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Can the Neoclassical Model Explain the Distribution of Foreign Direct Investment Across Developing Countries?

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Abstract

Since the beginning of the 1990s, foreign direct investment (FDI) in developing countries has increased dramatically. The distribution of FDI flows across these countries, however, is highly uneven; only a small number attract comparatively large amounts of foreign capital. This paper investigates whether the pattern of FDI flows can be explained by the standard neoclassical model or by modified versions of this model that allow for differences in production technologies across countries. The results suggest that the standard neoclassical approach is not particularly useful if we want to understand FDI flows to developing countries.

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Contents Page

SUMMARY

Since the beginning of the 1990s, direct foreign investment (FDI) flows to developing countries have increased dramatically, and they now constitute the largest share in the net resource flows to these countries. Although FDI flows have increased in relative and absolute terms, they have gone to a relatively small group of countries. Low-income countries have, on average, been less successful in attracting FDI than middle-income countries, but as the distribution of FDI flows is highly uneven for both these country groups, average group performance is easily overestimated. After exploring the distribution of FDI flows across developing countries, this paper investigates whether this distribution can be explained by the standard neoclassical model or by modified versions of this model that allow for different technologies across countries. In the strictest version of the neoclassical model, with only capital and labor as inputs and identical technologies across countries, the poorest countries should attract most foreign capital, provided capital is sufficiently mobile across all countries. Apart from the strictest version of the neoclassical model, the paper also tests alternative versions of this model that have country-specific technologies. Under these alternative specifications, the poorest countries do not necessarily attract the most foreign capital, since their production technologies may be less capital-intensive, or their total factor productivity may be lower, than that of richer countries. Although the modified versions of the neoclassical model are somewhat better in explaining the distribution of FDI flows across developing countries than the strictest version, none of the specifications pass a significance test. The paper, therefore, concludes that for understanding the distribution of FDI flows across developing countries, the standard neoclassical model, either with or without exogenous differences in technologies across countries, is not very helpful.

I. Introduction

Capital flows to developing countries have increased substantially since the late 1980s, and as a result net resource flows to these countries have risen above their previous record high, recorded just before the start of the debt crisis in 1981. In 1994, net resource flows to developing countries were about US$207 billion, of which US$89 billion went to low-income countries and US$118 billion to middle-income countries.[2] As a percentage of GNP, net resource flows have returned to about the same level as before the 1980s debt crisis. As Table 1 shows, in 1980 net resource flows to developing countries were 4.1 percent of their total GNP. The level subsequently fell to 2.9 percent in 1985 and 2.7 percent in 1990, after which it climbed back to just above 4 percent in 1993–94. Table 1 also shows that, especially for low-income countries, foreign capital has gained importance, unlike in the 1970s when net resource flows to low-income countries, in percent of GNP, were about half of what middle-income countries received. Another difference between the two surges in net resource flows is that in the 1990s foreign direct investment (FDI) is the largest component, while in the second half of the 1970s and the beginning of the 1980s private loans were the main component of net resource flows. Furthermore, during the first half of the 1990s FDI flows to low-income countries rose by a factor of seven, while FDI flows to middle-income countries 'only' doubled (World Bank, 1996).[3]

Table 1. Net Resource Flows to Developing Countries, 1970–94
(As a percentage of GNP)

	Developing Countries	Low-Income Countries	Middle-Income Countries
1970	2.4	1.4	3.3
1980	4.1	2.7	4.9
1985	2.9	2.8	2.6
1990	2.7	4.4	1.8
1991	2.8	4.7	2.3
1992	3.3	5.5	2.7
1993	4.3	7.4	3.5
1994	4.1	7.8	3.0

Source: World Bank, *World Debt Tables* (1992 and 1996)

Figure 1 gives the composition of capital flows to developing countries. The

[2]The classification of middle-income countries and low-income countries is based on the classification given on page 14 of the *World Debt Tables*, Vol. 1 (World Bank, 1992). Whenever I refer to "low-income" or "middle-income" countries, I am referring to groups of countries, and, hence, what holds for a group does not necessarily hold for each of its members.

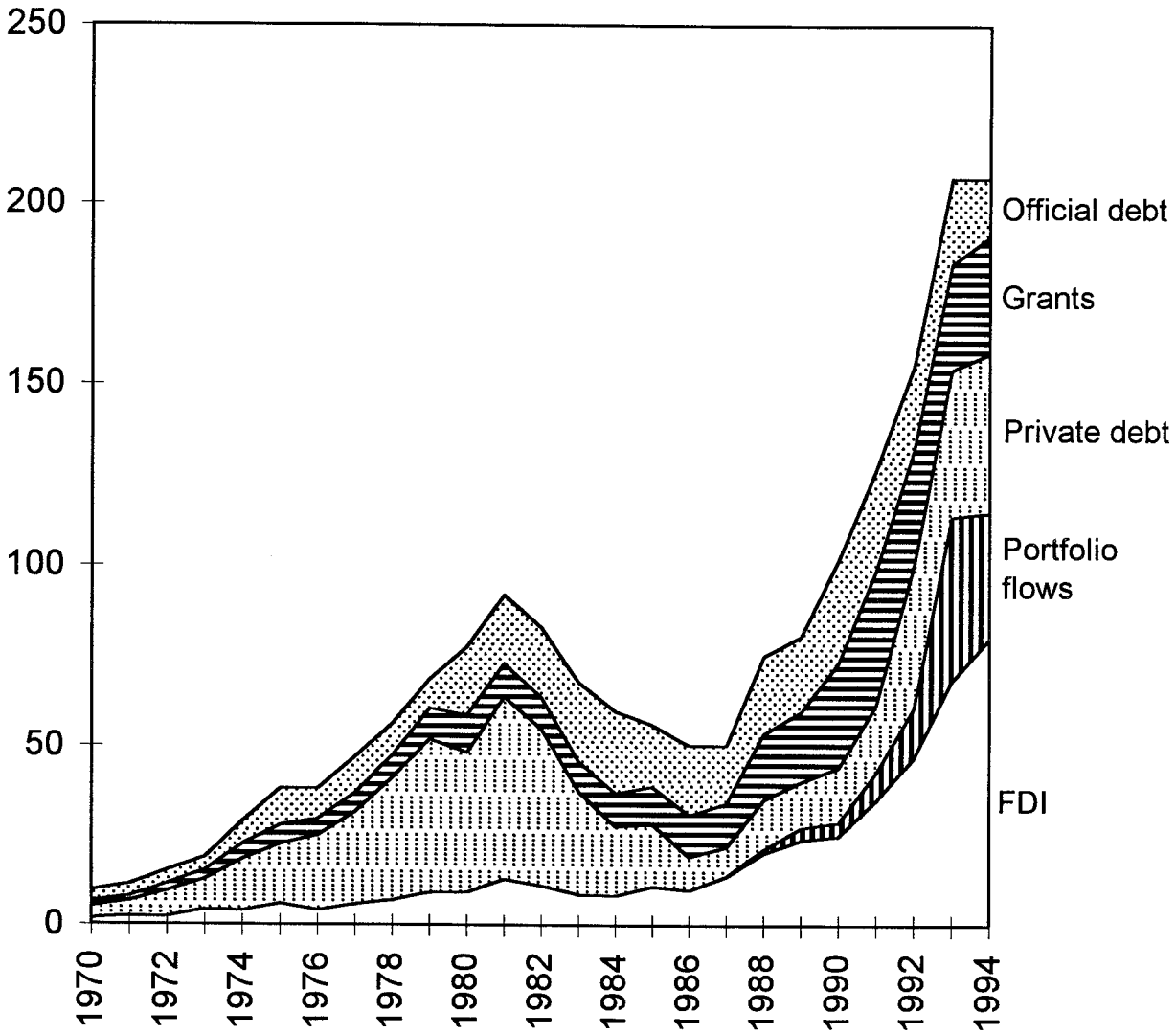
[3]The figures for the group of low-income countries are somewhat inflated in recent years because of the rise in investment flows to China.

rise in foreign capital flows to these countries is to a large extent accounted for by the increase in FDI, which has been the largest item in net resource flows to developing countries since 1992. From 1970 to 1994, FDI flows to developing countries rose in current U.S. dollars from US$2.27 billion to US$80.1 billion, which is a compounded annual growth rate of some 6.5 percent; total net resource flows to developing countries grew by about 5.5 percent per year over the same period. Important recipients of FDI in recent years were Mexico, Malaysia, Indonesia, China, Thailand, and the Philippines. In 1994 the first three countries accounted for almost 60 percent of total FDI flows to developing countries, excluding the economies in transition. The four East Asian countries (excluding China) together have accounted for approximately 50 percent of FDI flows to developing countries since 1990 (Jaspersen, Aylward, and Sumlinski, 1995).

It is encouraging to see that many developing countries have regained access to foreign capital after the sharp decline in capital flows resulting from the debt crisis in the 1980s, and, especially, that FDI has become a main component of their net resource flows. Unlike other types of capital flows, FDI can introduce new foreign technologies into the host economy, and its economic importance may therefore be larger than what is measured by the transfer of financial resources. Empirical support for this hypothesis is, for example, provided by Borensztein, De Gregorio, and Lee (1995), who confirm that FDI is an important vehicle for the transfer of technology. It would, therefore, be interesting to see which developing countries are receiving most of the FDI. Furthermore, as FDI comes closest to the definition of foreign capital in the standard neoclassical model, as presented by, among others, MacDougall (1960), it would be interesting to find out whether this model can explain the pattern of FDI flows to developing countries. Lucas (1990) already raised the question, Why isn't capital flowing from rich to poor countries?, arguing in the case of India, that the small amount of capital flows to this country cannot be explained by a standard neoclassical model with only capital and labor as inputs. The focus of this paper, however, is not so much on the *volume* of FDI flows from industrial to developing countries as on the *distribution* of these flows across the latter.

Section II of this paper looks at the distribution of FDI flows to developing countries. Section III investigates whether the observed distribution can be explained by the standard neoclassical model or by extended versions of this model in which production technologies differ across countries. For this purpose, production functions are estimated that satisfy the neoclassical properties of constant returns to scale and diminishing marginal returns to capital and labor. On the basis of the estimated production functions, marginal rates of return to capital are calculated, which are subsequently compared with the pattern of FDI flows to developing countries. The results are summarized in Section IV.

Figure 1. Composition of Net Resource Flows to Developing Countries, 1970–94
(In billions of U.S. dollars at current market prices)



II. The distribution of FDI flows

In the introduction it was established that FDI flows to developing countries have increased considerably since 1970 and, especially, since the beginning of the 1990s. Table 2 gives the shares of FDI flows to and from low- and middle-income countries in total FDI flows.[4] Although FDI flows to and from developing countries have continuously increased in absolute value over the years, the share of these countries in world FDI flows decreased in relative terms until the end of the 1980s but rose sharply thereafter. What will not be surprising is that developing countries have a larger share in world inward FDI flows than in world outward FDI flows. High-income economies have most of the time accounted for some 95 percent or more of total outward FDI.

Figure 2 shows the shares of low- and middle-income countries in total inward FDI flows over the years 1971–94. While total inward FDI flows dropped in the early 1990s, FDI flows to developing countries have increased dramatically since then, with low-income countries' share increasing the fastest. As Figure 2 shows, in 1994 both groups of countries had almost the same share in total inward FDI flows—18.5 percent for low-income countries, and 19.2 percent for middle-income countries.

What Figure 2 does not tell is whether the increasingly larger amount of FDI that is flowing to developing countries is the result of their growing importance in the world economy in terms of GNP, or of other factors that have made developing countries more attractive to foreign investors. Figure 3 shows that for middle-income countries the ratio of FDI to GNP has increased slightly since 1986. The relative increase in FDI flows to middle-income countries is, thus, less pronounced than the increase in the absolute size of these flows. The rising amount of FDI flows to this group of countries has been partly matched by the increase in their GNP. The group of low-income countries, however, has experienced a significant rise in the FDI-GNP ratio. The increase in the early 1990s was largely accounted for by China. China's FDI-GNP ratio was about 6 percent in 1994, and, because of the country's size, these 6 percent had a strong upward effect on the weighted average of the FDI-GNP ratio for low-income countries. If China is excluded from the group of low-income countries, the average FDI-GNP ratio in 1994 was about 1 percent, which corresponds with the average for middle-income countries in that year.

It is also interesting to look at the distribution of FDI-GNP ratios among individual countries in each of the two income groups. Of the 82 developing

[4]The differences between totals for inward and outward FDI flows are most likely the result of underreporting of inward FDI flows and differences in the definition of FDI among countries. See, for example, Luttik (1992), de Jong and others (1993), and IMF (1987 and 1992).

Table 2. Share of Developing Countries in Total Inward and Outward FDI Flows, 1975–94

	1975–79	1980–84	1985–89	1990–94
	(In billions of U.S. dollars)			
Inward FDI flows	137.7	263.5	596.8	927.3
High-income countries	105.7	213.1	519.2	673.3
Developing countries	32.0	50.4	77.6	254.0
Low-income countries	6.9	8.5	25.8	98.3
Middle-income countries	25.1	41.8	51.8	155.7
	(In percent of total)			
Developing countries	23.3	19.1	13.0	27.4
Low-income countries	5.0	3.2	4.3	10.6
Middle-income countries	18.3	15.9	8.7	16.8
	(In billions of U.S. dollars)			
Outward FDI flows	161.6	177.2	676.6	1,032.7
High-income countries	160.2	172.4	652.8	977.5
Developing countries	1.4	4.9	23.8	55.2
	(In percent of total)			
Developing countries	0.8	2.7	3.6	5.3

Sources: IMF, Balance of Payments Statistics; and
World Bank, *World Debt Tables* (1992 and 1996).

Figure 2. Share of Developing Countries in Total Inward FDI Flows, 1971–94
(In percent of total)

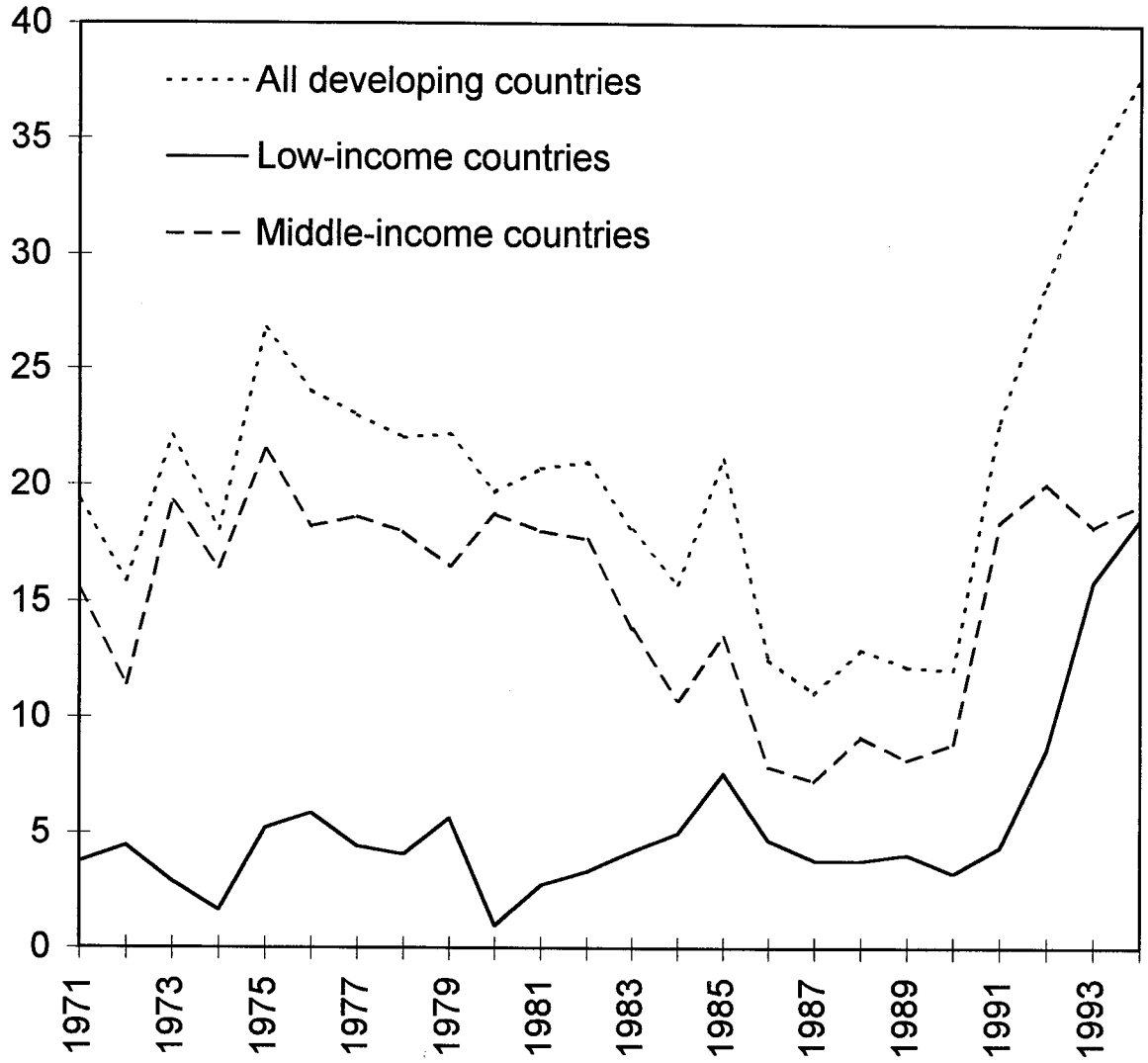


Figure 3. FDI Flows to Developing Countries, 1970–94
(As a percent of GNP)

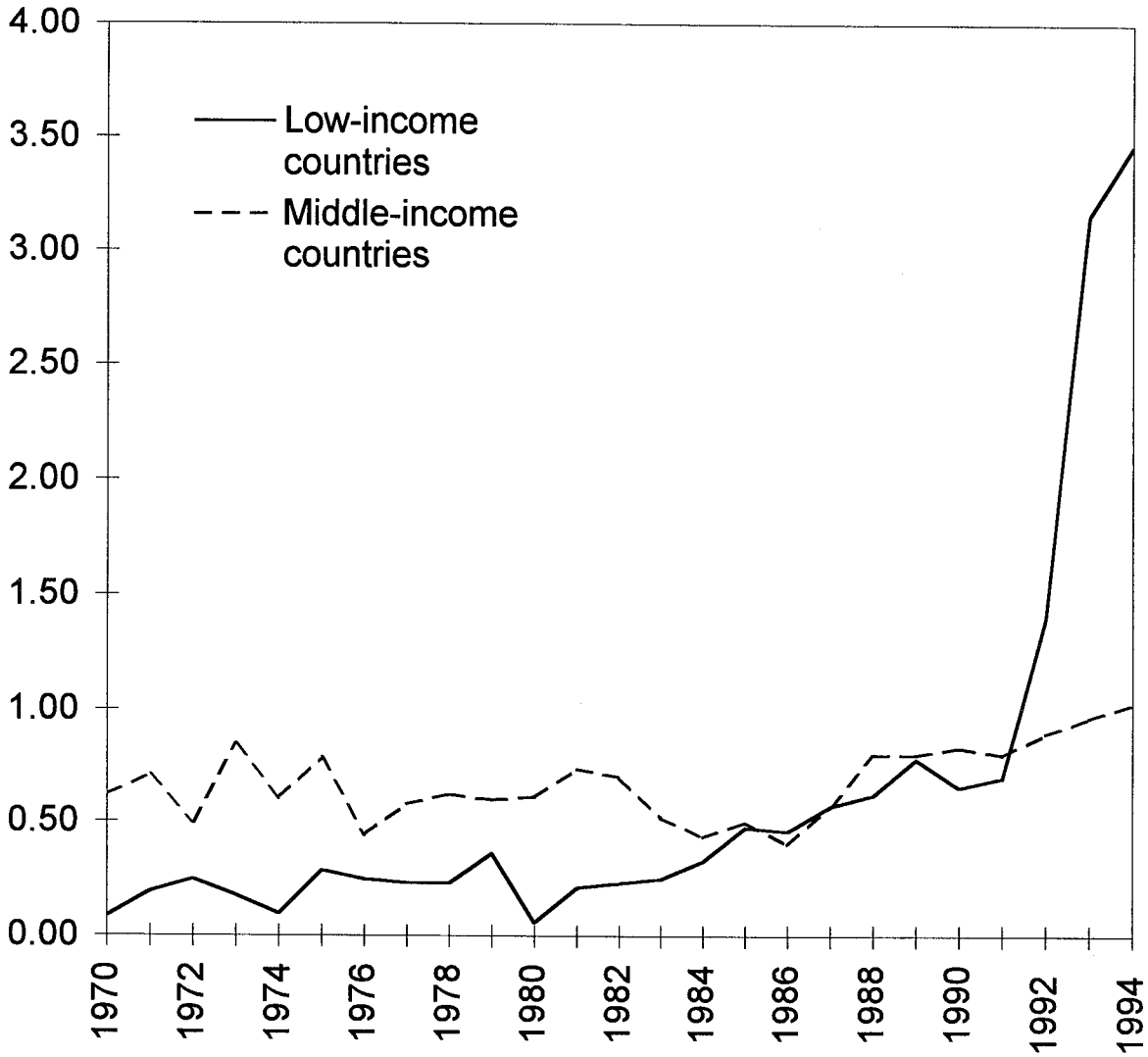


Figure 4. Distribution of FDI-GNP Ratios for Low-Income Countries, 1974–94
(Five-year moving averages; in percent)

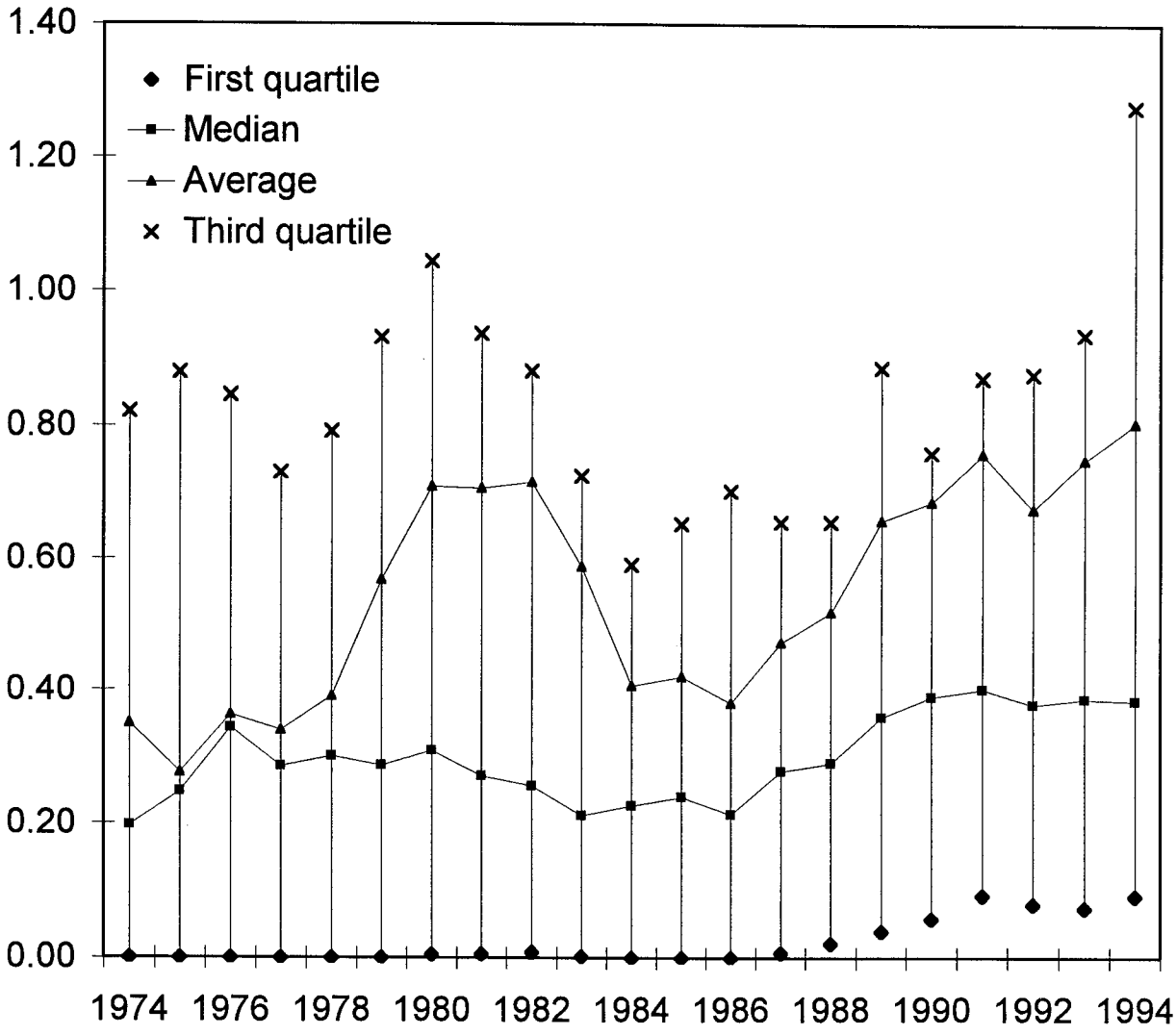
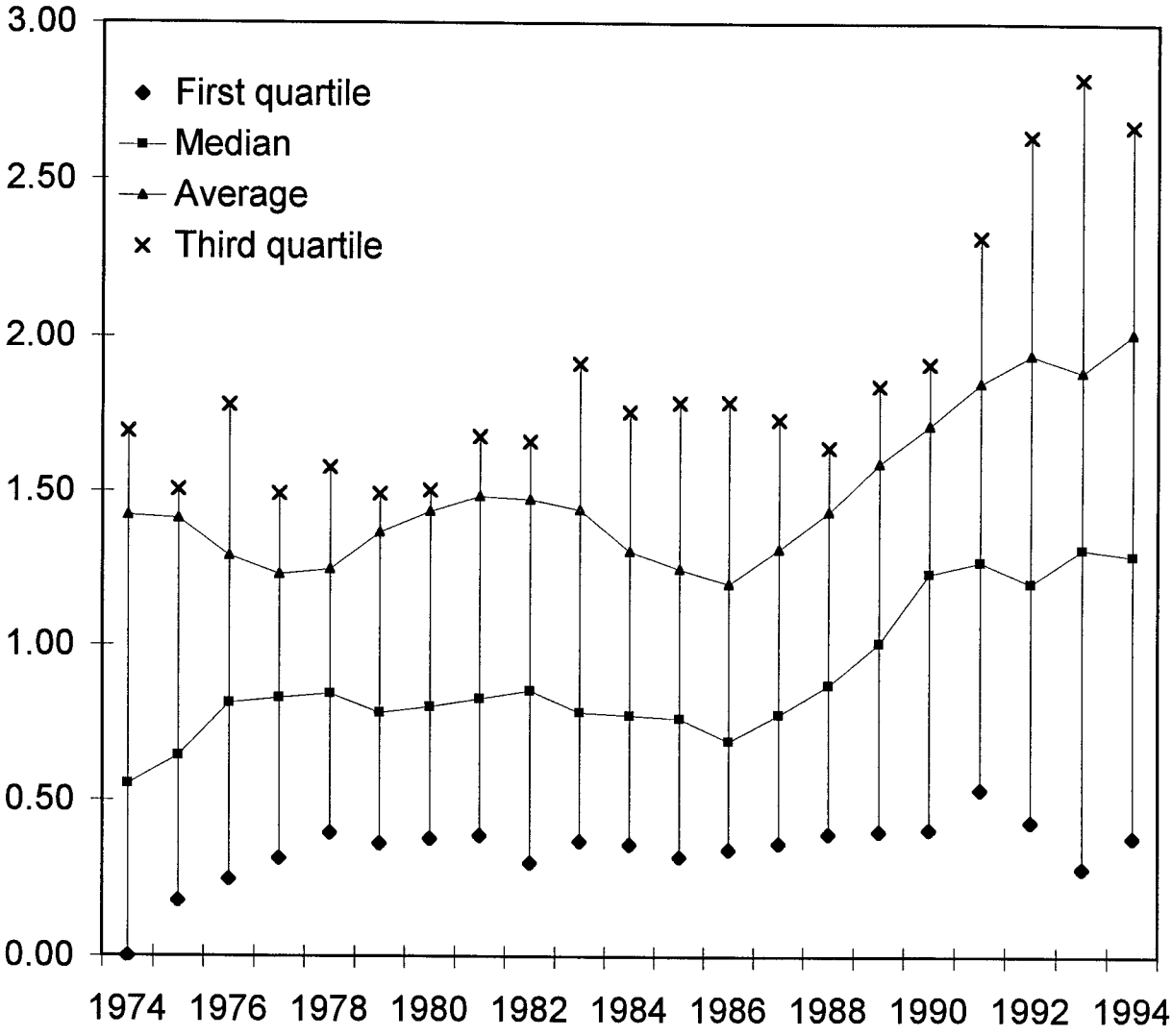


Figure 5. Distribution of FDI-GNP Ratios for Middle-Income Countries, 1974–94
(Five-year moving averages; in percent)



countries in the sample, 36 are low-income countries and 46 are middle-income countries (See Appendix Table 8). The distribution of five-year moving averages of the FDI-GNP ratios of the low-income countries is shown in Figure 4. For instance, 1974 gives the average FDI-GNP ratio over 1970–74. For each five-year period, Figure 4 indicates the median, the average (arithmetic mean), and the upper bounds of the first and third quartile of the distribution. Hence, the vertical lines that connect the upper bounds of the first and third quartiles constitute an interval that covers 50 percent of the observations. The smaller the interval, the closer these 50 percent of the observations lie around the median. That the distribution of the FDI-GNP ratio is skewed is immediately clear when the median is compared with the average of the distribution. In all periods, the average of the distribution is larger than the median, implying that a relatively small group of low-income countries is receiving large amounts of FDI compared with their GNP, whereas a larger group of low-income countries is receiving comparatively small amounts of FDI. Especially in periods in which capital flows to developing countries increase—such as at the end of the 1970s and beginning of the 1990s—the distribution becomes more skewed. What is striking is that until 1988 the countries in the bottom 25 percent of the distribution received zero or less FDI.[5] In periods when the low-income group increased its share in inward FDI flows, therefore, only a few of its members succeeded in attracting the additional FDI.

The picture for the group of middle-income countries is somewhat different, but there are also resemblances with that for the low-income countries. As can be seen in Figure 5, the distribution is also skewed, but not all middle-income countries in the first quartile are deprived of FDI. Again, the arithmetic mean of the distribution is above the median, but the distance between the two fluctuates less than for the low-income countries. The distribution becomes less dense around the median at the beginning of the 1990s. What seems to hold for low-income countries—a relatively small number of countries receives comparatively large amounts of FDI—also holds for the group of middle-income countries; however, for the group of low-income countries, the distribution becomes more uneven in some periods than for the group of middle-income countries. An important difference between the two groups is that the median for middle-income countries is always larger than the median for low-income countries. Hence, middle-income countries are, in general, more successful in attracting FDI than low-income countries. This conclusion contrasts with the earlier observation that the low-income countries have become especially successful in attracting FDI since the beginning of the 1990s. This will be elaborated upon below.

Resuming, the distributions of the FDI-GNP ratios show that the "average" middle-income country is more successful in attracting FDI than the "average"

[5]A negative inflow of FDI means a net reduction in an investment position.

low-income country: arithmetic means and medians are always highest for middle-income countries. The distribution of the FDI-GNP ratios is skewed for both country groups, and average group performance may be overestimated, as in both income groups a comparatively small number of countries receives relatively large amounts of FDI.

III. FDI AND THE MARGINAL PRODUCT OF CAPITAL IN DEVELOPING COUNTRIES

If the neoclassical model is taken literally, with only capital and labor as inputs and identical technologies across countries, the poorest countries should have the highest rates of return to capital and, consequently, attract the most foreign capital. Regarding the discussion in the preceding section, it is at least doubtful that this model can explain the observed distribution of FDI flows to developing countries because, if it were correct, low-income countries should have had the highest FDI-GNP ratios. The strictest version of the neoclassical model may not be able to explain the observed pattern of FDI-GNP ratios, but a modification that allows for different technologies across countries might perform better.

In this section, production functions are estimated that satisfy the neoclassical properties of constant returns to scale and diminishing marginal returns to labor and capital. Subsequently, the marginal products of capital that follow from these production functions are calculated. The obtained results are used to investigate how much of the distribution of FDI flows across developing countries can be explained by the marginal product of capital. Several specifications of the production technology are tested. For the first specification, the strictest version of the neoclassical model, it is assumed that all countries in the world use the same production technology. For the second one, it is assumed that technologies differ between countries in the intercept of the production, that is there can be differences in total factor productivity (TFP) across countries. Finally, for the third specification, it is assumed that technologies between countries can differ in the slope of the production function, that is there is no restriction on differences in the intensity with which the factors of production are used.

The basic equation that is estimated is the log-linear Cobb-Douglas production function:

$$\ln(q_t) = A + \alpha \ln(k_t) + \varepsilon_t, \tag{1}$$

where q_t is real GDP per worker, k_t the capital stock per worker, and ε_t the error term, all in period t. The intercept A represents TFP, and α is the capital share parameter; a higher α implies that the production technology is more intensive in

capital and less intensive in labor. In the first specification of the production function, A and α are assumed to be identical across all countries, developing and industrial. In the second specification, A is unrestricted, while α is assumed to be identical for all countries. In the third specification, A is assumed to be identical across all countries, while α is allowed to be different across countries.

The production function in (1) is a monotone transformation of $f(k) = \exp(A)k^{\alpha}$. The marginal product of capital is then given by

$$\frac{\partial f(k)}{\partial k} = \alpha \exp(A)k^{\alpha-1}. \tag{2}$$

The value of the marginal product of capital can be calculated by substituting into (2) the value of the observed capital stock per worker and the parameter values that are estimated with (1). It follows from equation (2) that, under identical technologies across countries, that is uniform A and α, countries with comparatively low ratios of capital per worker have high marginal products of capital and low per capita incomes. These countries should then attract the most capital from abroad, according to the neoclassical hypothesis. When technologies differ and countries with comparatively low ratios of capital per worker also tend to have low TFPs, the high marginal products of capital that follow from capital scarcity are at least partially offset by the low TFPs. If there is, indeed, a positive relationship between the size of the capital stock and TFP, this may give an indication of why low-income countries, on average, receive less FDI than middle-income countries, as was found in Section II. This reasoning would also support the proposition that human capital, infrastructure, and political stability matter for FDI, as the estimate of A captures the effects of these factors on the productivity of capital and labor.

A lower α also reduces the marginal product of capital for a given capital-labor ratio. It implies that the production process is less capital intensive. If firms can choose from technologies with different α's, they may choose a technology with a low α when capital is comparatively scarce and a technology with a higher α when capital is more abundant. This would suggest that, in poor, capital-scarce developing countries, production technologies are more intensive in labor and, therefore, have a lower α than technologies in more capital-abundant countries. If α would increase with a country's capital stock, reflecting adjustments in the appropriate technology, it would be another alternative explanation of the relatively small FDI flows to low-income countries.

A. The Data

The data that have been used to estimate the production functions are from the Penn World Tables Mark 5.6 (PWT56), which are an updated version of the

data set developed and discussed by Summers and Heston (1991). The advantage of this data set is that variables can be compared across countries and over time, which is convenient for pooled estimations, as the ones presented below. The variables *KAPW* and *RGDPW* in PWT56 give, respectively, the capital stock per worker—k in equation (1)—and real GDP per worker—q in equation (1)—in constant international dollars. Summers and Heston (1991) construct the variable *KAPW*, which runs from 1965 to 1990, by using a perpetual inventory method. According to this method, capital stock per worker is estimated as the cumulated, depreciated sum of past gross domestic investment in producers' durables, nonresidential construction and other construction. Although this data set contains time-series for 150 countries, *KAPW* is, unfortunately, available only for a limited number of countries. For the countries with asterisks in Appendix Table 8 both *KAPW* and FDI data are available, and they constitute the sample that has been used to estimate the production functions. For some countries for which *KAPW* data are available in PWT56 (Poland, Yugoslavia, Syria, and Iran), there are no or only limited data on inward FDI flows; these countries were, therefore, not included in the sample. The final sample then consists of 10 low-income countries, 25 middle-income countries and 22 industrial countries. For these countries *KAPW* is available from 1965 to 1990. There are 12 missing observations: Swaziland (4), Nepal (5) and Botswana (3). Hence, the total number of observations is 1,470 (47 countries times 26 observations per country, minus 12 missing observations).

B. Estimation Results

Several production functions have been estimated under different assumptions of technology. The results are presented in Table 3. The results in column (1) were obtained by estimating

$$\hat{q}_{i,t} = A + \alpha \hat{k}_{i,t} + \varepsilon_{i,t}, \tag{3}$$

where a $\hat{}$ indicates the logarithm of a variable, the index i refers to countries, and the index t refers to periods. This is a pooled regression, and it does not allow for country-specific effects; therefore, A and α are identical for all countries. Two other specifications of the technology have been tested that allow for different technologies across countries. Columns (2a) and (2b) are based on a specification that allows for different intercepts. The basic equation for this specification is

$$\hat{q}_{i,t} = A_i + \alpha \hat{k}_{i,t} + \varepsilon_{i,t}. \tag{4}$$

The results in columns (3a) and (3b) are based on a specification of the technology that allows for different slopes; the basic equation is

$$\hat{q}_{i,t} = A + \alpha_i \hat{k}_{i,t} + \varepsilon_{i,t}. \tag{5}$$

Columns (2a) and (3a) give the estimation results for the basic equations (4) and (5), in which countries are assumed to have the same technology for all periods. This assumption may be too restrictive, however, for production technologies change when economies mature. The specifications in columns (2b) and (3b) allow for this change in technology and assume that countries with a low capital-labor ratio will use a different technology than countries with a higher capita-labor ratio. To test this hypothesis, the sample has been divided into three sets on the basis of the size of the capital-labor ratios. Each set contains one-third of the observations, with the lowest capital-labor ratios in the set Ω_{33}, the highest ratios in Ω_{100}, and the intermediate ones in Ω_{66}. DUM^{33} and DUM^{66} are intercept dummies; for example, $DUM^{33}_{i,t} = 1$ when $k_{i,t} \in \Omega_{33}$ and zero otherwise. κ^{33} and κ^{66} are slope dummies with, for instance, $\kappa^{66} = \hat{k}_{i,t}$ when $k_{i,t} \in \Omega_{66}$ and zero otherwise. The parameter estimates on DUM^{33} and DUM^{66} must be interpreted as corrections on the estimated values of the intercepts A_i, whereas estimates on κ_{33} and κ_{66} should be interpreted as corrections on the slope parameters α_i. All equations have been estimated using ordinary least squares (OLS) and the standard errors are calculated from a heteroscedasticity-consistent covariance matrix.[6]

Column (1) of Table 3 shows that, under the assumption that all countries in the sample use the same technology, the TFP parameter, A, is estimated to be equal to 3.881, while the slope parameter, α, is estimated to be equal to 0.594. The latter is somewhat higher than what it is usually thought to be. Generally accepted values of the capital share parameter, with capital narrowly defined to include only physical capital, lie in the range of 0.3 to 0.5.[7]

Under the specifications in columns (2a) and (2b) each country has a unique intercept that captures country-specific effects, such as the stock of human capital, infrastructure, and government policies. The estimate on the capital share parameter now lies in the appropriate range. The results in column (2b) show that countries with relatively low capital-labor ratios use the least capital-intensive technologies, whereas the most capital-intensive techniques are used by countries with intermediate capital-labor ratios. Given the strong correlation between per capita output and the capital-labor ratio, these results imply that the middle-income countries are using the most capital-intensive techniques and the low-income countries the least capital-intensive techniques. This is a correction in the technology that raises the marginal products of capital in middle-income countries compared with those in low-income countries, and it could explain the relatively large flow of FDI to middle-income countries. The effects of the intercept dummies in column (2b), however, seem to work in the other direction: TFP is

[6]See White (1980).

[7]See, for instance, Table 10.8 of Barro and Sala-i-Martin (1995) and the references from which the figures in that table were taken.

Table 3. Estimation Results: Production Functions under Different Technology Specifications

(Pooled data; 1,470 observations; Dependent variable = $\hat{q}$)

Variable	1	2a	2b	3a	3b
A	3.881			4.831	4.968
	(0.096)			(0.095)	(0.163)
$\hat{k}$	0.594	0.496	0.497		
	(0.010)	(0.010)	(0.015)		
DUM^{33}			0.341		0.196
			(0.210)		(0.211)
DUM^{66}			−0.929		−1.217
			(0.230)		(0.238)
κ^{33}			−0.056		−0.044
			(0.023)		(0.023)
κ^{66}			0.098		0.129
			(0.024)		(0.024)
R^2	0.81	0.99	0.99	0.99	0.99

Notes: All estimations are OLS. $\hat{q}$ is real GDP per worker (log). $\hat{k}$ is capital stock per worker (log). See text for the definition of dummy variables, DUM^{33}, DUM^{66}, κ^{33}, and κ^{66}. Standard errors are in parentheses. The reported standard errors are based on a heteroscedasticity-consistent covariance matrix. Under the specifications in columns (2a) and (2b) there is no common intercept; each country has a unique intercept. Under the specifications in columns (3a) and (3b) there is no common slope parameter; each country has a unique slope parameter. The estimates of the individual intercepts and slope parameters are given in Appendix Tables 6 and 7.

higher in countries with the lowest capital/labor ratios and lower in countries with intermediate capital/labor ratios. As will be shown below, the net effect of these corrections is a reduction in the difference between the average marginal products of low-income and middle-income countries.

Columns (3a) and (3b) present the estimation results under the assumption that technologies across countries differ in the slope parameter of the production function. Under this specification, there is no common slope; each country has a unique capital-share parameter. The corrections from the dummies point in the same direction as does the specification with unique intercepts (columns (2a) and (2b)); however, DUM^{33} is now not significant.

The estimation results have been used to calculate the marginal products of capital for each of the 35 developing countries in the sample. Five sets of marginal products have been calculated under different assumptions regarding the production technology. Table 4 reports the average FDI-GNP ratios over 1970–94 and the average marginal products of capital over 1965–90 for each specification. The averages are lagged, to allow for a slow response of FDI flows to high marginal products of capital.

Table 4. Marginal Products of Capital 1/

	FDI 2/	1	2a	2b	3a	3b
	(1970–94 averages)	(1965–90 averages)				
Low-income countries	0.67	1.9004	1.8676	1.6851	1.8953	1.7074
Excluding Sierra Leone	0.66	1.6946	1.0892	0.9923	0.9230	0.8368
Middle-income countries	1.05	1.0064	0.9793	0.9654	0.9976	1.0072
Excluding Paraguay	1.06	0.9534	0.8077	0.8154	0.7887	0.8189
High-income countries	...	0.4879	0.4923	0.5206	0.5142	0.5370

1/ Column numbers refer to the specifications in Table 3.
2/ In percent of GNP.

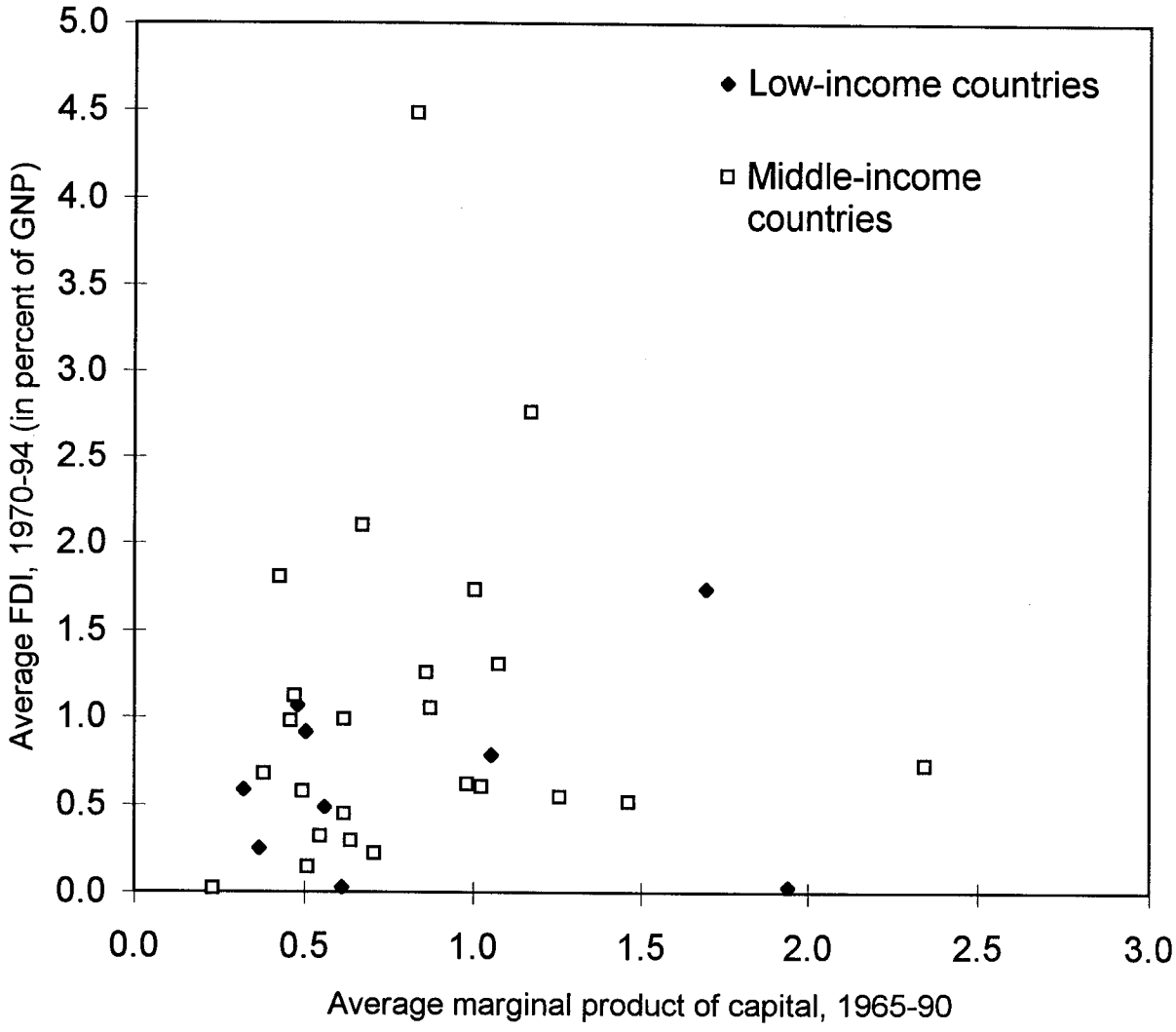
It is striking to see that, once differences in technologies across countries are allowed, the difference between the average marginal products of middle- and low-income countries is smaller than in the specification with an identical technology for all countries (column (1) of Table 4). Under all four specifications, the marginal product of capital is higher in low-income countries than in middle-income countries, implying that the latter should, on average, receive less FDI. However, each income group has a country that generates large outliers in the marginal products of capital (Sierra Leone for the low-income countries, and Paraguay for the middle-income

countries), and excluding these countries leads to average marginal products of capital that are much closer to each other. Hence, allowing for different technologies seems to improve the explanatory power of the marginal products, although not sufficiently. When the outliers Sierra Leone and Paraguay are excluded, the specification in column (3b) comes closest to explaining why the average middle-income country receives more FDI than the average low-income country. Under this specification each country has its own capital share parameter, and, in addition, technologies change as countries become less capital scarse. Figure 6 is a scatter diagram for the technology specification in column (3b), from which the observations on Sierra Leone and Paraguay have been excluded. A Spearman rank test on the observations in this diagram yields a value of 0.199, which is insignificant at the 10 percent level. Hence, countries with the highest average marginal product of capital do not seem to have the highest average FDI-GNP ratio.

Of course, information is lost when taking averages over the entire sample period, and perhaps more can be learned when averages are taken over shorter periods. Hence, the next step will be to investigate whether the distribution of five-year moving averages of the FDI-GNP ratios can be explained by the marginal products of capital that were calculated for the five sets of specifications. One approach would be to regress the marginal products on the five-year moving averages of the FDI-GNP ratios, but then a relationship between the two variables (linear or nonlinear) would be assumed. Instead, a somewhat more flexible non-parametric approach is followed here, which tests whether the relationship between the FDI-GNP ratios and the marginal products of capital can be described by an increasing function. The proper test for this relationship is a Spearman rank test, with which it is possible to test whether a high FDI-GNP ratio corresponds with a high marginal product of capital.

Table 5 lists the Spearman rank tests for annual marginal products of capital and the five-year moving averages of the FDI-GNP ratios. The null hypothesis is that of no positive relation between the FDI-GNP ratio and the marginal product of capital. As the results show, regardless of the assumed specification of the technology, for most years the null hypothesis cannot be rejected. The specifications that allow for different technologies across countries give the most significant results, but only for 7 out of the 21 time periods at the 10 percent significance level. These results certainly do not support the strictest version of the neoclassical model, with identical technologies across countries; however, even when different technologies are allowed across countries, the results do not seem to support a positive relationship between FDI and the marginal product of capital.

Figure 6. Marginal Product of Capital and FDI 1/



1/ Excluding Sierra Leone and Paraguay.

Table 5. Spearman Rank Test on Positive Relationship Between Marginal Product of Capital and FDI-GNP Ratio, 1970–94 1/

	N 2/	1	2a	2b	3a	3b
			(Spearman rank coefficients)			
1970–74	35	0.253*	0.242*	0.236*	0.192	0.242*
1971–75	35	0.109	0.225*	0.267*	0.221	0.304**
1972–76	35	0.147	0.073	0.080	0.046	0.084
1973–77	35	0.092	0.045	0.046	0.032	0.043
1974–78	35	0.171	0.146	0.089	0.126	0.094
1975–79	35	0.018	0.155	0.163	0.186	0.199
1976–80	35	0.470**	0.499**	0.387**	0.450**	0.311**
1977–81	35	0.214	0.374**	0.255*	0.337**	0.223*
1978–82	35	0.205	0.414**	0.336**	0.422**	0.327**
1979–83	35	−0.111	0.026	−0.021	0.039	0.031
1980–84	35	−0.079	0.081	0.050	0.063	0.034
1981–85	35	−0.278	0.022	0.049	0.119	0.140
1982–86	35	−0.144	−0.022	−0.016	0.006	0.015
1983–87	35	−0.274	−0.192	−0.193	−0.184	−0.198
1984–88	35	−0.166	0.000	0.007	0.026	0.043
1985–89	35	−0.404	−0.172	−0.063	−0.130	−0.042
1986–90	33	−0.300	−0.075	−0.013	−0.068	0.005
1987–91	32	−0.006	0.212	0.218	0.216	0.228
1988–92	32	−0.266	−0.004	0.012	0.051	0.029
1989–93	34	−0.131	0.196	0.263*	0.292**	0.314**
1990–94	32	−0.045	0.243*	0.258*	0.276*	0.310**

1/ Column numbers refer to specifications in Table 3. The test statistic is $t = r_s\sqrt{(N-2)/(1-r_s{}^2)}$ with r_s as the Spearman rank coefficient. There are $N-2$ degrees of freedom. * indicates significant at 10 percent significance level; ** indicates significant at 5 percent significance level.
2/ Number of observations.

IV. Conclusions

The investigations in this paper have focused on FDI flows to developing countries. Although these flows have increased in relative and absolute terms, they have gone to a relatively small group of countries; meanwhile, a large number of developing countries remain deprived of FDI or receive only minor amounts. It was found that low-income countries were, on average, less successful in attracting FDI than middle-income countries. But since the distribution of the FDI-GNP ratios is very skewed for both income groups, this result is less clear-cut on the individual country level. While the highest FDI-GNP ratios are found in the group of middle-income countries, there are many low- *and* middle-income countries that receive minor amounts of FDI.

Furthermore, the empirical results in this paper suggest that the marginal product of capital, as defined by the standard neoclassical model, cannot explain the observed distribution of FDI flows to developing countries. Modifications that allow for differences in TFP or capital share parameters across countries do not sufficiently improve the explanatory power. What might improve the explanatory power of the marginal products is a more endogenous specification of the technology. This would mean allowing the production technology of a country to be dependent on structural characteristics of its economy, such as the stock of FDI. In this paper, two specifications (corresponding to columns (2b) and (3b)) have been tested under which countries can use different technologies as their capital-labor ratios increase beyond a certain threshold. It was found that under these specifications capital-scarce, low-income countries use the least capital-intensive production techniques, whereas middle-income countries use the most capital-intensive techniques. These specifications with variable technologies give a better, although not sufficient, explanation of FDI flows to developing countries, but it will be interesting to further investigate them. Finally, in this paper the effect of human capital on the marginal product of capital is measured only through the intercept. It should be explored whether the inclusion of human capital as a separate factor of production yields marginal products of capital that can better explain the pattern of FDI flows to developing countries.

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Table 6. TFPs (A) and Capital Share (α) Parameters for Industrial Countries 1/

	2a	2b	3a	3b
	A_i		α_i	
Australia	5.080	5.073	0.521	0.507
Austria	5.022	5.018	0.516	0.502
Belgium	5.062	5.053	0.519	0.505
Canada	5.161	5.153	0.529	0.515
Denmark	4.959	4.950	0.509	0.495
Finland	4.784	4.775	0.492	0.479
France	5.092	5.082	0.522	0.508
Germany	4.903	4.893	0.503	0.490
Iceland	5.210	5.210	0.537	0.523
Ireland	4.932	4.932	0.507	0.494
Israel	4.976	4.965	0.511	0.497
Italy	5.080	5.070	0.523	0.508
Japan	4.742	4.747	0.487	0.475
Luxembourg	5.018	5.010	0.514	0.501
Netherlands	5.179	4.169	0.531	0.517
New Zealand	5.083	5.076	0.521	0.508
Norway	4.775	4.767	0.491	0.478
Spain	5.102	5.104	0.524	0.511
Sweden	5.056	5.046	0.518	0.505
Switzerland	4.867	4.859	0.500	0.487
United Kingdom	5.184	5.175	0.533	0.519
United States	5.323	5.317	0.545	0.531

1/ Column numbers refer to the specifications in Table 3.

Table 7. TFPs (A) and Capital Share Parameters (α) for Developing Countries 1/

	2a	2b	3a	3b
	A_i		α_i	
Low-income countries				
Honduras	4.262	4.362	0.428	0.429
India	4.145	4.199	0.402	0.399
Kenya	4.043	4.087	0.384	0.381
Madagascar	3.878	3.946	0.369	0.368
Malawi	4.093	4.071	0.368	0.355
Nepal	4.542	4.526	0.448	0.435
Nigeria	4.608	4.620	0.462	0.455
Sierra Leone	5.409	5.345	0.608	0.586
Sri Lanka	3.969	4.024	0.399	0.393
Zambia	4.139	4.220	0.407	0.407
Middle-income countries				
Argentina	5.077	5.099	0.523	0.512
Bolivia	4.329	4.401	0.438	0.434
Botswana	4.528	4.586	0.456	0.454
Chile	4.895	4.949	0.504	0.497
Colombia	4.437	4.449	0.454	0.442
Côte d'Ivoire	4.922	4.943	0.509	0.502
Dominican Rep.	4.769	4.853	0.488	0.488
Ecuador	4.387	4.394	0.449	0.436
Greece	4.705	4.704	0.484	0.470
Guatemala	4.902	5.004	0.505	0.508
Jamaica	4.518	4.615	0.459	0.460
Korea, Rep. of	4.467	4.509	0.457	0.448
Mauritius	5.015	5.099	0.520	0.521
Mexico	5.022	5.025	0.517	0.504
Morocco	4.857	4.936	0.500	0.500
Panama	4.359	4.352	0.446	0.432
Paraguay	5.471	5.476	0.597	0.588
Peru	4.605	4.636	0.471	0.462
Philippines	4.330	4.437	0.435	0.438
Portugal	4.834	4.882	0.497	0.490
Swaziland	4.610	4.701	0.469	0.470
Thailand	4.343	4.432	0.435	0.436
Turkey	4.495	4.570	0.457	0.454
Venezuela	5.151	5.133	0.529	0.514
Zimbabwe	3.642	3.715	0.359	0.355

1/ Column numbers refer to the specifications in Table 3.

Table 8. Country Sample

Low-Income Countries		Middle-Income Countries		Industrial Countries
Bangladesh		Algeria		Australia
Benin		Argentina	*	Austria
Burkina Faso		Barbados		Belgium
Burundi		Belize		Canada
Central African Rep.		Bolivia	*	Denmark
Chad		Botswana	*	Finland
China		Brazil		France
Comoros		Cameroon		Germany
Egypt		Cape Verde		Iceland
Ethiopia		Chile	*	Ireland
The Gambia		Colombia	*	Israel
Ghana		Congo, People's Rep.		Italy
Guinea-Bissau		Costa Rica		Japan
Guyana		Côte d'Ivoire	*	Luxembourg
Haiti		Dominica		Netherlands
Honduras	*	Dominican Rep.	*	New Zealand
India	*	Ecuador	*	Norway
Indonesia		El Salvador		Spain
Kenya	*	Fiji		Sweden
Lesotho		Gabon		Switzerland
Madagascar	*	Greece	*	United Kingdom
Malawi	*	Guatemala	*	United States
Mali		Jamaica	*	
Mauritania		Korea, Rep. of	*	
Nepal	*	Malaysia		
Nicaragua		Mauritius	*	
Niger		Mexico	*	
Nigeria	*	Morocco	*	
Pakistan		Oman		
Rwanda		Panama	*	
São Tomé & Príncipe		Papua New Guinea		
Sierra Leone	*	Paraguay	*	
Sri Lanka	*	Peru	*	
Togo		Philippines	*	
Uganda		Portugal	*	
Zambia	*	Senegal		
		Seychelles		
		St. Vincent		
		Swaziland	*	
		Thailand	*	
		Trinidad & Tobago		
		Tunisia		
		Turkey	*	
		Uruguay		
		Venezuela	*	
		Zimbabwe	*	
N: 36	10	46	25	22

Notes: FDI-GNP ratios from 1970 to 1994 have been constructed for the 82 low- and middle-income countries listed in this table. The data are from the IMF's *Balance of Payments Statistics Yearbook* and the World Bank.
Capital stock data are available from the Penn World Tables (Mark 5.6) for all industrial countries and the 35 developing countries marked with an asterisk.