How Much Telecommuting Should We Count On? A Forecast for Tel-Aviv in 2020

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Telecommuting is suggested as one of a series of transportation demand management measures designed to reduce commuting trips. In the process of planning the transportation system for the Tel-Aviv metropolitan area for the year 2020, it became necessary to forecast the extent to which trip tables can be reduced as a consequence of expected levels of telecommuting. In the absence of an appropriate behavioral model to forecast the demand for telecommuting, a simple modeling approach is presented. This model is based on the assumption that, for telecommuting to take place, certain conditions must be met: jobs must be amenable, employers must agree, employees must desire to telecommute, and so on. The simple model assumes the probability that each of these conditions will be satisfied and calculates the number of potential telecommuters and trips eliminated on the basis of the joint probability of the necessary conditions.

Transportation planners are increasingly searching for ways to curb the growth of the demand for travel, particularly of the drive-alone mode. The high direct costs of road construction, the high social costs of automobile ownership and use, in both developed and developing countries, is of increasing concern. Among the variety of means considered, there is a growing interest in the potential substitution of travel by telecommunications (*1–4*). With commuting trips being at the heart of the congestion problems in many urban areas, the options of performing remote work, substituting for commuting, are of particular interest.

Telecommuting is the substitution of commuting by work done at home or in a remote (neighborhood) work center, for part or full time, that has positive effects on congestion. Although at present there is only limited adoption of formal telecommuting arrangements, it is nevertheless desirable to assess the potential of this option in the long term.

The forecasts of telecommuting have largely overestimated the pace of growth of its adoption. Most forecasts have assumed that the potential elimination of unpleasant and costly commuting trips, as well as the flexibility involved in many telecommuting arrangements are so attractive that the option to telecommute will be widely requested. Few forecasts are based on analytical approaches, and even those often fall short of addressing all the relevant issues. Only recently have behavioral modeling approaches been offered (*5*). Formal models at this point are primarily contributing to a conceptual understanding of the role various factors play in the decisions associated with working at home; however, because they are based primarily on self-selected samples, the validity of these factors for forecasting purposes is limited.

As part of the transportation planning for the metropolitan area of Tel-Aviv for the year 2020, a forecast of telecommuting was called for. Specifically, the question posed was the extent to which a reduction in the growth of trip tables can or should be taken into account by planners.

This paper presents the results of a simple approach that provides some forecasts of telecommuting. The second section presents the rationale and essence of the simplified approach. The third section discusses the details of the forecast for the Tel-Aviv metropolitan area and the major findings. Finally, the fourth section presents some conclusions drawn from this study.

SIMPLIFIED APPROACH TO FORECASTING TELECOMMUTING

How much telecommuting will take place in the future is a question of relevance to a number of policy makers, including those involved in the planning of the infrastructure of telecommunications, transportation, real estate, and other social services. In the area of transportation, the specific question is how much substitution can be expected and, hence, to what degree could future trip tables (origin-destination matrices) be reduced?

A variety of forecasting techniques have been used by researchers, producing a very wide range of forecasts (*2*). For example, Nilles (*4*), adopting a technological substitution approach, produced a range of forecasts that may not be sufficiently narrow for planning purposes. The main shortcoming of forecasts presented to date is that they fall short of accounting for the complexity of the telecommuting phenomenon.

A number of studies that attempt to develop behavioral models of telecommuting are under way (*5,6*). However, these are still in their infancy and cannot provide the long-term forecasts necessary for current planning practice.

The approach presented here is a very simple one that relies on an elimination process. It is based on the identification of seven conditions, five of which must be satisfied for telecommuting to take place. On the basis of the likelihood that these conditions will be met, a calculation of the number of trips that can be expected to be eliminated in the future is presented.

In most metropolitan areas, the introduction of new corridors is not a viable option. Increasingly, planners are concerned with the environmental problems of a city and with the consequences of growing congestion on the economy of the metropolitan area. Consequently, the current effort to develop a long-range transportation plan, with 2020 as its target year, has included telecommuting as an option that needs to be considered as a measure to mitigate the growth of commuter traffic in the city.

Very long-range forecasting is subject to numerous limitations, most notably the inability to forecast the values and norms to prevail in future generations. Very clearly it is already possible to observe how today's children assimilate computers differently from

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most adults. However, because forecasts are needed now, some assumptions must be made, in lieu of factual information. To produce a usable forecast, the following forecasting approach makes specific assumptions about these necessary and supporting conditions.

The rationale of a simplified approach involves the following attributes. First, it entails reliance on available data. Second, only a simple "back-of-the-envelope" calculation method is used. In the following example, the calculations were performed on a spreadsheet program. Explicit assumptions are crucial in this approach, as in any other. All of the above attributes result in a quick turnaround, which allows for "sensitivity analyses" to examine the implications of the assumptions integrated in the analysis. The process as applied here consists of a number of stages, as depicted in Figure 1. The model assumes that five conditions must be satisfied, that is, they must have nonzero probability. The conditions are assumed to be independent, and thus the model uses a multiplicative form of joint probability. The model may be used with various levels of detail, depending on the particular need and available resources.

Necessary Conditions for Telecommuting

Seven conditions that enable telecommuting were identified. Five of the seven are necessary conditions that must be satisfied, whereas the remaining two are supporting conditions. They are (schematically) indicated in Figure 1. Each will be briefly discussed.

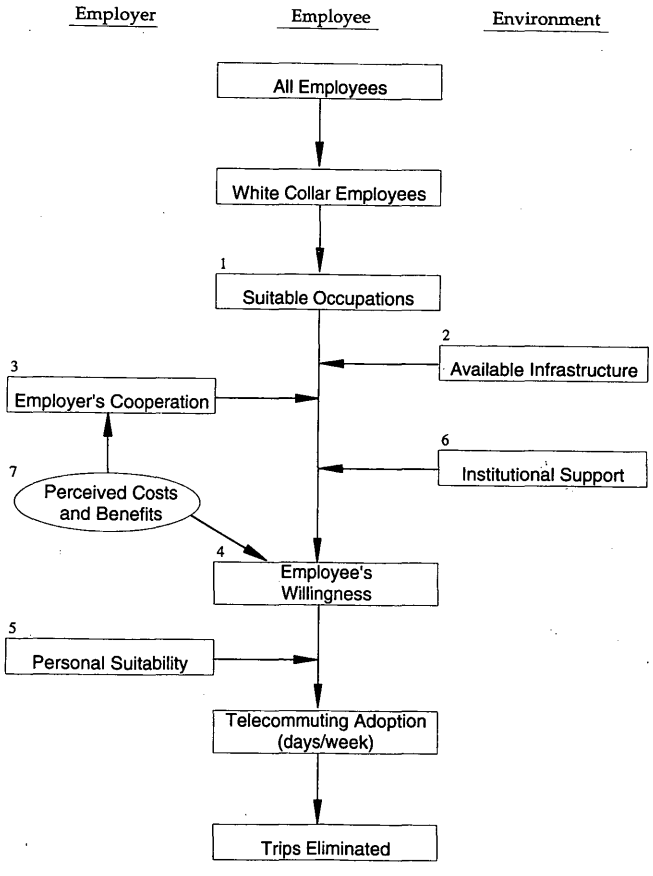

FIGURE 1 Screening process: conditions for telecommuting.

Condition 1: Job Suitability

Not every job can be done from a remote location. Clearly some occupations require on-site performance, as in the case of operation of equipment or personal interaction with the public. Occupations vary in the degree to which they are suitable for remote performance, and it is necessary to identify, for each job description, the extent to which it is amenable for remote operation. This condition will be further elaborated.

Condition 2: Infrastructure Availability

Working from a remote location requires that certain facilities be available to the worker, including such instruments as a telephone, a terminal or a computer, and a modem, but not necessarily all of them.

Condition 3: Employers' Willingness

Workers cannot unilaterally adopt telecommuting. It is necessary that such arrangements be accepted by the employers. Employers' support consists of the organization's stand on telecommuting and to some extent on the attitude of the individual manager who supervises the telecommuter. Both are necessary and may not always coincide. Employers are likely to weigh a number of factors before they engage in supporting telecommuting, such as the following:

1. An expectation that remote work will bring about cost savings, particularly with regard to space requirements. The potential for such savings is not quite clear. On the one hand, the cost of office space is known to be an important factor in office location. On the other hand, in many U.S. cities there seems to be an over supply of office space, resulting in attractive offers by the real estate industry. Moreover, if a large share of the labor force will in fact telecommute, office space costs are likely to decrease and offers may become even more attractive. Another related issue is the question of how much space can, in fact, be saved if employees telecommute only 1 to 3 days a week and hence still require a space in the office. Thus, employers' support on the basis of cost savings may be more of wishful thinking than actual savings.
2. Productivity gains should be expected, or at least no decrease should occur. Numerous reports indicate that the flexibility to work at home does in fact result in productivity gains. Consequently, employers are likely to view telecommuting as a positive measure.
3. There should not be any damage to the employer's image. Some employers may be concerned that having an "invisible" workforce may not contribute to the image of the organization. Moreover, if telecommuting may emerge to have a gender bias, the additional effects on the image may play a role.
4. There will be no opposition on behalf of related institutions, namely the government and the labor unions. This condition is separately discussed, but it is noted here because it may affect the employer's position.
5. The employers are to have the right to decide which employee may engage in telecommuting. One can expect that employers will not allow all employees automatically to engage in such arrangements, on the basis of job requirements, whether real or perceived by particular managers, and on the basis of the individual worker's characteristics.

6. At the managers' level, the question is whether they feel that they can successfully perform their own jobs if their subordinates are not present.

In summary, the employer's position is expected to be based on a series of factors, each of which can be assessed differently by individual employers.

Condition 4: Employees' Willingness

Research on employees' attitudes toward telecommuting and their willingness to engage in such arrangements can be divided to two types. The first emphasizes the benefits side, such as the time and cost savings and the potential increase in family time. This research type is often based on responses to direct questions presented to individuals. In general, these studies suggest a wide-ranging demand for telecommuting arrangements. The second type presents a more critical view, noting that along with the benefits there may also be some costs, such as slower promotion, responsibility for equipment, and social isolation. Thus, this type of research attempts to emphasize a more balanced, some may argue skeptical, perspective.

The decision of individuals of whether to adopt telecommuting is not yet quite understood, and empirical evidence at this point is too limited to identify the likely behavior. It can reasonably be assumed that the market consists of numerous segments, each of which assigns different weights to the variety of benefits and costs associated with telecommuting. In any case, it is unanimously accepted that telecommuting is a voluntary arrangement; hence Condition 4 is defined as being the employee's willingness to engage in telecommuting.

Condition 5: Personal (Employee) Suitability

Personality attributes affect the ability of some people to work by themselves with little or no supervision, whereas others need the office environment to help them execute their tasks. These attributes refer to self-discipline, level of organization, and other factors. Hence, not all people can perform telecommuting satisfactorily (from the employer's perspective and possibly even from their own). Employers require the right to determine who can take part in telecommuting. Some telecommuting consultants who have interviewed candidate telecommuters report that about 70 percent of the candidates can be considered suitable from a personality perspective (*7*). There are no other sources to substantiate this figure.

Supporting Conditions

In addition to the necessary conditions, there are at least two supporting conditions, which, if fulfilled, will strongly encourage the wide-scale adoption of telecommuting. For the long-term forecast, it is assumed that people will be aware of the telecommuting option (*6*), and therefore it is not defined as a condition.

Condition 6: Institutional Support

Working at home in formal arrangements requires that some legal issues be attended to: for example, liability, insurance, and employee rights. Both governments and labor unions need to at least agree to if not support such working arrangements, if these are to be offered to employees.

Condition 7: (Perceived) Costs and Benefits of Telecommuting

Both major actors in the adoption process, the employers and the employees perceive the costs and benefits of telecommuting in ways that do not necessarily reflect the actual costs and benefits. However, it is the perceived value that affects their decision to undertake telecommuting.

Telecommuting is "marketed" on the basis that individuals will enjoy significant savings from the elimination of commuting trips. Common notions on commuting describe it as a cost imposed, particularly on suburban residents, who must spend much time and costs traveling to work. An increase in commuting costs will certainly encourage more individuals to consider the alternative offered by telecommuting. However, telecommuting may not be the single alternative for coping with rising commuting costs. An individual may make a variety of adjustments to reduce commuting costs, such as a change of departure time, a change of mode, use of a more comfortable car, and so on. Thus, telecommuting is just one option of a very wide range of coping strategies (*2*; unpublished data).

Forecasting Potential of Telecommuting for Tel-Aviv

The Tel-Aviv metropolitan area is the largest in Israel. It lies along the Mediterranean coast, with about 1 million inhabitants presently living in it. Most of the current population growth is in the outer ring of metropolitan communities. Consequently, Tel-Aviv is already suffering from severe congestion on the major corridors leading to the central city. At present, Tel-Aviv has only one rail link serving it from the north; thus almost all workers must rely on buses and automobiles for commuting. Tel-Aviv is clearly the greatest center of employment and commercial activities in Israel.

Step 1: Forecasting Total Employment for 2020

The data in Table 1 are for the total labor force in Israel because data at a comparable level of detail for Tel-Aviv are not available. The next step is to determine the share of workers in the Tel-Aviv metropolitan area. The metropolitan area is defined by the Central Bureau of Statistics (CBS) to include the district of Tel-Aviv and some parts of the central district, as shown in Figure 2. In 1989 there were 598,700 employees working in the Tel-Aviv metropolitan area and 683,000 in the central district (including those within the metropolitan part of the district).

The total employment in the Tel-Aviv metropolitan area was forecast under a separate task of the long-range planning process (*9*). The employment forecasts are for three very broadly defined economic sectors: commercial, services, and manufacturing. Assuming that white-collar occupations fall primarily in the second group, the growth assumptions for the 2020 distribution of jobs (Table 2) are based on the growth projected in the study by the Israel Institute for Transportation Planning and Research (IITPR).

TABLE 1 Number of Workers in Job Categories Suitable for Remote Work, 1989 (*8*)

CBS Code		Occupation	Number of employees	Percent Female
0		Scientific and Academic		
	02	Engineers & Architects	27000	12
	05	Lawyers	10000	27
	06	Academics,in Social science[1]	11300	45
	07	Academics in Humanities[2]	6400	78
	0x	Others[3]	4000	--
1		Professional and Technical		
	11	Accounting	8700	14
	12	Authors, artists & Journalists	22500	49
	18	System An. & Programmers	12500	36
	19	Others[4]	6700	16
2		Managers		
	all	Managers	83700	16
3		Clerical		
	30	Supervising Clerks	15800	42
	31	Accounting clerks	75700	66
	32	secretaries and typists	56500	98
	34	Communications workers	5200	(80)[5]
	37	General office clerks	36100	80
	38-9	Other clerks	27000	60
4		Sales workers		
	43	Insurance workers	9700	15

[1] This category includes a variety of occupations who are university graduates and not included in other classifications.

[2] This class includes a large share of teachers.

[3] This includes other employees in class 0 whose jobs are suitable.

[4] Out of this figure, 3000 are in para-engineering (code 176) of whom we assumed 55% may be suitable for remote work.

[5] Low statistical reliability.

Step 2: Forecasting Share of White-Collar Employment

The share of white-collar employment in the Tel-Aviv district is slightly higher than the national average (50.0 percent compared with 46.6 percent). For the target year it has been assumed that the share of white-collar employment in the metropolitan region will remain at 50 percent. This is assumed to be a conservative figure, biased upwards, because it is likely that further suburbanization of employment will disperse these and other jobs to the exurban areas in the central district.

Step 3: Identifying Job Suitability

This step is aimed at the identification of the fulfillment of Condition 1, namely, the job suitability. It involves two stages: one for the current situation and one for the forecast date.

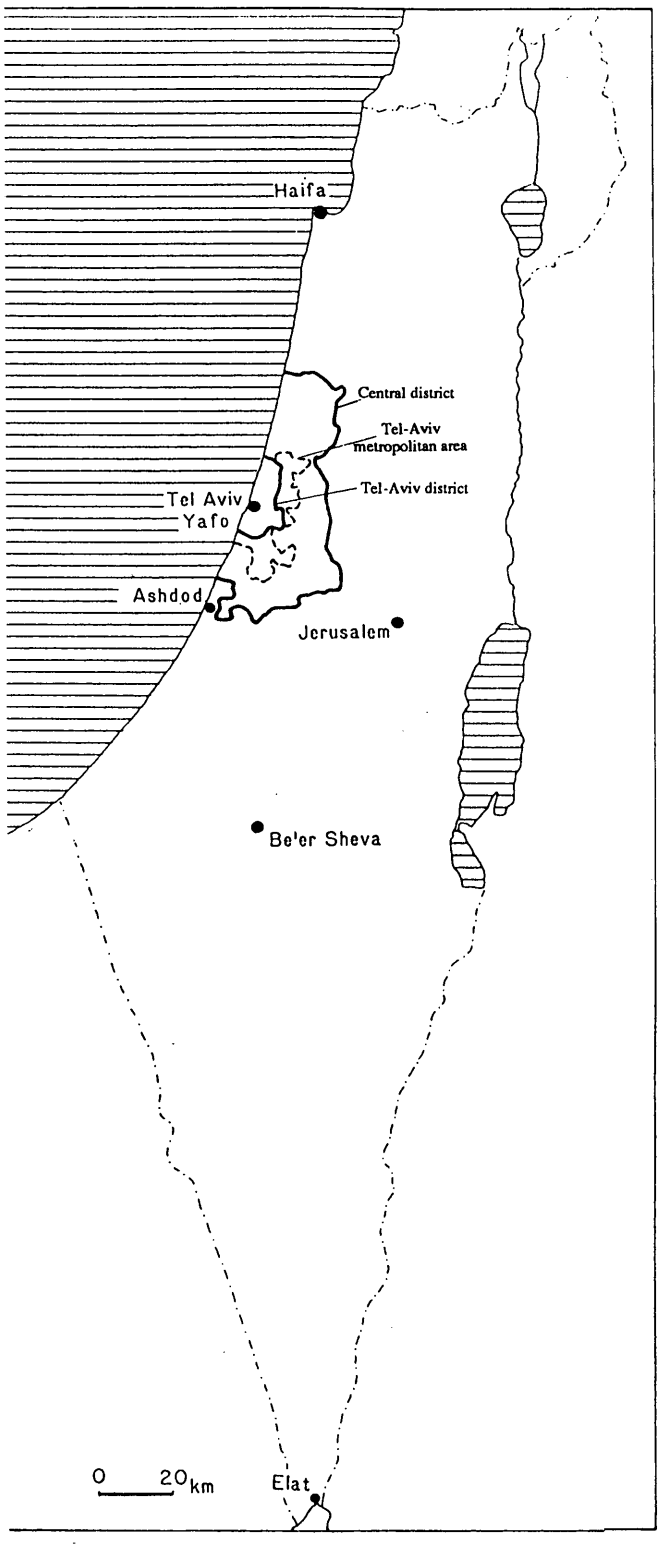

FIGURE 2 Tel-Aviv and central districts of Israel.

Current Job Distribution. For each job type an assumption was made about the share that could perform work from a remote location. Two considerations were taken into account. First, the share of employees assumed to be involved primarily in data or information manipulation, as part of their routine performance. The second criterion was the extent to which the physical presence at the work place is considered important or vital for the performance of the job. For example, whereas in principle teachers could teach from a remote location, at least by present norms, their physical presence at the work place is considered crucial.

Table 1 presents the job categories and the numbers of workers assumed suitable for remote work in Israel for 1989. The table presents the two-digit job classification of the CBS for those occupations whose jobs seem suitable for remote work. The assumptions made on the basis of the two-digit classification may be judged as crude, and a finer analysis of job content on the basis of more detailed classification may be in place. However, for the present context, we accept these assumptions as sufficiently detailed.

The above data represent 51 percent of all employees in the occupation Codes 0 through 4, but there are wide variations. Specifically, in Category 0, the 124,400 employees represent 47 percent of all in that category. In Categories 1 through 4, the respective shares are 22, 100, 86, and 8 percent.

Table 1 also denotes the share of women in each category. Clearly, some occupations are so-called pink occupations in which the share of women is predominant. This point should be considered because the introduction of telecommuting may have differential impacts along gender lines if some occupations are more likely than others to be offered for telecommuting.

Forecasting Occupational Distribution for 2020. This step focuses on the question of whether the distribution shown in Table 1 will change toward the target year. One possible approach to respond to that issue is to adopt a general assumption that Israel will follow a trend evident in other, more advanced economies.

A comparison of the occupation structure in Israel (1989) and the United States [1986 data, based on U.S. Bureau of Census (*10*)] is complicated by the differences in definitions. However, some categories are comparable. For example, the share of systems analysts and programmers is similar in both countries, whereas the share of secretaries and typists in Israel is only 3.86 percent of the labor force compared with 4.82 percent in the United States. This figure indicates that Israel does not lag in information-related occupations but is probably lagging in the level of service in white collar work because of the lower numbers of secretaries.

On the basis of the U.S. forecasts of occupations (*10,* Table 626), the labor force will grow by 19 percent between 1986 and 2000 (intermediate growth assumption), but secretarial and clerical jobs will grow by 7 and 20 percent, respectively. Typists and data entry clerks will increase by 16 and 14, respectively. Systems analysts and computer programmers are expected to increase their share and reach 1 percent of the labor force by the end of the decade.

It can be assumed that in the time horizon considered for this forecast, technological development in machine-readable data entry will reduce the number of jobs in simple clerical and data entry positions. Notably, these are precisely the types of jobs that, from a job suitability perspective, are most amenable for telecommuting.

In Israel, clerical jobs have grown by only 10 percent in the decade between 1980 and 1990 (*11*), whereas professional and technical occupations have grown by 34 percent and managers have grown by 66 percent. To an extent, this growth may be attributed to changes in definitions (which may permit salary increases) but also to the sharp decrease in the number of accounting clerks, which

TABLE 2 Forecasts of Telecommuting by Occupation, 2020

Optimistic Scenario							
A	B	C	D	E	F	G	H
Code	Title	1989	Growth 2020	Emp 2020	% Suitable	Poten. 2020	Poten. 1989
02	Engineers	14108	2.50	35269	70	24688	9875
05	Lawyers	5225	2.40	12540	70	8778	3658
06	Soc.Sci	7054	2.30	16224	80	12979	5643
07	Humanit	3344	2.22	7424	80	5939	2675
0*	Other 0	2100	2.20	4620	50	2310	1050
11	Account	4546	2.35	10683	60	6410	2727
13	Artists etc	11756	2.30	27039	85	22983	9993
18	Compu.pro	6531	3.20	20900	65	13585	4245
19	Other 1	3501	2.40	8402	60	5041	2101
2	Managers	43733	2.40	104960	50	52480	21867
30	Sup. Clerk	8256	2.30	18988	30	5696	2477
31	Accnt.Cls	39553	1.40	55375	60	33225	23732
32	Typists	29521	1.03	30407	75	22805	22141
34	Commun.	2717	2.75	7472	30	2242	815
37	Gen. Clerk	18862	2.45	46213	30	13864	5659
38-9	Oth.Clerk	14108	2.45	34563	40	13825	5643
43	Insurance	5068	2.35	11910	50	5955	2534
Total		219983	2.06	452987		252805	126834
Minimalist Scenario							
A	B	C	D	E	F	G	H
Code	Title	1989	Growth 2020	Emp 2020	% Suitable	Poten. 2020	Poten. 1989
02	Engineers	14108	2.50	35269	40	14108	5643
05	Lawyers	5225	2.40	12540	40	5016	2090
06	Soc.Sci	7054	2.30	16224	30	4867	2116
07	Humanit	3344	2.22	7424	30	2227	1003
0*	Other 0	2100	2.20	4620	25	1155	525
11	Account	4546	2.35	10683	20	2137	909
13	Artists	11756	2.30	27039	40	10816	4703
18	Compu.pro	6531	3.20	20900	40	8360	2613
19	Other 1	3501	2.40	8402	20	1680	700
2	Managers	43733	2.40	104960	25	26240	10933
30	Sup. Clerk	8256	2.30	18988	5	949	413
31	Accnt.Cls	39553	1.40	55375	30	16612	11866
32	Typists	29521	1.03	30407	30	9122	8856
34	Commun.	2717	2.75	7472	10	747	272
37	Gen. Clerk	18862	2.45	46213	10	4621	1886
38-9	Oth.Clerk	14108	2.45	34563	15	5185	2116
43	Insurance	5068	2.35	11910	20	2382	1014
Total		219983	2.06	452987		116224	57658

in turn may be attributed to the increasing role of computers in this area.

Among clerical workers, there was a very slight increase in the number of typists and secretaries and a very significant increase (81 percent) in the number of "general office clerks" (Code 37) between 1986 and 1989. This figure may be indicating an increase in the number of office workers whose work is more complex than simple secretarial work and consequently may be less amenable to telecommuting.

In summary, the expected changes in the distribution of occupations seem to develop in two contradictory trends: on the one hand, an increase in computer-related occupations and on the other hand, a decrease in the number of simple clerical occupations.

Step 4: Defining Range of Conditions Tested

In this step, assumptions are made about the levels of Conditions 2 through 7. In this particular forecasting effort, these levels were collapsed into one step. However, on the basis of the judgment of the forecaster, as to the desired or affordable level of detail, each condition can be treated as a separate step.

Given the nature of the current effort, it was decided that the forecast should lean toward optimistic conditions. Hence, the following was assumed:

1. Condition 2, regarding the availability of the infrastructure, will be set at 100 percent; that is, the infrastructure does not impose any constraint on the adoption of telecommuting. This is an optimistic assumption not because of the availability of the necessary technology but more so because of the treatment of costs, implied in this assumption. Costs are assumed not to hinder telecommuting.
2. Condition 3, the employers' support, is assumed to be satisfied and set to 100 percent. This again means that there will be no opposition on behalf of the employers. This optimistic assumption is adopted on the basis of assumed governmental and public pressure to adopt as many Transportation Demand Management (TDM) measures as possible, telecommuting being one of them. Thus, the assumed high level of employer support is based, in turn, on the assumption that employers wish to take a "politically correct" position.
3. Condition 4 addresses the employees' standing with respect to telecommuting. Here two assumptions were set: one that tends to be more optimistic and a second that tends to be a minimalist position. At present, there is no clear indication of how many employees really would like to telecommute. In response to the simple question, Would you like to work at home?, a simple affirmative response is often given. It is also unclear to what extent the current studies reflect the general population of white-collar employees or just a narrow group of self-selected individuals. More elaborate studies that attempt to model the choice of telecommuting are under way but still do not provide forecasting of this choice. The assumptions made here are thought to refer to the total white-collar segment, including the large number of individuals who work as what may be labeled "manual information workers," that is, they are employed in tasks of information processing that do not require intellectual involvement. The assumption is that these workers may place greater weight on the social interaction at the workplace (*12*), and hence a lower desire to telecommute. The optimistic assumption was set to 80 percent of the employees wishing to work from their homes, and the minimalist assumption was set to 50 percent.
4. Condition 5, personal suitability, was set to 70 percent, on the basis of reports by telecommuting consultants involved in the process of screening individuals at organizations (*7*).
5. Condition 6 refers to institutional support. Again, under the desire to identify the upper bounds of potential trip savings, it was assumed that there is 100 percent support. Government and labor unions are assumed here not to impose any restrictions on the adoption of telecommuting.
6. Condition 7 refers to the perceived costs (and benefits) of telecommuting to the employer and the employee. Given the assumed complete support of employers, their perception is not addressed here and only the employees' perception is discussed here. In the face of increasing congestion, an individual may consider a wide set of responses for coping with these rising costs (*2*; unpublished data). These strategies include a change in departure time, a change of mode, relocation of home or workplace, telecommuting, and although they are last, two unrecognized approaches are seemingly popular coping strategies. The first is the acceptance of costs; that is, individuals adjust by accepting the costs of congestion as a given and lower their expectations and anxiety associated with traveling on congested systems. The second is lowering the costs by improving the amenities during travel—more comfortable cars, air conditioning, better sound systems, cellular telephones, and so on—instruments that effectively lower the costs of the time lost traveling. Other, long-term coping strategies may also be employed. In fact, Gordon et al. (*13*) report that despite claims of rising congestion in American cities, actual commuting travel times do not substantiate the common notions. This may be a reflection of the fact that, although more facilities are congested more hours per day, individuals have adjusted in ways so that similar travel times are maintained. If this is a correct interpretation, then the likelihood of switching to telecommuting because of congestion is somewhat diminished.

In Israel, where it is believed (although not tested by research) that the car serves as a status symbol, the latter strategy is attractive because it fulfills two objectives simultaneously. Hence, rising congestion costs experienced (and expected to continue in the future) in the Tel-Aviv metropolitan area are likely to affect individuals primarily in the direction of a solution that does not necessarily move people out of their cars. The assumption adopted here does not necessarily support telecommuting.

Step 5: Calculations

The results of the simple calculations of the trip reductions are indicated in Tables 2 and 3. The former is the calculation of the distribution of suitable occupations for the Tel-Aviv metropolitan area for the target year (2020). The latter is the actual calculation of trips eliminated by each occupation.

Table 2 is based on the share of employment in the occupations listed in Table 1, and Column C presents the data for 1989 (the deviation from 50 percent is attributed to the inclusion of the city of Ashdod in the metropolitan area in this forecasting effort). Data in Column D are the assumed occupation-specific growth rates that were derived by judgment on the basis of the overall growth rate produced by IITPR (*9*). The resulting number of workers in each category in 2020 are shown in Column E.

As noted earlier, Table 1 includes all workers in each class whose job description is, in principle, a candidate for telecommuting. However, not all employees in these jobs can perform work from a

TABLE 3 Forecast of Trip Reduction as a Result of Telecommuting

Optimistic Scenario							
A	B	C	D	E	F	G	H
Code	Title	1989	Emp 2020	Poten. 2020	Time Away(%)	Screen-ing	Trips Saved
02	Engineers	14108	35269	24688	60	0.56	8295
05	Lawyers	5225	12540	8778	70	0.56	3441
06	Soc.Sci	7054	16224	12979	70	0.56	5088
07	Humanit	3344	7424	5939	70	0.56	2328
0*	Other 0	2100	4620	2310	60	0.56	776
11	Account	4546	10683	6410	70	0.56	2513
13	Artists etc	11756	27039	22983	80	0.56	10297
18	Compu.pro	6531	20900	13585	60	0.56	4565
19	Other 1	3501	8402	5041	60	0.56	1694
2	Managers	43733	104960	52480	50	0.56	14694
30	Sup. Clerk	8256	18988	5696	40	0.56	1276
31	Accnt.Cls	39553	55375	33225	70	0.56	13024
32	Typists	29521	30407	22805	85	0.56	10855
34	Commun.	2717	7472	2242	40	0.56	502
37	Gen.Clerk	18862	46213	13864	25	0.56	1941
38-9	Oth.Clerk	14108	34563	13825	25	0.56	1936
43	Insurance	5068	11910	5955	25	0.56	834
Total		219983	452987	252805			84058
Minimalist Scenario							
A	B	C	E	E	F	G	H
Code	Title	1989	Emp 2020	Poten. 2020	Time Away(%)	Screen-ing	Trips Saved
02	Engineers	14108	35269	14108	25	0.35	1234
05	Lawyers	5225	12540	5016	25	0.35	439
06	Soc.Sci	7054	16224	4867	20	0.35	341
07	Humanit	3344	7424	2227	25	0.35	195
0*	Other 0	2100	4620	1155	25	0.35	101
11	Account	4546	10683	2137	20	0.35	150
13	Artists	11756	27039	10816	50	0.35	1893
18	Compu.pro	6531	20900	8360	40	0.35	1170
19	Other 1	3501	8402	1680	20	0.35	118
2	Managers	43733	104960	26240	20	0.35	1837
30	Sup. Clerk	8256	18988	949	20	0.35	66
31	Accnt.Cls	39553	55375	16612	25	0.35	1454
32	Typists	29521	30407	9122	50	0.35	1596
34	Commun.	2717	7472	747	20	0.35	52
37	Gen. Clerk	18862	46213	4621	20	0.35	323
38-9	Oth.Clerk	14108	34563	5185	20	0.35	363
43	Insurance	5068	11910	2382	20	0.35	167
Total		219983	452987	116224			11499

remote location. Column F presents the assumed share of workers in each category who can telecommute. For example, under the optimistic scenario, it is assumed that 80 percent of the workers in social sciences and humanities (Codes 06 and 07) can become candidates for telecommuting from a job suitability perspective. Similarly, only 30 percent of the supervising clerks can do so because their jobs require much more social presence. Column G presents the number of workers in each category who are defined as candidates, from the job suitability perspective. The total numbers for 2020 are 252,805 and 116,224 workers for the optimistic and minimalistic scenarios, respectively.

Table 3 is a continuation spreadsheet, in which Column E is identical to Column G in Table 2. The next assumption relates to the amount of time each category of telecommuters can stay at home. These assumptions are presented in Column F of Table 3. For example, it is assumed that telecommuting engineers can work from home 60 percent of the time, although general clerks can do so only 25 percent of the time. These assumptions are based on judgments.

Column H in Table 3 presents the screening factor composed of two conditions. First, the personality condition, in which the 70 percent suitability has been assumed for both scenarios, although one may argue that this is an optimistic figure. The second is the employee's willingness condition, which in the optimistic scenario is assumed to be 80 percent and in the minimalistic scenario is assumed to be 50 percent. The product of both conditions is presented in Column G. Finally, in Column G the number of trips eliminated is presented. Under the optimistic scenario this amounts to 84,058 person trips and in the minimalistic scenario only 11,499 trips are eliminated.

IMPLICATIONS AND CONCLUSIONS

The numbers derived from the calculations presented earlier, 84,058 and 11,499 person trips for the optimistic and minimalistic scenarios, respectively, can be challenged on a number of grounds. However, before doing so, it is necessary to translate these figures into policy-making inputs.

First, these numbers represent 5.6 and 0.8 percent of the total number of work trips in the year 2020. Because these are person trips, they must, for planning purposes be translated into vehicle trips. If under an optimistic assumption only car trips are considered and a 1.1 occupancy rate is assumed, then the figures are reduced by about 9 percent. However, a more likely situation is that many of these trips will be diverted from transit because transit is a priori perceived as a less convenient mode of travel and therefore more likely to be traded off for telecommuting; then the numbers are reduced even further.

Although the numbers are relatively small and do not seem to be of a magnitude that justifies a change in the 2020 trip tables, one could refine the assumptions and argue that because congestion is more severe on the radial corridors to Tel-Aviv, the reductions mentioned earlier will not be uniformly distributed in the metropolitan area but are more likely to be realized on congested facilities.

These numbers can also be challenged on the grounds that they are based on either too optimistic or too pessimistic assumptions. Although such arguments are legitimate on the basis of persuasion, it is believed that the two scenarios provide the range of likely outcomes, and for each argument in one direction, a counter argument can be suggested. One particular optimistic assumption that was not explicitly mentioned is that for telecommuting to take place, all parties involved, and in particular the employer and employee, must agree on such arrangements simultaneously. If that fails, the forecasts presented earlier will be significantly lower. The aforementioned assumption that the conditions are independent is also a simplification of reality. It is very likely that some of the conditions are intertwined, and thus the multiplicative form may distort some of the probabilities assumed earlier.

Forecasting a phenomenon with which little empirical experience exists and that carries much hope for relieving problems that cannot be miraculously solved by any single measure is a serious challenge. The simple approach presented in this paper provides an order of magnitude of what can be expected. However, it is necessary to move ahead to behavioral models that can better explain under what circumstances individuals are likely to choose telecommuting in one of the many forms in which it may be offered. Such studies will provide input into the design of policies to encourage trip elimination. An important by-product of such studies will be the explanation of trip generation behavior in situations in which trips need not be made (*14*).

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