Telecommunications Network Quality and Export Performance

Kara T. Boatman and Joseph F. Francois*
NERA and the University of Maryland;
Research Division, U.S. International Trade Commission

ABSTRACT

In this paper we examine the contribution of national telecommunications infrastructure to export performance in the service and manufacturing sectors of developing countries. We place emphasis on trade in producer services, which are now at the center of the current GATT initiative to liberalize trade in services. We also examine the contribution of network quality to aggregate export performance.

1. INTRODUCTION

In this paper we examine the contribution of national telecommunications infrastructure to export performance in the service and manufacturing sectors of developing countries. The recent literature on trade in services has focused attention on investment restrictions and the need to establish a local presence in service export markets. (See Deardorff, 1985; Feketekuty, 1985; Francois, 1990a; Gibbs, 1985; Hindley, 1988). The role of intermediate services as linkages in the coordination and control of the interdependent elements of complex, modern production processes has also been emphasized. (See Francois, 1990b,c). Because traded services are often information intensive, the ability to engage in cross-border service transactions depends critically on available telecommunications facilities in the partner countries. In this paper, we analyze, empirically, the role of national telecommunications infrastructure in this process. We place emphasis on producer services, which are now at the center of the GATT initiative to liberalize trade in services. We also examine the contribution of network quality to export performance in the manufacturing sector.

The results presented here indicate that telecommunications network quality is an important determinant of the pattern of trade in both goods and services. This is consistent with the observation that trade in services often involves cross-border transmission of information, and with the observation that such information flows are also an important aspect of global integration of manufacturing. Our results thus lend support to the notion that the development and modernization of the service sector in third world countries and Eastern Europe, in particular their integration into the global economy, depends on upgrading their underlying telecommunications infrastructure. We also offer evidence that the ability of developing countries to export manufactures can be constrained by their underlying telecommunications infrastructure.

2. BACKGROUND

Telecommunications provides a critical cross-border linkage between producers and their overseas markets. For this reason, a high quality telecommunications system can enhance a country's export performance in a number of ways. Telecommunications linkages may promote exports by facilitating entry into non-traditional export markets. Such linkages facilitate the adoption of increasingly complex production processes and may thus make possible the transition to more sophisticated and more valuable manufactured exports. In this context, a good telecommunications system may also help to attract exporting multinational corporations and encourage the integration of local firms into globally integrated industries.

Additionally, today's "smarter" telecommunications equipment not only transmits information; it can also process it. This capability may allow a country to export a variety of services in addition to traditional manufacturing and primary exports. As an example, Singapore's sophisticated telecommunications system has played an important role in that country's regional dominance of financial services exports.[1] Therefore, as domestic income levels rise and a country's advantage in traditional exports erodes, a well-run telecommunications system may facilitate a transition to "high-tech" manufacturing exports and, ultimately, to service exports.

Table 1

Export and FDI Share of Foreign Service Revenues for U.S. Service Firms

	Export Share	FDI Share
Travel	100	0
Franchising	100	0
Licensing	100	0
Education	98	2
Legal	95	5
Health	61	39
Transportation	61	39
Construction	61	39
Information	50	50
Telecommunications	50	50
Motion Pictures	50	50
Management/Consulting	47	53
Miscellaneous	45	55
Software	40	60
Engineering	25	75
Insurance	22	78
Data Processing	17	83
Investment Banking/Brokerage	16	84
Advertising	15	85
Leasing	15	85
Accounting	8	92
Total	42	58

source: Office of Technology Assessment (1991, p.43).

Because traded services are relatively information intensive, the availability and cost of telecommunications linkages is likely to be

Boatman, K.and J.F. Francois (1992), "Telecommunications Network Quality and Export Performance," in M.D. Lofstrom and D.J. Wedemeyer, eds., REGIONAL INTERESTS AND GLOBAL ISSUES: THE CHALLENGE OF TELECOOMUNCATIONS INTEGRATION FOR THE PACIFIC, Pacific Telecommunications Council, pages 827-831.

particularly important for international service transactions. This is because services, unlike goods, are consumed as they are produced. This characteristic of service transactions often requires a direct interaction between user and provider. Because of this need for interaction, it may be necessary for the provider of services to establish a presence in the importing country. Once a local market presence is established, services are then traded through the local establishment. As a result, while actual trade involves the cross-border movement of information, equipment, and personnel, the final "traded" service includes a bundle of services that have been both traded and produced locally. Telecommunications network quality can facilitate the interaction between user and provider, and may reduce the extent to which a local presence is required.

Table 1 presents measures of the relative importance, in revenue terms, of local market activities (reported as foreign direct investment or FDI revenue) and the cross-border movement of information, equipment, and personnel, for the foreign service transactions of U.S. providers. It can be seen that while local market activities and cross-border information and factor flows are both important factors in services trade, this varies significantly by service type. For services that are information intensive, such as information services, management/consulting, and engineering, we expect the quality and availability of telecommunications links to have an important effect on the pattern of trade in services.

3. THE BASIC APPROACH AND DATA

It is important to distinguish between domestic and international telecommunications networks. Although a sophisticated international telecommunications network currently links most countries in the world,[2] it is of little value to individual firms in exporting countries unless their domestic systems are also adequate. An international call must not only be transmitted across borders, but it must reach its party within the destination country. A domestic telecommunications "bottleneck" substantially decreases the value of the international network to inbound and outbound callers alike. The analysis presented here treats the international portion of the telecommunications network as exogenous and constant. We focus on the quality of the network as a positive influence on export performance.

It is also important to understand the relationship between telecommunications equipment and telecommunications services. The quality of a country's telecommunications system must ultimately be assessed in terms of the quality of service provided to its customers. However, the ability to obtain a dial tone, the speed with which a call can be completed and the ability to simultaneously transmit data and voice messages all depend on the type of equipment in the network. Therefore, the quality of the equipment corresponds directly to the quality of service; although measures of equipment quality are used in this paper, they are in fact measures of service quality as well.

The quality of a country's telecommunications system can be measured in a number of ways. It is important, however, that such measures capture both access to telecommunications services and the degree of modernization inherent in those services. Expressed differently, a model should reflect both the quantity and quality of telecommunications services.

In this paper, we rely on two measures of network characteristics: (i) lines using electronic switching (ESS), and (ii) number of telephone access lines per 100 population (density). ESS is a quality variable that measures the number of access lines which use solid-state switching devices and computer-like operations to complete calls. The density variable is the most common measure of telecommunications availability.

Since producer services such as management consulting and data processing are information-intensive, and since telecommunications services facilitate the transfer of information, it follows that a country's ability to export services like these are likely to be influenced by the quality of its telecommunications system. However, this relationship is extremely difficult to test empirically. Accurate service trade data are notoriously difficult to obtain, since service exports have traditionally been calculated as a residual in national accounts data. However, service trade data for the U.S. and selected trading partners have been compiled for 1986 and later years. Although these data are by no means complete, they do permit a crude test of the relationship between telecommunications and developing country service exports.

We focus our attention on developing countries. Our sample on trade in services includes 13 countries, while the sample for exports of manufactured goods includes 43 countries.[3] Our data on trade in services are drawn from the Bureau of Economic Analysis' benchmark survey. The benchmark survey covers U.S. exports and imports with 28 countries in 1986 for eleven service sectors. Revisions to this data were published in June 1989 and September 1990 (see Krueger 1989 and DiLullo and Wichard 1990). Utilizing data on U.S. bilateral service flows, we analyze the composition and volume of U.S. trade in services, assessing the role of information intensity and telecommunications network quality in determining the pattern of trade in services.

Aggregate data on exports for each country are from the International Monetary Fund's Direction of Trade Statistics Yearbook. In addition to measures of telecommunications network characteristics, we also expect export performance to depend on income levels and relative country size.[4] Data on population, GDP, and other macroeconomic indicators are from the World Bank's World Development Report. Commodity trade data (on an SITC basis) are from the United Nations.

4. THE RESULTS: SERVICES

While the literature on trade in services has emphasized investment restrictions, the results presented here highlight the role of available telecommunications linkages. Because traded services are often information intensive, the ability to engage in cross-border service transactions depends critically on available telecommunications linkages.

To formally assess this relationship, we have run regressions on 1986 telecommunications and service trade data using the following functional form:

$$\text{Exports} = a_0 + a_1(\text{Density}) + a_2(\text{ESS}) + a_3(\text{Pop}) + a_4(\text{PCY})$$

where Density and ESS are defined above, Pop is total population, and PCY is per-capita GDP. The dependent variable represents one of the following per-capita export categories: total service exports, "other total" service exports,[5] management consulting and public relations, mining services, advertising and "other" service exports.[6] While there were several additional service categories for which trade with the U.S. was reported in the benchmark survey, the available sample for developing countries was insufficient for any meaningful analysis.[7]

Regressions were run for all service categories for which there were at least 10 observations. An exception was made in the case of "other total" service exports; although there were only 7 observations, this category was judged to be important to the analysis. Consequently, correlation analysis was performed. All results are reported in Table 2.[8]

The results in Table 2 indicate that density and ESS switching are both positive and significant influences on total per capita service exports to the U.S., as well as on per capita exports of mining services. In addition, telecommunications quality appears to play

Table 2

Regression Results:
Per-Capita Service Exports, 1986

	a_0	a_1	a_2	a_3	a_4	Adj. R^2	n
Total Services	-1.85	.33	.36E-05	.97E-02	-.59E-04	-.88	10
	-(1.46)	(4.39)	(1.38)	(.87)	-(.13)		
F		17.85	1.43			17.65	
(pr>F)		.025	NA			.005	
Management Consulting	-.15	.01	.37E-06	.90E-03	-.17E-04	.35	10
	-(1.00)	(1.46)	(1.61)	(.59)	-(.39)		
F		2.22	2.5			2.20	
(pr>F)		.25	.25			.25	
Mining	-.17	.20E-01	.91E-06	.19E-02	-.86E-04	.39	13
	-(.86)	(1.76)	(2.71)	(.85)	-(1.38)		
F		3.17	7.33			2.62	
(pr>F)		.25	.05			.25	
Advertising	-.23	.24E-01	.46E-06	.26E-02	-.64E-04	.03	10
	-(1.19)	(1.63)	(1.04)	(1.64)	-(.94)		
F		2.69	2.59			1.06	
(pr>F)		.25	.25			NA	
Other	-.14	-.79E-02	.28E-06	.68E-03	.68E-04	12 .62	12
	-(1.49)	-(1.38)	(1.67)	(.81)	(2.20)		
F		2.63	2.92			5.42	
(pr>F)		.25	.25			.10	
Total Services Excluding telecomm		.93	.78				6

t-ratios are reported in parentheses. F-statistics for the full model are reported in the R^2 column.

a role in explaining exports of management consulting and public relations services, and to have some impact on exports of advertising services. However, the results for the category of "other services" were inconclusive. Correlation analysis between per capita exports of telecommunications-exclusive services and telecommunications network quality yielded strong results as well. Correlation coefficients of .93 and .78 were generated for density and ESS switching, respectively.

To assess the individual influence of telecommunications density and ESS switching on service exports, F statistics for each telecommunications variable are also reported. These are based on partial sums of squares. Telecommunications density contributes significantly to the explanatory power of the empirical model. However, ESS switching does not appear to play as important a role in explaining total service exports. ESS switching is significant for the remaining categories.

The F statistics indicate that both telecommunications density and ESS switching contribute significantly to the explanatory power of the empirical model. The exception is the category of total service exports, where ESS does not contribute significant explanatory power. While the level of significance is quite low in most cases, this may be due to the small sample size.

5. THE RESULTS: TOTAL EXPORTS

Regressions were run using 1986 data for telecommunications and aggregate exports. The same functional form is used as in the analysis of services. Exports are again measure on a per-capita basis. Results are reported in Table 3 for 1986 for our sample of developing countries. The coefficients on both telecommunications density and ESS switching are significant, and have the expected sign. The coefficient on population is negatively signed in both runs, as expected. The coefficient on per-capita income is positively signed, also as expected.

The results suggest that, in the context of the developing countries in our sample, an increase of .01 lines per-capita would yield an increase in exports of $61 per-capita. Similarly, an increase of 5000 ESS switched lines generates an additional $1 of export revenue per person. It is important to note

Table 3

Regression Results:
Per-Capita Total Exports, 1986

	a_0	a_1	a_2	a_3	a_4	Adj R^2	n
Parameter Estimates	-188.76	61.20	.02E-02	-1.49	.13	.73	43
	-(1.28)	(2.89)	(3.79)	-(.59)	(1.12)		
F		7.6	15.12			29.19	
(pr>F)		.01	.005			.005	

t-ratios are reported in parentheses. F-statistics for the full model are reported in the R^2 column.

that while the incremental contribution of additional investment in telecommunications infrastructure to export revenues may appear to be quite small, these investments typically occur in large increments.

To assess the individual influence of telecommunications density and ESS switching on aggregate exports, F statistics for each telecommunications variable are also reported, based on partial sums of squares of the error terms. Telecommunications density is a significant explanatory variable for LDC exports. The ESS switching variable is also significant. The F statistics indicate that both telecommunications density and ESS switching contribute significantly to the explanatory power of the empirical model. The contribution of the ESS variable is significant at the 99.5% level.

6. THE RESULTS: HIGH TECHNOLOGY MANUFACTURES

While the results described in Section 5 suggest that telecommunications quality influences export performance, it is unlikely that network quality influences all exports equally. Because telecommunications is postulated to generate greater benefits as production processes become more complex, a strong relationship between network quality and exports of high technology products was expected. Regressions were run using 1986 data for various 4-digit categories of manufactured exports. We continue to use the functional form described in Section 4. Selected results are presented in Table 4.

Table 4

Regression Results:
Per-Capita Manufactured Exports, 1986

	a_0	a_1	a_2	a_3	a_4	Adj. R^2	n
Office machines	-22.35	1.55	8.93E-05	5.81E-02	5.98E-03	.47	29
	(-1.92)	(1.33)	(1.87)	(.37)	(1.03)		
F		1.8	3.73			7.32	
(pr > F)		(.25)	(.10)			(.025)	
Electric power machinery	-8.56	.73	3.83E-05	2.33E-02	2.09E-03	.51	29
	(-1.88)	(1.44)	(2.37)	(.33)	(.83)		
F		2.29	5.71			8.14	
(pr > F)		(.25)	(.06)			(.025)	
Telecom equipment	-20.77	1.49	7.58E-05	4.50E-02	5.71E-03	.65	30
	(-2.56)	(1.78)	(2.83)	(.40)	(1.37)		
F		3.33	8.33			14.39	
(pr > F)		(.25)	(.05)			(.005)	
Automotive electric equipment	-.38	3.94E-02	.17E-05	1.11E-03	8.75E-05	.55	28
	(-1.85)	(1.73)	(2.38)	(.34)	(.77)		
F		2.85	5.71			9.09	
(pr > F)		(.10)	(.05)			(.025)	
Other electrical machinery	-4.42	.30	1.25E-05	1.12E-02	1.58E-03	.53	30
	(-2.06)	(1.35)	(1.77)	(.38)	(1.43)		
F		1.88	3.13			9.19	
(pr > F)		(.25)	(.10)			(.025)	
Accounting machines, computers	-1.78	1.78E-05	.15	-6.47E-03	-3.09	.63	21
	(-1.28)	(3.83)	(1.22)	(-.27)	(-.05)		
F		1.8	14.4			9.40	
(pr > F)		(.25)	(.005)			(.025)	
Aircraft engines	-3.70	1.04E-05	.16	1.17E-02	1.23E-03	.62	20
	(-2.30)	(2.14)	(1.30)	(.68)	(2.00)		
F		5.0	7.5			8.78	
(pr > F)		(.05)	(.025)			(.025)	

As the results above indicate, ESS switching consistently contributes significantly to the explanatory power of the model. Telecommunications density also contributes to the model's explanatory power, but often at a lower level of significance.

7. CONCLUSIONS

In this paper, we have examined the relationship of telecommunications infrastructure to trade in intermediate or producer services. We have also examined the contribution of network quality to export performance in the manufacturing sector. Our results indicate that telecommunications network quality is a significant determinant of the pattern of trade in goods and services.

The quality of telecommunications services does appear to play a role in explaining service export performance across developing countries. However, the paucity of the data makes it difficult to determine whether exports of certain services are more heavily influenced by telecommunications than others. In addition, it is important to note that these data exclude transactions between multinational corporations. Thus the hypothesis that telecommunications facilitates the transfer of headquarters services from parent to subsidiary cannot be tested here. Moreover, these data do not reflect service trade between developing countries or between LDCs and other industrialized countries, but only their comparative advantage in exporting to the U.S.

Telecommunications network quality also appears to influence exports of certain manufactured products. In particular, density and ESS switching emerge as significant influences on exports of high technology manufactured products and producer intermediate goods. Our results suggest that telecommunications quality may play an important role in the ability of Asian exporters like Hong Kong and Singapore to enjoy a comparative advantage in exports of high technology manufactures.

Our results suggest that the contribution of national telecommunications infrastructure to developing country export performance should be considered in telecommunications policy decisions.

NOTES

*This paper represents the opinions of the authors, and is not meant to represent the opinions of the ITC or any of it members.

1. See Motiwalla (1988).

2. The international network is comprised largely of undersea cable as well as communications satellites launched by private firms in the U.S. and other industrialized countries.

3. The list of countries in the services sample include: Argentina, Brazil, Venezuela, Saudi Arabia, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, South Africa, Israel, Mexico and India. The list of countries in the manufactured exports sample included: Ethiopia, Kenya, Liberia, Madagascar, Malawi, Morocco, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Zambia, Hong Kong, Indonesia, Korea, Malaysia, Pakistan, Papua New Guinea, Philippines, Singapore, Thailand, Greece, Hungary, Portugal, Turkey, Yugoslavia, Israel, Oman, Saudi Arabia, United Arab Emirates, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay and Venezuela.

4. In the empirical trade literature, models of this type are known as gravity models. The recent theoretical literature on trade with product differentiation and imperfect competition provides a theoretical basis for expecting this relationship between trade, income levels, and relative country size. (Helpman and Krugman, 1985).

5. "other total" represents total service exports less telecommunications service exports.

6. "other" service exports include agricultural, health management, accounting, educational, mailing and reproduction, personnel supply, and sports and performing arts.

7. These categories included: computer and data processing, database and information services, R&D and testing, legal services, industrial engineering, industrial maintenance and repair, and primary insurance. These categories contained either exclusively "0" observations for developing countries, or so few positive observations that the analysis was meaningless.

8. Highly suggestive, suggestive and poor results are reported together in Table 10. Note that the density and ESS coefficients reported for "other total" service exports represent correlation results, not regression results.

REFERENCES

Deardorff, Alan V., (1985) 'Comparative advantage and international trade and investment in services.' in Robert M. Stern, editor, ***Trade and investment in services: Canada/U.S. perspectives***, Toronto: Ontario Economic Council, pp. 39-71.

DiLullo, Anthony J. and Wichard, Obie, (1990) 'U.S. international sales and purchases of services.' ***Survey of Current Business*** 9, pp. 37-71.

Francois, Joseph F., (1990a) 'Trade in nontradables: proximity requirements and the pattern of trade in services.' ***Journal of International Economic Integration***, 5(1), pp. 31-46.

Francois, Joseph F., (1990b) 'Producer services, scale, and the division of labour.' Oxford Economic Papers, 42, pp. 715-729.

Francois, Joseph F., (1990c) 'Trade in producer services and returns due to specialization under monopolistic competition.' ***Canadian Journal of Economics*** 23, pp. 109-124.

Gibbs, Murray, (1985) 'Continuing the international debate on services. ***Journal of World Trade Law***, 19, pp. 199-218.

Helpman, E. and Krugman, P., (1985) ***Market structure and foreign trade: increasing returns, imperfect competition, and the international economy***, Cambridge: The MIT Press.

Hindley, Brian (1988) 'Service sector protection: considerations for developing countries.' ***The World Bank Economic Review*** 2, pp. 205-224.

Krueger, Russell C., (1989) 'U.S. international transactions, first quarter 1989.' ***Survey of Current Business*** 6, pp. 50-92.

Motiwalla, Juzan (1988) 'Computer Land.' ***CIO Magazine***, July, 1988.

Wichard, Obie G., (1988) 'International services: new information on U.S. transactions with unaffiliated foreigners.' ***Survey of Current Business*** 10, pp. 27-34.