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Author

Nicol, Lionel Y.

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Lionel Y. Nicol

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COMMUNICATIONS, ECONOMIC DEVELOPMENT,
AND SPATIAL STRUCTURES: THEORETICAL FRAMEWORK

Lionel Y. Nicol

Introduction: Toward a Communications Theory of Spatial Structures

Advocates claim that improvements in telecommunications have social and economic benefits of various kinds: that they increase economic productivity and growth, that they generate new sectors of activities, that they help reduce the congestion of large urban centers while facilitating a more efficient use of intraurban land, that they improve the efficiency of the system of cities while reducing interregional imbalances, and so on.

The review of the research in that field, however, shows that little in the way of proof has yet been offered to support these claims.¹ Indeed, because they lack theoretical foundations, the existing studies can lend plausibility to, but cannot prove, these claims.

If these hypotheses are tenable, however, the potential role of communications in economic development and their actual effect on spatial structures have probably been underestimated.

We need, therefore, to define a conceptual framework and lay down the theoretic foundations for future research that would establish the

roles of communications in development.

This paper is part of a program of research that aims at significantly advancing our understanding of the developmental role of communications and our capacity to predict and measure the effects of investment projects in that sector. Specifically, it focuses on the type and nature of effects that communications improvements may have on economic performance and structure, and subsequently on the location of economic activities in space. Although this analysis is quite general in scope, emphasis is placed on its applications for developing countries.

Thus, in the first part, we try to characterize various aspects of the role that information plays in production and distribution. The contribution of economic theory in explaining that role is also critically reviewed.

In the second part of this paper, we lay down the fundamental hypotheses and concepts pertaining to the effects of communication improvements on economic activity and structures, on the one hand, and on spatial structures on the other. In that section, we emphasize the articulation between aggregate economic and spatial effects of telecommunications improvements. Specifically, we ask how better telecommunications can and do affect the location and distribution of economic activities in space, both at the intraurban level and at the level of the system of cities. Virtually all location theories present the efficient location problem in terms of a tradeoff involving transportation costs alone. Within the conventional framework, indeed, information and communication are not decision variables. By contrast, our approach rests on the assumption that access to information, and hence the

necessity for economic agents to communicate, is a fundamental determinant of economic and spatial structures.

Finally, we analyze in a broad context the role that telecommunications could and ought to play in economic and urban development in LDCs, and its implications for telecommunications investments in developing countries.

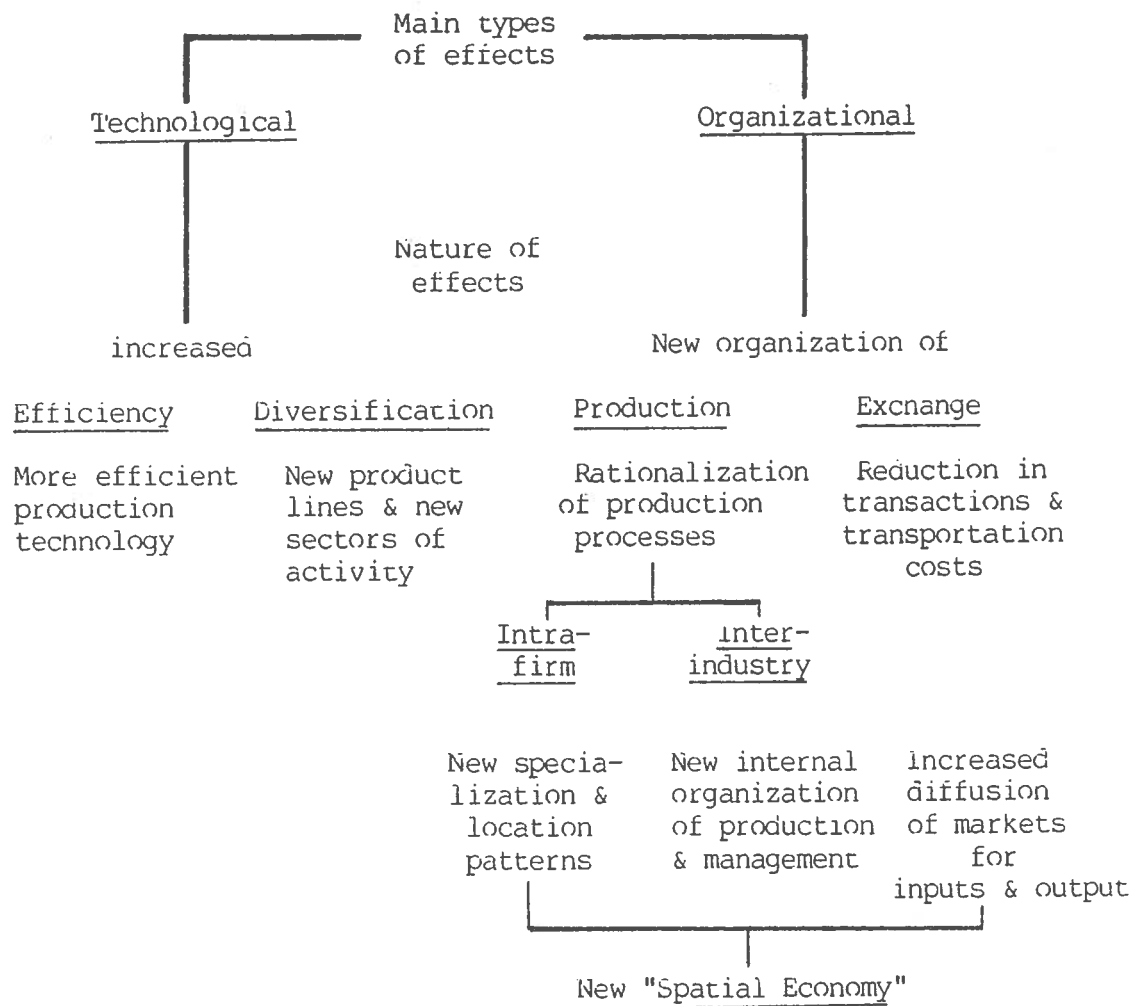
1. Theoretical Foundations of the Communications Problem

1a. Information and Economic Activity

Better communications can affect the level and performance of economic activities in two respects. First, better means of communication may bring about more efficient production processes and make possible the emergence of new sectors of activity. In turn, productivity gains and the increased diversification of the economic base can be conducive to economic growth. We call this a technological effect. A second major impact is organizational. On the one hand, improved communication systems can foster rationalization, both within the firm (through better internal organization of production and management) and throughout the economy (through the emergence of a new functional and spatial division of labor). On the other hand, better information networks and flows can substantially reduce transactions costs, thus enhancing market diffusion (i.e., the expansion and densification of the marketplace) and efficiency. These various effects are summarized in Figure 1.

Information, therefore, has value and is desirable for itself. But

Figure 1: Effects of communications improvements on economic activity and structures.



appropriation of the information embodied in messages is costly and, indeed, communications channels are not free goods. Furthermore, individuals have a limited capacity for acquiring and processing information. The idea behind the social concept of organization is precisely to overcome this bottleneck through specialization in information gathering.

It has been argued that information gathering is the most fundamental of all forms of division of labor.¹ This follows from one of the most intriguing economic characteristics of information first pointed out by Arrow: the fact that the cost of information is independent of the scale on which this information is used. In other words, the net benefits derived from information gathering are non-additive. Arrow provides a more mundane definition of this property: it is a situation in which "if by joining in an organization a number of individuals can acquire separate signals which can then be used by all of them, net benefits increase more than proportionately to the size of organization."³

Yet acquiring information is only one facet of the problem; transmitting it is another. It is, indeed, a fundamental tenet of the economics of information that conveying information is costly, a fact that in turn vindicates the need for coordination.

According to Arrow, the need for coordination has two basic causes:

First, the various production units are competing for a common pool of resources, financial and material.

Second, different decisions complement or substitute for each other.

At this point, the role played by communications within the economic sphere becomes more apparent, for "the entire economic system of markets can be regarded as a large organization with prices, purchases, and sales as signals communicated."⁴ As a matter of fact, Arrow's comment epitomizes a fundamental feature of general equilibrium theory according to which prices constitute the essential information exchanged on markets. Within the highly abstract framework of the Arrow-Debreu model, prices are, indeed, the only form of communication needed in addition to the information held initially by the various agents--consumers and producers--for the "tatonement" process to converge, that is, for equilibrium to obtain and for markets to clear.

As to analysis of the processes by which information and knowledge are produced, diffused, stored, and used, it is either absent from this framework, or, at best (because these processes absorb substantial resources) categorized under the generic term of "transaction costs." According to Lamberton, "so important would information and knowledge seem for economics that it must appear incredible that its study has been neglected."⁵ At this point, it is interesting to investigate further the kind of treatment that the problem of information has received in economic theory.

1b. Information and Economic Theory.

More than two decades ago, Stigler commented: "One should hardly have to tell academicians that information is a valuable resource: knowledge is power. And yet it occupies a slum dwelling in the town of economics. Mostly it is ignored."⁶ Except for some qualifications, the same still largely applies.⁷

Traditional economic theory completely bypassed the problem of information by assuming that decisions are based on perfect information. Within the competitive framework, indeed, firms are assumed to have complete information about demand for their products, factor supply conditions, and technology. Similarly, omniscient customers have full knowledge of commodity characteristics, prices, and of their own preferences. As a result, the pervasiveness and magnitude of the costs actually associated with bringing about a change in resource allocation is obscured. Transaction costs--the costs of running the economic system--are assumed to be zero when, in fact, they represent the major impediment and in some cases an insuperable obstacle to the formation of markets. Market failures occur, indeed, when transaction costs are so high that the existence of the market is no longer worthwhile from an economic point of view. Likewise, the very existence of vertical integration may suggest that the costs of operating competitive markets are not zero. By contrast, traditional economic analysis confuses transaction costs with production costs when it ascribes a parametric role to information and communication structures in production and distribution systems. Transaction and production costs, however, differ fundamentally, as pointed out by Arrow, in that "the former can be varied by

a change in the mode of resource allocation, while the latter depend only on the technology and tastes, and would be the same in all economic systems."⁸

In short, information and communication are not decision variables in conventional theoretical analyses. And yet the costs of communication and information represent a main component of transaction costs⁹ that reflect the costliness of the information needed to enter and participate in any market. Thus, markets are costly to use. In addition, the transmission of information is not costless. The costs of transmitting information vary with both the nature of the information transmitted and the types of the recipient and sender. Conversely, lack of adequate information or obstructions to its exchange both give rise to inefficiencies; this is a clear indication that there is an economic value in transmitting information from one agent to another, as well as in the creation of new information. In that respect, the theory of the firm subsumed in conventional economic theory is incredibly lean,¹⁰ and there is a pressing need for more research in a field--the economics of information--that is still largely in its infancy.

By contrast, our approach rests on the assumption that access to information, and hence the necessity for economic agents to communicate, is a fundamental determinant of economic and spatial structures. Consequently, any significant improvement in their capability to communicate, that is, to exchange information or to transfer knowledge, must have a direct effect on both the production and consumption possibility sets facing individual economic agents. At the same time, other things being equal, better communications systems are likely to increase the ability

of these agents actually to realize the new potentials they face. These effects will occur through a series of technological, behavioral, and locational adjustments on the part of these agents, insofar as these adjustments are not precluded by institutional or other barriers. In short, within our framework communication becomes a control variable in the decision-making process of individual agents.

2. Fundamental Hypotheses and Concepts

In the previous section we pointed out the potential effects of communications on production technology, on the rationalization of production processes and management and on market efficiency. We also hinted at their role in the articulation of economic and spatial structures. This section analyzes these effects in greater detail.

2a. Effects of Communications on Economic Activity and Structures

General Hypotheses. There is no need to demonstrate the actual importance of information in the economic sphere. Anecdotal evidence and casual observation suggest that advanced economies are moving into the so-called "information age." As Webber observes, "A telling mark of the postindustrial economy is the proportionate shift in its inputs from natural resources to informational resources."¹¹ This shift appears to be empirically supported by recent studies that show the growing share of information-based and knowledge-intensive activities in developed economies--a phenomenon that Porat called the "Information Economy".¹² According to Porat's study, total "information activity," including both market and nonmarket transactions, accounted for 46% of the GNP in the

United States in 1967. Explicitly, this means that in 1967, 46% of the nation's wealth originated in the production, processing, and distribution of information goods and services, Porat's definition of the information activity. Yet there is little doubt that the information sectors, which according to Porat encompass a "primary information sector" (including all industries that supply the bundle of information goods and services exchanged in a market context) and a "secondary information sector" (including those portions of non-information firms engaging in purely informational activities plus most of the public bureaucracies), represent a much larger share today than they did in 1967 (25% and 21% of GNP respectively). Obviously, communications--that is, the transmission and distribution of information--account for only a part in the spectacular growth of the information activity. Other major components entering this activity include the production of information goods and capital (e.g., information processing and storage machines), the selling of information services (knowledge production and inventive industries such as R&D firms), risk management activities (insurance and financial companies, speculative brokers) and all activities performed by the various services (or quasi-firms) embedded in non-information enterprises that are ancillary to or in support of the main productive activity. Nonetheless, the strategic or even critical role that communications play in the development of the information economy is readily apparent.

Fundamentally, better communications are expected to induce a reduction of inefficiencies (through, for example, lower transactions costs) and an expansion of the production possibility set facing individual firms (because of the new technologies available). These effects,

which reflect the catalytic role that communications play in the economic sphere, are partly the result of the more efficient use of scarce resources and factors in production, and partly of a less frictional economic environment. Better communications, in other words, lubricate the economic machine which then becomes more productive.

This, however, is a rather static view of the catalytic effects of communications in economic activity. One thing that scientists know about catalytic reactions is that response time is a very important characteristic. Similarly, in this economic context, the response times of exogenous improvements in communications, as well as the nature of the responses, are important aspects in the evaluation of the effects of communications on economic activities.

Thus, communications do not generally enter the production process as ordinary inputs, although it is clear that they do for example in brokerage activities, but rather appear commensurate to a form of technical change. The specific forms taken by this change mirror economic growth theory's traditional dichotomy between "disembodied" and "embodied" technical change.¹³

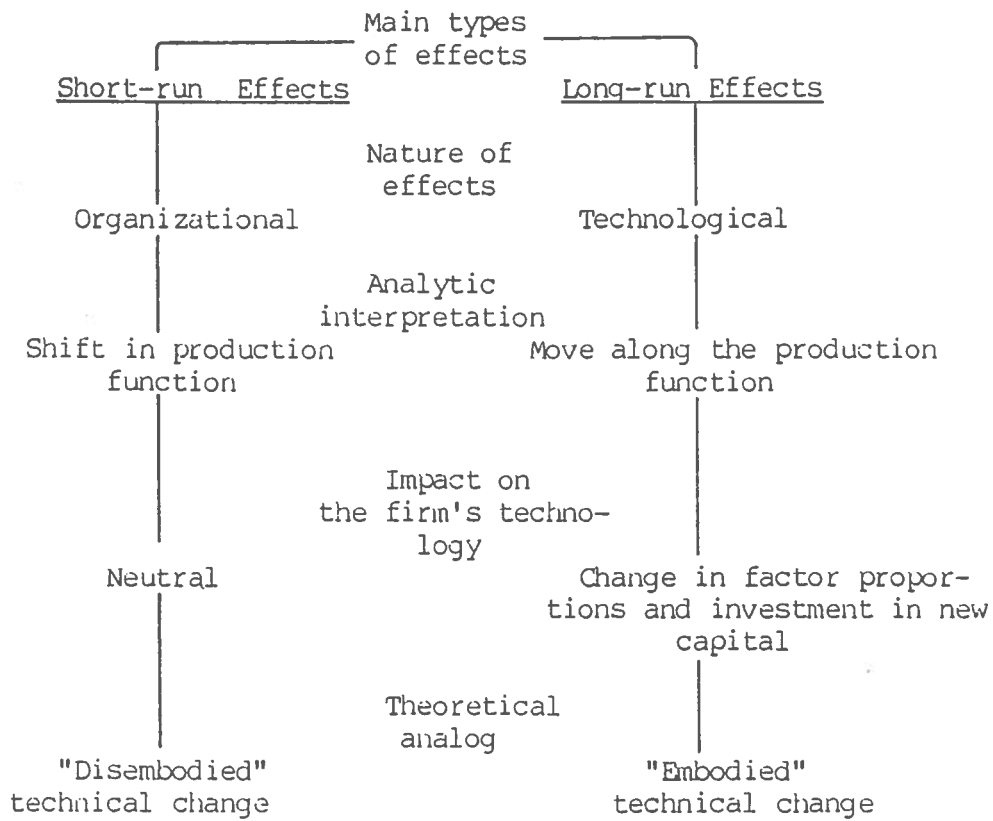
Using the technical change analogy to differentiate between types of communications effects, we shall assume hereafter that the nature of short-run effects of an improvement in communications is akin to a disembodied technical change, insofar as these effects do not imply an alteration either in the type or in the proportion of inputs used up in production. Existing inputs are exogenously "improved" or used more efficiently, so that the short-run effects of communications improvements on total factor productivity accrue to the firm in the form of

"costless advances." By way of contrast, long-run effects are likely to involve the use of scarce resources. As in the case of embodied technical change, the occurrence of these effects is contingent upon the use of "new" capital, that is, either upon investment in new technology, or upon relocation. Both types of technical change appear to be relevant to an improvement in communications. We now proceed to characterize further these two sets of effects.

Effects of Communications Improvements on the Firm. Figure 2 summarizes the main characteristics of the effects that communications improvements are likely to have on individual firms both in the short and in the long run. Effects akin to "disembodied" technical change reflect both an improvement in the flow and diffusion of information as networks permeate an ever-expanding and more intricate web of economic activities. The occurrence of these desirable effects, however, requires that no insuperable barriers preclude the mobility of factors between the various sectors of activity. Provided that this requirement is satisfied, improved communications should induce significant gains in total factor productivity.

Examples of activities where these effects are likely to be highly visible can be found in sectors that deal with the coordination of national or international activities. A typical case is provided by the communication-dependent tourist industry, a major foreign exchange earner in many developing countries. In these countries, the tourist industry, and its numerous ancillary and support services activities, are significantly constrained by inadequate and unreliable international communication. This inadequacy often results in low or inefficient

Figure 2: Effects of communications improvements
on the individual firm.



capacity utilization and substantial loss in the foreign-exchange-generating capacity of that industry. Thus larger flows and better diffusion of information are instrumental to the expansion and efficient operation of existing markets. Eventually new markets may develop as latent demand becomes effective, so that this type of effect supports the hypothesis that an improvement in communications would also be conducive to growth.

Effects akin to the "embodied" type, on the other hand, probably occur as a result of the dependence of entire sectors of activity upon the use, and hence the availability, of communications (whether for their use as direct inputs, or because of the existence of structural linkages). Such activities include all market transactions of information goods and services that are produced in the primary information sector. They also include, to an increasing extent, the activities of most public and private bureaucracies as they become more dependent upon office automation and transmission systems. Paramount examples are provided by risk-management activities, such as insurance, financial and brokerage activities, which are currently undergoing deep structural and organizational changes following the introduction of computerized data processing and transmission systems.

Yet, the industry which has been forced to rely upon new information technology to the greatest extent is the banking industry insofar as it depends upon the fastest processing of information for both its domestic and international operations. In that respect, indeed, the banking industry is considered the flagship for other sectors of activity.

Because of the growth of multinational corporations, the financial centers of the world are becoming increasingly dependent upon quick, efficient communication networks. Multinational businesses, therefore, rely upon international banks to provide information-dependent financial services responsive to international market conditions. Consequently, traditional banking transactions such as deposit accounting, fund transfers and foreign exchange have come to rely increasingly upon sophisticated telecommunications systems. The impacts of the new communications technologies on the banking industry have been substantial, and in some instances, immediate.

Before electronic fund transfer (EFT) capabilities existed, settlements were traditionally made at 10 am the day following the initiation of the transaction. The introduction of the new technology eliminated the 16-hour float process, which cost banks more than \$1 billion annually in lost interest. In major international banking transactions, where billions of dollars are moved daily, float problems involve the loss of significant amount of interest during the time that the transaction is taking place.

The benefits of new communications technology do not accrue to international transactions alone. On the domestic side of banking operations, for example, the advent of new technology sponsored services such as automated teller machines (ATMs) can mean substantial savings as well as one considers that the cost of an ATM transaction is roughly half that of a teller transaction.¹⁴

In all cases, communications technology is clearly the infrastructure for such applications as office automation, new customer services,

electronic banking, network information systems, and teleconferencing. Note that the influence of communication technology on economic activity is by no means new. For example, such communication innovations as the U.S. domestic telegraph system in the 1840s, the opening of the trans-Atlantic cable in 1866, and the consolidated stock market ticker tape in 1875 had profound effects on the performance of financial markets.¹⁵ But the emergence of "new sectors of activity" is contingent upon investment in new types of capital. Returns on this capital represent, at least in part, the realization of the potential of the improved communications system. This class of effects is best illustrated by a change in the firms' production possibility set, that is, by an expansion of the set of all reachable production plans facing these firms. This expansion, in turn, is a prerequisite to the emergence of a new division of labor and of new specialization patterns. A good example of this emerging pattern is provided by the growing business support services industry, which performs ancillary and support functions that have not been "internalized" by individual firms (data processing, programming, maintenance, training, and so on). The spectacular development of the software industry, with its highly specialized, relatively small scale units, and fairly easy entry, is illuminating in that respect. Embodied technical change, therefore, provides the basis for the development of "new" activities.

Although both types of effects are concurrent aspects of the developmental role of communications, they need not occur simultaneously. The benefits of a reduction in transaction costs are likely to be felt in the short run, following an improvement in communications. This is based on the presumption that most short-run benefits imputable

to communications improvements will accrue to firms in the form of "external benefits."

Specifically, newer communication technology and better communications networks and systems, while improving the transmission and distribution of information, imply the better diffusion of markets. This improvement will materialize, from the firm's point of view and notwithstanding institutional barriers, in the form of larger and more efficient markets. More efficient markets, in turn, will eventually mean a more competitive environment for the individual firm. In the process, some firms may well lose their monopoly power over local markets, which would then become accessible to competitors. At any rate, an improvement in communications will provide firms with a powerful incentive (and possibly with the means) to rationalize production and management, as they strive to internalize some of the benefits they derive from better communications.

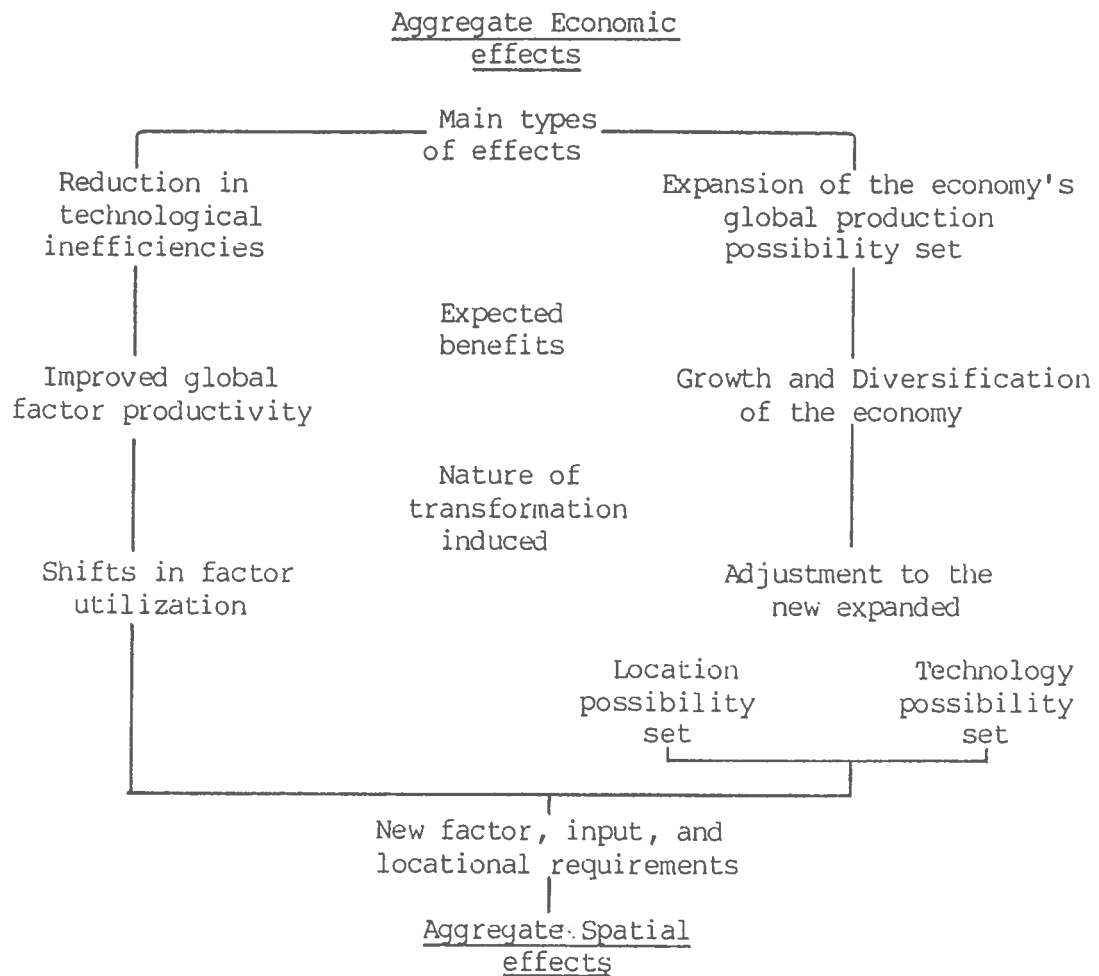
The long run, by contrast, will be characterized by industries both adjusting technologically to the new environment and optimizing their production plans and activity levels with respect to the new possibility sets they face. These adjustments will involve the transition from old to new types of capital, and possibly the relocation of productive activities. Within the context of LDCs, however, the materialization of these transformation effects would likely require longer lead times; in some cases they may even be precluded by the limitations put on these adjustment processes by severe financial constraints, the scarcity of skills, and the overall inadequacy of the infrastructure base.

In summary, in addition to the obvious socioeconomic advantages associated with any significant improvement in communications (e.g., a reduction in the time-cost of calling a party), substantial external benefits may also accrue to individual firms. Arguably, those benefits represent the dominant form of the effects of an improvement in communications in the short term. In the longer run, as firms and industries strive to realize more fully the potential benefits associated with the new possibility set they face (by means of technological adjustments and diversification) a new functional and spatial division of labor will likely emerge. In the aggregate, therefore, we expect these transformations to alter the existing structures and patterns and yield in equilibrium a new spatial economy, or, put differently, a new economic geometry of space.

A synopsis of the foregoing is presented in Figure 3. The purpose of this diagram is to propose a simple illustration of the relationship between aggregate economic and spatial effects. The analysis of the effects of communications improvements on spatial structures is presented in the next section.

Note that implicit in the scenario above is the assumption of "Hicks-neutral"¹⁶ catalytic effects in the short run, implying a proportional change in the level of all existing inputs used in production. In the long run, however, there is no reason to believe that the technical changes brought about by an improvement in communications will remain neutral. On the contrary, firms facing a new production possibility set may be induced to substitute between factors in order to move toward a more efficient production plan. Such a move can show up in

Figure 3: Effects of communications Improvements
on economic activity and structures:
Relationship between aggregate economic
and spatial effects



some sectors as a trend in capital deepening, while in other sectors it may imply the substitution of land for capital.

2b. Effects of Communications on the Distribution of Economic Activities in Space

Virtually all location theories define spatial equilibrium in terms of a tradeoff involving transportation costs. Within a single urban area, the locational decision of a firm is traditionally seen as a tradeoff between the price of land at any given distance from the city center and the costs and market gains that a firm would incur in shipping its product from the location to the retailing and transport node located at the very center of the city. Furthermore, it is conventionally assumed that all commercial activity occurs in the Central Business District (CBD), so that scale economies are fully realized. These scale economies in turn result from scale efficiencies in input markets, marketing, communications, and public-service provision. The theory of market areas, on the other hand, assumes that the long-run pattern of cities represents an optimal equilibrium. This equilibrium is defined by an economic tradeoff between the production efficiency of urban concentration and the transport savings associated with spatial dispersal. The optimal division of these costs yields an optimal dispersal of production within a system of cities. This approach, therefore, assumes the existence of a hierarchy of cities ranked according to their respective efficiency in producing a traded good. Efficient city size, in turn, is defined in terms of a tradeoff between scale economies in production and size diseconomies. Independently of their direct causes, the fundamental source of scale economies in the conventional models is

physical proximity.¹⁷

Scale economies in production, whether direct or resulting from backward as well as forward linkages, and agglomeration economies due to indivisibilities and to the need for face-to-face contacts, have traditionally been proposed as the rationale underlying the formation and growth of cities and/or their clustering into large metropolitan areas. This assumption appears well supported by empirical evidence, in particular in LDCs where the process of development is characteristically accompanied by strong trends in urban concentration.¹⁸ Yet, to the best of our knowledge, no studies so far have explicitly taken into consideration the potential effects of a change in the level of communication on equilibrium spatial patterns.

There is a major need, therefore, to integrate communications into the conventional proximity-based models of location theory. Such an approach, however, would require the substitution of new concepts for the simpler idea of proximity implicit in the linear distance-cost relationship underlying traditional models. A crucial implication of this substitution should be to enlarge the scope of the basic tradeoff underlying conventional spatial allocation models to encompass considerations of both distance (say, from the city center) and communications, rather than transportation costs alone.

The concept of connectivity¹⁹ is introduced for this purpose. A fundamental effect of improving connectivity over space is the weakening of agglomeration economies traditionally associated with the spatial concentration of economic activities. From a modeling perspective this is equivalent to extending the conventional transportation-based model

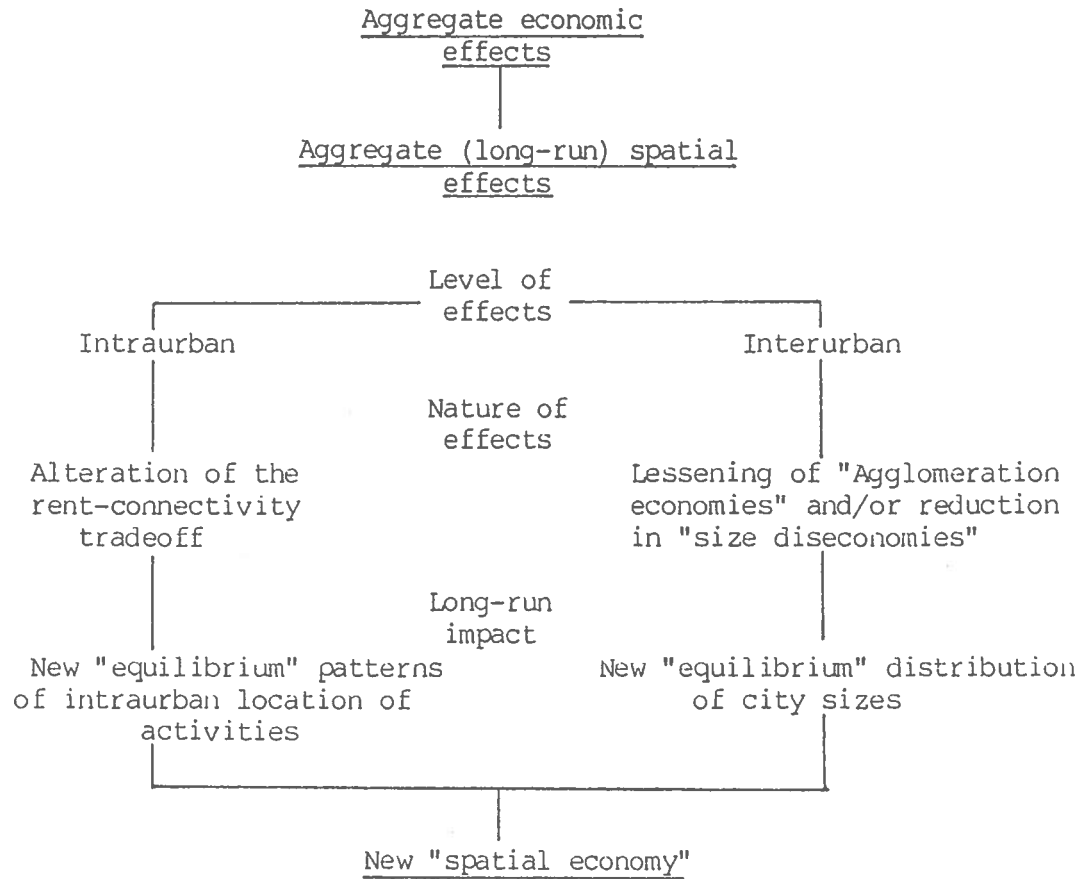
of spatial structure by means of the introduction of communications as a control variable in the locational decision-making process of economic agents.

The result, should this approach be carried over to the stage of a fully developed model, would be nothing short of a communications theory of spatial structures. In practice, this involves two levels of analysis. On the one hand, the impact of communications on the intraurban location of economic activities would be embedded in a spatial equilibrium model based on the new rent-connectivity tradeoff (as opposed to the conventional rent-transportation costs tradeoff). On the other hand, one needs to investigate the developmental effects of communications on the system of cities, that is, on the interurban distribution of economic activities. These two levels of analysis and their respective outcomes are illustrated in Figure 4. These effects could initially be modeled using an equilibrium model of city sizes that extends the conventional approach to systems of cities.²⁰ In either case, however, the derivation of a meaningful, let alone realistic, behavioral model of urban development must start with the study of the underlying economic structure. The preliminary study of the effects of communications on economic activity and structures is intended to do exactly this: to provide the microfoundations of the spatial model.

2c. Articulation of the Effects of Communication on Economic and Spatial Structures.

As it should be apparent from the foregoing, the effects of communication on economic activities and structures on the one hand, and on spatial structures on the other, do not belong to disjointed sets. On

Figure 4: Effects of communications improvements
on spatial structures



the contrary, they are different manifestations of a single process. We postulate further the existence of a strong and well-defined relationship between these types of effects.

Before turning to the detailed analysis of this relationship, however, it might be useful to illustrate the nature of the articulation of economic and spatial structures within a more general context. The analogy with a scheme once developed by S. Robinson in a paper on theories of economic growth and development²¹ is illuminating in that respect.

Following Robinson, we define "potential benefits" as the possible social benefits that could actually be realized given the existing economic and preference structures. Thus, potential profits include no element of uncertainty. "Tension," on the other hand, is defined as the "perceived possibility of profit," and as such it implies some kind of knowledge (i.e., access to information). A major distinction between potential benefit and tension lies, therefore, in that tension is defined to include potential benefits arising in the economic structure, while potential profit is defined for given structures. Within this framework, economic development can be seen as the emergence and working out of tension, the realization over time of potential profits generated by changes in the economic structure. Seen in this light, the role of communications in the developmental process becomes apparent. Communications, by improving the flow of information--and, hence, knowledge of the potential profits arising from changes in the economic structure--play a fundamental role in the generation of tension. In short, we postulate that communications, being instrumental in the generation of

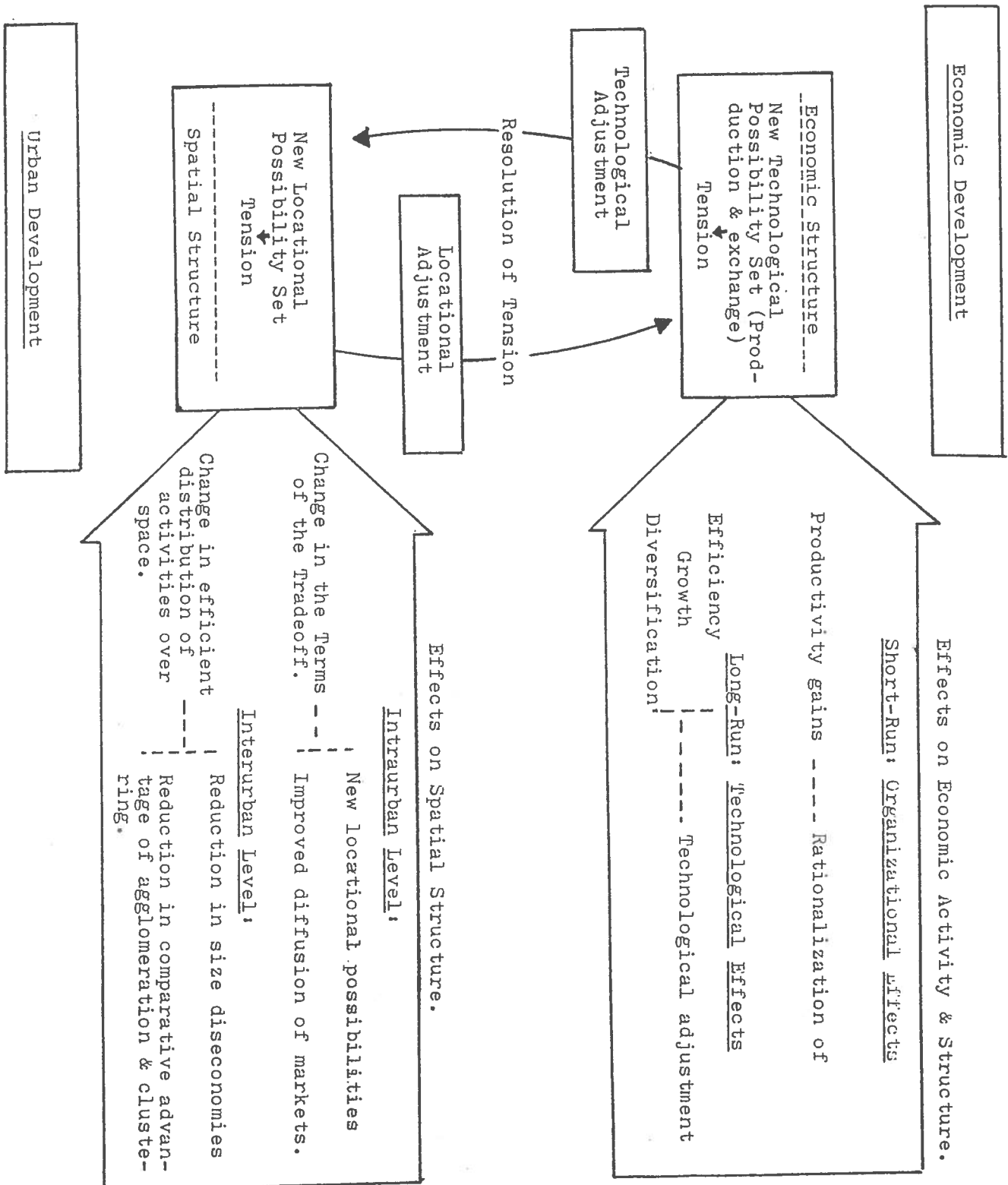
tension, represent a driving force in the process of economic development.

Within this framework, several types and levels of effects can be distinguished. First, we can differentiate between short- and long-run effects at the firm and aggregate levels respectively. Second, communications improvements can affect the spatial structure at the intraurban or at the interurban level. We contended earlier that the articulation between economic and spatial structures depends on firms' technological adjustment to changing economic and technical conditions. By expanding or altering the production possibility sets facing individual firms, a change in communications, that is, a change in the pattern, volume, and possibly quality, of information flows generates new "tensions" as economic agents become increasingly aware of the potential benefits associated with this change. Technological adjustments and decisions to relocate productive activities will eventually tend to reduce these tensions, resulting in a new long-run configuration of the spatial economy. Thus, the developmental process will be set in motion as new developments occur. This process is illustrated in Figure 5. The diagram emphasizes the nature of the articulation between the effects of communications improvements on production and exchange, on the one hand, and on spatial structure, on the other.

Two essentially different--albeit interrelated--issues compose the problem of communications and economic development. These issues are epitomized by the two arrows in Figure 5.

The issue implicit in the lower arrow--intra- vs. interurban spatial effects--has already been addressed, but it calls for some

Figure 5 Effects of an Improvement
in Communications: Interaction of
Economic and Spatial Effects.



additional comments. In the main, location theory defines a spatial equilibrium in terms of a tradeoff between rent and transportation costs. At the intraurban level, firms will locate at that distance from the city center where marginal changes in the price of land are offset by marginal changes in the costs that these firms will incur to produce and ship their production from that location to the retailing and transport node at the city center. At the interurban level, on the other hand, efficient city sizes are defined in terms of a tradeoff between the scale economies associated with urban concentration (also called agglomeration economies) and the savings in transportation costs associated with increased spatial dispersal. Balancing off these costs and benefits yields the optimal distribution of activities within the system of cities.

The foregoing points out two fundamental features that underlie models of the process of urban growth.

First, they emphasize the pervasiveness of scale economies in all economic activities. We have already mentioned the fact that the existence of economies of scale has traditionally been posited as the most important causal factor underlying the formation and growth of urban agglomerations.

Second, they present geographical proximity as the fundamental determinant of these economies of scale.

Within that context, transportation fulfills the crucial role of securing the "ties of proximity" over increasing distances.²² In contrast, an approach encompassing the role of communications in

contemporary economies would aim at weakening the ties of proximity in the distribution and organization of economic activity in space. The consequences are far-reaching and convey important policy implications. For the time being, however, this approach raises complex conceptual and analytical issues that are mainly due to the elusive nature of the communications problem itself. In the first place, some analog to the simple distance-cost relationship must be found. Unlike the transportation problem, the communications problem does not belong in a simple two-dimensional framework. New concepts embodying completely new dimensions must be found.

One of these concepts is connectivity. So defined, the new framework shifts the emphasis from transportation to communications, and vindicates the substitution of connectivity for proximity. The rationale for improving transportation systems has traditionally been to "stretch" the ties of proximity over larger areas so that the benefits of agglomeration economies could be achieved at ever-increasing distances from the city center. By way of contrast, improvements in connectivity tend to lessen the centripetal effect of distance in the urban monocentric setting. Here, the emphasis is rather on access to information than on physical accessibility alone. The reasons for this shift in emphasis hardly come as a surprise. The advent of the so-called "service economies" in developed countries is already shaking up conventional patterns, reflecting the fact that "Unlike the natural resource inputs to prior generations of industry, information inputs are easily transported over geographic distances."²³ Bank headquarters may still be found in central business districts and the location of local branches may still be determined by physical access considerations, yet bank

accounts management and data processing are often performed at remote facilities.

Thus, the new approach explicitly accounts for the existence of both functional and informational backward and forward "linkages" in production. Similarly, the critical importance of information networks--specifically, their size, density, and effectiveness--to the fluidity of transactions and to the diffusion of markets is posited at the outset.

A second concept, which we call *fillere*, accounts for the scale and patterns of information exchanges. Economic activities seem indeed to benefit from larger scales of operation which, in turn, are induced by larger market sizes or densities. In the present context, "market" is a generic term used to designate a set of potential transactions (they need not actually take place) that reflects the activity of economic agents forming a community of interest (for our purpose, economic interest). A subset of these potential transactions can be associated like a fingerprint with each firm depending on that firm's sector of activity, size, location, and so on. In fact, individual sets of potential transactions could be aggregated at the industry level in order to picture the type, nature and pattern of functional relationships, hence transactions, characterizing this industry in a particular area. We call such set a *fillere*. This concept embodies both the idea of structural (backward and forward) and informational linkages and the idea of scale (the size of the potential community). Clearly, the value of a given *fillere* to any individual agent increases with the set of actually connectable agents. Thus, larger cities are likely to achieve, ceteris

paribus, higher levels of agglomeration economies because of the combined result of larger filleres and multiplier effects. Concurrently, the value of a given fillere depends on the characteristics of the communications infrastructure. That is, at any given size, a city endowed with a better communications system will enjoy a higher level of connectivity overall, hence realizing more fully the potential economies of scale.

Within the new framework, an improvement in communications will alter the topography of connectivity levels and, with it, the level and distribution of potential benefits associated with alternative locations. As we noted earlier, substantial benefits may accrue to firms and industries in the form of positive externalities, whether or not the firm or industry had to relocate in order to capture the full benefits. Thus, a significant improvement in communications may trigger a spatial reallocation process (which may or may not be a competitive one) that will eventually yield new equilibrium patterns of location as firms adjust to their new expanded possibility sets. Finally, depending upon the nature and scale of the improvement being considered and upon the effects we want to focus on, this framework can be adjusted to model changes in intra- as well as interurban patterns of location. Within the context of the monocentric city, for example, an improvement in communications may expand the location possibility set facing firms and possibly result in a "flatter" rent gradient. Since the intensity of communication usage varies greatly across sectors, a clear sectoral division of space may likewise emerge. Alternatively, a significant improvement in interurban communications systems may reduce the comparative advantage of agglomeration and clustering and eventually alter the

regional or national distribution of city sizes. The net effect rests ultimately on the type and magnitude of the improvement which is assumed.

The issues implicit in the upper arrow in Figure 5--long- vs. short-run economic effects--have already been presented in the section analyzing the effects of communications improvements on the firm. A simple illustration will suffice.

Suppose, for example, that the availability and quality of telecommunications services in an area have been substantially upgraded as the result of a major investment project in that sector.

In the short run, individual firms will benefit from the more efficient environment in which they operate. These external benefits may show up in the form of productivity gains or cost reductions (in particular, transactions costs).

In the longer run, new sectors of activity (e.g., telecommunications-based industries and knowledge-intensive activities) may develop. Existing firms and industries, on the other hand, will strive to adjust to the new technical possibility set they face in order to internalize the benefits of improved telecommunications. In some cases this adjustment can mean the rationalization of production and distribution through the more intensive use of information inputs in these processes. In other cases, it can mean technological shifts as a result of technology transfers. Finally, it can mean new product lines or production levels, thanks to the enhanced diffusion of markets. In all cases, however, the realization of these benefits requires

structural or organizational changes that will eventually yield a new division of labor and new specialization patterns. In some instances, this adjustment will be accompanied by a relocation of activities conforming to the new spatial economy. For example, activities that were previously constrained to central locations by the lack of adequate communications may now have some incentives to decentralize their production units in order to capture scale economies more fully. The long-term aggregate effects could therefore show dramatic changes in the spatial structures of the large and congested cities, particularly in the fast growing cities of the developing world.

2d. Effects of Communications on Economic Development

Ultimately, this paper aims at providing a theoretical basis for the empirical investigation of the developmental effects of communications. A theoretical model is needed to provide guidance in the assessment and estimation of the economic benefits associated with the improvement of communications, particularly in the context of developing countries.

Before we turn to the analysis of the contribution of communications to the developmental process, however, we must define what we actually mean by economic development.

Communications and Economic Development. Few words are as vague and filled with ambiguities as "development." This, however, has not always been the case. In the 1960s--the heyday of the so-called "Dominant Paradigm"²⁴--definitions of development centered upon the rate of economic growth (e.g., GNP per capita), while the patterns of economic

development experienced in Europe and North America formed the undisputed blueprint of development for other nations.²⁵ These were also the days of what F. W. Frey calls "the Great Dichotomies" (industrial vs. agricultural, modern vs. traditional, urban vs. rural, and naturally, developed vs. underdeveloped). As Frey commented, "Development and modernization have certainly been convenient impressionistic umbrellas for loosely covering the immense changes involved in moving from a traditional (rural) to an advanced (urban) contemporary society."²⁶ The much-documented correlation between development and urbanization has been considered one of the dogmas of development economics. Consequently, development has traditionally been identified with an urban phenomenon. It took some time for a distinction to emerge between "economic growth" and "economic development" as concurrent aspects of the transformation of an economy over time. While the former is defined as increases in the aggregate product, without references to changes in the structure of the economy, the latter encompasses the structural changes that necessarily accompany the developmental process.

Within the present context, the structural approach is obviously the relevant one. Our approach, which has emphasized throughout the potential developmental role of communications, is grounded in the belief that infrastructure investments should be geared to comprehensive development objectives rather than to simply sustaining economic growth. In a regional context, therefore, development ought to mean (1) the expansion of output and income within the region; (2) the integration of the regional economy through the development of activities based on technologies and processes that offer real opportunities for local entrepreneurship and for the generation of new and diversified forms of

employment; and (3) improvement of the efficiency of the system of cities within the region.

Necessary conditions for sustained regional growth and development appear to be, therefore, the increasing productivity of firms within the region that enables these firms to compete effectively in national or even international markets, the efficient working of these markets, and economic diversification through the development of new sectors of activity that had traditionally been economically or technologically impossible.

If we accept this argument, then, it is clear that improving communications, and in particular telecommunications, can contribute to increase factor productivity and enhance market efficiency substantially. The argument also implies that the role of telecommunications in economic development has not been fully understood, and that its benefits may have been substantially underestimated. Macroanalyses, for example, reveal a clear correlation between telephone capacity and economic development. Richer societies have more telephones. Insofar as telecommunications have been studied at all, however, they have generally been regarded as following the development process rather than stimulating it. And yet we have shown good reasons to believe that telecommunications can contribute significantly to economic development.

In line with the preceding analysis it is possible to say that improved telecommunications--better telephone service, for example--can promote development in several ways:

First, by allowing a firm to substitute lower- for higher-cost

information inputs to its production process, telecommunications improvements may directly increase production efficiency and lower costs. This is a simple and direct input-substitution effect.

Second, the existence of an effective telephone system may change the set of economically efficient inputs on which a firm can draw, for example, by making it possible to use cheaper land at another location.

Third, the improved system may expand significantly the set of sellers of inputs and buyers of output with which a firm can deal efficiently, thus generally lowering its costs and expanding its potential markets.

Fourth, an effective telephone system can allow for the efficient operation of firms in sectors that were formerly economically impossible, for example, long-distance brokerage.

Fifth, telecommunications itself is a substantial sector of the economy, which generates income, complementary activities, and multiplier effects in the economy.

Finally, an efficient telephone service may be necessary for firms to realize the full benefits of scale economies in production and organization, thereby attracting firms that would not otherwise have considered locating within the area.

Thus, a major improvement in telephone service alone may yield a wide range of observable effects. Within firms, we might expect to see shifts in organization and in patterns of production and marketing as they respond to economic opportunities offered by the new service. New

firms can be expected in sectors affected by telecommunications. Since telecommunications improvements alter the information-cost structure of an area, the locational patterns of information-sensitive sectors can be expected to change, and along with them, the rent and land-value structures of the urban area within which they are located. As new sectors emerge and as existing firms take advantage of opportunities offered by the change, incomes and outputs should grow and employment in the modern sector should expand.

Communications and Urban Development in LDCs. Improved telecommunications may affect not only the performance of firms within a given metropolitan area, but also the structure of urban places in a larger region. Decentralizing efforts to reduce social costs associated with the concentration of production in developing countries' primate cities have frequently been thwarted by the apparent economic necessity for firms to remain in close proximity to their suppliers and markets. Poor communications, although not the only reason for this necessity, are probably significant in the perpetuation of urban concentration. Some observers have argued that the tendency toward concentration is simply a reflection of the higher economic efficiency of large cities. In this view, the trend will cease when the externality costs outweigh the efficiency gains. If communications investments are socially determined, however, and if their role in shaping location decisions is not recognized, then telecommunications improvements may not be optimally located to generate an efficient system of urban places. Such a system should allow for the decentralization of those parts of the production process that can be more efficiently conducted in secondary or smaller places. Without adequate telecommunications, it is doubtful that such a

structure can develop in a modernizing economy.

It is evident that these various types of effects of telecommunications improvements imply complex tradeoffs between communications and transportation. At one level, we might expect the direct substitution of telephone messages for other forms of communications based on physical transportation of messages: motorized or bicycle messenger services, for example. In view of the widespread use of such modes in metropolises in developing countries and their contribution to traffic congestion, such a tradeoff may increase efficiency in two ways. A cheaper input may be substituted directly for a more costly input in the production process. Indirectly, reduced congestion may improve the efficiency of transportation in the metropolitan cores, with benefits for other economic activities.

At a larger scale, the probable effects of telecommunications improvements on transportation are murkier. If, for example, decentralization of production is enhanced, then the effect may be to require more physical transportation of goods and materials. Presumably, this cost would be more than offset by lower costs in other inputs--land, labor, services--or locational shifts would not occur. From an efficiency point of view, it does not matter whether more or less transportation is required, as long as the final outcome is favorable. If, however, substantial transportation investments must be made to realize the gains from telecommunications improvements (i.e., there is no excess transportation capacity), then the two must be regarded as complements rather than substitutes. Whether substitution or complementarity is the case will depend on specific circumstances. Again, we raise this issue

here to illustrate the necessity for careful research rather to argue the likelihood of one or the other.

Conclusion: Some Implications for Investment

If telecommunications do affect development in the ways described here, the implications for investment are substantial. Economic development requires a range of investment types; the lack of any important element may constitute a bottleneck that inhibits the effectiveness of other investment forms. For example, it is evident that telecommunications improvement will not work unless capital is available to firms to expand their operations or to move into new fields. Similarly, without transportation facilities the locational efficiencies attainable with advanced telephone service may not be realized. But, at the same time, those investments without concomitant telecommunications improvements are also likely to be less productive than they might otherwise be. A careful analysis of the effects of telecommunications investments could lead to a substantial reappraisal of the importance of this component of investment strategy in developing countries.

Endnotes

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9. The other major source of transaction costs is generally referred to as "exclusion costs."
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16. A technological change is said to be Hicks-neutral if, with the capital-labor rates constant, the ratio of marginal products is also constant. For a discussion of both disembodies and Hicks-neutral technical change see Solow, R.M. "Technical Change and the Aggregate Production Function." R.E. Stat., 39 (August) pp. 312-320.

17. This view is well summarized by Melvin M. Webber: "Cities develop only because proximity means lower transportation and communication costs for those interdependent specialists who must interact with each other frequently or intensively. Throughout human history, people have been moving near each other, trying to increase their opportunities for mutually satisfactory transactions. Of course, shortened distances are equivalent to higher densities and are inevitably associated with some considerable costs of congestion, high rent, loss of privacy, and so on. Nonetheless, over all historic time and over all the world's space, there has been a nearly universal movement to villages, towns, cities, and now, megalopolitan concentrations. M.M. Webber (1973) op. cit.
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19. This is by no means a new concept. The idea of "connectedness" is drawn from the theory of Graphs and has long been applied to communication networks. More recently, the word "connectivity" has been used--although not explicitly defined--by Melvin M. Webber to designate that need generated by economic development "because of increasingly complex relations among increasingly interdependent persons and organizations." As M. Webber puts it, "In essence, development generates requirements for connectivity. The more development, the more specialization, the more interdependency, the more need for connectivity." Conversely, "Demand for connectivity also generates city expansion: indeed, it is the sole source of

urban growth." M. Webber (1980) op. cit.

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