

INTEGRATING MODELS OF DIFFUSION OF INNOVATIONS: A Conceptual Framework

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■ **Abstract** This chapter provides a conceptual framework for integrating the array of variables defined in diffusion research to explicate their influence on an actor's decision to adopt an innovation. The framework groups the variables into three major components. The first component includes characteristics of the innovation itself, within which two sets of variables are defined concerning public versus private consequences and benefits versus costs of adoption. A second component involves the characteristics of innovators (actors) that influence the probability of adoption of an innovation. Within this component six sets of variables concern societal entity of innovators (either people, organizations, states, etc.), familiarity with the innovation, status characteristics, socioeconomic characteristics, position in social networks, and personal qualities. The third component involves characteristics of the environmental context that modulate diffusion via structural characteristics of the modern world. These latter characteristics incorporate four sets of variables: geographical settings, societal culture, political conditions, and global uniformity. The concluding analysis highlights the need in diffusion research to incorporate more fully (a) the interactive character of diffusion variables, (b) the gating function of diffusion variables, and (c) effects of an actor's characteristics on the temporal rate of diffusion.

INTRODUCTION

Sociology has long been interested in the factors that influence the spread of innovations across groups, communities, societies, and countries. With the more recent phenomenon of globalization, encompassing highly efficient communication systems and global interdependencies in economics, business, marketing, language and culture, this interest has begun to focus on modeling processes at work in this spread, an area of inquiry referred to formally as diffusion.

Diffusion of innovations refers to the spread of abstract ideas and concepts, technical information, and actual practices within a social system, where the spread denotes flow or movement from a source to an adopter, typically via communication and influence (Rogers 1995). Such communication and influence alter an adopter's (an actor's) probability of adopting an innovation, where an actor may be any

societal entity, including individuals, groups, organizations, or national polities. In the broadest sense, studies of diffusion have provided an empirical and quantitative basis for developing more rigorous approaches to theories of social change (e.g., new conceptual and mathematical explanations of social change) (DeFleur 1966), and principles of diffusion are often used in assessments of world economic and political developments. Thus, diffusion has become a widely investigated research area in sociology, economics, political science, and communication.

Although the study of diffusion of innovations began with Tarde's 1903 book on *The Laws of Imitation*, a more concerted development of this approach did not occur until forty years later, when Ryan & Gross (1943) published results on the spread of hybrid-corn use among Iowa farmers. Since that study's publication, more than 4000 research papers have appeared on the diffusion of such diverse innovations as agricultural practices (Fliegel 1993, Griliches 1957), technologies (Burt 1987, Coleman et al. 1966, Palmer et al. 1993), fertility-control methods (Rogers & Kincaid 1981, Rosero-Bixby & Casterline 1994), policy innovations (Berry & Berry 1992, Boli-Bennett & Ramirez 1987, Valente 1995), and political reforms (Meyer 1987, Starr 1991). Analyses of the respective sets of variables considered in these studies are associated with different concepts and methods involving diverse processes, principles, and determinants of diffusion. Consequently, the literature associated with each of these factors often tends to analyze diffusion in isolation from the insights of the others [exceptions include Rogers (1962, 1995) and Strang & Soule (1998)].

As a means of correcting this situation, this chapter examines how diverse concepts, variables, and processes related to the diffusion of innovations can be integrated. The goal is to establish a conceptual framework of variables influencing the diffusion of innovations rather than to provide an exhaustive review of the literature associated with each variable. Therefore, discussion focuses on the nature of each variable and its importance to the process of adoption, and not on every detail of its effects. Moreover, because adoption processes are different for individual persons and for collective entities within which individuals operate (e.g., political states or organizations), the different nature of adoption processes that depend on these distinctions is noted throughout.

This conceptual framework is derived by grouping diffusion variables into three major components:

1. Characteristics of innovations
 - *public versus private consequences*
 - *benefits versus costs*
2. Characteristics of innovators
 - *societal entity*
 - *familiarity with the innovation*
 - *status characteristics*
 - *socioeconomic characteristics*
 - *position in social networks*
 - *personal characteristics*

3. Environmental context

- *geographical settings*
- *societal culture*
- *political conditions*
- *global uniformity*

Each of these sets of variables is associated with subvariables described in the text. The chapter concludes by discussing implications of this framework for future research on diffusion of innovations.

THREE MAJOR COMPONENTS IN THE DIFFUSION OF INNOVATIONS

Characteristics of Innovations

While most analyses of diffusion have emphasized actors and their perceptions of innovations, along with variables of environmental context influencing the adoption process, relatively few scholars have studied the characteristics of innovations per se as determinants of diffusion. In the available literature, however, authors have most commonly considered two factors associated with innovation: public vs. private consequences (e.g., Feder & Umali 1993, Meyer & Rowan 1977, Strang & Meyer 1993) and benefits vs. costs (Fliegiel & Kivlin 1966, Greve 1998, James 1993).

PUBLIC VERSUS PRIVATE CONSEQUENCES Private vs. public consequences refer to the impact of an innovation's adoption on entities other than the actor (public consequences) versus that on the actor itself (private consequences). Innovations that result in public consequences involve collective actors—countries, states within countries, and organizations and social movements—mostly concerned with issues of societal well-being. Among such innovations are political models of democracy (Uhlin 1995, Wejnert 2001a), welfare and education policies (Thomas & Lauderdale 1987, Boli-Bennett & Meyer 1978), and state laws (Berry & Berry 1990, 1992). The macro-goal of these innovations relates to broad, often historical issues, appealing to and engaging a broad audience, e.g., involvement of the international community in the issue of decolonization (Strang 1990) or of the student milieu in antiapartheid protests (Soule 1997). Hence, adoption of innovations with public consequences often leads to reforms that are historical breakthroughs, such as laws protecting civil rights, welfare policy, patent laws, or international regulation protecting the natural environment.

Innovations with private consequences affect the well-being of adopters that are either individuals or small collective entities such as organizations, peer groups, and rural communities. These innovations are intended to improve the quality of individual lives or to reform organizational and social structures. Examples of such innovations include new fertility-control methods (Rosero-Bixby & Casterline

1993, 1994, Rogers & Kincaid 1981), new medical practices (Coleman et al. 1966, Ferraro 1993), improving agricultural technologies (Ryan & Gross 1943, Saltiel et al. 1994, Sommers & Napier 1993) or management styles and technological production (Oakley et al. 1992, Straub 1994, Palmer et al. 1993). The micro-goals of such innovations reflect the needs of an individual person or a collectivity, such as improvement of living standards, enhancement of a group's or a person's reputation, or increases in a company's productivity.

Although both types of innovations result in societal changes, the manner of channeling information from an innovation's source to an adopter differs depending upon the innovation's consequences. The importance of this distinction lies in the fact that different mechanisms of interaction between the source of an innovation and an adopter result in diffusion processes that differ in nature. Innovations with public consequences are mainly adopted when information and imitative models are uniformly distributed around the world. This process is most effective when norms, values, or expectations about certain forms or practices become deeply ingrained in society—institutionalized—and reflect widespread and shared understandings of social reality (Meyer & Rowan 1977:343) as, for example, with the rapid spread of mass education, social security systems, and models of nation-states among the world's political states (Thomas et al. 1987).

Another, lesser, influence on innovations with public consequences is the effect of media (Oberschall 1989, Weimann & Brosius 1994). Media becomes a channel of influence on adoption primarily when the innovations are popular, well-defined societal issues. For example, Strodthoff et al. (1985), in a study on the diffusion of ideology in environmental movements, argued that media covered information about the movements only after their goals became well-established public concerns. In this respect, media effects support the role of institutionalization, spreading information about those institutionalized practices that captivate public interest. As Uhlin (1995) argued in his study on the diffusion of democracy models, media is effective in providing information about innovations with public consequences, but the persuasive role in the adoption of an innovation is country-to-country interaction. It seems, however, that there would be limited international interest in adoption of democracy if the democracy models were not institutionalized. Therefore, as argued by Wejnert (2002), institutionalization, complemented by other mechanisms of diffusion, is rather critical to the diffusion of democracy.

As these and other studies suggest, the spread of innovations with private consequences occurs largely due to spatial and temporal contiguity between a source of a new practice and a potential adopter. Two effects are particularly substantial here: (a) spatial effects such as geographic proximity, interpersonal communication, institutional or individual coercion, and (b) the pressure of social networks. Such factors were important in the case of firms' adoption of poison-pill defenses against hostile takeover by competitors (Davis 1991), of fertility-control methods (Rosero-Bixby & Casterline 1993), and of modern coarse cereals (Jansen et al. 1990). For instance, Davis (1991) argued that close relationships and strong ties within interlocking directorates (formed when one person sits on the board of

directors of two firms) serve a socialization-like role, familiarizing executives with novel strategies. [Although Strang & Soule (1998) questioned the application of Davis's argument to any organizational innovations, they support its relevance to the diffusion of the most significant corporate strategies.] Similarly, Rosero-Bixby & Casterline's (1994) study on adoption of family planning practices in Costa Rica supported the significant contribution of social interactions within neighborhoods to delay of fertility transition across all socioeconomic strata.

There are many cases where the consequences of an innovation are not so dichotomous. In practice, many innovations simultaneously reflect direct (manifested function) and indirect (latent function) consequences. For instance, according to Oakley et al. (1992), adoption of numerically controlled machinery both helped Hungarian companies to make a profit (private consequence) and fulfilled requirements of a governmental plan of placing Hungary closer to the economic standards of developed nations (public consequence). Similarly, while adoption of fertility-control methods by Korean village women resulted in private consequences of reduced family size, it also promoted organization of a women's movement that led to adoption of less traditional gender roles and reduction of violence against women (public societal consequences) (Rogers & Kincaid 1981).

BENEFITS VS. COSTS Cost variables relate to monetary and nonmonetary direct and indirect costs, or risks associated with the adoption of an innovation. Direct costs, or financial uncertainty, are typically clear and are relative to the economic situation of an actor. These include such costs as patents of industrial innovation, new agricultural seeds, fertilizers or equipment, computer-operated machines, satellite antennas, or reform of social policies or institutions (Bakardjieva 1992, Gerwin 1988, MacLeod 1991, Ormrod 1990, Rosero-Bixby & Casterline 1994, Saltiel et al. 1994).

While indirect costs are not often clearly identifiable as outcomes of innovations, they can add markedly to the cost or risk of adoption and can significantly modulate the rate of adoption. Purchasing a new kind of fertilizer in order to use innovative seeds (Feder & Umali 1993), for example, is an indirect cost of innovations, as is upgrading computers (Oakley et al. 1992), and modernization of industrial technologies (James 1993). Indirect costs may also be nonmonetary [called by Gerwin (1988) "technical uncertainty"], such as time spent on retraining a labor force to use an innovation to produce electronic instead of manual watches (Dahlman et al. 1985). Other examples include restructuring production units to conform to an innovation, as in farm production (Sommers & Napier 1993); modifying management styles needed to enact technological innovations (James 1993); and merging industrial units to produce an innovation. This last is especially onerous for single corporations and developing countries, relative to their current direct costs for production (James 1993).

Another form of indirect costs are social costs related to the outcome of adoption [called social uncertainty (Dewar & Dutton 1986)]. One example of such a social

cost is innovation-induced social conflict, as with union opposition to labor-saving technology (Gerwin 1988), societal opposition to tax laws (Berry & Berry 1992), or stigmatization of actors who adopted socially disapproved contraceptive methods (Rosero-Bixby & Casterline 1993).

Direct and indirect costs of innovations often inhibit adoption, especially when costs exceed an actor's resource potential. Analysis of the introduction of birth-control policies in developing countries shows that the direct costs of purchasing fertility-control devices and of promoting birth-control methods, together with indirect costs of training medical personnel in method application and of teaching women about birth-control use, were too high for many developing countries to consider adoption (Bongaarts 1994). Similarly, indirect costs related to the merging of industrial units and the modification of management styles inhibited adoption of technological innovations by companies in developing countries (James 1993), while agricultural innovations that required simultaneous indirect costs for complementary innovations were not affordable for farmers in poor societies (Feder & Umali 1993).

Characteristics of Innovators

The above discussion has focused on the characteristics of innovations that modulate the process of diffusion, while for the most part ignoring characteristics of innovators or actors. Similarly, much of the literature, while attending to the characteristics of innovators (actors), has paid little attention to the influence of an actor's characteristics on other components of diffusion. However, characteristics of actors may substantially influence the perception of an innovation's costs and benefits, thus interacting with characteristics of the innovation *per se*.

Six sets of actor variables appear to modulate the adoption of innovations: (a) societal entity of innovators, (b) familiarity with the innovation, (c) status characteristics, (d) socioeconomic characteristics, (e) relative position in social networks, and (f) personal characteristics that are associated with cultural variables that modify personality characteristics of actors at a population level.

SOCIETAL ENTITY OF INNOVATORS The nature of diffusion processes differs depending on the societal entity of adopters because adoption processes are different for an individual actor (a person) compared to small or large collective actors (national polities, organizations, communities, social movements, a group of friends, a family). Overall, the entity of innovators can affect such factors as the type of innovation selected for adoption, the nature of interactions between the source of an innovation and an adopter, the importance of strong vs. weak social ties in adoption, and the macro vs. micro character of adoption outcomes.

Adoptions by large collective actors are often concerned with large-scale historical changes. Nations, states, or social movements, for example, adopt mainly innovations with public consequences, such as educational models (Boli-Bennett &

Meyer 1978, Inkeles & Sirowy 1983), welfare policies (Thomas & Lauderdale 1987), land reform models (Thomas & Lauderdale 1987), democracy models (Uhlin 1995), patent laws (MacLeod 1991), or state policy (Berry 1994). These collective entities interact with the source of an innovation predominantly through nonrelational channels of communication, such as the spread of rule-like behavioral models called institutionalization (Meyer 1977) and through the media. Moreover, weak ties between elements of the collective increase the probability of adoption, e.g., student messengers carrying news about protest actions between university centers (Wejnert 1988) or railroad personnel spreading news about worker strikes around a country (Bloom 2002).

Small collective actors, such as firm networks, organizations, or groups of friends, adopt innovations with mainly private, environmental consequences (that change the innovators' environment), as in cases such as adoption of a multinational enterprise (MNE) strategy by mature motor vehicle industries (Rosegger 1991), the style of management of newly merged industrial units (James 1993), or strategies of violence adopted by youth gang members (Berkowitz & Macaulay 1971). Such adoptive behaviors are channeled through relational and nonrelational means of communication, and they can be influenced by either strong or weak social ties. For example, firms belonging to the same professional organizations tended to adopt similar management styles (weak ties of professional relations) (Newell & Swan 1995, Swan & Newell 1995). Similarly, management strategies designed by multifirm consortia in the automotive industry—frequently generic and precompetitive models of behaviors—were adopted primarily by highly integrated networks of partners (institutionalized innovations adopted via strong ties) (Rosegger 1991).

In contrast, individual actors adopt innovations with mainly private personal, individual consequences. Such innovations depend on interactions through strong ties, such as the community ties and face-to-face interactions critical, e.g., for adoption of fertility-control methods (Rogers & Kincaid 1981), and the network connectedness that facilitates interpersonal interactions in the adoption of scientific methods in professional specialties (Valente 1995, Valente & Rogers 1995). Furthermore, whether an innovation is considered for adoption by an individual actor is strongly determined by compatibility between the characteristics of an innovation and the needs of an actor (Ferraro 1993, Fliegel 1993, Freedman & Takeshita 1969, Saltiel et al. 1994, Valente 1993, Valente & Rogers 1995).

FAMILIARITY WITH THE INNOVATION The familiarity associated with an innovation relates to how radical it is (Dewar & Dutton 1986, Rogers 1995). Because people are naturally cautious in approaching novelty, the rate of adoption of an innovation—all other factors being equal—increases as its novelty decreases (Greve 1998). When the apparent familiarity of a new idea is increased, for instance by media information and the opinion of experts (Meyer & Rowan 1977, Mizuchi 1993, Newell & Swan 1995, Weimann & Brosius 1994), the perception

of risk by an adopter is substantially reduced, facilitating adoptive behavior. For instance, those farmers familiar with novel types of seed because of previous experience in adopting hybrid-seed corn had significantly higher rates for adopting hybrid sorghum seed than did farmers without such previous experience (Rogers 1962). Familiarity with the outcome of an innovation can also be acquired by observing the outcomes of other actors, depending on the connectedness of actors in a network (Bobrowski & Bretschneider 1994, Chaves 1996, Coleman et al. 1966, Feder & Umali 1993, Hedstrom 1994). Learning through such observation lowers the risk of adoption by eliminating novelty or uncertainty of outcome (Galaskiewicz & Burt 1991, Glick & Hays 1991, Holden 1986, Land et al. 1991, Valente 1995).

A number of factors reduce novelty and increase familiarity with innovations. For instance, as Rogers (1995) demonstrated, information obtained from close peers located in social and organizational networks has more weight than information obtained from objective sources, such as from the media or from scientific evaluations of an innovation. Moreover, familiarity with innovations having public consequences is increased by nonrelational sources of information (institutionalization and media) (Meyer & Rowan 1977), while familiarity with innovations having private consequences results primarily from spatial and/or temporal interaction between the source of an innovation and an adopter (Dewar & Dutton 1986). Thus, it seems that an innovator's familiarity with an innovation is not only a function of the source of information about the innovations (e.g., media, institutionalization, direct interaction or observation); it also depends on the private vs. public consequences of the innovation.

STATUS CHARACTERISTICS Status characteristics of adopters refer to the prominence of an actor's relative position within a population of actors. In the most general terms, variance of these characteristics is a function of an actor's social entity and the homogeneity of an actor's networks. Collective actors with high status, i.e., those that control either political power or economic resources, such as governments, large corporations, or world economic organizations, usually adopt an innovation first and then impose adoption of the innovation on lower status actors, as when coercion by large firms significantly promoted adoption of MDF structures by small corporations (Palmer et al. 1993). Similarly, industrial units that received state subsidies adopted computerized technology when this adoption was requested by a state government (Oakley et al. 1992).

An actor's high social position significantly modulates the likelihood of adoption within culturally homogenous groups, such as when adoption of innovations by high-status firms generates adoption of technological innovations in similar firms (Herbig & Palumbo 1994). On the other hand, the low economic status of third world countries dramatically slowed the worldwide diffusion of modern agricultural practices, while the advanced technological and economic status of Western Europe and the United States enhanced technological adoptions across

these countries (Bell 1972, Feder & Umali 1993, Moscardi & de Janvry 1977). Furthermore, high-status collective actors can also affect individual adoptions, such as when adoption of agricultural innovations by farmers in developing countries was induced by governmental policy intervention in the form of subsidies and financial credits to farmers who adopted innovative practices while support was withdrawn from farmers who continued old practices (Feder & Umali 1993).

The predictive power of an individual actor's status on adoption of an innovation varies positively with the prominence of the actor's position in a network, such as in the case of coercion of less influential youth gang members by superior peers (Baerveldt & Snijders 1994) or of the adoption of tetracycline by physicians when high-status colleagues with whom they frequently communicated also adopted the drug (Coleman et al. 1966). In a study on the effect of the media, Weimann & Brosius (1994) argued that an actor's status characteristics interact with media effects because media mainly affects high-status members who identify innovations and then spread them within a group of lower-status members. These findings are modulated by the fact that high-status adopters initiate adoption of innovations that are mainly noncontroversial and consistent with established norms. Under these particular circumstances, network members of the lowest ranked status adopt such innovations last. On the other hand, when innovations are more controversial in nature, low-status, peripherally located actors may initiate the adoption process apparently because they are less fearful of losing popularity by nonconformist behavior (Becker 1970, Heyman & Mickolus 1981).

SOCIOECONOMIC CHARACTERISTICS The focus here is on socioeconomic characteristics of the actor per se, rather than on the socioeconomic conditions in the environment external to the actor. Two categories of socioeconomic variables have been most frequently studied: economic and sociodemographic. Early studies of diffusion emphasized individual actor variables, such as education level, economic well-being, and cosmopolitanism (DiMaggio & Powell 1983, Ryan & Gross 1943). More recent studies have analyzed variables of collective actors, such as degree of technological advancement, GNP, level of development (developed vs. developing countries), financial resources, centrally planned versus market economies, political system, and labor market practices (Feder & Umali 1993, Most & Starr 1990, Oakley et al. 1992, Saltiel et al. 1994).

Overall, the rate of diffusion appears to be correlated with characteristics of actors' that create "objective feasibilities" of adoption of innovations. For example, the rate of diffusion of innovations, even ideological ones such as democracy, has been correlated with a country's overall economic development, measured by development indicators such as relative position in the international-trade market and by standard of living (Mahajan & Muller 1994). Economic variables have had both potentiating (James 1993) and inhibiting effects on diffusion, as in cases of unsuitable economic policies (Nabseth & Ray 1974) or of poor economic conditions (Bongaarts 1994).

Economic conditions of the actor, then, along with cultural and political circumstances, determine the susceptibility of potential adopters to innovations. For instance, some technologies are not available to citizens of developing states because countries are too poor to introduce them into domestic markets (Rogers & Shoemaker 1971). Some studies suggest that economic variables have often accounted for more variance in likelihood of an individual's adoption than do sociodemographic variables such as race, gender, marital status, and education level (Morris 1991), or an actor's social position, education, and cosmopolitan views (DeMaggio & Powell 1983). For collective actors such as trade unions, economic variables accounted for more variance in adoption rates than did spatial factors (Hedström 1994). Similarly, economic variables carried more weight than did institutionalized models in adoption of occupational licensing by states (Zhou 1993).

POSITION IN SOCIAL NETWORKS Since timing of adoption typically depends on the interaction of social units in a process of communication (Rogers 1995), a major focus in diffusion research has been on variables that mediate communication processes—including both the transmission and absorption of information—between members of societal microstructures. Interactions can occur between individuals, between individuals and the media, or via business/professional organizations. Thus, research has examined an actor's position in social networks in relation to their interactions within four major spheres: (a) interpersonal networks for individual actors, (b) organizational networks for collective actors, (c) structural equivalence of individual and collective actors, and (d) social density.

The main focus of research on face-to-face interactions between individual actors has been on social relations within small, well-connected groups, i.e., interpersonal networks. Direct interactions between individuals, under certain conditions, significantly accounted for adoption of a variety of innovations, from fertility-control methods (Freedman & Takeshita 1969, Rosero-Bixby & Casterline 1993, 1994), agricultural practices (Rogers et al. 1970, Ryan & Gross 1943), new medicines (Coleman et al. 1966), and ethnic self-identity (Hout & Goldstein 1994), to scientific knowledge (Valente & Rogers 1995) and scientific specialties (Michaelson 1993). This impact appears to be related to the fact that adoption by some actors has a cumulative effect on the adoption decisions of other actors in the social network, such that the number of adoptions follows an exponential progression until only avid opponents of adoption remain (Coleman et al. 1966). Thus, in many cases adoption is better accounted for as a network-based decision, where exposure to an innovation through a network of peers has a cumulatively increasing influence on adoption as pressure toward conformity builds and as risks perceived by potential adopters decrease (Valente 1995).

Two sets of variables that influence the impact of interpersonal networks on individual actors have been defined. The first is network connectedness (i.e., closeness of communication between members). The second concerns characteristics of

actors that influence openness to novel information. The most significant network-connectedness variables predicting adoption are inversely related to network size (Freedman & Takeshita 1969, Rosero-Bixby & Casterline 1993) but directly related to network closeness, measured as number of friends and advisees each actor has within the network (Coleman et al. 1966, Valente 1995). Also important are frequency of interactions among members (Katz & Lazarsfeld 1955) and openness of communication within a network, referring to the level of privacy of shared information (Rogers & Kinkaid 1981). The rate of adoption within interpersonal networks also appears to be modulated by variables that determine openness of an actor to novel information, such as authority and prestige (Burt 1987), extent of an actor's social connectedness with others as advisers, close friends, or discussion partners (Coleman et al. 1966, Valente 1995), and the relative level of innovation-relevant knowledge (Michaelson 1993, Valente & Rogers 1995).

Networks composed of organizations similar in terms of structure, content, and goals (e.g., labor unions, medical associations, railroad companies, or firms with interlocking directorates) have effects similar to interpersonal networks, but they also provide means of diffusion of innovations that are independent of direct interpersonal interactions (Hannan & Freeman 1988, 1989, McAdam & Dieter 1993). For instance, Swan & Newell (1995) argued that the network of professional organizations was the single most influential variable in determining the adoption of new technology by firms (accounting for 18% of the variance). Similarly, Chaves (1996) indicated that the existence of religious networks almost doubled the probability of adoption of the practice of ordination of women. A broadened range of predictors in those studies would probably lower the weight of this effect, but the significance of networks on adoption rate is supported by other analyses. For instance, DiMaggio & Powell (1983) argued that coercion and mimicry between institutions lead to isomorphism of the institutions' practices, and Davis (1991) demonstrated that business networks significantly weighted the adoption of a policy of shareholder's rights.

The channel of influence on diffusion from an actor's position in organizational networks can be viewed as twofold, and it is somewhat similar to that operating in interpersonal networks. One channel is horizontal, where upper-level executives of different but competing organizations influence the spread of innovations across organizations. For example, directors of interlocked companies who were alumni of elite business schools, were similarly trained, and who belonged to the same network of graduates—hence being structurally equivalent—were more likely to adopt the same innovative practices for their firms than were directors who did not graduate from these elite schools (Palmer et al. 1993).

A second channel is vertical, where the flow of information is from upper-level executives down to members within the organization (Newell & Swan 1995). For instance, as Mizruchi's (1993) studies of the political behavior of large corporations indicated, variables related to the degree of central structure and central authority within organizational networks substantially enhanced the effectiveness of a

vertical channel of influence. Highly centralized, stratified networks use coercive pressure on their members to achieve conformity of practices, causing homogeneity and increasing rates of adoption. Mizruchi's findings were supported by Conell & Cohen's (1995) study on the effects of national labor unions in controlling the spread of strikes, by Scott & Meyer's (1994) analysis of the promotion of uniform technological practices by industrial organizations, and by Ferraro's (1993) finding that a medical organization (American Medical Association) delayed the diffusion of HMOs by transmitting discouraging information among physicians.

Within vertical and horizontal channels of influence, organizational networks can affect the rate of adoption of innovations via multiple effects. They can, for example, be informative, as when members learn of the newest industrial developments (Newell & Swan 1995) or strikes in other factories (Conell & Cohen 1995); or conducive, facilitating contact with former adopters, such as in meetings with representatives of companies that have already adopted new production inventory control systems (Newell & Swan 1995) or with groups of scientists that have developed new scientific paradigms (Crane 1972). Another kind of effect is educational, such as providing professional advising on new developments, workshops dedicated to innovation promotions, publication of experts' opinions in newsletters, and discussions with academic consultants on the beneficial aspects of adoption (Newell & Swan 1995, Swan & Newell 1995). Still others are coercive, by using explicit or implicit rewards or negative contingencies to produce conformity and compliance with respect to adoptive behavior (Ferraro 1993, Usselman 1991); or modeling, by providing standard, uniform models of correct decisions (Mizruchi 1993).

Structural equivalence of members in a network, i.e., an actor's perception of concordance with other members in a social and/or organizational network, particularly of comparable economic and social status, modulates adoption of innovations because it affects homogeneity of adopters' behaviors (Burt 1987, DiMaggio & Powell 1983). For individuals, structural equivalence is determined by (a) demographic factors such as sex, age, race, ethnicity, marital status, and education (Morris 1993); (b) social indicators like education (Valente & Rogers 1995) and occupation (Burt 1987); and (c) culture, such as similarity of language, cultural tradition, religion, self-identity, values, and norms (Abbott & DeViney 1992, Chaves 1996, Hout & Goldstein 1994). Collective actors perceive structural equivalence via (a) economic factors—level of wealth or economic system (Burt & Talmund 1993, Palmer et al. 1993), (b) cultural factors such as historical background (Russett 1967, Uhlin 1993), and (c) behavioral factors, e.g., similarities of action (Holden 1986) or strategy (Oberschall 1989).

Abbott & DeViney (1992) demonstrated that the structural equivalence between states contributed more than twice as much as all other selected variables to the predictability of adoption of welfare policy. Similarly, Mizruchi (1993), studying the behavior of large corporations, showed that equivalence between firms better predicted homogeneity of behaviors in highly stratified networks than did the

level of cohesion between firms. Therefore, weighting actors by their structural equivalence may lead to a more accurate prediction of adoption, and thus of the rate of adoption, than by focusing solely on direct interactions between actors or on communication links. Structural equivalence may facilitate adoption by activating actor competition, as shown in Burt's (1987) reanalysis of Coleman et al.'s (1966) classic study on diffusion of a new drug (tetracycline) among physicians; not friendship and direct interactions but rather competition for prominent position in a network was the main motive of physicians' adoption of tetracycline.

Finally, social density refers to the density of existing adoptions within an organization, where the greater the density of adopters, the less the perceived risk of adopting by nonadopters (Hannan & Freeman 1987). Because each adopter also subsequently serves as a transmitter influencing other potential adopters who are in close social proximity, the density of actors who have already adopted an innovation may be an important influence on the adoption rate within a network (Blau et al. 1992, Knoke 1982). However, as Hannan & Freeman (1987) argued, the cumulative number of adoptions within an organization, or within a unit of an organization, promotes new adoptions up to a critical point of exhaustion of resources, after which the adoption rate decreases (Hannan & Freeman 1987). This finding indicates that the effect of density is not temporally static but rather varies over time, depending on the density of prior adoptions and on the duration of time intervals between former and new adoptions.

PERSONAL CHARACTERISTICS Thus far, relatively little research has investigated personal characteristics of individual actors as modulators of adoption of innovations. However, as Weimann & Brosius (1994) suggest, personal characteristics that seem to have relevance to the adoption of innovations are self-confidence and independence or "psychological strength" because they would likely modulate the extent to which an actor adopts an innovation without waiting for the security of knowing that others have so acted. Psychologically strong actors select the most important innovations from the abundance of information covered by the media, rapidly adopt those innovations, and using their own social networks, create a public agenda that significantly promotes adoption. Conversely, psychologically weak actors depend on the opinions of stronger actors who relay media information. Additionally, Menzel (1960) showed that self-confidence and risk-taking characteristic of individual actors affected an actor's receptiveness to novel information as well as the rate of adoption of innovations.

Personal characteristics, however, do not develop in a sociocultural vacuum, but rather are modulated by societal culture. Such modulatory effects would be at the level of national populations, or at least at the level of large subgroups of populations in cases where heterogeneity of culture is found within countries. A study by Herbig & Palumbo (1994b), comparing patterns of adoption of novel industrial practices in American and Japanese societies, supported the possibility of modification of personal characteristics by culture. Accordingly, American

culture that supported the value of independence, risk-taking, and individual success resulted in an adoption pattern in which, once exposed to an innovation, American actors rapidly adopted novelty. Their eventual rate of adoption, however, was temporally prolonged due to a relative paucity of collective interaction and collaboration. In contrast, in Japan individual actors were generally slow to adopt innovations, rendering the time to initial adoption relatively late compared to the American population. Nevertheless, as the authors suggested, the temporal rate of adoption, once the adoption process began, was significantly shorter than for Americans probably because Japanese culture socialized actors to be strongly competitive but also to value collectivism.

Caution in interpreting the role of personal characteristics has been illustrated in studies on diffusion of violent behaviors induced by media (Berkowitz & Macaulay 1971, Bollen & Phillips 1982, Holden 1986). Such authors argue that diffusion in loosely connected, usually larger networks may be predominantly influenced by media exposure, e.g., diffusion of murder-suicides (Bollen & Phillips (1982), criminal violence (Berkowitz & Macaulay 1971), or air hijacking within a population (Holden 1986). Although the relevance of such findings to a media effect on adoption is questionable, the results may provide evidence for the impact of personal characteristics on adoption. In both cases, the innovation is one of extremely low frequency and very low appeal in the population. Thus, diffusion of such behavioral patterns as hijackings or murder-suicides throughout the population at risk, in most cases the entire United States, is actually extremely low because the ratio of adopters to the population of potential adopters is extremely low. Moreover, because of the low appeal of the behavior to the population, its spread is probably independent of media communication. The spread of low-frequency behavioral patterns may be more accurately viewed as one of behavioral imitation among psychologically prone actors than as due to a process of diffusion or to media effect on adoption.

Environmental Context

A fundamental element in adoption theory is recognition that innovations are not independent of their environmental context but that they rather evolve in a specific ecological and cultural context and that their successful transfer depends on their suitability to the new environments they enter during diffusion (Ormrod 1990). Environmental context variables fall into at least four subgroups: (a) geographic settings, (b) societal culture, (c) political conditions, and (d) globalization and uniformity. The variables of the first subgroup refer mainly to innovations with private consequences that are adopted by individual actors, the latter three to innovations with private and public consequences that are adopted by micro- and macro-level actors. In his analysis of worldwide diffusion of technological innovations, James (1993) refers to contextual factors as “externalities” and suggests that they affect the practicality and benefits of adoption, as well as an adopter’s willingness and

ability to adopt an innovation. Therefore, in most cases, externalities have a permissive effect, where their presence or absence largely determines the decision regarding adoption of an innovation.

GEOGRAPHICAL SETTINGS Geographical settings affect adoption by influencing the applicability of the innovation to the ecological infrastructures of the potential adopter and by exerting spatial effects of geographical proximity. The impact of ecological infrastructures such as climate, weather, or soil conditions on adoption generally applies to either agricultural (Fliegel 1993, Saltiel et al. 1994) or technological innovations (Ormrod 1990) because some of these innovations can be adopted only when they are suitable to an actor's ecological conditions. For instance, Jansen et al. (1990) argued that nonadoption of very profitable modern cereal by Indian peasants was affected by the frequent occurrence of floods to which the new crop had limited resistance. Similarly, ecological conditions and land quality (texture of soil and slope of land) affected decisions to adopt sprinkler irrigation and tail water recovery pits by individual farmers in the United States (Negri & Brooks 1990), and lower quality of land was positively correlated with adoption of water-saving technologies by Texas farmers (Nieswiadomy 1988). Moreover, Ormrod's (1990) studies on diffusion of technological innovations across different climatic zones demonstrated that climate accounted for as much as 73% to 76% of the variance in the adoption rate of air conditioners and home food freezers by individual consumers.

Many studies of diffusion are concerned with a second category of geographic settings: effects of the spatial factor of proximity (distance) on an innovation's adoption (Hagerstrand 1967, Strang & Tuma 1993). This variable refers to an automatic spread of innovations between individual actors who are in close geographical contiguity, such as within rural or urban communities or counties located within the same geographical region (Brown 1989). Geographical proximity is generally estimated as the relative rate of adoption between geographically spaced actors. Because proximity can affect the frequency of communication and the personal nature of interactions between actors, it enhances the spread of information and ideas and facilitates imitative behavior (Rogers 1983). A prime example of such a proximity effect is how farmers adopting interrelated agricultural technologies early accepted only a part the package (only seeds and fertilizers), whereas their neighbors, after observing the early adopters, accepted the whole package (herbicides and chemicals as well as seeds and fertilizers) (Leathers & Smale 1991). Correspondingly, the direct observation allowed by close geographical distance positively affected adoption of similar family-size models by residents of counties in the American South so strongly that it maintained its significance even after controlling for all other added variables (Tolnay 1995).

Frequently, the effect of geographical proximity is visible in cases of adoption of policy reforms by macro-level actors, such as adoption of municipal reform by

American cities (Knoke 1982), new administrative programs and policies across American states (Walker 1969), state lottery and innovative tax policies by neighboring American states (Berry & Berry 1990, 1992), and principles of democracy by countries located within the same geographical region in the world (Huntington 1991). Abbott & DeViney (1992), discussing diffusion of welfare policy across the world, added that geographic proximity alone does not have a very significant effect on a country's adoption of welfare policy unless it is supported by the closeness of countries in interaction, e.g., comparability in trade, capital flow, language, or religion.

Tolnay (1995) argued that the effects of density of potential adopters are a function of geographical proximity or distance between social units, and hence, spatial effects are best estimated as a joint function of distance and density. Extending the understanding of spatial proximity to adoption potential (measured as the distance \times density of adoptions in interacting units), he estimated adoption rate in relation to adoption potential, which when nonlinear, or linear with a slope not equal to unity, diffusion is assumed to have occurred. Congruently, Rasler (1996) posited that during the Iranian revolution escalation of political protests across the country was a positive function of a density of protestors within a certain geographical area as well as of the geographical proximity.

SOCIETAL CULTURE A broad spectrum of variables of societal culture is studied in diffusion research—belief systems (values, norms, language, religion, ideologies), cultural traditionalism, cultural homogeneity, and socialization of individual actors—as influencing adoption of innovations. In addition, studies emphasize actors' adoption behaviors as a function of an impact of culture on societal values, characteristics that confer high status and composition of networks.

The impact of belief systems on decisions of micro- and macro-level actors has been described in a number of studies. Tolnay's (1995) work on diffusion of reproductive patterns among married couples living in the American South that follow common linguistic and religious counters is one example. In another, welfare policy was adopted more rapidly among countries that had similar religion and language (Abbott 1992). Sommers & Napier (1993) similarly documented more frequent adoption of sustainable agricultural practices by farmers in Amish vs. non-Amish communities, modulated by Amish communities' cultural attitudes toward land and soil protection.

Belief systems constitute culture, but culture also affects societal values and, in turn, influences adoption of innovations. For example, Straub (1994) examined how comparability in culture-induced systems of values affected the variability in adoptive behaviors between Japanese and American companies. In Japan, private companies more frequently adopted fax technology than email, the reverse of the pattern in America. Fax, being a more official means of communication, was more compatible with Japanese culture, which promotes more formalized social relations, while email, a more informal form of communication, was more congruent with American culture, which endorses less formalized social relations.

Similarly, Herbig & Miller (1991) argued that companies have been found less likely to adopt innovations that conflict with societal cultural mores and systems of belief, or that are discordant with local customs, norms, and tradition, because such incongruence increases the costs of adoption (too high potential risk of societal disapproval). On the other hand, when an innovation is consistent with local cultural traditions, belief-system variables have been one of the strongest factors determining the adoption ceiling, i.e., the number of actual adoptions to the number of potential adopters.

Perception of cost of adoption of innovations that are incongruent with local cultural values seems to be greater for individual than for collective actors. Therefore, innovations conflicting with cultural norms are adopted only by a relatively small percentage of individual actors who are potential adopters. For instance, residents of the Peruvian village of Los Molinos would not adopt the practice of boiling drinkable water because it conflicted with their norm of serving such water only to sick people (Rogers 1962). Similarly, in Costa Rica, married couples significantly retarded the rate of adopting fertility-control practices because they conflicted with cultural values about optimum family size (Rosero-Bixby & Casterline 1993, 1994). Thus, individual actors usually express higher degrees of congruence with societal cultural values than do collective actors; consequently they follow societal norms in their adoptive behaviors more strictly, such as when traditional farming practices were employed by Amish farmers because protection of soil and water resources is believed to have religious significance and because the Amish belief system emphasizes that family goals must be in harmony with religious and community standards (Hostetler 1987). On the other hand, marginal individuals, outsiders in a community, who are free from societal norms, adopt unconventional practices sooner than their conventional neighbors (Becker 1970).

Culture also affects two further variables: (a) characteristics that confer high status, thereby having a significant impact on individual adoption behavior and (b) the composition and/or structure of social networks that are conducive to more rapid adoption. For example, favorable attitudes toward sustainable agriculture (e.g., organic or management-intensive), embedded in the local culture of Montana communities, conferred higher status on adopters of those practices. In turn, this had a significant direct effect on adoption of such practices by Montana farmers (Saltiel et al. 1994).

With respect to social networks, Chaves (1996) observed that adoption of ordination of women occurred within networks of religious organizations with similar religious practices. For micro-level actors, the effect of culture on the structure of social networks is most notably visible in isolated networks, such as youth gangs (Baerveldt & Snijders 1994) or in covenant communities, rural or religious communities that are established by homogeneous groups (Smith 1966). In such networks, adoption of an innovation by a network's more prominent members induces adoption across community members, such as when Korean villagers adopted the practice of family planning or Brazilian farmers adopted agricultural innovations [Valente (1995) re-analysis of Rogers & Kincaid (1981) study in

Korean villages, and Rogers et al. (1970) study in Brazil]. Moreover, the effect of culture on the composition of social networks strongly affects whether decisions to adopt are made by individuals or, for example, by village elders, as in a clan-based society.

Two other aspects of culture can affect adoption rates. First, a high degree of cultural traditionalism is often associated with social inertia in adopting new practices and ideas, adversely affecting a country's adoption of technological developments and extending the time between early and late adoptions. Myrdal (1968), for example, thought that these factors applied to India's unproductive economic behavior, where the strong cultural constraints on the societal positions of most people may have gradually reduced incentives to adapt novel approaches to farming.

Second, the degree of cultural homogeneity of a country's population may be positively related to adoption because it increases the degree of structural equivalence between transmitters and potential adopters (Takada & Jain 1991). Herbig & Palumbo (1994a), for example, argued that the cultural homogeneity of Japanese society might have increased the rate of adoption of industrial innovations, whereas American cultural heterogeneity might have slowed it. In another study, these same authors also argued (1994) that particular attributes of societal culture have had a causal effect on the speed of diffusion of innovations across societies and on the differential rate of adoption of technological innovations by the United States vs. Japanese industry. Japanese culture, resistant to change and risk adverse, promotes collective decisions, which prolongs adoption of innovations. American culture, on the other hand, shortens the time for adoption of innovations by promoting authoritarian, aggressive, and competitive behaviors.

There is one additional way in which cultural variables may influence adoption rates: socialization of individual actors, which is influenced strongly by culture, may mobilize available societal talents of entrepreneurship, perseverance, determination, and marketing skills required of actors who consider adoption of new practices or policies (Rothwell & Wisseman 1986, Ruttan 1988). Socialization contributes to the development of such characteristics as competitiveness and proficiency, which are needed for enactment of many types of innovations, including vast ones such as the transition toward a market economy and political democracy (Beteille 1977, Offe 1991).

POLITICAL CONDITIONS Diffusion studies concerned with the impact of political conditions on adoption of innovations have primarily analyzed the character of political systems, along with the regulations and norms inherent in the legal systems that control actors' behaviors. Researchers analyzing adoptive behavior of large collective actors have found strong effects of states' political stability on adoption of new policies (Berry & Berry 1990, 1992) and of bureaucratic efficiency on cross-national adoption of welfare policies (Abbott & DeViney 1992).

Political situations could inhibit or postpone adoption of some innovations. For example, in the case of adoption of democratic movements and ideas of transformation of a political system, political conditions appear to be important variables

affecting diffusion of new ideas, as in the political situation inhibiting the development of democratic movements in the former Soviet Union (Sedaitis & Butterfield 1991).

For small collective actors, variables of political conditions include national policies, the structure of government, bureaucracies, the political character of a state, and the existence of political freedoms and laws. Particular emphasis has been placed on the extent to which state policy, by supporting traditional national practices, affects adoption. Here it has been demonstrated that the rate of adoption is strongly influenced by protecting domestic technologies from replacement by technologies from foreign countries (Fleury 1988, James 1993) and by distributing concessions and repressions to various political, corporate, and social groups (Rasler 1996). Several studies suggest that the rate of adoption of innovations by companies or professional organizations is a function of state legislative systems. Patent laws, for example, have regulated firms' adoption of technological innovations (MacLeod 1991, Usselman 1991), and professional-license laws have modulated the diffusion of professional licenses (Zhou 1993).

With respect to individual actors, the adoption of innovations seems to be markedly determined by states' ideological doctrines and by political censorship. For example, Bakardjieva (1992) demonstrated that, because of political reasons and fear of exposure to Western advanced technology, citizens of former Soviet-bloc countries did not have available durables such as satellite antennas, fax machines, or cellular phones until the 1990s, when changes in political conditions led to the diffusion of communication technology to this region. Correspondingly, political censorship and ideological doctrines in former communist states rejecting Western philosophical thought appeared to have limiting effects on adoption of scientific knowledge by members of academic communities (Wejnert 1996).

GLOBAL UNIFORMITY Variables related to global uniformity reflect the view of the contemporary world as one cultural community, characterized by collective development grounded in a synchronized, cohesive process of evolution. This uniform evolution is thought to be a function of three exogenous variables. The first is institutionalization, the spread of rule-like behavioral models that are supported by common recipes and an implicit structure of incentives for the adoption of approved forms of practices, programs, or policies. Standardization of those models elicits adoption of institutionalized practices (Meyer & Rowan 1977). Second is global technology, global adoption of technological innovations, including agricultural and industrial practices, that is facilitated by the growth of multinational corporations (Rosegger 1991, Silverberg 1991), as well as by the generally low threshold of diffusion of technological innovations (Mahajan & Muller 1994). Third is world connectedness via modern communication systems or media effects.

Uniform evolution is also markedly enhanced by the fact that the process of diffusion per se often promotes the development of similar societal structures, and

this, in turn, facilitates diffusion of additional practices and ideas (Thomas et al. 1987). For example, the temporal rate of diffusion for computer use in American public schools, begun in 1970s, grew so rapidly that by 1988 over 97% of schools had one or more computers. The ratio of computers per student increased from one for every 12 students in 1993, to one for every 8 students only a year later. Adoption of external networking through the Internet or area providers was equally rapid but took a different path, determined by the density of computers a school already owned (Anderson & Magnan 1996). Therefore, schools' initial adoption of computers facilitated adoption of a practice of external networking.

As a number of studies have emphasized, institutionalized practices mainly affect adoptions by collective actors. Two separate sources appear to contribute to the process of institutionalization in societies and, hence, to the adoption of innovations. The first is a base of scientific knowledge in which costs, benefits, and outcomes of adoption of schematic practices are specified, attracting potential adopters and encouraging actors to comply with new models (Meyer & Rowan 1977), such as when institutionalization of world opinion toward perceived population growth decreases population expansion (Kirby & Kirby 1996). Second is the introduction of new practices to the public in modern states by interest-group politics, which, by selective legitimization and rationalization of particular institutional forms and practices, contributes to their normalization. This latter case is illustrated by occupational licensing in the United States. In this case, governmental policies and court rulings created a favorable and legitimate institutional environment for the spread of licensing by defining the practice as normative (Zhou 1993). Similarly, patent laws introduced by state governments normalized technological innovations and promoted their diffusion (MacLeod 1991), and the 1960 United Nations declaration that delegitimized imperialism in global political discourse led to an increased rate of decolonization (Strang 1990).

Moreover, collective actors often identified institutionalized practices as being modern and as most central and relevant to mainstream societal evolution. Under these circumstances, collective actors (in most cases either political authorities in a country or managers of an organization) believe that it is advantageous to comply with accepted, modern behaviors that have gained rule-like status because those who adopt established practices are more likely to be rewarded with rapid advancement. Many modern policies, for example welfare (Thomas & Lauderdale 1987), education policy (Boli-Bennett & Meyer 1978, Boli-Bennett & Ramirez 1987), or nation-state models (Meyer 1987), are adopted based on this premise.

Global technology has an effect on adoption of innovations by micro- and macro-level actors. For macro-level actors, the global adoption of technological innovations is facilitated by the growth of multinational corporations (Silverberg 1991) as well as by the generally low threshold of diffusion of technological innovations (Mahajan & Muller 1994). It seems, however, that individual actors—unlike the collective actors who often adopt global technology because their

industrial co-partners had adopted it (Rosegger 1991)—make decisions to adopt technology based on rational principles, such as when household income played the dominant role relative to education and occupational status in cases of adoption of home computers (Dutton et al. 1989).

According to some studies, institutionalization and global technology are promoted when the similarity of actors' external conditions leads to similarity of their behaviors. In this sense, institutionalization and global technology would be understood as a response to the same external conditions rather than as a result of decision-making in the process of adoption and, hence, would be unrelated to diffusion. Literature on adoption of innovations suggests, however, that actors who have similar external conditions often pursue different actions. For instance, holding external conditions constant, actors select different innovations when two or more alternative or similar innovations are available (Arbena 1988), or they try a new idea before its adoption (Rogers 1995). The argument, then, is that institutionalization and global technology play an important role in diffusion, stimulating and enhancing processes of adoption.

Finally, some authors view global uniformity as generated by two distinct media effects on adoption of innovations. A primary effect of media exposure is the dissemination of information about innovations directly to potential adopters, the media thereby acting as a major channel of communication in the diffusion process (Rogers 1973, Rogers & Shoemaker 1971). Innovations with public interest that diffuse in loosely connected, large organizational networks, such as strategies of protest of social movements, may be predominantly influenced by primary media effects (Obershall 1989).

In a secondary effect, media information interacts with actors who may actively select information and transmit it across a social network. The process of adoption of innovations appears to involve media communications in interaction with interpersonal or organizational networks, and both factors seem to complement and support each other in promoting diffusion (Katz 1968). The classic example is Coleman et al.'s (1966) analysis of media exposure in well-connected networks of physicians, where media affected initiators and isolated actors while the spread of innovation to other actors within the network was subsequently facilitated vertically (from innovators down) by direct interactions. These findings were later supported by Weimann & Brosius' (1994) study of the impact of media on psychologically strong individuals who were affected by the primary role of media and then supported media's secondary role by transmitting the information across their social networks. Moreover, Strodtzoff et al. (1985) further explained that initiators who are affected by media's primary effects often seek out communication channels to promote information retrieved from media about innovations to a broader audience and to stimulate discussion about those innovations, further extending the impact of primary effects.

Overall, the accounts of global uniformity in diffusion have often emphasized a process of cultural Westernization of the world, mainly through the influence

of Western Europe and the United States. This is concordant with the effects of institutionalization on diffusion discussed above but particularly has to do with the dominance of Western cultural characteristics that generate standard practices. Western practices often connote symbolic meanings of socioeconomic advancement and elevated status. For less developed countries progressing toward economic prosperity, characteristics of modernity and Western culture are some of the strongest stimuli eliciting adoption of innovations, including those of an ideological nature (Fukuyama 1992, Pellicani & Volpacchio 1991). Such a process has been cited, for example, as contributing to a favorable environment for the diffusion of computer-controlled machinery in Hungary (Oakley et al. 1992), the triumph of United States and Western cultural values and norms across Eastern European societies in the 1990s (Karnouh 1991), and the spread of American sport practices in South American countries (Beazley 1988, Guttman 1994). Despite the inefficiency of these technologies for Hungarians, and the degradation of national cultural roots due to the influence of Western mass culture (Koralewicz & Ziolkowski 1993), these innovations were still broadly adopted.

Conversely, characteristics of modernity and Western culture can also invoke great antipathy and serve as barriers to adoption of innovations, including those of an ideological nature. The critical assessment and opposition toward diffusing Western models is visible especially among societies with cultures not sharing European cultural roots. Japanese preservation of cultural identity through its selective adoption of innovations and, preceding adoptions, modifications of Western styles of management and political decision-making is a strong example of cultural opposition to Western models (Kissinger 2001). Animosity of countries in the Middle East toward Western cultural and economic relations is another (Kurzman 1996).

IMPLICATIONS FOR FUTURE RESEARCH ON DIFFUSION OF INNOVATIONS

The above discussion demonstrates that a broad array of variables can significantly influence the probability of whether an actor will adopt an innovation. Analyses of these variables suggest that there are at least three areas of diffusion research that need to be extended in order to better understand the process of adoption.

The first area concerns the interactive impact of variables on diffusion of innovations. While the above discussion treats the broad array of diffusion variables independently for the sake of clarity, in reality they exert their effects on the process of diffusion interactively. The interaction between variables can be either potentiating or mitigating, and the relative weight of each variable may change according to the circumstances characterizing the innovation and its context. By way of illustration of this complexity, one example of such interaction is the

relative impact of spatial effects. Depending on the variable and circumstances, a number of exogenous variables appear to interact in a complex manner with spatial effects, including demographic (age, sex, mobility rate, race, ethnicity) and socioeconomic (education, urbanization, industrialization, economic well-being, health conditions) variables (Berry & Berry 1990, Hedström 1994, Tolnay & Glynn 1994). Thus, inclusion of demographic and socioeconomic variables has reduced the power of spatial effects in predicting diffusion among collective actors (Berry & Berry 1992), though, as Tolnay's (1995) study demonstrated, after adding the socioeconomic variable, spatial effects still remained statistically significant predictors of diffusion among individual actors.

In addition to these interactions, the effects of spatial variables appear to be significantly modulated when connectedness between actors is determined more strongly by other, nonspatial societal context variables. For instance, spatial factors have been found to be much less significant in influencing adoption than structural equivalence based on higher-order conceptual ties that bind together individuals, organizations, or countries, including cultural, political, ideological, philosophical, and economic connectedness (Abbott & DeViney 1992). Thus, Strang (1990) found that, in other than the most economically dependent colonies, similarity of ideological and political systems resulting from the hegemony of imperialist countries over colonial states was much more predictive of the diffusion of decolonization among colonial countries than was the spatial proximity of those countries. A similar effect of structural similarity helps to explain imitation of models of political structures by structurally equivalent, even though spatially isolated, actors (Uhlin 1993).

Although structural equivalence variables appear to modulate the likelihood that actors will imitate the adoptive behavior of others, they may in certain cases act instead as a permissive factor. Thus, a second area that may be profitably extended in diffusion research concerns the gating function of variables influencing adoption. The gating function of a variable denotes influence of one variable on other variables that affect actors' decision of adoption. In other words, a variable that serves a gating function affects adoption indirectly by influencing the impact of other variables on an actor's decision.

For instance, the importance of competition among structurally equivalent actors is a predictor among individuals (Burt 1987, Coleman et al. 1966, Francois 1971, Freeman 1984), industrial corporations (Galaskiewicz & Burt 1991, Mizruchi 1993), and organizations (Berkowitz 1982, McPherson 1983). Moreover, the fact that the predictive power of structural equivalence varies positively with the prominence of an actor's position (Burt 1983, 1992, Burt & Talmud 1993, Mizruchi 1993) raises the possibility that actors who hold a central role in their network of influence are presumably more competitive and, hence, more attentive to social network norms than actors with lower positions (Becker 1970). For a variable of structural equivalence, thus, it may be that a certain threshold of relative similarity must be reached to substantially increase the probability of competition among actors

and, hence, of adoption. In this case, structural equivalence would serve a gating function whereby the opportunity for adoption is open when actors have sufficiently similar structural characteristics but is closed when structural characteristics fall below a certain threshold level of similarity.

The third area of diffusion that would benefit from further conceptual and empirical development concerns an actor's threshold of adoption in relation to actor characteristics. Such work would extend prior studies by Granovetter (1978) and Granovetter & Soong (1983), as well as re-analysis of existing studies conducted by Valente (1995). Most accounts of diffusion have focused on the sources and nature of information about an innovation that are available to an actor. What has received much less attention in diffusion research is the actor, *per se*, as an important contributor to the diffusion process, an emphasis well articulated by Rogers (1995). Of course, as noted above, actors interact with the larger societal context; and among contextual influences most likely to interact with actor characteristics are network connectedness, spatial proximity of former adopters, and structural equivalence with former adopters. An actor's characteristics, on the other hand, involve factors determining the perception of the value of an innovation and the actual feasibility of adoption, such as an actor's economic situation, social position, or personal characteristics. The implication of a salient role for the actor is that the actor's characteristics will modulate both the process of information intake and the process of decision making about whether to adopt an innovation (Normile 2000).

The importance of actor characteristics is most critically observed when considering the temporal rate of diffusion. Given equal exposure to information about an innovation, no other diffusion variable than variation in time to adoption—the very essence of the temporality of diffusion—so strongly suggests the contributory role of actor characteristics in adoption and diffusion. Viewing diffusion as an interactive dynamic between actor and environment, the environmental factors transmitting and stimulating adoption would be modulated by attributes of potential adopters. This proposition appears to be the equivalent of Rogers' (1995) suggestion that it is an actor and an actor's characteristics that account for differences in the time of adoption between first adopters (innovators) and later adopters (laggers). That is, if the magnitude of external influences is held constant across actors, variation among actors in time of adoption of an innovation should be highly dependent on an actor's characteristics or, put differently, on an actor's threshold of adoption.

The future development of the above areas would shed light on scholarly issues relating to assessment of the rate and the pattern of adoption of innovations. Pragmatically, such development would shed light on public and scholarly concern about actors' resistance to adoption of certain innovations or retrieval from prior adopted innovations (e.g., genetically modified agricultural production among Asian farmers) (Normile 2000), or on the other hand, overflowing adoption of other innovations across the world, like cell-phones or Internet connections.

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