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TELECOMMUTERS IN THE U. S.?**

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MEASURING THE MEASURABLE: WHY CAN'T WE AGREE ON THE NUMBER OF TELECOMMUTERS IN THE U. S.?

by

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ABSTRACT

Using telecommuting as a case study, we demonstrate that definitions, measurement instruments, sampling and sometimes vested interests affect the quality and utility even of seemingly objective and “measurable” data. Little consensus exists with respect to the definition of telecommuting, or to possible distinctions from related terms such as teleworking. Such a consensus is unlikely, since the “best” definition of telecommuting depends on one’s point of reference and purpose. However, differing definitions confound efforts to measure the amount of telecommuting and how it is changing over time. This paper evaluates estimates of the amounts of telecommuting occurring in the U. S. obtained from several different sources: the U. S. Census, the American Housing Survey, several Work at Home supplements to the Current Population Survey, a series of market research surveys, and the trade association-sponsored Telework America surveys. Many of the issues raised here are transferable to other contexts, and indirectly serve as suggestions for improving data collection in the future.

Keywords: telecommuting, teleworking, data quality, measurement issues, social science data, transportation impacts of telecommuting

1. INTRODUCTION

Measurement issues lie at the heart of empirical and policy studies. Without the appropriate quality and quantity of data, it becomes impossible to assess situations, trends and projections for the future. Social scientists have devoted considerable attention to issues of measurement and to the development of research instruments that improve the quality of data. Much of this attention has focused on problems associated with qualitative factors, such as those described in the book *Measuring the Unmeasurable* (Nijkamp, *et al.*, 1983).

In social science research, however, the role of subjectivity is a concern not only with respect to capturing relevant traits of the population of interest, but also insofar as it relates to the researchers themselves. The incorporation of analysts' values into the process of model-building and forecasting is well-known (e.g. Skamris and Flyvbjerg, 1997; Wallace, 1994), and not discussed further here. Instead, we focus on the even simpler issue of the data inputs to such models and forecasts. We emphasize that even at this most elemental level of analysis, "objectively measurable" quantities can be influenced by the subjectivity of the analyst.

Thus, this paper makes a distinction between measurable and "unmeasurable" input variables and addresses what may seem quite trivial, namely, the measurement of clearly objective quantities. By measurable we mean that a phenomenon is of a finite value, at a given time and place, and that this value can be gauged in a consistent manner. Repeated measurement should produce consistent results.

Using telecommuting as a case study, we explore several different issues with respect to the assessment of the extent to which it is occurring – certainly an objective, measurable characteristic. Issues we address include the importance of context, the need for a definition that is consistent and at a relevant level of precision (Churchman, 1959), the potential impacts of sampling variance and bias, the potential for personality or ideology to skew the measurement process and the interpretation of the results, and the tendency to treat personal experience or anecdotal information as representative. The result is multiple sets of data that are widely divergent, constraining the quality of analysis that can be conducted and clouding the dialogue that takes place on the subject, as we will demonstrate in detail in succeeding sections. Although telecommuting is the example explored in depth here, the issues raised are by no means unique to that context (see, e.g., Maier, 1991 on census data collection; Smith, 1995 on educational attainment; Raley, *et al.*, 2000 on child care; and Mokhtarian, *et al.*, 2004 for further discussion of these and several examples in transportation). Our hope is that this paper will be of value as an assessment of specific measurement issues and sources with respect to telecommuting, but also as an example of a more general set of issues to consider in collecting and evaluating data of many kinds.

The organization of the remainder of this paper is as follows. In Section 2 we introduce the case study of telecommuting. Section 3 discusses the importance of context to measuring telecommuting, and places the current paper in the particular context of studying the transportation impacts of telecommuting. Section 4 identifies some issues to consider in evaluating the definition, quality, and quantity of data on the number of telecommuters in the U.S., and applies those considerations to evaluating several data sources with respect to their suitability for a study of the transportation impacts. In Section 5 we discuss issues relating to measuring telecommuting frequency. Section 6 offers some concluding remarks.

2. BACKGROUND FOR THE CASE OF TELECOMMUTING

The mode of working known as telecommuting has enjoyed considerable growth since aerospace engineer Jack Nilles coined the phrase more than a quarter-century ago (e.g., Nilles, *et al.*, 1976), even if it has not spread as rapidly as its enthusiasts may have predicted. The data discussed in this paper suggests that 10-12% of the workforce were salaried employees who telecommuted at least once a month in 1998, with an average annual growth rate of 20% since 1988. Telecommuting appears to have considerable popular appeal, with potential benefits to the worker, the employer, and society at large (Handy and Mokhtarian, 1996b; Salomon and Salomon, 1984). In view of the potential role of telecommuting as a “complex solution” (i.e., “a single intervention which is intended to solve many problems”; Salomon, 1998, p. 22), it would be desirable for public discourse about it to be based on a clear and common understanding of what it is and what trend it is taking. Instead, the lack of a concise and universally-accepted definition of telecommuting has confounded research and policy-making since the beginning. The use of inconsistent, unclear, or unsatisfactory definitions by different studies has resulted in a fundamental ambiguity with respect to the importance of the phenomenon. A number of attempts have been made to place telecommuting and its relatives within a typology of remote work options (Dick, 1996; Fritz, *et al.*, 1995; Helling and Mokhtarian, 2001; Huws, *et al.*, 1990; Kraut, 1988; Lamond, *et al.*, 1997; Lindstrom, *et al.*, 1997; Mokhtarian, 1991; Niles, 1994; Qvortrup, 1992, 1996; Salomon, 1990), yet we seem no closer to consensus than ever.

Perhaps such ambiguity is inevitable precisely because of the complex, multifaceted nature of telecommuting as a social phenomenon, and because of the volatility of the technological, institutional, and social environment in which it is occurring. Perhaps the ambiguity (or, for that matter, the need for specificity) will diminish over time as it becomes more and more commonplace. But in the meantime, it remains important for those studying the phenomenon, and those promoting it as sound public policy, to be clear about its boundaries in the context of interest.

This paper, then, is neither so bold nor so foolish as to attempt to achieve consensus with respect to the “best” definition of telecommuting. Rather, a key purpose is to identify some important issues to keep in mind when collecting and evaluating data on the phenomenon, and to apply those issues to the evaluation of currently available data on the amounts of telecommuting occurring in the U. S. Other valuable studies (e.g. Pratt, 2000, 2001, 2002) have also commented on definitional issues, analyzed telecommuting estimates based on various surveys, and offered advice on designing new surveys to measure telecommuting. The current paper does not focus on the design of new telecommuting surveys, but rather on the critical evaluation of existing data sources, offering our own original observations on the subject as well as synthesizing some of those expressed elsewhere. Nevertheless, the issues we raise in the context of appraising available data sources can be used to improve the design and reporting of future telecommuting data collection efforts as well.

3. THE IMPORTANCE OF CONTEXT

One reason for the numerous definitions of telecommuting – and a reason why consensus is unlikely – is that the “best” definition varies with the focus of interest. For example, if one’s interest lies in assessing the demand for home office space and furniture (e.g., Melman, 1998), it

would be important to focus on home-based workers (as opposed to mobile workers – “road warriors”), but whether a given worker were a salaried employee or self-employed may be less relevant, and a precise estimate of the number and timing of the hours spent working at home may also be less relevant. On the other hand, in assessing the demand for ICT equipment, identifying mobile workers (in addition to home-based workers) is extremely relevant. If one’s interest lies in forecasting the spatial and temporal distribution of the demand for telecommunications services, then the location of the work, and even the times of day at which it takes place, becomes important.

The perspective taken in this paper is a focus on the transportation impacts of telecommuting. Specifically, the context is a time-series analysis of the impacts of telecommuting on vehicle-miles traveled (VMT) at the nationwide level (Choo, *et al.*, forthcoming). This perspective drove two fundamental boundaries in the study. First, it motivated the choice of the word (and the focus on) “telecommuting” as opposed to “teleworking”. At the broadest extreme, telecommuting is sometimes used interchangeably with teleworking to refer to *using information and communications technology to perform work “at a distance”*. Clearly, this definition includes many situations in which travel either is not affected (overtime work from home; home-based self-employment for which the alternative is not working at all; ordinary uses of fax, e-mail, and telephone to reach distant parties) or is actually facilitated (use of mobile phones and laptops to support work while traveling). Although we acknowledge the legitimate interest of some groups in focusing on the “work” aspect rather than the “commuting” aspect of the phenomenon, from the perspective of understanding the potential to reduce peak-period congestion, the definition of telecommuting should be narrower than that of teleworking in the broadest sense. Conversely, it can be quite confusing when a broad term such as teleworking is then given a more narrow definition, as in the context of legislation promoting the trip reduction aspects of telecommuting.

Second, our perspective motivated a focus on salaried employees of an organization, referred to as telecommuters, rather than on all teleworkers. In particular, we distinguish telecommuters from self-employed home-based business workers. Telecommuters are assumed essentially to eliminate (or greatly reduce, if teleworking at a location other than home) the commute on days that they telecommute, although this is a simplification, since some research (Mokhtarian, 1998) suggests that about 6% of telecommuting occasions may still involve the normal commute (i.e. that telecommuting is only partial-day in those cases). For home-based business workers, on the other hand, the impact on transportation is not clear, since it is unknown what the alternative to the home-based business would be in each case. For many people the alternative is presumably a conventional job with a conventional commute, but for many others the alternative may be a part-time job or no job at all, in which case the commute “reduction” due to working at home is lower or non-existent. In fact, at least one study (Mokhtarian and Henderson, 1998) found that home-based business workers in California had a daily mean drive alone travel time one-third higher than home-based telecommuters (0.82 versus 0.62 hours), although not as high as conventional workers (1.14 hours). Further, from a policy standpoint, home-based businesses have not been the subject of the same attention as telecommuters have been, presumably because self-employed workers already have (to a large extent) the flexibility in choosing work times and locations that salaried employees are seeking to achieve through telecommuting.

In view of the ambiguity of the transportation impacts of home-based work, we focus only on conventional telecommuting here. However, home-based work is subject to many of the same measurement difficulties, and obtaining reliable data on its nature and extent is challenging (see, e.g., Pratt and Davis, 1985; Pratt, 1997). The available evidence indicates that home-based businesses enabled by ICT are a growing segment of the workforce. Although their numbers currently appear to be smaller than those of salaried telecommuters, they work at home more often. Thus, we believe that home-based business workers merit the same careful analysis that salaried telecommuters do.

In this paper, then, we treat *telecommuting* as *that subset of teleworking in which salaried employees of an organization replace or modify the commute by working at home or a location closer to home than the regular workplace, generally using ICT to support productivity and communication with the supervisor, co-workers, clients, and other colleagues*. We do not consider after-hours work to be telecommuting, if the employee still spends a full day at the regular workplace. We discuss the gray area of contract workers in Section 4.1.

4. HOW MANY TELECOMMUTERS ARE THERE?

A number of organizations have produced estimates of the amount of telecommuting or home-based work in the U. S. from time to time. As indicated in the previous sections, the emphasis in this paper is on evaluating those existing U. S. data sources with respect to their usefulness and reliability for assessing the amount of telecommuting, especially from a transportation perspective. At least three dimensions are important to that evaluation: definition, quality, and quantity. In this section, we address key issues associated with each of these dimensions in turn, and then assess the available data in view of those issues. Most of the sources measuring telecommuting at the aggregate level focus on home-based telecommuting. This is not a major concern, since center-based telecommuters in the U. S. probably number only in the hundreds (Stanek and Mokhtarian, 1998). Thus, the discussion below will be restricted to home-based work.

4.1 Who is a Telecommuter?

In evaluating sources measuring the amount of home-based work, the first question that arises is, “Who is being counted?” That is, “How is telecommuting [or whatever term is used] defined in this study?” This question actually contains several others:

- **What kind of worker is being counted?** If the types of occupations being measured are not restricted, counts of home-based workers will include farm workers, live-in domestic workers, and self-employed service workers in occupations such as child care, plumbing, and so on. Since even some non-information workers can sometimes legitimately telecommute (Mokhtarian, 1998), categorizing each occupation as representing information work or not is far from straightforward.
- **What is the threshold frequency for being counted?** Obviously, there will appear to be a lot more telecommuters if the criterion is telecommuting “at least once a month”, than if the criterion is doing it “at least three days a week”.
- **What other criteria are applied?** Some surveys try to screen out inappropriate respondents (e.g., homemakers or uncompensated employees of a family business) by asking if they con-

duct “paid work at home”. This can have several problems: (1) The “paid work” may be a moonlighting job, undertaken in addition to a regular job involving commuting. In that case it would be erroneous to consider the respondent a telecommuter. (2) A respondent may interpret the question as referring to being paid explicitly and directly for work done specifically at home. As a professional being paid a fixed salary rather than an hourly wage, she may not consider work at home to be “paid work” *per se* and hence erroneously not be counted as a telecommuter (Pratt, 2000). Deming (1994) distinguished between working at home “for pay” (including salaried telecommuters as well as self-employed home workers), and “taking work home” which he classified as “unpaid”. It is likely that many respondents to a question about working at home for pay would not make that distinction unless it is carefully drawn for them. (3) On the other hand, if a salaried professional *does* consider his work at home to be “paid work”, but only works *overtime* at home without eliminating any commute trips, he could be erroneously *counted* as a telecommuter.

Another criterion sometimes applied is to ask whether the individual works at home under a “formal arrangement” with the employer. This screen seems likely to miss the considerable amount of irregular and ad hoc telecommuting that occurs, and even many regular telecommuters may not consider themselves to have a formal arrangement (Dannhauser, 1999).

A final important definitional question to ask is:

- **What forms of employment are being counted?** Specifically, does the count include home-based business workers, salaried employees, or both? An additional complication is the prevalence of multiple job holding or moonlighting. Unless the questions about working at home are carefully worded, moonlighters could be classified as telecommuters (since they were initially identified as salaried), but erroneously so if most of their work at home is conducted for a home-based business rather than as a salaried employee.

Some surveys include additional categories, such as contract workers. The latter may be employees of a staffing or temp agency, or may be technically self-employed, but have a long-term arrangement with one or a small number of clients for whom they may act almost as an employee (Pratt, 2000). Given the transportation context of the present study, we include contract workers among the count of telecommuters, in the belief that contract workers are more similar to salaried employees than to independently self-employed workers in their commute and other travel patterns.

4.2 Quality and Quantity of Telecommuting Data

With respect to *quality*, some questions to ask are:

- **On what size sample are the numbers based?** In a survey of home-based work, it is sometimes not clear if the reported sample size represents the entire sample of conventional as well as home-based workers, or only the number of home-based workers in the sample. In the former situation, clearly the number of home-based workers will be considerably smaller than the reported sample size, which means that the estimates of *characteristics of home-based workers* will be less precise than the published full sample size would suggest.
- **Was the sample properly drawn and weighted to be representative of the population?** On the other hand, unless the sample is properly handled, even a very large sample can be

unrepresentative of the population of interest, and therefore inferior to a smaller sample that *is* representative. Unfortunately, the procedures by which the sample was drawn and weighted are seldom presented in publicized summaries of the results, and thus it can be difficult to judge the reliability of the sample.

- **Could the results have been influenced by internal or external considerations?** The individuals who are counting home-based workers are human beings living in a social context for their work, not completely impartial machines performing a neutral and exact calculation. As such, all humans bring an element of subjectivity to the task at hand. Even something as elemental as the analyst's personality – e.g. whether she is an optimist or a pessimist – may affect how she approaches the problem and interprets the results. In the current context, there may be a number of forces at work to bias upward the published forecasts of telecommuting (Salomon, 1998). It should be emphasized that the effect of these forces on any given individual may be conscious or unconscious:
 - Widely-publicized statements of key opinion leaders have predicted major increases in remote work, and it can be difficult to “buck the current”. For example, management expert Peter Drucker claimed in 1989 (p. 38) that “[i]n 20 years Japanese office workers may still commute ... to downtown office towers. But no one else in the developed world will... [C]ommuting to office work is obsolete”¹. More recently, the senior and respected statistician Norman H. Nie predicted that, “by 2005, at least 25 percent of the American workforce will be telecommuters or home office workers” (1999, p. 50).
 - When putatively neutral government agencies include predictions of major increases in their reports (e.g., USDOE, 1994), it may invest those predictions (sometimes made by other interested parties) with greater weight.
 - When the same numbers or predictions (whether quantitative or qualitative) are repeatedly cited in a variety of contexts, they take on the aura of “conventional wisdom” and tend to be accepted more and more readily.
 - Often the predictions are made or sponsored by a party with a vested interest in promulgating a higher number. Such predictions are not wrong simply because of that fact, but they should be viewed with considerable caution.
 - The media are oriented toward reporting unusual events or novel ideas rather than the typical, and so they are likely to invest evidence of a new trend with greater weight than is warranted.²
 - On the other hand, there is a natural tendency to rely heavily on personal experience and anecdotal information in interpreting data, and to project that perspective onto the population as a whole. Thus, reporters and academics, whose jobs naturally lend themselves to working remotely and from multiple locations, may be more inclined than a “typical” worker to see telecommuting as becoming the norm.
 - Technological determinism, the belief that technology can be counted on to solve societal problems, often leads to overoptimistic projections of the adoption or impacts of technological innovations (Ferguson, 1986; Kraut, 1987). This syndrome is certainly represented among some of the proponents of telecommuting as a solution.
- **Are the results plausible?** One way to help counter the inevitable lack of objectivity discussed above is to subject results to a separate reality check. If a certain result has logical implications that are not credible, then clearly the legitimacy of the result is open to question.

With respect to *quantity*, in addition to the sample size question raised above, another relevant question is simply:

- **For how many years are comparable counts available?** For a study such as ours (Choo, *et al.*, forthcoming), involving a time series analysis, it was important to have a series of data for as many years as possible, with the variable of interest defined consistently across time.

4.3 Evaluation of Available Sources

Five different sources of published data on the number of home-based workers in the US were identified for this study.³ Table 1 summarizes the important information about each source. The source labeled “market research firms” refers to a series of annual surveys of home-based work directed by a single individual, Thomas E. Miller, under the auspices of several different firms over time: LINK Resources, FIND/SVP, and Cyber Dialogue.

[Table 1 goes about here]

One immediate observation from the table is the disparity in definitions of what is being counted by each source. This doubtless contributes to the wide range of numbers for years in which there is more than one estimate (consider, for example, the estimates of 3.6 – 11.1 million for 1997). Key issues associated with each source can be briefly summarized as follows:

US Census Bureau: The decennial census counts only those who worked at home most of the preceding week, so it undercounts telecommuters by excluding those who do so less than three days a week (for a discussion of the proportion of telecommuters for which that is true, see Section 5 below). On the other hand, it includes farm, domestic, and service workers whose home-based work does not replace a commute, so in that respect it is an overcount (Handy and Mokhtarian, 1995; Pratt, 2000). The net effect of these two counteracting biases is uncertain (although various occupations can be screened out in a specialized analysis of the Census data). In any case, full Census data are available only for decennial years, which further limits their suitability for many studies. It is interesting, however, that the proportion of the employed labor force working at home by this definition stands at 3% in both 1990 and 2000, suggesting that this segment of home-based work is not increasing beyond the normal growth in the population. The ongoing Survey of Income and Program Participation⁴ counted those who worked *only* at home at least one day of a typical week in the previous month, and hence probably undercounts the number of telecommuters.

American Housing Survey: The AHS counted people working at home in a number of different categories, but we focus here on the one of particular interest to a study of transportation impacts: the number of people working at home instead of traveling to work. This counted people working at home at least one day of the preceding week instead of traveling to work, which probably undercounts the total number of telecommuters, since many people are likely to telecommute relatively casually. Although asking about “working at home instead of traveling to work” is perhaps the clearest way the commute reduction impacts can be identified, even that wording is subject to misinterpretation. Some self-employed individuals may include themselves in this category, on the premise that if they weren’t self-employed they would normally be commuting to a salaried job. Potentially, some multiple job-holders may include themselves here

if they stayed home from their primary salaried job in order to work at their second job, or chose to regularly work part-time at their primary job in order to engage in a home-based second job. Interestingly, using the same definitions the AHS counted slightly fewer people (5.6 million) telecommuting in 1999 than in 1997 (5.7 million; Pratt, 2002).

Current Population Survey (CPS) of the Bureau of Labor Statistics (BLS): This source probably undercounts telecommuters by focusing on those with “formal arrangements”. Nie (1999, p. 50) says that the 1997 estimate “is likely to be low by as much as 1 million, because of the ambiguity of their telecommuting question.” BLS also publishes counts of wage and salaried employees working at home, which of course are higher than the counts of wage/salaried employees with formal arrangements working at home for pay, but the difference is largely due to overtime work done at home, which is not of interest in the context of evaluating transportation impacts. It is again interesting that the number of telecommuters counted by the same definition declined slightly in 2001 (3.4 million) compared to 1997 (3.6 million).

Market research firms: This represents the longest series of data on number of telecommuters, with estimates available each year between 1988 and 1998. The estimates are based on 2,000 – 2,500 randomly-selected households interviewed by telephone each year. Individual observations are presumably weighted to reflect national distributions on key variables.

There are several concerns with the market research data:

- Since telecommuters represent a relatively small proportion of the total work-at-home population (other segments measured in the same survey include self-employed home workers, moonlighters, and those who only do overtime work at home), the projected number of telecommuters in the population is based on numbers much smaller than the total sample sizes in these studies. For example, the 1991 estimate is projected from a sample of 176 telecommuters (personal communication of Tom Miller to P. L. Mokhtarian, 7/15/1991). Properly weighting the sample to provide an unbiased estimate of the true proportion of telecommuters is by no means a cut-and-dried process. For example, FIND/SVP originally publicized the number of telecommuters in 1996 as 8.7 million, and later revised its estimate upward to 9.7 million. Smaller corrections were also made to the numbers initially disseminated for 1990, 1993, and 1995 (see notes on Table 1).
- Moonlighters are theoretically counted in a separate category (“part-time self-employed homeworkers”). But, in a personal communication to Susan Handy (3/8/1993), Mr. Miller reported that among the 4.19 million conventional employees counted as telecommuters in 1992, 1.83 million (44%) were moonlighters. This raises the question as to whether some people in this category were incorrectly classified as telecommuters when in fact all their home-based work was conducted for their second job.
- The number of telecommuters estimated for 1998 was placed at 15.7 million. A press release on Cyber Dialogue’s web site commented that this number comprises 7.4 million full-time employees, 4.0 million contract-based workers, and 4.3 million “part-time employees who telecommute informally”. The latter segment was found to contain mostly “retirees and homemakers who are capitalizing on the full-employment economy to supplement income via home-based work.” It seems clear, then, that this segment of part-time informal telecommuters is for the most part not going to be reducing commute travel. We considered eliminating this group from the total, but ultimately decided not to do so because previous

years' totals for conventional employees also included both full- and part-time employees without distinguishing them – and so eliminating part-time employees from the 1998 total only would have been inconsistent.

Overall, the impression given by the concerns outlined above is that these data are likely to overcount the number of “true” telecommuters – those who will genuinely be reducing commute travel. Nie (1999, p. 50) also shares the belief that at least the 1998 estimate is “arguably too high because of their sampling methodology”, although he does not elaborate.

Telework America: The trade association International Telework Association and Council (ITAC) sponsored surveys of teleworking during “Telework America” (TWA) promotional weeks in 1999, 2000, and 2001. The surveys were conducted by different parties and differed in sampling procedure and definition of a telecommuter (see notes on Table 1). Because of these distinctions, it is difficult to compare the three numbers.

The estimated number of telecommuters for 1999 was 19.6 million (employees and independent contractors). It is not entirely clear why this number is so much higher than others for the same and nearby years. The survey director speculates that it may be due to the inclusion of multiple job holders whose home-based work is primarily for their second job (personal communication of J. H. Pratt to P. L. Mokhtarian, 8/16/2002).

The number of telecommuters estimated for TWA in 2000 (10.3 million) counted only the “regularly employed”, and is much lower than the 1999 number – lower even than the 1997 and 1998 numbers (11.1⁵ and 15.7 million) in the market research series. Further, using screens consistent with the year 2000 survey, the number of telecommuters in 2001 is estimated by us to be 10 - 12 million (see notes on Table 1). Placing the 2000 and 2001 TWA numbers in sequence with the market research series, and remembering that a more valid number for the 1998 Cyber Dialogue study would be 11.4 million (excluding the 4.3 million part-time informal telecommuters who were largely retirees and homemakers), suggests that the number of telecommuters has been fluctuating around 10-11 million for the five years 1997-2001. This observation, combined with the slight declines (or, relative stability) previously noted for the four AHS and CPS counts taken between 1997 and 2001, raises the question of whether that degree of penetration of telecommuting might constitute an equilibrium; at a minimum it suggests that telecommuting might be growing much more slowly now than in years past. Pratt (2002) raises a similar question, using different definitions for various forms of telework.

5. HOW OFTEN DO THEY TELECOMMUTE?

Data on the frequency of telecommuting are even less available than data on the number of telecommuters, and when they are available, they are subject to many of the same issues discussed with respect to number of telecommuters. In addition, data on telecommuting intensity are often gathered and/or presented in the form of number of hours per week that are worked at home. The translation of that form to number of commute trips eliminated is ambiguous, with widely varying impacts on VMT and peak-period VMT. A further complication is that telecommuting often results in a rearrangement of the work schedule to suit personal needs, so that work on a telecommuting day may not occur during the conventional 8 a.m. – 5 p.m. window. Thus, when

surveys report the proportion of time that a telecommuter works outside “normal working hours”, it is not clear how much of that is replacing time in the regular office and how much is overtime supplementing a full day in the office.

The press releases and other reports associated with the marketing research numbers adopted for our time series study provide some information about telecommuting frequency, for several but not all of the years in the series. This information is generally in the form of average number of hours per week worked at home. This average ranges between 16.5 and 19, as reported for four of the 11 years in the series, with a frequency of 7-8 days/month (which translates to 1.6 – 1.8 days/week) reported for a fifth year. Importantly, for one year (1997), it was reported that the average hours per week worked at home was 18-19, with a median of 12. Thus, typical frequencies are lower than the arithmetic average suggests, which is skewed upward by a small proportion of very high frequency telecommuters.

To be included in the count for the marketing research studies, telecommuters needed to “work at home during normal business hours”, at least one day a month. We can probably assume that one *full* day a month is meant (i.e. that for at least one day a month, the worker does not commute to the office at all). We generally know nothing beyond that about the number of days over which an average weekly number of hours of home-based work is spread, nor how many of those days (1) eliminate the commute altogether (full day telecommuting); (2) shift one or both legs of the commute out of the peak (partial day telecommuting); or (3) do not affect the commute at all (overtime work at home). However, more information is available for one year. In 1995 (FIND/SVP, 1995), it was reported that "employee brings work home after hours" an average of 39.6 hours per month, while "employee telecommutes" 39.5 hours per month. With an average of 4.3 weeks per month, this suggests an average of 9 hours per week – one day a week or slightly more – spent in actual telecommuting, with a similar amount spent on after-hours work. This may be a typical result for the other years in which totals of 16.5 - 19 hours per week worked at home are reported.

The CPS surveys also collected data on hours per week worked at home. For the 3.6 million wage and salary workers doing paid work at home related to their primary job in 1997, the mean number of hours per week usually worked at home was reported to be 14.9 (<ftp://ftp.bls.gov/pub/news.release/History/homey.031198.news>, accessed 8/23/2002). For the 3.4 million wage and salary workers doing paid work at home related to their primary job in 2001, the mean number of hours per week usually worked at home was reported to be 18.0 (<http://www.bls.gov/news.release/homey.nr0.htm>, accessed 7/30/2002)⁶. Although translating hours per week to days per week is problematic as discussed above, the consistency of these numbers with those reported by the market research studies suggests a certain amount of robustness in this measure of telecommuting intensity.

A number of studies in the academic literature estimate average telecommuting frequencies in days per week that are similar to the 1995 market research result. For example, Handy and Mokhtarian (1995) reported an average of 1.2 days per week, across eight different studies. Additional sources cited in Mokhtarian (1998) report average frequencies ranging between 0.9 and 1.4 days per week. Since the dates of these studies range from the late 1980s to mid-1990s, and include programs in the Netherlands and Australia as well as the US, they suggest a fair

amount of spatial and temporal stability in typical telecommuting frequencies. As one could reasonably hypothesize changes in either direction over time (Handy and Mokhtarian, 1996a), the observed stability may be the result of counteracting trends largely canceling each other out.

Sources for the SIPP and AHS surveys also contain some information on frequency. Table 2 presents the distribution of days worked at home for various categories of people measured by those two surveys. Both surveys imply considerably higher average frequencies of home-based work than the other evidence presented above, but in neither case is the evidence clear-cut.

[Table 2 goes about here]

The 1997 SIPP survey found an average of 1.8 days a week (out of 5.2 on average) worked at home for “mixed” workers (those who did not work only at home) and 4.9 days per week for “home” workers (those who worked only⁷ at home); 3.9 days per week overall. However, both the mixed and the home categories include self-employed as well as salaried workers, whereas to be comparable with the other estimates presented above, we should look only at salaried workers. Kuenzi and Reschovsky (2001) report that 1.034 million (36%) of the mixed workers and 3.190 million (50%) of the home workers were self-employed in 1997, but do not provide enough information to separate the frequency distributions appropriately. A simple weighted average of the averages yields an estimate of 3.8 days a week⁸ worked at home for the salaried workers, but that relies on the assumption that the frequency distribution of salaried mixed workers is the same as that of self-employed mixed workers, and similarly for home workers. To the contrary, it is likely that salaried workers are more concentrated among the lower frequencies and self-employed workers are more often found at higher frequencies.

The lowest possible average frequency for salaried workers that is consistent with the SIPP data can be obtained by assuming that the 1.034 million self-employed mixed workers entirely occupy the higher frequency categories of Table 2, and that the 3.195 million salaried home workers all occupy the lower categories. This yields a lower-bound telecommuting frequency for salaried workers of 2.9 days a week. In trying to reconcile these numbers with the lower ones found in the many studies mentioned above, several observations can be made:

- The emphasis on a “typical” week is likely to inflate reported frequencies. Respondents may tend to report a desired or target frequency, which some studies (e.g., Mokhtarian, *et al.*, 1997; Varma, *et al.*, 1998) have shown to be higher than the actual frequency.
- By design, the sample on which these numbers are based was biased toward higher frequencies, by excluding people who worked only from home less than one day in the typical week.
- Table 3 of Kuenzi and Reschovsky (2001) classifies workers as self-employed, “yes” or “no”. It is not stated whether this classification is based on the primary job or not. If the distinction was not clarified to the respondent, the self-employed category may include a number of moonlighters who would more properly be considered salaried.
- To be counted, the individual must have worked only at home at least one day in a typical week, but it is not clear whether *all* days worked at home in Table 2 were *only* worked at home. If days of working partially at home (perhaps only overtime), and partially at the main office are included, the actual frequencies of commute-eliminating telecommuting could be

quite consistent with those mentioned above, which excluded overtime work at home and included relatively little partial-day telecommuting.

- On the other hand, if all days in Table 2 *were* “only” worked at home, then the SIPP total column shows that 5.71 million people, or 4.3% of the workforce, worked at home 4 or more days a week. This is a considerably higher proportion than for the 2000 decennial census, which is difficult to explain.

The AHS survey is similarly biased toward more frequent (once-a-week or more) telecommuters, and averages of 3.3-3.4 days a week worked at home are found for the 1995, 1997, and 1999 waves. In this case, Keil (2000) and the web source are clear that the distribution is for the number of days worked at home instead of traveling to work (i.e. that presumably each day represents an eliminated commute trip). But, focusing for example on the 1997 numbers, although 96.1% of the group (5.47 million) is presumably wage/salaried (since they worked at home at least one hour a week on a wage or salary job), 47.4% of the same group (2.70 million) worked at home at least one hour a week self-employed (similar proportions of 93% and 46%, respectively, apply to the 1999 data, as shown in Pratt, 2002). Thus a high proportion of the salaried workers in this group are also moonlighting as self-employed (or conversely), and there is likely to be some confounding of the two forms of work when a given respondent doing both reports on the number of days she works at home.

As noted in Section 4.3, the 1997 telecommuting penetration estimates for the SIPP and AHS surveys were close to each other (5.0 and 5.5 million, respectively) and far lower than the market research estimate (11.1 million). We now see that the average telecommuting frequencies estimated by SIPP and AHS are considerably higher than those reported by the market research firm. To a great extent, these two sources of conflict will counteract each other. Nevertheless, it is obviously more desirable to be confident in each factor than to count on errors in opposite directions canceling out. The danger in accepting a low estimate of number of current telecommuters with a high estimate of average frequency, is that it may lead analysts to overestimate the yet-to-be-realized demand for telecommuting (by projecting higher-than-realistic telecommuting frequencies onto an also larger-than-realistic segment of eventual adopters).

6. CONCLUSIONS

The analysis in this paper indicates that a great deal of uncertainty surrounds estimates of the number of telecommuters and frequency of telecommuting. It is clear that the answers obtained depend very much on the questions that are asked, and that framing the phenomenon of interest is central to framing the questions (see, e.g., Mokhtarian, 2003). Achieving consensus on the “best” definition of telecommuting (or any of its relatives such as teleworking) is unlikely, due to its multifaceted nature and the variety of perspectives from which people approach the subject. In view of that reality, it is imperative to critically scrutinize published numbers on the amount of telecommuting, to determine their suitability for an intended purpose. Understanding the definition of telecommuter used in the data collection is one paramount concern, but questions with respect to the quality and quantity of the data also need to be asked.

The magnitude of costs and benefits of a policy at hand (e.g., promoting telecommuting, building a new road in a metropolitan area, devising parking policies or improving rail systems), should

be one major consideration with respect to how much data should be collected and how precise it should be. The imperfect evidence that is available suggests that telecommuting appears to be an important enough trend to justify the cost and effort required to collect reliable data with respect to its adoption and frequency, on an annual basis. The issues raised in this paper are intended to help researchers, policymakers, and the public be informed consumers of already-available data, but can also be taken as implicit advice with respect to the design and reporting of future data collection efforts – whether for telecommuting or in other areas of public policy analysis. Clearly, although *post hoc* attention to these issues is crucial, it is even more desirable to attend to them in the data collection design stage itself.

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REFERENCES

Armour, Stephanie (2001) Telecommuting gets stuck in the slow lane. *USA Today*, June 25, 1A-2A.

Braus, Patricia (1993) Homework for grownups. *American Demographics* (August), 38-42.

Choo, Sangho, Patricia L. Mokhtarian, and Ilan Salomon (forthcoming) Does telecommuting reduce vehicle-miles traveled? An aggregate time series analysis for the U. S. *Transportation*.

Churchman, C. West (1959) Why measure? Chapter 4 in C. West Churchman and Philburn Ratoosh, eds., *Measurement Definitions and Theories*. New York: John Wiley and Sons, Inc., 83-94.

Dannhauser, Carol Leonetti (1999) Who's in the home office? *American Demographics* (June), 50-56.

Deming, William G. (1994) Work at home: Data from the CPS. *Monthly Labor Review* (February), 14-20.

Dick, Geoffrey N. (1996) Telecommuting: From definitions to a broad conceptual model. *Proceedings of the PRIISM '96 International Conference*, Maui, Hawaii, January, 218-223.

Drucker, Peter F. (1989) Information and the future of the city. *Urban Land* (June), 38-39.

Ferguson, M. (1986) The challenge of neo-technological determinism for communication systems, industry and culture. In M. Ferguson, ed., *New Communication Technologies and the Public Interest*. London: Sage Publications, 52-70.

- FIND/SVP (1995) The new home office consumers. *InterActive Consumers: The Monthly Primary Research Report* **2(1)** (January), 1-7. Contact: postmaster@findsvp.com.
- Fritz, Mary Elizabeth Watson, Kunihiro Higa, and Sridhar Narasimhan (1995) Toward a telework taxonomy and test for suitability: A synthesis of the literature. *Group Decision and Negotiation* **4**, 311-334.
- Garber, Andrew (2001) Telecommuting fails to fulfill high hopes. *Seattle Times*, September 17.
- Gordon, Gil (1990) 1990 data from work-at-home survey shows continued growth, diversity. *Telecommuting Review: The Gordon Report* (October), 9-10.
- Gordon, Gil (1991) Work-at-home survey data shows continued growth; telecommuters said to hit 5.5 million. *Telecommuting Review: The Gordon Report* (July), 10-11.
- Gordon, Gil (1993a) LINK's 1993 data shows steady work-at-home growth – and a few surprises. *Telecommuting Review: The Gordon Report* (June), 11-12.
- Gordon, Gil (1993b) Minor revisions noted in LINK Resources study – and some supporting trend data. *Telecommuting Review: The Gordon Report* (July), 10.
- Gordon, Gil (1997) Telecommuters by the millions – 11 million, to be exact. *Telecommuting Review: The Gordon Report* **14(8)** (August), 14-16.
- Handy, Susan L. and Patricia L. Mokhtarian (1995) Planning for telecommuting: Measurement and policy issues. *Journal of the American Planning Association* **61(1)** Winter, 99-111.
- Handy, Susan L. and Patricia L. Mokhtarian (1996a) Forecasting telecommuting: An exploration of methodologies and research needs. *Transportation* **23**, 163-190.
- Handy, Susan L. and Patricia L. Mokhtarian (1996b) The future of telecommuting. *Futures* **28(3)**, 227-240.
- Helling, Amy and Patricia L. Mokhtarian (2001) Worker telecommunication and mobility in transition: Consequences for planning. *Journal of Planning Literature* **15(4)** (May), 511-525.
- Huws, Ursula, Werner B. Korte, and S. Robinson (1990) *Telework: Towards the Elusive Office*. New York: John Wiley and Sons.
- Keil, Jack (2000) Home workers and their homes. *Housing Economics* (January), 6-11.
- Kraut, Robert E., ed. (1987) *Technology and the Transformation of White Collar Work*. Hillsdale, NJ: Erlbaum Associates.
- Kraut, Robert E. (1988) Chapter 2: Homework: What is it and who does it? In K. E. Christensen, ed. *The New Era of Home-Based Work*. Boulder, CO: Westview Press.

- Kuenzi, Jeffrey J. and Clara A. Reschovsky (2001) *Home-Based Workers in the United States: 1997*. United States Census Bureau Report P70-78, U. S. Department of Commerce, Economics and Statistics Administration, December. www.census.gov/prod/2002pubs/p70-78.pdf, accessed February 15, 2002.
- Lamond, David, Kevin Daniels, and Peter Standen (1997) Defining telework: What is it exactly? In Paul J. Jackson and Jos M. van der Wielen, eds. *Proceedings, Second International Workshop on Telework: 'Building Actions on Ideas'*, 177-187. September 2-5, Amsterdam.
- Lindstrom, J., A. Moberg, and B. Rapp (1997) On the classification of telework. *European Journal of Information Systems*.
- Maier, Mark H. (1991) *The Data Game: Controversies in Social Science Statistics*. Armonk, NY: M. E. Sharpe, Inc.
- Mariani, Matthew (2000) Telecommuters. *Occupational Outlook Quarterly* (Fall), 10-17.
- Melman, Stephen J. (1998) Home workers. *Housing Economics* (April), 10-13.
- Mokhtarian, Patricia Lyon (1991) Defining telecommuting. *Transportation Research Record* **1305**, 273-281.
- Mokhtarian, Patricia L. (1998) A synthetic approach to estimating the impacts of telecommuting on travel. *Urban Studies* **35**(2), 215-241.
- Mokhtarian, Patricia L. (2003) Telework reflections. Chapter 11 in P. Jackson and B. Rapp, eds., *Organisation and Work Beyond 2000*. Berlin: Springer-Verlag, pp. 153-155.
- Mokhtarian, Patricia L. and Dennis K. Henderson (1998) Analyzing the travel behavior of home-based workers in the 1991 CALTRANS Statewide Travel Survey. *Journal of Transportation and Statistics* **1**(3), 25-41.
- Mokhtarian, Patricia L., Ilan Salomon, and Sangho Choo (2004) *Data and Measurement Issues in Transportation, with Telecommuting as a Case Study*. Institute of Transportation Studies, University of California, Davis. Report number UCD-ITS-RR-04-29, Institute of Transportation Studies, University of California, Davis, July. Available at <http://www.its.ucdavis.edu/publications/2004/UCD-ITS-RR-04-29.pdf>.
- Mokhtarian, Patricia L., Chaang-Iuan Ho, Shun Hung, Toan Lam, Elizabeth Raney, Lothlorien Redmond, David M. Stanek, and Krishna V. Varma (1997) *Residential Area-Based Offices Project: Final Report on the Evaluation of Impacts*. Prepared for the Federal Highway Administration and the California Department of Transportation Office of Traffic Improvement. Research Report UCD-ITS-RR-97-17, Institute of Transportation Studies, University of California, Davis, September. Available on the web at www.its.ucdavis.edu/tcenters/reports.htm.
- Nie, Norman H. (1999) Tracking our techno-future: What are the social consequences of innovation? *American Demographics* (July), 50-52.

Nijkamp, Peter, Helga Leitner, and Neil Wrigley, eds. (1983) *Measuring the Unmeasurable*. NATO ASI Series, Series D, Behavioral and Social Sciences, Number 22. Boston: M. Nijhoff.

Niles, John S. (1994) *Beyond Telecommuting: A New Paradigm for the Effect of Telecommunications on Travel*. Report DOE/ER-0626, prepared for the U. S. Department of Energy, Office of Energy Research and Office of Scientific Computing, Washington, DC, September.
<http://www.lbl.gov/ICSD/Niles/>

Nilles, J. M., F. R. Carlson, Jr., P. Gray, and G. J. Hanneman (1976) *The Telecommunications-Transportation Tradeoff: Options for Tomorrow*. New York: John Wiley and Sons.

Pratt, Joanne H. (1997) *Counting the New Mobile Workforce*. Report No. BTS97-A-01, prepared for the U. S. Department of Transportation, Bureau of Transportation Statistics, April.

Pratt, Joanne H. (1999) *Cost/benefits of Teleworking to Manage Work/life Responsibilities*. Report on the 1999 Telework America National Telework Survey, a project of the International Telework Association and Council. Available from www.telecommute.org/twa/twa1999/twa.shtml.

Pratt, Joanne H. (2000) Asking the right questions about telecommuting: Avoiding pitfalls in surveying home-based work. *Transportation* **27**, 99-116.

Pratt, Joanne H. (2001) Piggybacking on existing surveys: A methodology for obtaining new perspectives on changing travel behaviors. In David A. Hensher, ed., *Travel Behaviour Research: The Leading Edge*. Amsterdam: Pergamon Press.

Pratt, Joanne H. (2002) Teleworkers, trips and telecommunications: Technology drives telework – but does it reduce trips? Paper # 02-3166 presented at the 81st Annual Meeting of the Transportation Research Board, Washington, DC, January (01047 on the meeting CD-ROM).

Pratt, Joanne H. and John A. Davis (1985) *Measurement and Evaluation of the Populations of Family-Owned and Home-Based Businesses*. Prepared by Joanne H. Pratt Associates, 3520 Routh Street, Dallas, TX 75219, for the Small Business Administration under contract no. SBA-9202-AER-85, December.

Qvortrup, Lars (1992) Telework: Visions, definitions, realities, barriers. In OECD (ed). *Cities and New Technologies*. Paris, France: OECD.

Qvortrup, Lars (1996) From teleworking to networking: Definitions and trends. In Paul J. Jackson and Jos M. van der Wielen, eds. *Proceedings, New International Perspectives on Telework: From Telecommuting to the Virtual Organization*, 305-321. July 31 - August 2, Brunel University, West London.

Raley, R. Kelly, Kathleen Mullan Harris, and Ronald R. Rindfuss (2000) The quality and comparability of child care data in U. S. surveys. *Social Science Research* **29**, 356-381. doi:10.1006/ssre.2000.0673, available online at www.idealibrary.com.

- Russell, Cheryl (1996) How many home workers? *American Demographics* **18(5)**, 6.
- Salomon, Ilan (1990) Telematics and personal travel behavior with special emphasis on telecommuting and teleshopping. In H. M. Soekkha, *et al.*, eds. *Telematics - Transportation and Spatial Development*. Utrecht, The Netherlands: VSP, 67-89.
- Salomon, Ilan (1998) Technological change and social forecasting: The case of telecommuting as a travel substitute. *Transportation Research C* **6(1/2)**, 17-45.
- Salomon, Ilan and Meira Salomon (1984) Telecommuting: The employee's perspective. *Technological Forecasting and Social Change* **25**, 15-28.
- Skamris, Mette K. and Bent Flyvbjerg (1997) Inaccuracy of traffic forecasts and cost estimates on large transport projects. *Transport Policy* **4(3)**(July), 141-146.
- Smith, T.W. (1995) Some aspects of measuring education. *Social Science Research* **24**, 215-242.
- Stanek, David M. and Patricia L. Mokhtarian (1998) Developing models of preference for home-based and center-based telecommuting: Findings and forecasts. *Technological Forecasting and Social Change* **57**, 53-74.
- United States Department of Energy (1994) *Energy, Emissions, and Social Consequences of Telecommuting*. Report DOE/PO-0026, Office of Policy, Planning, and Program Evaluation, Washington, DC, June. Available from NTIS, Springfield, VA 22161, (703) 487-4650.
- United States Department of Transportation (2000) *Our Nation's Highways: Selected Facts and Figures – 1998*. Publication No. FHWA-PL-00-014, Office of Highway Policy Information, Federal Highway Administration, Washington, DC. Available at www.fhwa.dot.gov/ohim/onh.htm.
- Urban Transportation Monitor* (1991) Recent survey finds significant telecommuting increase in U. S. over past year. July 19, p. 2.
- Varma, Krishna V., Chaang-Iuan Ho, David M. Stanek, and Patricia L. Mokhtarian (1998) Duration and frequency of telecenter use: Once a telecommuter, always a telecommuter? *Transportation Research C* **6(1/2)**, 47-68.
- Wallace, William A. (1994) *Ethics in Modeling*. Oxford, UK: Elsevier Science (Pergamon).

Table 1: Summary of Data Sources for Number of Telecommuters

Data Source	Year	Count of Home Workers (millions)	Sample Size	Who Measured	Frequency Threshold	Nature of Arrangement	Form of Employment
US Census	1980	2.2 (2.3% of total emp.)	one in six US households (HHs)	all workers \geq age 16	most of previous week	any	salaried and self-employed
	1990	3.4 (3% of total emp.)					
	2000	3% of total emp.					
	1997 SIPP	9.3 (7% of total emp.)	32,925 interviews	civilian non-institutionalized population \geq age 15	worked <i>only</i> at home \geq one day in a typical wk. of previous mo.	any	salaried (5.0M) and self-employed (4.2M)
American Housing Survey	1995	4.8	61,000 dwelling units	HH members \geq age 16	\geq one day the previous wk. instead of commuting		
	1997	5.7		“	“		5.5M worked at home at least 1 hr. that week on a wage/salary job; 2.7M at least 1 hr. that week self-employed
	1999	5.6		“	“		5.2M worked at home at least 1 hr. that week on a wage/salary job; 2.6M at least 1 hr. that week self-employed
Current Population Survey	1991	1.9	~60,000 HHs	non-farm workers \geq age 16	none (30% worked at home \geq 8 hrs/wk)	any	wage and salary
	1997	3.6	~50,000 HHs	“		formal	wage and salary workers, doing some paid work at home for primary job
	2001	3.4	~60,000 HHs	“	\geq once/week	formal	wage and salary workers, doing some paid work at home for primary job
Market Research Firms: LINK Res.	1988	2.2			none		company employees
LINK Res.	1989	3.0			none		salaried employees
LINK Res.	1990	4.0	2,500 HHs		none		company employees
LINK Resources	1991	5.5	2,500 HHs, 176 tele-commuters	all occupations (assumed)	none		company employees

Table 1 (continued)

Data Source	Year	Count of Home Workers (millions)	Sample Size	Who Measured	Frequency Threshold	Nature of Arrangement	Form of Employment
LINK Resources	1992	6.6	2,500 HHs	all occupations (assumed)	none	formal (3.1M), informal (3.5M)	company employees, including “conventional” (4.2M) and “contract-based” (2.4M)
LINK Resources	1993	7.3	2,500 HHs		none		“pure corporate telecommuters” (5.12M) plus contract workers
FIND/SVP	1994	9.1	2,000 HHs		≥ one day/month		corporate (6.6M) and contract workers (2.6M)
FIND/SVP	1995	8.5	1,200 HHs		≥ one day/month		conventional employees (5.4M) and contract workers (3.1M)
FIND/SVP	1996	9.7					conventional employees (6.5M) and contract workers (3.2M)
FIND/SVP	1997	11.1	2,000 HHs		≥ one day/month		conventional employees (7.7M) and contract workers (3.4M)
Cyber Dialogue	1998	15.7	2,000 people ≥age 18	all occupations (assumed)	≥ one day/month	NR	full-time employees (7.4M), part-time emps. (4.3M), and contract workers (4.0M)
Cyber Dialogue	2000	16.3		all occupations (assumed)	“	NR	
Telework America	1999	19.6	2,711 surveys; 247 teleworkers	≥ age 18, head of HH, all occupations	“		employees (78%) and independent contractors (22%)
	2000	10.3	1,877 HHs	≥ age 18, all occupations (assumed), regularly employed home-based teleworkers	“		emps. (8.3M) and contract workers (2.0M)
	2001	18.5	1,170 HHs				“employees” (salaried, contract, and self-employed not distinguished)

Notes for Table 1 (blanks in main table mean no information available)

Data Source	Year	Information Sources	Notes
US Census	1980	Deming (1994)	
	1990	Deming (1994)	
	2000	<i>USA Today</i> , 8/6/2001	
	1997	Kuenzi and Reschovsky (2001); personal communication of Earl Letourneau, earl.j.letourneau@census.gov , to the first author, 3/6/2002	Survey of Income and Program Participation (SIPP). Sample size obtained from Letourneau. The breakdown by form of employment was calculated from Table 3 of Kuenzi and Reschovsky, where “not self-employed” is assumed to mean “salaried”. According to Letourneau, the self-employed category does not include contract workers, and so they are assumed to be included under salaried. The 1995 SIPP identified 10.9M home-workers, but the 1997 survey focused more clearly on work at home for the primary job, and so the two sets of numbers may not be directly comparable.
American Housing Survey	1995	Keil (2000), Pratt (1997)	
	1997	Keil (2000)	
	1999	Pratt (2002)	
Current Population Survey	1991	Deming (1994)	
	1997	Dannhauser (1999), Mariani (2000), ftp://ftp.bls.gov/pub/news.release/History/home.y.031198.news , accessed 8/23/2002	Figure reported is “the number of wage-and-salary employees who said they did some telecommuting from home [for their primary job] and got paid for it” (Dannhauser, p. 53).
	2001	http://www.bls.gov/news.release/homey.nr0.htm , accessed 7/30/2002	“At least once a week” is referred to as “usually”. Question wording: “Do you have a formal arrangement with your employer to be paid for the work you do at home, or were you just taking work home from the job? 1. Paid 2. Taking work home”
Market Research Firms: LINK Res.	1988	Braus (1993), “1991 Telecommuting Data from LINK Resources Corporation” (June 1991)	
LINK Resources	1989	Gordon (1990), “1991 Telecommuting Data from LINK Resources Corporation” (June 1991)	Telecommuters defined as “salaried employees doing work at home during normal business hours”.
LINK Resources	1990	Braus (1993), Gordon (1990), “1991 Telecommuting Data from LINK Resources Corporation” (June 1991)	Telecommuters defined as “salaried employees doing work at home during normal business hours”. 3.6M in 1990 source changed to “4.0 million” in 1991 source.

Notes for Table 1 (continued)

Data Source	Year	Information Sources	Notes
LINK Resources	1991	Gordon (1991), <i>Urban Transportation Monitor</i> (1991), undated press release from LINK Resources received 7/15/1991, personal communication from T. Miller to P. L. Mokhtarian, 7/15/1991	Telecommuters defined as “company employees who work at home part- or full-time during normal business hours”. Press release indicates 43% of telecommuters are in professional and executive occupations; “nearly one-fourth are in a variety of manual and low-tech jobs”.
LINK Resources	1992	LINK Resources “1992 Home Office Fact Sheet”; personal communication from Thomas Miller to S. L. Handy, 3/8/93	Telecommuters defined as “company employees who work from home part- or full-time during normal business hours”. Includes “contract-based” workers as well as “conventional employees”. Of the 4.2M conventional employees, 1.83M moonlight and 2.36M do not.
LINK Resources	1993	Gordon (1993a, c); USDOT (2000)	Gordon (1993a) reported 7.5M; adjusted to 7.6M in Gordon (1993b); reported as 7.3M in USDOT (2000, p. 6).
FIND/SVP	1994	FIND/SVP (1995), Russell (1996), presentation made by Thomas Miller to Telecommute '94 conference, San Francisco, Oct. 25-27.	Sample size mentioned in 12/7/95 audioconference cited below.
FIND/SVP	1995	July 21, 1997 press release on etrg.findsvp.com/prls/pr97/telecomm.html , accessed 7/21/97; audioconference presentation of T. Miller to Telecommuting Advisory Council, 12/7/95	Telecommuters defined as those working for an outside employer but working at home during normal business hours at least one day/month. Commented that the frequency screen of one day/month was added in the last two years, but that the rest of the definition has been consistent throughout. Number of telecommuters placed at 8.1M in 12/7/95 audioconference; later updated to 8.5M.
FIND/SVP	1996	USDOT (2000); July 21, 1997 press release on etrg.findsvp.com/prls/pr97/telecomm.html , accessed 7/21/97	Number of telecommuters in 1996 originally placed at 8.7M (USDOT, 2000). In 1997, this number was revised to 9.7M. A later FIND/SVP document reporting on the 11.1M telecommuters estimated for 1997 (etrg.findsvp.com/prls/pr97/telecom.html , accessed 1/20/98) commented, “Only 8.5 million telecommuters were identified in the company's last major survey on the trend two years ago” – apparently downplaying the 1996 number.
FIND/SVP	1997	July 21, 1997 press release on etrg.findsvp.com/prls/pr97/telecomm.html , accessed 7/21/97; Gordon (1997); Gordon (1998)	Screening question: “Do you work at home during normal business hours one or more days a month?” Miller states same definition used in past FIND/SVP surveys. In Gordon (1998), Miller indicates that applying 1998 definitions to 1997 would yield a total of 10.5M telecommuters (6.9M full-time employees, 3.6M contract workers) rather than the 11.1M published number.
Cyber Dialogue	1998	Oct. 28, 1998 news release on www.cyberdialogue.com/news/releases/1998/10-28-sb-telecommuting.html , accessed July 19, 2001; Gordon (1998)	Exact definition of telecommuting used: “working at home for an outside employer during normal business hours a minimum of one day/month or more”.

Notes for Table 1 (continued)

Data Source	Year	Information Sources	Notes
Cyber Dialogue	2000	Pratt (2002)	Cites Miller (unpublished).
Telework America	1999	Pratt (1999) (survey conducted by Joanne Pratt in association with Thomas Miller), and personal communication with first author, 8/16/2002	Pratt (1999): “In this study, teleworkers, also called telecommuters, are defined overall as employees or independent contractors who work at least one day per month at home during normal business hours.” Personal communication: Includes multiple job holders.
	2000	www.telecommute.org/twa2000/research_results_summary.shtml , accessed 12/8/2000 (survey conducted by Jack Nilles)	Number calculated from reported total of 16.5M “regularly employed teleworkers” x 0.93 (reported proportion who are home-based or home- and center-based) x [0.54 (reported proportion who are employees) + 0.13 (reported proportion who are contract workers)]. Source comments that the 2000 TWA survey differs from the 1999 one in focusing only on “regularly employed” teleworkers, whereas the 1999 study included “occasionally employed” people. However, it goes on to say that “if the growth rate found in the year 2000 study were applicable to the total number of teleworkers found in the 1999 study, that would imply a total of 23.6 million teleworkers nationwide.” A later document posted to the ITAC web site (“Telecommuting (or Telework): Alive and Well or Fading Away?”, www.telecommute.org/aboutitac/alive.shtm , accessed 8/20/2001) refers to the 23.6M figure, without reference to 16.5M. A cynical view of this information suggests that the sponsors initially wanted to apply a more rigorous (and therefore presumably considered more appropriate) definition in the 2000 study, but then did not want to publicize a result that was lower than in the 1999 study. If true, this is a classic example of the results (as publicized) being influenced by external considerations.
	2001	www.telecommute.org/twa/twa2001/newsrelease.htm (survey conducted by D. Davis and K. Polonko of Old Dominion University); Pratt, personal communication to first author (3/8/2002). The full report on the 2001 survey costs \$499; the information provided here is based on the freely-available sources noted	Reported total was 28.8M, which includes work done “on the road, in telework centers or in satellite offices.” Table entry of 18.5M calculated from 28.8M x [0.217 (reported proportion working {only} from home) + 0.424 (reported proportion combining working at home with some other form of teleworking)]. However, since distinctions between forms of employment are not mentioned, the numbers probably include all teleworkers, not just salaried employees and contract workers. If salaried employees and contract workers comprised the same percentage of teleworkers in 2001 as they did in the 2000 TWA survey (67%), the relevant number of telecommuters in 2001 is 18.5 x 0.67 = 12.4 M. Pratt indicates that the 2001 number comparable to the 16.5M reported for 2000 is 15.8M. If 15.8M is deflated by the same factor of 0.62 used in the note above for the year 2000 (representing the proportion of the total who work from home and are salaried employees or contract workers), the result is 9.8M.

Table 2: Distribution of Days Worked at Home

Number (%) of workers working at home	SIPP (1997) ^{1,3} (worked only at home at least one day of a typical week in the previous month)			American Housing Survey ^{2,3} (worked at home at least one day last week instead of traveling to work)			
	<i>Mixed workers</i>	<i>Home workers</i>	<i>Total</i>	<i>1995 (web)</i>	<i>1995 (Keil)</i>	<i>1997 (web and Keil)</i>	<i>1999 (web)</i>
Days/week worked at home ↓							
1	1.725 (60)	0.511 (8)	2.236 (24.1)	2.152 (44.5)	1.234 (25.7)	1.465 (25.7)	1.469 (26.0)
2	0.604 (21)	0.192 (3)	0.795 (8.6)		1.042 (21.7)	0.988 (17.4)	1.014 (18.0)
3	0.201 (7)	0.319 (5)	0.521 (5.6)	0.854 (17.6)	0.586 (12.2)	0.647 (11.4)	0.652 (11.6)
4	0.115 (4)	0.192 (3)	0.307 (3.3)		0.322 (6.7)	0.304 (5.3)	0.283 (5.0)
5	0.201 (7)	3.576 (56)	3.777 (40.8)	0.917 (19.0)	0.763 (15.9)	1.508 (26.5)	1.408 (25.0)
6	0.0288 (1)	0.639 (10)	0.667 (7.2)		0.293 (6.1)	0.275 (4.8)	0.251 (4.5)
7	0 (0)	0.958 (15)	0.958 (10.3)		0.562 (11.7)	0.507 (8.9)	0.561 (9.9)
Not reported	–	–	–	0.916 (18.9)	–	–	–
Total population (millions)	2.875 (100)	6.385 (100)	9.260 (100)	4.839 (100.0)	4.8 (100.0)	5.694 (100.0)	5.639 (100.0)
Average days/week worked at home	1.8	4.9	3.9	–	3.3	3.4	3.4

¹ SIPP: Source is Kuenzi and Reschovsky (2001). “Home” workers are those who worked only at home, while “mixed” workers worked at least one full day at home in the preceding week, but also worked elsewhere. Numbers are calculated from the percentages given in Figure 1 of the source.

² AHS: Web source for 1995: www.census.gov/hhes/www.ahs.html, “National Data”, “Publications”, “1995 Supplement”. Figure 2 of Keil (2000) displays a bar chart showing the distribution of days worked at home in 1995 and 1997. The 1995 Keil numbers and percentages in the table above are approximations obtained from visual inspection of Figure 2, based on the reported total of 4.8 million. He apparently redistributed most of the 18.9% of people in the “not reported” category of the web data into the 5, 6, and 7 days per week categories. The 1997 and 1999 distributions were obtained by queries of the respective data sets on the Census web site at ferret.bls.census.gov/cgi-bin/ferret, accessed 8/6/2002. The 1997 distribution obtained in this way matches the bar chart in Figure 2 of Keil.

³ All columns include self-employed as well as salaried workers; see further discussion in the text.

ENDNOTES

¹ In fairness, in the same article (p. 38) Drucker commented that “Contrary to what futurists predicted 25 years ago, the trend is not toward individuals working in their homes.” His focus was on the decentralization of office work from high-density downtown business districts. However, “sound bites” such as “commuting to office work is obsolete”, coming from an acknowledged expert, lodge in the public consciousness and have often been cited in support of the telecommuting phenomenon.

² Conversely, once the “new trend” becomes commonplace, they are likely to overreport evidence of a backlash or retrenchment or yet a different trend, as indicated by several recent articles suggesting that telecommuting “isn’t working” (Armour, 2001; Garber, 2001).

³ Pratt (1997) discusses 19 large-sample surveys that measure home-based work in some form. In view of the context in which the present study was undertaken, we focused on surveys offering population-wide estimates (rather than focusing on a specific segment of the population), available for multiple years, with the ability to distinguish salaried telecommuters and contract workers from home-based businesses.

⁴ www.sipp.census.gov/sipp/sippov98.htm, accessed February 17, 2002.

⁵ As indicated in the notes to Table 1, this number may actually be 10.5 million in terms of consistency with 1998 definitions.

⁶ The source cited cautions that the 1997 and 2001 numbers cannot be directly compared, due to differences in question wording.

⁷ I.e., “every day they worked, they reported working at home” (Kuenzi and Reschovsky, 2001).

⁸ There are a total of 5.036 M = 1.841 M (mixed) + 3.195 M (home) “non-self-employed” or salaried workers, according to Table 3 of Kuenzi and Reschovsky (2001). $1.8 (1.841/5.036) + 4.9 (3.195/5.036) = 3.8$.