RIS
DISCUSSION PAPERS

Infrastructure Availability, Foreign Direct Investment Inflows and Their Export-orientation: A Cross-Country Exploration

Nagesh Kumar

RIS-DP # 26/2002

Research and Information System
for the Non-Aligned and
Other Developing Countries

RIS DP #26-2002

Infrastructure Availability, Foreign Direct Investment Inflows and Their Export-orientation: A Cross-Country Exploration

Nagesh Kumar

Version 2.0: 2 March 2002

Research and Information System for Non-aligned and Other Developing Countries,
Zone 4B India Habitat Centre, Lodi Road, New Delhi-110003.
Tel: +91-11-4682175; Fax: 4682174;
email: nagesh@ndf.vsnl.net.in

An earlier version of this paper was presented at the Third Global Development Network (GDN) Conference held in Rio de Janeiro, Brazil, 9-12 December 2001. I have benefited from comments of Professor K.L. Krishna on an earlier draft besides feedback of participants. The usual disclaimer applies.

Infrastructure Availability, Foreign Direct Investment Inflows and Their Export-orientation: A Cross-Country Exploration

Abstract

This paper analyzes the role of infrastructure availability in determining the attractiveness of countries for FDI inflows and for export-orientation of MNE production. We posit that investments by governments in providing efficient physical infrastructural facilities improve the investment climate for FDI. MNEs may be particularly sensitive to infrastructure availability for locating their investments designed to feed the global, regional or home country markets. First, a single composite index of infrastructure availability is constructed capturing availability of transport infrastructure, telecommunications infrastructure, information infrastructure, energy availability for 66 countries over 1982-94 period using the principal component analysis. The role of infrastructure index in explaining the attractiveness for foreign production by MNEs is evaluated in the framework of an extended model of foreign production. The estimations corroborate that infrastructure availability does contribute to the relative attractiveness of a country towards FDI by MNEs, holding other factors constant. Furthermore, the export-orientation of production of MNE affiliates, especially when the production is meant for third country markets, is significantly related to infrastructure availability. Therefore, MNEs' decision making pertaining to location of product mandates for global or regional markets sourcing is significantly influenced from infrastructure availability considerations. These findings suggest that infrastructure development should become an integral part of the strategy to attract FDI inflows in general, and export-oriented production from MNEs in particular.

Infrastructure Availability, Foreign Direct Investment Inflows and Their Export-orientation: A Cross-Country Exploration

1. Introduction

A considerable volume of literature has highlighted the importance of physical infrastructure as a determinant of economic growth (e.g. Aschauer 1989; Easterly and Rebelo 1993; and Gramlich 1994; World Bank 1994, for reviews). Availability of good quality physical infrastructure could also improve the investment climate for foreign direct investment (FDI) by subsidizing the cost of total investment by foreign investors and thus raising the rate of return. The favourable role of physical infrastructure in influencing the patterns of FDI inflows has been corroborated by recent studies, e.g. Loree and Guisinger (1995), and Mody and Srinivasan (1996). Multinational enterprises (MNEs) may consider the quality of infrastructure available to be specially important while deciding to relocate export-platform production undertaken for efficiency considerations. In other words, quality of physical infrastructure could be an important consideration for MNEs in their locational choices for FDI in general and for efficiency-seeking production in particular.

This paper makes some explorations to analyse the role that infrastructure availability plays in determining the relative attractiveness of a country for FDI inflows and their export-orientation. Such an analysis may be of relevance to policy given the strong competition among countries for FDI inflows. Governments of different countries, developed and developing alike, are competing among themselves to attract more FDI inflows with a variety of investment and tax incentives and other policy preferences (see Wheeler and Modi 1992; Mytelka 1999; Oman 2000, among many others).

A practical problem faced by empirical studies analyzing the role of infrastructure availability is that of measurement of availability of the different components of infrastructure objectively in an inter-country setting. There are many aspects of infrastructure, for instance, transportation facilities like road network, ports, airports etc., communication infrastructure covering

telecommunication network; information infrastructure; energy availability, etc. (see World Bank, 1994, for indicators of different aspects). However, an objectively measured and constructed comprehensive indicator of infrastructure availability is not available. World Economic Forum Reports (1999, 2002) provide country scores and country rankings on among many other indicators, infrastructure. However, these scores suffer from some problems of measurement and construction that limit their usefulness in quantitative analysis. Firstly, the scores are based on subjective perceptions of businessmen in different countries on different aspects of infrastructure availability and quality and not on any objective measurement. The aspects of infrastructure covered are changed over the years so the rankings of countries are not comparable over time. Finally, different aspects of infrastructure are averaged to obtain a single index of infrastructure. Assigning equal weights to different aspects of infrastructure, although convenient, may not be appropriate conceptually. Therefore, this paper first develops a composite index of the availability of different aspects of physical infrastructure using the principal component analysis. An Infrastructure Index ($INFRINDEX_{it}$) is computed for a sample of 66 countries (i.e. i = 66) for three points of time (t = 1982, 1989, 1994). The sample covers developed as well as developing countries for which data on all the relevant variables is available. Three points of time enable us to observe the movement of countries within the sample in terms of development of infrastructure. Having developed the index, the paper goes on to evaluate its role in explaining the patterns of MNEs activity in the sample countries in a four-dimensional setting in the framework of an extended model of location of foreign production. Then we analyze the role of infrastructure in explaining the export-orientation of foreign affiliate production. MNE affiliates could be either exporting to their home countries or to third countries as a part of regional or global product mandates from their parent firms. It has been argued that these two types of export-oriented production are of a different nature. The third-country oriented production is seen as more demanding of locational factors as MNEs aim to achieve overall efficiency and competitiveness. Hence, it is possible that infrastructure availability is more valuable to MNEs relocating production for third-country sourcing rather than home country sourcing.

The structure of the paper is as follows. Section 2 constructs a comprehensive measure of infrastructure availability for 66 countries for three points of time and ranks countries on the basis of their respective infrastructure index scores. The changes in relative ranks of different countries are also observed on the basis of these ranks. Section 3 analyzes the role of the infrastructure index in explaining the relative attractiveness of countries for foreign production

by US and Japanese MNEs in the framework of an extended model of overseas production. Section 4 goes on to analyze the role of an infrastructure index in explaining the export-orientation of MNE affiliates. Finally, Section 5 concludes the paper with a few remarks that have policy implications.

2. A Comprehensive Measurement of Infrastructure Availability and Changing Country Rankings

As observed above, there are several aspects of physical infrastructure which complement each other such as telecommunication, transport, information or energy availability. While these indicators are correlated among themselves (see Canning 1998), none of them will capture the overall availability of infrastructure adequately. A country may have a very good network of roads but a telecommunication infrastructure that is not so good, for example. Here the statistical technique of principal component analysis (PCA) becomes handy in constructing a single index that captures the variance or information contained in different variables capturing different aspects of infrastructure. PCA finds linear combinations of the original variables to construct the principal components or factors with a variance greater than any single original variable. The aspects of infrastructure covered in the construction of a composite index and their measurements are as follows:

Transport Infrastructure:

There could be several aspects of transport infrastructure such as availability of and quality of roads and railways. However, a high correlation ($r = 0.8$ for all the pairs) has been observed between road length and length of railway lines (per 1000 population) [Canning 1998]. Therefore, in order to capture the transportation infrastructure and its quality, we use road length and the availability of vehicles for transportation:

ROADS: road length per square kilometre of area.

VEHICAP: commercial vehicles per 100 inhabitants.

Data Sources: World Bank *World Development Indicators*, *UN Statistical Yearbooks* and *World Road Statistics*.

Telecommunication:

The availability of telecommunication infrastructure is captured with the help of teledensity.

PHONECAP: telephones per 100 inhabitants.

Data Sources: World Bank *World Development Indicators*, *UN Statistical Yearbooks* and ITU.

Information Infrastructure:

Information infrastructure available in the country is captured with the help of intensity of electronic as well as print media as follows

NEWSCAP: newspapers per 1000 inhabitants.

TVCAP: televisions per 1000 inhabitants.

Data sources: UNESCO.

Energy Availability:

Energy availability is captured by intensity of energy use.

ENERCAP: energy use per inhabitant.

Data Sources: World Bank *World Development Indicators*, and *UN Statistical Yearbooks.*

The eigen values and respective variance of these factors are as given in Table 1. Only the first factor or principal component has an eigen value larger than one and explains over two thirds of the total variance. There is a large difference between the eigen value and variance explained by the first and the next principal component. Hence, the first principal component is adequate to serve as the composite index representing the combined variance of different aspects of infrastructure captured by the six variables. The factor loadings for each of the six original variables are given in Table 2.

Table 1: Eigen Values and Variance Explained By Principal Components

Principal Components	Eigen values	% of variance	Cumulative variance
1	3.97	66.1	66.1
2	0.85	14.2	80.3
3	0.64	10.6	91.0
4	0.26	4.4	95.4
5	0.18	3.0	98.4
6	0.09	1.6	100.0

Source: Author's computations as described in text.

Table 2: Factor Loadings for the Original Variables

Variable	Factor loadings
PHONECAP	0.94813
ROADS	0.54185
NEWSCAP	0.79419
ENERCAP	0.83648
VEHICAP	0.76896
TVCAP	0.92426

Source: Author's computations as described in text.

Having computed an Infrastructure Index ($INFRINDEX_{it}$) for each of the sample countries for three points of time as per the above procedure, it is now possible to rank them in terms of relative infrastructure availability. Table 3 presents the $INFRINDEX_{it}$ scores for the 66 sample countries for the three points of time. The index varies within a range of –1.2 to +2.4. Generally, inter-country ranks do not change much between the three points of time covered. The top five countries and bottom two countries, for instance, continue to remain the same with minor change in place between them. Some countries, however, have moved upwards in country rankings consistently by investing in physical infrastructure improvement. Notable cases of upward mobility include, South Korea from 35th rank in 1982 to 25th in 1994, Thailand from 56th to 47th, Singapore from 17th to 11th, Costa Rica from 41st to 38th, and Chile from 40th to 36th. The notable downward movements have also been observed: Germany has slipped from 7th to 18th following the unification with East Germany, UK from 16th rank to 20th, and Saudi Arabia from 22nd to 33rd, among others.

Table 3: Rankings of Countries According to Infrastructure Index ($INFRINDEX_{it}$), 1982-94

Rank 1994	country	$INFRINDEX_{1994}$	Rank 1989	Country	$INFRINDEX_{1989}$	Rank 1982	Country	$INFRINDEX_{1982}$
1	United States	2.44273	1	United States	2.41968	1	United States	2.02935
2	Japan	2.36172	2	Japan	2.29555	2	Japan	1.82319
3	Canada	1.89205	3	Canada	1.8811	3	Canada	1.41687
4	Luxembourg	1.73162	4	Sweden	1.70466	4	Luxembourg	1.30236
5	Sweden	1.67212	5	Luxembourg	1.53416	5	Sweden	1.28386
6	Norway	1.52846	6	Norway	1.48019	6	Denmark	1.13781
7	Finland	1.44903	7	Finland	1.4794	7	Germany	1.10165
8	Belgium	1.4489	8	Denmark	1.34868	8	Australia	1.05021
9	Bahrain	1.38964	9	Bahrain	1.34076	9	Bahrain	1.0418
10	Denmark	1.38758	10	Belgium	1.31807	10	Finland	1.02937
11	Singapore	1.34743	11	Australia	1.26306	11	Netherlands	0.88252
12	Netherlands	1.30416	12	Netherlands	1.2405	12	Switzerland	0.87869
13	Australia	1.2956	13	Switzerland	1.22119	13	Norway	0.86446
14	Austria	1.28174	14	Singapore	1.16123	14	Austria	0.85724
15	Switzerland	1.22144	15	Germany	1.16097	15	Belgium	0.8446
16	Hong Kong	1.14583	16	Austria	1.14009	16	United Kingdom	0.83229
17	New Zealand	1.12503	17	New Zealand	1.06574	17	Singapore	0.78281
18	Germany	1.12368	18	United Kingdom	1.03152	18	New Zealand	0.76335
19	France	1.05585	19	France	0.94743	19	Kuwait	0.70526
20	United Kingdom	1.03903	20	Hong Kong	0.93917	20	France	0.64487
21	Kuwait	0.90388	21	Italy	0.43815	21	Hong Kong	0.39198
22	Italy	0.53724	22	Kuwait	0.42462	22	Saudi Arabia	0.23671
23	Barbados	0.49551	23	Barbados	0.35235	23	Italy	0.18446
24	Spain	0.46988	24	Spain	0.26076	24	Barbados	0.12672
25	Korea, Rep.	0.45245	25	Ireland	0.24964	25	Trinidad and Tobago	0.01876
26	Ireland	0.37463	26	Trinidad and Tobago	0.24071	26	Ireland	0.01833

27	Hungary	0.34187	27	Israel	0.22442	27	Hungary	-0.01878
28	Brunei	0.33497	28	Greece	0.19664	28	Israel	-0.05326
29	Greece	0.32905	29	Hungary	0.19617	29	Greece	-0.10661
30	Israel	0.2542	30	Saudi Arabia	0.11214	30	Spain	-0.14469
31	Trinidad and Tobago	0.2253	31	Brunei	0.06871	31	Venezuela	-0.30044
32	Portugal	0.19305	32	Korea, Rep.	0.05472	32	Portugal	-0.36381
33	Saudi Arabia	0.15653	33	Portugal	-0.05475	33	Argentina	-0.42579
34	Argentina	-0.27991	34	Argentina	-0.33159	34	Libya	-0.46655
35	Venezuela	-0.36482	35	Libya	-0.45378	35	Korea, Rep.	-0.46743
36	Chile	-0.4446	36	Venezuela	-0.46283	36	Brunei	-0.4946
37	Mexico	-0.46811	37	Mexico	-0.51994	37	South Africa	-0.60952
38	Costa Rica	-0.50549	38	Chile	-0.53031	38	Malaysia	-0.67238
39	Libya	-0.50987	39	Costa Rica	-0.53999	39	Mexico	-0.68061
40	Malaysia	-0.51738	40	Malaysia	-0.56997	40	Chile	-0.70549
41	Jamaica	-0.53723	41	South Africa	-0.58182	41	Costa Rica	-0.72101
42	South Africa	-0.59532	42	Jamaica	-0.62901	42	Jamaica	-0.73539
43	Turkey	-0.60838	43	Panama	-0.67574	43	Panama	-0.76533
44	Panama	-0.64454	44	Turkey	-0.68492	44	Fiji	-0.85548
45	Colombia	-0.75404	45	Colombia	-0.77561	45	Ecuador	-0.89126
46	Fiji	-0.78283	46	Brazil	-0.80075	46	Colombia	-0.91575
47	Thailand	-0.78934	47	Ecuador	-0.82147	47	Turkey	-0.92631
48	Ecuador	-0.83008	48	Fiji	-0.83117	48	Brazil	-0.93333
49	Brazil	-0.83293	49	Thailand	-0.858	49	Iran, Islamic Rep.	-0.95026
50	Dominican Republic	-0.87265	50	Iran, Islamic Rep.	-0.89185	50	Dominican Republic	-0.95842
51	Peru	-0.90627	51	Peru	-0.90552	51	Peru	-0.95868
52	Iran, Islamic Rep.	-0.91339	52	Dominican Republic	-0.91574	52	Sri Lanka	-1.0185
53	Egypt, Arab Rep.	-0.91425	53	Egypt, Arab Rep.	-0.9416	53	Philippines	-1.02437
54	Philippines	-0.95124	54	Philippines	-0.96488	54	Egypt, Arab Rep.	-1.03087
55	Honduras	-0.96289	55	Honduras	-1.00015	55	Honduras	-1.05183
56	Sri Lanka	-1.0388	56	Guatemala	-1.05405	56	Thailand	-1.07308
57	Indonesia	-1.04078	57	Indonesia	-1.05617	57	Guatemala	-1.07517
58	Guatemala	-1.05389	58	Sri Lanka	-1.06354	58	India	-1.13305
59	India	-1.05419	59	India	-1.06385	59	Zambia	-1.1497
60	Zambia	-1.11507	60	Zambia	-1.10537	60	Indonesia	-1.15077
61	Nigeria	-1.14461	61	Nigeria	-1.14676	61	Papua New Guinea	-1.1589
62	Pakistan	-1.14617	62	Liberia	-1.1494	62	Pakistan	-1.17125
63	Papua New Guinea	-1.15284	63	Pakistan	-1.15282	63	Liberia	-1.18444
64	Liberia	-1.16172	64	Papua New Guinea	-1.16084	64	Nigeria	-1.19773
65	Bangladesh	-1.21477	65	Bangladesh	-1.21732	65	Zaire	-1.22871
66	Zaire	-1.21916	66	Zaire	-1.22072	66	Bangladesh	-1.23054

Source: Author's computations as described in text.

3. Role of Infrastructure Index in Explaining Variation in MNE Presence Across Countries

Having constructed a single index of availability of different aspects of infrastructure in a country, we may now proceed to analyze its role in explaining the attractiveness of a country as a location for production by MNEs. The latter is measured in terms of output (proxied by

net sales) of affiliates of foreign MNEs in a particular country. Given the data availability, the analysis is restricted to overseas affiliates of US and Japanese MNEs. The attractiveness of a country to foreign investors or MNEs could depend upon several factors besides availability of infrastructure. Hence, the need for an analytical framework.

The variation in $AFSAL_{hijt}$, i.e. sales of affiliates of MNEs of *h*th home country (US or Japan), in *j*th manufacturing sector and at *t*th point of time is sought to be explained in the framework of an Extended Model of Location of Foreign Production formulated by us elsewhere (see Kumar 2000a, for more details). This model draws upon the complementary approaches of the gravity model of international trade (see for instance, Ferrantino 1993, Eaton and Tamura 1996, and Brainard 1997) and the theory of international operations of firms (see Dunning, 1993). This model explains the affiliate sales in terms of some demand (or gravity factors) in the host country captured by population (*POP)*, per capita national income (*INCOME)*, the geographical distance between the home and the host country (*DISTANCE)*, the extent of cultural affinity (*CULTUR)* (proxied by linguistic homogeneity) between the home and host country, and the extent of urbanization *(*$URBAN_I$). The index of infrastructure ($INFRINDEX_{it}$) enters in the model as one of the locational variables following the theory of foreign operation of firms that make local production preferable to exporting. The other locational factors included are wage rates (*WAGE)* and a vector of variables capturing different elements of host country's policy framework ($POLICYVARS_k$) such as relative openness of country's trade regime, performance requirements imposed by host countries on foreign affiliates, the extent of investment incentives provided by host governments, the extent of tax incentives extended by host governments and the tax rates (see Equation 1).

$$\begin{aligned} \ln AFSAL_{hijt} = {} & \alpha + \theta_1 INFRINDEX_{it}, + \theta_2 INCOME_{it}, + \theta_3 DISTANCE_{ih}, \\ & + \theta_4 CULTUR_{ih}, + \theta_5 URBAN_i, + \theta_6 \ln POP_{it}, + \theta_7 WAGE \\ & + \eta_k \Sigma_k POLICYVARS_k, + \tau_j \Sigma_j D_j, + \lambda_t \Sigma_t T + \varepsilon_{hijt}, \end{aligned} \qquad [1]$$

where α, θ_k, η_k, τ_j, λ_t are estimated coefficients. The predicted signs of coefficients are: θ_3, $\theta_6 < 0$ and others are > 0 (positive).

Model [1], therefore, combines the demand factors in the host countries that act to pull MNEs towards them as well as factors that make affiliate sales rather than exporting as the mode of market servicing. Some of these factors are structural in nature in the sense that they are given in

a short period, e.g. $INFRINDEX_{it}$, *POP, INCOME, DISTANCE, CULTUR, URBAN, WAGE,* as well as factors that are subject to host government policy and can be changed in the short run.

The empirical verification of the hypotheses formulated above is conducted with regression analysis with a data set for 66 countries for the three points of time over the 1982-94 period and seven broad sectors of manufacturing using an exclusive Glob-Ted data base created by us. Details of the scope and coverage of the data set and the variable measurements are provided in the Data Appendix. Since the data set pools observations across seven branches of manufacturing and over three points of time, controls for sectoral and time dimensions had to be included. Correction for possible heteroskedasticity is made using White's consistent estimator. An additional problem faced in testing the effect of *INFRINDEX* was its high collinearity with *INCOME*. High correlation between infrastructure and income levels is expected and has also been observed by World Bank (1994), and Canning (1998), among other studies. In order to avoid this problem, *INFRINDEX* is regressed on *INCOME* and the residuals from this regression viz. *INFRINDEX** will be used in its place.

Table 4 summarizes the model estimation results. The model explains the variation in the intensity of MNE presence across countries quite well as is apparent from the high ratios of variation explained and high F-values. *INFRINDEX**, even after adjusting for per capita income levels, comes up with a predicted positive and statistically significant effect on the attractiveness of the country for both US and Japanese MNEs. Therefore, availability of physical infrastructure significantly adds to the attractiveness of a country as a host for operations of MNEs, holding other factors constant. Japanese MNEs appear to be more sensitive to the quality of infrastructure than US MNEs as the effect of the variable is stronger in the former case than the latter in terms of both the magnitude as well as the level of statistical significance.

Table 4 also summarizes the estimations made for the developing country sub-sample. *INFRINDEX** continues to exert significant effect even in the developing country sub-sample for the US MNEs. For Japanese MNEs, even though *INFRINDEX ** has a positive sign, it is not significantly different from zero in statistical terms. This could possibly be explained in terms of the fact that a bulk of the investments by Japanese MNEs in developing countries are home-market oriented as 66 per cent of the total output of Japanese affiliates in developing countries was exported back to Japan (see Kumar 1998). As will be argued later, the home

market-oriented FDI being largely of low cost labour-seeking nature may not be sensitive to the quality of infrastructure available in the host countries.

Table 4: Role of Infrastructure as a Factor Explaining the Patterns of Sales of Affiliates of US and Japanese MNEs

Dependent Variable	Home Country	Sample	Coefficient and t-value of *INFRINDEX**	Control variables included in the Model	Adjusted R^2	F-value	N
ln*AFSAL*	US	Full	0.57237* (1.865)	Population, Income, Distance, Culture, Urban, Wage, Openness, Incentives, Performance requirements, Tax Rate, Tax Incentives; Sector, time and regional dummies	0.70	51.92	500
ln*AFSAL*	Japan	Full	1.4778*** (5.332)	-do-	0.57	42.27	728
ln*AFSAL*	US	LDCs	1.4838* (1.721)	-do-	0.66	22.04	255
ln*AFSAL*	Japan	LDCs	1.4988 (1.415)	-do-	0.68	33.74	350

Note: Figures in parentheses are t-values. Levels of significance are *** : 1 percent; ** : 5 percent; and * : 10 percent.
Source: own estimations.

4. Role of Infrastructure Availability in Determining Export-Orientation of MNEs' Production

MNEs have evidently played an important role in the rapid growth of manufactured exports of Asian newly-industrialising countries viz., Taiwan, Singapore, Hong Kong, Malaysia. These countries have actually been successful in attracting MNEs to locate export-oriented or offshore production. Export-oriented FDI arises in the process of rationalization of production according to international differences in factor prices undertaken by MNEs. Because of their potential in expanding manufactured exports and transfer of knowledge to the host countries, most governments compete among themselves to attract such investments by means of a number of policy instruments. A large number of export processing zones have been set up by different countries in an effort to attract MNEs to set up export-oriented units by providing subsidized infrastructure and a freer policy environment.

Export-oriented FDI is a special type of FDI and is governed by different factors than is domestic market seeking FDI (Kumar 1994a). Being efficiency-seeking in nature, export-oriented FDI could be more sensitive to availability of quality infrastructure than overall FDI.

The past analysis of export-oriented FDI has generally focused on production for home-country sourcing. However, in the recent period, a growing proportion of export-oriented FDI has involved serving third country markets. As a part of efficiency-seeking restructuring of their operations in response to liberalization of trade and investment regimes world-wide and formation of regional trading blocs, MNEs assign product mandates to their subsidiaries for serving the entire regional or global market in the mandated product rather than each subsidiary operating as a miniature replica of their parent firms (see Kumar 1998, for a detailed analysis). Thus there are two distinct types of export-oriented FDI: one, serving primarily the MNE's home market (viz. home-market oriented) and those serving third countries (viz. rest-of-the-world market-oriented) FDI. The analytical framework employed to analyze the locational patterns of export-oriented FDI, posited that the two types of export-oriented FDI flows are determined differently. It has been argued that the home-market-oriented production abroad, essentially cost saving in nature, is rationalized abroad to benefit from international differences in factor prices and raw material costs (and some times to escape high pollution abatement costs) for home market consumption by MNEs. The home-market oriented production abroad by US MNEs was encouraged by the Offshore Assembly Provisions in the US Tariff Code which allow duty free re-import of components exported by US enterprises for offshore assembly (under US tariff items 9802.00.60 and 9802.00.80 since the 1960s). Rapid appreciation of the Japanese yen since the Plaza Accord of 1985 and rising wages in Japan prompted Japanese corporations to rationalize their home-market oriented production globally. The extent of relocation of production has been considerable enough to invite widespread fears of a 'hollowing out' of Japanese industry. The home-market-oriented FDI generally involves production of intermediate goods which are often custom made (Kumar 1998).

The third-country-oriented production abroad, on the other hand, results from the strategy of MNEs to assign the responsibility for serving specific regional or even global markets in particular product lines to certain affiliates. This strategy is some times called product mandating and results from the efficiency-seeking restructuring or specialization within the MNE, as observed earlier as for instance: a Malaysian affiliate of Minolta corporation producing a particular range of cameras for Minolta's markets world-wide; a Brazilian affiliate of Singer producing a particular model of sewing machines for the global markets; Ford of the UK producing the Escort model of cars for the European Union (EU) members and neighbouring countries, and so on. This strategy helps the corporation to internalize the economies of specialization and scale by focusing attention on the production of a specific

product line. Global product mandating as a strategy has been made possible by the recent trend of liberalization of economies world-wide. The protected markets of the earlier era had led to a horizontal expansion of MNEs where MNE affiliates in different national markets tended to represent 'miniature replications' of their parent firms often producing the entire range of parent firm's products at sub-optimal scales. The recent trend of regional economic integration has contributed greatly to the process of internal restructuring of enterprises by eliminating the tariff and non-tariff barriers across the participating countries and thus removing the need to maintain horizontal national operations for MNEs. The Single Market Plan of the European Union, for instance, has prompted not only the European MNEs but also the American and Japanese MNEs operating in the Common Market to restructure their operations on a pan-European basis (see Kumar 1994b, for illustrations). Third-country-oriented ventures, therefore, produce final goods for serving the mandated markets which generally cover host country local market.

This analytical framework thus emphasizes besides the infrastructure index, the role of wage rates (holding the quality of labour constant), viz. *WAGE*; geographical distance (*DISTANCE)*; preferential trading arrangements between home and the host countries, e.g. *DNAFTA, DCARRIBBEAN*; strategic or preferential access of host country with major trading blocs *DEU*, *DNAFTA*, *DLOME;* openness of the trading regime (*OPENNESS)*; host country market size *MSIZE*; and specific policies of the host governments concerning export-orientation e.g. export-obligations (*EXCOMT)* imposed at the time of entry (see Kumar 1998, for more details).

Availability of quality infrastructure as measured in terms of $INFRINDEX_{it}$, is posited to help the country attract export-oriented investment from MNEs, holding other factors constant. The product mandating is expected to cover a much more complex operation compared to the labour intensive intermediate goods processing as involved in home-market-oriented production. Hence, the quality of industrial infrastructure may be a more important consideration for location of third-country-oriented exports than for home-country-bound production.

Furthermore, many developing country governments have established export processing zones in an explicit effort to attract MNEs to set up export-platform ventures by offering them a more liberal trading environment in an otherwise closed economy. Apart from a

liberal trading environment, these zones also provide a more efficient infrastructure, port facilities, and privileges such as tax holidays and sometimes even more harmonious industrial relations by curbing or restricting strikes, etc. These zones have been used by MNEs for labour intensive processing mainly for home markets. Hence, size of export processing zones (*EPZONES)* is expected to be positively related to home market export orientation of affiliates.

The above propositions are verified with the data set covering 66 host countries, two home countries, viz. the US and Japan, three points of time between 1982-94 and seven branches of manufacturing, extracted from the Glob-Ted data base, as described earlier. The dependent variables are propensity of affiliates to export to the home markets ($EXPHOM_{hijt}$) in affiliate sales and the propensity to export to the third countries or the rest of the world ($EXPROW_{hijt}$). The sources for the dependent variables are the 1982, 1989, and 1994 Benchmark Surveys of US Direct Investments Abroad and MITI's Benchmark Surveys of Japanese Corporations Overseas Activities for the 1983 (for 1982), 1989, and 1992-93 (for 1994). Since the data set pools observations across seven sectors and over three points of time, controls for sector and time are included. The model specifications are as follows:

$$EXPHOM_{hijt} = f(INFRINDEX_{it,}, WAGE_{it}, DISTANCE_{hi}, DNORTHAM_{i,} \\ DCARIBBEAN_{i}, OPENNESS_{it}, EPZONES_{it,}, D_{j,}, T_{t}) \quad [2]$$

and

$$EXPROW_{hijt} = f(INFRINDEX_{I,}, WAGE_{it}, MSIZE_{it}, DEU_{i,}, DNAFTA_{i,} DLOME_{i}, \\ DEFTA_{i}, OPENNESS_{it}, EXCOMT_{it,}, D_{j,}, T_{t}), \quad [3]$$

where h = USA or Japan, the home countries; i = 1 - n host countries; j = 1 - 7 manufacturing industry groups; and t = 1982, 1989, or 1994 point of time; D_j is a vector of 6 dummies identifying all the broad manufacturing sectors except the miscellaneous sector; T_t are dummy variables separating observations belonging to 1982 and 1994. The variable measurements and data source are provided in the Data Appendix.

The estimation results have been summarized in Table 5. The equations for the US affiliates are able to explain a respectable proportion (36 and 51 per cent) of total variation in the dependent

variables for cross-sections and are significant in terms of F-test at one per cent level. The proportion of variation explained in the Japanese case is rather poor although the overall equations remain statistically significant in terms of F-tests at the one per cent level. One possible reason for the rather poor performance of the model in the later case is the bias arising from the poorer quality of Japanese statistics because of lack of mandatory powers to collect data response unlike the US.

The quality of infrastructure captured by *INFRINDEX* has a positive significant coefficient while explaining third country orientation of exports of both US and Japanese affiliates as per the hypotheses. *INFRINDEX* has a positive significant effect in explaining the home-market orientation of US affiliates. In the case of Japanese MNEs, the coefficient of *INFRINDEX* is not significantly different from zero. It would corroborate our hypotheses that export-oriented production in general and third-country- oriented production, in particular, is highly dependent upon the ability of host countries to provide quality infrastructure, holding other factors constant.

Table 5 : Role of $INFRINDEX_{it}$, as a Factor Explaining the Export-orientation of Affiliates of US and Japanese MNEs

Dependent Variable	Home Country	Sample	Coefficient and t-value of $INFRINDEX_{it}$,	Other Factors Controlled or specified in the Model	N	F-value	Adjusted R^2
EXPHOM	US	Full	0.12E-02* (1.77)	Wage rate, Distance, Openness, EPZones, North America Dummy, Caribbean dummy, Sector and Time dummies	432	17.01	0.36
EXPHOM	Japan	Full	-0.99E-02 (-1.16)	-do-	450	6.73	0.15
EXPROW	US	Full	0.58E-01*** (4.80)	Wage rates, Openness, Export commitments, Market Size, EU and NAFTA Dummies, EFTA and Lome dummies, sector and time dummies	397	27.17	0.51
EXPROW	Japan	Full	0.37E-01** (2.41)	-do-	442	9.77	0.25

Note: Figures in parentheses are t-values. Levels of significance are *** : 1 percent; ** : 5 percent; and * : 10 percent.
Source: own computations.

The variable measuring presence of export processing zones comes up with a significant positive coefficient in the case of home-market-oriented production for both US as well as Japanese affiliates. It suggests that the policy of setting up enclaves providing a liberal trading environment and infrastructure in the form of export processing zones has helped

countries attract home-market-oriented production which is essentially of the labour processing type from MNEs.

5. Concluding Remarks

This paper has analyzed the role of infrastructure availability in determining attractiveness of countries for FDI inflows and their export-orientation. We posit that investments by governments in providing efficient physical infrastructural facilities improve the investment climate for FDI by subsidizing the cost of total investment by foreign investors and thus raising the rate of return. MNEs may be particularly sensitive to infrastructure availability for locating their investments designed to feed the global, regional or home country markets as these investments are efficiency-seeking in nature.

The empirical verification of the role of infrastructure availability have been hampered by the lack of a comprehensive indicator of different types of infrastructures. Therefore, a single composite index of infrastructure availability was first constructed capturing measures of transport infrastructure, telecommunications infrastructure, information infrastructure, energy availability, etc. The changes in the relative rankings of the 66 sample countries over the 1982-94 period based on the Infrastructure Index suggest that some countries e.g. South Korea, Thailand, Singapore, Costa Rica and Chile have moved up the ladder by consciously investing in development of investment while others have been left behind.

The role of an infrastructure index in explaining the attractiveness of a country as a host for foreign production by MNEs is evaluated in the framework of an extended model of foreign production that draws upon complementary approaches of the gravity model of foreign trade and theories of international investment. The estimations made with an exclusive four-dimensional data-set covering 66 countries suggest that infrastructure availability does contribute to the relative attractiveness of a country towards FDI by MNEs, holding other factors constant. Furthermore, the export-orientation of production of MNE affiliates, especially when the production is meant for third country markets, was significantly related to infrastructure availability. Therefore, MNEs' decision-making pertaining to location of product mandates for global or regional markets sourcing is significantly influenced by infrastructure availability considerations. It is clear, therefore, that besides its direct contribution to growth, infrastructure investment contributes to improvement of overall investment climate in the country and helps attract FDI.

These findings suggest that infrastructure development should become an integral part of the strategy to attract FDI inflows in general, and export-oriented production from MNEs in particular. A number of developed and developing country governments have indulged in policy competition between themselves to attract MNEs through investment incentives. These investment incentives tend to distort the patterns of FDI in favour of developed countries given their capacity to provide substantial fiscal incentives (see UNCTAD 1995, and Moran 1998, for examples of investment incentives provided by some developed country governments). Rather than getting sucked into competition with developed countries by offering investment incentives, governments of developing countries would do well to focus on development of physical infrastructure in their countries. This would help to mobilize the domestic as well as foreign investments and help in expediting the process of their development.

In this context, the slackening of public investment in infrastructure development in a number of developing countries, such as India, as a part of the structural adjustment is a matter of concern. In India, for instance, fiscal adjustment has been achieved by squeezing public investment rather than government consumption. Concerns have been raised about the declining budget for key infrastructure sectors such as energy, transport and communications not only in terms of proportion of national income but even in nominal terms. As private investment has not been able to substitute for public investment, the gap between demand and supply of infrastructural services is widening and is threatening to affect the future growth prospects besides discouraging FDI inflows (see Kumar 2000b, for details). An implication for the Fund-Bank administered structural adjustment programmes is that fiscal targeting should be with respect to government (current) expenditure and not with respect to the overall fiscal position. Secondly, lending of multilateral development banks to developing countries should refocus on the infrastructure investment in view of faltering public investment in these sectors. This would not only make up for declining public investment but would also help to crowd-in foreign and domestic private investment in these sectors.

Data Appendix

The data set for the analysis reported in this paper draws upon the **Global Technology and Economic Development (GLOB-TED) data base** created by us from different sources. The core of the data base is built around information on operations of foreign affiliates of US and Japanese MNEs obtained from national sources. The data on other variables, viz., sample country's macroeconomic, technological, geopolitical, structural and policy characteristics was compiled from a variety of sources that include OECD, UNCTAD, UNIDO, UNESCO, UNSTAT, IMF, the World Bank, among others.

The Affiliate Data

The data on operations of affiliates of US and Japanese MNEs in different host countries have been obtained for three years viz. 1982, 1989, and 1992. These data have been obtained from the home country sources viz., The Benchmark Surveys on US Direct Investments Abroad for the years 1982 and 1989, and 1994, brought out by the US Department of Commerce (Bureau of Economic Analysis) in the case of US MNEs; and unpublished exclusive extracts from data tapes of the Second (for the year April 1983-March 1984), Fourth (1989/90) and Fifth (1992/93) Basic Surveys on Overseas Business Activities conducted by the Japanese Ministry of International Trade and Industry (MITI) for Japanese MNEs made available to us by JETRO's Institute for International Trade and Investment, Tokyo. Figures from the Second MITI survey which are for 1983 have been substituted for 1982, and for the Fifth survey 1992/3 for 1994.

The Country Coverage

The coverage of the data base is determined by the coverage of the benchmark surveys and includes 74 countries with an overlapping set of 44 countries reported by both the home countries. The countries included in the sample are United States, Japan, Canada, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, New Zealand, Australia, Hungary, Argentina, Brazil, Chile, Colombia, Ecuador, Peru, Venezuela, Costa Rica, Guatemala, Honduras, Mexico, Panama, Puerto Rico, Bahamas, Barbados, Bermuda, Dominican Republic, Jamaica, Neth. Antilles, Trinidad & Tobago, UK Islands , Egypt, Liberia, Libya, Nigeria, South Africa, Zaire, Zambia, Bahrain, Iran, Israel, Kuwait, Saudi Arabia, UAE, Bangladesh, Brunei, China, Fiji, Hong Kong, India, Indonesia, Malaysia, Pakistan, Papua New Guinea, Philippines, Singapore, Korea, Sri Lanka, Taiwan, Thailand. Not all these countries, however, are included in individual equations estimated depending upon the missing values of some independent variables. The developing countries sub-sample covers all non-OECD countries.

Sector Classification

The affiliate data for each host country has been reported into seven broad manufacturing sectoral categories (*j*s) as follows:

- Food and kindred products
- Chemicals and allied products
- Primary and fabricated metals
- Machinery, except electrical
- Electric and electronic equipment
- Transportation equipment
- Other manufacturing.

Some regrouping of manufacturing sub-sectors in Japanese data was necessary to ensure conformity to the above classification.

The variable measurements are as follows:

$AFSAL_{hijt}$: sales of affiliates of MNEs from *h* th home country, in *i*th host country and *j*th sector in *t* th year. Source: Glob-Ted database.

POP_{it}: population of country in millions. Source: World Bank, *World Data 1997* (CD-Rom).

$INCOME_{it}$: per capita GNP in current US $. Source: World Bank, *World Data 1997* (CD-Rom).

$DISTANCE_{hi}$: distance between the *h*th home country and *i*th host country has been measured between centroids of the national areas in terms of radians of the earth's surface. Source: Boisso/ Ferrantino data, courtesy M.J. Ferrantino, US International Trade Commission, Washington, DC.

$CULTUR_{ih}$: a measure of linguistic similarity between *h*th home and *i*th host country ranging between 0 (i.e. no similarity) and 10,000 (perfect similarity). Source: Boisso/ Ferrantino data, courtesy M.J. Ferrantino, US International Trade Commission, Washington, DC.

$URBAN_{i}$: urban population as a percentage of total population. Source: World Bank's *World Data 1997*.

$WAGE_{it}$: to adjust the average nominal wage rates (*NWAGE*) in *i*th country in US $ (provided by UNIDO) for quality of labour, it was regressed on the gross enrolment rates for secondary (*GRENRSEC*) and tertiary (*GRENRTER)* education in *i*th country (UNESCO data). The residual from this equation has been taken as a measure of adjusted wage. Source: GLOB-TED database.

$INFRINDEX_{it}$: is a composite measure constructed by using a principal component analysis as explained in the text.

$OPENNESS_{it}$: has been estimated by adjusting the trade intensity (total merchandise trade as a percentage of gross national product, *MTGNP*, World Bank Data) for a country's structure. *MTGNP* has been regressed on different aspects of structure viz., country area size, population, per capita income, transport cost (captured by cif/fob value), special natural resource endowment (OPEC dummy) (following Pritchett, 1996). Residual from this equation are expected to measure more a policy rather than a structural openness. Source: GLOB-TED database. See Kumar (1998) for more details.

$PRFREQ_{it}$: proportion of US affiliates that were imposed certain performance requirements by *i*th host country in *t*-5th year. Source: GLOB-TED database based on US Benchmark Surveys for 1977, 1982, and US Department of Commerce's unpublished data for 1989.

$INCENT_{it}$: proportion of US affiliates that received investment incentives from *i*th host country in *t*-5th year. Source: US Benchmark Surveys, values for 1989 have been repeated for 1994 in the absence of relevant values.

$TAXINCENT_{it}$,: represents the difference between statutory tax rates and actual or effective tax rates i.e. $TAXRATE_{it}$. Source: courtesy Professor Shang-Jin Wei, Harvard University 1997 and US Department of Commerce, Benchmark and Annual Surveys of US Direct Investment Abroad, respectively.

$TAXRATE_{it}$: foreign income taxes paid by US affiliates in *i*th country as a proportion of the net income plus foreign income taxes, averaged over two years to suppress the effect of occasional carried-over taxes. Source: US Department of Commerce, Benchmark and Annual Surveys of US Direct Investment Abroad.

$PATENTRIGHT_{it}$: an index of the relative strength of patent protection available in the host countries representing a sum of a country's performance in terms of five criteria, namely, extent of coverage, membership in international patent agreements, provisions for loss of protection, enforcement mechanisms, and duration of protection. It takes a value between 0 and 5. Nearest years available (viz. 1980, 1985, and 1990) are used. Source: Ginarte and Park (1997).

$LOCONTREQ_{it}$: proportion of US affiliates that were imposed certain requirements concerning local content by *i*th host country in *t*-5th year. Source: GLOB-TED database based on US Benchmark Surveys for 1977, 1982, and US Department of Commerce's unpublished data for 1989.

$EXPHOM_{hijt}$: proportion of exports to the home country in total sales of affiliates of MNEs from *h*th home country in *i*th country, in *j*th sector of manufacturing, and at *t*th point of time (Sources: Respective US Benchmark Surveys and MITI surveys).

$EXPROW_{hijt}$: proportion of exports to third countries in total sales of affiliates of MNEs from *h*th home country in *i*th country, in *j*th sector of manufacturing, and at *t*th point of time (Source: respective US Benchmark Surveys and MITI surveys).

$MSIZE_{it}$: logarithm of gross national product of *i*th country in *t*th year in market prices in US$ (World Bank data).

$EXCOMT_{it}$: proportion of US affiliates that were required to export a certain proportion of their output from *i*th host country in *t*-5th year (source: US Benchmark Surveys for 1977, 1982, and US Department of Commerce's unpublished data for 1989).

$EPZONE_{it}$: total employment in nearest past year in *i*th country (Sources: ILO/UNCTC).

$DNAFTA_{it}$: a dummy variable identifying countries participating in the North American Free Trade Area.

$DNORTHAM_{it}$: a dummy variable identifying the North American countries.

$DCARIBBEAN_{it}$: a dummy variable identifying the Caribbean countries.

DEU_{it}: a dummy variable identifying the members of the European Union at respective points of time.

$DLOME_{it}$: a dummy variable identifying the African, Caribbean and Pacific countries that participated in Lome Convention.

$DEFTA_{it}$: a dummy variable identifying the members of the European Free Trade Association.

References

Aschauer, D.A. (1989). 'Is Public Expenditure Productive?', *Journal of Monetary Economics* 23(2): 117-200.

Brianard, S. Lael (1997). 'An Empirical Assessment of the Proximity-Concentration Trade-off Between Multinational Sales and Trade', *The American Economic Review*, 87(4): 520-544.

Canning, David (1998). 'A Database of World Stocks of Infrastructure, 1950-95', *The World Bank Economic Review* 12(3): 529-47.

Dunning, John H. (1993). *Multinational Enterprises and the Global Economy,* Reading: Addison-Wesley.

Eaton, Jonathan and Tamura, Akiko (1996). 'Japanese and U.S. Exports and Investment as Conduits of Growth', National Bureau of Economic Research, NBER Working Paper Series, Working Paper 5457, Cambridge, MA: USA.

Easterly, William, and Sergio Rebelo (1993). 'Fiscal Policy and Economic Growth: An Empirical Investigation', *Journal of Monetary Economics,* 32(3): 417-58.

Ferrantino, Michael J. 1993. 'The Effect of Intellectual Property Rights on International Trade and Investment', *Weltwirschaftliches Archiv* 129: 300-331.

Ginarte, Juan C and Walter G Park, (1997). 'Determinants of patent rights: A cross-national Study', *Research Policy* 26: 283-301.

Gramlich, E.M. (1994). 'Infrastructure Investment: A Review Essay', *Journal of Economic Literature* 32(3): 1176-96.

Kumar, Nagesh, (1994a). 'Determinants of Export-Orientation of Foreign Production by U.S. Multinationals: An Inter Country Analysis', *Journal of International Business Studies 25*(1): 141-56.

Kumar, Nagesh (1994b). 'Regional Trading Blocs, Industrial Reorganizations and Foreign Direct Investments - The Case of Single European Market', *World Competition 18 (2)*:35-55.

Kumar, Nagesh (1998). 'Multinational Enterprises, Regional Economic Integration, and Export-Platform Production in the Host Countries: An Empirical Analysis for the US and Japanese Corporations', *Weltwirtschaftliches Archiv* 134(3): 450-483.

Kumar, Nagesh (2000a). 'Explaining the Geography and Depth of International Production: The Case of US and Japanese Multinational Enterprises', *Weltwirtschaftliches Archiv* 136(3): 442-476.

Kumar, Nagesh (2000b). ed. *Indian Economy under Reforms: An Assessment of Economic and Social Impact*. New Delhi: Bookwell.

Kumar, Nagesh (2002). *Globalization and the Quality of Foreign Direct Investment,* New Delhi: Oxford University Press, forthcoming.

Loree, David W. and Stephen E. Guisinger (1995). 'Policy and Non-Policy Determinants of U.S. Equity Foreign Direct Investement', *Journal of International Business Studies,* Vol. 26, No. 2, Second Quarter 1995.

Mody, Ashoka and Krishna Srinivasan (1996). 'Japanese and United States Firms as Foreign Investors: Do They March to the same Tune*?'* Washington, DC: World Bank, mimeo.

Moran, Theodore H. (1998). *Foreign Direct Investment and Development: The New Policy Agenda for Developing Countries and Economies in Transition*, Washington DC: Institute for International Economics.

Mytelka, Lynn. (1999). 'Locational Tournaments for FDI: Inward Investment into Europe in a Global World', in Neil Hood and Stephen Young (eds.). *The Globalization of Multinational Enterprise Activity and Economic Development,* UK: St. Martin Press.

Oman, Charles (2000). *Policy Competition for Foreign Direct Investment,* Paris: OECD Development Centre.

Pritchett, Lant (1996). 'Measuring Outward Orientation in LDCs: Can it be done', *Journal of Development Economics* 49: 307-335.

UNCTAD (1995). *World Investment Report: Transnational Corporations and Competitiveness,* New York: United Nations (Sales No.: E.95.II.A.9).

Wheeler, D. and A. Mody (1992). 'International Investment Location Decisions: The Case of U.S. Firms' *Journal of International Economics*(33): 57-76.

World Bank (1994). *World Development Report 1994: Infrastructure for Development,* New York: Oxford University Press.

World Economic Forum (1999) *The Global Competitiveness Report 1999,* New York: Oxford University Press for the WEF, Geneva.

World Economic Forum (2002) *The Global Competitiveness Report 2001-2002,* New York: Oxford University Press for the WEF, Geneva.