COMPANY INCENTIVES AND TOOLS FOR PROMOTING TELECOMMUTING

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ABSTRACT: The aim of this article is to identify company and employee benefits from telecommuting. Telecommuting implies that a large proportion of the company's office space is unoccupied. To use this efficiently, flexible offices could be introduced in which the employees do not have their own office but use any desk in an open office space. In addition, if telecommuting implies reductions in office space in which employees donate the use of their homes—rent free—to the employer, it is quite fair for the employer to consider returning some of that savings to the telecommuters in compensation for the use of their homes. The results indicate that employees are in fact sensitive to the monetary compensation and that company benefits could be obtained.

Keywords: *telecommuting; flexible office; individual preferences; rental savings; mixed logit; work efficiencies; company benefits*

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1. INTRODUCTION

As telecommuting has the potential to mitigate the traffic pressure from work commuting, it is important to identify company benefits to make it more acceptable from a company policy perspective. Benefits commonly referred to in literature include improved work efficiency, personal control, and working atmosphere (Bélanger, 1999; Hill, Ferris, & Märtinson, 2003) and improvements in the company's environmental profile (Arnfalk, 2002; Robèrt, 2000, 2005; U.S. Department of Transportation, 1993).

As there have been high expectations of telecommuting as a traffic-managing tool, an extensive amount of research has addressed impacts on travel patterns as a whole (e.g., Balepur, Varma, & Mokhtarian, 1998; Bernardo & Ben-Akiva, 1996; Mokhtarian, 1998). Further research has dealt with identification of typologies of telecommuters as a way to assess future growth and trends of telecommuting (Drucker & Khattak, 2000; Mannering & Mokhtarian, 1995; Popuri & Bhat, 2003; Sullivan, Mahmassani, & Yen, 1993). Mokhtarian and Salomon (1996a, 1996b, 1997) conducted extensive studies to identify potential attitudinal barriers preventing telecommuting.

Karnowski and White (2002) concluded from their nationwide sample of telecommuting programs in organizations with facility managers that the most important facility management outcomes of telecommuting programs is "efficient space use". However, they further discovered that: "the respondent organizations favoured meeting employee needs over improving productivity, better space use, etc.". In relation to this, they suggested that "the largely unmeasured savings in facility physical assets appear to be worthy of study and wide dissemination". In this study, we try to develop these ideas and investigate if there are potential win-win situations in relation to telecommuting and more efficient use of office space.

The aim is to discover company incentives to promote telecommuting and to find tools that the company can use to promote this work form. The main company incentive addressed here is the potential savings from reduced rental costs that a company may gain from introducing flexible offices simultaneously with telecommuting. Flexible office is an arrangement in which the employees do not have their own office but instead use any desk in an open office landscape, available to several employees at the company. Telecommuting, but also other activities outside the office (e.g., meetings and business trips), implies that a large proportion of the company's office space may be unoccupied. To use this efficiently, flexible offices are a way to optimize the use of square meters.

In addition to the rental savings, other hypothesized benefits that the company may gain from telecommuting are investigated, such as more efficient

employees and reduced stress. These factors are evaluated by the employees' own perception of them. One should therefore keep in mind that the perceived individual efficiency gains may be different from company gains.

We also discuss the future potential of telecommuting arrangement given the present telecommuting situation, focusing on tools that the company can use to promote telecommuting. The propensity to adopt telecommuting is modeled as a function of socioeconomic variables and access to technical equipment, work task suitability, and management attitudes.

2. THE SURVEY

The survey was conducted at the telecom company Ericsson on all employees in the office district (460 employees). The employees received their questionnaires through the company's internal mail system. The questionnaire included stated preference questions designed to confront the respondents with hypothetical choices concerning the employees' monetary valuation of flexible offices and telecommuting habits and preferences. The survey also incorporated a number of questions regarding socioeconomic characteristics and commuting habits. The sections of the questionnaire containing telecommuting and socioeconomic questions are presented in the appendix.

After the employees answered the questions, they sent the questionnaires back anonymously. The response rate was approximately 55% (254 respondents out of the total workforce of 460 employees), which was considered remarkably high in comparison to previous surveys carried out in the company.

After cleaning the data (e.g., omitting respondents not answering the questionnaire completely or answering "do not know" to the stated preference question), the remaining number of observations used in the analysis of flexible offices was 217. However, only 65% of the returned questionnaires could be used in the analysis of telecommuting habits and preferences, as partial missing data was extensive for these questions. Hence, 163 observations were used in that part of the analysis.

Noteworthy is that the population of Ericsson employees in Nacka Strand is expected to be quite homogenous (e.g., the population consists of a higher percentage telecommuting office workers than in Stockholm or in Sweden at large). The figures presented in this article should therefore not be considered as transferable to Swedish employees in general.

Some socioeconomic and work travel characteristics of the employees in the sample are presented in Table 1. The 14% that travel to work fewer than 5

TABLE 1
Data Description on Socioeconomic and Work-Travel Related Variables

Variables	*Number of Employees*	*Percentage*
Commute frequency		
Fewer than five times per week	33	14
Five or more times per week	199	86
Total	232	100
Member in a carpool		
Yes	1	0
No	234	1
Total	235	100
Present type of office		
Private office	124	54
Shared office	19	8
Landscape	80	35
Flexible office	8	3
Total	231	100
Travel mode to work		
Car only	134	57
Public transportation	76	32
Boat	3	1
Other modes	22	9
Total	235	99
Sex		
Female	63	27
Male	170	73
Total	233	100
Age		
Less than 26	1	0
26 to 35	60	26
36 to 45	84	36
46 to 55	46	20
56 to 65	42	18
Total	233	100
Local business trip frequency		
Fewer than 1 trip per month	161	69
1 to 4 trip(s) per month	62	27
More than 4 trips per month	10	4
Total	233	100
Individual income		
Less than 30,000 SEK per month	52	22
Between 30,000 and 40,000 SEK per month	94	41
More than 40,000 SEK per month	85	137
Total	231	100
Number of full telecommuting days		
None	55	34
A few full days per month	67	41
Four full days a month	41	25
Total	163	100

days per week all report that they telecommute at least a few full days per month, and 60% telecommute more than 4 full days per month. Furthermore, the level of income is considerably above the average income level in Sweden because only 22.5% earn less than 30,000 Swedish Krona (SEK) per month and 36.8% earn above 40,000 SEK per month (8 SEK corresponds approximately to 1 U.S. dollar at the time of this study). 73% of the employees are men. A majority of the employees drive to work regularly, and very few travel to work by boat (see Table 1). The category *other modes* in Table 1 includes the employees that reported that they use two or three of the modes in the table and those that use other modes not listed in the table (e.g., bicycle and walk).

A majority of the employees have a private office, but 35% of them have their desk in an office landscape (see Table 1). About 30% of the employees make at least one local business trip per month, and very few of them make more than four such trips per month. Only one of the employees was a member in a car-sharing facility.

3. VALUATION AND PREFERENCES REGARDING TELECOMMUTING

3.1. REASONS FOR PREFERRING AND DISAPPROVING TELECOMMUTING

It is essential to increase the understanding of barriers and facilitators influencing the preference and the actual choice to telecommute, in order to find tools that the company can use to promote telecommuting. The present study shows, in coherence with other studies based on stated preference data (Mokhtarian & Salomon, 1997; Sullivan et al., 1993), that a large number of employees report that they would prefer to telecommute but in fact do not do so. Mokhtarian and Salomon (1996a, 1996b, 1997) have developed a model framework in which they model the choice and the preference to telecommute separately. The gap between the preference and the actual choice they observe is attributed to a lack of external facilitators or constraints (such as family, unsuitable work tasks, a negative attitude from employer, or lack of space at home). A negative preference to telecommute is primarily attributed to internal constraints (such as a need for personal interaction or other psychological factors) or weak lifestyle-related drives (such as long-term objectives related to family, work, hobbies, etc.).

We have therefore chosen to analyze the preference and the choice to telecommute separately, and we first investigated facilitators and barriers

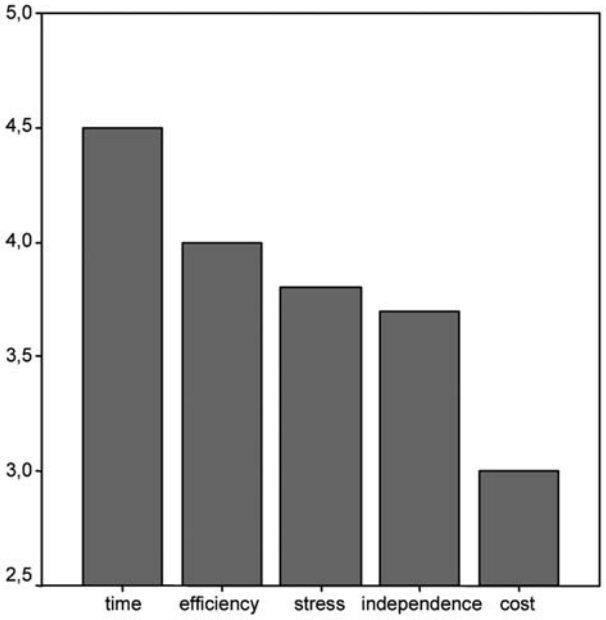

Figure 1: The Importance of Five Hypothesized Incentive Factors As Ranked By Employees Who Prefer to Telecommute More than They Currently Do
NOTE: time = saving time; efficiency = increasing efficiency; stress = reducing stress; independence = having more independence in daily life; and cost = reducing travel costs.

affecting the employees' preference for telecommuting. Employees who reported that they would prefer to increase their current telecommuting frequency (53% of the sample) were asked to grade the importance of the following five hypothesized incentive factors related to telecommuting: saving time (not specified any further), increasing efficiency, reducing stress, having more independence in daily life, and reducing travel costs. To some extent, the results will indicate potential benefits from the company perspective.

As shown in Figure 1, saving time is ranked as the most important reason for wanting to telecommute more (4.5), and increased efficiency at work is ranked as the second most important (4.0). The one given the lowest rank was savings in travel costs (3.0).

The respondents that reported that they had no desire to increase their current amount of telecommuting were asked to rank seven hypothesized constraints or disadvantages with the work arrangement. The rankings of these factors are shown in Figure 2. These may to some extent illuminate down-

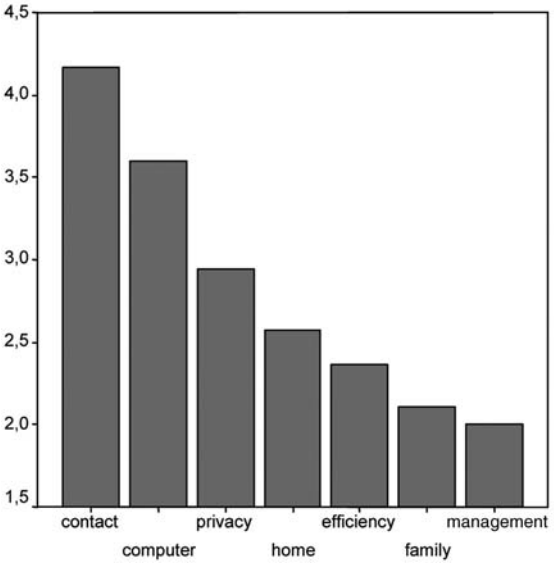

Figure 2: The Importance of Seven Hypothesized Constraints Or Disadvantages, Ranked By Employees Who Do Not Prefer to Telecommute More than They Currently Do

NOTE: contact = lack of contact with colleagues; computer = slow computer equipment; privacy = the dividing line between private life and work weakens; home = no arranged office space at home; efficiency = reduced efficiency; family = distraction from family members; and management = disapproval of telecommuting by management.

sides from the company's perspective. However, such factors may also help to identify constraints that could be removed to promote telecommuting. Factors influencing the actual choice to telecommute will be further investigated and discussed in the following section.

Lack of contact with colleagues and slow computer equipment are stated as the most important disadvantages among the employees not wanting to telecommute more than at present (graded 4.2 and 3.6, respectively). Still, it is important to emphasize that even employees that telecommute regularly were asked to report the reasons for not preferring to increase the telecommuting frequency even more. The disadvantages may thus not be general but depend on the amount of present telecommuting. Neither distraction from family members nor disapproval from management appears to affect the preference to telecommute substantially.

Slow computer equipment could be regarded as a policy measure to promote telecommuting, as it is a relatively important factor. Still, almost all

respondents that have reported slow computer equipment as a constraint have also reported absence of colleagues as the most important factor, which is a psychological constraint and thus difficult to eliminate. The effect of company-sponsored computer equipment as a policy measure to increase telecommuting is therefore difficult to assess. In the following sections, we will further investigate how access to various information technology (IT) equipment influences the actual telecommuting frequency.

3.2. IDENTIFICATION OF TWO EXTERNAL CONSTRAINTS

In this section, we will focus on two immediate barriers that prevent employees from telecommuting more than at present although they prefer to telecommute more: work task suitability and manager's permission. In contrast to mental internal constraints, these are primarily assumed to limit the actual possibilities of telecommuting and are therefore referred to as external. As concluded in the beginning of this section, a large proportion of the employees wished to telecommute more, and we therefore assume that external barriers exist. From a company-policy perspective aiming at increasing telecommuting, particular interest should be paid to overcoming these constraints.

Out of 118 employees who reported that they wanted to telecommute more, 93 had work tasks permitting that, and 84 had the permission from management to telecommute as much as the work tasks permit. The rest answered "no" or "do not know". If both constraints are analyzed together, 65 of 118 employees who prefer to telecommute more frequently neither lack suitable work tasks nor are prohibited from doing so by the manager. For them, the reason for not telecommuting more is still not known. Still, of the 118 employees who prefer to telecommute more, 53 are prohibited from telecommuting more or do not know whether they are prohibited by at least one of these constraints.

In particular, a rather large proportion of these respondents report that they do not know whether the manager would allow telecommuting as much as the work tasks permit although they would prefer it. This could either be explained by the fact that they do not dare to ask or do not have sufficient motivation for asking. The reason for not knowing the work task suitability is likely because of inexperience with telecommuting, which results in an uncertainty as to whether work tasks are really suited for this work form.

3.3. MODELING THE PROPENSITY TO TELECOMMUTE

To further investigate some hypothesized barriers or motivations for telecommuting, we modeled the propensity to telecommute as a function of socioeconomic data, IT equipment access, and manager's permission to telecommute as much as the work task permits, as reported by the employees. Most important for identifying constraints or incentives were of course IT equipment access and manager's permission to telecommute as much as the work task permits. The reason for including socioeconomic variables was partly to control for them. However, socioeconomic factors that are correlated with telecommuting adoption may also help to understand motivators for, and hence the process of, adopting telecommuting. This may provide valuable background knowledge when promoting telecommuting.

In this study, an ordinary multinomial logit model (MNL) was employed. Four alternatives were first defined in the model: telecommuting no full days, a few full days per month, more than 4 full days per month, and several full days per week. As only seven respondents reported that they telecommute several full days per week, this alternative was merged with the alternative representing more than 4 days per month. Hence, the final model consisted of three alternatives:

Alternative 1: No full days (base alternative)
Alternative 2: A few full days per month
Alternative 3: Four full days per month or more

Letting n represent an individual and i an alternative, the utility of alternative i for individual n is formally defined as the following:

$$U_{ni} = V_{ni} + \varepsilon_{ni} \tag{1}$$

in which

$$V_{ni} = \beta_{0i} + \beta_{1i}H_n + \beta_{2i}W_n + \beta_{3i}I_n \tag{2}$$

V_{ni} is the deterministic part of the utility function, and ε_{ni} is a stochastic component assumed to be independently and identically Gumbel distributed. The β parameters correspond to variables or attributes of importance to the choice decision (e.g., the propensity to telecommute). Positive values of β correspond to an increased utility related to increases in the certain variable, whereas negative values correspond to a disutility. If a variable has a t statistic

above 1.96 (absolute value), the hypothesis that the variable does not have an impact on the individuals' choice decision could be rejected at a 95% significance level. Different β vectors were defined for the two alternatives representing 4 full days per month or more and a few full days per month, respectively (i.e., $i = 2$ or 3). The alternative representing no full telecommuting day ($i = 1$) was taken as the base alternative and was thus not assigned any parameters to be estimated (i.e., $V_{n1} = 0$).

H_n is a vector of individual and household characteristics. This vector includes variables such as age, gender, and dummy variables for those who normally use the car for commuting and for women with or without children. W_n is a vector of employment-related characteristics including the number of business trips per month and the manager's permission to telecommute as much as the work task permits. Preference to telecommute at a satellite office rather than from home is also included, assumed to work as a proxy variable for lack of space at home. Finally, income class is included in this vector. This variable takes the value 1 through 6, representing range of monthly income before tax: less than 20,000; 20,000 to 29,999; 30,000 to 39,999; 40,000 to 49 999; 50,000 to 59,999; and above 60,000 SEK.

The vector $I_n$contains variables related to IT access, such as company-sponsored laptop and broadband at home. Broadband was defined as any type of Internet connection that is not modem based. To have a permanently installed computer at home, sponsored by the company, was also meant to be included in this vector but was excluded, as only two employees had this facility.

The probability (P_{in}) that individual n will choose alternative i is then given by the standard MNL:

$$P_{in} = \frac{e^{Vin}}{\sum_j e^{Vjn}} \tag{3}$$

3.4. MODEL RESULTS

In this section, the modeled parameter estimates are presented (see Table 2).

Socioeconomic Variables

Women with children (1 to 18 years) have a significantly higher propensity to telecommute than others do. At a 90% level of significance, we found

TABLE 2
Model of Telecommuting Frequency

Parameter Description	*Parameter Estimate*	*t Statistics*
Woman without children[b]	–1.07	–1.59
Woman with children[a]	2.28	2.87
Woman with children[b]	1.52	1.76
Driving to work[a]	–0.90	–2.45
Age 46 to 55[b]	–1.60	–2.56
Age 46 to 55[a]	–0.67	–1.43
Laptop[a]	1.28	2.15
Laptop[b]	2.36	2.17
Broadband[a]	0.79	1.69
Broadband[b]	–0.73	–1.10
Alternative specific[a]	–0.64	–1.13
Alternative specific[b]	–2.03	–1.28

NOTE: The base alternative represents no full telecommuting day. Variables having *t* statistics of at least 1,96 and 1,65 are significant at a 95% and 90% level, respectively. Total number of observations = 163; log-likelihood value = –155.22.
a. Alternative 2, representing a few full days per month.
b. Alternative 3, representing 4 full days per month or more.

that women without children have a lower propensity than men to adopt the highest telecommuting frequency (Alternative 3). Men with children do not increase their telecommuting frequency compared to men without children. The variable *men with children* was therefore excluded from the model specification.

The age effect is rather weak, but employees between 46 and 55 years old are significantly less inclined than others to telecommute 1 day or more per week (Alternative 3) as compared to those not telecommuting at all (base alternative).

Finally, those who drive a car to work on a regular basis have a significant decreased propensity to be choosing Alternative 2 (i.e., telecommuting a few full days per month).

Work-Specific Variables

The income variable did not have a significant impact on the telecommuting frequency. The income variable was therefore excluded. To ensure that the reason for the weak income effect was not a falsely assigned function form, the estimated model's predicted number of observations in the sample was compared to the actual number of observations for different income classes. No large mismatch between the predicted and the observed number

of observations for different income classes could be observed, which strengthened the hypothesis that income does not have a significant impact on telecommuting. The absence of the income effect was somewhat surprising. In a telecommuting choice model including a broader category of Swedish employees (Börjesson, 2003), this variable was the most significant one to the propensity to telecommute, whereas in the present model, it was not significant at all. The reason is likely to be that all the respondents in this sample have a rather high income compared to the average worker in Sweden. Age and gender effects are similar in both studies.

The number of business trips did not have any effect on the telecommuting frequency, and neither did the wish to work from a satellite office instead of from home. This result is consistent with Figure 2, showing that having no arranged office space at home was not considered as an important obstacle for telecommuting. Permission from management to telecommute as much as the work tasks permits was not significant, which is also consistent with Figure 2.

Variables Related to IT Equipment

There is a problem of proving the causal effect of telecommuting and IT equipment in general. As for company-sponsored laptops, it may very well be the case that respondents that the employer allows to telecommute receive one, but for others, the employer is not interested to pay for one. Still, in the model we test the correlation between these equipments and the telecommuting frequency.

Access to a laptop from the company proved to have a positive and significant effect on both frequency alternatives. However, only 12% of the respondents lacked a company-sponsored laptop, which indicates that it is likely to be perceived as a prerequisite for telecommuting. Access to broadband at home is not significantly different from 0 for Alternative 3, although slow computer equipment was one of the highest ranked constraints for preferring to telecommute more. Nevertheless, this variable has a positive effect at a 90% significance level, on less frequent telecommuting (Alternative 2) compared to both no telecommuting and more frequent telecommuting. Having a broadband connection at home is much rarer than having a laptop (most likely because of the fact that the company does not sponsor the broadband connection). Only 26% of the respondents had a broadband connection at home.

4. VALUATION OF THE FLEXIBLE OFFICE

To investigate the potential benefits of introducing flexible offices, we explicitly test the employees' monetary valuation of their private offices in comparison to a flexible office place, at a particular working site of the IT company Ericsson, located in Stockholm, Sweden. We analyzed the following questions using a mixed logit model (MXL):

- Would a monetary compensation affect the employees' willingness to accept a flexible office, and if so, how does the probability of accepting it correlate with the monetary compensation?
- Can the company afford to give a sufficient monetary compensation to make the employees accept the flexible office and still obtain net savings from reduced rental costs?

We have also derived an example of the company's estimated rental savings for one of the most favorable levels of compensation (e.g., one of the most beneficial win-win situations).

Many companies (e.g., some departments at Ericsson, Telia, Vattenfall, and Siemens) have applied flexible offices as an attempt to reduce workspace. The latter three still keep this arrangement at some of their departments. At most Ericsson departments, however, the flexible office arrangement has been abandoned as a consequence of negative employee attitudes. As reported by Rapp and Rapp (2001), the main reason for those negative employee attitudes is that it implies a more intimate working atmosphere with colleagues. Answering questions and helping coworkers resulted in a feeling of reduced individual efficiency. However, according to their study, better communication among employees improved teamwork substantially, resulting in increased overall work efficiency in the company. To avoid this dilemma, they suggested a new incentive structure within the company, rewarding group accomplishments instead of individual achievements.

The fact is that employees perceive advantages related to telecommuting such as increased efficiency at work, saved time, and reduced stress points at a potential correlation between telecommuting and more productive personnel. However, these positive aspects (reviewed from the employees' perspective) cannot simply be converted into monetary gains for the company. One of the potentially most important company benefits from telecommuting is therefore reduced rental cost. However, these gains are real only if the company can use the free space left by a telecommuter. One means to accomplish this is to introduce flexible offices, which, however, may appeal less to the

TABLE 3
The Stated Preference Question Given to the Respondents

Alternative A	*Alternative B*
You receive a salary increase of *X* SEK per month, and everyone at your department changes workplace to flexible office rooms.	Everyone at your department keeps the present workplaces.

Which alternative would you choose, considering your present workplace?

- Undoubtedly Alternative A
- Probably Alternative A
- Probably Alternative B
- Undoubtedly Alternative B
- Don't know

employees. Accordingly, we model the employee's valuation of their present stationary office in comparison to a flexible office compatible with telecommuting. Such monetary compensation would, on the other hand, reduce the company's net profit. As a calculating example, we elaborate the most profitable compensation level from the company's perspective.

Hence, in this section, we analyze a more direct economic motive for promoting telecommuting within the company by explicitly analyzing the employees' willingness to use this compressed form of workspace to save rental costs to the company.

4.1. METHOD

To test the employees' potential acceptance of changing their present office room to a flexible office, we first defined what was intended:

> A flexible office is designed as an office landscape, with more or less extensively restricted workplaces. When the employees appear at the office, they use foldaway desktops, plug in the laptop to the Internet in a prepared connecting plug; i.e, no private work places exist. Paper storage is arranged in a common bookcase.

To estimate the average probability of changing the present office place to this alternative, the respondents were asked to answer the following stated preference question (see Table 3).

The monetary compensation (*X* in the stated preference question above) was assigned values of 0; 500; 1,000; 2,000; 4,000; and 8,000 SEK. Each respondent was presented with only one single question to avoid bargaining bias. In other words, if they had repeated choice situations, the respondents might compare different levels of monetary compensations and choose Alternative A only at the highest level. The levels of attributes were first tested in a focus group interview and a pilot study. The respondents were also asked to state their present workplace (private office, office landscape, flexible office, other) for us to trace dependency between this parameter and the probability of accepting the flexible office.

In the analysis, we explicitly tested the deviations in results if we include or exclude the more uncertain respondents answering "probably alternative A" or "probably alternative B" in the sample. This, however, showed no significant impact on the estimated parameters, and we decided to include all 217 observations in our analysis.

When studying the employees' monetary valuation of a flexible office, we wanted to take special consideration of the potential diversity in preferences and prerequisites in the population. For instance, work tasks might prevent some employees from adopting a flexible office, regardless of the amount of the monetary reward. To determine the monetary valuation of the flexible office, we therefore used a MXL, as this model allows individual variation in parameter values (see Hensher & Greene, 2003; Revelt & Train, 1998). In MNLs (see Equations 1, 2, 3 in Section 3.3), the preference vector (β) is assumed to be constant for all individuals *n* in the population (Ben-Akiva & Lerman, 1985). This assumption does not take taste differences into account. In the MXL, the restriction is eliminated so that the valuation of the attributes is permitted to vary for different individuals in the population (i.e., the standard deviation of parameters is incorporated). One could intuitively expect that the reduction of aggregation in the parameter estimates would therefore improve the model performance (see the appendix for theory and estimation techniques of this model).

In addition to the monetary compensation (bonus), we also constructed seven dummy variables to see if there were certain socioeconomic characteristics correlated to the willingness to accept a change of workplace. These were the following: sex, age (younger or older than 35), income (less or more than 35,000 SEK per month), work trip (5 or more work trips per week, versus fewer than 5), telecommute (being a telecommuter or not), telepref (willingness to telecommute more or not), and finally workplace (a dummy variable of having private office room or not).

TABLE 4
Model of Willingness to Accept Flexible Office

Parameter Description	*Parameter Estimate*	*SE*	*t Statistics*
α_i	–1.15	0.35	–3.31
Bonus (β_{mean})	0.0012	0.00056	2.10
Standard deviation (β_{sd})	0.0019	0.0012	1.60

NOTE: The hypothesis that a variable does not have an impact on the individuals' choice decision can be rejected at a 95% significance level if the *t* statistic is above 1.96 (absolute value). Total number of observations = 217; Mixed logit model draws = 20,000; log-likelihood value = –136.91.

4.2. RESULTS

We specified both an MXL model and an MNL model for testing the probability of accepting a specified flexible office, as dependent on a monetary compensation and the probability to accept the flexible office dependent on the socioeconomic variables. The explanatory power of the MXL model was stronger than the MNL model, and the standard deviation was significant for the monetary valuation of the flexible office. For the socioeconomic variables, only the MNL model converged, limiting us to use this model solely for estimation of these variables. Variables having *t* statistics of at least 1.96 (see Table 4) are significant at a 95% significance level. In the one-sided test (here used for testing the significance of standard deviation), the *t* value has to be no more than 1.6 to show a 95% significance level. The estimated results from the MXL model are presented in Table 4.

The MXL model showed that a monetary compensation would have a considerable impact on the employees' willingness to choose a flexible office instead of their present workplace (the parameter estimates of the monetary compensation was significant at a 95% significance level; see Table 4). Even the standard deviation is significant at a 95% significance level using a one-sided test (*t* statistic = 1.6). This supports the expectation that there are in fact evident taste variations in the population (which would motivate the use of the MXL model). Figure 3 presents the dependency between the amount of monetary compensation and the probability of accepting a flexible office. We choose to show the modeled probability estimations at compensation levels of 0; 500; 1,500; and 2,000 (SEK).

Three of the seven dummy variables tested (in the MNL model) showed significant parameter values. These were sex, age, and work trip. The four remaining variables (income, telecommute, telepref, and work place), were far from significant, having *t* statistics ranging between 0.36 and 1.06. We

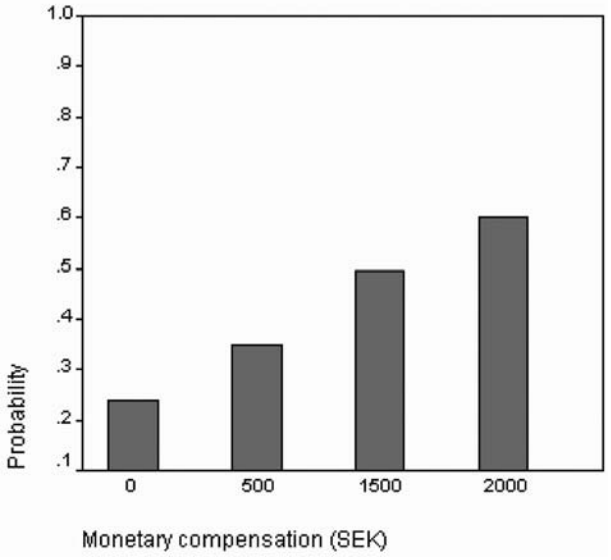

Figure 3: Average Probability to Accept Flexible Office, as Dependent on the Monetary Compensation (SEK) and Predicted by the Mixed Logit Model

TABLE 5
Socioeconomic Differences for Willingness to Accept Flexible Office

Parameter Description	*Parameter Estimate*	*SE*	*t Statistics*
α_i	1.48	0.55	–2.71
Bonus (β_{mean})	0.0022	0.00059	3.67
Standard deviation (β_{sd})	0.0019	0.0012	1.60
Sex	–1.04	0.35	–2.99
Age	–0.64	0.31	–2.09
Commute	–1.08	0.47	–2.29

NOTE: Significance was tested at a 95% level (*t* statistic 1.96). Total number of observations = 217; log-likelihood value = –131.93.

therefore constructed a model consisting solely of the significant variables: bonus, sex, age, and work trip. The MNL estimates are presented in Table 5.

From Table 5, we see that the monetary bonus is significant at a 99% confidence level, even if factoring in the three socioeconomic variables (*t* statistic = 3.67). Furthermore, men seem to be more willing to accept the flexible office than women are (*t* statistic = –2.99), and employees younger than 35

tend to be more willing to accept the flexible office than older employees are (t statistic = –2.09). Finally, as one could expect, people traveling fewer than 5 days to work per week tend to be more willing to accept the flexible workplace (t statistic = –2.29).

4.3. NET BENEFITS OF INTRODUCING FLEXIBLE OFFICES

From the estimated probability of accepting a flexible office presented in Figure 3, we could make approximate predictions of the number of employees accepting flexible offices if they had the opportunity to choose. To estimate the savings of introducing flexible offices, we have made a simple calculation using the following assumptions:

- Number of employees: 500
- Level of compensation: 500 SEK per month
- Payroll tax: 40% of the yearly compensation
- The rent of a stationary office in Nacka Strand: 6,000 SEK per month (Bolmgren, personal communication, December 20, 2003).

At a compensation rate of 500 SEK per month, approximately 40% of the employees are willing to accept flexible offices, according to the model (see Figure 3). That makes 200 out of 500 employees willing to accept flexible offices. According to the case presented by Rapp and Rapp (2001), half of the office area was reduced for those adopting flexible offices. This is also used in the calculated example of the company's potential economical savings for introducing flexible office in combination with a monetary bonus system:

Saved money for office space:
6,000 SEK per workplace×100 workplaces = 600,000 SEK

Total compensation to 200 employees, sharing 100 flexible offices:
200 employees×(500/0.6) SEK per employee = 166,667 SEK

Hence, the company benefit from introducing flexible offices is the following:

(600,000 – 166,667) SEK per month = 433,333 SEK per month

At the four levels of compensation (0; 500; 1,000; 2,000 SEK per month) presented in Figure 3, the net benefits are largest at a compensation rate of 500 or 1,000 SEK per month, according to the MXL model. These two levels

gave roughly the same net benefit. These calculations correspond well to cost reductions in another telecommunication company in the district (Telia), in which the company leadership introduced flexible offices and promoted telecommuting. They have reduced the office space per employee by about 30%, from 34.8m^2 to 24.6m^2, resulting in a rental cost reduction of 22,400 SEK per year. The total number of employees at this department is 650, resulting in annual savings of approximately 14.59 million SEK and a reduction of about 200 office places.

5. DISCUSSION

According to the employees' perception of advantages and disadvantages of telecommuting, the company is likely to receive net benefits from telecommuting itself. A majority of the employees who preferred to telecommute more state that they become more efficient and save time when telecommuting. In addition, reduced efficiency and distraction from family members were perceived as the least important factor causing a resistance to telecommute more than at present. Increased efficiency is therefore a factor that could serve as an incentive for the company to promote telecommuting. One interesting issue from a company beneficial perspective is also whether the saved time is converted into the employee's off-duty or on-duty hours. One could well expect that some of the employees' saving of time could be used to increased work time, which would be of value for the company.

Yet the perceived individual efficiency gains might be different from the tangible company gains. This dilemma was stressed by Rapp and Rapp (2001), noting that more contact among colleagues, as a result of introducing flexible offices, may increase the company efficiency but somewhat reduce the perceived individual efficiency. In reverse, less contact between colleagues (caused by telecommuting) may therefore increase efficiency as perceived by individuals but cause a reduced efficiency at the company level. In the present study, lack of contact with colleagues and a weakened dividing line between private and work life were important factors for the unwillingness to telecommute more than at present. This fact may, for the reasons stated above, not only be a mental constraint for not wanting to telecommute more but also reflect the risk that telecommuting may reduce company efficiency.

In Sections 3.2 and 3.3, we investigate hypothesized barriers and motivations for adopting telecommunication to find tools that the company can use to promote telecommuting. Because more than half the respondents pre-

ferred to telecommute more than at present, we assume that there exists external barriers preventing telecommuting. The fact that the probability of telecommuting increases when having access to a company-sponsored laptop indicates the importance of suitable technological equipment for the ability to telecommute.

The fact that all but 12% of the respondents had a company laptop indicates that the technical prerequisites are rather good already, and that this might be one of the reasons for the high telecommuting frequency in the present case study. This conclusion is verified by a Dutch study (Peters, Tijdens, & Wetzels, 2004) showing that having a personal computer at work increases the propensity to telecommute substantially. Sponsoring computer equipment at home or providing laptops could perhaps serve as a means to show that the company encourages telecommuting actively, which in itself may make it more accepted. However, the role of IT as a promoting tool should not be exaggerated, as it is far from the only factor necessary for telecommuting. In addition, the employees are likely to need such equipment anyhow to be more flexible and to be able to work extra from home when that is required.

As perceived by a large proportion of the employees, suitable work tasks or prohibition from managers were identified as constraints for telecommuting. Hence, by trying to remove these constraints, the telecommuting frequency is likely to increase as a whole. For all but the most frequent telecommuters, the ability to organize work so that suitable work tasks could be saved for the telecommuting day is rather good, according to this study. Work task constraints such as meetings and security issues may, however, be difficult to remove. Of these two constraints, manager's permission seems to be the one easiest to remove because it is more easily influenced from a company policy perspective. Although the management does not prohibit telecommuting, there is a large difference between actively promoting it and accepting it but showing a negative attitude.

The most direct company benefit from introducing telecommuting is rental savings, on condition that a flexible office is introduced simultaneously. In Section 4, we therefore tested the employees' willingness to accept a flexible office in exchange for their present one. Monetary compensation proved to have a significant impact on the employees' propensity to accept the flexible office. This verified our hypothesis that making the employees share the rental savings from compressed office space would imply a better acceptance of this work arrangement.

Our expectation was that persons having their own office would be less willing to change workplace than, for instance, those sitting in landscaped

offices (because we expected that private office rooms were perceived as more attractive). To our surprise, no significance was evident regarding the respondents' present workplace. However, male employees and employees younger than 35 tend to be more willing to accept the flexible office, which might result from the fact that these groups have more flexible work tasks or that they are more open to changed work conditions in general. The variable identifying telecommuters was insignificant, but this is hardly surprising because this variable is correlated with the weekly number of commutes, which was a significant variable. Those who make fewer than five commutes per week were probably more willing to accept flexible office because they spend, on average, less time at the office. Telecommuters (who are more likely to commute fewer than five times per week) may also be more open-minded to new work arrangements. This means in fact that telecommuters demand less compensation to accept a flexible office than others do.

According to the calculations in Section 4.3, the company may gain net savings from reduced rental costs although compensating the employees for accepting a flexible office. However, these predictions should not be over-interpreted. An important limitation is the implicit assumption that the monetary compensation would be the only factor determining the willingness to adopt a flexible workplace. Certainly, there are other factors influencing the choice probability as well. This is revealed in the significance of the standard deviation in the MXL, leading us to believe that the flexible office does not suit all work tasks and all employees in the sample. The fact that other factors besides monetary compensation also has an impact on accepting a flexible office is verified from the significance of the parameters α_i in Tables 3 and 4 and in the other variables in Table 5. Of course, a more thorough investigation would identify countless incentives and obstacles influencing the choice to accept the flexible office other than the magnitude of the monetary bonus tested in this study.

Our objective in this study is not to predict the company's exact financial savings, but the study indicates that there might exist an economic rationale for testing the idea. The potential monetary savings from flexible office arrangements are determined by future telecommuting trends. The idea of introducing flexible offices in combination with facilitating telecommuting is therefore not far-fetched, in particular because telecommuters demand less compensation to accept a flexible office than others do. However, the telecommuting frequency among the studied group is already substantially higher than in the Swedish workforce on average. Even the fact that employees regularly spend time at meetings, business trips and other activities outside the office would contribute to the prospects of reducing the office space.

6. CONCLUSIONS

In summary, there seems to be a majority of employees who want to telecommute more. We therefore believe that it should be possible to increase the telecommuting frequency, in this case as in many others, by changing the management attitudes and perhaps also sponsoring further computer support and equipment to the employees. This study further indicates that the employees' perceived increase in work efficiency from telecommuting is ultimately profitable to the company. We also conclude that monetary compensation to the employees for accepting a flexible office might imply a profitable win-win situation, which, particularly in combination with telecommuting, could bring rental savings to the company.

Accordingly, telecommuting is most profitable if the company simultaneously implements flexible offices and compensates the employees for this. To offer "packet solutions", in which the company allows telecommunication conditionally on the employees' acceptance of flexible offices, could therefore prove to be an effective reorganization of the work. In reverse, this kind of packet solution might reduce the levels of the monetary compensations for introducing a flexible office, suggested in Figure 3. This conclusion can be drawn because employees commuting fewer than five times per week (telecommutes) demand less compensation for accepting a flexible office than others. Furthermore, by offering this kind of package solution, the company could use the positive employee attitudes toward more telecommuting as an argument for promoting acceptance of flexible offices. Some of the extra monetary rental savings could be used for sponsoring computer equipment and support to the telecommuters to decrease obstacles to telecommuting. Hence, flexible offices, in combination with promotion of telecommuting, could contribute to a win-win situation, in which both the employees and the companies could find incentives to telecommuting (and ultimately, even the society at large from a macroscopic environmental perspective).

The idea of economically compensating employees who telecommute in combination with reducing their office space is not too far-fetched. Employees who telecommute without corporate compensation are in effect donating the use of their homes, rent-free, to the employer, and thereby potentially saving the employer lots of rent. It is quite fair for the employer to consider returning some of that savings to the telecommuters in compensation for the use of their homes. As a direction for future research, it would be desirable to survey employees with respect to the adoption of telecommutes and flexible office space as a package in return for additional compensation.

APPENDIX A
Questionnaire

BACKGROUND QUESTIONS

1. At what company do you work?
2. How many trips from home to Nacka Strand do you do per week?
   - ❑ <1
   - ❑ 1
   - ❑ 2
   - ❑ 3
   - ❑ 4
   - ❑ 5
   - ❑ >5
3. How often do you travel local business trips in Stockholm?
   - ❑ Never
   - ❑ Fewer than 1 trip per month
   - ❑ 1 to 4 trips per month
   - ❑ Several trips per week
4. Do you have a driver's license?
   - ❑ Yes
   - ❑ No
5. Do you have access to a company car?
   - ❑ Yes
   - ❑ No
6. Are you a member of the carpool?
   - ❑ Yes
   - ❑ No
7. What travel mode do you use for your commutes?
   - ❑ Car all the way
   - ❑ Boat (possibly in combination with other travel modes)
   - ❑ Public transportation (possibly in combination with other travel modes, except boat)
   - ❑ Other
8. How many persons live in your family, including yourself?
   - ❑ Grown-ups (older than 18 years) _____ persons
   - ❑ Small children (0 to 6 years) _____ persons
   - ❑ School children (7 to 18 years) _____ persons
9. Some personal information
   a. Age
      - ❑ Younger than 26 years
      - ❑ 26 to 35 years
      - ❑ 36 to 45 years
      - ❑ 46 to 55 years
      - ❑ 56 to 65 years
      - ❑ Older than 65 years

b. Gender
- ❑ Woman
- ❑ Man

c. Income per month (before tax)
- ❑ Less than 20,000 SEK
- ❑ 20,000 to 29,999 SEK
- ❑ 30,000 to 39,999 SEK
- ❑ 40,000 to 49,999 SEK
- ❑ 50,000 to 59,999 SEK
- ❑ 60,000 SEK or more

QUESTIONS REGARDING HABITS AND ATTITUDES TOWARD TELECOMMUTING

Telecommuting is here defined as carrying out regular work during office hours from home instead of from the office.

1. Have you, during the past 12 months, telecommuted from home during office hours?
   - ❑ Yes
   - ❑ No→please go directly to Question 4
2. On average, what is your average frequency of whole telecommuting days?
   - ❑ No whole days
   - ❑ Some days per month
   - ❑ 3 to 4 days per month
   - ❑ Several days per week
3. On average, what is your average frequency of part-time telecommuting days (e.g., half day home and the rest at the office)?
   - ❑ No whole days
   - ❑ Some days per month
   - ❑ 3 to 4 days per month
   - ❑ Several days per week
4. What is your computer status at home?
   - ❑ Own permanently installed computer, connected to broadband
   - ❑ Own permanently installed computer, connected to modem
   - ❑ Permanently installed computer sponsored by the company and connected to broadband
   - ❑ Permanently installed computer sponsored by the company and connected to modem
   - ❑ Company-sponsored laptop, connected to broadband
   - ❑ Company sponsored laptop, connected to modem
   - ❑ Computer without Internet connection
   - ❑ None of the above alternatives

5. Do your work tasks allow you to telecommute more from home than at present?
   - ❑ Yes
   - ❑ No
   - ❑ Don't know
6. Would your employer allow you to telecommute as much as your work assignments permit?
   - ❑ Yes
   - ❑ No
   - ❑ Don't know
7. Would you like to carry out these work assignments as telecommuting?
   - ❑ Yes→Please answer Question 8 and then Question 10
   - ❑ No→Please answer Question 9 and then Question 10
   - ❑ Don't know
8. Why would you like to telecommute more? Use 1 through 5 to state the importance of the following reasons (1 = *totally disagree*; 5 = *totally agree*)

1	2	3	4	5	
❑	❑	❑	❑	❑	Timesaving
❑	❑	❑	❑	❑	Increased work efficiency
❑	❑	❑	❑	❑	Reduced stress
❑	❑	❑	❑	❑	Independence in daily life
❑	❑	❑	❑	❑	Reduced travel costs

9. Why would you not like to telecommute more? Use 1 through 5 to state the importance of the following reasons (1 = *totally disagree*; 5 = *totally agree*)

1	2	3	4	5	
❑	❑	❑	❑	❑	Distraction from family members
❑	❑	❑	❑	❑	Reduced work efficiency
❑	❑	❑	❑	❑	Weakened dividing line between private and work life
❑	❑	❑	❑	❑	Lack of contact with colleagues
❑	❑	❑	❑	❑	Negative attitudes from employer or colleagues
❑	❑	❑	❑	❑	No arranged work place at home
❑	❑	❑	❑	❑	Slow computer connection

10. Assume that your company arranged office premises at a distance fewer than 3km from your home (i.e., a satellite office). The satellite office would offer the same facilities as your regular workplace, but the people you share the work place with are not necessarily from your company.
    a. Would you prefer a satellite office rather than your regular work place?
    - ❑ Yes
    - ❑ No
    - ❑ Don't know

b. Would you rather telecommute from a satellite office than from home?
- ❑ Yes
- ❑ No
- ❑ Don't know

APPENDIX B
The Mixed Logit Model—Theory and Estimation Technique

If β_i were known to the modeler, the probability that individual *n* would choose alternative *i* in a choice set of J alternatives is given by the standard logit model:

$$P_{ni}(\beta) = \frac{e^{V_{in}(\beta_i)}}{\sum_j e^{V_{jn}(\beta_j)}}, \quad (1)$$

Now we do not know the preference parameter for one specific individual. Therefore, we assume that the preference vector varies in the population with the normally distributed density function $f(\boldsymbol{\beta} \mid \theta)$, in which $\theta = (\beta_{1,mean}, \ldots \beta_{J,mean}, \beta_{1,sd}, \ldots \beta_{J,sd})$ represents the mean value ($\beta_{i,mean}$) and the standard deviation (βi,sd; see Figure 1 below). The aim is then to estimate the parameters of θ.

As a result, the utility function in equation (1) is reformulated as:

$$U_{ni}(\boldsymbol{\beta}i) = \alpha_i + (\boldsymbol{\beta}_{i,mean} + \mu\beta_{i,sd})\mathbf{X}_{ni} + \varepsilon_{ni} = V_{ni}(\boldsymbol{\beta}_i) + \varepsilon_{ni}, \quad (2)$$
$$\boldsymbol{\beta}_i = (\boldsymbol{\beta}_{i,mean} + \mu\beta_{i,sd})$$

in which μ is N (0,1) distributed and ε_{ni} is Gumbel distributed with 0 mean.

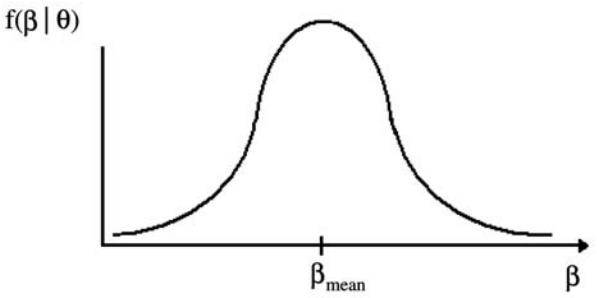

Figure A1: The Normally Distributed Density Function of β, Having a Mean and a Standard Deviation That We Estimate in the MXL Model

The choice probability P_{ni}, given by equation (1) must then incorporate the density function $f(\boldsymbol{\beta} \mid \theta)$. The mixed logit formula for a population of n individuals is the choice probability integrated over all possible values of $\boldsymbol{\beta}$, expressed as the following:

$$L(\theta)_{ni} = \int P_{ni}(\boldsymbol{\beta}) f(\boldsymbol{\beta}|\theta) \mathbf{d}\boldsymbol{\beta} \tag{3}$$

The task is to find the value of θ that best correlates with the density distribution (i.e., estimate the model according to the observed data; Revelt & Train, 1998). Maximum likelihood was used for the estimation procedure.

As before, let i denote the alternative that person n chooses among J alternatives. The ordinary log-likelihood function of Equation 3, taken over the total population of N individuals is then given as:

$$\text{Log likelihood } (\theta) = \Sigma_{n=1, \ \ldots N} \Sigma_{j=1 \ \ldots J} \delta_{nj} \ln L(\theta)_{ni} \tag{4}$$

in which $\delta_{nj} = 1$ if individual n chooses alternative i and 0 otherwise. One obstacle that immediately appears is that Equation 3 has no closed form (i.e., the integral cannot be solved analytically). We must therefore approximate this integral by a summation over a large number of randomly chosen values of $\boldsymbol{\beta}$. The approximation procedure is described through the following three steps (Train, 1999):

1. Take R draws from the density function $f(\boldsymbol{\beta} \mid \theta)$ and label these draws β_r, r = 1, 2, . . . R.
2. For each β_r, form $P_{ni}(\boldsymbol{\beta}_r)$ from the logit equation (1).
3. The simulated probability is the average of these calculated logit probabilities, P_{ni}:

$$\text{Simulated probability}_{ni}(\theta) = (1/R) \Sigma_{r=1, \ \ldots R} P_{ni}(\boldsymbol{\beta} r) \tag{5}$$

From this, we can create a simulated log-likelihood function from the simulated probabilities:

$$\text{simulated log-likelihood function } (\theta) = \Sigma_{n=1, \ldots N} \Sigma_{j=1 \ \ldots J} \delta_{nj} \ln(SP_{ni}(\theta)) \tag{6}$$

in which $\delta_{ni} = 1$ if individual n chooses alternative i and 0 otherwise. The estimated parameters are those that maximize Equation 6. Under regularity conditions, the estimator is consistent and asymptotically normal (Hajivassiliou & Ruud, 1994; Lee, 1992). When comparing the results from 10,000 and 20,000 draws, the parameter values differ first at the fourth decimal, convincing us that using 20,000 draws is sufficient. The estimation procedure was individually programmed in the programming language Ox.

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