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The Future of Telecommuting

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Abstract

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THE FUTURE OF TELECOMMUTING

Susan L Handy and Patricia L Mokhtarian

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Telecommuting, loosely defined as the substitution of working at home, or at an office close to home, for commuting to a usual work site,¹ promises something for almost everyone. Workers, faced with increasing household responsibilities, see telecommuting as a way to reduce stress and increase their free time. Employers are beginning to see telecommuting as a way to reduce costs and as a new kind of benefit they can provide to employees. Transportation planners see telecommuting as a promising way to combat increasing congestion, increasing energy use, and declining air quality. Communities may see telecommuting as a potential economic development strategy. Telecommunications companies, computer and peripheral manufacturers, and software developers see telecommuting as a promising new market for their products. Although some of these visions of telecommuting may prove overly optimistic, there are certainly many sound

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environmental, social and economic reasons for the increasing attention to telecommuting.

But while it is clear that interest in telecommuting is growing, it is not clear how quickly the number of workers who actually telecommute is growing, nor is it entirely clear even how many workers currently telecommute.² Data on current levels of telecommuting are typically based on small and often non-representative samples, and a lack of consensus on how telecommuting and teleworking are defined can lead to widely disparate estimates and forecasts.³ This lack of consensus on the meaning of 'teleworker' may partly explain competing estimates of current levels of teleworking in Europe. A study conducted by the respected research firm Empirica, and purportedly based on a representative sample, produced an estimate that there are currently 1.25 million teleworkers in the EU, 0.8% of the labour force.⁴ Another telecommuting expert challenges this estimate as far too low, citing evidence suggesting that the total is about 4.6 million, or 2.8% of the labour force—three times higher than the Empirica estimate.⁵

Forecasting from such a wobbly foundation is challenging, to say the least. The US Department of Transportation⁶ forecast that 5.2% to 10.4% of the labour force would be telecommuting in 2002—a 100% difference between the low forecast and the high forecast. Currently, workers who telecommute do so an average of 1–2 days per week, a part-time basis; the US DOT report forecast an increase to 3–4 days per week, approaching a full-time basis. Together the numbers produce forecasts ranging from 1.0% (if telecommuting continues on a part-time basis) to 8.3% of workers telecommuting on a given day in 2002—a wide range for a relatively short-term forecast. Even with better data on current levels of telecommuting, however, forecasting trends from a relatively small base would be difficult.

An evaluation of the future of telecommuting must thus begin with an evaluation of the forces that will determine that future. The future of telecommuting depends first on the degree to which workers have the opportunity to telecommute; this opportunity in turn depends on the nature of the job, the state of technology, and the willingness of employers. These might be characterized as supply-side issues. The future of telecommuting also depends on whether, given the opportunity to telecommute, workers will choose to telecommute; the individual worker's choice depends on his or her characteristics and concerns—in other words, demand-side issues.

The goal of this article is to assess qualitatively the future of telecommuting by outlining important trends in these factors and evaluating the implications of these trends. The picture that emerges is favourable—trends seem to be leading in the direction of increased telecommuting—but just how favourable remains to be seen.

The opportunity to telecommute: supply-side issues

Workers can only choose to telecommute if they are given the opportunity to telecommute. One basic factor is simply the nature of the job: certain jobs are conducive to telecommuting and other jobs are not. Data input and computer programming are classic examples of 'telecommutable' jobs. More generally, 'information workers'—workers who work with information more than people or things—are considered the primary candidates for telecommuting. Jobs that demand a physical presence—waiters, hairdressers, for example—are not. However, while some jobs are clearly not candidates for telecommuting, many jobs involve at least some tasks that,

barring other constraints, could be performed at home rather than at the usual work site. In other words, jobs are not simply one or the other but fall along a spectrum, from not at all, to partially, to fully telecommutable, with most jobs falling somewhere between the extremes.

Nevertheless, information workers are more likely to have more tasks that could be performed away from the office. A first trend to consider, then, is the growth in information workers. Currently, information workers are generally estimated as being 50% or more of the labour force. The US DOT report⁷ defined information workers as 'individuals whose primary economic activity involves the creation, processing, manipulation or distribution of information', and predicted that they will increase from 56% of the workforce in 1992 to 59% of the workforce in 2002. However, labour force data are usually broken down into relatively crude occupational classifications. Some occupations may be primarily information oriented and others primarily not, but few are entirely one or the other. This limits the analysis to rather rough estimates of the number or share of information workers. Handy and Mokhtarian⁸, for example, estimated that 'telecommuting-conducive' occupations⁹ grew from 53% of the US labour force in 1980 to 57% in 1990. In any event, it is probable that information workers—or potential telecommuters—represent a significant, if not majority, share of all workers and that this share is increasing.

Not all potential telecommuters, however, will actually have the opportunity to telecommute. One current limitation is technology, both its capabilities and its cost; as its capabilities continue to increase and costs continue to decrease, technology will enable more workers to telecommute. A second limitation is the unwillingness of many employers to allow their employees to telecommute. However, significant trends in the business world related to trends in technology—the rise of a global economy and changes in corporate climate—suggest that employers may become more comfortable with telecommuting and may increasingly recognize its potential benefits. As these trends continue, more workers should have the opportunity to telecommute.

Technology

Although a number of factors will influence the future of telecommuting, technology may be the most important, because of its direct link to telecommuting and because it underlies trends in many other factors also affecting telecommuting. Technology is related to telecommuting in two (not always distinct) ways: it provides the means by which telecommuters communicate with and stay linked to the office, and it may provide the means by which telecommuters get their work done while at home. Technology has always been important in fulfilling the first function and is increasingly fulfilling the second function as well.

Telecommuting, as currently practised, most often involves very simple and widely available telecommunications technology, primarily the telephone. Concludes one telecommuting expert: 'the most important single piece of technology is still the basic phone'.¹⁰ Answering machines and faxes help to improve the link between home and office and are also widely used; 15% of telecommuters had a fax machine at home in 1992.¹¹ More sophisticated communication services, such as call waiting, call forwarding, three-way calling, speed calling, and caller ID, will also make it easier for telecommuters to be away from the office. In 1992, 30% of telecommuters were linked to

the office by modem—a significant share of the 52% of workers with computers at home.¹² A modem hook-up provides another communication link, giving telecommuters electronic mail and data-transfer capability. The deployment of a nationwide broadband network should make telecommuting even easier in the future, by making these links more widely available and by increasing their speed and quality.

The technology used depends on the nature of the work that is done at home. Much of the work that telecommuters do at home does not require equipment beyond what is used to keep in touch with the office. Reading, thinking and paperwork are often cited as tasks that telecommuters take home. But workers are increasingly using computers in the office. This suggests two things: first, that many workers will not be able to telecommute without a computer at home, and second, that increased availability of certain technologies, such as computers, and improvements in technology, such as the networks that link computers, will expand the set of work tasks that can be done at home. Thus, advances in telecommunications technology will enable increased telecommuting and may change the nature of telecommuting, in terms of the type of work and the type of workers involved and the frequency with which they telecommute.

Cost is a critical issue, however, in that it determines how widely available the new technologies will be. If technological improvements are not affordable to the employer or the employee, they will have little impact on telecommuting. For the most part, the cost of telecommunications and computer equipment has been declining, but telecommunications charges, which are based on volume, have not.¹³ Who will pay these costs—the employer or the employee?—is also raised as an important issue. Employers may be reluctant to pay for computing equipment for employees who telecommute only one or two days per week, since they are already supplying such equipment in the office. If costs decline, this issue will have less of an impact. In the meantime, if the employer chooses not to pay for needed equipment, the employee may not have the choice to telecommute, particularly if the employee is on the low end of the wage scale.

Computer and peripheral manufacturers and software developers are now developing products specifically targeted to home workers. Apple Computer and Dell Computer in 1992 introduced easy to use, low-cost computers aimed at the 'small-office, home office' or 'SoHo' market.¹⁴ Products such as Shiva's Lan Rover, a remote network server, facilitates telecommuting by allowing multiple users to dial in and connect to a central network over standard phone lines, and 'then work exactly as if they were in the office'.¹⁵ This technology also improves network security, another issue that may affect telecommuting. Other security technologies are also being developed, including 'tokens', a small circuit card which plugs into the telecommuter's computer and which must be read by the central computer before access is allowed.¹⁶ Not surprisingly, the industry is pushing a high-technology definition of telecommuting. One industry journal describes the 'simple needs' of an employee who works at home one or two days per week: 'a PC and fax, a remote E-mail package, and a second phone line for faxes and E-mail'.¹⁷

The global economy

Technology has been an important facilitator of the globalization of the economy: 'the movement to global free trade is being driven by an alliance between telecommunications and economics that permits you to deal with a business associate in a Tokyo office from a

mountain perch in Colorado as if you were across the table . . .'.¹⁸ The emergence of a globally integrated economy, including the growth of multinational corporations, was dependent on the development of, and has increased the need for, a way to bypass the time differences and overcome the spatial separation between businesses located in different parts of the world. Technologies such as electronic mail, voicemail and fax have been instrumental in this trend.

A related trend is towards offshore work, where US companies shift a portion of their business to locations outside the USA. Telecommunications is often the facilitator: 'the increasing capacity, speed and reliability of worldwide communications networks broaden the possibilities for American production jobs to shift offshore, take advantage of lower cost Third World labour, and still tie into American capital and consumer markets'.¹⁹ Lower-skill data entry is particularly likely to move offshore, but companies may also locate higher skill work elsewhere. For example, software development centres for a number of US companies have been located in Bangalore, India.²⁰ This trend represents an extreme form of telecommuting.

Although some argue that rural areas in the US will be the losers to offshore areas,²¹ it is also possible that some rural areas will use telecommunications infrastructure to compete successfully. At least a handful of rural communities are already deploying telecommunications in their economic development strategies. Oberlin, Kansas, for example, is building a telecommunications centre into its town centre in an effort, not only to provide local residents with jobs, and thus stem the migration from town to city,²² but also to attract a modest number of professional workers to the town.²³ Similar activities have met with some success in small towns throughout Nebraska.²⁴ Steamboat Springs, Colorado, looks at telecommuting as 'a type of economic development that fits our community', and is actively trying to lure professionals who work at home, dubbed 'lone eagles'.²⁵ Rather than globalization, these examples represent increased nationalization of the high-technology economy.

These trends have important implications for telecommuting. First, the use of telecommunications technologies to coordinate globally—and even nationally—dispersed employees will increase, thus working to decrease the cost of the technologies and to increase the familiarity and level of comfort with them. These same technologies can be used to coordinate locally dispersed employees. Second, employers must be increasingly comfortable with relying on workers who are globally dispersed. This may increase their level of comfort with workers who are locally dispersed.

Corporate climate

The business environment is changing in ways that may help to support telecommuting. One obvious concern is with costs. As *Newsweek*²⁶ put it, 'management dogma everywhere is to keep costs to a minimum', the result being that 'if bigness was yesterday's corporate creed, today's is flexibility'. Although businesses may recognize the social and environmental benefits of telecommuting, the potential of telecommuting to reduce costs and even increase productivity is the key to increased interest in telecommuting.

One way in which savings are achieved is by keeping only the most vital operations under the corporate roof and handling everything else by a network of joint ventures, spin-offs, subcontractors and temporary workers.²⁷ Increasingly, costs are being controlled by eliminating employees with full benefits and hiring temporary or contingent

workers who are paid less, who are not given benefits, and who are sometimes not even given an office, meaning that they must work at home. Dillon²⁸ estimated that this 'just-in-time' labour force comprised as much as 25% of employment in California. Increases in part-time employment are also a result of the drive to cut labour costs.²⁹ The current labour market, with the threat, or at least the perceived threat, of lay-offs among highly educated and highly skilled workers, as well as low-skill workers, seems to be a 'buyers' market, wherein potential employees are happy to accept whatever benefits and work conditions the employer is willing to offer.

One of the work alternatives to which employers are beginning to turn is 'hoteling'. Workers who are frequently out of the office, including sales representatives, consultants and telecommuters, are assigned office space on an as-needed basis; the 'drop-in office' is used by many different employees in turn. Workers can call in to reserve a space before they arrive at the office, hence the analogy to hotels. Early adopters of this concept, including Xerox, AT&T, Ernst and Young, Dun and Bradstreet and Kodak, report real or expected savings in the millions of dollars.³³ This practice clearly supports telecommuting, with home and/or a centre serving as alternate work locations when appropriate. Telecentres, in particular, may find a niche, as hoteling filters down to smaller organizations for which reserving hoteling space in their own facilities may not be practical, but which can use multiemployer telecentres to reduce their permanently owned or leased space needs.

However, hoteling is not an unmitigated good. For employers, there is an institutional, financial and temporal cost involved in setting up such a programme, involving as it does a major restructuring of organizational culture and physical space. For employees, the practice may be undesirable for some (particularly when mandatory), promoting a sense of 'officelessness' that may affect morale, productivity and loyalty.³¹ For the economy, there may be wholesale near-term shifts in the level and spatial distribution of the demand for office space, further weakening already soft real estate markets in business districts of metropolitan areas.

Links between the use of a contingent workforce and telecommunications technology also have important implications. Telecommunications technology is facilitating the creation of 'armies of "intellectual mercenaries"', that is, consultants who make their living doing short-term projects for companies via the computer network.³² For example, Johnson and Johnson has a network of consultants 'on tap' to work on particular projects as they arise. These consultants are located throughout the USA, and even in Europe and Japan.³³ AT&T's 'language line services' provides a 24-hour telephone-based language interpretation. The service is based in Monterey, but the contract workforce is located from Maine to Hawaii. A service that offers transcriptions of TV shows also makes use of contract workers located throughout the country.³⁴ As companies become accustomed to a dispersed and relatively autonomous workforce, they may become more comfortable with telecommuting.

Although making greater use of temporary and contingent workers, corporations are increasingly concerned with retaining valued employees and fostering loyalty among their important workers. One analyst concluded that 'the major challenge of tomorrow may not lie in balancing employer's needs with workers' skills, but in balancing workers' personal needs with job demands'.³⁵ This is especially apparent in the case of women, for whom child- and elder-care issues are important. This means new and untraditional benefits as well as flexible working arrangements, which are particularly attractive because they cost

relatively little. Indeed, work-at-home arrangements have been recommended as a way organizations can promote work/family balance.³⁶ A number of managers interviewed by *The New York Times* believed that work-at-home arrangements allowed them to retain and recruit valuable employees.³⁷ Telecommuting may provide a way to help workers who are on maternity or sick leave to stay active on a voluntary basis, as well as to retain workers who move out of the area for family reasons. It may also allow companies to hire workers they would otherwise be unable to—highly skilled workers who live too far away to commute and workers with disabilities, particularly mobility limitations. A number of telecommuting programmes have been initiated in the USA specifically to serve the needs of employees with disabilities.³⁸ Businesses are increasingly recognizing these benefits: a survey of 463 businesses of all sizes, from a variety of industries, showed that only 15% of the businesses currently offered telecommuting but that 52% planned to offer the option by 2000.³⁹

This flexibility may not apply to everyone, however. The emergence of a two-tiered workforce has implications for telecommuting, in that the possibility of telecommuting and the experience of telecommuting may differ for each.⁴⁰ Professional workers, for example, generally have more autonomy and more control over their work; their work is non-routine and they are paid for their knowledge and judgment. Companies may be comfortable providing such workers with the option to telecommute. Support staff and data entry workers, on the other hand, have little autonomy and are often closely monitored by supervisors; the work often involves routine tasks and frequent face-to-face interaction, and may be subject to repetitive measures of output. For many of these workers, telecommuting may not be feasible or desirable. Unions have sometimes opposed telecommuting arrangements for their members, even when the company has been willing. The concern has been that workers will be even more closely monitored, forced to increase productivity, and have benefits taken away. Little evidence has emerged to support these fears, however, and even unions now seem open to considering the potential benefits of telecommuting.⁴¹

At the same time, employers fear that telecommuting will decrease productivity. Companies that have tried telecommuting, however, invariably report overall increases in productivity for workers at all levels. For example, government employees in Denver who telecommuted were at least as productive at home as in the office. Says the manager of this telecommuting programme: 'We've found that, rather than slacking off, they're more productive because they are working right there at their [home computers]'.⁴² An Analytica survey of 74 organizations employing teleworkers found that '[t]he attribute on which there is the greatest agreement that teleworkers are superior is productivity'.⁴³ 47% of the sample felt that teleworkers had higher productivity, and an additional 20% felt that it was comparable to their in-office counterparts. More reports like these will encourage employers to consider telecommuting but, as long as the perception that telecommuting reduces productivity persists, employers will widely resist telecommuting.

Not surprisingly, computer and telecommunications companies, who have a vested interest in the future of telecommuting, have established heavily publicized telecommuting programmes for their own employees, in an effort to prove the benefit of telecommuting; AT&T, Bell Atlantic, Pacific Bell, Apple Computer and IBM, for example, have all started up telecommuting programmes in the past few years.

Technology is clearly driving many changes within the corporation. With computer networks, information becomes widely available at all levels of the organization. This

works to increase both decentralization, because lower level employees can know more than before, and centralization, because managers can more easily keep tabs on employees. The result is a shift from a hierarchy to an 'adhocracy'.⁴⁴ Thus, technology may play an indirect, as well as a direct, role in facilitating telecommuting, by increasing the level of trust and flexibility within corporations.

The choice to telecommute: demand-side issues

Although more workers should have the opportunity to telecommute, not all workers who have the opportunity will choose to do so. Partly the choice depends on personality. Some workers do well working on their own with little direct supervision and limited interaction with co-workers; others need a more structured environment or crave a more social setting. The typical experience in telecommuting programmes is that some workers, who enthusiastically enter the programme, end up quitting after a period of time. Nevertheless, telecommuting has many potential benefits for workers, and several lifestyle trends suggest that more and more workers may seek these benefits and even demand the opportunity to telecommute.

Sociodemographic trends

Trends in the sociodemographic characteristics of the workforce mean that more workers will face the sorts of constraints that make the flexibility of telecommuting appealing and sometimes indispensable. In particular, telecommuting may have important benefits for working parents. For example, they may value highly the time savings that telecommuting provides (due to the elimination of the commute trip) because it allows them to increase the limited time they have to spend with their children. Telecommuting might allow a parent to stay at home with a sick child and still work, rather than missing work altogether. It is by now conventional wisdom that telecommuters should not, as a rule, expect to both work and to care for a child at home on a regular basis. However, telecommuting would allow those who have in-home care to spend more time with their children throughout the day and facilitate logistics for those who have out-of-home care.

Households in need of such flexibility have increased as a share of total households in the USA. While the number of married couples with children under the age of 18 in the house has been declining as a share of all households, the percentage of married couples with children that have two wage earners has increased from about half in 1970 to two-thirds in 1990. Single-parent households, which have even greater needs for flexibility, increased from 6% of households in 1970 to 9% in 1990,⁴⁵ and made up 30% of all families with children in 1990.

As of 1990, nearly 60% of women with children under the age of 6 were in the labour force, as were 75% of women with children between the ages of 6 and 17.⁴⁶ Interestingly, about a third of the children of working mothers were cared for in their own home in the late 1980s;⁴⁷ telecommuting for these mothers is not likely to eliminate the need for a second care-giver, but it would enable them to have more frequent contact with their children and be in close proximity in case of emergencies.

The ageing of the population may also increase the demand for telecommuting. Many workers now care for elderly parents and have some of the same needs for flexibility as

parents with young children. As life expectancies increase and as the baby boom population moves into retirement years, households with elder-care responsibilities are likely to increase. In addition, retired workers may choose to continue to participate in the workforce, by consulting and doing contract work out of their home. Work-at-home arrangements may, in fact, enable and encourage retired workers to take on consulting and contract work. The retirement age population as a proportion of the adult population in the USA is expected to grow by 8.2%, from 16.7% in 1990 to 18.0% by 2010.⁴⁸

Time pressures and congestion

Time savings may be increasingly important to all workers, not only those who have responsibility for caring for children or elderly parents. A time-use survey conducted in the late 1980s showed that Americans feel more rushed than ever and that their 'perception of time scarcity' shapes their behaviour.⁴⁹ A desire for more free time may be a strong motivator for telecommuting.

Thus, increasing congestion, and the increase in travel time that results, may also encourage greater telecommuting in the future. Federal Highway Administration data show that, by aggregate measures, congestion has increased significantly in recent years: the percent of peak hour vehicle-miles-travelled on urban interstates that was at volume-to-capacity ratios of 0.8 or greater increased from 41% in 1975 to 69% in 1990.⁵⁰ At the same time, the average commute distance increased from 9.4 miles in 1969 to 11.0 miles in 1990, according to the Nationwide Personal Transportation Survey.⁵¹ In many metropolitan areas, the search for moderately priced housing leads households farther and farther away from the urban centre, and miles beyond suburban employment sites as well. These trends suggest worsening commutes.

On the other hand, the NPTS data show that commute times actually decreased slightly, from 20.4 minutes in 1983 to 19.7 minutes in 1990, on average.⁵² Lave⁵³ has argued that congestion will not get a lot worse in the future, given structural shifts in the demographics of automobile ownership and use. The growth rate of automobile use should now equal the growth rate of the population, since nearly every potential driver now has access to an automobile. Other researchers argue that shifts in residential location compensate for increasing congestion, thus keeping average commute times roughly constant.⁵⁴ If these researchers are right and congestion does not increase dramatically in the future, or at least commute times do not increase, then the role of congestion *per se* as a motivation to telecommute may remain more or less at its current level of importance. However, government policies designed to reduce congestion and improve air quality may themselves stimulate greater telecommuting.⁵⁵

Stress

The crisis in health care, particularly spiralling healthcare costs, may also work to increase telecommuting. The connection is that telecommuting may be hypothesized to reduce stress-related illnesses because it reduces commuting, which can be highly stressful. Studies by Novaco⁵⁶ show that commuting adversely affects blood pressure, tolerance for frustration, short-term memory, occasions of illness, mood, residential satisfaction and job stability. Commuting even affects those who are normally relaxed and easy-going. Telecommuting may also reduce stress-related illnesses more directly. A study of

Westinghouse employees showed that more control at work meant lower levels of stress.⁵⁷ If telecommuting increases the control that workers have, then it may also reduce stress levels. Job stress disability claims increased dramatically in California in the 1980s and were the fastest growing type of disability claim.⁵⁸

On the other hand, it is possible that telecommuting increases stress, at least for some telecommuters. Some telecommuters experience the perception or reality of higher management expectations placed on them than on their in-office counterparts. Also, the home environment may be more demanding and offer less freedom than the work environment, particularly for women and particularly for women with childcare responsibilities.⁵⁹ Female telecommuters have reported greater work pressures than both male telecommuters and female non-telecommuters.⁶⁰ But telecommuters of both genders must struggle with separating home and work responsibilities. Other household members may create stress for telecommuters by interfering with work, if they are also at home, or by pressuring the telecommuter to take on more of the household chores, if they are not. Telecommuters may have difficulty separating work and home; 'workaholics', in particular, may find it difficult to call it quits for the day.⁶¹ In addition, it is sometimes suggested that commuting helps to *relieve* stress, because it provides many workers with the only time they have entirely to themselves and serves as a buffer between work and home.⁶² Thus, telecommuting may have the potential to relieve stress for many, but probably not for all.

Research needs

This discussion has been unavoidably qualitative and at times ambiguous: the current understanding of telecommuting is simply too limited for a more conclusive analysis of the impact of these trends. There is a very clear need for additional research on telecommuting in a variety of areas—data collection, telecommuting adoption and forecasting.

Data collection is a primary need. The available data on current levels of telecommuting and the characteristics of current telecommuters are inadequate. A large part of the problem is that different definitions of telecommuting and different survey methods have been used in every data collection effort. Because telecommuters are a relatively small segment of the population, surveys designed to identify and question telecommuters will have to be relatively large-scale in order to generate a significantly large sample of telecommuters. If the survey itself is short and focused, a large-scale survey may be feasible and affordable, even if the cost of searching for telecommuters is relatively high. At a minimum, efforts need to be made to coordinate the treatment of telecommuting in relevant surveys that are conducted by different agencies—and to ensure that telecommuting is addressed at all. On a positive note, it appears that carefully written questions regarding paid work at home will be included in the next American Housing Survey, a large-sample, nationwide effort conducted every few years.⁶³

More in-depth research on the individual choice to telecommute is also needed. The overall level of telecommuting on the sum of individual choices with respect to telecommuting, and the macro-scale forces described here must be considered within the context of the larger set of factors that affect individual choice. A number of extensive efforts are, in fact, under way to understand the choice to telecommute and empirically to model that choice.⁶⁴ Further research on the managerial and organizational adoption of telecommuting is also needed, particularly on key barriers such as the management of

remote staff and the performance evaluation of white-collar professionals. The results of such studies will help planners identify policies that will support telecommuting and may provide a basis for the development of forecasting models.

In addition, case-studies of telecommuting programmes are needed. Although a number of such studies have been completed,⁶⁵ the methods used to evaluate the impacts of the programmes have not always been rigorous. Additional studies, using sound research methods, are necessary to confirm and clarify the findings of the existing studies with respect to the full range of potential impacts of telecommuting. In particular, the long-term patterns and effects of telecommuting in a variety of areas—the individual, the family, the community, transportation, land use—need to be monitored, through panel surveys of telecommuters and control-group workers and through other means.

With better data on telecommuting and trends, and a better understanding of the individual choice to telecommute, methods for forecasting future levels of telecommuting can be developed.⁶⁶ The simplest forecasting methods, time-series projections, do not directly account for the effect of the trends described in this article. Directly accounting for these trends will require much more sophisticated forecasting methods, as well as a much better understanding of the trends and their implications for telecommuting. Forecasts of telecommuting are important in planning for infrastructure needs and evaluating the effectiveness of alternative air quality policies.

In all these research efforts, it is important not to ignore non-home-based telecommuting, home-based workers who are not telecommuters, and other forms of teleworking. An extensive research project on telecentre-based telecommuting is under way at the University of California at Davis. The goal is to understand the potential role of such centres and to evaluate their impacts on travel. Although there are some hypothesized advantages of telecentres over home-based work for both employees and employers,⁶⁷ their viability remains unproven to date.⁶⁸ Efforts should also be made to collect data on contract or contingent workers and on home-based businesses, which represent additional sources of home-workers who would not be defined as telecommuters. Trends in both types certainly reflect changes in work styles, and may also result in changes in travel patterns. The same is true of mobile workers. A recent report of the US Congressional Office of Technology Assessment⁶⁹ points to the lack of accurate data on the extent of this phenomenon and raises a number of important issues deserving of further study. In particular, concerns about a potential loss of privacy and complete permeability of the boundary between work and non-work realms are well founded, and apply to a lesser extent to conventional telecommuting as well.

Conclusions

The future of telecommuting depends on the willingness and desire of employers and employees. Trends in a variety of factors suggest that the willingness and desire on the part of both groups will increase, although telecommuting is clearly not for everyone. To begin with, it is only appropriate for certain types of businesses and certain types of occupations. Second, not every business that could in theory allow its employees to telecommute will choose to do so; and not every worker who has the opportunity to telecommute will choose to do so at all times or, in some cases, at any time. The future of telecommuting also depends on government policies to facilitate and encourage telecommuting, by

providing education, incentives and successful examples, and by eliminating barriers. Such policies may directly and indirectly increase the willingness and desire of employers and employees. For the most part, existing policies tend to support telecommuting, although some indirectly hinder it. In any event, government could do substantially more to encourage telecommuting.⁷⁰

Thus, although we cannot say how quickly telecommuting will increase or to what ultimate level, we may be reasonably certain that telecommuting will increase. We can be much less certain about the nature of telecommuting in the future. One issue is the frequency of telecommuting, more specifically, whether workers will telecommute occasionally, all the time, or something in between. A related issue is the duration of telecommuting for a given individual: is telecommuting sustained over a period of several months or years; is it an on-again, off-again alternative for many? A third issue is where telecommuters will work, whether at home or at a telecentre. A fourth issue is the use of technology, ie the extent to which telecommuting will involve sophisticated computer and telecommunications technologies. A fifth issue is what types of workers will choose to telecommute and whether it will be an option for management-level workers, lower-wage workers, or both. But the distribution of telecommuters, by the nature of their telecommuting, will have important implications for the social, economic, transportation and environmental impacts of telecommuting.

Notes and references

1. Telecommuting is defined here as the substitution of working at home for commuting to a usual work site, or the substitution of commuting to a telecentre, for commuting to the more distant usual work site. (See M N Bagley, J S Mannerling and P L Mokhtarian, *Telecommuting Centers and Related Concepts: A Review of Practice* (Institute of Transportation Studies, University of California at Davis, Research Report No UCD-ITS-RR-94-4, prepared for the California Department of Transportation, Office of Traffic Improvement, March 1994), for a definition and discussion of telecentres). The key element of this definition is the elimination of commute trips for a home-based telecommuter, or a reduction in trip lengths for a telecentre-based telecommuter. Telecommuting may (and usually does) occur on a part-time basis. Home-based businesses are excluded from this definition, as are workers who work at home for part of the day, but still commute to the work site.
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