

Executive Summary: Improving Quality of Life Through Telecommuting

BY WENDELL COX | JANUARY, 2009

Spurred by advances in information technology, especially the spread of broadband services, telecommuting is the fastest growing mode of getting from home to work.

The number of jobs filled by telecommuters could grow nearly four-fold to 19 million and deliver substantial economic, environmental and quality of life benefits for the United States over the next 12 years. Thanks to its potential to cut costs, increase productivity, and expand the supply of potential employees, telecommuting is emerging as a standard business strategy for a large number of organizations. Spurred by advances in information technology, especially the spread of broadband services, telecommuting is the fastest growing mode of getting from home to work. Facilitated by continued expansion in broadband, especially higher speed broadband, telecommuting is poised to become more popular than transit and non-household car pools as a means of accessing work.

Given the range of potential benefits, including the possibility that it could help create new employment opportunities among lower-income Americans who lack the mobility to access many existing jobs, government should pursue policies to accelerate and maximize telecommuting. At a minimum, the potential benefits of telecommuting provide one more reason for policies to spur the deployment and adoption of broadband, which is an essential facilitator of telecommuting.

There are at least two steps the federal government could take to spur telecommuting.

First, it could reform the current pre-tax commuter expense plan that provide subsidies for parking (and transit) expenses to make it mode neutral. Second, the Obama Administration should initiate an interagency examination of the potential benefits, as well as strategies for accelerating telecommuting, as part of a national effort to reduce greenhouse gas emissions and create economic opportunities for lower-income Americans and rural communities.

This report examines the literature and data related to telecommuting and reveals a number of clear trends:

Telecommuting is growing rapidly. Telecommuting in the United States—or working at home while connected by information technology (computers, the broadband-enabled Internet and mobile telephones) to employment, customers and clients—is growing rapidly. Telecommuting is the only U.S. mode of commuting that has gained market share since 1980 other than driving alone. Moreover, at least three times as many more jobs could be converted to telecommuting. This would result in a 16 percent reduction of travel and greenhouse gas emissions relative to work trip travel.

Demographic trends favor telecommuting. More than 80 percent of metropolitan growth since 2000 has been to areas in which telecommuting trails only driving alone and all car pools. Moreover, domestic migration trends are strongly associated with areas in which telecommuting is dominant. There has been a 3.2 million net domestic migration gain since 2000 in metropolitan areas in which telecommuting trails only driving alone and all car pools (and a 3.2 million net domestic migration loss in those where telecommuting trails mass transit or walking).

Telecommuting seems likely to emerge as second only to driving alone. Telecommuting has exceeded the share of walking as a commuting mode. Current rates indicate that telecommuting will soon, if it has not already, exceed car pools that are not composed of household members. Current trends indicate that telecommuting will exceed mass transit's market share by 2015 and the share of all car pools by 2030. Telecommuting exceeds the market shares of mass transit and walking in the overwhelming majority of metropolitan areas, including most large metropolitan areas.

Telecommuting has emerged as a mainstream organization strategy. As information technology has improved, telecommuting has become more of a mainstream business practice. Many organizations—private, public, and non-profit—now organize entire departments around telecommuting, rather than simply providing the option to some employees to telecommute some or all of the time.

Telecommuting improves economic productivity. Research demonstrates that economic productivity is enhanced by minimizing travel to work and by increasing the number of jobs that can be accessed by people. By virtue of its travel time of near zero, telecommuting can be inherently more productive for compatible jobs. And telecommuting workers are potentially more productive than non-telecommuting workers.

Telecommuting assists in achieving public policy goals. The use of telecommuting is important in addressing public policy objectives, such as containing the growth of traffic congestion and reducing greenhouse gas emissions. Telecommuting has the potential to eliminate 136 billion miles of vehicle travel and 55 million metric tons of carbon dioxide emission per year by 2020. At virtually nil, the cost of greenhouse gas emissions through telecommuting is dramatically below the United Nations International Panel on Climate Change (IPCC) ceiling of \$50 per ton.

Telecommuting could reduce inner city unemployment. Lack of geographical access to jobs is a contributor to unemployment, especially among minority households. There may be a potential for reducing unemployment by focused programs to expand telecommuting by residents of lower income, inner city areas. This could require new training programs and government encouragement. Such a program, however, could slow the trend toward off-shoring of service jobs to other countries, while reducing welfare and unemployment insurance budgets.

Telecommuting needs to be a key transportation strategy. Telecommuting offers superior benefits in relation to public policy objectives. Telecommuting can reduce the number of work trips and thus help to contain the growth in traffic congestion. Moreover, telecommuting causes no work access-related greenhouse gas emissions, and overall leads to lower greenhouse gas emissions than other forms of commuting.

There are barriers to telecommuting. The most important barriers to increased telecommuting are the reluctance of businesses to use the strategy; the availability of broadband access, especially higher speed broadband; and the fact that many jobs are not compatible. However, each of these barriers is becoming less important as time goes on.

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An increase in telecommuting could assist in addressing public policy goals, such as slowing the growth of traffic congestion and reducing greenhouse gas emissions.

In the old economy, when most things were on paper, when phones were analog, and when fewer jobs involved information tasks, it was difficult for most workers to work remotely. Now armed with a computer, a broadband connection, and a smart Internet Protocol (IP) phone, home workers can perform all the functions that they would in the typical office environment. Information technology has become such an integral part of the office environment that physical location is less important than ever before. Home-based workers can keep in touch via email and instant messaging applications. They can connect easily and securely to work servers using virtual private networks.

They can collaborate on documents with colleagues with a wide array of software programs, and can attend meetings virtually through tele- or video-conferencing. Smart office phones can automatically route office calls to the home and/or alert them by email when they have a voice mail message. And with the proliferation of high-speed broadband, the connection between the home computer and the office is now almost as fast as the connection between the office computer and the office.

As a result, telecommuting (working at home) has increased more rapidly than other methods of travel to work (such as driving, car pools and public transit).¹ At the same time, an increase in telecommuting could assist in addressing public policy goals, such

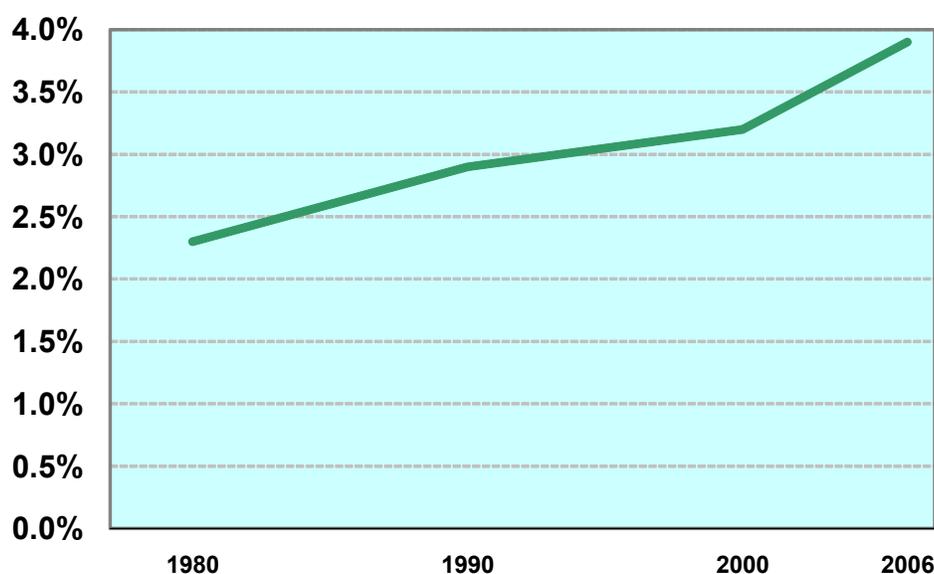
as slowing the growth of traffic congestion and reducing greenhouse gas emissions. Moreover, trends are developing that could increase telecommuting in the future.

This paper reviews telecommuting in the context of the overall policy and demographic framework and evaluates the potential for telecommuting to become a more important component in accessing employment.

WHAT IS TELECOMMUTING?

Telecommuting is principally working at home and being linked to customers, clients and/or the employer by means of telecommunications, such as computers and telephones. Telecommuting also includes telework centers, which are remote locations to which employees commute to work and

FIGURE 1: WORK AT HOME MARKET SHARE TREND: 1980 - 2006



are linked electronically to customers, clients and/or the employer.² Historically, some companies have permitted some employees to telecommute. Increasingly, however, telecommuting has become a “mainstream” business organization strategy, as employees design entire departments that routinely use telecommuting, with employees seldom visiting the base work location.

It can also mean entire corporate departments operating from remote and dispersed locations. For example, some companies have established “virtual call centers,” which are customer service centers dispersed across the nation, with agents working from their homes. For example, Jet Blue Airlines operates a reservations call system that is dispersed among workers in their homes.³ Before these technological advances, call centers had to be housed in centralized locations, to which employees would commute.⁴

Advances in IT and telecommunications have made telecommuting far more widespread and productive. Easier-to-use computers, virtual private networks, ubiquitous email, digital phone systems that allow calls to be easily forwarded and voice messages to be sent by email, electronic collaboration systems, broad-

band telecommunications, and other new applications and technologies have made it much easier to work at home.

According to the Decennial Census, the number of telecommuters (defined as those working at home most days during the week) increased to 4.2 million in 2000, a 92 percent increase from 1980. During that period telecommuting was the only commute mode besides solo driving to increase in market share. From 1990 to 2000, telecommuting (defined as working at home most days during the week) increased by 23 percent, which was double the growth of the overall workforce.⁵ And telecommuting has continued to gain market share since 2000. According to the American Community Survey, telecommuters accounted for 3.2 percent of the workforce in 2000, 3.5 percent in 2003,⁶ and 3.9 percent in 2006 (see Figure 1).⁷ According to research firm Gartner Inc., more than 23 percent of our nation’s work force worked from home at least one day per month in 2005.

THE BENEFITS OF TELECOMMUTING

Telecommuting can help the nation address key challenges by delivering substantial economic, environmental and quality of life benefits.

Increased Mobility

By taking cars off the road, telecommuting helps relieve traffic congestion. The problem of traffic congestion, especially in metropolitan areas, is well documented and the data indicate that congestion is steadily worsening. Freeway traffic volumes in the 50 largest urban areas have increased 136 percent since 1982, or about 2.5 times faster than freeway capacity over the same period. As a result, drivers are increasingly likely to encounter peak period travel delays. In 2005, approximately 60 percent of peak hour travel occurred under congested conditions, up substantially from 24 percent in 1982. Peak period travel delay per capita has risen 260 percent.

Not surprisingly, most urban traffic congestion occurs during the peak travel hours when the majority of people commute to and from work.⁸ This congestion could be reduced if car trips are reduced by an increase in telecommuting. Without the large volume of commute travel, peak periods would exhibit the relatively limited congestion that is typical of off-peak hours.

Telecommuters reduce their overall daily driving about one-third in addition to their reduced work trip travel distance.

Because of the significant costs involved, it seems unlikely that the nation can ever build sufficient new capacity to meet the demands of a growing economy, much less build enough new capacity to restore more favorable traffic conditions. Thus, telecommuting offers one of the few clear paths for reducing traffic congestions. Moreover, the potential reductions are substantial.

A conservative estimate of telecommuting's potential indicates that 14 percent of current jobs could be converted to telecommuting.⁹ The benefits would extend beyond the work trip itself because telecommuting also reduces the ancillary car trips that workers make during the day. The literature indicates that telecommuters reduce their overall daily driving about one-third in addition to their reduced work trip travel distance.¹⁰ Indeed, despite concerns about increased non-commute driving, a recent review of the literature

has found that, not only does telecommuting reduce commuting vehicle miles traveled, but it does not appear to be associated with an increase in the amount of non-commute mileage traveled. Indeed, telecommuting reduces daily vehicle travel by 53 to 77 percent.¹¹ In addition to this direct benefit, an increase in telecommuting could have the beneficial side effect of more cost-efficient freight traffic by reducing the amount of time that shippers lose to traffic delays. By reducing total traffic volumes, telecommuting could reduce product price levels by cutting shipping costs.

Energy and Environmental Benefits

Any vehicle trip eliminated by telecommuting also provides an immediate environmental benefit by reducing greenhouse gas emissions.¹²

Converting 14 percent of jobs to telecommuting positions as projected would eliminate 136 billion vehicle travel miles annually in the United States by 2020 and 171 billion miles by 2030. This represents approximately 5 percent of anticipated total travel and 16 percent of work trip travel.¹³ The reduction in greenhouse gas emissions would be essentially the same—approximately 5 percent of emissions attributable to overall roadway travel and 16 percent relative to work trip travel. At current fuel economy rates, a shift of this magnitude to telecommuting would reduce annual carbon dioxide emissions by nearly 55 million metric tons—or nearly one percent of current national carbon dioxide emissions. Based upon new projections by the U.S. Department of Energy, the reduction in carbon dioxide emissions would be nearly the same in 2030, even after the substantial improvements in automobile fuel economy required by the recently enacted federal energy legislation.¹⁴ This is an important contribution toward reaching greenhouse gas emissions reduction objectives, a task that requires a myriad of strategies.

Moreover, reducing greenhouse gas emissions by telecommuting is cost effective. According to the United Nations IPCC,¹⁵ a cost of between \$20 and \$50 per ton is the maximum amount necessary to accomplish significant reversal of greenhouse gas concentrations between 2030 and 2050. Telecommuting achieves its greenhouse gas emissions reductions at virtually no cost.

The environmental benefits could be greater still if changes in telecommunications technology, employer attitudes and employee preferences, as well as continued evolution toward a more service-oriented economy and migration to less populated areas, convert a larger number of jobs to telecommuting.

Because telecommuters—full and part-time—drive less, they use less energy. In fact, one study estimated that telecommuters last year saved 840 million gallons of gasoline and reduced carbon emissions by almost 14 million tons.¹⁶ With private vehicles responsible for 20 percent of greenhouse gas emissions, the potential benefits from widespread telecommuting are significant.¹⁷

Economic Benefits

Telecommuting can provide a wide array of economic benefits, in part through reducing time spent in traffic but also by increasing access to work.

By reducing work time lost sitting in traffic, telecommuting could increase productivity at the individual, business and regional level. It may also help alleviate poverty and income disparities by creating new job opportunities for workers who live in geographically remote communities or for those unable to compete for certain jobs because they lack the transportation to distant work places.

Higher Business Productivity: There are good reasons to believe that telecommuting allows people in many jobs to work more productively.¹⁸ Telecommuting is reported to boost worker productivity anywhere from 10 to 50 percent for individual businesses because of a reduction in employee absences and time lost to traffic delays.¹⁹ One study estimated that telecommuting reduces absenteeism costs by \$2,000 annually per telecommuting employee.²⁰ For example, by relying on IT (e.g., broadband, mobile email and voice, etc.), the retailer Best Buy was able to give a large share of its corporate headquarters employees the option of more flexible work hours, including working at home. As a result, work output increased by 35 percent. While some of this increase may have resulted from some individuals working more hours (due to a more flexible schedule), some was presumably due to workers becoming more efficient. Moreover, telecommuting can also boost government productivity. The Arizona

Health Care Cost Containment System, (AHCCCS) introduced its virtual home office program in 2006 and the productivity of participating workers increased by 33 percent.²¹

Companies also save money and boost productivity by reducing office space. As more people work from their homes, there will be less demand for office space, which lowers the cost of doing business.²² For example, Jet Blue reportedly saves 20 percent per reservation through the use of its telecommuting virtual call center.²³ At Sun Microsystems, where 48 percent of the workforce telecommutes part-time and 6 percent does so full-time, the company has realized office space savings equivalent to \$387 million dollars.²⁴ One study estimates that, if a predicted additional 10 percent of the workforce takes up telecommuting within the next ten years, the United States would need 3.3 billion square feet less office space. Forgoing the construction of this amount of space would save 28.1 billion tons of greenhouse gas emissions.²⁵

Higher Personal Productivity and Better Quality of Life: The research cited above generally shows that minimizing travel time results in greater productivity. Because telecommuting has no travel time, it is reasonable to posit that it is, all things being equal, the most productive means of accessing work. This makes it possible for commuters to use their limited time more profitably. Thus, the combined increase in personal productivity from telecommuting would translate into overall productivity improvements. One study found that 97 percent of workers and 87 percent of employers reported increases in productivity.²⁶

Telecommuting may also reduce living costs for some Americans by facilitating the movement away from more expensive larger and coastal metropolitan areas to smaller and internal metropolitan areas and non-metropolitan areas.

All things being equal, people have a better quality of life if they have more time to do the activities that they prefer or that are required in their households. Because work trip travel times are minimized, telecommuters tend to have a better quality of life. They spend virtually no time commuting to and from work and therefore do not encounter the inconvenience of driving or riding in crowded trains and buses. Telecommuters

also save by not incurring commute expenses, which enables them to have more discretionary income. On an annual basis, the gross amount of time gained by full-time telecommuting can range from six to nearly 13 full days (24 hours) in time per year.²⁷

Higher Urban Area Productivity: Academic researches generally conclude that there is a strong relationship between mobility and productivity. University of Paris researchers found that increases in the number of jobs that can be accessed by people in a particular period of time also boost the productivity of an urban area.²⁸ A related team found that the higher economic productivity of the Paris metropolitan region in relation to the London metropolitan region was attributable to the superior highway and mass transit services in Paris.²⁹ Our own research found that greater automobile use is strongly associated with higher urban income levels. This econometric analysis of data from 99 urban areas indicates that average gross product per capita is strongly related to the amount of travel.³⁰ Because telecommuting equates to an effective increase in mobility, increases in telecommuting should translate into regional productivity benefits in much the same way as improvements in mobility.

As noted previously, reduced traffic congestion resulting from telecommuting also makes for more efficient movement of freight across a region. That efficiency, in turn, improves regional competitiveness as illustrated by recent research in Portland, Oregon³¹ and Vancouver, British Columbia.³² Thus, the efficiency of urban economies is enhanced as travel speeds are improved and mobility maximized.

National and Local Economic Development: By reducing the need for geographic proximity to jobs, telecommuting enables geographic population dispersion, especially to rural, small urban and other non-metropolitan areas that have been generally bypassed by economic growth. Telecommuting also may promote economic development in smaller and/or rural communities by opening the door to geographic dispersion of some businesses as well as workers.

Businesses that can maximize telecommuting will gain greater geographic flexibility and might be able to locate closer to key shipping facilities or sources of

raw materials and other vital inputs. And home based businesses in rural areas are better able to thrive. For example, Becky Collins, or “Granny B,” is running a successful business of homemade pillowcase dresses from her rural hometown in Louisiana. With the help of her now independent website, Collins is now a full-time entrepreneur, demonstrating the potential of commerce with the help of broadband.³³

Increased telecommuting might also provide an alternative for some companies from offshoring some service jobs, such as reservation services and technical assistance that are comparatively non-technical. This could be accomplished by a focused program to provide the necessary information technology and broadband access to households in lower cost areas (inner cities or rural areas) by establishing virtual call centers that employ residents in their homes. This would require businesses to invest in computers and Internet connections for employees in their homes. Such investment would replace similar investments that would be required for employees working in offices (or in India or elsewhere), so net cost increases would likely be limited. Another alternative would be to establish telework centers in such communities. While training would be required, the economics of such a program might well be competitive with the economics of offshoring in some businesses.

In addition, the availability of the information technology in houses could improve the computer literacy of children and adolescents and increase their overall educational and employment prospects when they reach adulthood, bringing about societal gains. Telecommuting could also reduce the incidence of welfare and unemployment in the future and reduce poverty.³⁴

All of these are important objectives in a global economy that is becoming increasingly competitive and could contribute to improved American competitiveness.

Economic Opportunity: One of the most important potential gains from telecommuting could be greater economic opportunity for lower income households, rural Americans and the disabled.³⁵ A substantial body of research shows that mobility, especially access to an automobile, increases economic opportunity by bringing more jobs within reach of the jobseeker. Converse-

ly, those who lack mobility are often cut off from economic opportunities. By eliminating the need to travel to work, telecommuting can level the playing field and bring more jobs within reach of lower income households that do not have automobiles, to disabled individuals with restricted mobility, and to rural Americans who live far from many potential work places.

Research indicates that cars are an indispensable mechanism for expanding employment opportunities for lower income citizens with regard to jobs in metropolitan areas. University of California researchers have estimated that if automobiles were available to all African American households, the gap between white non-Hispanic and African-American unemployment would be reduced by nearly one-half.³⁶ A Brookings Institution report concluded: “Given the strong connection between cars and employment outcomes, auto ownership programs may be one of the more promising options and one worthy of expansion.”³⁷

A study by the Progressive Policy Institute noted:

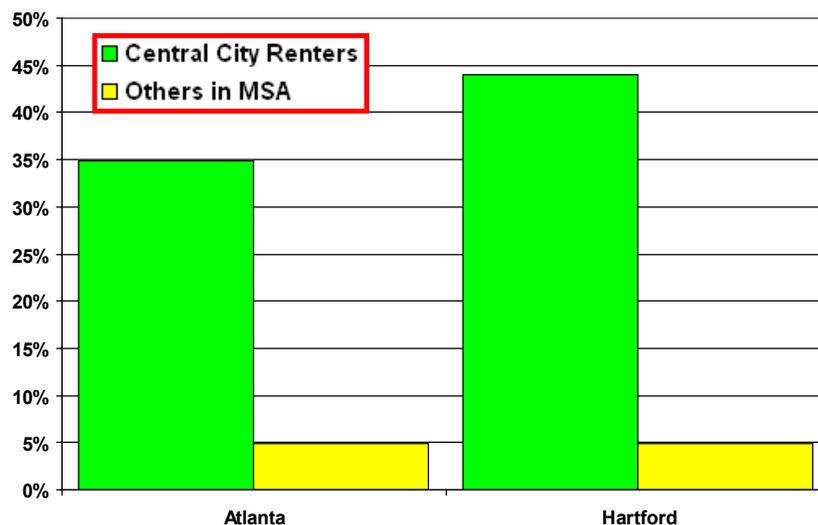
In most cases, the shortest distance between a poor person and a job is along a line driven in a car. Prosperity in America has always been strongly related to mobility and poor

people work hard for access to opportunities. For both the rural and inner-city poor, access means being able to reach the prosperous suburbs of our booming metropolitan economies, and mobility means having the private automobile necessary for the trip. The most important response to the policy challenge of job access for those leaving welfare is the continued and expanded use of cars by low-income workers.³⁸

Unemployment is more concentrated in the core cities of the nation’s metropolitan areas and a higher percentage of these residents do not own vehicles. This is illustrated by Atlanta and Hartford. In the city of Atlanta, 35 percent of renting households do not have vehicles, while in the city of Hartford, the figure is 44 percent. By contrast, among all metropolitan area homeowners and renters living outside both the cities of Atlanta and Hartford, fewer than 5 percent of households do not have vehicles (see Figure 2).

Cars are necessary to improve the low-income quality of life because the mass transit service that would serve the same function expeditiously does not exist. This is illustrated by a Federal Transit Administration study of Boston, which has one of the best public transport sys-

FIGURE 2: PERCENTAGE OF HOUSEHOLDS WITH NO CAR



tems in the United States. The study found that only 14 percent of jobs in the high-growth suburbs of Boston were within one hour's transit ride of inner-city low-income areas (Lacombe, 1998).

By substituting for mobility, telecommuting has the potential to offer even more positive returns than could be achieved by a program that would provide cars to low income households.

BARRIERS TO TELECOMMUTING

There is considerable potential for expanding telecommuting, but some barriers must first be overcome. The principal barriers are:

Business Reluctance: Business acceptance of telecommuting is growing. According to a 2007 survey by Hewitt Associates, 38 percent of employers allow some form of telecommuting, up from 14 percent a decade ago.³⁹ Still, many business managers are reluctant to allow employees to telecommute. Despite the empirical evidence showing productivity gains, many employers remain skeptical about the level of performance they can count on from employees working outside the direct view of supervisors. Some of the reluctance may reflect a natural comfort with traditional practices. Information technology can allay these concerns, however, by providing accurate data on employee production, whether the employee is housed in the office or at home. In the case of telecommuting employees serving customers by telephone, calls can be monitored for training and quality, just as if they were in an office. Indeed, information technology has been cited as the "key factor" in reversing a historic trend toward lower productivity from the mid-1970s to the mid-1990s.⁴⁰ Telecommuting has played a part in this and is likely to play an even greater part in the future.

Job Compatibility: Telecommuting is not compatible with all jobs because some work requires employees to be physically present at the job site. For example, the work of plumbers or construction workers cannot be performed by telecommuting. The requirement of physical presence represents the ultimate limitation on the potential for telecommuting. In some cases, it is possible for employees to telecommute only on some days rather than every day. However, improving technology is widening the potential span of jobs in which telecommuting can be used. Consider the fact that in

2001, doctors performed the first trans-Atlantic tele-surgery. Internet-based telephone systems, conference calls and video conferencing, for example, are commonly replacing physical meetings.

As noted previously, it is estimated that up to 14 percent of current commuters could switch to telecommuting,⁴¹ or more than 19 million employees at 2006 employment levels. However, this number may grow as organizations gain more experience with remote workers and discover that many jobs are performed as effectively by remote employees.

Broadband Availability: Broadband connections are a virtual necessity for effective telecommuting because they enable employees to be connected to the office at all times and enable the high speed exchange of data, especially video and files with long download times. While dial-up access to the Internet may be acceptable for some type of remote work, reliance on dial-up will typically limit productivity compared to broadband because some activities are virtually impossible over dial-up connections.

Relatively low adoption rates among some groups of Americans and/or relatively limited availability of broadband in many rural areas is a major limitation to the growth of telecommuting.

Conversely, lack of broadband is a significant barrier to telecommuting. Relatively low adoption rates among some groups of Americans and/or relatively limited availability of broadband in many rural areas is a major limitation to the growth of telecommuting.

For example, the most recent data from the Pew Internet & American Life Project show that only a small minority of Americans with annual incomes of \$30,000 or less have broadband service in their homes. Among those earning less than \$20,000 a year, only 13 percent had a broadband connection as of May 2008. For those with household incomes of \$20,000-\$30,000 a year, just 19 percent reported a home broadband connection.⁴² This is the same group that loses out on job opportunities because of mobility issues and that could benefit significantly from jobs that would be open through telecommuting. Without broadband, the potential telecommuting opportunities disappear.

Similarly, rural Americans are also relatively less likely to enjoy home broadband. According to the Pew survey, only 38 percent of rural households had a broadband connection, compared to 57 percent of urban homes and 60 percent in suburbia. The lower adoption rates in rural communities, which could benefit substantially from telecommuting options that connect them to jobs at distant locations, appear to reflect a combination of lower interest and reduced broadband availability. Overall, broadband is less available in rural areas than in urban ones.⁴³

This barrier should become less significant over time as broadband spreads to more remote communities and is adopted at higher rates by lower income households. Yet, telecommuting opportunities and resulting benefits would be realized much sooner if public policy was used to accelerate the spread of broadband. Businesses, too, can promote telecommuting by paying for employees' home broadband connections and also by providing computer equipment. Some businesses are already taking such steps, though it is likely that businesses are more inclined to make such investments for more senior employees than for new hires or lower level jobs.

Tax Restrictions: Some state laws may also present a threat to telework by enabling states to subject telecommuters to taxes based on where the employer is located.

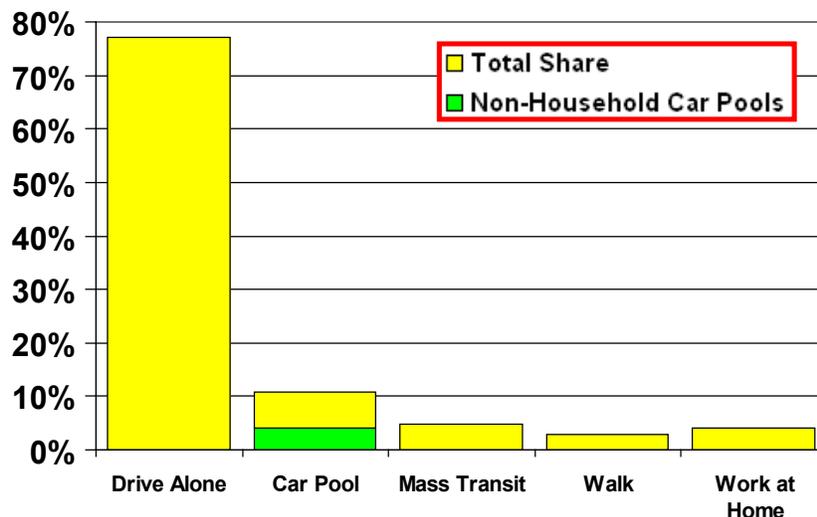
If a nonresident chooses to telecommute some of the time to an employer located in the state, the state may tax the telecommuter on 100% of his or her income, including the income earned from home. Because the telecommuter's home state may also tax the income earned from home, the telecommuter may face double taxation.⁴⁴

COMMUTING: TRENDS AND EVALUATION OF WORK ACCESS MODES

Because the benefits of telecommuting are so significant, it is important to consider the variety of positive impacts. But as noted above, a clear one relates to transportation. In considering the role of telecommuting on transportation and mobility, it's worth comparing telecommuting to other modes of getting to work. Since 1980, virtually all growth in commuting in the United States has been "driving alone." Driving alone has risen from a 1980 market share of 66 percent to the present 77 percent. The alternative travel modes have done less well (see Figure 3).⁴⁵

Car pooling has declined by 4.2 million daily commutes. This represents a market share loss from 20 percent to 10 percent. In 2006, 14.9 million workers commuted by car pool, compared to 105 million who commuted by driving alone. Between 1980 and 2000, car pool commuting declined by more than 3,000,000

FIGURE 3: COMMUTE SHARE MARKET: 2006



daily commuters and experienced a market share loss from 19.7 percent to 12.2 percent. In the latter part of the 1990s, the number of people using car pools increased somewhat, though the market share continued to decline. The latest data indicates no material change in car pool usage, however; by 2006 the car pool market share had dropped to 10.2 percent, barely one-half of the 1980 figure. The car pool share is considerably smaller if household car pools are excluded.

Transit has gained 0.5 million daily commuters. However, commuting has grown by a greater rate and transit's share of work trips has fallen from 6.3 percent to 4.9 percent between 1980 and 2006.

The walk share of work trips has been falling and has declined 1.4 million, with a market share loss from 5.7 percent to 2.9 percent, a drop of nearly one-half. From 1980 to 2006, the number of people walking to work dropped by 1,500,000.

Working at home, however, gained strongly and is the only method of commuting other than single-occupant driving that has experienced both an increase in numbers, a rise by 3.2 million daily commutes, and market share, a rise from 2.3 percent to 4.0 percent, an increase of approximately 75 percent. The rate of increase is accelerating, with the annual market share increase for working at home more than doubling from 2.0 percent in the 1990s to 2.6 percent in the 2000s.

It seems likely that driving alone and working at home have experienced more positive trends because they make more jobs accessible in a shorter period of time than the other commuting modes. As noted above, greater job access in a shorter period of time is associated with a higher standard of living and a better quality of life.

EVALUATION OF WORK ACCESS MODES

It is important to analyze more carefully the transportation impacts of telecommuting compared to other modes. The strengths, weaknesses and prospects of the most usual work trip modes vary substantially in the current policy context.⁴⁶ Each of the significant modes are evaluated based upon their travel time, labor market access, flexibility, commuter costs, general tax subsidies and greenhouse gas emissions.

DRIVING ALONE:

As noted above, driving alone is by far the most popular way to commute to work partly because driving alone is flexible and has superior travel time in comparison to other travel modes. However, it is more costly to users than car pools or mass transit and receives fewer subsidies per passenger mile than mass transit. Currently, driving alone is the most intensive in greenhouse gas emissions. However, considerable improvement could emerge in the future. Generally, cars are used extensively because, all things being equal, they complement the life styles of commuters and households.

Travel Time: Superior travel time is a principal advantage of driving alone. The average daily round trip commute time for driving alone in 2007 was 48 minutes, which is the best of any motorized mode. This is nearly nine minutes less than car pools and one-half that of transit (see Figure 4).

Labor Market Access: Driving alone provides ubiquitous access throughout a metropolitan area. The commuter can access 100 percent of jobs from any residence within the metropolitan area by car.

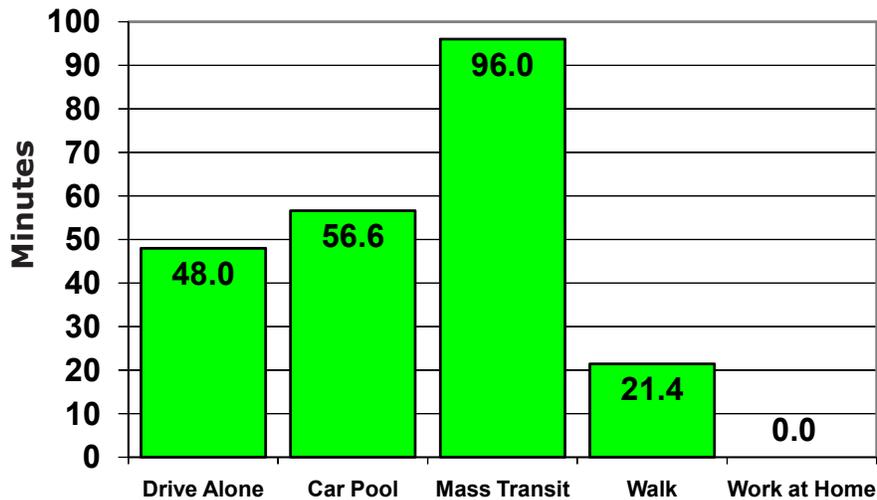
Number of Jobs Accessible: Equal to the metropolitan labor market.

Flexibility: Driving alone provides maximum flexibility. The driver is not constrained by timetables or the schedules of fellow workers. The single-occupant commuter can leave work at any time in response to unforeseen circumstances. The driver can make whatever stops to and from work as are necessary, such as day care centers or for shopping. However, the increase in congestion, particularly non-recurring congestion can make driving less reliable.

Commuter Costs: Consequently, driving alone is more costly for commuters than car pools, walking or telecommuting and also tends to be more costly for commuters than transit.

General Tax Subsidies: Driving alone involves some non-user taxpayer subsidies. Most of the direct costs of driving alone are paid for directly by drivers (largely through gas taxes). Based upon overall highway figures, user fees including direct user tolls and indirect

FIGURE 4: DAILY ROUND TRIP COMMUTE TIME BY MODE: 2007



user charges in the form of motor fuels taxes and vehicle-related fees provide 72 percent of total costs. Approximately 14 percent of these amounts are used for non-highway purposes, such as transit. Regardless of the treatment of the highway user fees applied to other programs, the deficit between highway expense and revenues is approximately \$0.01 per passenger mile.⁴⁷ The lion's share of the rest come from general fund subsidies such as sales taxes and property taxes, most of which support local roadways, rather than high-capacity state owned roadways, such as freeways.

Greenhouse Gas Emissions: At present, driving alone produces more greenhouse gas emissions than the other commute methods on a passenger mile basis. In 2005, the average car emitted 481 greenhouse gas grams per mile. However, this figure is likely to improve. For example, the 35 mile per gallon new cars and SUV's required by 2020 in the United States would emit 212 grams per passenger mile. Even more progress could occur. It is reported that Volkswagen has developed a two-seater car that will achieve 235 miles per gallon, and would thus emit less than 40 grams per passenger mile. There are reports that limited marketing will begin in 2010.⁴⁸ These emission rates would be lower than present mass transit greenhouse gas emissions in the United States.

CAR POOLS:

Car pools are the second most popular method of commuting. However, when car pools composed of household members are excluded,⁴⁹ car pools rank third among the commute modes, following mass transit, with a market share of 4.1 percent.

In recent decades, considerable public policy effort and funding has been expended to increase car pool use. High-occupancy vehicle lanes (HOV) have been built on many freeways. These exclusive lanes allow car pools to speed by stopped traffic in general purpose lanes of freeways. Yet, the general trend of car pools has been downward.⁵⁰

Car pools are less costly for commuters than driving alone. The importance of this advantage is illustrated by the fact that average participant incomes are lower in larger car pools.⁵¹ Car pools also have the advantage of lower greenhouse gas emissions. As a shared mode of transport, however, car pools have longer travel times and are less flexible than driving alone.

Travel Time: Car pools are generally slower than driving alone, with an average round trip journey to work of 56.6 minutes per day. Car pools with three or more participants have an average round trip work trip travel time of approximately 70 minutes.⁵²

Labor Market Access: Like driving alone, car pools can provide ubiquitous access throughout a metropolitan area. A car pool can access 100 percent of jobs from any residence within the metropolitan area by car. However, because jobs and residences are so widely dispersed throughout urban areas, it can be difficult to form car pools.

Number of Jobs Accessible: Number of jobs accessible by car pools is equal to the metropolitan labor market.

Flexibility: Car pools may be the most inflexible mode. People in car pools must coordinate their schedules with other car pool participants. It can be very difficult for a car pool participant to leave work for unforeseen circumstances in the middle of the day, because someone else has driven the employee to work and the riders who rode to work with the driver would have to find other means of transportation home. Further, there will tend to be less flexibility with respect to other stops on trips to and from work, such as day care centers or for shopping.

Commuter Costs: Car pool costs are lower than the cost of driving alone, because the participants share in the transportation expenses (and parking expenses, where there is a charge). Depending on the trip and metropolitan area, car pools can be less or more expensive for participants than transit.

General Tax Subsidies: Car pools are subsidized in the same ways as individual cars. In addition, in a number of metropolitan areas, separate car pool lanes have been built (HOV-lanes). There is no definitive research on the subsidies to car pooling. But the costs per traveler are less since the same highway expense is divided by more passengers in the same vehicle.

Greenhouse Gas Emissions: Car pools are the least greenhouse gas intensive mode of transport to work. On average, car pools produce 217 greenhouse gas grams per passenger mile.⁵³ Based upon currently marketed technology (above), this figure could improve to 71 grams per passenger mile.

MASS TRANSIT:

Mass transit's principal advantages to commuters are its low cost relative to driving alone and its lower greenhouse gas emissions. However, as a shared mode

of employment access, transit has the disadvantage of longer travel times. Moreover, in some larger metropolitan areas with large downtowns, mass transit is currently competitive with the automobile principally for downtown trips, which renders it as a "niche" market. Mass transit also plays an important role in providing mobility in city cores for people without access to cars.

Travel Time: Mass transit has the longest average travel times of any major commute mode. The average daily round trip travel time is 96.4 minutes, double that of driving alone. However, transit can be time-competitive with driving alone for some trips to the nation's largest central business districts (downtowns), because traffic congestion is so intense. Examples include commuter rail trips to central business districts such as Manhattan and the Chicago Loop from distant suburbs.

Labor Market Access: In the mass transit industry, people without cars are often referred to as the "captive market," while transit users with cars are referred to as the "choice market." This market segmentation is illustrated by the substantial differences in transit use. Where transit service is rapid and frequent, it can compete quite well with driving alone and attracts a significant market share. Such service, however, is nearly exclusively limited to downtown (central business district) access. Mass transit is necessarily centered on downtown areas, where high employment densities justify service from many parts of the metropolitan area. Approximately one-third of transit commuting is to the central business districts of New York and Chicago, which account for only two percent of the nation's employment, while 35 percent of transit commuting is to the nation's 13 largest downtown areas (which comprise only four percent of national employment). On average, only 10 percent of employment is in central business districts.⁵⁴ Mass transit does not provide the direct and rapid access to non-downtown jobs that would make it competitive either with driving alone or car pools. As a result, there is comparatively little transit commuting to areas outside downtowns and this deters transit commuting by people who have access to cars. Generally, transit commuters to areas other than downtown have incomes considerably below average and lower incomes are generally associated with a lower rate of automobile availability.⁵⁵

Number of Jobs Accessible: With respect to automobile competitiveness, the number of jobs accessible by mass transit is limited to the incidence of high frequency, rapid transit service.

Flexibility: Mass transit can be both flexible and inflexible. Because mass transit operates on a schedule, it does not provide the flexibility of driving alone, which allows the commuter to travel at will. On the other hand, in central business districts where there are high levels of service, the mass transit commuter may be able to leave in the middle of the day for unforeseen circumstances. Finally, mass transit schedules can make it difficult, if not impossible to make stops on the trip to and from work, such as day care centers and shopping.

Commuter Costs: Mass transit fares are generally lower than the cost of driving alone and can be less than the cost of car pools.

General Tax Subsidies: Mass transit requires larger non-user taxpayer subsidies. In 2006, general taxpayer and non-user subsidies were approximately \$30 billion, or \$0.61 per passenger mile. Subsidies accounted for 77 percent of capital and operating expenditures.⁵⁶

Greenhouse Gas Emissions: Mass transit produces lower greenhouse gas emissions than driving alone, but higher than car pools. Overall, mass transit produces 234 greenhouse gas grams per passenger mile. There is, however, a substantial range. In the New York City metropolitan area (with 40 percent of the nation's transit ridership)⁵⁷, mass transit produces 137 greenhouse gas grams per passenger mile. Outside the New York City metropolitan area, mass transit produces 308 greenhouse gas grams per passenger mile.⁵⁸ It is likely that mass transit will improve on its greenhouse gas intensiveness. However, achieving material improvement is likely to require fuel economy improvements that could be challenging because as mass transit service expands, customer density tends to decline, which increases greenhouse gas emissions on a per passenger mile basis. Mass transit fuel efficiency could also be improved by significant expansion of less carbon intensive electricity generation alternatives, such as nuclear, solar or wind power because most urban rail systems are propelled by electricity.

WALKING:

Considerable attention has been given in recent years to pedestrian oriented development, in which work locations are close enough to permit large numbers of people to walk to work. Nonetheless, as indicated above, walking continues to lose market share as a mode of travel.

Walking is a personal, rather than shared mode of work access, because it is not constrained by timetables or the commuting schedules of other workers. Walking takes little time, is virtually costless, requires few tax subsidies (e.g. payment for sidewalks) and produces almost no greenhouse gas emissions. The most substantial disadvantage of walking, however, is its very limited labor market access, which makes it a niche market.

Travel Time: The average walking commute round trip is 21.4 minutes, less than one-half the drive alone commute time.

Labor Market Access: Walking provides only limited access to employment and only those jobs that are within walking distance can be accessed.

Number of Jobs Accessible: With respect to automobile competitiveness, number of jobs accessible by walking is limited to jobs within walking distance of the residence.

Flexibility: Walking is flexible. A walking commuter can leave work at any time in response to unforeseen circumstances. The walker can make whatever stops to and from work as are accessible along the way, such as day care centers or for shopping. However, the potential for stops during the work trip can be limited if such locations are not accessible within walking distance.

Commuter Costs: Walkers incur almost no commuting costs.

General Tax Subsidies: Walking requires almost no non-user taxpayer subsidies.

Greenhouse Gas Emissions: Overall, almost no greenhouse gas emissions are associated with walking to work.

BICYCLES:

Bicycles are another low cost option for commuting. Bicycling is a personal, rather than shared mode of work access, because it is not constrained by timetables or the commuting schedules of other workers. Bicycles can provide access to many more jobs than walking and many fewer than automobiles and car pools. Bicycles can also be unattractive to many commuters in uncomfortable weather, especially in the hot and cold continental climate that is typical in much of the United States. Bicycles can be used in combination with transit, since many transit vehicles accommodate bicycles, whether by parking at access points or placing bicycles on transit vehicles. The latter combination, however, has only limited capability, as a strong increase in such volume would overwhelm the available space on transit vehicles.

Travel Time: Travel time is not reported in the 2007 American Community Survey.

Labor Market Access: Bicycles provide greater access to employment than walking, but less than cars.

Number of Jobs Accessible: With respect to automobile competitiveness, number of jobs accessible by bicycles is limited to jobs within bicycling distance of the residence.

Flexibility: Bicycling is flexible. An occupant commuter can leave work at any time in response to unforeseen circumstances and can make some stops along the way to and from work.

Commuter Costs: Bicyclists incur almost no commuting costs.

General Tax Subsidies: The subsidies to bicycling would be largely limited to the cost of establishing, building, and maintaining bike lanes or paths. There is no definitive research on this issue.

Greenhouse Gas Emissions: Almost no greenhouse gas emissions are associated with bicycling to work.

TELECOMMUTING:

Telecommuting offers considerable advantages.⁵⁹ It requires no travel time, is flexible and costless to telecommuters. Telecommuting incurs no general tax

subsidies and is not associated with commute-related greenhouse gas emissions. Telecommuting can provide broader labor market access than driving, but cannot be used for jobs that require physical presence at work or activity site. On the other hand, telecommuting alone has no geographical access constraints and, as a result, potential number of jobs that the telecommuter can theoretically choose from is larger even than driving alone.

Travel Time: Telecommuting's most important advantage is its travel time—zero. The telecommuter saves nearly five hours weekly in travel time compared to those who drive alone and nearly 10 hours weekly compared to mass transit commuters.

Labor Market Access: Like driving alone, telecommuting provides access to jobs throughout the labor market, but also potentially beyond that to almost any location in the United States, including the entire world. However, telecommuting will not be an option in cases where the worker's physical presence is required or because of other circumstances.

Number of Jobs Accessible: With respect to automobile competitiveness, there are no geographical limitations. Telecommuters often work in geographical areas that are remote from their base office location and may even work in other nations. As a result, the potential number of jobs from which to choose can be greater than are available by automobile in the labor market. The ultimate example of this is the off-shoring telecommuting in which, for example, customer service representatives in India or the Philippines telecommute to jobs in the United States. A reservations agent, for example, may work electronically at a center in New York and live in Cheyenne.

Flexibility: Telecommuting provides maximum flexibility, along with driving alone. The telecommuter is not constrained in accessing work by mass transit timetables or the schedules of others. The telecommuter can leave work at any time in response to unforeseen circumstances and can travel as necessary, such as to day care centers or for shopping.

Cost to the Commuter: Generally, telecommuting imposes no costs on the commuter. Costs are usually paid by the employer.

TABLE 1: RANK EVALUATION OF COMMUTING MODES

	Travel Time	Labor Market Access	Potential Number of Jobs	Flexibility	Commuter Cost	General subsidy	GHG Emissions
PERSONAL MODES							
Drive Alone	3	1	2	1	6	5	6
Walk	2	6	6	1	1	1	1
Telecommute	1	3	1	1	1	1	1
Bicycle	?	5	3	4	2	1	1
SHARED MODES							
Car Pool	4	1	2	6	5	4	4
Mass Transit	5	4	4	5	4	6	5

Non-User Taxpayer Subsidies: Telecommuting requires no non-user taxpayer subsidies.

Greenhouse Gas Emissions: Telecommuting has no work trip related greenhouse gas emissions.

TELECOMMUTING: COMPETITIVE ASSESSMENT

Telecommuting has emerged as a strongly competitive mode of access to work.

Telecommuting Compared to Car Pools: While sufficient data on household car pools are not available, it is likely that telecommuting is now used by more employees than non-household car pools in most metropolitan areas.⁶⁰

Telecommuting Compared to Mass Transit: Working at home has already emerged as a larger commute mode than mass transit and walking in the overwhelming majority of large and small metropolitan areas (see Table 2). Working at home is more popular than transit in 68 percent of metropolitan areas over 1,000,000 population, or 34 out of 50 areas. Working at home is more popular than transit in 90 percent of all metropolitan areas, or 284 out of the 315 metropolitan areas for which data is available. There is a clear pattern among the large metropolitan areas in which transit is more popular than working at home. Except for Las Vegas,⁶¹ each of the metropolitan areas has a large, dense, historic downtown area (central business district). Twelve of the 16 metropolitan areas have a downtown area among the nation’s 25 largest, while Milwaukee, Buffalo and Providence have dense, historic downtown areas. Only in the metropolitan areas with the six largest downtown areas is the transit mar-

ket share more than 3 percentage point greater than the work at home market share. In all of the others, working at home could become more popular than transit in the next 25 years if national trends are applied.

Telecommuting Compared to Walking: Working at home is more popular than walking in 82 percent of metropolitan areas over 1,000,000 population, or 41 out of 50 areas. Working at home is more popular than walking in 73 percent of metropolitan areas, or 230 out of 315 areas. All of the nine metropolitan areas in which walking is more popular than working at home have dense, historic downtown districts, and all but one (Milwaukee) are in the Northeast. Generally, the differences are slight where walking is more popular than working at home.

TELECOMMUTING, DEMOGRAPHICS AND THE FUTURE

The markets in which telecommuting is strongest are attracting overwhelming majority of population growth and net domestic migration.

Population Growth: National population growth trends correspond to areas in which working at home is more popular. The areas in which working at home is more popular are growing faster than the nation’s average.

There was 8.6 percent population growth between 2000 and 2006 among the metropolitan areas in which working at home is more popular than mass transit. In the metropolitan areas with higher rates of mass transit usage, the population growth rate was 3.8 percent. Overall, 80 percent of metropolitan growth has been in areas where telecommuting is more popular than mass transit.

There was 8.5 percent population growth between 2000 and 2006 among the metropolitan areas in which working at home is more popular than walking. In the metropolitan areas with higher rates of walking, the population growth rate was 2.0 percent. Overall, 93 percent of metropolitan growth has been in areas where telecommuting is more popular than walking.

Net Domestic Migration: Similarly, net domestic migration (moving within the nation) trends favor areas where working at home is more popular. During the 2000s, there has been a market shift in domestic migration patterns.⁶² There is considerable movement from larger metropolitan areas to smaller areas, both metropolitan and non-metropolitan. To a substantial effect, this is being driven by the unprecedented housing price differentials that have developed in the last decade between some metropolitan areas and the rest of the nation.⁶³ These movements favor telecommuting, because they are generally to areas in which telecommuting is more important.

For example, there has been a nearly 3.6 million net domestic migration loss in the metropolitan areas in which mass transit has a higher market share than working at home. Approximately 3.2 million of these domestic migrants have settled in metropolitan areas with higher work at home market shares. The other

400,000 domestic migrants have moved to non-metropolitan areas, where mass transit has very small market shares.⁶⁴ The net domestic migration rates in the metropolitan areas with higher mass transit market shares is minus 4.4 percent, while the net domestic migration rate is plus 2.2 percent in the metropolitan areas with a higher work at home market share.

The Trend: Thus, the demographic trends indicate that telecommuting is likely to continue its growth (see Figure 5). Based upon present trends (2000-2006):

Working at home will have accounted for a greater volume than non-household car pools by 2007 or 2008. Assuming continuation of current trends, working at home is poised to become more popular than car pooling during the 2020s. Likewise, working at home will become more popular than transit before 2015 (see Figure 5).

CONCLUSION AND POLICY RECOMMENDATIONS

It is clear that there is great potential for substituting commute trips with telecommuting. The public policy advantages are also substantial, especially from reduced infrastructure requirements, reduced greenhouse gas emissions and greater economic opportunity for disadvantaged households.

FIGURE 5: WORK AT HOME, TRANSIT AND WALKING TREND: 1980-2006

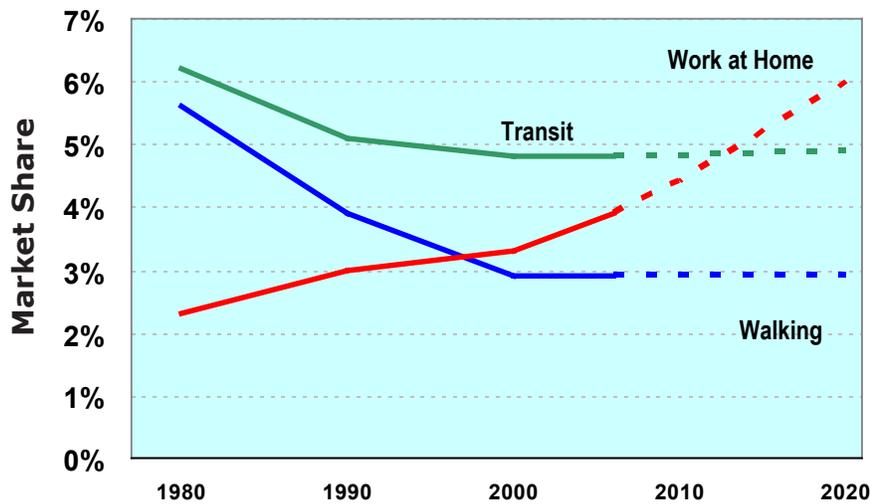


TABLE 2: PRINCIPAL COMMUTING MODES BY METROPOLITAN AREA OVER 1,000,000 POPULATION: 2006

Population Rank	Metropolitan Area	Car Alone	Car Pool	Mass Transit	Walk	Work at Home	Work at Home > Transit?	Work at Home > Walk?
1	New York	50.6%	7.5%	29.9%	6.1%	3.7%		
2	Los Angeles	73.4%	11.8%	6.1%	2.6%	4.2%		YES
3	Chicago	71.8%	9.2%	11.0%	2.7%	3.6%		YES
4	Dallas-Fort Worth	79.7%	11.9%	1.6%	1.6%	3.9%	YES	YES
5	Philadelphia	74.1%	9.0%	8.8%	3.7%	3.1%		
6	Houston	77.5%	13.0%	2.7%	1.6%	3.1%	YES	YES
7	Miami	78.4%	10.1%	3.9%	1.6%	3.9%	YES	YES
8	Washington	65.8%	11.6%	14.2%	3.0%	4.1%		YES
9	Atlanta	77.1%	11.3%	3.7%	1.4%	4.9%	YES	YES
10	Detroit	84.9%	8.5%	1.4%	1.5%	2.8%	YES	YES
11	Boston	70.8%	8.1%	11.3%	4.6%	3.7%		
12	San Francisco	63.1%	10.5%	13.6%	4.1%	5.8%		YES
13	Phoenix	74.7%	14.4%	2.2%	1.8%	4.5%	YES	YES
14	Riverside-San Bernardino	75.6%	15.5%	1.5%	1.8%	4.2%	YES	YES
15	Seattle	70.6%	11.7%	7.5%	3.1%	5.3%		YES
16	Minneapolis-St. Paul	78.8%	8.8%	4.1%	2.4%	4.5%	YES	YES
17	San Diego	74.8%	10.8%	3.1%	2.7%	6.5%	YES	YES
18	St. Louis	82.8%	9.1%	2.5%	1.4%	3.2%	YES	YES
19	Tampa-St. Petersburg	80.5%	9.6%	1.4%	1.8%	4.3%	YES	YES
20	Baltimore	75.8%	9.4%	6.4%	3.2%	3.6%		YES
21	Denver	75.9%	9.8%	4.6%	2.3%	5.2%	YES	YES
22	Pittsburgh	76.8%	9.3%	6.0%	3.9%	3.0%		
23	Portland	71.1%	10.9%	6.4%	3.1%	6.0%		YES
24	Cleveland	81.5%	8.1%	3.9%	2.2%	2.9%		YES
25	Cincinnati	82.3%	8.9%	2.6%	2.4%	3.0%	YES	YES
26	Sacramento	75.4%	12.2%	2.5%	2.2%	5.1%	YES	YES
27	Orlando	79.5%	10.8%	1.9%	1.4%	4.4%	YES	YES
28	Kansas City	83.3%	9.1%	1.2%	1.5%	3.6%	YES	YES
29	San Antonio	78.3%	11.8%	2.4%	2.3%	3.2%	YES	YES
30	San Jose	76.8%	10.2%	3.6%	2.4%	4.5%	YES	YES
31	Las Vegas	77.4%	12.0%	3.9%	1.7%	2.9%		YES
32	Columbus	83.4%	7.8%	1.7%	2.1%	3.9%	YES	YES
33	Indianapolis	83.4%	9.2%	1.1%	1.5%	3.7%	YES	YES
34	Virginia Beach	78.6%	10.4%	1.9%	2.8%	4.7%	YES	YES
35	Providence	81.5%	9.1%	2.6%	2.8%	2.6%		
36	Charlotte	78.8%	12.9%	1.7%	1.3%	4.1%	YES	YES
37	Austin	75.6%	13.0%	2.3%	1.7%	5.0%	YES	YES
38	Milwaukee	80.2%	8.4%	4.3%	3.0%	2.9%		
39	Nashville	82.3%	10.3%	0.8%	1.5%	4.1%	YES	YES
40	Jacksonville	79.6%	12.0%	1.2%	1.8%	3.7%	YES	YES
41	Memphis	82.4%	10.8%	1.5%	1.5%	2.2%	YES	YES
42	Louisville	82.6%	10.4%	2.1%	1.5%	2.7%	YES	YES
43	Richmond	81.3%	10.9%	1.6%	2.0%	3.2%	YES	YES
44	Hartford	81.7%	8.4%	2.3%	3.1%	3.0%	YES	
45	Oklahoma City	80.9%	11.4%	0.6%	1.7%	3.8%	YES	YES
46	Buffalo	80.8%	8.6%	4.2%	2.8%	2.4%		
47	Birmingham	83.5%	10.7%	0.7%	1.1%	3.2%	YES	YES
48	Salt Lake City	75.1%	12.9%	3.9%	2.3%	4.1%	YES	YES
49	Rochester	82.2%	7.9%	2.3%	3.5%	2.9%	YES	
50	New Orleans	78.8%	12.9%	2.0%	1.7%	2.7%	YES	YES

Source: Calculated from United States Bureau of the Census, American Community Survey data.

At the same time, the impressive gains of telecommuting have been achieved with virtually no public subsidies. The substantial public policy advantages of telecommuting offer justification for considering public programs that encourage its expansion.

As a result, public policy should seek to accelerate and maximize telecommuting, especially to reduce greenhouse gas emissions, reduce the demand for traveling to work and to improve economic opportunity for disadvantaged households.

There are at least two steps the federal government could take to spur telecommuting.

First, **Congress should reform the current pre-tax commuter expense plan (Internal Revenue Code Section 132)**. This allows employees to exclude from gross income up to \$220 per month for “qualified parking” (defined as parking provided to an employee on or near the business premises of the employer) or up to up to \$115 per month for qualified mass transit expense to and from work. This system biases employee decisions toward driving and transit and away

from telecommuting and other modes (e.g. walking and bicycling). From an economic perspective, the ideal policy would be to simply eliminate this provision completely.

Second, **the Obama Administration should initiate an interagency examination of the potential benefits as well as strategies for accelerating telecommuting**. This should be a part of a national effort to reduce greenhouse gas emissions and create economic opportunities for lower-income Americans (especially in inner cities, where auto availability is limited) and rural communities.

Telecommuting is growing rapidly in the United States and assuming continued expansion in broadband is poised to become more popular than transit and non-household car pools as a means of accessing work. This trend, if encouraged by public policies, could deliver enormous economic and environmental benefits and could even play an important role in creating new opportunities for employment among lower-income Americans.

ENDNOTES

1. The U.S. Bureau of the Census collects data on work trip modes, including “work at home.” For simplicity, this report uses “work at home” and telecommuting interchangeably. Some working at home is not telecommuting. In 1980, before the personal computer and the Internet, there were about 2.2 million people working at home, a figure that had been declining since the first data, which was for 1960 (4.7 million). Since 1980, however, working at home has increased substantially. It is not known how many of the 5.4 million 2006 home workers were actually telecommuters. It seems reasonable to assume that virtually all of the growth in working at home since 1980 has been telecommuters (and perhaps more). As a result, telecommuting and working at home are used interchangeably in this report.
2. Except as otherwise noted, “telecommuting” as used in this report does not include telework centers, principally because there is little, if any data on telework centers.
3. Robert D. Atkinson, “Framing a National Broadband Policy,” *Commlaw Conspectus* 16.1 (2007): 145-177 <commlaw.cua.edu/abstracts/16_1.cfm>.
4. As used in this report, “commute” and “commuting” refers to trips to and from work and “commuter” refers to a worker (employee or self-employed).
5. U.S. Census Bureau, “Census Bureau Releases Information on Home Workers,” released on October 20, 2004 <www.census.gov/Press-Release/www/releases/archives/census_2000/002966.html> (accessed November 13, 2008).
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8. As used in this report, the terms commute and commuter refer to people traveling to and from work.
9. Rockbridge Associates, Inc., “National Technology Readiness Survey” <www.rockresearch.com> (accessed November 13, 2008).
10. Margaret Walls and Elena Safirova, “A Review of the Literature on Telecommuting and Its Implications for Vehicle Travel and Emissions,” *Resources for the Future*: Washington, D.C., December 2004 <www.rff.org/Documents/RFF-DP-04-44.pdf> (accessed November 13, 2008).
11. *Ibid.*, 19.
12. An exception is walking, which has very little potential for commuting growth.
13. It is assumed that per capita annual travel would remain at 2006 levels. While per capita travel had increased through the 1990s, the rate of increase has slowed considerably during the 2000s, principally due to the increase in gasoline prices. In fact, between 2004 and 2007, per capita travel declined 1.3 percent.
14. Calculated using fuel economy factors from the United States Department of Energy, Energy Information Administration, *Annual Energy Outlook: 2008*.
15. Terry Barker, Igor Bashmakov, et al., “Mitigation from a cross-sectoral perspective,” *Climate Change 2007: Mitigation of Climate Change, Working Group III Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, (Cambridge, MA : Cambridge University Press, November 2007) : 621 <www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter11.pdf>.
16. Statistics cited in “A Smarter Shade of Green,” Technology CEO Council: Washington, D.C., February 2008: 19 <www.techceocouncil.org/images/stories/pdfs/TCCsmartgreen2-1.pdf>.

17. Calculated from U.S. Department of Energy, "Energy Information Administration data for 2008 (cars and SUVs)." See also: <www.bts.gov/publications/transportation_statistics_annual_report/2003/html/chapter_02/greenhouse_gas_emissions.html>.
18. For a review of telework productivity literature, see Ralph D. Westfall, "Does Telecommuting Really Increase Productivity?" *Communications of the ACM* 47(8) (August 2004).
19. Brad Allenby and Joseph Roitz, "Implementing the Knowledge Economy: The Theory and Practice of Telework," Batten Institute Working Paper, 2003 <www.telcoa.org/id146.htm>. See also Edward E. Potter, "Telecommuting: The Future of Work, Corporate Culture, and American Society." *Journal of Labor Research* 24.1 (Winter 2003): 73-84.
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21. Wylie Wong, "Bringing the Office Home," *StateTechMag.com*, (October/November 2008): 28-31.
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44. In 2007, Congressman Chris Shays (R-CT) introduced The Telecommuter Tax Fairness Act (H.R. 1360) to address this issue, and Senator Chris Dodd (D-CT) introduced similar legislation (S.785).
45. Commuting market share data is from the U.S. Bureau of the Census, Decennial Census Data and American Community Survey, 2006.
46. Modes attracting 2.5 percent or more of work trips.
47. Calculated from *Highway Statistics: 2006* (Federal Highway Administration). These figure are an approximation, since highways are also used by trucks and no current, definitive research is available that allocates highway costs to commercial, personal or work travel.
48. Estimated from U.S. Department of Transportation and U.S. Department of Energy data. Assumes city traffic for passenger cars and includes upstream lifecycle emissions. Greenhouse gas emissions for sport utility vehicles estimated at 618 grams per passenger mile. Also see <www.volkswagen.co.uk/volkswagen-world/futures/1-litre-car> and <www.volkswagen.de/vwcms_publish/vwcms/master_public/virtualmaster/de3/unternehmen/mobilitaet_und_nachhaltigkeit/technik___innovation/Forschung/1_Liter_Auto.html>.
49. It is estimated that approximately 80 percent of two-person car pools are composed of household members. Alan E. Pisarski, “Commuting in America III,” Transportation Research Board: Washington, D.C., October 2006) <www.trb.org/CI/III>.
50. There have been some substantial successes, however, such as the El Monte busway-carpool lanes along I-10 in the Los Angeles area and the Shirley highway carpool lanes along I-395 and I-95 in the Washington, DC area.

51. Pisarski, *op. cit.*
52. Based upon average car pool size of 2.22, estimated from U.S. Bureau of the Census, American Community Survey, 2005.
53. Estimated from U.S. Department of Transportation and U.S. Department of Energy data. Assumes city traffic for passenger cars and includes upstream lifecycle emissions. Greenhouse gas emissions for sport utility vehicles estimated at 618 grams per passenger mile.
54. Calculated from U.S. Bureau of the Census, “Demographia: United States Central Business Districts (Downtowns),” Census Transportation Planning Package, 2000 <www.demographia.com/db-cbd2000.pdf>.
55. Calculated from U.S. Bureau of the Census, “U.S. Metropolitan Areas with Largest Central Business Districts: Income by Mode,” Census Transportation Planning Package, 1990 <[www.publicpurpose.com/ut-25cbd\\$.htm](http://www.publicpurpose.com/ut-25cbd$.htm)>.
56. Calculated from U.S. Bureau of the Census governments and National Transit Database information. Subsidies include user fees from personal vehicle petroleum sales.
57. This is principally the result of two factors—a very large central business district and very high population density, both of which contribute substantially to mass transit demand. New York’s central business district (south of 59th Street) has approximately 1,750,000 jobs, more than three times that of the second largest central business district, Chicago’s Loop. New York’s central business district is the second largest in the world, following Tokyo’s Yamanote Loop. The second factor is the exceedingly high population density of the four largest boroughs of New York (Manhattan, the Bronx, Brooklyn and Queens). There are few areas of the world with more people in such a small area (such as Mumbai, Jakarta, Metro Manila and Tokyo’s 23 wards). Only one other U.S. central city has more than one-half New York’s population density (San Francisco), but has less than 1/10th the population.
58. Calculated from U.S. Department of Transportation and U.S. Department of Energy data, “Greenhouse Gas Emissions per Passenger Mile: Public Transport & Personal Mobility: USA: 2005,” <www.demographia.com/db-ghg-carstr.pdf>. Includes power generation, transmission and petroleum refining. Excludes stations, maintenance facilities and administrative facilities.
59. Telework centers are not considered here. Telework centers could be accessed by any mode of work trip travel, such as driving alone, car pool, mass transit or walking. It is expected that commuting to telework centers would involve shorter trips than commuting to principal business locations.
60. This is based upon an assumption that the share of car pools that comprise non-household members is similar across the nation.
61. Las Vegas has an unusually large number of service jobs that require a physical presence, especially on the Las Vegas Strip and other locations with hotels and gaming establishments.
62. Excludes natural growth (births minus deaths) and net international migration.
63. Calculated from U.S. Bureau of the Census data <www.demographia.com/db-intmigra-msa.pdf> and from “3rd Annual Demographia International Housing Affordability Survey: 2007 Ratings for Major Urban Markets,” Data for 3rd Quarter 2006 <www.demographia.com/dhi2007.pdf>.
64. Analysis of U.S. Bureau of the Census domestic migration data (2000-2006).

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