

IS ITT SUBSITUTE OR COMPLEMENT FOR URBAN TRANSPORTATION? A CRITICAL LITERATURE REVIEW

Mehmet C. Marın[†]

Özet

Bu çalışma, telekomünikasyonun ulaşım için bir ikame mi yoksa tamamlayıcı mı olduğu, yoksa ikisi arasındaki ilişkinin daha derin kompleks bir ilişkiyi gösterdiği konusundaki tartışmalara dair literatürün bir kritiğini sunmaktadır. Önceki araştırmalar, ikisi arasındaki ilişkinin hem bir ikame hem de tamamlayıcı nitelikte olabileceğini gösteren delillerle desteklese de, genelde çok basit olduğu düşünülen bu ilişkilerin farklı boyutlarını da gözden kaçırmaktadırlar. Birincisi, bir gezinin telekomünikasyon teknolojisi ile ikame edilip edilemeyeceği, gezinin amacına bağlı olmaktadır. Okula gitmek, boş vakitleri değerlendirmek ve akrabaları ziyaret etmek amacıyla yapılan gezilerin telekomünikasyonla ikame edilme ihtimalleri, bu gezilerin amacı olan yüz yüze etkileşim felsefesine ters düştüğünden, zayıf bir ihtimal olarak kalmaktadır. Öte taraftan eğer gezinin amacı, enformasyonun iletilmesi için yapılıyorsa ve bu iletişimde yüz yüze görüşmeler gerekmiyorsa, çalışma yolculukları yerine teknoloji kullanımı ikame edilebilir. Ayrıca çalışmalar, internet, faks ve telefon gibi yeni teknolojilerin, hem mevcut yolculukları yeniden yapılandığı hem de önceleri hiç düşünülmecek yeni gezilerin ortaya çıkmasında etkili olduğunu göstermektedir.

Anahtar sözcükler: BT, kent içi yolculuklar, ikame, tamamlayıcı, mekansal ekonomik aktiviteler.

Abstract

This paper provides a critical literature review on the debate of whether transportation and telecommunication are substitutes or complements, or they involve in a more complex relationships. The review shows that although there are some evidence that support both a substitution and complementary theory, the previous studies ignores many aspects of the relationships that are more complex than previously thought. First, whether a trip can be substituted by telecommunication is dependent on the purpose of the trip. Trips with a purpose of schooling, leisure, and/ or visiting family relatives are less likely to be substituted by telecommunication technologies, since their goals are to directly interact with other people. The work trips, on the other hand, may be substituted, as long as their information content does not require face-to-face contacts and if their aim is to transmit information. These studies also indicate that new telecommunication technologies such as internet, fax, and

[†] Arş. Gör. Dr., Kahramanmaraş Sütçü İmam Üniversitesi

telephone may actually lead to both modification of the trips and generation of new trips that would not be occurred before.

Key Words: ITT, urban trips, substitution, complementary, spatial economic activities.

1. Introduction

Advances in Information and Telecommunication Technologies (ITT) and their impacts on transportation have been the subjects of various disciplines (Salomon et al 1991; Sheppard 1990; Nilles 1988). Since the invention of the telephone, there has been a change in our perceptions of the potential impacts of telecommunication technologies to affect travel behavior. Fiction and nonfiction writers have similarly speculated about the possible future impacts of the new Technologies as far back as 1780s and even assumed the elimination of the need for travel at some extent (Mokhtarian 2000). This subject is also dear to transportation and urban planners, because transportation and information technologies have determining effects on the urban form. The potential impacts on urban form arises from the fact that technology can provide means for controlling spatially dispersed activities by overcoming geographical constraints on production, distribution, and management (Kumar 1990). This subject has gradually gained more attention with increasing utilization of the telecommunication technologies as a means of telecommuting. It is commonly believed that this mode of work will dominate in the near future (Wunderlich 1997).

The literature indicates that there may be three possible relationships between ITT and transportation, i.e., substitution of ITT with movement of people and transmission of information, complementary relationships, and modification of travel behaviors (Nilles 1988; Selvanathan and Selvanathan 1994; Bennison 1988; Salomon et al 1991).

A review of the literature will show that majority of the studies concentrate on whether ITT is a substitute or complement of transportation (Salomon 1986; Salomon et al 1991; Bennison 1988; Hamer et al 1991; Plaut 1997). Yet, this issue is not resolved. This paper first provides a review of the studies on the controversial substitution/ complementary hypotheses by summarizing their arguments and empirical results that both theories offer. Then it proceeds to give a critical account of the methodologies and conclusions they arrive. The specific studies chosen in this study are directly related to the question this paper aimed to answer. Furthermore, they are so far the most extensive empirical works conducted on the subject area.

The remaining part of this paper is planned as follows: Section One gives an overview of the relationships among ITT, transportation, and spatial economic activities. Then, Section Two criticizes and discusses the hypotheses offered to explain relationships between transportation and ITT and then proceeds to the conclusions of these empirical studies. Finally, the last section critically summarizes the studies and provides a conclusion.

2. Relationship between Transportation, ITT, and Urban Spatial Economic Activities

Spatial organization is the expression of a society that undergoes changes in time. The recent developments in telecommunication and information technologies has led to the transformations with respect to how we produce, consume and arrange our every day activities as well as how individuals in the so called network society interact with each other. Hence, it is expected that these changes will also translate the space into a new form (Castells 1996: 410). Furthermore, globalization of the World economy and spread of the internet are viewed by some scholars as ‘the death of the city and geography’ or ‘placeless digital city’ whereas by another group as ‘the renaissance of the regional economics’ or ‘new logic of agglomeration’ (Laple 2001). In the literature, the discussions on the relations between new technologies and society in a wider sense and between new technologies and the city in a narrower sense are extensive. An excellent review of the subject can be found in Graham and Marvin (1996).

The role of transportation is central to the analysis of spatially extensive economic activities, because it produces accessibility necessary to overcome spatial friction between the production and consumption processes of commodities circulating in the space. Production of accessibility, however, costs both money and time. In a capitalist economic system, time is a significant cost, since it affects rates of returns on the capital advanced or invested. That is “the more rapidly capitalists can make revenues on capital advanced, the less capital they have to advance and the greater profits they make” (Sheppard 1990, 1007). The transportation can affect the capital advanced in two different ways: first, until their consumption, additional costs resulting from storage facilities of goods are added to transportation costs. Second, there is proportionality between the time of circulation and amount of capital advanced to pay for both fixed and circulating capital (Sheppard 1990).

Transportation infrastructure is an important factor for location of many industries, since it influences not only transport costs/ movement time of commodities, customers, and workers, but also risk and uncertainty, liaison between suppliers and customers, and access to market information. Industries vary, however, in their requirements for each of these factors (Leitham et al 2000).

Sheppard (1990) points out that a capitalist can reduce his transportation costs by either locating closer to the inputs requiring high transport costs or adopting an organizational system for production that reduces time, or transportation costs, such as ‘just-in-time’ system. The transportation system can affect the profitability of the production through monetary costs of transportation that enters into production process and circulation time. Hence, any innovation that reduces time, or transportation efforts, will increase the rate of profits. While transportation can be considered as a good, its several characteristics distinguish it from other commodities. First, it is very difficult for an individual firm to appropriate the benefits of transportation improvements, unless it has an exclusive right to the improved transportation system. Otherwise, every firm and individuals will benefit from improved transportation in the region as well as firms and individuals who purchase goods but located in other regions. Second,

transportation investments are very large for a firm to realize alone. This reduces the chance of innovations in the transportation arena. Third, “transportation is both a capital good and a wage good; improvements in transportation translate immediately and directly into reduced costs for capital goods and for the real wages” (Sheppard 1990, 1021).

Over time, technological progress has reduced costs of transportation and communication, leading to relaxation of spatial constraints preventing the urban growth. These changes have modified the spatial organization of the city throughout the history. The growth of preindustrial city was constrained by productivity of agriculture and costs of transporting agricultural supplies from the hinterland to the city. In one sense, these two set bounds defining an optimal city size. The guilds, on the other hand, regulated production by clearly defining specialties, controlling entry, and setting standards. Since the industrial revolution, which transformed small towns into industrial cities, the distance, and thus transport costs, have remained and are still an important determinant in industrial location and city growth. This is because transport costs are not only a function of distance but also time. Furthermore, in the industrial city land markets replaced the guilds as the main regulating institution, which is more flexible in reacting to market forces. Today, while the improvements in transportation and communication have resulted in ever larger cities by reducing the significance of physical constraints on the growth, they are also threatening the very existence of the cities by facilitating the mobility of commodities and services that once could be only found in cities (Duranton 1999).

Krugman (1991) showed that when the transportation costs of manufactured goods are too high, manufacturing would disperse over the space. On the other hand, if the transport costs were very low, then a small advantage in one location would lead to agglomeration of all industry in that location, forming a core-periphery structure.

By contrast, Fujita and Ogawa (1982) demonstrate that agglomeration economies will lose its significance, when the communication technology improves and becomes cheaper. They introduce the agglomeration economies into their model as an endogenous variable by assuming that firms are more productive, when they receive information more intensively. The intensity of information is a function of the numbers of firms in a given location and it is subject to distance decay. The distance decay is very important where communication technologies are very poor. This leads to formation of a Central Business District (CBD), which enables firms to minimize costs associated with information gathering. Although the rents in the CBD are relatively higher in comparison to those in other locations within the same city, gains associated with the high productivity that result from the Access to the information more than offset these high rents. As the communication technologies improve and relevant costs decline, however, the CBD gradually becomes relatively expensive due to high rents and congestion. Ultimately, increasing costs of the CBD locations will force firms to move into edge cities or suburbs.

Although declining agglomeration economies has contributed to the weakening of the CBD locations, recent evidence point out that development in communication and computer technologies is leading to an information society whose

economic activities rely on a disproportionate share of information input. New ITT enable firms to control and coordinate spatially dispersed operations from a single location as well as allow workers to conduct their everyday business from their home using computers without traveling to their offices. The same information tools allow firms to be highly flexible in their location choices (Kumar 1990).

Both for the sender and addressee there are mobile and immobile elements in the telecommunication system. The immobile element cannot be forced to physically move. On the other hand, the mobile component applies both to the sender and receiver, because the spatial action field is extended by the transmission of the information. In this sense, the only difference that distinguishes the sender from the addressee is its activeness. However, when this concept is translated into the physical transport, it becomes clear that the active element (to move) is much important than the passive element (to be visited). This results from the fact that the associated costs including time, energy and money are much higher for the active part. Despite this fact, the passive part of transport contributes to the extension of the spatial action field in which the visited person acts in the same way as telecommunication does. This definition points out a very close interrelationship between the transportation and telecommunication, for both contribute in a more or less complementary manner to the extension of the human spatial behavior (Zumkeller 2000: 24).

4. Controversy over ITT versus Transportation: Substitution, Complementary, or Modification

In the postindustrial society, information technologies have replaced previous manufacturing and service economic activities. For example, in 1967's US, the generation, processing, transmission, and management of information already occupied more than 53 percent of the total employee compensation (Salomon 1985). Much of the travel observed take place to convey information between individuals in different locations. People can interact through physical movement or communication networks (Salomon 1986). Declining costs along with improvements in ITT encouraged some researchers to develop two computing hypotheses with respect to the relationship between travel and communication: while Selvanathan and Selvanathan (1994) and Kellerman (1985) argues that the two are close substitutes, Clark and Unwin (1981) and Salomon (1985, 1986) argue that they are complements. Whatever the relationship is, both physical transportation infrastructure and telecommunications are a subsystem of the communication system (Salomon 1985).

Technological advances in microelectronics and communications have given rise to the claims that electronic transmission of information would replace travel-based interactions. This hypothesis has drawn attention from many planners, because it has very significant implications for the transportation planning, location decisions, and society at large. The substitution hypothesis, however, relies on the assumption that costs of traversing through the telecommunication are lower than those of travel (Salomon 1991).

The substitution hypothesis assumes that as the ITT improve and spread over larger populations, they will replace physical travel. Thus, for a constant content of

communication, there will be a shift in traffic from transport system to the telecommunication networks. This can be explained by the fact that the transportation has various negative effects such as congestion, pollution, and safety costs, whereas the ITT does not have these impacts on the society and it is relatively equalitarian. Three types of substitutions commonly cited are teleworking, teletexting, and teleconferencing (Salomon 1986, 1985). “Teleworking is the substitution of telecommunication technology for work related travel. Telecommuting, a subset of teleworking, is the partial or total substitution of telecommunications and /or computer technology for the daily commute to and from work” (Nilles 1991, 413). A telecommuter or teleworker can conduct his/her business either working at home or at a regional office close to home. Teleworking at a regional office still requires some commuting, but it is expected to be shorter than ordinary travel. Although it may appear that teleworking would necessitate some sort of high-tech communication tools, this is not accurate, for a telecommuter can simply take some parts of his jobs home and return it back after it is done. In fact, it is likely that more than half of the telecommuters do not use a computer while working at home (Nilles 1991; Mokhtarian 1991).

Pendyala et al (1991) point out that teleworking provides an individual with the opportunity to arrange a more flexible schedule of everyday tasks, since it reduces time-space constraints. Not only does this lead to changes in travel behaviors of telecommuter but also of the entire household. The authors studied survey results of the State of California Telecommuting Pilot Project, which was to “evaluate the feasibility and effectiveness of telecommuting within State government agencies” (Pendyala et al 1991, 384). The program participants, experimental and control groups were given a three-day travel diary in the beginning of the program in 1988 and in 1989 to assess the changes in travel behaviors. Their hypothesis was that there would be a reduction in the numbers of work trips, which in turn would reduce the peak-hour traffic congestion. They also anticipated a possible increase in new numbers of trips that were not made before, but resulted from flexible schedule. They also hypothesized that telecommuters might choose different destinations and different times of the day to pursue non-work activities such as shopping. There might be some changes in mode choice. Further, some new task might be assigned to the telecommuter who had more discretionary time. Between two time periods, there was a slight increase in the car ownership in both groups and telecommuting did not result in discard of vehicles by telecommuters. Moreover, though telecommuters traveled 19.5 miles on average compared to 15.4 miles of commuters, the difference was not statistically significant at 5 % level. In terms of trips, the analysis showed that telecommuters reduced their trips by 2 %, which were interpreted as being corresponding to the commute trips to work and from work. When telecommuters and commuters were compared with respect to this reduction in total trips, the difference was statistically significant at 5 % level. Furthermore, the analysis showed that on telecommuting days, the telecommuters reduced the numbers of total car trips and peak-hour trips. They estimated that the decrease in the total travel per telecommuting day was 40 miles. On the other hand, the notion that a flexible schedule may increase the total numbers of non-work trips was

not supported by the statistical analysis. One interesting result was that there was a statistically significant increase in the single stop chains from 55 % to 75 %, which led to shorter average trip lengths on telecommuting days. This higher percentage of single stop chains on telecommuting days does not indicate that telecommuters reduced their trip-linking efficiency.

The authors analyzed how telecommuting affected freeway use, too. They found that on average telecommuters spent 10% of telecommuting day on the freeway. This meant they only spent 0.68 miles on freeway and 6.12 miles on surface streets on average. This was statistically different from previous behavior. By contrast, when they commuted, they spent 50 % of a trip on the freeway. The authors calculated that there was on average a 90 % decline in freeway use with no increase in surface street travel during telecommuting. By contrast, the same statistical analysis for the control group did not show any systematic changes before and after experiment, suggesting that telecommuting was the reason behind travel behavioral changes. The findings also implied that there was more traffic concentration in streets around residential locations, even though the total amount of surface street travel virtually stayed the same.

Another interesting aspect of this study is that it investigated the spatial distribution of trips before and after the experiment. The findings showed that although there were not any statistical difference in distance traveled between a telecommuting and commuting day for a non-work trip, majority of the non-work trips during telecommuting days were closer to home within a 25 miles radius. The authors interpreted this as an indication that the telecommuters either performed different purposes or substituted locations close to work with those that were close to home in telecommuting days. After a more through analysis they concluded that the shrinkage in the non-work trip space was a result of substitution of trips made close to work with destinations closer to home. Interestingly, the contraction in non-work trip space was also statistically significant for the telecommuter's household in terms of before and after the experiment. The same test for control group did not find any difference between the two waves.

They also performed a temporal analysis of the travel behavior. The study showed that home trips were evenly spread out on telecommuting days in comparison to other days. While the commuting day peaks did not vary across two waves of the study, those made on teleworking days seemed to be more spread over time. Yet, the same for work trips on telecommuting days was not large enough to make any substantial conclusion. On the other hand, the trip distribution of non-work destinations other than home did not vary across waves or groups. They seemed to follow very similar patterns across two study periods and two groups. The authors explained this persistency of the same patterns across groups and time by habits. By contrast, non-work trips showed a remarkable difference between two waves. Finally, the analysis showed that "the distribution of home trips between peak and off-peak periods is significantly different between the waves and is dependent upon whether or not the telecommuter is telecommuting" (Pendyala et al 1991, 406).

Selvanathan and Selvanathan (1994) investigate the substitution/complementarity relationship using the demand elasticities of

communication, public, and private transport in the United Kingdom and Australia. They argue that if the communication is a substitute for transportation, then an increase in the price of transportation should reflect to an increase in the demand for communication. On the other hand, if the relationship between two is a complementary, then they both should change in the same direction. The study used data of population and annual consumption expenditures in current and constant prices. It estimated demand for private transport, public transport, communication, and all other goods. The estimated demand equation showed that both constant terms for private and public transport were negative, while that of communication was positive. This was interpreted as an “autonomous trend out of public and private transport into communication.” Per capita consumption of communication on average increased exponentially, by a rate of 2.9 percent per annum in UK and by 4 % in Australia. The estimates also showed that when there was an increase in income, about 25 % of this increase would be spent on transportation, especially private transportation and communication. Furthermore, the results show that when there was a price increase, demand for all three goods decreased and all pairs of private transportation, public transportation, and communication had positive signs. This implies that Transportation and communication pairs and public and private pair were substitutes. They also estimated price and income elasticities of demand for the three goods. The analysis showed that an increase in the demand for private transport was about twice the percentage increase in income in both countries. Based on point elasticities, they suggested that private transport with an elasticity greater than 1 was a luxury good in both countries, whereas public transport with an elasticity less than 1 was considered to be a necessity. On the other hand, the communication was a luxury good in UK, but a necessity in Australia. The authors contributed this difference between the two counties to vast distances among Australian cities. In contrast to income elasticities, price elasticities of three goods were less than 1 in absolute value. The own price elasticities of private, public transport, and communications were -0.5 , -0.4 , and -0.1 respectively for UK, and -0.6 , -0.7 , -0.6 for Australia. By contrast, all cross-price elasticities were positive. For example, “cross-price elasticity of public transport with respect to the price of private transport in the U.K. and Australia is 0.19 and 0.49, respectively. The cross-price elasticity of communication with respect to the price of private transport was 0.57 for the U.K. and 0.31 for Australia” (Selvanathan and Slevanathan 1994, 7).

On the other hand, Zumkeller (2000) suggests that that the interrelationship between telecommunication and transportation goes far beyond the simple substitution theory as advanced by some authors. The fallacy of this theory has already been proved with emerging new evidence: “there is a further increase to be expected in the field of telecommunication as well as in the field of transport giving the background of increasing spatial division of labor and further dispersion and specialization of private life. However, this will happen consistently, interrelated between transport and communication, probably with a stronger growth in the fields of telecommunication due to the lower cost in terms of personal time, cost, pollution etc.” (Zumkeller 2000: 24).

While there are relatively few empirical studies supporting the substitution hypothesis, empirical studies that support complementarity hypothesis are scarce. Yet, the economic theory points out that the relationship between ITT and transportation is much more complex, for it may affect the behaviors of organizations and individuals. The effects of transportation and communication can be grouped into direct, resulting from a change in the relative use of two modes and indirect that results from “shifts in the ‘activity system’” (Salomon 1986, 1985).

Salomon (1986) points out that the complementarity refers to two behaviors: the first is the enhancement, which is defined as the generation of additional trips induced by the use of telecommunication technologies. These additional trips would not be occurred without telecommunication. The second is the complementarity between transportation and telecommunication technologies. The complementarity occurs in situations in which the use of one input contributes to the efficiency of the other. In other words, the more ITT is utilized in the application of transportation system, the more efficient the transportation system will be (Salomon 1986). According to Salomon (1986), the premise that the technological improvements will overtime enhance the competitiveness of the telecommunication mode against transportation ignores two issues. First, some of microelectronic innovations that enhance competitiveness of telecommunication are also being used in automobile industry. Second, this hypothesis fails to recognize the complementarity between the two modes. In other words, an increase in demand for telecommunication will also encourage the use of transport.

Clark and Unwin (1981) analyzed the effects of ITT on non-work travel in rural areas by using data from contact diaries. They points out that compared to 23 % of work related trips, of total non-business travel covered 67 % trips aimed at shopping, socializing, and schooling. They argue that the use of ITT have a particular implication for rural areas, because it can reduce time and distance. This study hypothesizes that the purpose of a trip is a major factor whether telecommuting can be substituted with the travel. ITT cannot be substituted for trips that require movements of people or goods, participation in sports and recreational activities, shopping, and consumption of personal social services. By contrast, they argue, many business trips that are related to information and advice can be substituted with ITT. Their study area covered 50 contiguous parishes in Lincolnshire, UK. A random sample of 511 respondents was asked to record details of non-work trips over a period of 5 days. The analysis used survey results of 361 respondents. 60 percent of the population had telephones at home and 32 % had access to a telephone within 5 minute walking distance. The share of telephone was highest among professionals and managers with an 87 %, while 15 % did not have a telephone access. The authors chosen to focus on 979 trips, 58.1 % of all contacts, made to non-local destinations, since they represented the trips that could more likely be substituted with telecommunication. The results showed that elderly, unskilled, and semi-skilled occupations made relatively less trips in comparison to others. Those who owned an automobile had a higher-level communication activity, making more post-telephone contacts, despite the fact that they made up a small percent in the total sample. The study also discovered that

although it was possible to transmit some information without a trip, many non-local trips occurred exclusively to convey information. Most of these information trips involved in a wide range of more distant locations relative those of transportation. Although ITT can theoretically replace the majority of information trips, this is clearly depend on the nature of the information. A major cause of non-local trips were related to purchases, collecting goods, obtaining services, keeping prearranged appointments, all of which accounted 41 % of the entire transactions. The second reason for the trips with an 18.3 % was conversation and chatting, which did not have any information content. Almost all of these took place between relatives or friends. Only did 8.7 % of all long-distance trips involve in consumption of information services. Of which “the getting and giving advice and information is the most important, accounting only for 4.4 % of transactions but the other information service transactions generate negligible volumes of movements in the area” (Clark and Unwin 1981, 52). This is a significant finding, because it shows that over all effects of the travel will be determined by the relative shares of individual trip categories in the total trips and their telecommunication impacts. The authors argue that telecommunication can successfully replace trips made for simple information purposes such as paying bills, filling in forms, ordering goods, making appointments. However, these types of trips made up an insignificant share of the total trips in this case study. Furthermore, most of these transactions were made during multi-purpose trips. The data also showed that telephone contacts gave rise to new trips, and vice versa. Thus, telephone usage and travel were complement rather than substitutes.

Bennisson (1988) also supports the idea that the relationship between ITT and travel is not a simple tradeoff. In a study of business videoconferencing, he found that while some business trips and some limited degree of telephone and written communications were replaced by the videoconferencing, the videoconferencing also created its own communication event. He concluded that “ for a potential user the choice is between different ways of communicating, and it is not a question of making a trip or having a videoconference, but of communicating face to face (thereby generating a trip) or through an electronic or other medium” (Benisson 1988, 299). Thus, the relationship between the ITT and transportation cannot be expressed in terms of a tradeoff.

Zumkeller (2000) arrives the same conclusion as Benisson (1988). The hypothesis this study postulates is derived from the previous experience with telephone. Accordingly, if the penetration of the telephone was strongly correlated with the growth of the transportation market in the past, then new ITT that are a major derive in overcoming spatial separation, and thus ease the investigation of the new destinations, would create a new demand for transportation. Based on an empirical study conducted in Germany, Sweden and Korea, it was found that additional communication and information possibilities did not result in a decline in the human physical movement.

Plaut (1997) looks at the substitution/complementarity debate from a different perspective by utilizing input/output coefficients of Western European industry. Plaut (1997) argues that about two thirds of all telecommunication and transportation in

Western Europe is used by the industry, and thus it is important to analyze the relationship between the two within the industry. An input–output analysis describes the flow of commodities and services among all individual sectors in a national economy for a defined period of time. Two forms of input-output matrix used were direct coefficients, which measured the amount of direct purchase of inputs per \$1 of output for an industry, and total coefficients, which measured both direct and indirect purchases of inputs per \$1 output. Data set contained input output tables for aggregate European Community and for nine individual states in 1980. He used Spearman correlation coefficient to measure the relationship between the transportation and communication in different industries for both entire European Union and individual states. The results showed that the relationship between communication and transportation was positive and thus complementary for the European Community (EC). This was the case in all three transportation subsectors and almost for all countries in EC. Most of the correlations were significant at 1 % level. The estimated coefficient for the EC as a whole was positive and stronger than those of many individual countries. The estimated correlations for individual countries showed that they were statistically significant and positive for 18 out of 25 cases. On the other hand, the degree of correlations varied across countries and sectors. Particularly, positive correlations were relatively stronger for maritime and air transport and for countries such as Denmark and Netherlands, but weak in the case of Spain. He also estimated correlations for total coefficients for the individual countries and entire EC. The results showed that all the coefficients were positive and statistically more significant than estimates of direct coefficients.

4. Conclusion

Much of the literature on substitution/complementarity of transportation and ITT debate is clearly theoretical. Though there are few empirical studies that support hypotheses, approaches and methodologies employed in each of these studies are distinctive. The utilization of various approaches is useful, because they allow different methodologies and perspectives to test the same hypotheses. On the other hand, the limited number of empirical studies with diverse approaches makes it harder to arrive any definitive conclusion about the substitution and complementarity debate. For example, while study by Selvanathan and Selvanathan (1994) uses a Rotterdam Demand System, which relies on consumer utility theory, Plaut (1997) employees input-output coefficients, which is based on industrial production. These two different approaches and data set obtained from countries with unique characteristic might partially contribute to varying results. Selvanathan and Selavanathan (1994) found a substitution relationship, whereas the other revealed complementarity. Are the findings of such studies comparable? Plaut (1997), in one sense, provides an answer for this question. He suggests that the difference between the two may “reflect differences in the patterns of uses at the consumer level (the Rotterdam System), in contrast to industrial uses” (Palut 1997, 427).

Also, empirical studies such as those of Hamer et al (1991), Pendyala et al (1991) Moore and Jovanis (1988) suffer from design problems. For example, in most

of these studies the participation to the experiment such as telecommuting is voluntary and limited to some public agencies. While some studies, e.g., Pendyala et al (1991), includes a control group for comparison purposes, the sample is still biased. In these designs, because subjects chose themselves, and thus were aware of the experiment, they might act differently from their actual behaviors. Hence, those who decided to participate to telecommuting were probably different than others who did not. Another problem with such design is their generalization to other cases and to individuals who were not involved in the experiment. By implication, one should be very cautious in interpreting the results of such studies. Finally, the nature of the problem, extensive and detailed data requirements make empirical studies for telecommunication and travel very difficult.

Although these studies do not allow making any definite conclusion about the nature of the relationship between the ITT and travel, it is certain that the relationship is much more complex than simple substitution or complement. Certain interactions that do not require face-to-face contacts can be made through telecommunication. On the other hand, declining costs and improvements in ITT will probably facilitate new contacts, and thus result in new trips. The net effects of ITT on travel behavior will be depended on overall proportions of different activities and their suitability for substitution. As Zumkeller (2000) argues the prominent role of the ITT is a tool to plan and to perform physical transport as well as to make trips more efficiently. On the one hand, the ITT can be substituted for more or less standardized trips. On the other hand, "the ITT opens the window to get in contact with far away destinations possibly resulting in a related long-distance travel. This view is consistent with the historical fact that transport and development of media were more or less correlated" (Zumkeller 2000: 26).

Reference

- Bennison, D, 1988, "Transport/ Telecommunication Interactions: Empirical Evidence from a Videoconferencing Field Trial in the United Kingdom." *Transportation Research A* 22, no. 4: 291- 300.
- Castells, M, 1996, *The Rise of the Network Society. The Information Age*, Volume 1. Blackwell Publ: Malden, Mass., Oxford, UK.
- Clark, D and Unwin, K, 1981, "Telecommunication and Travel: Potential Impact in Rural Areas." *Regional Studies* 14: 47-56.
- Durantón, G, 1999, "Distance, Land, and Proximity: Economic Analysis and the Evolution of Cities." *Environment and Planning A* 31: 2169-2188.
- Graham, S and Marvin, S, 1996, *Telecommunication and the city. Electronic Spaces, Urban Places*. Routledge: London.
- Fujita, M and Ogawa, H, 1982, "Multiple Equilibria and Structural Transition of Non-Monocentric Urban Configurations." *Regional Science and Urban Economics* 12: 161-196.
- Hamer, R, Kroes, E, and Ooststroom, H, 1991, "Teleworking in the Netherlands: an Evaluation of Changes in Travel Behaviour." *Transportation* 18: 365-382.

- Kellerman, A, 1985, "Telecommunication and the Geography of Metropolitan Areas." *Progress in Human Geography* 8: 222-246.
- Krugman, P, 1991, *Geography and Trade*. MIT Press: Cambridge, MA.
- Kumar, A, 1990, "Impact of Technological Developments on Urban Form and Travel Behavior." *Regional Studies* 24, No 2: 137-148.
- Laple, D, 2001, "City and Region in an Age of Globalization and Digitization." *German Journal of Urban Studies* 40, No 2. Available at http://www.difu.de/index.shtml?/publikationen/dfk/en/01_2/01_2_laepfle.shtml [Access Date: 08.09.2003].
- Leitham, S, McQuaid, RW, and Nelson, JD, 2000, "The Influence of Transport on Industrial Location Choice: a Stated Preference Experiment". *Transportation Research A* 34:515-535.
- Mokhtarian, P, 1991, "Telecommuting and Travel: State of the Practice, State of the Art." *Transportation* 18: 319-342.
- Mokhtarian, P, 2000, "Telecommunication and Travel Behavior." Available at <http://gulliver.trb.org/publications/millennium/00115.pdf> [Access Date:05.09.2003].
- Moore, A and Jovanis, P, 1988, " Modeling Media Choice in Business Organizations: Implications for Analyzing Telecommunication-Transportation Interactions." *Transportation Research A* 22A, No 4: 257-273.
- Nilles, J, 1991, "Telecommuting and Urban Sprawl: Mitigator or Inciter?" *Transportation* 18: 411- 432.
- Nilles, J, 1988, "Traffic Reduction by Telecommuting: A Status Review and Selected Bibliography." *Transportation Research A* 22A, No 4: 307-317.
- Pendyala, R, Goulias, KG and Kitamura, 1991, "Impacts of Telecommuting on Spatial and Temporal Patterns of Household Travel." *Transportation* 18: 383-409.
- Plaut, P, 1997, "Transportation – Communications Relationships in Industry." *Transportation Research A* 31A, No 6: 419-429.
- Salomon, I, 1986, "Telecommunications and Travel Relationships: A Review." *Transportation Research A* 20, No 3: 223-238.
- Salomon, I, 1985, "Telecommunications and Travel: Substitution or Modified Mobility." *Journal of Transportation and Economic Policy*, September: 219-235.
- Selvanathan, E, and Selvanathan, S, 1994, "The demand for transport and communication in the United Kingdom and Australia". *Transportation Research B* 28, No 1: 1-9.
- Sheppard, E, 1990, "Transportation in a Capitalist Space –Economy: Transportation Demand, Circulation Time, and Transportation Innovations." *Environment and Planning A* 22: 1007-1024.
- Wunderlich, R, 1997, "The Urban Effects of Telecommuting". Available at http://rewind.cx/roland/reports/Urban_Effects_of_Telecommuting.pdf [Access Date: 06.09.2003].
- Zumkeller, D, 2000, "The Impact of Telecommunication and Transport on Spatial Behavior." *Periodica Polytechnica Ser Transp. Eng.* 28, No 1: 23-38.