大葉大學 九十四 學年度 研究所博士班 招生考試試題紙					
系所別	組別	考試科目（中文名稱）	考試日期	節次	備註
管理研究所博士班	甲	統計學	6月20日	第2節	P3-1

註：考生可否攜帶計算機或其他資料作答，請在備註欄註明（如未註明，一律不准攜帶）

一 選擇題(每題3分，共18分)

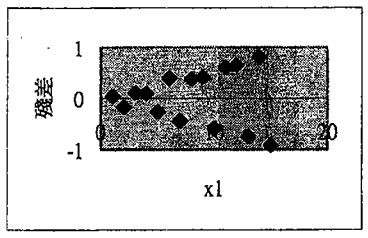
1. 今有2種品牌，5種不同款式手機上市。有兩家雜誌分別給這5*2=10種不同組合手機排名。問可用何種統計值，檢定兩家雜誌的 10 種手機排名是否一致? (1)皮耳森相關係數 (Pearson correlation coefficient) (2) 卡方值(χ^2-值) (3) Durbin-Watson d statistics (4) Spearman rank correlation coefficient (5) 以上皆非

2. (續上題) 2種品牌,5種不同款式手機上市,有50位消費者，隨機分10組,每組5人就10種不同組合手機其中一種組合，分別進行評分(0-100分)，欲檢定在不同品牌下，消費者對5種不同手機款式評分,是否有差異,該用何種統計檢定法? (1) One-way ANOVA (2) One-way MANOVA (3) Two-way ANOVA (4) Two-way MANOVA (5) ANCOVA

3. (續上題) 上述檢定之自由度為何? (1) 4, 40 (2) 4, 49 (3) 1, 40 (4) 8, 37 (5) 無足夠資料計算自由度

4. 假設有一迴歸模型: $Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\varepsilon$, 欲驗證模型合適性，於是抽取36個樣本，根據資料得ANOVA表。試問F檢定自由度為 (1) 5, 31 (2) 6, 29 (3) 7, 29 (4) 8, 27 (5) 無足夠資料計算自由度

5. 上述迴歸分析,所得殘差對自變數 x_1 作散佈圖如下。請問該圖代表什麼意義? (1)迴歸模型正確 (2)誤差未呈常態分配 (3)誤差平均值大於0 (4)誤差變異數不一致 (5)以上皆非



6. 上述迴歸分析,該使用哪一個統計值,檢定誤差項是否互相獨立 (1) t-檢定 (2) 卡方值(χ^2-值) (3) Durbin-Watson statistics (4) Spearman rank correlation coefficient (5) 以上皆非

二 問答題

1. 假設有一迴歸模型: $Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\varepsilon$, 根據研究資料的分析，得到下面不完全的迴歸分析摘要表。

Source	SS	df	MS	F	p-value
Regression	.	.	171.50	23.75	9.63E-7
Error	.	.	7.22		
Total	1238.83	.			

試回答下列問題：

(1) 請解釋 p-value 所代表意義為何？ (3%)

(2) 上述迴歸分析中，p-value 為 9.63E-7, 該作何結論? (3%)

(3) 迴歸模型中何謂共線性? 如何偵測? (3%)

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2. In an environmental strategies study, the researcher consider a corporate's environmental strategies from stakeholder management's perspective. An empirical analysis was conducted in Belgium during 1999, in which 197 firms were chosen for the survey. In the questionnaire, 10 items measure the environmental strategies, while 14 items measure the stakeholder's influence, plus the three control variables: multinational character of the firm, firm size, heritage of stakeholder management. A cluster analysis was performed on the 10 items of the environmental strategies, which divides the 197 firms into three groups: reactive strategy, pollution prevention, and environmental leadership respectively, see Table 1. Answer the following questions.

   (1) In Table 1, please give the degrees of freedom for all the ANOVA F values? (4%)

   (2) For item 1, what is the ANOVA F test for? Write down the null hypothesis (H_0). (4%)

   (3) Area=0.05 in the right tail under the F-distribution are given below. What conclusion can you make for the hypothesis in (2)? (4%)

   $F_{2,193}(0.05)=3.0427$, $F_{2,194}(0.05)=3.0424$, $F_{2,195}(0.05)=3.0422$, $F_{2,196}(0.05)=3.0419$, $F_{2,197}(0.05)=3.0417$

   $F_{3,193}(0.05)=2.6516$, $F_{3,194}(0.05)=2.6513$, $F_{3,195}(0.05)=2.6509$, $F_{3,196}(0.05)=2.6506$, $F_{2,197}(0.05)=2.6504$.

   (下標代表 F-distribution 之分子及分母自由度).

   (4) What needs to be done if the hypothesis in (3) is rejected? (4%)

Table 1. Final cluster means of resource-based environmental strategy profiles

	Reactive strategy	Pollution prevention	Environmental leadership	ANOVA *F*
Conventional green competencies				
Item 1: investments in product and manufacturing process related green competencies	1.66	2.12	3.29	79.9
Employee skills				
Item 2: investments in employee skills	2.04	2.78	3.48	47.3
Organizational competencies				
Item 3: investments in organizational competencies	2.41	3.21	3.97	76.6
Management systems and procedures				
Item 4: development of a written environmental plan	0.36	0.68	0.94	20.77
Item 5: life cycle analysis (LCA)	0.00	0.15	0.23	7.9
Item 6: internal environmental reporting	0.44	0.68	0.90	12.5
Item 7: external environmental reporting	0.13	0.16	0.77	38.9
Item 8: environmental performance inclusion in top management evaluation	2.56	3.83	4.32	113.1
Strategic planning process				
Item 9: integration of environmental issues	3.37	4.19	4.61	51.9
Item 10: participation of environmental managers in strategic planning	2.97	3.88	4.53	58.3
Number of firms	67	95	35	

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根據所附研究文獻，回答下列問題：

3. 分別列出 Table 2 中的研究變項是如何測量的。 (10%)

4. 第 27 頁中，作者根據 Table 2，做了下面的敘述。試說明作者根據什麼做了下面的結論，並評述其所用之統計方法的正確性及說法的正確性，並提出你的作法與說法。 (8%)

   「Work arrangement was significantly correlated with marital status and salary, but not with any of the studied variables.」

5. 根據第 25 頁的 Table 1，由 gender * telecommuters/non-telecommuters 的交叉分類表回答下列問題： (8%)
   (1) 某一個研究對象是女性的機率是多少?
   (2) 某一個研究對象是 telecommuter 的機率是多少?
   (3) 某一個研究對象是女性且為 telecommuter 的機率是多少?
   (4) 某一個女性研究對象是 telecommuter 的機率是多少?

6. 根據第 25 頁的 Table 1，依 gender * telecommuters/non-telecommuters 的交叉分類表回答下列問題： (10%)
   (1) 全部 97 人當中，有 27 人是男性的 telecommuter，計算 chi-square 時，這一個細格 (cell) 的期望次數是 31.4。試問這是如何算出來的?
   (2) 根據表格所列，此項分析得 χ^2=3.087，p≦.05。本文作者如何說明分析的結果。
   (3) 除了作者的說法之外，你還有其它的說法嗎?
   (4) 其實正確的計算結果是：χ^2=3.807，p=.051。在 α=.05 的情況下，你的結論是什麼?

7. 根據第 25 頁的 Table 1，marital status * telecommuters/non-telecommuters 的卡方檢定，得到 χ^2=6.647，達 .05 顯著水準。salary * telecommuters/non-telecommuters 的卡方檢定，得到 χ^2=7.703，未達.05 顯著水準。後者的 χ^2 值比較大，為何反而沒有達到 .05 顯著水準? (4%)

8. 本研究之第一個假設是：「H1: Telecommuters will receive higher job performance evaluations on the task dimension than non-telecommuters.」 (10%)
   (1) 將這個假設及其對立假設以中文表示之。
   (2) 研究者以何種統計方法來檢驗這個假設?
   (3) 此假設驗證的結果如何? 研究者根據哪些統計數據來做此判斷?
   (4) 研究者用來驗證此假設的統計方法適當嗎? 試陳述理由。
   (5) 試提出可以驗證此假設的其他統計方法。

9. 在 Table 5 中，針對 direct effect 的三項自變數: gender, marital status, and work arrangement 的迴歸模型裡，
   (1) R^2=0.023，其意義為何? (3%)
   (2) 就上述三項自變數, 請問有無不妥? 如何改善? (4%)

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Does "Out of Sight" Mean "Out of Mind"? An Empirical Investigation of the Career Advancement Prospects of Telecommuters

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ABSTRACT

The fear that telecommuting will have a negative impact on career advancement prospects has been a barrier to telecommuting acceptance. This study sought to examine whether professionals who telecommute on a part-time basis did indeed experience less advancement prospects than their non-telecommuting peers did. The results indicate that this fear is unfounded. Telecommuting did not have a direct effect on career advancement prospects or an indirect effect through job performance evaluations. Additionally, the level of telecommuting participation did not have an impact on career advancement. Employees who telecommuted more frequently did not experience significantly different job performance evaluations or career advancement prospects than those who telecommuted less. The paper concludes with the limitations of this study and directions for future research.

Keywords: *telecommuting, telework, distributed work arrangements, career advancement, job performance evaluations*

INTRODUCTION

Telecommuting has been hailed as a work arrangement that can offer innumerable benefits to society, organizations and individuals. Societal benefits include reduced air pollution from the reduction in people traveling to work (DiMartino and Wirth, 1990) and employment for those people who are unable to leave their homes (Mahfood, 1992). Organizations realize a number of benefits from telecommuting programs. In addition to increasing productivity (Hartman, Stoner and Arora, 1992; Pratt, 1984; Weiss, 1994) and increasing retention and recruiting (DiMartino and Wirth, 1990), telecommuting has also been found to contribute to cost savings from the reduction in office space and related overhead expenses (Jacobs and

VanSell, 1996). Employees who telecommute have reported many benefits of telecommuting, including eliminating long commutes (DiMartino and Wirth, 1990; Mahfood, 1992), decreasing personal costs such as transportation and parking (Fuss, 1995) and increasing flexibility to balance work and family commitments (DuBrin, 1991). But despite these many potential benefits, there is pervasive fear that limits telecommuting participation. Many employees have said they will not telecommute, despite the many benefits to themselves, society and the organization, because they fear that the work arrangement will have an adverse effect on their career advancement prospects (Connelly, 1995).

The impact of telecommuting on career advancement has been the subject of a great deal of speculation, yet it remains one of the least understood aspects of this work arrangement. Generally, managers and employees believe telecommuting will limit visibility and consequently, restrict career advancement opportunities (Bailey and Foley, 1990; Hamilton, 1987; Hooks, 1990). Employees believe limited career advancement opportunities to be one of the greatest disadvantages of telecommuting (DuBrin and Barnard, 1993; Khalifa and Davison, 2000). However, anecdotal evidence suggests that telecommuting may contribute to higher productivity and, consequently, greater advancement opportunities (Olson, 1989; Riley and McCloskey, 1997; Solomon and Templer, 1993). In a pilot study with 100 telecommuting managers, Bell Atlantic found 27% had higher work ratings and several were promoted at a time when promotions were not common (Weiss, 1994). Other research has suggested telecommuting will have no impact on career advancement prospects (Olson, 1989; Pratt, 1984). Pilot study results have provided mixed information on the promotability of telecommuters. For example, in a small study of nine remote employees, it was reported that four employees felt their promotability was not effected, two felt their promotability was increased because their work was recognized and rewarded, and three believed their promotability was hindered due to less visibility (Olson, 1983).

It is very important for both researchers and practitioners to understand how telecommuting impacts work outcomes, specifically career advancement prospects. The many potential advantages of telecommuting will only be realized if employees choose to participate in this work arrangement. Despite the promises of cleaner air, reduced stress, increased productivity, and a better balance between work and family, employees are fearful to accept a work arrangement that may have a negative impact on their career. It has even been suggested that should employees choose to telecommute and then experience limited career advancement opportunities that they may sue because they have been discriminated against due to perceived inequities of treatment (Fitzgerald, 1994). In addition to avoiding litigious threats, it is important to understand the impact of telecommuting on career advancement so that programs and training can be designed to reduce the potential negative outcomes of telecommuting and therefore encourage employee participation.

For almost as long as telecommuting has existed, researchers have called for the examination of how telecommuting affects career development (DeSanctis, 1983; Olson, 1983). Empirical research has not yet adequately addressed this issue for professional employees. Telecommuting participation is rapidly growing, particularly for professionals who work at home on a part-time basis. It has been reported that nine

million people work outside their corporate offices in the U.S. at least three days per month, an 83% increase since 1993 (Baig and Dunkin, 1998). Such rapid growth makes the examination of the career advancement prospects of professionals who telecommute part time an important issue. This study addresses this need by examining whether there are differences in career advancement prospects between professional telecommuters and non-telecommuters. In addition to examining whether career advancement prospect differences exist, this research also seeks to examine why this occurs. Job performance evaluations have been found to be a direct predictor of career advancement prospects (Igbaria and Baroudi, 1995). This research seeks to establish whether telecommuters and non-telecommuters receive different job performance evaluations from their supervisors, which lead to differences in advancement opportunities.

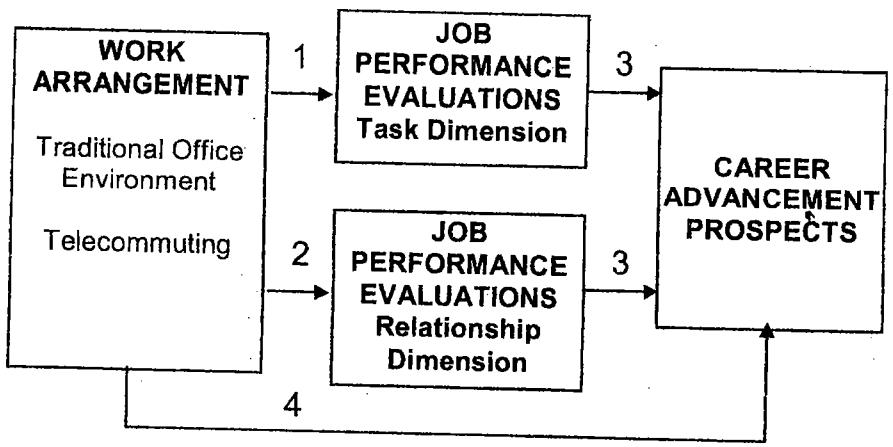
HYPOTHESES

This research seeks to determine whether professionals who telecommute experience significantly less career advancement prospects than their non-telecommuting peers. The model, contained in Figure 1, posits that work arrangement has a direct effect on career advancement prospects as well as an indirect effect through job performance evaluations.

Job performance evaluations play an important role in assessing an employee's promotability (Igbaria and Baroudi, 1995). Job performance has been found to be comprised of two dimensions, task and relationship (Greenhaus, Parasuraman and Wormley, 1990). The task dimension addresses factors concerning the performance of work, including such characteristics as productivity, accuracy and quality of work. The relationship dimension contains psychological and personality factors, such as cooperation, commitment and loyalty. The contradictory belief that telecommuting both helps and hinders career advancement may in fact be true. Telecommuting may result in a positive impact on the task dimension of job performance and a negative effect on the relationship dimension.

Cognizant that not all employees will be successful telecommuters, most orga-

Figure 1. Model of Proposed Relationships



Note: The numbers correspond to the hypotheses in the body of the paper, which support the identified relationships.

nizations approve this type of work arrangement on an employee-by-employee basis. Experts have suggested only those employees who are knowledgeable of their job, responsible and self-motivated should be allowed to participate in telework arrangement (Barnes, 1994; Wright, 1993).

Telecommuting may even contribute to the improvement of an employee's performance. Prior research and pilot studies have found telecommuters to be more productive than non-telecommuters (DuBrin, 1991; Hartman, Stoner and Arora, 1992; Solomon and Templer, 1993) and more productive on the days they are telecommuting (Ross, 1990). In addition to productivity gains, telecommuters have also been found to perform higher quality work (Fuss, 1995; Olson, 1989; Riley and McCloskey, 1997).

Given that the task dimension taps qualities that telecommuters are perceived to have, such as responsibility, and other work outcomes that are frequently a result of telecommuting, such as productivity and high quality work, it would be expected that telecommuters would score very high on this dimension of job performance.

H1: Telecommuters will receive higher job performance evaluations on the task dimension than non-telecommuters.

Telecommuters may be viewed as being less committed and loyal to the organization (Connelly, 1995; Mahfood, 1992), and are thus less likely to be considered for promotion. By participating in a telecommuting program, supervisors may perceive the employee is putting his/her family or personal life ahead of work responsibilities. Hooks (1990) found that 37% of those who participated in alternative work arrangements, such as telecommuting, believed their careers were damaged because the supervisors questioned their competitiveness and commitment. The relationship dimension of job performance reflects the supervisor's impression of an employee's loyalty and commitment. If supervisors believe telecommuters are not as committed as non-telecommuters, they may rate telecommuters lower on the relationship dimension of job performance.

H2: Telecommuters will receive lower job performance evaluations on the relationship dimension than non-telecommuters.

Research has found job performance evaluations to be the most powerful predictor of career advancement prospects (Igbaria and Wormley, 1995). Both the relationship and task dimensions of job performance evaluations have been found to have a significant, positive effect on promotability assessments (Igbaria, 1991; Igbaria and Greenhaus, 1992); however, the task dimension has been found to be a much stronger predictor (Greenhaus et al., 1990). This suggests that the most important factor contributing to future promotability is the ability to do the job well, not the supervisor's perception of loyalty and other relationship-oriented job performance factors.

H3: Both the task and relationship dimension of job performance will have a positive impact on career advancement prospects, although the task dimension will have a stronger effect than the relationship dimension.

Other factors may also have an impact on advancement opportunities. Telecommuters may lose contact with peers and may no longer be tapped into informational networks. Feeling left out of office communication was reported to be the greatest disadvantage of telecommuting

(Reinsch, 1997). Losing this communication network may have an impact on advancement opportunities. Relationships in informal social networks have been found to be an important factor on organizational advancement (Kanter, 1979; Tsui, 1984). If an employee is out of the office and does not maintain informal communication with colleagues on such things as training opportunities, new projects and job postings, this may hinder advancement opportunities. The "out of sight, out of mind" adage is certainly believed to be true (Haddon and Lewis, 1994; Hamilton, 1987; Shellenbarger, 1993). Employees may receive positive job evaluations but still not receive promotions because they are not seen and consequently not thought of at promotion time. Hartman, Stoner and Arora (1992) found that most telecommuters believed their career advancement had been hindered due to both decreased visibility and limited access to information and networking. This research proposes that telecommuting, in addition to impacting job performance evaluations, has a direct, negative effect on career advancement prospects.

H4: Telecommuters have fewer career advancement prospects than non-telecommuters.

Experts have suggested that employees limit the amount of time they telecommute so they do not hinder their advancement opportunities (Ritterhaus, 1994; Wright, 1993). In a small study Ramsower (1985) found that satisfaction with advancement opportunities declined with increasing telecommuting participation. This research explores whether increased telecommuting participation does indeed result in even more limited career advancement prospects.

Researchers have suggested that telecommuting results in diminishing returns. Productivity studies have found that with a high level of telecommuting participation, productivity actually declines (Bacon, 1989). A high level of telecommuting participation may result in a lower evaluation on the task dimension of job performance.

H5: Professionals who have a high level of telecommuting participation will receive lower job performance evaluations on the task dimension than professionals who have a lower level of telecommuting participation.

A supervisor may question the loyalty and commitment of a person who telecommutes most of the time, but not an employee who only telecommutes occasionally. High levels of telecommuting participation may therefore result in lower evaluations on the relationship dimension of job performance, which could consequently limit career advancement prospects.

H6: Professionals who have a high level of telecommuting participation will receive lower job performance evaluations on the relationship dimension than professionals who have a lower level of telecommuting participation.

Hypothesis 4 proposed that telecommuting would have a direct, negative impact on career advancement prospects. The lack of visibility and the loss of informal communication are believed to negatively impact career advancement opportunities. The more an employee telecommutes, the more negative this relationship would become. Employees with a high level of telecommuting participation have even fewer opportunities for network-

ing and informal communication and may therefore be more likely to be forgotten at promotion time.

H7: Professionals who have a high level of telecommuting participation will have less career advancement prospects than professionals who have a lower level of telecommuting participation.

METHODOLOGY

Overview of the Procedure

Telecommuting policies and experiences may vary widely from organization to organization. For this reason, it was deemed reasonable to conduct this research with a sample from one large organization. The organization, a large, highly competitive telecommunications firm, has been very active in establishing a telecommuting program both to provide flexibility to their workforce and to act as a guide for potential clients. Although the organization is multinational, the sample consisted of 225 professional employees telecommuting in the United States. The organization provided the names and internal mailcodes of these employees to the researchers.

This research required responses from both telecommuters and non-telecommuters as well as their supervisors. The organization was only able to provide information on telecommuters. A "fan out" method was employed to identify a matched sample of non-telecommuters. Each telecommuter, in addition to answering the questionnaire, was asked to identify both their immediate supervisor and a non-telecommuting employee who most closely matched his or her present position and level. The identified non-telecommuters then received a questionnaire. The non-telecommuters were asked to identify their supervisor. Each of the identified supervisors was asked to complete a short questionnaire. In addition todemographic questions, supervisors are asked to respond to questions concerning the job performance and career advancement opportunities for the employee. Participants were assured that their responses would be treated as confidential and that only data aggregated at the group level would be reported.

Sample

Completed questionnaires were received from 89 telecommuters (40% response rate), 71 non-telecommuters (49% response rate) and 97 supervisors (61% response rate). Since our analyses required responses from both employees and their supervisors, we were interested in the number of employee-supervisor pairs. We received usable responses from 53 telecommuter-supervisor pairs and 44 non-telecommuter-supervisor pairs.

As contained in Table 1, the telecommuters and non-telecommuters are very similar to one another. There are no significant differences between telecommuters and non-telecommuters on age, number of children, hour worked per week, job tenure, organizational tenure, education or salary. There is, however, a significant difference in the gender composition of these two groups. The gender distribution of the telecommuters was fairly equally split (51% men and 49% women) whereas the non-telecommuters were predominantly men (70% men and 30% women). There is also a statistically significant difference in the distribution of marital status for telecommuters and non-telecommuters. Although the majority of both groups were married (62% of telecommuters and 80% of non-telecommuters), there is greater variation in the marital status of the telecommuters.

Twenty-six percent of the telecommuters reported they were unmarried and not living with a partner and 9% reported being unmarried and living with a partner compared to 7% and 14% of the non-telecommuters, respectively. The data-collection process resulted in a sample of telecommuters and non-telecommuters from similar managerial and professional job types. A chi-square analysis revealed that there was not a significant difference in the distribution of job titles among the telecommuters and non-telecommuters.

Since the amount of time spent telecommuting could be an important contributing factor towards career advancement prospects, it was important to include how frequently each of the respondents telecommuted. The telecommuters were asked to report how often they

Table 1. Comparison of the Demographic Characteristics of Telecommuters and Non-telecommuters

	Telecommuters (N=53)	Non-telecommuters (N=44)	t
Age	45.45	45.59	.096
Number of children	1.72	1.84	-.506
Hours worked/week	47.89	46.70	-.822
Job tenure (years)	5.88	6.76	.714
Org. tenure (years)	19.91	22.27	1.548
			Chi Square
Gender			
male	27 (51%)	31 (70%)	3.087*
female	26 (49%)	13 (30%)	
Education			
high school	6 (11%)	5 (11%)	5.291
some college	21 (40%)	25 (57%)	
bachelors degree	14 (26%)	9 (20%)	
graduate degree	11 (21%)	3 (7%)	
Marital Status			
married	33 (62%)	35 (80%)	6.647*
unmarried, living w/ partner	5 (9%)	6 (14%)	
unmarried, not living w/ partner	14 (26%)	3 (7%)	
Salary			
$30,001-45,000	5 (9%)	5 (11%)	7.703
$45,001-60,000	15 (28%)	22 (50%)	
$60,001-75,000	27 (51%)	16 (36%)	
$75,000-90,000	3 (6%)	0 (0%)	
$90,001-115,000	2 (4%)	1 (2%)	
$115,001-130,000	1 (2%)	0 (0%)	
Telecommuting Participation			
5 days/week	0 (0%)		
4 days/week	1 (2%)		
3 days/week	2 (4%)		
2 days/week	14 (26%)		
1 day/week	36 (68%)		

$p \leq .05$* $p \leq .01$** $p \leq .001$***

telecommuted. A majority of the sample (N=36, 68%) reported that they telecommuted only one day per week. Therefore, those employees who reported telecommuting more than one day per week were considered to have a high level of participation (N=17, 32%). Employees who reported telecommuting only one day per week were considered to have a low level of participation.

Measures

Telecommuting participation was recorded as a dichotomous variable (1=telecommuter, and 0 = non-telecommuter). All of the respondents were asked to respond to a series of demographic questions. Gender and marital status were coded as dichotomous variables (1 = male, 2 = female and 1 = married, 2 = unmarried, living with partner and 3 = unmarried, not living with partner). Respondents were also asked to indicate the highest level of education they have achieved on a four-level scale from (1) some high school to (4) graduate degree. Respondents were asked to indicate the number of children they have. Age, job tenure and organizational tenure were obtained with open-ended questions and were measured in years. Number of hours worked per week was obtained with an open-ended question and measured in hours per week. Respondents were asked to indicate their current salary on a nine-level scale from (1) less than $30,000 through (9) more than $140,000 and indicate the proportion of this salary in their total family income from (1) 0-19% to (5) 80-100%. All respondents were also asked to indicate their job title in an open-ended question. Telecommuters were asked to indicated what percentage of their work time they spend telecommuting on a five-point scale from (1) all the time (5 days per week) to (5) time (one day per week).

- **Job Performance Evaluation.** Job performance was assessed using a measure developed by Touliatos, Bedeian, Mossholder and Barkman (1984). The supervisor was asked to respond to the extent that the employee exhibits 22 qualities on a five-point scale from (1) unsatisfactory to (7) excellent. One quality from the original measure, promotability, was excluded due to the overlap with a separate construct, career advancement prospects. Factor analysis has shown these qualities tap two dimensions of job performance, an appraisal of the relationships the individual has developed with the organization and its members (e.g., loyalty and commitment) and an appraisal of an employee's performance on tasks (e.g., ability, accuracy and productivity) (Greenhaus, Bedeian and Mossholder, 1987; Greenhaus et al., 1990; Igbaria and Baroudi, 1995). Items were averaged to form a composite score for the two dimensions of job performance, task (alpha = .934) and relationship (alpha = .935).

- **Career Advancement Prospects.** Each individual's career advancement prospects were assessed by their supervisor's response to the following inquiry: "How would you assess this employee's chance for promotion sometime during his or her career in this company?" Responses were made on a three-point scale: (1) slight chance, (2) good chance and (3) very good chance. This measure has been used by a number of researchers (Greenhaus, et al., 1990; Igbaria and Baroudi, 1995).

Data Analyses

Table 2 contains intercorrelations among the study variables. Work arrangement was significantly correlated with marital status and salary, but not with any of the studied variables.

This research proposes a model of relationships concerning the impact of a work arrangement on job performance evaluations and career advancement prospects. Hierarchical multiple regression was used to see if there is support for the proposed model. This method involves running multiple regressions to assess the direct and indirect effects of the work arrangement (telecommuting or not telecommuting) on the study variables. Changes in the beta weights as variables are entered allow for the reporting of total, direct and indirect effects. The initial beta weight when the variable is first entered represents the total effect. The beta weight after all of the independent variables have been entered represents the direct effect. The difference between the total effect and the direct effect reflects the indirect effect of the variables on the dependent measure (Cohen and Cohen, 1983). The significance of the beta weights is used to determine support for the hypotheses.

Prior to entering the study variables, it was necessary to enter, and therefore control, demographic variables that may cause spuriouseffects. The choice of control variables was governed by theory and prior empirical studies as well as dictated by the current data. Gender has been found to have a significant impact on career advancement prospects (Landau, 1995). The samples of telecommuters and non-telecommuters were found to differ significantly on gender and marital status. It was therefore necessary to control for both gender and marital status so that conclusions regarding differences in the work arrangement were not confounded by demographic differences.

RESULTS

Telecommuting was not found to have a direct or indirect effect on career advancement prospects. Hypothesis 1 proposed that telecommuters would receive higher job performance evaluations on the task dimension of job performance evaluations than non-telecommuters. As indicated in Table 3, this hypothesis was not supported. Hypothesis 2 proposed that telecommuters would receive lower job

Table 2. Intercorrelations of the Study Variables

	1	2	3	4	5	6	7	8	9	10
1. age	1.000									
2. education	-.122	1.00								
3. gender	-.201*	-.130	1.00							
4. org. tenure	.522**	-.173	-.227*	1.00						
5. job tenure	.463**	-.172	-.102	.361**	1.00					
6. marital status	-.296**	-.024	.344**	-.074	-.081	1.00				
7. salary	.210*	.279**	-.206*	-.024	-.165	.075	1.00			
8. job performance - task	-.135	-.021	.097	-.168	-.137	-.034	.166	1.00		
9. job performance - relationship	-.050	.023	.121	-.016	-.191	-.144	.224*	.812**	1.00	
10. career adv. prospects	-.367**	.169	.067	-.183	-.325**	.016	.117	.559**	.554**	1.00
11. work arrangement	-.010	.199	.198	-.157	-.073	.232*	.218*	-.031	-.056	-.115

$p \leq .05$* $p \leq .01$** $p \leq .001$***

performance evaluations on the relationship dimension than non-telecommuters. As indicated in Table 4, this was also not supported. Hypothesis 4 stated that telecommuting would have a direct, negative impact on career advancement prospects. The results of the regression used to test this hypothesis are contained in Table 5. This hypothesis was also not supported. Hypothesis 3 was the only hypothesis that was supported. It posited that the two dimensions of job performance evaluations would have a positive impact on career advancement prospects. The results of the regressions used to test this hypothesis are contained in Table 5. As other researchers have found, both the task and relationship dimension of job performance evaluations were found to have a significant impact on career advancement prospects.

This research proposed that the negative outcomes of telecommuting would increase with telecommuting participation. These hypotheses were not supported. Hypothesis 5 through 7 proposed that employees with a high level of telecommuting participation would receive more negative job performance rating on the task and relationship dimension and would have less career advancement opportunities than those employees who telecommuted less. As indicated in Tables 6, 7 and 8, level of telecommuting participation did not have a

Table 3. Direct, Indirect and Total Effects on the Task Dimension of Job Performance Evaluations

	Total	Direct	Indirect	R^2	ΔR^2
Gender	.111	.149		.012	
Marital Status	-.071	-.083			
Work arrangement	-.047	-.173		.014	.002

$p \leq .05$ $p \leq .01$** $p \leq .001$****
work arrangement (1=telecommute and 0=does not telecommute)
gender (1=male and 2=female) and marital status (1=unmarried and not living with a partner and 2=married or living with a partner)

Table 4. Direct, Indirect and Total Effects on the Relationship Dimension of Job Performance Evaluations

	Total	Direct	Indirect	R^2	ΔR^2
Gender	.176	.207		.048	
Marital Status	-.203	-.215			
Work arrangement	-.057	-.164		.051	.003

$p \leq .05$ $p \leq .01$** $p \leq .001$****
work arrangement (1=telecommute and 0=does not telecommute)
gender (1=male and 2=female) and marital status (1=unmarried and not living with a partner and 2=married or living with a partner)

Table 5. Direct, Indirect and Total Effects on Career Advancement Prospects

	Total	Direct	Indirect	R^2	ΔR^2
Gender	.053	-.021	.053		
Marital Status	-.001	.105	-.001	.003	
Work arrangement	-.148	-.116	-.148	.023	.020
Job Performance Evaluations – Task	.309*				
Job Performance Evaluations – Relationship	.307*			.355	.332

$p \leq .05$ $p \leq .01$** $p \leq .001$****
work arrangement (1=telecommute and 0=does not telecommute)
gender (1=male and 2=female) and marital status (1=unmarried and not living with a partner and 2=married or living with a partner)

Table 6. Direct, Indirect and Total Effects on the Task Dimension of Job Performance Evaluations

	Total	Direct	Indirect	R^2	ΔR^2
Gender	.084	.085	-.001	.007	
Level of Telecommuting Participation	.005			.007	.000

$p \leq .05$ $p \leq .01$** $p \leq .001$****
work arrangement (1=telecommute and 0=does not telecommute)
gender (1=male and 2=female) and marital status (1=unmarried and not living with a partner and 2=married or living with a partner)
level of telecommuting participation (0=low and 1=high)

significant impact on the two dimensions of job performance or on career advancement prospects.

DISCUSSION

Contributions to the Telecommuting Literature

A comprehensive review of the empirical studies on telecommuting revealed that this area of inquiry is frequently fragmented and the results are often contradictory (McCloskey and Igbaria, 1998). As the authors point out, there are a number of serious concerns in the telecommuting literature. First, there is not a clear, accepted definition of telecommuting. This results in a variety of different types of employees, such as self-employed individuals and employees who do a little paperwork at home in the evening, studied under the guise of telecommuting. Second, despite research that suggests the work experiences of professional and clerical workers differ, researchers have often analyzed both professional and clerical workers as a homogeneous sample of telecommuters (Hartman et al., 1992; Olson, 1983; Pratt, 1984; Ramsower, 1985). Many of the

Table 7. Direct, Indirect and Total Effects on the Relationship Dimension of Job Performance Evaluations

	Total	Direct	Indirect	R^2	ΔR^2
Gender	.152	.153	-.001	.023	
Level of Telecommuting Participation	.018			.023	.000

$p \leq .05$ $p \leq .01$** $p \leq .001$****
work arrangement (1=telecommute and 0=does not telecommute)
gender (1=male and 2=female) and marital status (1=unmarried and not living with a partner and 2=married or living with a partner)
level of telecommuting participation (0=low and 1=high)

Table 8. Direct, Indirect and Total Effects on Career Advancement Prospects

	Total	Direct	Indirect	R^2	ΔR^2
Gender	.136	.071	.065	.019	
Level of Telecommuting Participation	-.130	-.136	.006	.035	.016
Job Performance Evaluations - Task	.403*			.343	.308
Job Performance Evaluations - Relationship	.179				

$p \leq .05$ $p \leq .01$** $p \leq .001$****
work arrangement (1=telecommute and 0=does not telecommute)
gender (1=male and 2=female)
marital status (1=unmarried and not living with a partner and 2=married or living with a partner)
level of telecommuting participation (0=low and 1=high)

empirical studies concerning the effects of telecommuting are based on extremely limited sample sizes, which severely limit the generalizability of the findings. Conversely, many of the larger studies on telecommuting are based on responses to hypothetical questions, which only allow for the examination of attitudes and the perceived impacts of telecommuting as opposed to real effects or experiences.

The analyses of employees from different job types and work arrangements as a homogeneous telecommuting population may have resulted in many contradictions concerning the outcomes of this work arrangement. This research addresses this problem by using a very focused definition of telecommuting and limiting the analysis to professional employees. This study does not address supplemental work that is completed at home but rather work completed at home in lieu of the office through the use of information technology. Additionally, this research focuses on professional employees. Previous research has focused on the experiences of clerical workers who telecommute (DuBrin, 1991; DuBrin and Barnard, 1993; Ford and Butts, 1991; Olson, 1987), but empirical research has never focused solely on the experiences of pro-

fessionals who choose to participate in this work arrangement. Understanding the impact of telecommuting on the experiences of professionals is critical since the growth of telecommuting is primarily from this sector of the work force. Empirical research has never adequately addressed whether there are differences in the work outcomes for professional telecommuters and non-telecommuters. Therefore, the contribution of this research is that it addresses the conceptual and methodological weaknesses of prior telecommuting research by using a focused definition of telecommuting, limiting the analysis to professional employees, and comparing work outcomes from a relatively large sample of telecommuters and non-telecommuters.

Practitioner Implications

Organizational, individual and societal advantages could potentially result from telecommuting work arrangements. By allowing employees to work anytime, anywhere, the organization will be able to reduce costs, increase productivity and improve employee retention. The increase in flexibility will allow employees to balance work and family commitments, which could contribute to increased job satisfaction and reduced stress. By allowing employees to eliminate commuting, this work arrangement will also result in less pollution and a cleaner environment. Despite these many benefits, participation has been cautious due to fears that telecommuting will hinder career advancement opportunities. This research offers evidence that this feared outcome does not occur. Telecommuting did not have a negative impact on either the task or relationship dimension of job performance evaluations and there was not a significant difference in the supervisor's assessment of career advancement opportunities for the telecommuters or non-telecommuters. This is a very positive outcome that begins to alleviate the greatest concern of this flexible work arrangement.

These results should be of particular interest to practitioners who are anxious to have their employees participate in a virtual work arrangement. It is possible to structure a telecommuting program such that the feared negative outcome, limiting career advancement prospects, does not become a reality. Employees can participate in this mutually beneficial work arrangement without fearing the work arrangement will have an impact on their advancement opportunities.

Limitations and Directions for Future Research

This research offers evidence that despite the myths and fears, telecommuting does not have a direct or indirect negative impact on career advancement prospects. Future research should test the generalizability of these findings by addressing the study limitations. First, this research was conducted at one organization that was committed to making telecommuting work. There was support for telecommuting from the highest levels of the organization and training was provided for the participants and their supervisors. It is possible that that this organization was able to minimize the impact of telecommuting on career advancement prospects through these efforts. Second, the sample was limited to employees working in the United States. Culture could certainly have an impact on the acceptance and outcomes of telecommuting. Third, it has been suggested that telecommuters can maintain their advancement opportunities by coming to the office regularly (Fitzgerald,

1994). This study found that increased telecommuting participation did not have an impact on advancement opportunities. Overall this sample did not have a high level of telecommuting participation. None of the participants telecommuted full time. It is possible that the employees in this sample did not telecommute frequently enough to experience an impact on their job performance evaluations and career advancement prospects. Researchers should examine whether there are differences in job performance evaluations and career advancement prospects between professional employees who do not telecommute and those who telecommute more frequently than the current sample.

Although additional research is needed to confirm these findings, this study provides evidence that the greatest employee barrier to telecommuting, the fear of limited career advancement, is unfounded. Additional research should assess the generalizability of these findings. If employees can telecommute without compromising their career advancement, they would be more willing to participate, thus reaping additional benefits for themselves, their organizations and society.

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