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AN EMERGING DISTRIBUTED WORK ARRANGEMENT:
AN INVESTIGATION OF COMPUTER-BASED
SUPPLEMENTAL WORK AT HOME*

ALLADI VENKATESH and NICHOLAS P. VITALARI
Graduate School of Management, University of California, Irvine, Irvine, California 92717

Recent advances in information technology and changes in social and economic relationships have led individual workers and organizations to explore various types of distributed work arrangements. This paper examines a specific type of distributed work arrangement, supplemental work at home. This arrangement refers to full-time employees doing job-related work at home in the evenings and on weekends. Based on a theoretical analysis of supplemental work, data gathered from a 346 computer-owners and 104 nonowners are empirically examined. The results suggest that the amount of time spent on supplemental work is positively related to work self-determination variables (flexibility and control), portability of work tasks, the availability of telecommunications link between the firm and the home, and household income, and negatively related to commuting time and the presence of children at home. The paper discusses the implications of supplemental work for organizational design and the employer-employee relationship. It concludes that compared to other types of work at home, supplemental work is one remote work arrangement that is likely to persist especially for professionals and managers.

(DISTRIBUTED WORK ARRANGEMENTS; SUPPLEMENTAL WORK AT HOME; WORK AT HOME; TELECOMMUTING; ALTERNATIVE WORK ARRANGEMENTS; ORGANIZATIONAL DESIGN)

1. Introduction

Although decentralized organizational structures and managerial practices have existed for several decades, the emergence of information and communication technologies has radically increased the ability of organizations to distribute their work processes. One rationale for distributed work arrangements is that they provide the firm and its employees with greater flexibility, convenience, and effectiveness in the accomplishment of work (Becker, 1986).

This paper is an attempt to examine the role of information technology in the performance of supplemental work at home. The goal here is to develop a deeper understanding of distributed work in general and of supplemental work in particular. The rationale for the study stems from the far-reaching implications it has for organizations, management and employees who utilize this type of work arrangement.

The paper proceeds as follows. §2 elaborates on the concepts of distributed work arrangement and its subset, supplemental work at home. §3 develops a theoretical model for this paper and operationalizes selected variables of the model for empirical work. §4 outlines the research methodology. §5 discusses the results. §6 considers some implications for organizational management and suggests directions for future research.

2. Distributed Work Arrangements and Supplemental Work at Home

A distributed work arrangement is a decentralized organizational structure where the core organization distributes a portion of its functions to a remote site. The distributed work setting could be another organization or firm (i.e., via an interorganizational system), a nontraditional work setting (e.g., the home, a satellite office, or a mobile office vehicle), or a decentralized site that conducts specialized functions for the core organization (e.g.,

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a remote sales office or a customer service center). Work at home is a general term which refers to any employment related work performed at home, regardless of whether the individual who is performing the work is an employee of an organization or is self-employed. (For two recent reviews on work at home, see Kraut 1989 and Olson 1989.)

Kraut (1989) identifies four relevant categories of home based workers. Workers in the first category literally substitute home for a business site as a place of work, while being employed by an organization as regular wage earners. Examples of such workers include sales agents or sales people, journalists, and other professionals whose occupational duties can be discharged from their homes. The next category of workers is sometimes known as moonlighters; they have regular jobs outside their homes but perform additional work for secondary employers. The third category includes those who are self-employed and work out of their homes. In the final category, which includes mostly professionals or white collar types, are workers who bring home work; that is, they supplement their place of work, rather than substitute for it. The term "telecommuter" refers primarily to type I workers (substitutors), although it can include any employee who brings home work to do rather than "commuting" to work. Nilles first coined "telecommuting" to refer to "telecommunications-transportation tradeoff" (Nilles et al. 1976). Using extensive census and survey data, Kraut shows that the self-employed and supplemental worker categories are growing more rapidly and becoming more common than the other two (Kraut 1989).

Supplemental work at home, the last of the just cited categories and the focus of this study, is defined as a distributed work arrangement where the home is used as a setting for job-related work (i.e., work tasks performed on behalf of the primary employer) by individuals employed full time outside, after normal work hours or on weekends. Although there is a significant body of literature on work at home, the literature on supplemental work at home is rather sparse, and public attention has been limited. The reason for this is that supplemental work at home is not entirely a new phenomenon and has existed, in some measure, throughout our industrial history. Although less noticed than other forms of home based work, recently its growth has been fueled similarly by new information technologies, changing demographics, and organizational imperatives (Baer 1985; Kraut 1989).

Although supplemental work must be understood in the context of the demands and conditions that exist in both organizations and households, the relevant literature suggests that an important element in this link is the information technology itself (Baer 1985; Olson 1989; Ransower 1985; Vitalari, Venkatesh, and Gronhaug 1985). From an information technology point of view, the technological link affects the nature of the relationship of the organization to the household through first-order and second-order effects. The organization may discover new work scheduling options, new concerns over managerial control, new requirements for different work support structures (i.e., computer consulting, computing subsidies) and, in the long-run, may even restructure the core organization (Becker 1986; Olson 1983; Salomon and Salomon 1984).

In summary, supplemental work at home has the following attributes:
1. It is a remote work arrangement between two institutional environments: the core work organization and the household.
2. Work is distributed from the core organization to the home on a voluntary basis, at the discretion of the employee, according to organizational, household and individual factors.
3. The interinstitutional (or system) linkage is properly viewed as informal, and each system sets its own goals and modes of operation.
4. Information technology plays a key role in the interinstitutional linkage by augmenting the supplemental work at home arrangement.

We shall now present our theoretical model, selection of variables and hypotheses.

3. Research Framework

Supplemental work behavior is viewed as a function of three factors: (1) Organization/Work, (2) Information technology, and (3) Household. The dependent variable to be examined is the amount of time the individual spends on supplemental work at home. Figure 1 illustrates the general structure of the conceptual model guiding the research. In the following, first we present the theoretical framework underlying the model, and then we discuss the specific details of the model.

Theoretical Framework

The relevant theoretical ideas that form the background for our model come from recent developments in the areas of work externalization, post-bureaucratic forms of

| Figure 1. Conceptual Model for Supplemental Work at Home. |
organization, information technology in organizational contexts, and information technology in the context of work at home.

Work Externalization. According to Pfeffer and Baron (1988), the shift of productive activity from the work environment to the home can be viewed as an example of the concept, "work externalization." They theorize this as part of a larger concept of "work," using the traditional organizational theory framework as a point of departure for further elaboration. The traditional theory of work, argue Pfeffer and Baron (1988), is embedded in three fundamental notions: the extent of administrative control over the employee wielded by the organization, the development of long-term relationships between the organization and the employee as an idealized goal, and the physical proximity between the organization and the worker (Pfeffer and Baron 1988). Pfeffer and Baron contend that fundamental forces at work within the society are requiring a re-examination of the nature of work in terms of work internalization and externalization. They identify these forces as the changing workforce demography, the changing social norms about work and organizational attachments, changing technology, the diminishing role of physical proximity for work monitoring, and the changing economics of work organization. An important example of work externalization, according to Pfeffer and Baron, is work at home. According to them, "homework has spread particularly as developments in information technology and data communication have made it possible to do a number of tasks at home ...." (1988, p. 265).

Post-Bureaucratic Forms. A stream of research which has not been integrated fully into the organizational literature relates to the emergence of new organizational forms, or post-bureaucratic forms, which are attributable, in part, to new technologies. Simpson and Simpson (1988) use the term "hi-tech organizations" to describe them, and Huber (1984) calls them "post-industrial," while Miles and Snow (1986) employ the term "switchboard" (i.e., communication networks). Because the notions of bureaucracy are slowly being replaced by the notions of adhocracy, the term "post-bureaucratic," as used by Kanter (1989), appears best to describe these structures. Because they involve changes in the structure of skills, the structure of occupations, and the character of work environments, it is reasoned that the organizational changes wrought by these technologies are fundamental, not merely incremental. Frequently, emerging organizational forms appear to conflict with well-established normative notions of bureaucracy and administrative control.

Information Technology and Organizational Contexts. In Figure 1, information technology is shown as interacting with the organizational and domestic domains. The particular positioning of information technology in the model as a structurally interacting construct is consistent with theoretical work within the socio-technical systems area, as well as with the more mainstream organizational theory. We use the term "socio-technical perspective" to describe our own approach and to suggest the social character of technology as enunciated in the writings of Child (1986); Kling (1980); Rousseau (1983) and Trist (1981). The main conclusions of this literature may be summarized as follows.

Technology cannot be studied in isolation, but only in the specific historical and structural contexts in which it appears. Because of its socially embedded nature, technology cannot be viewed in completely deterministic terms. At the same time, one cannot regard technology as a purely passive phenomenon, because it contains certain inherent possibilities that unfold with continuous use. Thus one makes technology tick is both the structure (in which it operates) and agency (of its own). In the organizational context, even since the pioneering work of Woodward (1958), a number of researchers have formally examined the relationship between technology and organizational structure. Rousseau (1983) provides what is perhaps one of the most comprehensive and critical analyses of this issue to date. The question examined in her review is whether technology has an impact on organizational structures and performance. After examining a number of empirical studies, she concludes that the exact nature of technology's impact on organizational structures has eluded clear-cut definition, but the majority of the studies support the hypothesis that technology does influence organizational structures and management performance. This finding becomes the point of departure for our own study.

Information Technology and Work at Home. Information technology provides an extensive range of information processing capabilities that enable individuals, groups, and organizations to conduct work at home. A number of studies, both conceptual and empirical, have identified changes in the daily life of the individual and the household resulting from the use of computers at home. For a thorough review of this line of research, see Dutton, Rogers, and Jun (1987). To understand the pivotal role of information technology at home, researchers have begun to focus on two major developments: (a) computer-mediated work and (b) telecommunication (Kraut 1989). The actual potential of these developments is difficult to estimate except through empirical studies of the type attempted here.

Operationalization of the Model

The model described in Figure 1 shows three factors, Organizational/Work, Information technology and Home, with information technology acting as the link between the other two. Together, these three provide the independent variables for our study. In the figure, all three are shown as related to a fourth factor, supplemental work at home, which is the dependent variable of our study. In our analysis, which follows, we test the relationship between the three factors and the dependent variable, supplemental work at home, but we do not test the relationship (as shown in the figure) between the factors themselves. The linking arrows between the independent factors are for the sake of completeness, to demonstrate the role played by information technology in conceptual terms. We shall now discuss the operationalization of each of the three factors and their hypothesized relationships with supplemental work, the dependent variable.

Organizational/Work Factor. In selecting the organizational/work factor, we rely on some specific studies from earlier research. Of particular relevance to our study are the published works by Kraemer (1981); Kraut (1989); Nilles et al. (1976); Olson (1983); Ramssower (1985), and Salomon and Salomon (1984). Generally speaking, the early research on work at home has tended to examine this arrangement from the point of view of structural feasibility or technological opportunity, rather than of management theory. That is, the question often posed in this literature was, given that new technologies make it possible for job-related work to be performed at home, what trends are occurring in this direction and why do people want to work at home? Only recently have management scientists begun to examine this issue from a more mainstream organizational theory perspective (Pfeffer and Baron 1988), thus giving it a greater sense of theoretical urgency and legitimacy. Our approach in this study is to integrate these different approaches and to examine a selected set of organizational/work variables that are of interest to management and account for supplemental work performed at home. From the relevant literature, we have identified the following six most pertinent to our study: portability of work; work time at the office; perception of reduced work interruptions; commuting to work; and work self-determination, which includes ability to work at one's pace, the need for control over one's work, increased productivity, ability to maintain contact with one's superior, and satisfaction with working at home. We provide a brief discussion of these variables and their hypothesized relationship to the dependent variable, supplemental work at home.

Portability of Work. Work tasks vary in how easily they can be transported to and from the office setting. Hackman and Oldham (1975) and Galbraith (1977) have noted that job autonomy and control are keys in decisions about whether to decentralize work...
Kraut (1989) has noted that portability of the work tasks is central not only to the type of work that is brought home but to the type of occupations that tend to engage in work at home. Accordingly, in our study, an indicator variable was formulated to examine the degree to which the portability of work influences the dependent variable. Occupational categories with work tasks were divided into two groups. Group 1 (coded as 1) represented those occupations perceived to have portable work tasks. Group 2 (coded as 0) represented occupations observed to have limitedly portable work tasks. Occupations with work tasks considered portable (coded as 1) included accountants, architects, programmers, systems analysts, computer specialists, engineers, financial consultants, judges, lawyers, teachers, writers, managers, and sales workers. Occupations considered to have minimal or no portable work tasks (coded as 0) included life and physical scientists, health practitioners and technicians, clerical workers, craftsmen, operatives (e.g., meat cutters, assemblers), transport equipment operators, laborers, farmers, and service workers. Criteria for categorization were conservative. All occupations in Group 1 had to contain portable work tasks (i.e., writing, reading, simple computation, or correspondence) that could be accomplished independent of the office setting. Note that clerical workers, technicians, and health practitioners have some portable work tasks, although, relative speaking, the number of portable work tasks are minimal compared to professional and managerial occupations.

Supplemental work requires both managerial autonomy (i.e., tacit permission to work autonomously) and structural autonomy (i.e., the degree of worker independence from office resources). Realistically, in general, many jobs include well-defined tasks (e.g., report preparation, financial analyses) that are independent of office specific resources (e.g., special files, proprietary technologies, co-workers) and can be transported outside the central office setting. Note that computer and communications technology make many work tasks more portable and less dependent on formal organizational work settings. Therefore, it is expected that transportability would facilitate work at home. Since portability of work facilitates work at home, it is hypothesized that the number of supplemental hours worked at home will be positively associated with it.

Work Time at the Office. Time, for all practical purposes, is a finite resource that must be allocated among multiple activities. How this allocation takes place is both a theoretical and an empirical question. We refer to two theories which have some relevance here. First is the time-activity tradeoff theory, and the second is the centralized life interest (CLI) theory. According to the first, some economists and sociologists (see Becker 1965; Robinson 1977) have noted that time scarcity interacts with individual preferences for activities in determining time allocation decisions. The essence of the theory is that if one works in an activity and decides to increase the time spent on that activity, obviously this increase is possible only at the expense of some other activity or activities. Therefore, in our specific study, given that there are only 24 hours in a day, it is natural to conclude that people trade hours at work for hours of work at home. That is, at first glance, work at the office and supplemental work at home might appear to be negatively correlated. On the other hand, if work at home displaces some other activity at home, the relationship between office work and work at home need not be negative. In fact, this was indicated in our earlier work on home computing, although we did not prove it conclusively (Venkatesh, and Gronhaug 1985). For example, in that study, people who used computers at home reported that one consequence of using a computer at home was a reduction in watching television, and socializing with friends. When we couple this finding with another finding in that study that most people used computers for job-related activities, an inescapable conclusion is that the time spent on working at home does not come exclusively at the expense of hours at the office. That is, one can maintain the same level of work activity at the office and at the same time increase the time spent working at home by merely reducing the time devoted to other domestic activities. Working at the office versus working at home is not simply a matter of zero-sum game. However, to the extent that tradeoffs between activities do occur, it is safe to conclude that the activities that are likely to be traded off are those with low salience.

A second theory of some relevance here and which complements the above finding is the Centralized Life Interest (CLI) theory. First proposed by Dubin in 1956 and later developed with his co-researchers (Dubin, Champoux, and Porter 1975), the theory holds that workers with a centralized life interest in work have a high level of commitment to their work and therefore are more likely to demonstrate work commitment even during nonmandated time periods and at nonmandated locations. They carry their work orientation wherever they go. Under this scenario, one can argue that a person working 50 hours at the office with high work commitment could be doing more work at home than a 40-hour-per-week person with less work commitment. If we combine this theory with the time-activity tradeoff theory, especially as suggested in our earlier work, we expect that people who work more hours at the office are also likely to do more work at home. Of course, this relationship does not hold always. This is because, first, the person working more hours at the office does display a higher level of commitment than the person who works less hours. A second point is that this relationship, even if it holds, will ultimately reach a threshold level because there are only so many hours in a day. Therefore, even though the relationship may hold up to a point, it will become negative when the number of hours of work at office reaches higher levels. After this threshold, it is inevitable that a substitution effect between office hours and supplemental hours will be observed, since the employee must tradeoff directly between work done at the office and work done at home. Based on the foregoing analysis, we are unable to hypothesize the relationship between the number of hours spent at the office and supplemental hours of work at home.

Reduced Work Interruptions. The lack of controllable intervals of uninterrupted time (due to matrix organizational structures, highly enriched job settings, or open door policies) may create greater incentives to distribute work to the home. The type of job performed by the employee, independent of job level, is likely to influence the amount of uninterrupted time available to the worker. For example, a sales executive or a grade school teacher is less likely to have uninterrupted time during daytime work hours due to job demands. Nevertheless, whatever the reasons for the interruptions, if workers feel that the office is not conducive for certain types of work, they may attempt to work at alternate locations, such as their homes, where they may feel that they can reduce the frequency of work interruptions and achieve higher levels of concentration than in the office. These features may be major benefits of working at home. It is, therefore, hypothesized that the greater the perception of reduced work interruptions at home, the more hours of supplemental work will be performed at home.

Commuting to Work (Commute Frequency and Commuting Time). Prior research on telecommuting and work at home has examined the transportation-substitution effect of work at home practices (Nilles et al. 1976; Harkness 1977; Kraemer 1981; Olson 1983; Ramsower 1985). A general result that runs the entire gamut of these studies is that individuals tend, as commute distances (therefore, commute times) increase, to substitute working at home for office work. What seems actually to be happening is that as commute time increases, people prefer to stay at home and work rather than go to office everyday, since working at home reduces commuting effort. However, when the individual commutes to the office, because of the length of the commute, he/she either will be unable to work at home that day or will have to reduce the hours working at home. In other words, there are two aspects to the general result, commuting frequency and commute time. The significance of these two variables varies according to a specific work-at-home situation. In one situation, the worker has a choice between working at home and commuting to work. That is, if a typical work week is five days and assuming
that the worker has a choice, the question is, how many days is the worker willing to commute to work and how many days is he/she willing to work at home? This is what we call the "commuting frequency." Previous research shows that as commuting time increases, if the worker has a choice, he/she will prefer working at home and commuting less frequently. A second question is, if the worker has no choice but to commute to work, does he/she do less work at home as the commute time increases? The answer here, of course, is that since the day has only so many hours, more time taken up in commuting leaves less time for working at home.

In our study, we collected two types of information. The first variable is "commuting frequency," and the second is "commuting time." In reference to the first, we asked the respondent to indicate, on a five-point scale, his/her agreement or disagreement with the statement, "working at home has reduced the number of times I commute to work." As for the second, we asked the respondent to indicate the time taken in minutes to commute every day to work. Since our sample consisted of full-time employed people who commuted every day to work, we hypothesized that commute time would be negatively associated with supplemental work at home, and that commuting frequency would not be associated with it.

Work Self-Determination Variables

We refer to two sets of literature as being relevant to our study. The first set is based on research relating to work motivation and job satisfaction. The second is more specific to the literature on "telecommuting" and work at home. We combined these two streams of research in selecting appropriate variables for our own study.

From organizational theory, we borrow a term, "self-determination," to describe the underlying motivation for computer owners' decision to work at home. According to Deci, Connell, and Ryan (1989), "To be self-determining means to experience a sense of choice in initiating and regulating one's own actions." In the context of work, this concept has been linked to several related concepts with analogous meanings. Argyris (1957) and McGregor (1960) examined the satisfaction of higher order needs (e.g., self-esteem and self-actualization) as a motivator of job performance. Hackman and Oldham (1976) found that flexibility in one's job was positively correlated with job satisfaction. Deci and Ryan (1985) argued that autonomy and control were important determinants of quality of work and productivity.

The literature on telecommuting/work at home identifies similar variables as determinants of people's desire to work at home. In an article that is representative of the literature on telecommuting, Kraut (1989) identified flexibility, autonomy, absence of interruptions, decreased commuting, and increased productivity as the prime variables that motivate people to work at home. Olson (1989) came up with similar variables in her studies. A casual examination of these variables reveals that they are very similar to those found in the management literature mentioned earlier. Accordingly, we chose five variables for this study. First, we operationalized flexibility and freedom using the two variables, "ability to work at one's pace" and "control over one's work" and added three other variables, "desire for increased productivity," "ability to maintain contact with one's superior," and "satisfaction with working at home." Contact with a superior was considered important because one of the concerns of home-based workers is that the remoteness from the work place will result in a feeling of being left out of the decision making process at the office. The variables were presented as single items, and the respondent was asked to agree or disagree with the item on a six-point scale. An example of a statement is: "Working at home has increased my control over starting and ending a unit of work." Our hypothesis regarding these variables is that each of them will be positively correlated with supplemental work at home.

Information Technology Factor

In general, information technology is expected to facilitate supplemental work at home since a personal computer at home provides a powerful set of office tools and functions. Remote telecommunications provide access to databases which exist at the office as well as access to other computers. The higher accessibility of data base and computers would encourage supplemental work at home by providing telecommunication links. Telecommunication also de-couples employees from the office, increases the transportability of their work, and, if electronic mail facilities are provided, makes asynchronous communication with other employees possible.

Some preliminary evidence from research on computing in the home supports this hypothesis. Previous work has shown that households typically purchase personal computers for work-related purposes (Vitalari, Venkatesh, and Gronhaug 1985; Dutton, Rogers, and Jun 1987). Vitalari, Venkatesh, and Gronhaug (1985) found a perceived increase in the amount of work performed at home after purchasing a personal computer, with additional evidence that computer use changes household time allocation patterns, increasing attention towards work related activities and away from television watching and family interaction. Therefore, we hypothesize that the two information technology variables, computer at home and data communication linkage to an office computer, will be positively related to supplemental work at home.

Household Factor

The household as a social setting embodies time allocation patterns, activity structures, resources, values, attitudes, and individual attributes which influence work at home. Three constructs appear to be critical because they influence the conditions within the household and the household's time allocation patterns: household composition, the characteristics of the supplemental worker, and leisure and family time of the individual user.

In our exploratory study on computing in the home (Vitalari, Venkatesh, and Gronhaug 1985), we found that the amount of time spent on computing activity resulted in corresponding changes in the time allocated to family and leisure time. This explains our inclusion of family time and time spent on watching television (Figure 1). Historical studies on time budgets (Robinson 1977) have shown that time allocations across household activities have changed based on the composition of the household and on the attributes of individual members who participate in the specific activities. Accordingly, we have included both variables, the household composition and the attributes of the individual computer user, in our model. Specific variables that were selected for the study are described below.

Household Income. In general, greater incomes will affect the preference structures of household members. Often, income is used as a surrogate for a number of other constructs, such as levels of job responsibility; or, in the case of the home ownership, it means more discretionary income to buy time-saving goods and services. There are two reasons that higher household incomes may be associated with higher levels of supplemental work: (1) higher paid occupations are salaried, thus incentives may exist to engage in supplemental work for career advancement and job productivity; and (2) higher income households may have more discretionary time for supplemental work because they can purchase time-saving goods and services. Thus, we hypothesize that as income increases it is expected that the number of hours of supplemental work at home will also increase.

Residence Ownership. Ownership of a residence sometimes suggests a relatively stable household economic condition. Also, it may suggest a larger living space with room for a home office. We hypothesize a positive relationship between residence ownership and supplemental work at home.
Presence and Number of Children at Home. Children obviously impact household life and working conditions in the home environment. To explore this major effect, it is hypothesized that the presence of children in the household will be a negative influence on supplemental work.

As the number of children increases, added demands for parental time diminish the time available for supplemental work. Thus, the amount of time spent on supplemental work at home should decrease as the number of children at home increases.

Individual Characteristics

As the focal point of our study, the individual worker plays a decisive role in defining supplemental work arrangements. It is assumed that the individual evaluates and determines the amount of time spent on supplemental work at home after considering factors such as job demands, household demands and office conditions. To understand how the individual worker determines how much supplemental work will be done at home, this analysis has selected a set of individual attributes that are expected to influence the supplemental work decision process: marital status, age, sex, and educational attainment.

Marital Status. Considering that married individuals are likely to spend more time at home than single individuals, marital status is expected to influence work at home. However, married individuals may spend more time in domestic tasks, thus limiting the time spent working at home. Given these contradictory possibilities, we are unable to hypothesize the exact relationship between marital status and supplemental work at home.

Age. The age of the individual is expected to influence the amount of supplemental work. However, the direction of the predicted relationship remains ambiguous. On the one hand, older workers may have fewer distractions from young children at home, but they may have risen to levels of responsibility involving job tasks that are less technical, less detail oriented, more supervisory, and less portable—thus reducing the benefits of supplemental work. However, Rice and Shook (1990) found a positive relationship between job level and the use of electronic mail. Since job level usually is highly correlated with age, by extrapolation their finding may suggest indirectly that supplemental work increases as age increases. Because of these contradictory possibilities, a clear relationship between age and supplemental work cannot be hypothesized.

Gender. Recent research (Bailyn 1989; Duxbury and Mills 1989) suggests that males and females engage in work at home for different reasons and have different perceptions about the meaning of work at home. Thus, males might be more likely to engage in supplemental work due to traditional divisions of labor in the home which assign upkeep and child care to the females, making it more difficult for a female spouse to work at home. However, divisions of labor within the home are changing, and more women are pursuing careers that require them to engage in supplemental work at home. We are, therefore, unable to hypothesize the nature of the relationship between gender and supplemental work.

Educational Attainment. Individuals employed in professional and managerial occupations usually have higher levels of education and are more likely to engage in supplemental work at home. Therefore, it is hypothesized that level of education is positively related to the number of hours spent on supplemental work at home.

Time Spent with Family and Watching TV. The classic tradeoff between work activities and leisure activities is expected to play a role in the amount of time spent on supplemental work. Given the finite amount of household or nonwork related time, spending more time with family members or watching television would leave less time for supplemental work at home. It is hypothesized that the number of hours spent on supplemental work will decrease as the number of hours spent with family members increase. Furthermore, as the total time spent on leisure time (i.e., watching TV) increases, the time spent on supplemental work should decrease.

Survey Design

The empirical work uses data collected from 450 U.S. households, a subsample drawn from a larger national panel of 907 households (614 with computers and 293 without computers) who participated in a two-year longitudinal study of computer use at home. In the study reported here, we used data from the households who participated in all the four waves of the main study. The sample includes 346 computer owners and 104 nonowners. Data were gathered via a pretested questionnaire using the CATI system (Computer Assisted Telephone Interviewing). CATI methods utilize computer technology to prepare and administer questionnaires, to collect data and to manage the data collection process. Owners and nonowners were asked the same questions, except that the nonowners were not asked questions about computer use. For a fuller description of the design, see Venkatesh and Vitalari (1989).

Sample Construction

Cost limitations prohibited the construction of a probability sample, so a longitudinal availability sample was developed. From a list compiled by a commercial agency, 614 households situated all over the U.S. were selected based upon a set of stratification variables which included type of computer, length of computer ownership, the number of children in the household, income, and geographic location. It is important to note that every household chosen for this sample had a fully functional personal computer (e.g., IBM PC, Apple II, Apple Macintosh, Hewlett-Packard, PC clones). In fact, more than 20 different brands of computers were represented in the sample. The study was designed to include only individuals who had purchased computers themselves, thus none of the computer owners in this study had been provided computers by their employers. This design was warranted, because early literature indicates that the characteristics of worker initiated supplemental work may be different from management initiated supplemental work, although both arrangements have strong management implications. When conclusions are drawn from the results of this study, it is important to note that the sample of computer owners used in this analysis represents a self-selected group of early adopters from a rare population who were interested in participating in a longitudinal study of household computer use.

A second national stratified random sample of 293 households without computers was selected, matched on income and geographic location. This matched sample permits comparison of households owning a computer to households without.

Analysis Approach

Two levels of analysis are used. At the first level, the paper examines whether computer ownership is related positively to supplemental work at home. A two-sample t-test is employed using fourth wave data. At the next level, two regression procedures. OLS and Tobit, are employed to analyze fourth wave data to test the hypothetical relationships specified in Table 1.

The reason why a Tobit model for estimation is used is that, the supplemental hours worked at home per week, does not assume values which are less than 0 (i.e., no supplemental work at home). In general, when the observed dependent variable is limited to a certain range, or the statistical analysis involves a censored or truncated sample, special regression procedures must be employed (Maddala 1983).1 The OLS procedure

1In this analysis, where \( t_i = 0 \), estimation of a model by ordinary least squares would yield inconsistent coefficient estimates. Moreover, the estimates would be inefficient, because the error term is heteroscedastic (i.e., variance of disturbance is not constant for all observations). In most cases, the OLS estimator will provide an underestimate of the true effect of the independent variables on the dependent variable.
produces inefficient and biased estimators when the lower bound of the dependent variable cannot be less than zero. However, as Degan and White (1976) have shown, the OLS procedure can yield satisfactory results under conditions of near-normality, and it is therefore advisable to use both OLS and Tobit techniques to ensure that they yield comparable results. Accordingly, in our analysis, we decided to use both techniques.

**Validity Issues**

As has been argued well by Mitchell (1985), survey researchers often ignore important validity measures in organizational studies. This study utilizes simple measures to examine important relationships in the supplemental work arrangement. With the exception of the proxy variables, measures were chosen based on simplicity, directness, and face validity. The purpose was not to construct multiple-item scales of constructs that were, at best, poorly understood given prior literature and research. Thus, most of the measures rest on face validity arguments which are justifiable, considering the simplicity of the measures.

5. Results

**Sample Characteristics**

This analysis is based on subsamples drawn from the longitudinal panel consisting of 346 personal computer owners and 104 households without computers. In each household, one individual was identified as the respondent for the survey. In households with computers, these individuals were the main users of the computer and thus were deemed most knowledgeable about the general use within the household. Only full-time employed individuals were included in the analysis. Both samples, that is, computer owners and nonowners, respectively, were predominantly male (89% and 88%), middle-aged (median years, 39 and 42), highly educated (post-graduates, 44% and 42%), and white (95% and 93%). Furthermore, a very high majority of the households had dual incomes (67% and 65%) and belonged to higher-income categories. Other studies have found computer owner households to have demographic profiles similar to those found in our study (see Dickerson and Gentry 1983).

**Analysis of Supplemental Work in Owner and Nonowner Households**

Table 1 presents the major occupational categories in the samples and the analyses for the amount of time spent on supplemental work at home and, by occupation, the amount of time spent at the office per week for both the owner and the nonowner samples. In the owner group, managers and administrators have the largest representation in the sample, followed by teachers, computer specialists and engineers, respectively. A similar ranking is seen in the nonowner group, except that computer specialists are not represented. On average, the computer owners spend about twice the number of hours on supplemental work at home (7.3 hours) as the nonowners (3.5 hours, p < 0.001, two-sample t-test). Owners also spend more time on job-related work (52.5 hours/week) than do nonowners (46.3 hours/week, p < 0.001). Although this illustrates a one-way causal relationship between computer ownership and supplemental work at home, it is equally possible to infer a two-way causation as follows: first, the need or desire to do work at home leads to the acquisition and use of a personal computer; second, the availability of a computer at home leads to more work performed at home.

**Table 1: Participation Rates, Supplemental Hours, and Total Hours by Occupation**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Owners (n = 346)</th>
<th>Nonowners (n = 104)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>Mean Suppl. Hours¹</td>
</tr>
<tr>
<td>Managers and Administrators</td>
<td>19.1 (1)</td>
<td>6.7</td>
</tr>
<tr>
<td>Teachers</td>
<td>13.5 (2)</td>
<td>10.4</td>
</tr>
<tr>
<td>Computer Specialists</td>
<td>11.9 (3)</td>
<td>8.7</td>
</tr>
<tr>
<td>Engineers</td>
<td>11.6 (4)</td>
<td>3.6</td>
</tr>
<tr>
<td>Sales workers</td>
<td>6.9 (5)</td>
<td>8.6</td>
</tr>
<tr>
<td>Accountants &amp; Financial Analysis</td>
<td>6.1 (6)</td>
<td>8.0</td>
</tr>
<tr>
<td>Writers and Creative Artists</td>
<td>4.7 (7)</td>
<td>7.4</td>
</tr>
<tr>
<td>Clerical</td>
<td>3.3 (8)</td>
<td>6.5</td>
</tr>
<tr>
<td>Physicians and Psychologists</td>
<td>2.8 (9)</td>
<td>7.2</td>
</tr>
<tr>
<td>Lawyers</td>
<td>2.2 (10)</td>
<td>9.3</td>
</tr>
<tr>
<td>Other (unclassified)¹</td>
<td>17.2 (6)</td>
<td>7.3</td>
</tr>
<tr>
<td>Total</td>
<td>100.0 (6)</td>
<td>52.5</td>
</tr>
</tbody>
</table>

¹ Mean hours spent on supplemental job-related work at home per week for occupational category.

**Table 2: Participation Rates, Supplemental Hours, and Total Hours by Occupation**

Table 2 displays the Tobit and OLS estimates for the observed variables. (A plus sign indicates a statistically significant positive relationship, a minus sign indicates a significant negative relationship.) Both procedures yield similar results in terms of the significance and directionality of the relationships between the independent and dependent variables. The r-squared values for OLS and Tobit procedures (adjusted $R^2 = 0.21$, $R^2 = 0.22$, respectively) were both significant at 0.01 level. A comparison of the results from both procedures suggests stability in the data.
TABLE 2

<table>
<thead>
<tr>
<th>Independent Variables*</th>
<th>OLS Estimates</th>
<th>Tobit Estimates</th>
<th>Hypothesized Relationship</th>
<th>Actual Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORGANIZATIONAL/WORK FACTOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portability of Work</td>
<td>0.165*</td>
<td>0.120*</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Working hours at the office</td>
<td>0.062</td>
<td>0.006</td>
<td>Inconclusive</td>
<td></td>
</tr>
<tr>
<td>Reduction of Interruptions</td>
<td>0.131b</td>
<td>0.107b</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Commuting Frequency</td>
<td>-0.012</td>
<td>-0.035</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Commuting time</td>
<td>-0.089*</td>
<td>-0.086c</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Work self-determination variables 6 out 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to work at one's own pace</td>
<td>0.091*</td>
<td>0.091*</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Control over one's work</td>
<td>0.029</td>
<td>0.026</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Increased productivity</td>
<td>0.195*</td>
<td>0.218*</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ability to maintain contact with superior</td>
<td>-0.047</td>
<td>-0.043</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Satisfaction with working at home</td>
<td>0.107*</td>
<td>0.108b</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>INFORMATION TECHNOLOGY FACTOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer at home</td>
<td>0.038</td>
<td>-0.047</td>
<td>+</td>
<td>ns</td>
</tr>
<tr>
<td>Telecommunication links with office</td>
<td>0.152*</td>
<td>0.378b</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>HOUSEHOLD FACTOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>usedold Demographics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household income</td>
<td>0.101*</td>
<td>0.128*</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Residence ownership</td>
<td>0.016</td>
<td>0.057</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Presence of children at home</td>
<td>-0.117*</td>
<td>-0.123b</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>No of children at home</td>
<td>-0.019</td>
<td>-0.016</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Individual-User Demographics 17 thru 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td>0.063</td>
<td>0.020</td>
<td>Inconclusive</td>
<td>ns</td>
</tr>
<tr>
<td>Age</td>
<td>0.065</td>
<td>0.021</td>
<td>Inconclusive</td>
<td>ns</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.025</td>
<td>0.003</td>
<td>Inconclusive</td>
<td>ns</td>
</tr>
<tr>
<td>Education</td>
<td>0.064</td>
<td>0.026</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Individual-User Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time watching TV</td>
<td>-0.034</td>
<td>-0.005</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Time spent with family</td>
<td>0.087</td>
<td>0.073</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

OLS: Adjusted $R^2 = 0.21$; F 15.533, df 25/409, $p < 0.01$.
Tobit: N 434; Limit Observations 128; Nonlimit observations 306; $R^2 = 0.22$; Mean square error 45.75; log-likelihood $=-1001.0336$.

Out of the 22 variables in the model, nine variables were found to be significant under both OLS and Tobit procedures, and the directionality of relationship turned out to be the same as hypothesized. A closer examination of the table further reveals that proportionately more organizational/work variables (six out of ten) are significant, closely followed by information technology variables (one out of two) but distantly ahead of household variables (two out of ten). This general result indicates that, although supplemental work is conducted at "home," it is very much governed by organizational/work and technology factors. The implication of this important result will be elaborated later in the discussion section.

In terms of specific organizational/work variables, recall that we had grouped five variables under the title work self-determination. Three of these variables, ability to work at one's own pace, increased productivity, and satisfaction with working at home, were found to be positively related to supplemental work. The first two variables are indicative of flexibility and performance potential, which are key factors in determining work at home. The fact that the satisfaction variable is significant should not come as a surprise, considering that the choice to work at home in our sample was left to the worker and not imposed by the organization. Surprisingly, two other variables, control over one's work and ability to maintain contact with superior, were not found to be significant.

Two explanations are possible. Control over one's work, which also indicates work autonomy, is correlated with the flexibility variable ($r = 0.39, p < 0.01$) and probably was suppressed due to multi-collinearity. The other variable, ability to contact the superior, does not appear to be a major factor in our sample, which consists of full-time employees who probably are at work everyday and are not at any special disadvantage compared to other employees. Also, the ease of accessibility through telephone may diminish its significance.

From among the other organizational variables, subjects' perceptions that working at home was useful in reducing work interruption is positively related to time spent working at home. Given the strong relationship, the result tentatively suggests that the increased likelihood of interruptions in the workplace may provide an incentive to work at home. Portability of work, as hypothesized, was positively associated, thus confirming the notion that the intrinsic character of work has a bearing on work at home. Finally, the hypothesis of a negative relationship between commute time and supplemental work was supported. As commute times increase, it may be more efficient for the worker to remain at the office and work extra hours there than to commute and work at home. This may not be the case for part-time workers or individuals who can substitute home work hours for office work hours or who can choose the time of day for their commute.

The impact of information technology on supplemental work appears mixed. While a telecommunications linkage from the home computer to an office computer is significantly related to supplemental work, the presence of a computer at home does not appear to be related to the amount of supplemental work done at home. This contradicts our earlier univariate finding that computer owners spend a great deal more time at home on supplemental work than do noncomputer owners (see Table 1). Thus, in a multivariate framework, the telecommunications link variable seems to have a greater relative impact on supplemental work than mere computer ownership.

As hypothesized, the presence of children at home was negatively associated with supplemental work at home. The relationship between children and supplemental work needs some explanation. The presence of children in the home had a negative impact on supplemental work at home. However, the number of children at home is not associated with supplemental work. These results seem to indicate that the presence of children negatively impacts on supplemental work, but the number of children per se has no effect. However, given that most of our sampled households with children had two or less, there is not sufficient variability in the data to yield any significant association. As hypothesized, increasing household income levels are positively related to the amount of time spent on supplemental work at home.

Thus, the results of the regression analysis show a strong agreement between OLS and
Tobit procedures. As Greene has pointed out (1981), Tobit and OLS estimators will produce consistent results when the departure of the dependent variable from normality is minimal.

6. Discussion

The objectives of this section are (a) to interpret the results in terms of their implications for the management of distributed work, organizational design, and the employer-employee relationship, (b) to examine the role that information technology plays in facilitating supplemental work at home, and (c) to assess the role of the household factor in performing supplemental work at home.

The Organization and the Supplemental Work Arrangement

Although supplemental work is performed at home, a noneconomic work domain, it is still considered an extension of the work environment. The evidence in our study indicates that people are engaged in supplemental work at home, not because of some transcendental desire on their part to be with their families, but rather to achieve work-related objectives that are not fully attainable within the formal work environment. The key role played by organizational/work variables in the performance of supplemental work at home demonstrates that work at home must be understood in both macro and micro organizational terms.

The macro implication of this is, first—to borrow from Pfeffer and Baron (1988)—that work externalization is a node in the continuum of employment relationships that keeps externalizing over time. Historically, organizations resisted the sanctioning of work externalization unless they were certain that bureaucratic controls could be preserved or unless the nature of jobs was such that they could not be performed within the physical confines of the work environment (e.g., field sales). Supplemental work at home seems to defy these two objectives. Second, it is clear from our study that individuals in certain types of occupations or jobs are more likely than others to be involved in supplemental work at home, because some aspects of the type of work they do are portable. The role of occupational type emerged as an important factor at two levels. Elementary frequency analyses indicated that managerial and professional occupations are the primary users of the supplemental work at home arrangement. In retrospect, this result makes sense, since these occupations are characterized by significant autonomy, control over schedules, and work tasks that can be transported relatively easily. Managerial and professional occupations may also have more to gain from engaging in supplemental work at home than other occupations, due to contemporary incentive rewards such as bonuses, promotions, career advancement, and long-term income growth. Nonmanagerial and nonprofessional occupations may have fewer incentives to work additional hours since clerical, para-professional, and hourly employees are less affected by such reward schemes. Moreover, nonmanagerial or nonprofessional occupations may not have the autonomy and discretion to carry out work at an alternative site. It appears, therefore, that the nature of work is changing in our post-industrial society but it is not occurring uniformly across all sectors of employment. Bell (1973) has already shown that it is the knowledge work that is subject to momentous change in the information society. Supplemental work at home needs to be recognized as a new node in an evolutionary process which should be incorporated into formal management thinking on job design and worker motivation.

From a more micro point of view, our study shows that people who engage in supplemental work do so because they perceive concrete benefits from this activity. Since our sample consisted of people who purchased their computers on their own, rather than those who were provided computers by their organizations, one can conclude that the motivation to engage in this activity is nonmandated and intrinsically generated. However, the individual does not have complete control over this activity, because supplemental work mainly signifies work in addition to regular office work, and its nature and scope are limited by organizational imperatives, regardless of how much an individual would want to work at home. It is, however, incumbent on organizations to become cognizant of the factors that motivate employees to work at home. Organizations that are entrenched in traditional bureaucratic forms of governance will find this a greater challenge than will those that are inclined to experiment with post-bureaucratic forms. After all, as our study shows, people carry out additional work at home to avoid interruptions, to work at their own pace, and to increase their productivity. Thus, the key driving objectives for work at home are flexibility and productivity. Neither objective can be considered particularly revolutionary from management's point of view, and, therefore, they would seem to be consistent with what management would desire from their workers.

Finally, commute time was found to relate inversely to the amount of time spent on supplemental work at home. While the result is self-evident, it affirms the need for flexibility in work arrangement. Management perhaps should try to accommodate staggered or flexible work schedules to neutralize regional traffic problems. If supplemental work arrangements are formally implemented, organizations may find it more feasible to implement staggered beginning and ending work times for employees.

Information Technology and Supplemental Work at Home

The theoretical framework presented in this paper posits that information technology, in the form of personal computers and telecommunications technology, would facilitate supplemental work at home. By comparing computer owners and nonowners (Table 1), we found support for the proposition that personal computer ownership does, indeed, positively influence the time spent on supplemental work. The regression analysis, however, failed to find a significant positive association between computer ownership and the utilization of the supplemental work arrangement. One preliminary interpretation of this result is that the technological impact of personal computing, in the context of other variables, is less notable than the other variables. Such an interpretation would be consistent with previous studies of computing that have refrained from concluding computer technology is a causal agent motivating human or social behavior (Kling 1980; Attewell and Rule 1984) and, instead, have turned to social or psychological explanations.

Nonetheless, the results in Table 1 clearly indicate that computer owners, on average, work approximately twice as many supplemental hours per week as nonowners. This, by any measure, is a significant difference. Previous surveys have found that respondents perceived that work at home increased after purchasing a personal computer (see Vitalari, Venkatesh, and Gronhaug 1985). A reasonable interpretation of these results, based on the available data, is that individuals who already engage in supplemental work at home may find that the presence of a computer in the home increases the amount of supplemental work done at home, although computer ownership per se may not cause supplemental work at home. Thus, the causal agent is as much the individual as it is the computer. Under this interpretation, it may be said that the personal computer facilitates and legitimates supplemental work at home. This explanation links the facilitating nature of information technology with ongoing social and psychological processes.

Significant support was found for a positive relationship between the availability of a telecommunications link between the office and home computers and the number of supplemental hours worked (Table 2). Strictly interpreted, the result demonstrates that a telecommunications linkage, in the context of the other variables, has a relatively stronger influence on supplemental work than does computer ownership per se. The result seems to further suggest that telecommunications linkages will play a central role in the remote work arrangements of the future.
The Household and the Supplemental Work Arrangement

The analysis found rather modest support for the proposition that conditions in the home setting influence the supplemental work arrangement. The existence of children in the home and the household's income level are related to the number of hours spent on supplemental work at home. However, leisure activities do not correlate with supplemental work at home.

The finding that household income is positively related to supplemental work hours tentatively suggests that higher income employees may have stronger incentives and more discretionary time for supplemental work. Further research is necessary to determine whether other factors (e.g., single income, occupation, educational background, prior computer experience) associated with lower incomes are negatively associated with the amount of time spent on supplemental work. One question for future research is whether individuals in lower income households have more difficulty working at home. Any future analysis, however, must contend with the correlation of income with job level and job autonomy, which do affect an individual's ability to work at home.

The Implications of Supplemental Work for Managerial Practice and Organizational Design

This study discloses that employees in some occupations do spend more time than others on supplemental work at home. The major reasons for working at home remain autonomy, flexibility and increased productivity. The major structural factor that permits work at home is its portability. It is important for organizations to consider these factors in designing jobs that can be performed within a home setting.

Another finding of our study points to the facilitative role played by technological infrastructure in conducting supplemental work at home. The apparent importance of telecommunications technology suggests that organizations must pay close attention to providing appropriate structures if they conclude that work at home is desirable from their point of view. In the post-industrial information age, the character of work at home needs to be understood in technological terms. If the home were to become an extended work environment, what makes this possible is the telecommunications link.

In summary, one of the objectives of the study was to explore the significance of the interplay between the core organization and the distributed site. The study reaffirms the key role of organizational and information technology variables as pivotal in this process.

Future Research

The analyses in this study provide some support for the conceptual framework proposed earlier. Future research should focus on more comprehensive measures of the office, information technology configuration, household, and individual. Given the unaccounted for variance of OLS and Tobit procedures, other variables need to be considered. For example, more data on office and group work norms, individual job descriptions, company policies, work loads, and work cycles would be helpful in understanding supplemental work behavior. Long-term studies should be conducted to explore the potential effects of extended supplemental work on the household, the individual worker, and the organization. Conceptually, due to childcare responsibilities, divisions of labor, beliefs about work and household expectations concerning household members, some households may have difficulty adapting to a supplemental work arrangement.

The productivity effects of the supplemental work arrangement appear to be worth pursuing. Trends in information technology suggest increasing options for distributing work and increasing opportunities for location-independent work arrangements. This study suggests that presently the supplemental work arrangement is feasible and useful for some workers. Future studies should assess whether new technologies would enhance the feasibility of this arrangement and how such arrangements would promote the well-being of the employees.

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References

STRATEGIC RISK: AN ORDINAL APPROACH

JAMES M. COLLINS AND TIMOTHY W. RUEFII
School of Management, University of Alaska, Fairbanks, Alaska 99775
IC Institute and Department of Management, Graduate School of Business,
The University of Texas, Austin, Texas 78712

Strategic management researchers have shown increasing awareness of the importance of the concept of risk at the strategic level. In recognition of this interest, this research adopts a commonly used conceptualization of risk and shows how this conceptualization leads to a new measure of risk, based upon the chance of loss of relative position within a set of firms. This framework is shown to be particularly appropriate for strategy research. Information contained in probability distributions describing the relative positions of sets of firms over time is shown to be partitionable on the basis of gain or loss in position as well as on firm identity, leading to the derivation of a new measure of strategic risk for an individual firm. This development also provides a hierarchical quantification of risk at the levels of the industry, group and individual firm. The ordinal risk measure is applied to both hypothetical data for illustration and to data on the U.S. airline industry.

(RISK; STRATEGIC; ORDINAL ANALYSIS; AIRLINES)

1. Introduction

Risk in the strategic context has been recognized as an important and complex concept. Bettis (1981) pointed out the complexity of the relationship between hazards and the competitive behavior of firms, while Jemison (1987), in a study examining the relationship among performance, risk, and organizational processes, suggested that risk tapped a different dimension of firm behavior than did return. In recent years, strategy researchers have, with increasing frequency, incorporated the concept of risk in studies of the strategic behavior of organizations. Empirical studies of risk in the area of strategic management have, for the most part, employed ex post measures of risk. A financial model of risk has been employed by a number of industrial organization and strategic management researchers (e.g., Fisher and Hall 1969; Caves and Yamgy 1971; Hurdle 1974; Schramm and Sherman 1974; Melicher, Rush, and Wint 1976; Caves 1977, pp. 4 and 69; Wint 1977; Montgomery and Singh 1984; Barton 1988; Chatterjee and Lubatkin 1990). However, a recent paper by Fama and French (1992) presents strong evidence that the measure generally used, $\beta$ from the Capital Asset Pricing Model (CAPM), does not have the relation to returns required by theory.

Be that as it may, the most common approach in strategic management studies has been to employ an ex post accounting measure of risk. (For arguments on the appropriateness of this approach see, e.g., Cool and Schendel 1987; Woo 1987; Amit and Livnat 1988a.) The measure of choice in such studies (see starred references at the end of the paper for examples) has been the variance of a set of returns over time. This measure has been criticized as lacking in validity in strategic management contexts (March and Shapira 1987) in that variance (or standard deviation) as a measure of risk implies a concept that defines ex post risk as any deviation, positive or negative, from previous performance. More recently, Ruefli (1990) has shown that the use of the mean and variance of the same variable as dependent and independent elements in a model leads to a pernicious version of the identification problem (Koopmans 1949) if a shifting underlying distribution of returns is assumed, or spurious correlation if a single stable

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