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Barriers in Spatial Interactions and Communications

A Conceptual Exploration

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Abstract

Barriers are defined as discontinuities in broadly defined marginal costs of communication usually leading to a discontinuity in interaction. This paper addresses conceptual issues about barriers to communication. Several typologies of barriers are given. For example, according to the degree of permeability, barriers may discourage interaction, or may even be entirely impermeable, but examples may also be given of barriers which stimulate communication in one or both directions. Another typology of barriers addresses reasons of existence, including natural barriers, barriers created for protection purposes, barriers created for reasons of convenience, etc. The paper concludes with a number of suggestions for further research on communication barriers.

1. Prologue

Information and communication economics is a recent but rapidly evolving field of scientific research. For instance, several studies show that about half of all economic activity in the USA can be attributed to the processing of knowledge and information rather than of physical goods. This trend has even evoked the question whether conventional sectoral subdivisions (primary, secondary and tertiary) are still very relevant and whether a cross-sectional view on sectors, according to a typology of information intensity, would not be an appropriate complement to our statistical data base, in particular because in almost all countries the information-handling sector of the economy is increasing in importance.

In addressing issues which are evolving in this new information economy, it is however important to clarify that the information sector is an amalgamate of activities. They vary in the nature of their demand for information, labour, telecommunications and physical transport, and consequently in the sensitivity to barriers. The main distinction suggested here is between high-technology manufacturing facilities, knowledge production facilities, and information processing facilities, such as bank clearinghouses or remote printing facilities.

Several remarks are in order here. First, information and communication as commodities, serve to reduce uncertainties, so that the efficiency and productivity of the economy is closely linked to the timely availability of appropriate knowledge and information. In this case we look at information and communication from the angle of point activities, enhancing the economic output of a certain place, firm or sector (e.g., educational facilities). The lack of information can thus reduce the potential efficiency of places, firms or sectors. Relocation within an information field is a viable option in order to gain efficiency.

Secondly, the information and communication sector is an important sector in itself, which is typically organized according to high-speed and reliable social and spatial interaction channels. Thus - in addition to flows of persons and commodities - we observe rapidly increasing flows of information (knowledge, facts etc.). These flows might either follow person or commodity flows (or even partly be embodied in these)

or follow their own patterns (or maybe even set the trend for person or commodity flows). Especially the contribution of information to a higher efficiency of a spatial interaction system as a whole (or even as a generator of these flows) deserves more scientific attention, not only in a national but also in a transnational setting (cf. Batten et al, 1988).

Such information flows, for instance, determine to a large extent, the economic linkages between countries via transmission of information of currency rate fluctuations, movements of capital markets, exchange of consultancy services, regulations etc. In particular, transborder communication of information flows seems to become a main feature of an interconnected European economy. Free trade theories seem to receive an increasing relevance nowadays in the area of transborder flows of information. Particular attention is also paid to the impact of barriers in spatial communication.

Our societies tend to become information societies (see Giaoutzi and Nijkamp, 1988, and Naisbitt, 1982). Those nations or regions having access to up-to-date information via efficient and flexible communication channels will have a comparative advantage, (cf. Lakshmanan, 1988) whilst those lagging behind will encounter serious difficulties in being competitive at a European or world-wide scale. International exchange of information and know-how through adequate transmission channels (e.g., telecommunication) is of critical importance here.

For instance, in the European Community a coordination plan for networks, telecommunications services development and common infrastructure projects has been launched in order to favor the development and implementation of advanced networks and services (e.g., the introduction of an Integrated Services Digital Network (ISDN) and planning for broadband networks of the 1990's).

Barriers with respect to less favored regions (involving a reduction in regional imbalances and unequal opportunities faced by the poorest parts of Europe) may be removed through the development of advanced services and networks, as is also recognized in the so-called STAR programme. This programme is focusing attention on an amelioration of structural economic disparities with respect to less favored regions (LFRs) through an improvement of the telecommunications system (see also Lauder, 1988).

This paper addresses the issue of barriers to communication. Some major characteristics of barriers are discussed in section 2. The evolution of barriers is the subject of section 3. Section 4 is devoted to the structure of communication costs related to barriers; it is followed by section 5 which shortly discusses the location of barriers. The paper concludes with a typology of barriers (section 6) and suggestions for further research (section 7).

2. The Nature of Barriers: Major Characteristics and some Examples

In view of an appropriate analysis of barrier effects in communications, we need a more precise description of these concepts. Communication refers in the present framework to all types of spatial interactions between different actors or groups in space or between different geographical units, which are directly or indirectly associated with information and knowledge transfer. Thus communication can be represented in terms of flows from point *i* to point *j*. Very often communication is restricted to those spatial interactions that are related to the transfer of information in contrast to physical transport of goods or persons. However, this distinction is not always very clear or relevant, since - beside substitution of communication modes - complementarity may also occur. For instance, mail delivery is essentially physical transport, although the contents may be information. Similarly, personally delivered consultancy services may be regarded as physical transport, but its meaning is information transfer. Thus it makes sense to consider all spatial interactions in which knowledge transfer is a main objective as communication.

Hence barriers in communication may be interpreted as all obstacles in space or time that - apart from normal average distance frictions costs in spatial communication - impede a smooth transfer or free movement of information related activities; or in other words, barriers have a distinct, often stepwise, disruptive influence on spatial flows. Thus barriers cause non-linear shock-wise disutilities. Any discontinuity in the intensity of communications, in the spatial or temporal dimensions, is an indication of the existence of a barrier. Examples may be language (including machine language) disparities, cultural or socio-economic differences, international borders, differences in time zones, physical barriers such as mountains or lakes, lack of capacity in an electronic mail or telephone network, differences in skill between potential

senders and receivers, protectionist measures for one party, different telephone tariffs, or even differently perceived bottlenecks in communication. Thus a barrier effect has to be interpreted against the background of "jumps" in prevailing distance decay phenomena in a spatial system. For example, it has been found for countries of the European Community that crossing a border leads to a reduction of about one fifth of the volume of trade or passenger flows which might be expected in case of absence of a border (Broecker, 1984, and Nuesser, 1985.)

An interesting example of the effects of barriers of spatial disparities was analyzed by Klaassen et al (1972), who tried to assess the language disparity between the Flemings and the Walloons on the basis of telephone calls between the Dutch and French-speaking areas in Belgium. These disparities are mainly caused by psychological and cultural differences. In their analysis the authors have used a gravity model in which the number of telephone calls between each region in each language area was explained from the number of subscribers in the region of origin and of destination, and from the distance friction between these regions. Agglomeration effects were also taken into consideration. But the main idea of their contribution was to identify whether - besides a normal distance decay pattern for information intensity - linguistic barriers exerted an additional impact on interregional telephone calls to such an extent that a significant decline in flow intensity could be measured.

It is noteworthy that substitution or complementarity relationships between different communication modes are of critical importance for a thorough analysis of barriers. Barriers may in case of substitution lead to considerable shifts (e.g., from mail to telephone in case of an unreliable postal service or from telephone to electronic mail or fax in case of significant time zone differences). For example, it was claimed by Baumol and Wolff (1984) that the transmission of live performances from theatres to television broadcasting represents one of the largest leaps in productivity that have ever taken place, as approximately the same amount of efforts is able to offer services to millions of people watching television instead of to a couple of thousand people visiting a theatre.

On the other hand, in case of complementarity, barriers may reduce all flows (e.g., a low penetration rate of informatics infrastructure may also reduce the use of electronic mail). Furthermore, in case of the introduction of new communication of information infrastructure, barriers may emerge from three sources, viz. impediments in the creative process, in the diffusion and adoption process, and in the spinoff process of new technologies (see Figure 1, derived from Nijkamp and Salomon, 1989).

Figure 1 Phases in technology impact assessment

In general, forecasting of new technologies is characterized by many uncertainties emerging, inter alia, from such factors as the attributes of the technology at hand (e.g., the degree of transferability), the behavior of market agents (e.g., the competitive structure of the industry) the intervening opportunities offered by related technologies, and the information supply regarding the potential of such new technologies. The market of new technologies is in general marked by oligopolistic competition, technological diversity, and behavioral varieties of potential users. In all these cases various types of bottlenecks or barriers may emerge.

Clearly, the adoption of telecommunication services has a geographical component, not only in terms of the spatial location pattern of adopters, but also in terms of a judgement of real physical distance and barriers versus socio-psychological distance and barriers between senders and receivers of information. Perception of distance and the importance of direct face-to-face contacts are major factors in adoption of a certain telecommunications technology (see Meyerowitz, 1985 and Salomon, 1986).

From a geographical viewpoint, it has to be added, that the current organization of socio-economic life in Western countries is based on ever increasing interpersonal interactions (face-to-face contacts, business linkages, etc.); because our economies exhibit increasingly a complicated network structure. This exponential rise in the demand for interactions is hampered by the physical ability to fully interact at an (inter)-personal level with all people involved. Therefore, telecommunications services are, to some extent, necessary in order to compensate for an exponential saturation level for direct human interactions - the use of telecommunications services is likely to exhibit a rapid growth in the near future (see Figure 2). The 'telecommunications gap' reflects here essentially the increase in the use of telecommunications services caused by physical constraints on persons who have a potentially exponential growth curve for human interactions. Thus here telecommunications may act as a substitute for physical travel facing the barriers of a limited time budget.

Figure 2. The 'telecommunications gap'.

Finally it has to be added that barriers may include a directional bias, so that communication flows do not face the same barrier effects in all directions (e.g., due to capacity limits). This is evident for both physical transport and telecommunications.

In a more comprehensive way, barriers (including substitutions and complementary effects) may also be interpreted from the viewpoint of a human activity space. The underlying idea is that our economies are increasingly tending towards a network economy with a large variety of

overlapping and interlinked networks. Such a compound network structure implies essentially that all physical and non-physical spatial interactions may be regarded as a set of layers, which can be projected in a geographical space which embodies all communication networks in an integrated way. Any barrier in one such layer will (positively or negatively) affect the communication flows in the other layers. Such barriers may depend on congestion (or capacity) phenomena, on the quality of the network in a given layer, on socio-psychological perceptions, on hierarchical spatial interaction patterns, on the economic evaluation of the duration of communication time etc.

3. Evolution of Barriers

Barriers may have very different reasons of existence. The simplest group of barriers one may think of consists of barriers which are **given by nature**, such as mountains or marshlands (see Figure 3).

Another group of barriers evolves because of reasons of **convenience in tariff structures** of public transport or communication. The use of zones in such tariff structures implies a discontinuous increase of communication costs when the border between two zones is crossed. The use of zones is often dictated by reasons of administrative convenience, technical feasibility or user-friendliness. Road pricing systems, based on the zonal principle (such as in Singapore or toll roads) also belong to this group.

barriers				
given by nature	created for reasons of convenience in tariff structures	created with the purpose of protection _____	resulting from unintended side effects of various policies, standards and values	evolving as a consequence of other barriers (isolation)
		physical non- physical		

Figure 3. Reasons for the existence of barriers

A third group of barriers is created with the explicit purpose of **protection**. Examples range from physical barriers such as the Chinese Wall and the fence in front of one's house, to non-physical barriers of institutional or financial nature. These barriers are often a reflection

of a conflict of interest. The conflict may assume different forms. The Chinese used their Wall to prevent invasion from barbarians living in the North. Here the conflict is between territorially separated groups. But often barriers do not only reflect a conflict between territorially separated groups, but also between different groups living in the same territory. Trade barriers provide a protection of firms at the expense of the consumers living in the same country. In this view, removal of barriers leads to an intensification of conflicts: some groups will benefit, others will lose. Therefore, equity problems are bound to arise when barriers of this type are reduced.

A fourth group of barriers evolves as an unintended side effect of other decisions. For example, the construction of canals, railway lines and highways may only improve accessibility in one direction. This conflict between accessibility in various directions and modes often occurs with traditional ways of communication. With telecommunications it seems to be absent, however.

Another example of unintended barriers is found in the field of product standardization. Formulating general standards for products leads to a decrease in production costs, because of economies of scale. However, if different countries appear to have formulated different standards, this is a barrier to the international trade. It must be added, that it is often difficult to distinguish intended and unintended barriers. In the European Community, a great many examples can be observed where national standards have been formulated or maintained with the implicit aim of creating a barrier against foreign competition.

Barriers may also evolve as an unintended result of differences in values or ideologies. Such differences may make it difficult for one social group to communicate with another social group. In this case, barriers are primarily social, but often mechanisms are at work which make that such barriers also receive a spatial expression. A well-known example is ethnic segregation in cities. Also at the higher spatial level of states, differences in values or ideologies may hamper communication, international cooperation and trade.

Finally, certain barriers evolve as a result of the existence of other barriers. Barriers lead to a certain degree of isolation which

gives rise to the evolution of other barriers. Examples are: information, language, and cultural barriers. Such barriers may continue to exist, long after the original barriers leading to their existence have been removed. Thus, although "barriers create barriers", it is not necessarily true that the removal of barriers of one type will lead to the disappearance of the induced barriers.

Another example of this phenomenon is the structure of road networks in border areas. The number of points where the border can be crossed is relatively small. Thus, an institutional barrier leads to a transport network which is favoring intraregional transport at both sides of the border, but which is a disincentive for border crossing transport. Even when the border would be removed, the transportation network will continue to be biased towards intraregional transport.

4. Barriers and Communication Costs

Communication is subject to disutilities or costs: the longer the distance one wants to span, the higher the disutilities or costs of communication. When a discontinuity or sudden increase occurs in the costs of communication, one speaks of a **barrier** to communication. As shown in Figure 4, such a discontinuity in the marginal costs of communication can lead to a discontinuity in the intensity of communication. Figure 4 is a typical example of the effects of crossing a border on costs related to administrative formalities and waiting time.

marginal cost
of communication

intensity of
communication

Figure 4. Barriers to communication and discontinuities in intensity of communication

on the part of the author
+ a discontinuity

Not every discontinuity in the marginal costs of communication leads to a discontinuity in the intensity of communication. This is shown by Figure 5 which represents the costs of transport along a route with sections of different quality. Here discontinuities in the marginal costs of communication do not give rise to gaps, but only to kinks in the curve representing the intensity of communication.

Figure 5. Barriers to communication without discontinuity in intensity of communication

Cost discontinuities that take effect on the geographical dimension are of major interest, as they may affect the spatial distribution of economic activities and inter-regional and international competition.

The relationship between costs and distance in telecommunications are very complex. There are some distance-based costs, in particular with regard to the capital requirements, and less so with regard to the operating costs. Various cost allocation models are being used in order to distribute the distance cost among users. These are expressed in pricing schemes, which incorporate direct distance costs or distorted distance costs in order to allow for cross-subsidization among different users of the system. As the relationship between distance and rate is not smooth, and set along some delineations which are not perfectly concentric, wide distortions of rate-to-distance relationships can be found: longer distances are often charged less than shorter distances in other directions.

Also of interest are cost discontinuities which take effect along the temporal dimension. While telecommunication rates exhibit smaller sensitivity to distance, compared to travel, they usually are very sensitive to the temporal dimension. This results in a number of barriers.

The sensitivity to the duration of communications, creates situations where it is less costly to travel than to use telecommunications. This is the case in relatively short distances and long durations. Thus, there exists a possibility for a modal barrier, that is, an alternative mode of interaction becomes more attractive.

Many telecommunications systems use time-of-day pricing as a measure for attaining efficiency in the system usage. As the rates vary widely between the different time periods, communications between locations in different time zones can be assumed to overcome a cost barrier which is not symmetrical. Also, the difference in time zones between locations creates another type of barrier, attributed to the fact that work times are not (or only partially) overlapping. Thus, communicating through a synchronous telecommunication system between such locations require at least one party to change work schedules from normal, a step involving some financial or administrative costs. A similar situation may arise between countries in which the work days are differ than the conventional Monday through Friday.

Tariff structures of communication (post, telephone) often display large discontinuities in marginal costs (see Figure 6). The observed intensity of interaction is often very smooth, however. Thus, the relationship between costs and intensity of communication is not always straightforward. Several other factors play a role, such as lack of information or awareness about rates and other types of costs which are not included in the tariff. Most important is probably that communication often serves as a means for other kinds of spatial (e.g., trade, tourism) interaction. Therefore, the intensity of a certain type of communication does not only depend on the costs of communication, but also on patterns of other kinds of spatial interaction. For example, telephone tariffs between The Netherlands and the USSR are equal to those between the Netherlands and Greece. Yet, the intensity of use is much higher for Greece than for the USSR because trade and tourism are much more intensive towards Greece than towards the USSR. Therefore,

barriers to communication must be defined in a broad sense so that they include barriers to all kinds of spatial interaction.

It should be added that the costs of barriers charged to the user are not always based on the actual cost pattern, but sometimes on a fictitious pattern from a central place onwards. This "basing point" price policy may happen e.g. in case of telecommunications.

Depending on the prevailing market structure, pricing schemes can result in distortions because they are structured to attain different policy objectives, such as incentives for remote areas, income distribution or marketing. In many cases, it seems that the distortions are a result of historical developments, rather than intentional. Whatever the reason for the distortions, they can be seen as barriers, as they provide a relative advantage in some areas relative to others.

The disutilities or costs of barriers may be subdivided into user costs (e.g., a toll to be paid for using a tunnel), and social costs (all uncompensated costs of a barrier charged to society at large, e.g. cultural barriers).

Figure 6. Tariff structure and intensity of communication for telephone

A barrier separates an area in two parts. It may have the same influence on both parts of the area, for example if waiting time is the same for both directions when crossing the border. But often, the costs involved in crossing a barrier will depend on the direction of the interaction. Telephone tariffs from country A to B may be rather different from those in the opposite direction. This may lead to a distorted balance of incoming and outgoing telephone calls. Similarly, a congested section of a route may function as a barrier in one direction, whereas traffic in the other direction may move freely. This is an example of a directional bias, as discussed in Section 2. Indeed, one must not forget that communication costs and intensities do not only depend on distance and time, but also on direction.

An even stronger difference occurs when a barrier provides a **disincentive** to interaction in one direction whilst **stimulating** interaction in the other direction. This occurs, for example, when two countries have different levels of excise duties. As shown in Figure 7, such a difference provides a disincentive for consumer A to cross the border for shopping. For consumer B, however, the excise duty differential functions as a negative barrier stimulating shopping across the border.

Figure 7. Excise duty differentials and cross border shopping

One may even proceed a step further by considering barriers which are stimulating communication in both directions. An example of this is provided by subsidy programs aiming at stimulating international scientific cooperation such as the ERASMUS programme of the European Community.

This discussion leads to the following classification of barriers:

1. **Impermeable barriers**, typically due to political factors, prohibit any transborder flow. (Broadcasting may be an exception, as it can overcome most borders).
2. **Discouraging barriers**, reflecting a discontinuous increase in communication costs.
 - 2.a. **symmetric** discouraging barriers: equal in both directions
 - 2.b. **asymmetric** discouraging barriers: not equal in both directions
3. **Mixed barriers**, reflecting a discontinuous increase in communication costs in one direction, and a decrease in the other direction
4. **Stimulating barriers**, reflecting a discontinuous decrease in communication costs.
 - 3.1. **symmetric** stimulating barriers: equal in both directions
 - 3.b. **asymmetric** stimulating barriers: not equal in both directions

The large majority of the barriers to be discussed in this paper belong to the classes of discouraging and mixed barriers. The group of stimulating barriers seems to be of smaller importance. These barriers often serve the purpose of compensating for discouraging barriers of other types.

5 Location of Barriers

Barriers are often associated with border areas. However, especially in the context of communications, this association may not necessarily apply. We suggest to distinguish between border related and non-border related barriers.

In the context of technological change and its growth potential, border areas deserve special attention. Border areas may be defined as regions in a compound spatial system (but not necessarily lagging or underdeveloped regions), which are acting as filters to the exterior

environment of this system. Hence they often are less oriented towards the center but usually more to the external economic world. Border areas often have a potential because of their gateways function, so that communication/interaction infrastructure is of utmost importance. Such border areas may well act as generators of early adapters of technological innovations, depending on their specific locational profile for technological change.

Various border regions which usually do not have the infrastructure for attracting new 'technological regimes' (à la Nelson and Winter, 1982) fear nowadays a relative decline in their competitive position, given the fact that many new activities are agglomeration-oriented. On the other hand, many of these new technological initiatives are (fairly) footloose oriented, so that in principle border areas could have a potential for attracting such activities. In this context, especially the high-tech manufacturing sector, the information sector and the computer service sector are potentially promising candidates for upgrading the economic position of border areas. So far, however, these sectors exhibit a fairly irregular spatial distribution pattern, with some orientation toward major agglomerations but sometimes also with some orientation toward intermediate areas or specific external areas (the region of Twente or Limburg in the Netherlands is a glaring example of the latter case). An important question is whether regions are able to benefit from their specific strong points and to suppress their weak locational profile regarding the new technology sector. In this regard, telecommunications may act as a critical success factor.

6. A Typology of Barriers

The following types of barriers will be discussed in this section: physical barriers, congestion barriers, fiscal barriers, institutional barriers, technical barriers, market regulation barriers, time zone differences, and cultural, language and information barriers.

Physical barriers such as mountains are created by nature. They usually are symmetric: communication is discouraged in both directions to the same extent. There are also physical barriers which are man-made, however, (e.g., the iron-curtain). Protection oriented barriers of this type often have a strongly asymmetric influence: discouragement of communication is not equal in both directions.

⌈ **Congestion barriers** exist because of a discrepancy between demand and supply of communication infrastructure. It is not the limited capacity as such which causes the barrier, but the fact that demand exceeds the capacity. Traffic jams are a well-known example here, but insufficient capacity of links or nodes in telephone networks may also occur. Since demand for communication usually strongly fluctuates during the course of the day, ⌈ congestion barriers are time-dependent: at off-peak hours they may be non-existent. ⌋

Visa costs are an example of **fiscal barriers** to international communication. ⌈ In the field of trade, fiscal barriers such as import duties are used to protect domestic producers. These barriers provide a discouragement to trade and communication which is usually not symmetric. ⌋ Smuggling is a way to circumvent fiscal barriers; since it is not included in official figures, it leads to an underestimate of trade and communication.

Import levies have been abolished for trade within the European Community. ⌈ Another type of fiscal barrier still exists in the European Community: differences in excise duties. As already explained above, such differences discourage trade in one direction, but provide a stimulus in the other direction. Reduction of excise duty differentials will most probably lead to a reduction of cross border shopping. Thus, removing fiscal barriers may lead to a reduction in international trade in this case. ⌋

⌈ Even if excise duties would be equalized, fiscal barriers may continue to exist. Some European Community countries for example, demand value added taxes at the time of import, which is discriminatory in favor of domestic producers. Subsidies are another form of fiscal barrier which may continue to exist in the European Community. ⌋

⌈ **Institutional barriers** relate to costs involved in crossing a border between different jurisdictions. This entails differences in currencies, laws and regulations. Crossing a border gives rise to delays which may be quite substantial, especially when goods are transported. ⌋ For the road haulage sector this gives rise to both driver costs and opportunity costs of vehicle utilization. Avoidance of border delays is vital for firms working according to just-in-time principles.

Even when delays are short, crossing borders is still an important cost component because of the paper work needed for it.

Another cost component relates to differences in currencies. For example, firms involved in international trade may be confronted with high hedging costs.

⌈ Differences in company law may discourage firms from becoming transnational. ⌋ For example, differences in accounting practices among countries lead to higher costs for central management control. A related problem is "fiscal suspicion" against transnational corporations (Cost of Non-Europe, 1988, p. 202). This may lead to rigid controls against transnational corporations to prevent tax evasion.

In many cases, institutional barriers are created as a result of the functional division between different agencies, and have a geographical significance only as an indirect outcome. For example, the division between national public roads authority and municipal governments responsible for local urban roads, can result in a lack of planning coordination, manifested in a different speed limit and costs.

In the case of telecommunications, a noteworthy example is the regulation of intrastate telephone systems in the U.S. by state agencies, while interstate systems are regulated by federal agencies. This creates barriers along state lines.

⌈ A well-known example of **technical barriers** to communication is incompatibility in railway systems of various countries, giving rise to delays or inconveniences when crossing borders. Technical barriers also occur in other forms, i.e., when producers must alter their products to comply with industrial standards or legal regulations in other countries. Such barriers to trade are quite significant for various products such as foodstuffs, automobiles, building materials and in telecommunications. ⌋

⌈ Another form of technical trade barrier occurs when producers must have their product tested and certified by the importing country. ⌋ This may give rise to long delays and high costs before new goods can be introduced in a country. The pharmaceutical industry is a well-known example of an industry frequently facing this barrier.

Market regulation is another source of barriers to communication and trade. In Europe, tariffs for international air traffic are quite high due to regulatory policies. Similarly, in the road haulage sector cabotage and quota systems lead to high tariffs in international transport.

In a wider sense, market regulations leading to discrimination against foreign firms is clearly present in government procurement. This is clearly visible in sectors such as the arms industry, business services and ship-building where domestic firms get preferential treatment above foreign firms.

A difference in time zones is also a barrier to communication. The overlap in official working times in London and New York is relatively small. Between London and Tokyo the overlap is even almost empty. This is a clear disincentive for using the telephone for business purposes. Other modes of communication such as telefax and electronic mail are not subject to this type of barrier, however.

Cultural, language and information barriers are other forms of barriers hampering communication. These barriers do not always coincide with national borders (cf. the linguistic frontiers in Belgium and Switzerland). Education aiming at making people multi-lingual helps to reduce the impact of language differences, but differences in the mother tongue will continue to reduce communication across linguistic frontiers (cf. Klaassen et al., 1972).

It should be noted that language barriers also refer to machine and protocol differences which often prohibit, or complicate information flows.

Also cultural differences within countries may be substantial. The cultural gap between Northern and Southern Italy may be larger than between Northern Italy and France, for example. Clearly, various cultural barriers may sometimes only be perceived obstacles, but may nevertheless have a great impact on spatial interaction.

Information barriers relate to the fact that information on places further away is often limited and that it costs extra money to obtain it. Here national borders continue to play an important role.

Newspapers, and radio and television programmes often have a strong orientation towards their home country. Another example is given by general purpose interactive videotex systems. These systems have an almost exclusive orientation on the own country. The linkage of videotex systems from more than one country is still in its infancy.

7. Epilogue

The issue of barriers to communication is an intriguing one. Barriers involve essentially a significant discontinuity in a network interaction pattern (or at least a 'jump' in the cost of interaction). Thus discontinuous interaction costs may be caused by external obstacles, such as physical factors (e.g., mountains, lakes), cultural-political factors (e.g., language barriers) or socio-economic factors (e.g., welfare discrepancies), or by internal obstacles emerging from a lack of capacity of the network concerned (e.g., congestion).

In the first case, barrier costs will exist irrespective of the volume of traffic and supply-oriented barriers so as to increase the communication potential between different groups or regions. The new tunnel programmes across the Alps are a good example of this. In the second case, the barrier costs are dependent on the volume of traffic and hence two types of policy options may exist: (a) a reduction of effective demand or use of the network concerned (e.g., by a fare policy, road pricing, tariff structure etc.); (b) an extension of the capacity of the network, either by new expansion investments or by a more efficient use of the existing network, for instance, via shifting hours of use (e.g., for computer networks, telephone networks or electricity networks).

A host of policy implications may emerge from the analysis of barriers. At the international and national scales, efforts to reduce or increase barriers must be based on the proper understanding of how these policy tools function and what kinds of side effects they may have.

For the individual firm seeking (re)location, the "costs space" is characterized by a multiple cost distribution. For example, transport costs for moving physical goods or information is typically seen as a function of distance, possibly with decreasing marginal costs, and which

may have some discontinuities at transshipment points, political boundaries etc. Another cost distribution is, for example that of governmental incentives provided, in some countries for less favored regions. These, again, are typified by clear discontinuities along administrative lines which may or may not overlap with other jurisdictional delineations.

The various cost distributions are set by different factors or agents and are therefore, in many cases, not coordinated. That is, the telephone code areas which determine the costs of calling are not coordinated with the lines along which other discontinuities are set. This implies that the study of barriers need to address the institutional dimension, including the questions of who sets what barriers and why, and what authority do the agencies have to alter such barriers.

A superimposition of the various cost distributions generates a map which shows the total costs involved in locating an activity at any point in space. This map also shows the discontinuities which may be seen as positive or negative barriers to spatial interaction. They may be seen as lines which separate particular (remote) regions, or more interestingly, as enclaves close to the core.

The main problem with the Total Cost Map is that there is no single map that can be drawn for a particular area. The actual cost of spatial interaction is idiosyncratic, depending on the particular interaction pattern of a given firm. Still, the barriers' location and effect (positive or negative) may be generalized. Such a map can be used for analyzing the effects of barriers on the locational patterns of firms and for supporting policy making intended to affect these patterns.

The consequences of barriers may be manifold, not only in financial-economic terms, but also in general welfare terms. A main difficulty in assessing the consequences of barriers stems from the fact that barriers do not only cause direct time (and hence money) loss, but lead also to a reduction of the potential for development in a given area. The latter problem has been thoroughly analyzed by Biehl et al (1986) by using a so-called quasi-production function approach to all EC-regions. An analogous research endeavour would be desirable, since appropriate communication infrastructure is one of the critical production factors for regional development.

The previous remarks point to the need for answering the following research questions:

- What are the available empirical facts on European communication patterns in international information transfer?
- What is the spatial behavior of actors in generating, processing and transferring transborder information flows?
- What are the foreseeable shifts in the international interaction patterns for the information sector in view of technological socio-economic and demographic developments?
- Are new bottlenecks in transborder information transfer to be expected in an open European market and - if so - how can they be dealt with in a policy and planning context?

Research could take place along several lines:

- inventory research: trying to identify which bottlenecks may (or do) exist in which networks, and how they may be (or have been) removed. This would imply a **typological** approach;
- identification of appropriate research strategies for the different ways of measuring and analyzing such barriers to communication;
- research into the impact of **external** barriers. In this case one would need to identify a reference pattern of spatial communications (without external barriers but with only a distance friction included), followed by an analysis/estimation of the reduction in communication caused by the existence of a barrier;
- research into the impact of **internal** behavioral mechanisms in a network with limited capacity. The resulting congestion phenomena include non-linear cost functions and hence non-linear dynamic response patterns.

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