injuries that are easier to observe and relate to the workplace, such as surface and open wounds, burns, and traumatic injuries to bones. In contrast, SOII was less likely to capture traumatic injuries to muscles, tendons, and the like, which include sprains and strains. These injuries are quite frequent both in SOII and in workers' compensation.

Subsequent analysis by Leslie I. Boden and Al Ozonoff provides undercount estimates that are considerably smaller than those of Rosenman and colleagues.¹⁹ Boden and Ozonoff match SOII and workers' compensation data from 1998 to 2001 for six States: Minnesota, New Mexico, Oregon, Washington, West Virginia, and Wisconsin. The undercount estimates differ by State, but they indicate that on average SOII may be picking up only about 69 percent of the injuries and illnesses appearing in SOII, in workers' compensation, or in both systems. SOII did best at capturing cases in West Virginia (79.4 percent) and worst in the State of Washington (55.7 percent). Similarly, the researchers find widely varying estimates of the extent to which workers' compensation captures injuries that appear in SOII, workers' compensation, or both systems—from 72.4 percent in Minnesota to 96.9 percent in Washington State.

It is difficult to gauge the reason for the difference in the findings of Rosenman and colleagues, on the one hand, and Boden and Ozonoff, on the other. The difference may be due to differences in the methodologies used, or it may be due to State-by-State variation. However, the Rosenman SOII-capture estimate of 38.8 percent is lower than the results found by Boden and Ozonoff for any State, suggesting that differences in methodology play a role.

Unreported cases. Cases that are unreported in multiple data systems constitute another group of undercounted cases. In the context of the BLS survey, this means that cases not reported in SOII may also not be reported elsewhere. Applying some assumptions, it is possible to estimate the number of such cases by means of a technique

called capture-recapture. This technique was first applied to the estimation of animal populations in the wild, but it has been adapted to generate improved estimates in a wide variety of situations, such as drug use, homelessness, infectious diseases, and occupational injury and illness.²⁰

Without going into too many technical details,²¹ capture-recapture uses probability theory and multiple overlapping, but incomplete, data sources to make inferences about the size of a partially unobserved population. Whereas the most straightforward application of the capture-recapture method uses basic probability theory, more sophisticated analyses rely on multivariate models. The latter analyses identify all unique cases recorded in at least one source and then use log-linear or logistic models to estimate the number of cases unrecorded by any source.²² Capture-recapture is a natural extension of the matching of data sources described in the previous section.

After matching individual cases in SOII and workers' compensation data for Michigan from 1999 to 2001, Rosenman and colleagues used capture-recapture to estimate that although the data sources together included a total of 79,379 cases on average each year, an additional 15,654 were not captured in either data system.²³ The latter cases bring the annual average total of cases to 95,033. Thus, 16.5 percent of cases went unreported. Further, when the SOII estimate of 30,800 was compared with the total, including unreported cases, Rosenman and colleagues estimated that SOII captured only 32.4 percent of all cases.

Boden and Ozonoff applied capture-recapture to the data for the six States in their study.²⁴ They found that cases unrecorded in either SOII or workers' compensation ranged from 13 percent of all cases in Minnesota and New Mexico to 3 percent in Washington State and West Virginia. The researchers' estimate of the total SOII undercount after utilizing capture-recapture was also smaller than that of Rosenman and colleagues, ranging from 46 percent in Washington to 22 percent in West Virginia. On average, SOII is estimated to capture about 60 percent of all cases across the six States. As previously mentioned, capture-recapture has been used for a variety of purposes. In an interesting non-U.S. example, Anton W. Moll Van Charante and Paul G. Mulder found that employers reported only 35.6 percent of injuries to the government in the Netherlands.²⁵

Capture-recapture is a sophisticated technique for making inferences about unreported cases. However, the methodology does rely on some assumptions to generate results. One important assumption, termed "source independence," is that the recording of cases in one system is

independent of the recording of cases in another system. In fact, sources could be positively or negatively source dependent, meaning that a case recorded in one system is, respectively, more likely or less likely to be recorded in another system. For a variety of reasons, Boden and Ozonoff expect that SOII and workers' compensation are positively source dependent. Some of these reasons are that the same person might record a case in both systems; if a worker does not report a case, it is not likely to be recorded in either system; and if an employer does not think a case is compensable, then he or she might erroneously believe that it also is not OSHA recordable.

If two sources are positively source dependent, then the estimate of the number of cases not captured in either system is biased downward; that is, underreporting is greater than when the number of cases is estimated under the assumption of independence. Without data from a third source or without additional assumptions, it is not possible to estimate the extent of source dependence. Still, Boden and Ozonoff conduct a sensitivity analysis by estimating the undercount under a couple of positive dependence scenarios.²⁶ Assuming different values for the odds ratio that a case is reported in SOII, given that it is reported in workers' compensation,²⁷ they show that the estimated coverage of both SOII and workers' compensation drops with positive source dependence—sometimes substantially. However, they concede that they do not know what the correct odds ratio is (although they believe it is greater than one), leaving the source dependence issue unresolved.

Reasons for the undercount findings

The previous two sections summarize research which concludes that SOII misses some cases that are recorded in workers' compensation and other cases that do not appear in workers' compensation. Although willful underreporting might be one explanation for these findings, there are a variety of other explanations as well:

- SOII and workers' compensation are independent systems, so a case might be recordable in one system but not the other.
- Employers might have legitimate doubts about the recordability of some cases, particularly those being contested in the workers' compensation program.
- An aspect of SOII—its timeliness—may contribute in a modest way to the undercount, particularly when

updates to logs occur after data collection.

- The undercount research studies might be unable to overcome some methodological challenges that increase the estimated undercount.

These hypotheses are discussed next.

Because SOII and workers' compensation are technically independent systems for recording injuries and illnesses, there may be valid reasons that a case could appear in one system but not the other. For example, in the matching work previously described, cases with days away from work are matched. In SOII, a case with days away from work must involve at least 1 day away from work following the day of the incident. However, a workers' compensation insurer might capture a compensable case that involves permanent disability without days away from work or with only partial days away from work. As a result, as Eleni Messiou and Brian Zaidman note, some workers' compensation claims may not include enough days away from work to be classified as a days-away-from-work case in SOII.²⁸ Another area of concern is the treatment of multiple spells out of work associated with the same injury (the question being whether a recurring injury is treated as a new injury each time it recurs).²⁹

Messiou and Zaidman,³⁰ as well as Nicole Nestoriak and Brooks Pierce,³¹ point out that the timing of the compilation of different sources of occupational safety and health information may partially explain why some workers' compensation cases do not match to SOII cases. SOII is fielded soon after the end of the reference year in order to correspond to the time when OSHA requires the summary of injuries and illnesses to be posted in the workplace. In contrast, workers' compensation records are continuously updated, and the extracts from the workers' compensation database that are used for matching research are often drawn long after the end of the reference year. Some cases are noticed or reported with a lag, causing them not to get entered into the OSHA log before SOII is administered. Also, although employers are instructed to update their OSHA logs when new information is obtained, they may forget to do so or might do it after they respond to SOII. Thus, the workers' compensation information may be more up to date and more inclusive than the information available for SOII. This difference complicates the matching of cases and leads to nonmatches.

Consistent with the previous hypothesis, a reanalysis of Boden and Ozonoff's Wisconsin data by BLS found that SOII misses relatively more cases late in the survey year and also misses a large fraction of cases that are entered

into the workers' compensation database after the end of the survey year.³² Cases that occur late in the survey year are less likely to have been entered into or updated in the log by the time the survey is administered. However, the fact that the yearend effect is apparent for December but not for November or earlier suggests that whatever effect is operating is a relatively short-window effect; consequently, it can explain relatively little of the year-round SOII undercount. Cases that are not entered into the workers' compensation database until the following year may not be recognized in time to be entered into OSHA logs and captured in SOII.

The issue of timing also may affect the matching of contested cases—that is, those cases which the employer does not recognize either as existing or as being work related. It is reasonable to expect that an employer might not record such a case on OSHA logs until the status of the workers' compensation case is resolved (if ever). Such a resolution might occur long after the data in SOII have been collected. Thus, a resolved contested case might appear in the workers' compensation files but not in the SOII files being matched.

The quality of the undercount estimates depends critically upon how well the SOII cases are matched to workers' compensation cases and how well the researchers can adjust for differences between the SOII and workers' compensation data. Missed matches are counted as undercounts in both data sets. There are aspects of SOII that create challenges for matching cases and for estimating an undercount with respect to workers' compensation.

Cases match only if the two lists of cases cover the same populations of injuries and illnesses (that is, if the lists have the same scope). If lists are not consistent, then a case might appear on one list but not the other. Some inconsistencies between lists can be corrected directly through exclusions. For example, an injury resulting in few days away from work may be OSHA-recordable but not compensable according to workers' compensation. It is important to recognize that the fields used for exclusion may be error prone and that any errors incurred can effectively lead to mismatch issues. For example, if a particular case is recorded as having 6 days away from work in SOII but has 8 days away according to workers' compensation, then excluding the case from SOII on the basis of a 7-day waiting period exclusion will make it appear as if SOII did not capture that case while workers' compensation did.³³ Mismatch bias depends on the matching technology used by the researcher, on the error rates in SOII data elements, on error rates in the workers' compensation data elements, and on whether the error rates in the workers' compensa-

tion and SOII data elements are positively correlated with each other.

In addition, there are aspects of SOII that create additional difficulties. SOII is an establishment survey in which only certain establishments are sampled. Workers' compensation reports cover all compensable cases and are frequently based on company records. In the case of a company with multiple establishments, it is possible that only certain establishments of that company are in SOII, whereas the workers' compensation data contain data on all of the company's establishments. Researchers conducting SOII-to-workers'-compensation matches have found it difficult to identify the establishment locations for workers' compensation cases; this in turn makes it difficult to determine whether a particular workers' compensation case should have a corresponding case in SOII. Boden and Ozonoff's solution to this problem is to use a universe file of establishments (the Quarterly Census of Employment and Wages) to determine the fraction of the total employment at the affiliated firm covered by the sampled BLS establishments. This fraction is then used to lower the weight applied to the workers' compensation unlinked cases (because these cases may be from an establishment not sampled for SOII). Although this solution makes good use of the available information, it does introduce additional nonsampling error.

Subsequent BLS analysis of Boden's Wisconsin sample abstracted from the multiestablishment problem by analyzing only matches for single-establishment companies. SOII misses relatively fewer cases in single-establishment firms, suggesting that it may be difficult to overcome matching problems for multiestablishment companies. However, it is also possible that establishments in single-establishment companies differ from establishments in multiestablishment companies in characteristics (for example, establishment size) that are associated with the likelihood of matching cases between SOII and workers' compensation. Future multivariate analysis may help determine the relative importance of factors responsible for the single-establishment result.

Another aspect of SOII that may cause a difficulty in matching is the fact that large establishments report only a sample of their cases. Specifically, a small number of large establishments are told to report cases that occur only during a particular timespan in the survey year. Inconsistencies between the date of onset of injury or illness for a SOII case and that of the corresponding workers' compensation case may lead to mismatches and measured underreporting both in SOII and in workers' compensation. For example, suppose that, according to

workers' compensation, a particular case occurs during the reporting timeframe for an establishment that subsamples cases in SOII. Suppose, however, that the case is recorded on the OSHA log as occurring outside the subsampling timeframe. Because it is recorded in this way, the case will not be reported to SOII, and it will appear that there is a SOII undercount. Similarly, if a case appears to occur outside the subsampling timeframe according to workers' compensation, but falls within that timeframe when recorded on the OSHA log, then the case will be reported to SOII and it will appear that there is a workers' compensation undercount.

There is some empirical evidence of the impact of case subsampling on the undercount estimates. Determining date of onset may be particularly difficult for some types of cases, such as carpal tunnel syndrome. Indeed, consistent with this explanation for potential underreporting was Boden and Ozonoff's finding that carpal tunnel syndrome cases had a higher incidence of underreporting than other cases. (Note, however, that differences in date of onset may make it difficult to match a case even if it appears in both systems.) Further, Nestoriak and Pierce found that SOII captures a slightly lower percentage of cases where subsampling occurs.³⁴ However, they also found that undercounting was greater, and that case subsampling arises, in larger establishments. Disentangling the various effects will require multivariate analysis; BLS plans to conduct such an analysis in the future.

This discussion points out that there are a number of features of workplace safety and health data that make it difficult to match cases. Although false positive matches may also occur, it seems likely that the preponderance of mismatches are false negatives—that is, failures to match cases that should be matched. Thus, matching errors seem to be biased in favor of an undercount.

The empirical work of Rosenman, Boden, and others utilizing capture-recapture methodology finds that a large number of cases go unreported in multiple data systems. Lenore S. Azaroff, Charles Levenstein, and David H. Wegman detail a variety of "filters" that may cause this to occur. Azaroff and colleagues hypothesize that workers who report health problems to supervisors may risk (or fear) a variety of adverse outcomes.³⁵ Supporting this hypothesis, Tim Morse, Laura Punnett, Nicholas Warren, Charles Dillon, and Andrew Warren found evidence that workers at unionized facilities were more likely than workers at nonunionized facilities to file workers' compensation claims for musculoskeletal disorders, despite rates of such disorders that were

comparable between the two groups of workers. These researchers hypothesized that unions protect workers reporting musculoskeletal disorders.³⁶ Other filters identified by Azaroff as discouraging workers from reporting include safety incentive programs that reward teams of workers who do not sustain and report injuries and the failure of workers (and employers) to perceive the work-relatedness of a particular health condition. For all these reasons, a workplace injury or illness could go unreported, and thus unrecorded, in any occupational injury and illness tracking system.

Even when workers do report injuries, argue Azaroff and colleagues, there may be incentives working against taking time off or reporting a case as work related. Among such incentives are the uncertainty of receiving workers' compensation benefits if a claim is contested, the waiting periods before partial wage-replacement workers' compensation benefits are paid, worker ignorance about workers' compensation, and employer and employee incentives that favor the use of health insurance in place of workers' compensation. Rosenman and colleagues,³⁷ as well as Jeff Biddle and Karen Roberts,³⁸ found that many Michigan workers who were diagnosed with work-related repeated-trauma injuries did not file workers' compensation claims. Factors that raised the probability of filing included the severity of the condition and the generosity of wage loss benefits. Thus, in some situations where an occupational injury or illness has arisen, either the worker does not report it as such, does not take time off work, or does not file a workers' compensation claim. These cases will not appear in SOII or workers' compensation.

Although the foregoing analysis has largely discussed employee incentives not to report injuries and illnesses, employers also may have underreporting incentives. Increasingly, injury and illness rates are used as an evaluation criterion in competitions for contract work. Lower rates improve a bidder's chances of winning a contract. In addition, it is alleged that some employers underreport to avoid OSHA scrutiny, because OSHA targets employers with higher rates for inspection.³⁹ It is important to note that, although commentators have advanced hypotheses regarding reporting disincentives faced by employers and workers, little research on the magnitudes of the impacts of these various disincentives on underreporting has been conducted.

Bureau of Labor Statistics activities

BLS has initiated a variety of activities aimed at under-

standing and, to the extent possible, addressing the undercount issue:

1. *Expansion of SOII's scope.* As mentioned earlier, BLS is expanding the scope of SOII to include State and local government workers in all States. BLS also is exploring with OSHA ways to capture data for Federal Government workers. These expansions of the survey encompass all public sector workers for the first time, including those in high-hazard occupations, such as police officers, fire-fighters, and public health workers.

Collecting data for the self-employed and household workers requires a different data collection approach from the one utilized by SOII, because these workers are not covered by the Occupational Safety and Health Act and are not included in the SOII establishment-based sample frame. BLS has no plans to expand SOII to cover these workers, but it will work with other groups in exploring the use of alternate data systems that cover these workers.

2. *A quality assurance recontact survey.* In 2007, BLS conducted a quality assurance recontact survey which indicated that BLS survey processes were not responsible for an undercount. BLS recontacted a sample of 3,600 establishments that participated in the 2006 survey and asked them to submit their OSHA logs. The data on the logs were compared with data from SOII. There was no systematic evidence that SOII had undercounted cases recorded on the OSHA logs.

3. *Examination and extension of undercount research.* BLS is currently studying matched SOII data and workers' compensation data for Wisconsin that were previously assembled and analyzed by Boden and Ozonoff.⁴⁰ After that analysis concludes, BLS will analyze data for Kentucky and Maine. The goal is to determine whether certain types of cases and respondents display greater evidence of underreporting and to determine what factors other than willful underreporting might be responsible for any undercount finding. These factors include legitimate differences among different data systems and methodological aspects of undercount research that might provide biased estimates of the SOII undercount.

4. *Employer interviews.* In 2008, BLS is interviewing a small number of SOII respondents to learn the decisions they make about reporting cases to workers' compensation and reporting them on the OSHA log.

The purpose is to understand situations where workers' compensation cases are not recorded on OSHA logs and vice versa. The interviews are being conducted by a BLS cognitive survey methodologist. At the 2009 budget request level, BLS plans to expand the number of these interviews conducted in Fiscal Year 2009.

5. *Piloting the estimation of workplace injuries and illnesses from multiple sources.* The work of Rosenman and colleagues, Boden and Ozonoff, and others suggests that no single data source can measure the total burden of workplace injuries and illnesses. Using multiple data sources can improve completeness of coverage by including workers and cases that are outside the scope of any particular data source and by covering cases that, for a variety of possible reasons, do not appear in a particular data set. This, in fact, is the rationale for the BLS Census of Fatal Occupational Injuries. BLS hopes to work in partnership with the National Institute for Occupational Safety and Health, the Council of State and Territorial Epidemiologists, and some States to pilot the estimation of workplace injuries and illnesses using multiple data sources. This pilot would focus on two types of injury or illness—one acute, such as amputations, and one with a more gradual onset, such as carpal tunnel syndrome—each studied in a small number of States. Employer- and non-employer-based data sources might be explored. Such a pilot would provide information on the feasibility and cost of implementing a multiple-source data system for measuring the total burden of workplace injuries and illnesses in the United States.

SOII IS DESIGNED TO MEASURE THE NUMBER of OSHA-recordable cases of workplace injuries and illnesses. It covers most, but not all, sectors of the U.S. economy. This means that SOII does not capture some workplace injuries and illnesses that appear in other data systems, because of differences in the scope of cases captured and sectors covered. SOII also may be limited in completeness by incentives that affect worker and employer reporting of workplace injuries and illnesses. Further, with an employer-based system for counting workplace injuries and illnesses such as SOII, it is difficult to measure long-latent occupational illnesses. For all of these reasons, SOII does not measure the total burden of workplace injuries and illnesses.

However, SOII has advantages over other data systems. It efficiently and quickly produces detailed estimates that

are consistent in definition across all States and industries. For cases with days away from work, it provides rich information about the occupation and demographics of injured or ill workers and about case characteristics such as the number of days away from work, the nature of the case (for example, a fracture), the body part affected, the event (a fall, for instance), the source (the floor, for example) and the timing of the incident. In comparison with SOII, many other data systems are not consistent across States (workers' compensation is the prime example); cannot produce detailed estimates by State, industry, and case characteristics (NHIS is an example); do not exist for all States; or are very expensive to collect. These other systems also may have major scope limitations (for example, they measure only hospitalizations) or may be affected by various reporting incentives.

Some recent studies conclude that both SOII and other data systems undercount cases of workplace injuries and illnesses. Explanations other than willful underreporting—such as differences in the cases captured by various data systems and methodological aspects of the undercount research—may account for this finding. Some have argued that the gold standard for producing estimates of the total burden of workplace injuries and

illnesses is a multiple data source system. Indeed, BLS has implemented such an approach in collecting workplace fatal injury data. However, in 2006, there were 4.1 million OSHA-recordable nonfatal workplace injuries and illnesses in private industry according to SOII, in comparison with 5,840 workplace injury fatalities counted by CFOI in all sectors of the U.S. economy. The vastly greater number of nonfatal injuries and illnesses suggests that it would be quite costly to implement a multiple data source system uniformly across all States for all nonfatal occupational injuries and illnesses. However, BLS hopes to partner with States and other organizations in a pilot to assess the cost and feasibility of a multiple data source approach for nonfatal cases.

Within the constraints of its mission as a statistical agency, BLS will continue to work to ensure that SOII accurately measures in-scope workplace injuries and illnesses. As described in this article, BLS will undertake and publish additional research designed to understand and explain differences between its estimates and those of other systems. Finally, where feasible, BLS will expand SOII's coverage of the economy to give a more complete picture of the total burden of workplace injuries and illnesses. □

Notes

¹ Under this Federal/State program, participating States perform many survey functions, such as sample refinement and data collection, coding, and keying information into a database. Participating States obtain their own estimates and select the industries for which they get these estimates. States match Federal funding for their data collection work in a 50–50 cost-sharing arrangement. For the 2007 survey year, 42 States and the District of Columbia participated in the SOII. BLS regional office staff collect data for nonparticipating States, and those data are used to produce national, but not State, estimates.

² Ishita Sengupta, Virginia Reno, and John F. Burton, Jr., *Workers' Compensation: Benefits, Coverage and Costs, 2005* (Washington, DC, National Academy of Social Insurance, 2007).

³ States also have varying "retroactive periods." Workers who are off work longer than these retroactive periods are paid income benefits for the waiting period.

⁴ *National Health Interview Survey*, National Center for Health Statistics, 2008. Documentation available at www.cdc.gov/nchs/about/major/nhis/his-desc.htm (visited July 17, 2008).

⁵ *Ibid.*

⁶ The National Hospital Discharge Survey collects data from a sample of approximately 270,000 inpatient records acquired from a national sample of about 500 hospitals. For more information, see www.cdc.gov/nchs/about/major/hdasd/nhdsdes.htm (visited July 16, 2008).

⁷ Quoted from www.cste.org/dnn/ProgramsandActivities/OccupationalHealth/OccupationalHealthIndicators/Indicator2/tabid/97/Default.aspx (visited July 16, 2008).

⁸ *Workplace Injuries and Illnesses in 2006*, News Release number USDL 07–1562, (Bureau of Labor Statistics, 2007).

⁹ OSHA instructs employers to record cases within 7 calendar days of learning that a recordable work-related injury or illness has occurred.

¹⁰ M. Warner, N. Schenker, M. A. Heinen, and L.A. Fingerhut, "The effects of recall on reporting injury and poisoning episodes in the National Health Interview Survey," *Injury Prevention*, October 2005, pp. 282–87.

¹¹ CFOI uses a variety of data sources, including death certificates, workers' compensation reports, and Federal and State agency administrative reports. CFOI does not use data from private health insurance companies or hospital visits.

¹² J. Paul Leigh, James P. Marcin, and Ted R. Miller, "An estimate of the U.S. Government's undercount of nonfatal occupational injuries," *Journal of Occupational and Environmental Medicine*, January 2004, pp. 10–18.

¹³ Through its OSHA Data Initiative survey, OSHA collects injury and illness data from larger establishments in historically high-rate industries. These data are used to target inspections under OSHA's Site-Specific Targeting (SST) program.

¹⁴ Leigh and others, "An estimate of the U.S. Government's undercount."

¹⁵ Arthur Oleinick and Brian Zaidman, "Methodological Issues in the Use of Workers' Compensation Databases for the Study of Work Injuries with Days Away from Work. I. Sensitivity of Case Ascertainment," *American Journal of Industrial Medicine*, March 2004, pp. 260–74.

¹⁶ *Ibid.*, p. 268.

¹⁷ All matching research involving SOII microdata was conducted at BLS under Memoranda of Understanding between BLS and the researchers' institutions, permitting access to SOII data only for the purpose of conducting the sta-

tistical matching studies. All analyses and tabulations that were removed from BLS were screened for confidentiality. All data sets containing confidential BLS information remained at BLS.

¹⁸ Kenneth D. Rosenman, Alice Kalush, Mary Jo Reilly, Joseph C. Gardiner, Mathew Reeves, and Zhewui Luo, "How Much Work-Related Injury and Illness is Missed by the Current National Surveillance System?" *Journal of Occupational and Environmental Medicine*, April 2006, pp. 357–65.

¹⁹ Leslie I. Boden and Al Ozonoff, "Capture-Recapture Estimates of Non-fatal Workplace Injuries and Illnesses," *Annals of Epidemiology*, June 2008, pp. 500–06.

²⁰ *Ibid.*

²¹ For more technical information, see Ernest B. Hook and Ronald R. Regal, "Capture-recapture methods in epidemiology: methods and limitations," *Epidemiologic Reviews*, 1995, pp. 243–64.

²² Boden and Ozonoff, "Capture-Recapture Estimates."

²³ Rosenman and others, "How Much Work-Related Injury and Illness is Missed."

²⁴ *Ibid.*

²⁵ Anton W. Moll Van Charante and Paul G. Mulder, "Reporting of Industrial Accidents in the Netherlands," *American Journal of Epidemiology*, July 15, 1998, pp. 182–190.

²⁶ Boden and Ozonoff, "Capture-Recapture Estimates."

²⁷ The odds ratio has a value of 1 if the two sources are independent. With positive source dependence, the odds ratio is greater than 1.

²⁸ Eleni Messiou and Brian Zaidman, "Comparing Workers' Compensation Claims and OSHA Data Initiative Cases." Mimeo, (Minnesota Department of Labor and Industry, 2005).

²⁹ An OSHA recordkeeping change in 2002 instructed employers not to count recurrent symptoms of the same injury or illness.

³⁰ Messiou and Zaidman, "Comparing Workers' Compensation Claims."

³¹ Nicole Nestoriak and Brooks Pierce. *Preliminary Report on the Boden Undercount Study* (Bureau of Labor Statistics, 2008).

³² *Ibid.*

³³ One possible source of error in the count of days away from work on the OSHA log arises from the fact that employers are required to record the number of days lost within 7 calendar days. Anecdotal evidence suggests that some employers may record the actual day count missed up to the point of recording, rather than estimating the number of days missed as they are instructed initially to do. Employers also are instructed to update the day count when the actual number of days is known.

³⁴ Nestoriak and Pierce. *Preliminary Report*.

³⁵ Lenore S. Azaroff, Charles Levenstein, and David H. Wegman, "Occupational injury and illness surveillance: Conceptual filters explain underreporting," *American Journal of Public Health*, September 2002, pp. 1421–29.

³⁶ Tim Morse, Laura Punnett, Nicholas Warren, Charles Dillon, and Andrew Warren, "The Relationship of Unions to Prevalence and Claim Filing for Work-Related Upper-Extremity Musculoskeletal Disorders," *American Journal of Industrial Medicine*, July 2003, pp. 83–93.

³⁷ K. D. Rosenman, J. C. Gardiner, J. Wang, J. Biddle, A. Hogan, M.J. Reilly, K. Roberts, and E. Welch, "Why Most Workers with Occupational Repetitive Trauma Do Not File for Workers' Compensation," *Journal of Occupational and Environmental Medicine*, January 2000, pp. 25–34.

³⁸ Jeff Biddle and Karen Roberts, "Claiming Behavior in Workers' Compensation," *The Journal of Risk and Insurance*, December 2003, pp. 759–80.

³⁹ Leigh, Marcin, and Miller, "An estimate of the U.S. Government's undercount."

⁴⁰ Boden and Ozonoff, "Capture-Recapture Estimates."