Graduate Institute of
International Studies | Geneva
Economics

HEI Working Paper No: 05/2007

Globalization and Country-Specific Service Links

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Abstract

The Jones-Kierzkowski model of global fragmentation of production draws attention to the cost and efficiency of "service links" connecting "production blocks" in different countries. Country-specific service links include transport and telecommunications infrastructure and the overall business climate. Mobile factors of production, most prominently foreign direct investment (FDI), can shop around for countries with the most functional and inexpensive service links along with low labor costs. Those countries with favorable business climates and well-functioning service links are able to attract FDI and other mobile inputs, and participate in international production networks. We provide evidence that successful exporters of manufactures, notably in East Asia, have relatively favorable service links. A cross-section analysis of manufactured exports and of FDI in manufacturing confirms the importance of service link infrastructure.

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January 12, 2007

Presented at the North American Economic and Finance Association meetings, Chicago, January 5-7, 2007.

[1] We thank our discusant Hylke Vandenbussche, and Mark Kuperberg, Stephen O'Connell, Philip Jefferson and Janet Ceglowski for helpful comments. Paul Goldsmith-Pinkham of Swarthmore College provided very able research assistance.

I. Introduction

High growth rates in East Asian countries, most prominently China, and to a lesser extent in some other developing countries such as Chile, Costa Rica, Mauritius, and most recently India, have transformed the way economists and policymakers think about economic development.[2] There can no longer be any doubt that participation in the global economy is a necessary condition for growth and development, and that the globalization of production offers tremendous opportunities for developing countries. At the same time, the development literature has increasingly emphasized the importance of appropriate domestic institutions and policies.[3] Countries with market-friendly policies and strong states are able to harness the possibilities of globalization for economic development. These successful countries, primarily in East Asia, have been able to expand and diversify exports. Other countries with weaker institutions, notably in Africa, have remained marginalized.

Figures 1-3 provide a quick review of the regional disparities in the extent to which developing regions have succeeded in raising exports through diversification into manufacturing. East Asia's share of world trade has boomed while Africa's has diminished, largely reflecting the extent to which these regions have succeeded in diversifying into manufacturing. Even in Africa, the share of manufactures in total exports has increased considerably, although much less so than other regions, especially East Asia. While manufacturing has been the pre-eminent mode of export diversification for developing countries, it is not the only one. Chile, for example, has substantially increased exports of horticultural products, wine, and fish along with manufactures. India's recent growth has been abetted by the well-known boom in exports of services. What these experiences have in common is reliance of access to foreign know-how and/or capital along with enhancement of local knowledge and production capabilities

[2] See Westphal (2002) and Radelet, Sachs and Lee (2001) for detailed analyses of the way in which East Asian countries based their development on integration into the global economy.
[3] See for example, Acemoglu, Johnson and Robinson (2005), Dollar and Kraay (2003), and Hall and Jones (1999).

through exports of products involving increasing levels of knowledge and sophistication.[4] In turn, expanding exports have contributed to growing employment and incomes and reduced poverty.

In this paper we propose to shed light on this phenomenon. Jones (1980, 2000) has drawn attention to the implications of increasing mobility of inputs and factors, in addition to final goods. While some factors are trapped within national boundaries, others are footloose. In such a world, absolute and comparative advantage jointly determine trade patterns and income distribution and the range of policies affecting international trade is much wider than the traditional theory of comparative advantage implies. Mobile factors of production, represented most prominently by foreign direct investment (FDI), can shop around for the most favorable locations. This is particularly relevant for vertical, i.e., export-oriented FDI as opposed to horizontal FDI, intended primarily for the local market. For vertical FDI, i.e. much of FDI in the manufacturing sector, a whole range of policies impinging on the business climate are important for attracting such factors. Those countries with favorable business climates are able to attract FDI and other mobile inputs, and participate in international production networks.

Jones and Kierzkowski (1990, 2001, 2005a, 2005b) and Jones (2000) pointed out that these international production networks involve "fragmentation" of previously unified production structures, whereby the production of goods, and increasingly services, is spread around the world.[5] Typically, the capital- or knowledge-intensive components of production such as design are retained in the developed countries, while the unskilled-labor-intensive or low-technology processes such as assembly are outsourced to developing countries. A recent example involves the *i-Pod* , with development undertaken in the United States, but even at the outset actual production spread among several East Asian countries. Their model emphasizes the crucial importance of the cost of the "service links" connecting "production blocks". Dispersing production across borders requires effective communication and transportation links between countries and the scope of fragmentation depends on these service links. It follows that the quality of a developing country's trade-related infrastructure is

[4] Westphal (2002) provides a detailed examination of how some East Asian countries used globalization to foster development.
[5] See also Arndt and Kierzkowski (2001) and Yi (2003).

particularly important for determining whether or not that country is a candidate for outsourced labor-intensive production processes. The development of service links entails substantial fixed costs, consisting of both "sunk" start-up costs and maintenance costs for infrastructure. The construction of infrastructure and the eradication of red tape and corruption are largely one-time costs. Also, costs of maintaining infrastructure such as harbor facilities and roads are at least partially delinked from the volume of production.

Of course service link infrastructure serves the economy as a whole, and is to some extent a public good.[6] Thus, if a country has lower service link costs for one sector it may well spill over to other sectors – e.g., waiting time to offload at ports or extent of time-consuming government regulations. The possible implication for a country contemplating investments to reduce service-link costs or lower the cost of producing a particular fragment is that the benefits of reducing service-link costs spill over to many other possible fragments, even if the service-link investment is limited in reducing costs of production of specific fragments. On the other hand, some types of service links may be particularly important for particular sectors. For example, for call centers telecommunications are critical, while air transport is crucial for perishable products.[7] Therefore the types of service links that matter for China, which exports manufactured products, may differ from those that currently matter for India, as an exporter of services.

Note that government regulations may as well (sometimes deliberately) raise the costs to consumers of obtaining foreign goods. But if they make participation in global production networks less likely (with other countries competing to supply the fragment in question), the perceived costs to the country may be quite different. In other words, one consequence of increased globalization that results in international outsourcing may be the efficiency gains when countries realize the competitive disadvantages their own regulations represent in becoming part of a globalized network. In short, those countries that provide adequate public services and limit corruption and red tape are more likely to

[6] Effective production of infrastructure may require liberalization and participation of foreign capital, however.

[7] This is not to say that air transport cannot be crucial for high technology products. An example is provided by Dell's use of its own fleet of Boeing 747's to transport goods around the world; one such plane with daily supply of 15,000 computers leaves Malaysia for the United States every evening.

prosper from globalization. In this paper we stress the importance of infrastructure and especially trade-related service links.[8]

Nike is a well-known illustration of these phenomena. Most of Nike's production is in developing countries while the research and design activities remain in the United States. Generally, Nike subcontracts with foreign companies, rather than engaging in FDI. The footloose factor in this case is knowledge rather than capital. At the same time, Nike's production sites are not spread evenly across developing countries. Nike relies on production facilities in over 50 countries, mostly in Latin America and Asia, but has almost no factories in Africa. That is, despite abundant availability of unskilled and under-employed labor, Africa is generally unattractive to foreign investors. The reason seems clear: the business environment remains very hostile in Africa despite attempts at economic reforms and a large pool of under-employed labor in agriculture and the urban informal sector.[9]

The remainder of the paper develops these ideas. Section II presents the framework. Section III provides indicators of service links in various developing countries. Section IV discusses statistical evidence that service links are important determinants of FDI and exports in manufacturing for developing countries. Section V concludes.

II. The Theory of Input Trade and Fragmentation

II.1. Comparative and Absolute Advantage

Consider a modified Ricardian setting as in Jones (1980, 2000) with two goods X and Y whereby the manufactured good X is produced with both labor and a footloose input (say foreign direct investment), while the traditional good Y is produced with labor alone. Labor is trapped within national borders but capital is mobile. Let

c_X^i = average cost for good X in country i,

a_{LX}^i = unit labor requirement for good X in country i,

[8] The effects of infrastructure on international productivity differences and specialization are examined in Yeaple and Golub (2006).
[9] This would suggest that anti-globalization activists who care about poverty reduction should be protesting against Nike for failing to source from Africa!

a^{i}_{KX} = unit capital requirement for good X in country i

w^i = wage in country i

r = global return to the footloose factor

p_X, p_Y = world prices of good X and Y

If both goods are produced,

$$c^i_X = a^i_{LX} \cdot w^i + a^i_{KX} \cdot r = p_X$$

$$c^i_Y = a^i_{LY} \cdot w^i = p_Y$$

Country i has a comparative advantage in good X when

$$\frac{a^i_{LX}}{a^i_{LY}} + a^i_{KX}\frac{r}{p_Y} \prec \frac{a^j_{LX}}{a^j_{LY}} + a^j_{KX}\frac{r}{p_Y}$$

Absolute advantage in attracting the footloose input now matters in addition to comparative advantage (relative unit labor requirements) in determining which country produces X. Thus, policies and institutions that enhance the productivity of the footloose factor in country i relative to country j such that $a^i_{KX} < a^j_{KX}$ will tend to create a comparative advantage in producing X for country i. For example, if manufacturing for export requires an influx of foreign technology or knowledge about global markets which can only be provided through FDI or more informal business networking, only those countries that are attractive to foreign investors will develop manufacturing industries and the benefits that accrue thereof. In particular, the adequacy of local infrastructure is likely to be an important factor in determining inward FDI in manufacturing.

II.2. Fragmentation of Production and Outsourcing

To gain more insight into the outsourcing phenomenon, suppose that production can be fragmented into production blocks dispersed in different countries connected by service links such as transportation and communications infrastructure. It is important to note that what we call "service link activities" by no means comprises all of what are popularly termed "services". Service link activities are those provided by communication, transportation, information gathering, and costs of coordinating production blocks that form part of a related production process that is spread over many regions or countries. Services that connect producers with consumers are not considered as service link activities since they do not connect various production blocks. As well, some services are provided as part of production blocks and should not be considered as service link activities. This important distinction can be illustrated, say, by the use of medical technicians in India that form part of a production procedure whereby a surgical operation takes place in the United States. The "service link" activities involved are not those performed by the technicians, but rather by the communication links between Delhi and New York.

Standard production theory often displays a variety of productive techniques that can be used to produce a given level of output – say in a unit isoquant with constant returns to scale. Implicit in such a representation is the notion that various heterogeneous bundles of, say, capital and labor can be assembled locally to produce output in an integrated production process. The possibility of fragmenting production processes opens up new possibilities suggested by the heterogeneity among different areas in a country or, more importantly, the possibility of spreading the production process over several countries, perhaps involving separate firms or, alternatively, keeping all production under the rubric of a multinational organization. Factors of production tend to be available at different prices in different areas, and also to differ in their productivities. As well, the various fragments or production blocks that are involved in the process tend to differ in the composition of required inputs. As a consequence, marginal costs of producing a given level of final output can be lowered by utilizing a finer division of labor (and other inputs) among a wider range of locales. To accomplish this, however, requires that service links be involved in connecting production blocks, in the form of communication costs, transport costs, insurance costs, obtaining knowledge of production availabilities and legal restrictions in foreign countries, etc. These we label service link costs, and we adopt the extreme assumption that they are independent of the scale of operations but tend to increase the greater the degree of fragmentation.

Heterogeneity is pervasive, and the dependence of particular kinds of service links depends on the type of commodities produced. Some require good air services, others make more use of good ports and require more streamlined customs procedures. Our attempt in this paper is to provide an overall index of the costs of service link activities, with the focus on how it differs from country to country, submerging the fact that the importance of various service links differs from commodity to commodity. Of course countries differ in the costs of production blocks. Figure 4 is intended to illustrate the tradeoff between service link costs and the combined marginal costs of production blocks involved in the production of a particular commodity. Illustrated are several possibilities, assumed to be the best among a large array of possibilities of, say, producing three fragments among contending countries (e.g. line 3). A completely integrated process with constant returns to scale might be shown by ray 1. Lines 2, 3, and 4 show the minimum costs available by outsourcing one, two, or three fragments of the process in a maximal fashion among various contenders. The broken heavy line depicts the minimum cost locus for production, with the choice of the degree of fragmentation depending upon the scale of output. The combination of required service links and production blocks ensures that the entire process reveals increasing returns to scale.

The concept of a world production possibility schedule has been put to good use in neoclassical trade theory. It shows optimal world patterns of production which, in models where production is especially simple (e.g. Ricardian labor-only models), illustrate how more of one commodity can be produced as output of another is reduced. In a world in which production of some commodity is being fragmented (say commodity X in Figure 5), it is necessary to consider harmonized changes in production in more than one country at a time. For illustrative purposes assume that there are three countries – one advanced (call it Home) and two less developed countries that are possible candidates for an internationally fragmented process. Commodity Y can best be produced without any outsourcing in an integrated manner in any of the countries. It is in the production of commodity X that fragmentation is a possibility. If integrated technology must be used, Home would have a comparative advantage in producing X relative to either of the two less developed countries. In Figure 5, the broken straight line ABC represents the world transformation schedule if there is no fragmentation and Home and the first less developed country make up the world.

To introduce the possibility of fragmentation in X production suppose that there are two production blocks that can be separated between countries, with, say, the first foreign candidate having a comparative advantage in producing fragment (a) compared with Home and compared with production block (fragment) (b). However, such fragmentation requires coordinating service-link activities, perhaps some of the costs borne by Home, but assume most by the first candidate.

A natural question arises. Suppose a country needs to develop harbor infrastructure before it can be used to support a production block that will be linked to other blocks abroad. This entails a current *capital expenditure*, perhaps provided by a foreign firm as part of FDI, or perhaps undertaken by government or private home investors. In any case, should these capital costs be considered as part of the cost of the required *service links* necessary to coordinate a local production block with others abroad? This is a "stock vs. flow" question. The service link costs, a flow variable, includes not only each period's maintenance costs, but also the annual repayments necessary to pay for the initial capital costs.

Consider Figure 5. The dashed locus DFE needs some explanation. If both countries produce only commodity Y, point A could once again be obtained. However, suppose that if any X is produced in a fragmented manner, resources must first be released from production of Y (say all in the foreign candidate, reducing total world production of Y by AD). As X-production expands, line DFE reveals the marginal costs (in units of foregone Y) as Home produces fragment (b) and the foreign candidate produces fragment (a). We assume that Home is sufficiently larger than the foreign country so that at point E all of the foreign candidate's labor (not used in providing service links) is committed to producing the X-fragment it is assigned. Further world production of commodity X must then be undertaken in an integrated fashion by Home, with marginal costs matching those shown along solid line AB. Note the distinction between the integrated locus AFBC and the fragmented locus DFE. Along AB only one country (Home) is releasing resources from Y to X, while along DFE marginal costs of producing X are reduced by the outsourcing of fragment (a) to the foreign country so that along this locus both countries are shifting labor out of Y into the X-fragment in which each country has a comparative advantage. World production of Y at point E is lower than at point B since at B all the foreign country's labor force is devoted to Y and at E none is.

Taking into account the production possibilities in this world if fragmentation is an option, the new optimal locus is AFE (extended with slope of AB). X-production lower than shown by point F would involve Home producing X and Y, with integrated production of X, and foreign producing only Y. But if X-production exceeds that shown by point F, techniques are altered so that fragment (a) is produced by the foreign candidate and fragment (b) by Home. This switch lowers the marginal cost of producing X, but is only undertaken if the service-link costs represented by AD can be covered by the lower marginal costs made possible by fragmentation.

Before turning to the different possibilities if the alternative foreign candidate is considered, imagine the consequences if both Home and the first foreign candidate experienced a growth in the labor force of, say, 5% each. The locus ABC would shift radially outwards by 5% (not drawn). However, if the service-link costs represented by distance AD do not change with this increased scale, the new locus of type DFE would intersect the new AB section at the same value for X, *i.e.* the amount shown by F. Given the higher levels of income and assuming homothetic tastes, such growth would make it more likely that fragmentation proves to be the preferred way to produce commodity X.

Now consider an alternative world in which the other foreign candidate and Home represent the two countries. Suppose this second candidate would have to incur even greater service-link costs in order to join in a fragmented technology (these costs shown by distance AD'), but that its comparative cost advantage over Home in producing fragment (a) is even greater than that of the first foreign candidate. The new dashed locus starting at D' would thus be flatter than DF. To keep Figure 5 from getting too cluttered this new locus is not drawn, but it could intersect AB either earlier or later than point F. Thus in comparing these two alternatives the comparison of service-link costs with the ability to lower marginal production costs is required in order to find out in which situation would fragmentation take place at earlier levels of X-production. It would also be possible to consider a more complicated setting in which the world consists of all three countries. Although the diagram is not constructed for this scenario, a question that comes to mind is not only which country would be the first to join in fragmented production with Home, but also what happens if demand for X is sufficiently great that both developing countries supply fragment (a) (still assuming Home is by far the largest of the three countries).

Note that in this multi-country world, developing countries are in competition for attracting footloose capital and production of fragments. China's displacement of other developing countries in labor-intensive manufacturing illustrates developing countries' vulnerability to this sort of competition from other developing countries.

II.3. The "Hinterland" and International Wage Differentials

The importance of a hinterland, i.e. a large pool of non-tradable inputs such as labor, in attracting mobile factors is stressed in Jones (2000). The large supply of labor in the countryside in China is an example. Lewis (1955) famously identified the problem of development as absorbing this large pool of labor into modern industry, thereby raising the marginal product of labor and real incomes. A modern alternative is expansion of export-oriented manufacturing through FDI instead of domestic capital accumulation as envisioned by Lewis. The availability of foreign capital inflows obviates some of Lewis's focus on the adequacy of domestic saving to finance capital accumulation. The size of the hinterland relative to the magnitude of capital inflows is influential in determining the extent to which local wages are driven up.

In addition to requiring favorable service links and business climate, as described above, such a scenario requires a relatively flexible labor market in the developing country such that manufacturing wages are not greatly out of line with the opportunity cost of labor in the rural areas and the informal sector, and labor is mobile between sectors. Unfortunately, many developing countries have retained the rigid labor market regulations of their colonial masters. French West Africa, South Africa, much of Latin America and India suffer from this problem.[10]

III. Service Links in Developing Countries

The next two sections apply the theoretical insights of the framework sketched above to the uneven spread of export diversification around the developing world noted in the introduction. The key insight is that the quality of a country's service links is decisive in determining the extent to which it can succeed in diversifying exports and boosting development through global fragmentation of manufacturing. We first illustrate

[10] See Rama (2000) for example on West African labor market rigidities.

variations in the quality of service links and wage differentials around the developing world, and then use these indicators to explain the pattern of global manufacturing FDI and exports among developing countries.

Service Links. The discussion above suggests that the extent to which a developing country is able to attract footloose factors and participate in the spread of global production through fragmentation depends on whether the lure of low labor or other variable costs more than compensates for the extra costs associated with separate production blocks and operating across borders. Some of these service link costs are country-specific. These country specific service links include both trade facilitation and the overall business climate.

Table 1 presents some service link and business climate indicators for selected developing countries.[11] Although there is some variation within regions, the poor quality of service links in Africa, South Asia and some of Latin America emerge clearly. The table shows the number of days in which there are power outages, the cost of a 3-minute telephone call to the United States, the length of time to obtain telephone service, the number of days to complete formalities and procedures for importing, and Transparency International's Corruption Perception index, which ranges from 0 (completely corrupt) to 10 (no corruption).

A few developed countries (Germany, Ireland and Spain) are shown to benchmark the comparisons. In these latter countries, power outages are minimal, a telephone call to the US costs about 50 cents for 3 minutes, it takes about 10 days for a telephone connection, and import procedures require a few days.

In North and Sub-Saharan Africa, in contrast, power outages are common, the cost of a 3 minute call to the US is often over $3.00, and the time to complete import formalities can be 1-2 months or more. South Africa and especially Mauritius are exceptions to this dismal situation in Africa. It is no coincidence that these two countries are among the few successful exporters of manufactures on the continent.

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[11] Choice of countries in Tables 1 and 2 is based on data availability and regional representation. See Appendix 1 for discussion of data sources and methods.

In South Asia, India and Pakistan also display unfavorable service links, as do Ecuador and Guatemala in Latin America. In contrast, Chile, the most successful exporter in South America, has a transparency index comparable to that of the developed countries, few power outages, and relatively rapid times to obtain telephone connections and complete import procedures.

In East Asia, Korea's service links are evidently as efficient as those in developed countries, with no power outages at all and very short times to import. Its corruption rating is not as good as Chile's, however. Other East Asian countries, including China, also compare very favorably to other developing countries with regard to the functioning of infrastructure and trade facilitation measures.

Many East European countries have favorable service links. For example, the quality of service links in the Czech Republic and the Baltics (represented here by Estonia) are comparable to those in most East Asian countries. Russia has somewhat less well-functioning institutions than the Baltics, but still much better than developing countries in Africa and South Asia.

Labor Costs. International disparities in labor costs are of course a key determinant of outsourcing. Table 2 shows 2004 hourly labor costs in the textile industry in selected developing countries, in U.S dollars and as a ratio of hourly GDP per person of working age.[12] The latter provides a rough indicator of whether manufacturing wages are overvalued relative to economy-wide productivity. As noted earlier, some developed as well as developing countries impose stringent restrictions on the labor market, resulting in dual labor markets with relatively highly paid protected workers and low-paid workers in the unregulated sectors (agriculture and the informal sector). Note for example, that Germany's textile wages are much higher than those of the U.S., such that US wages over GDP per working-age person are well below 1 but Germany's are well above 1, reflecting the well-known greater labor market rigidities in Europe. For developing countries, there are also clear regional patterns along with some intra-regional variation in wages adjusted by GDP per worker. Sub-Saharan African countries have

[12] The labor costs include fringe benefits and were obtained from a textile consulting firm's recent survey of labor costs around the world.

generally low wages in nominal terms but high in terms of per capita GDP, except for Mauritius, the most successful exporter of textiles in Africa. East Asian wages, on the other hand, are generally very low both in nominal terms and relative to GDP per working age person. In South Asia, India's high wages relative to GDP are consistent with India's failure to develop a strong manufacturing sector. India's other strengths – notably a highly educated English-speaking middle class--are apparently sufficiently strong to enable service sector off-shoring, however. Other South Asia countries have much lower labor costs relative to GDP. Central and South American countries, with the exception of Nicaragua, also have low labor costs relative to GDP, as do most Eastern European countries.

Tables 1 and 2 together present a stark contrast between Africa and East Asia, both with regard to service link costs and labor costs, providing certainly an indication of why Africa has been largely unable to diversify into manufacturing.

IV. Effects of Service Links and Labor Costs on Manufacturing FDI and Exports

We now investigate whether service links and labor costs affect globalization of manufacturing. As noted earlier, manufacturing is not the only mode of export diversification, but it has been the most prominent. We run cross-section regressions with data from 2004 or the nearest available year. It was not possible to construct a time series of the service-link index variables, as many of the key components of the index have only become available in the last few years. The sample consists of about 50 developing countries in Africa, Asia, Latin America and Europe, with data availability being the main criterion for inclusion.

Dependent variables. Several alternative dependent variables were used: manufactured exports, exports and imports of parts and components, and FDI in manufacturing, all scaled by working-age population. We also considered more disaggregated export and FDI variables.

Trade in Parts and Components.[13] The theory suggests that developing countries with better service links should be more involved in fragmentation and therefore have

[13] We are grateful to Lurong Chen of the Graduate Institute of International Studies for making available to us the data on trade in parts and components.

higher levels of both exports and imports of parts. Imports of parts are relevant because developing countries often have a comparative advantage in final assembly, which tends to be labor-intensive. Developing countries engaging in assembly will import larger volumes of parts and components.

Exports of Manufactures. The importance of assembly of final goods in developing country manufacturing exports also suggests that total exports of manufactures are a relevant dependent variable to consider. Exports of final manufactured goods from developing countries usually include inputs of parts or even just research and design from the developed countries. Nike shoes and apparel in general are the canonical example. Developing countries export the final good but firms in the United States or other developed countries provide key knowledge inputs. Thus exports of final goods reflect fragmentation and are rather typical of such North-South trade. In addition to total manufactured exports we considered a few sectors where developing countries are known to be involved as export platforms: exports of textiles, clothing, and machinery and equipment (the latter includes electronics). Manufactured export data were obtained from the WTO website.

FDI. Employing a little-used dataset from UNCTAD that disaggregates inward FDI by sector, we also investigate the determinants of inward FDI stocks in manufacturing. The theory of footloose factors is much more relevant to FDI in manufacturing than for other sectors, given that global outsourcing of manufacturing is likely to be far more responsive to country-specific service links and labor costs than other types of FDI. FDI in primary products such as petroleum is obviously determined primarily by natural resource abundance rather than the business climate, as evidenced for example by the willingness of oil companies to operate in rather hostile environments when oil is available. The applicability of the theory to the service sector is more ambiguous. Most service sector FDI, such as in transport, telecommunications, and finance, is horizontal rather than vertical; i.e., it is intended to serve the local market rather than as an export platform.[1415] Horizontal FDI is affected more by market size

[14] The distinction between horizontal and vertical FDI is a central feature of modern theories of FDI such as the knowledge-capital model (Markusen and Maskus 2001).

rather than comparative advantage and the business climate. Manufacturing FDI, on the other hand, is more likely to be vertical, i.e., export oriented, and foreign investors will shop around for the most favorable locations.[16]

The UNCTAD sectoral FDI data are only available for a limited number of developing countries and years. Nevertheless, the UNCTAD database provides a potentially valuable source of information on FDI for the purposes of this paper.

We used the stock of inward FDI in manufacturing in 2004 or the latest year available as the dependent variable. We also disaggregate further and examine FDI in the textile-apparel and machinery sectors.

Independent variables. Our key independent variable is an index of service link quality and costs. Service links were proxied by the synthetic measure of infrastructure consisting of transport, communications, and electric power reliability and costs, including those shown in Table 1, using data from around 2004. Appendix 1 provides a more complete description of the service link variable. Several control variables were also used, notably per capita GDP from World Development Indicators and average years of education from the Barro-Lee dataset. As a measure of the overall business climate we used the Heritage Foundation's Economic Freedom Index (EFI). The EFI is based on 10 sub-indicators such as openness to trade and FDI, property rights, regulation, taxation, etc, so as such is a good composite control for most other variables that are candidates for explaining exports and FDI. We also employed the ratio of the textile wage to GDP per working person shown in Table 2, as an indicator of unit labor costs.

While it is true that the explanatory variables cannot be considered endogenous, there seems to be little risk of simultaneity problems given that our dependent variables are manufactured exports and FDI in manufacturing. There is little plausible reverse causation from manufactured exports and FDI on the quality and cost of service links. While FDI in services is likely to entail improvements in service links, FDI in manufacturing is much less likely to be a cause of service link quality.

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[15] A further issue of reverse causation applies to service-sector FDI. High FDI inflows in producer services such as transport and telecommunications are likely to lead to service-link improvements. Reverse causation seems much less likely for the manufacturing FDI and exports.

[16] Of course, not all manufacturing FDI is vertical and some service-sector FDI is vertical. Manufacturing FDI in bottling plants, for example, is intended for the local market, while call centers are a well-known form of export-oriented FDI in services. Nevertheless it seems likely that manufacturing FDI is overall more export-oriented and footloose than FDI in services.

Results. Results are shown in Table 3 for the baseline regressions. All variables were logged. The results were highly supportive of the theory in the sense that the service link variable was always correctly signed and statistically significant for all the main manufacturing dependent variables, regardless of which combination of control variables are used. In most cases, however, the EFI and wage variables were correctly signed but not statistically significant when the variables shown in Table 3 were employed, and are not reported in the table. Per capita GDP was almost always correctly-signed and significant for all dependent variables. Education (years) was generally correctly-signed but often not significant, but is shown because of the attention this variable receives in the development literature. The wage variable was correctly-signed and statistically significant only in the total manufacturing regression. However, when used as the only variable, the wage variable was always correctly signed and statistically significant. Perhaps the limited number of observations for the wage variable, along with multicollinearity, explains the relatively unsuccessful results for wages in the multiple regressions.

Scatterplots of the alternative dependent variables against our service link index all reveal a very clear correlation, with the strongest for total manufactured exports, providing a visual basis for the econometric results, as shown in Figures 6-9.

Very similar results are obtained when textile exports and machinery exports are used instead of total manufactured exports.[17] Surprisingly, using apparel exports as the dependent variable was somewhat less successful, with the infrastructure index not always statistically significant when more controls are added. On the other hand, wages appear more important for clothing than for other industries. Perhaps the Multi-Fiber Agreement (MFA) system of quotas, which was still in effect in 2004, partially accounts for the less successful results for clothing exports. On the other hand, textile and clothing FDI was much better explained by the service link index than machinery and equipment FDI.

Interestingly, the service link index is highly successful for manufacturing FDI but fails completely to explain FDI in primary products. In the case of services, the

[17] Industry-level results are not reported to save space but are available upon request.

results are more mixed: without controls, the service link index variable has a statistically-significant positive effect on service-sector FDI, but when controls are added, it becomes insignificant. These results are consistent with the discussion above of the predicted effect of service links on the sectoral composition of FDI.

Similar results obtained when the dependent variable was scaled by GDP rather than population as far as the service link variable remaining a statistically significant explanatory variable for all the dependent variables.

The econometric results must be considered suggestive rather than conclusive given that the independent variables are not truly exogenous and there is substantial multicollinearity among them. Nevertheless, it is striking that service links are very important for explaining manufactured exports and FDI even after per capita income has been controlled for, and appear to matter more than educational attainment.

V. Conclusion

This paper re-examines issues of export-led growth using theories of global fragmentation of production. This approach stresses the importance of the institutional environment and especially the availability and cost of trade-related infrastructure, i.e., country-specific service links, in determining whether production is fragmented according to comparative advantage. We provide evidence that successful exporters of manufactures, notably in East Asia, have favorable service links. Cross-section analysis of both exports of manufactures and of FDI in manufacturing confirms the importance of service links for the outsourcing of manufacturing production to developing countries. Service links appear to be much more important than education in explaining whether a developing country participates in the global manufacturing process.

Given the demonstrated importance of trade-related infrastructure, an important political-economy question for future research is to explain why some countries invest in service-link infrastructure whereas others do not.

Appendix 1: Data Sources and Methods

Service links Index Construction

We measure the quality of a country's service links through a synthetic measure of infrastructure. This index was constructed using twelve different data variables used to compute three sub-indices for telecommunication, transport and electricity. Within these three sub-indices, telecommunications and transport received 40 percent weight and electricity 20 percent. The lower weight on electricity reflects 1) the fact that electricity is less closely related to the concept of a service link connecting countries—but still very important— than the other two components, and 2) the quality and availability of data on electricity was not as satisfactory as for the other two.

In the case of a country with missing data, the weight was divided equally among the country's available data. Once the sub-indices were calculated, they were each given equal weight of one-third and used to calculate the overall index. All variables were scaled by setting Germany as the benchmark.[18]

The construction of the service link index is shown in Table A-1.

Telecommunications. Telecommunication infrastructure was based on four variables: main-line subscribers per capita, cell-phone subscribers per capita, average cost of a call to the United States, and average delay in getting a phone line connected. In this category, the number of mainline and cell-phone subscribers were used to represent the scope of the telecommunication service links, and the cost and delay variables were used to represent the quality. Excluding connection delay, the data sets for the variables were fairly complete. Telephone subscribers per capita, average cost of a call to the United States, telephone mainlines per capita are obtained from World Bank World Development Indicators (WDI) online and average delay in getting a phone line connected is from the World Bank Enterprise Surveys Indicators (ESI).

Transportation. The transportation service link measure uses percentage of roads paved, railway track per square kilometer, average time to import, and registered number of air transports per capita. The railway track and air transport variables attempt to represent the quantity of service links in the country, while the paved roads variable

[18] Germany was chosen due to the completeness of data regarding Germany's infrastructure, as well as the high-level of infrastructure that Germany is assumed to have as a major developed country. (Some variables were missing for the United States).

quantifies the quality of road transport. Finally, the import time variable measures the effectiveness and quality of the country's ports and customs. Given the importance of import time in measuring service link costs, it was fortunate that the data were available for almost all countries. The percentage of roads paved, railway track per square kilometer, and registered number of air transports per capita are from WDI. Average time to import is from the World Bank Doing Business Indicators (DBI) and includes the total time it takes to comply with all import procedures including permits, port delays, customs clearance etc.

Electric Power. Although electricity is not directly connected to trade in the way the previous two components are, provision of electric power is central to coordination of production and communications. Inadequate supply of electricity severely disrupts global links as well as production. Electricity service links were measured using four variables: delay in obtaining an electrical connection, number of days with power outages, electric transmission loss, and electrical production per capita. Time to obtain electric service and power outage information are taken from ESI and the transmission efficiency and electricity production data are from WDI. Electric production measures the quantity of electric infrastructure in place, while the remaining three variables measure the quality of electricity infrastructure. While data were incomplete for electrical outages and delays, the data for transmission loss and electrical production were available for all countries.

The composite service link index is shown in Table A-2.

Foreign Direct Investment and Exports

The sectoral FDI data were obtained as an extraction from UNCTAD's STATFDI database. Both stock and flow data by country and industry are available. We used stock data in 2004 or the latest year available.

The total export data by industry were obtained from the World Trade Organization web page,
http://stat.wto.org/StatisticalProgram/WSDBStatProgramHome.aspx?Language=E
Exports and imports of parts and components were provided by Francis Ng.

Table 1
International Comparison of Service Links: Selected Indicators and Countries, 2005

	Electrical outages (days per year)	Telephone Cost to US ($ per 3 Minutes)	Telephone Connection Delay (days)	Total Time to import (days)	Transparency Index (0-10 scale)
Developed					
Germany	0.2	0.37	6.5	6	8.2
Ireland	1.7	0.64	15.2	15	7.4
Spain	1.0	0.65	10.4	10	7.0
North Africa					
Algeria	12.4	3.26	174.3	51	2.8
Egypt	13.9	2.45	89.8	29	3.4
Morocco	5.8	1.66	3.9	33	3.2
Sub-Saharan Africa					
Ethiopia	29.5	7.18	130.8	57	2.2
Kenya	83.6	4.86	80.6	62	2.1
Mauritius	6.0	2.69	16.6	16	4.2
Senegal	26.1	1.56	10.8	26	3.2
South Africa	5.5	1.28	6.6	34	4.5
Tanzania	60.6	6.59	18.3	51	2.9
Uganda	70.8	3.57	25.4	73	2.5
East Asia					
China	4.3	3.65	6.0	24	3.2
Indonesia	3.5	3.45	19.2	30	2.2
Korea	0.0	1.37	3.4	12	5.0
Philippines	4.7	1.37	9.1	22	2.5
Thailand	1.1	1.49	15.5	25	3.8
South Asia					
India	24.4	2.67	63.3	43	2.9
Pakistan	11.5	2.45	22.3	39	2.1
Latin America					
Brazil	3.5	0.83	12.6	43	3.7
Chile	2.9	2.32	7.2	24	7.3
Ecuador	9.5	2.11	92.7	42	2.5
El Salvador	7.9	2.40	6.2	54	4.2
Guatemala	9.5	1.21	34.3	36	2.5
Peru	6.1	1.92	8.1	31	3.5
East and Central Europe					
Czech Rep.	0.2	0.92	4.3	22	4.3
Estonia	1.2	0.97	3.8	14	6.4
Hungary	1.6	1.21	8.3	24	5.0
Poland	0.7	2.07	12.7	26	3.4
Romania	3.0	1.68	14.4	28	3.0
Russia	2.7	2.07	16.5	35	2.4
Slovenia	0.9	0.62	10.1	24	6.1

Sources: World Bank World Developed Indictors, World Bank Investment Climate Surveys, International Finance Corporation Doing Business Indicators, Transparency International.

Table 2

Labor Costs in the Textile Industry, Selected Developing Countries, 2004

		Hourly Labor Cost in the Textile Industry, US Dollars, 2004*	Hourly Textile Labor Cost as a Ratio of GDP Per Worker, 2004**
Developed Countries			
	United States	15.78	0.57
	Germany	27.69	1.57
North Africa			
	Egypt	0.82	0.62
	Tunisia	2.05	1.18
	Morocco	2.56	2.42
Sub-Saharan Africa			
	Mauritius	1.57	0.50
	South Africa	3.80	1.45
	Ethiopia	0.25	2.32
	Senegal	1.27	2.83
	Kenya	0.67	3.37
	Zambia	3.24	9.83
East Asia			
	Malaysia	1.18	0.35
	China	0.62	0.66
	Viet Nam	0.28	0.72
	Thailand	1.29	0.76
	Korea	7.10	0.80
	Indonesia	0.55	0.80
	Cambodia	0.28	0.97
South Asia			
	Sri Lanka	0.46	0.65
	Pakistan	0.37	0.75
	Bangladesh	0.28	0.84
	India	0.67	1.55
Latin America			
	Chile	1.54	0.38
	Mexico	2.19	0.46
	Costa Rica	2.11	0.64
	El Salvador	1.12	0.65
	Venezuela	2.85	0.79
	Honduras	0.77	0.90
	Dominican Republic	1.96	1.00
	Brazil	2.83	1.05
	Peru	1.93	1.09
	Colombia	1.97	1.20
	Nicaragua	1.87	2.62
Eastern Europe			
	Estonia	3.00	0.77
	Czech Republic	3.94	0.91
	Slovakia	3.40	1.07
	Poland	3.80	1.09

*Includes wages and fringe benefits. Other sources used for Ethiopia, Senegal and Zambia.
**First column divided by GDP per person of working age and multiplied by 2000.
Source: Werner International and World Development Indicators

Table 3
Regression Results, Alternative Dependent Variables

	Total Manufactured Exports		Exports of Parts and Components		Imports of Parts and Components		FDI Stock in Manufacturing	
Service Link Index	1.49	(4.2)***	1.53	(2.3)**	0.88	(2.4)**	0.91	(1.8)**
GDP Per Capita	0.62	(2.2)**	0.64	(1.3)*	0.53	(1.9)**	0.69	(2.0)**
Education	0.34	(0.7)	1.76	(1.8)**	0.75	(1.4)*	0.44	(0.8)
Observations	41		40		40		25	
Adjsted R-squared	0.79		0.60		0.65		0.71	
Service Link Index	1.62	(5.3)***	1.78	(2.9)***	0.88	(2.7)***	1.00	(2.6)***
GDP Per Capita	0.62	(3.2)***	0.94	(2.2)**	0.75	(3.3)***	0.64	(2.8)***
Observations	47		44		44		30	
Adjsted R-squared	0.80		0.57		0.65		0.69	

t stats in parentheses
(***) = 99% Significance
(**) = 95% Significance
(*) = 90% Significance

Table A-1
Construction of the Service Link Index

Transportation (weight = 0.4)
Time to import
Percentage of paved roads
Railway track per capita
Airline flights per capita

Telecommunications (weight = 0.4)
Main lines per capita
Mobiles per capita
Cost of a telephone call to USA
Delay in phone line connection

Electricity (weight = 0.2)
Delay in obtaining an electrical connection
Number of days with power outages
Electric transmission loss
Electrical production per capita

Table A-2 The Composite Service Link Index (Germany = 100)

East Asia	
Viet Nam	19.7
Indonesia	21.8
Philippines	25.3
Thailand	29.8
Cambodia	30.2
China	35.7
Malaysia	48.4

South Asia	
Bangladesh	9.1
India	15.2
Pakistan	16.7
Sri Lanka	22.5

Africa	
Kenya	7.0
Ethiopia	7.5
Tanzania	8.4
Uganda	9.1
Ghana	12.5
Senegal	18.8
South Africa	35.7
Mauritius	58.3

North Africa and Middle East	
Egypt	12.9
Tunisia	25.5
Saudi Arabia	34.6
Morocco	36.1

Americas	
Honduras	8.9
Ecuador	13.9
Bolivia	15.4
Colombia	22.0
Mexico	25.9
Brazil	27.1
Argentina	28.5
El Salvador	29.3
Venezuela	29.3
Costa Rica	32.9
Chile	38.3
Dominican Republic	43.4

Developing Europe	
Russia	26.9
Turkey	34.2
Poland	42.8
Lithuania	42.9
Latvia	47.1
Hungary	51.9
Estonia	60.3
Slovakia	64.7
Slovenia	67.1
Czech Republic	82.0

Figure 1

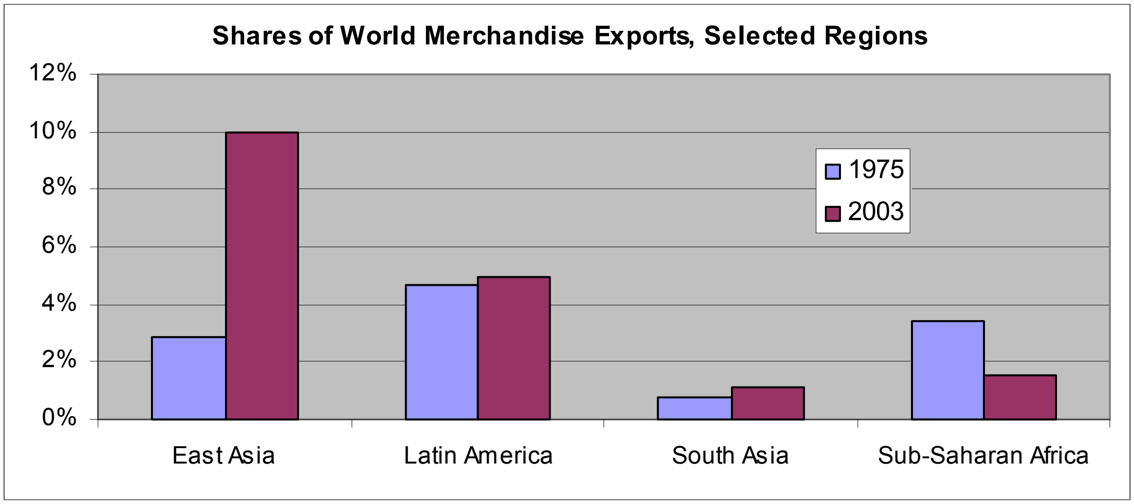


Figure 2

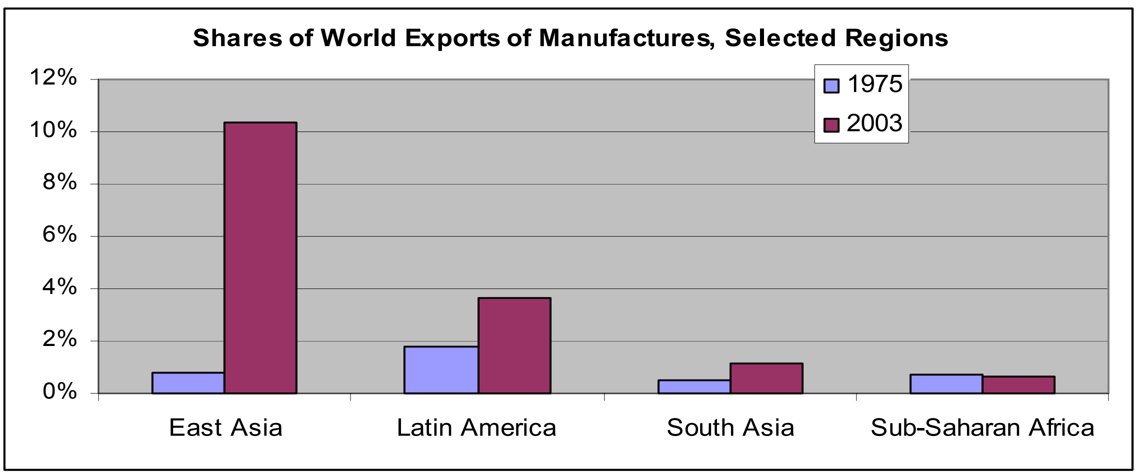


Figure 3

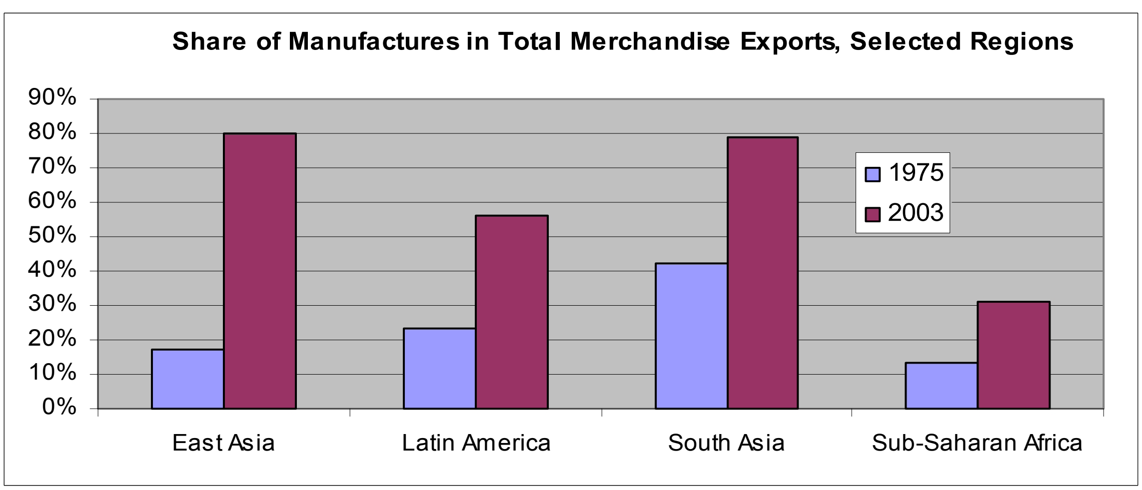


Figure 4. Costs and Fragmented Production

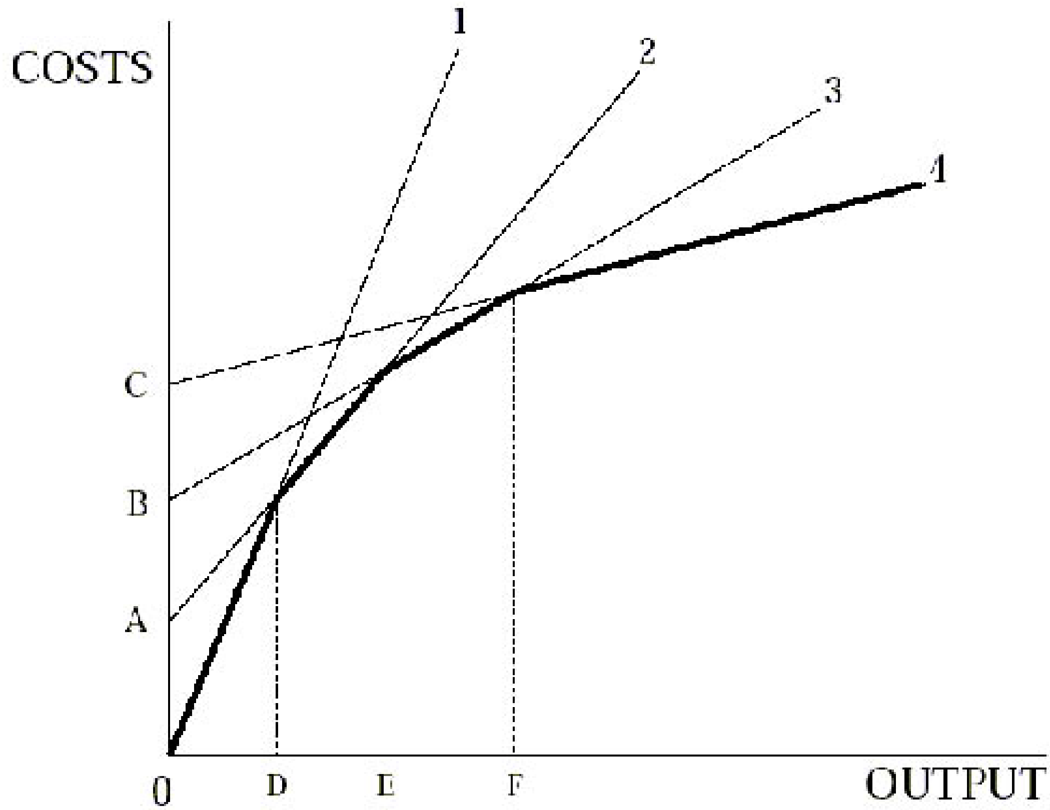


Figure 5: World Production Possibilities

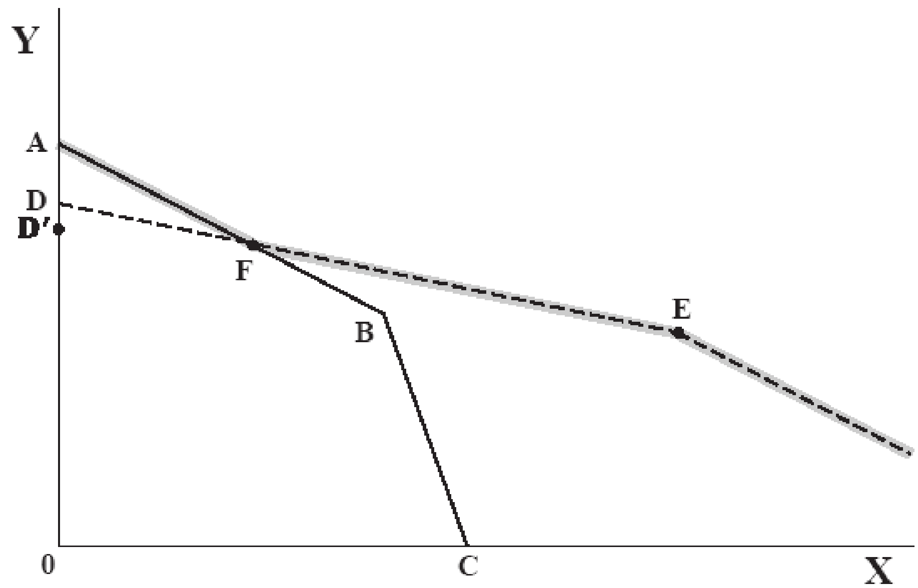
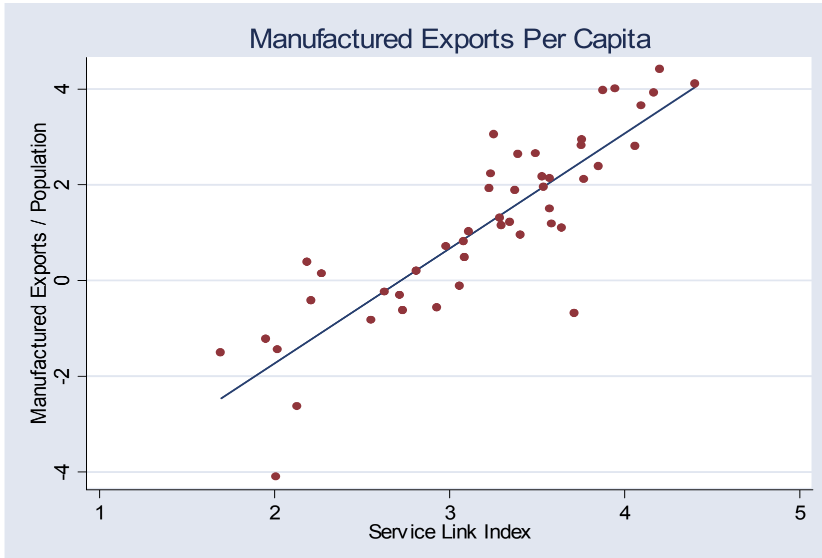


Figure 6



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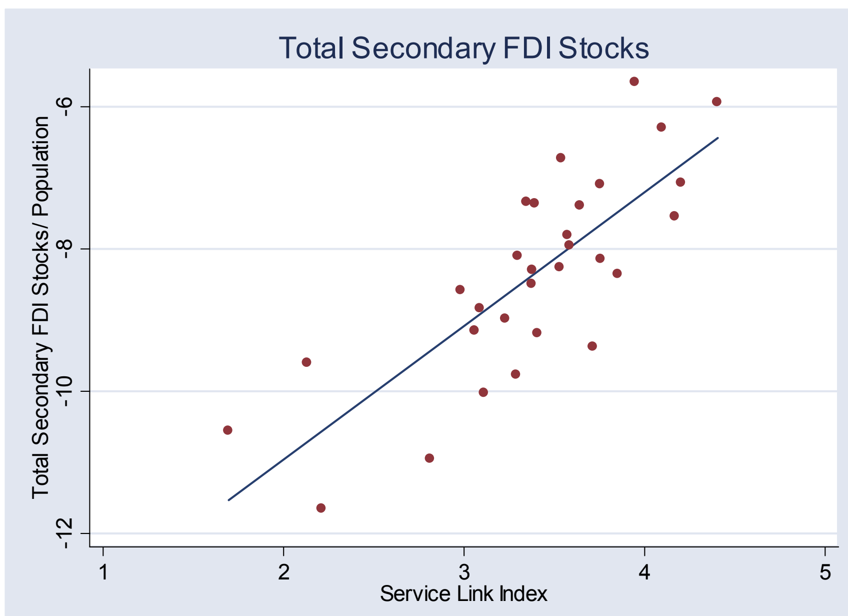

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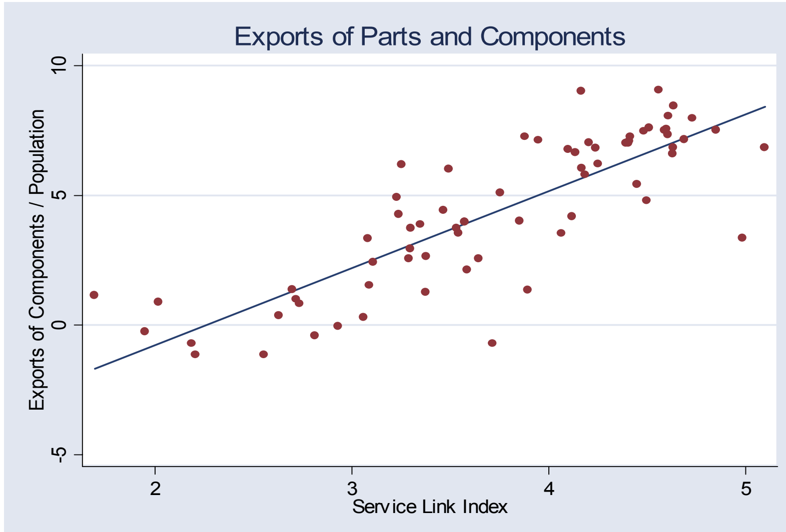

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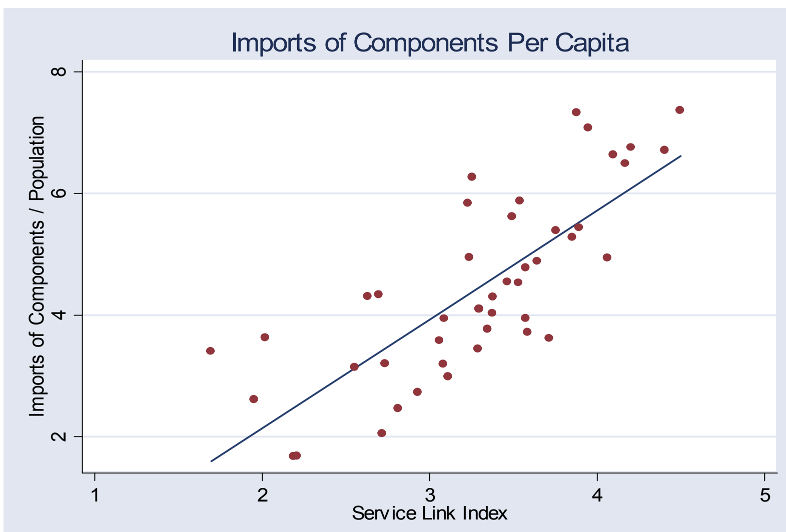

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