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Threshold effects in the relationship between inward foreign direct investment and import productivity growth in Latin America and the Caribbean

Dillon Alleyne

Stefan Edwards

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This document was prepared by Dillon Alleyne, Coordinator; and Stefan Edwards, Research Assistant, Economic Development Unit, Subregional Headquarters for the Caribbean.

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Abstract

In the extensive literature on the role of Foreign Direct Investment (FDI) in developing countries, some studies have found (see Blalock and Gertler 2004, Todo and Miyamoto 2002) that the impact of inward Foreign Direct Investment (FDI) flows on growth was positive and significant. Apart from contributing to domestic investment and employment, FDI enhanced local technology capacity, assisted in promoting innovation through technology transfers and, generally, strengthened the competitive environment in a host country. While it is the case that FDI has been important to the development of many economies of Latin America and the Caribbean, concerns about the capacity of FDI to raise the technological sophistication of these economies and to create more intersectoral linkages are at the heart of the debate about the benefits of FDI.

This study examines the impact of FDI on import productivity in Latin America and the Caribbean and found strong evidence of threshold effects with respect to the level of human capital. The findings indicated that the relationship between FDI and growth was dependent on the level of human capital available to the domestic economy. The implication was that raising the level of domestic human capital, through investment in domestic knowledge and innovation was important if countries in Latin America and the Caribbean were to benefit fully from FDI.

I. Introduction

The paper examines the impact of inward FDI on import productivity growth in the Caribbean and Latin America, from 1980-2007, with the objective of identifying a set of policy variables that are most effective in improving its efficiency. This continues to be an important issue despite the fact that a great deal of analysis had already been done with respect to the relationship between FDI and growth. The reasons for continuing interest in that area were many.

First, the literature on the impact of FDI on growth had been mixed despite the number of firm, country level and panel data studies on this subject (Lipsey et al, 2004). The general results provide evidence both for and against the positive impacts of FDI on growth in developing countries and as a result there is no consensus on this issue.

Secondly, FDI was promoted in the development literature as a major source of transfer of knowledge and technology to developing countries and, as a result, considerable resources have been expended in Latin America and the Caribbean to attract higher levels of FDI flows over time.

Thirdly, the policy emphasis on promoting FDI with a range of fiscal incentives in both Latin America and the Caribbean raises serious issues as to whether such an approach constitutes an optimum long run strategy. A careful assessment would require an examination of revenue losses versus the benefits of FDI. While such an approach is not contemplated here, a study of the productivity of such investment gives important information on FDI impact[1] on economic growth.

Fourthly, some authors such as, Hausmann and Rodrick (2005), have argued that the absorptive capacity of developing countries was the single most important factor in determining whether countries benefit significantly from FDI. For example, studies on Indonesia confirmed that such capacity might be important if local firms were to benefit from technology and other spillover effects (Lipsey et al 2004). This result is in line with the view that given the pressure of competition FDI flows will move to areas where there are complementary services and activities including a pool of labour that can advance their ability to innovate.

If that assessment is correct, then efforts and resources might be better placed on building a local domestic capacity to innovate as a complement to FDI rather than merely providing incentives to raise the level of FDI inflows (James 2006, 2009).

The study employed a threshold panel data approach along the lines of Hansen (1999) to examine the relationship between FDI and growth in import productivity growth in the Caribbean and Latin America. This approach was employed because it was argued that the impact of FDI on growth might be impacted by the level of local knowledge and capacity to innovate and that countries with lower levels of human capital may reveal lower productivity of FDI investment. If this hypothesis holds then a threshold effects model, which accounts for nonlinear effects between education and FDI in the growth process is more appropriate. The analysis first tested for threshold effects and having found these to be significant, a threshold effects model was then estimated to examine the relationship between productivity and FDI. The next section examines the theoretical formulation underpinning the analysis.

[1] Lipsey et al (2004) argue that while there was disagreement in the academic literature, policymakers have made the judgment that FDI was valuable to their countries. Costa Rica has been pursuing a strategy of targeted incentives in the last decade with success.

II. Modelling the relationship between FDI and Import productivity

This section discusses the approach to modelling the relationship between FDI and growth in Latin America and the Caribbean. The traditional modelling strategy is to establish a relationship between a measure of the growth of inward FDI and output usually defined as GDP. The approach taken here, however, examined the relationship between FDI and import productivity growth for several reasons. First, for many developing countries, the balance of payments (BOP) constraint is perhaps the most binding in terms of the need to finance the current account of the BOP. Raising the productivity of imports improves the efficiency of foreign exchange use. Secondly, given the openness of these economies, imports are an important part of the production process and taking account of this makes explicit the role of openness in this analysis.

In order to examine the relationship between import productivity growth and inward FDI, an economy producing goods along the following lines of a production function was assumed in which total output was a function of the capital stock, the employed labour force, the level of human capital, and total imports. A variable is also added to account for the efficiency of production (see annex).

The model was formulated to account for increasing returns to scale in production. In addition, because of data limitations, the productivity of imports was defined as output per unit of total imports rather than intermediate imports. This places some limitations on the analysis since total imports may distort the productivity measure if consumer imports are a significant share of imports.

The final formulation was reported as equation (10) in the annex as follows:

$$(1)\quad \Delta y_{it} = \gamma_0 + \gamma_1 H_{it} + \gamma_2 H_{it}\Delta k_{it\,d} + \gamma_3 H_{it}\Delta k_{it\,f} + \gamma_{4_{it}}\Delta k_{d} + \gamma_{it5}\Delta k_{f} + \gamma_6 \Delta l + \gamma_7 \Delta m2GDP_{it} + \gamma_8 lopen_{it} + \Delta\varepsilon_{it}$$

That relationship suggested that the growth in output per unit of imports was related to the level of human capital, H_{it} (the average years of education), the interaction between the level of human capital and the growth in domestic capital stock, $H_{it}\Delta k_{dit}$ and foreign capital stock per unit of imports, $H\Delta k_{fit}$, the changes in domestic capital stock Δk_{dit} and foreign capital stock Δk_{fit} and the growth in the labour force per unit of imports, Δl. The constant γ_0 which was exogenous technical progress might also be proxied by variables picking up fixed and time effects including financial variables and variables reflecting macroeconomic uncertainty.

The last two variables were the log changes in m2 to GDP ratio and openness (lopen) defined as the log ratio of exports plus imports to GDP. Because of how this last variable is defined, there is likely to have some correlation with the right hand side variable. An important consideration in the analysis was that there may be non-linearities among some of the variables of interest. One approach to model these variables might be to estimate the thresholds by linear splines, except that the thresholds were not known a priori.

It is important to understand the non linearities between the growth in output per unit of imports and the complementarities among the following variables $\gamma_2 H_{it}\Delta k_{d_{it}}$ and $\gamma_3 H_{it}\Delta k_{f_{it}}$ .The threshold relationship was the interaction between the level of human capital H_{it} and the change in FDI in the case of a double threshold was illustrated as follows:

$$(2)\quad \gamma_2 H_{it}\Delta k_{f_{it}} = \gamma_{21}\ I(H_{it} \le \lambda_1) + \gamma_{22} I(\lambda_1 < H_{it} \le \lambda_2) + \gamma_{23} I(\lambda_2 < (H_{it}))$$

Note that I (.) was the indicator function and λ_1 was the estimated threshold. When $H_{it} \le \lambda_1$, the coefficient γ_{21} referred to the impact of FDI on growth in regime one, or the low regime. On the other hand, when the coefficient was $> \lambda_1$, but $\le \lambda_2$ it referred to the impact of observations in a higher regime in threshold one. The case in which $H_{it} > \lambda_2$ referred to the observations at the second threshold in an even higher regime.

In order to estimate the model, the threshold variable λ_1 which minimized the concentrated sum of squares residual from a least squares regression, was computed. Assuming that the threshold variable was known, then the model could be estimated by OLS, but since it was unknown then it was estimated along with the other parameters. Following Hansen (1999) the threshold parameter was estimated as the value that minimized the sum of squared errors from the least squares regression. In order to determine whether the threshold was statistically significant, in the single threshold case for example, the null hypothesis that $\gamma_{21} = \gamma_{22}$ was tested. Since the classical tests did not follow a normal distribution, Hansen's (1999) bootstrap method was used to obtain probability values. Bai and Perron (1998) have shown that a second threshold, if computed sequentially, could be consistent. Thus, in the case of a second threshold, the procedure fixed the first and then went on to find the second. In a similar vein, the bootstrap method could be employed to discriminate between the first and second thresholds.

III. Characteristics of countries and FDI data in the sample

The section examines the profile of the countries employed in the study in terms of their level of income, population, land area and a measure of openness usually defined as the ratio of imports plus exports to Gross Domestic Product (GDP). The characteristics of FDI flows and stocks to the region from all sources were also examined and in addition a measure of inward FDI performance was also considered to determine how successful countries were in attracting FDI over time. Two other issues were also examined, as follows: first there was an examination of the relationship between the average important productivity and the ratio of investment to gross fixed capital formation for the period 1980-2007 to determine whether FDI improved import productivity. Secondly, the share of FDI as a percentage of average foreign exchange flows was considered to determine how important FDI was in total foreign exchange inflows.

It would have been ideal to employ the full complement of countries in Latin America and the Caribbean in the data analysis, however, due to data gaps, only 21 countries could be used over the period 1980 to 2007.

Table 1 showed that the countries represented a heterogeneous group in terms of their population size, land area, per capita income and openness as measured in terms of imports plus exports to GDP. For example, Barbados and Trinidad and Tobago had the highest per capita incomes for 2007, but had populations of less than 300,000 and 1.3 million, respectively. Brazil and Mexico had the largest populations of 190 million and 105 million, respectively, which dwarfed many other

countries in the sample, and had significant land areas of 8 million and 1.9 million km^2, respectively. There was also considerable variation by openness as Brazil was the least open economy while Honduras and Panama were the most open.

Table 2 reported the average FDI inflows and while there were variations among the countries in terms of sectoral composition of FDI, some common characteristics were also present. First, some US$ 32 billion of FDI flowed to the sample countries, but, of this amount two countries, Brazil and Mexico, accounted for as much as 56.7%. That was not surprising given the size of these economies and the range of their economic sectors and activities. At the same time, the average net FDI share to the region was 3.1%, while the average world share was 5.4%.

TABLE 1
PER CAPITA INCOME, POPULATION, LAND AREA AND OPENNESS (THE RATIO OF EXPORTS + IMPORTS TO GDP) *(Measurement unit)*

Countries	Per capita income 2007 (current USD)	Population 2007	Land Area (sq km.)	Openness 2007
Argentina	6645.2	39,490,465	2,736,690	45.0
Barbados	13392.6	254,543	430	104.8
Bolivia	1377.5	9,524,495	1083300	72.9
Brazil	7012.8	190,119,995	8,459,420	25.5
Chile	9850.7	16,636,135	743800	80.0
Colombia	4684.1	44,359,445	1,109,500	34.9
Costa Rica	5891.1	4,458,782	51060	102.5
Dominican Republic	4210.1	9,813,686	48320	66.3
Ecuador	3432.0	13,341,817	276840	66.8
El Salvador	3336.1	6,106,761	20720	74.4
Guatemala	2548.4	13,353,769	107160	67.9
Haiti	640.4	9,720,086	27560	45.6
Honduras	1670.7	7,174,129	111890	129.9
Jamaica	4801.8	2,675,800	10830	79.7
Mexico	9715.1	105,280,515	1,943,950	58.2
Panama	5828.1	3,343,341	74340	155.1
Paraguay	1994.9	6,126,643	397300	104.0
Peru	3770.5	28,508,481	1,280,000	51.1
Trinidad and Tobago	16350.7	1,328,216	5130	96.1
Uruguay	7296.8	3,323,906	175020	55.7
Venezuela	8298.6	27,483,000	882050	54.3

Sources: United Nations Conference Trade and Development (UNCTAD) (2009), *World Investment Report*, http://www.unctad.org/en/docs/wir2009_en.pdf
The World Bank (2011) *World Development Indicators* (WDI) *Online Database* http://data.worldbank.org/data- catalog/world-development-indicators

TABLE 2
AVERAGE INWARD FDI, NET FDI SHARES AND IMPORT PRODUCTIVITY
(US$ millions)

	Average FDI Inflow 1980-2007	Net FDI Share of LAC Total, 1980-2007	FDI Stock/GDP, 2008	Ratio of GDP/Imports, Average for 1980-2007
Argentina	3256.3	10.6	23.0	4.9
Barbados	23.1	0.1	22.9	2.2
Bolivia	248.6	0.8	34.5	3.2
Brazil	8169.8	26.7	18.5	8.4
Chile	2174.2	7.1	59.5	3.0
Colombia	1731.7	5.7	34.1	5.6
Costa Rica	385.9	1.3	36.8	1.9
Dominican Republic	469.3	1.5	24.8	2.7
Ecuador	339.8	1.1	22.2	2.9
El Salvador	181.7	0.6	30.3	2.1
Guatemala	193.9	0.6	14.3	2.3
Haiti	16.2	0.1	6.5	2.9
Honduras	179.7	0.6	36.3	1.3
Jamaica	224.4	0.7	72.3	1.6
Mexico	9187.8	30.0	31.1	3.3
Panama	465.2	1.5	72.6	1.3
Paraguay	77.0	0.3	15.3	1.9
Peru	1217.0	4.0	23.5	4.5
Trinidad and Tobago	383.0	1.3	69.5	2.6
Uruguay	233.3	0.8	28.7	3.6
Venezuela, RB	814.3	2.7	12.5	4.3
LAC Average*	32136.7	100.0	68.7	4.4

Sources: UNCTAD (2009) *World Investment Report*: http://www.unctad.org/en/docs/wir2009_en.pdf:
The World Bank (2011) *World Development Indicators* (WDI) *Online Database*
http://data.worldbank.org/data-catalog/world-development-indicators
*LAC refers Central America, South America and the Caribbean, the average refers to the simple arithmetic mean.

Some countries, such as Barbados, Bolivia, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Paraguay and Uruguay, received less than 1% of net FDI inflows in Latin America and the Caribbean over the period. When the FDI stock as a percentage of GDP was examined for 2008, however, the impact was much more substantial, for example, two Caribbean countries, Trinidad and Tobago and Jamaica, in addition to Panama, had the highest share of FDI flows as a percentage of GDP. The table also examined the productivity of imports or the ratio of GDP to imports over the period 1980-2007. Among those with the highest import productivity were Brazil, Argentina, Peru and Venezuela.

In table 3, average FDI inflows were examined over three subperiods between 1980 and 2009 and the overall trend for most countries showed an increase in average FDI in the second period, 1990-1999, relative to the period 1980-1989. In the sub-period 2000-2009, many countries experienced further increases. The exceptions were Venezuela, Paraguay, Bolivia and Argentina which may have been plagued by domestic policy changes which gave rise to uncertainty.

TABLE 3
AVERAGE FDI INFLOWS BETWEEN 1980-2009
(US$ millions)

Countries	Averages		
	1980-1989	1990-1999	2000-2009
Argentina	584.4	6813.1	5240.6
Barbados	5.9	12.8	45.4
Bolivia	29.7	423.3	369.7
Brazil	1721.4	9921.7	23959.6
Chile	481.2	3246.7	7778.9
Colombia	478.5	1807.0	5558.9
Costa Rica	71.7	351.3	1046.7
Dominican Republic	67.9	382.3	1337.0
Ecuador	85.0	470.9	527.7
El Salvador	12.6	147.3	490.3
Guatemala	108.5	151.5	465.7
Haiti	7.5	6.1	37.1
Honduras	24.9	86.0	550.7
Jamaica	7.9	223.3	781.3
Mexico	2388.2	8507.5	21784.0
Panama	-44.3	496.5	1236.9
Paraguay	17.7	138.6	85.5
Peru	28.9	1575.6	3026.3
Trinidad and Tobago	104.7	434.5	1027.4
Uruguay	49.7	116.0	816.2
Venezuela	156.3	2142.2	1302.2

Sources: UNCTAD (2009) *World Investment Report*, http://www.unctad.org/en/docs/wir2009_en.pdf:
The World Bank (2011) *World Development Indicators* (WDI) *Online Database*, http://data.worldbank.org/data-catalog/world-development-indicators

Table 4 examined the total FDI stock, FDI stock as a share of FDI to Latin America and the Caribbean and FDI stock as a share of Gross Fixed Capital Formation (GFCF).

TABLE 4
INWARD FDI STOCK AS A PERCENTAGE OF TOTAL LATIN AMERICA AND THE CARIBBEAN AND FDI STOCK AS A PERCENTAGE OF GFCF

(US$ millions)

	FDI Stock, 2007	FDI Stock , percent of LAC total, 2007	FDI Stock, percent of GFCF
Argentina	67574.00	6.01	112.00
Barbados	789.88	0.07	117.95
Bolivia	5485.00	0.49	259.03
Brazil	309667.99	27.52	127.37
Chile	99488.24	8.84	295.17
Colombia	56448.40	5.02	137.11
Costa Rica	8802.75	0.78	154.91
Dominican Republic	8253.00	0.73	110.60
Ecuador	10326.01	0.92	100.43
El Salvador	5916.30	0.53	180.23
Guatemala	4617.60	0.41	67.20
Haiti	385.56	0.03	45.66
Honduras	4223.80	0.38	112.81
Jamaica	8667.22	0.77	236.34
Mexico	272730.60	24.24	146.78
Panama	14572.20	1.30	366.55
Paraguay	2223.80	0.20	87.54
Peru	26807.71	2.38	120.02
Trinidad and Tobago	13367.94	1.19	277.26
Uruguay	6356.00	0.56	198.00
Venezuela, RB	43957.00	3.91	81.54
LAC Average*	35159.66	100.00	246.76

Sources: UNCTAD (2009), *World Investment Report*:
http://www.unctad.org/en/docs/wir2009_en.pdf:
The World Bank (2011), *World Development Indicators* (WDI), *Online Database,*
http://data.worldbank.org/data-catalog/world-development-indicators
*LAC refers Central America, South America and the Caribbean, the average refers to the simple arithmetic mean.

As was observed in table 2, when the FDI stock for the sample of countries used in the analysis was examined, Brazil and Mexico accounted for 56.7%, however, FDI as a share of GFCF was very significant for a variety of countries which suggested that FDI inflows had a considerable impact on capital formation. The FDI stock for the sample was quite representative as it accounted for 86.3% of inward FDI in 2007.

Some countries have been fairly successful in attracting FDI and, in the Caribbean the structure of incentives designed to attract FDI to the region were very generous.

The United Nations Conference Trade and Development index[2] of FDI performance was reported for overlapping years and it appears that many countries in the sample were successful in attracting FDI over time. This can be observed from the large values in excess of 1 as indicated in table 5.

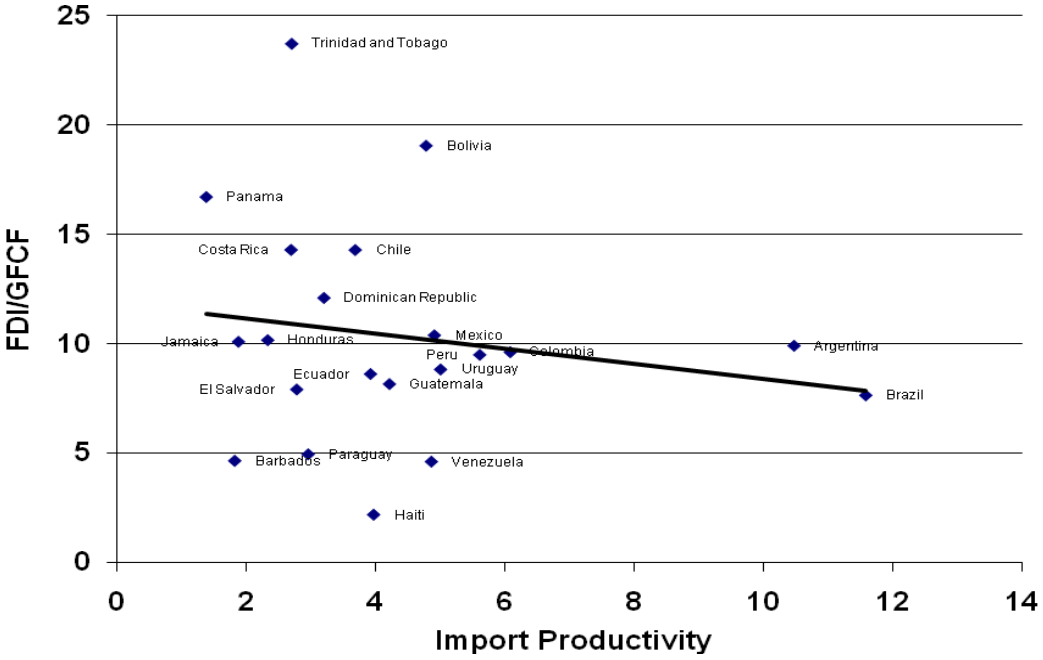
[2] The index is computed such that a value greater than one means that a country receives more FDI than its relative size measured as by its GDP.

TABLE 5
INWARD FDI PERFORMANCE INDEX

Countries	Index Value								
	1990-1992	1992-1994	1994-1996	1996-1998	1998-2000	2000-2002	2002-2004	2004-2006	Average 1990- 2006
Argentina	2.0	1.8	1.8	1.6	1.4	0.7	1.2	1.2	1.5
Barbados									
Bolivia	2.7	2.6	4.1	5.6	3.2	3.7	2.2	0.1	3.0
Brazil	0.4	0.5	0.7	1.4	1.4	1.5	1.6	0.9	1.1
Chile	3.0	3.9	4.9	3.9	2.3	1.7	3.5	2.7	3.2
Colombia	1.7	2.0	1.8	2.2	0.7	1.0	1.5	2.5	1.7
Costa Rica	3.5	3.2	2.7	2.1	1.0	1.0	1.9	2.3	2.2
Dominican Republic	2.6	2.4	1.8	1.6	1.6	1.6	1.8	1.8	1.9
Ecuador	1.8	3.4	2.5	2.1	1.2	1.8	2.8	0.6	2.0
El Salvador	0.3	0.2	0.1	2.0	1.2	0.6	1.4	1.0	0.8
Guatemala	1.2	1.0	0.4	0.9	0.5	0.5	0.3	0.8	0.7
Haiti	0.3	-0.1	0.0	0.1	0.1	0.1	0.1	0.7	0.2
Honduras	2.0	1.6	1.6	1.3	1.1	1.1	1.9	3.2	1.7
Jamaica	5.9	4.2	2.8	2.3	1.8	2.3	4.2	3.4	3.4
Mexico	1.7	2.4	2.6	1.8	0.8	1.1	1.2	1.1	1.6
Panama	2.9	3.9	3.8	6.6	2.5	1.0	3.0	4.4	3.5
Paraguay	2.0	1.7	1.3	1.5	0.7	0.3	0.5	0.5	1.1
Peru	-0.1	4.0	4.8	2.3	0.9	0.8	1.6	1.4	2.0
Trinidad and Tobago	3.9	8.5	6.6	6.6	2.2	2.9	4.5	2.7	4.7
Uruguay	0.3	0.7	0.7	0.4	0.3	0.5	1.4	2.4	0.8
Venezuela	2.4	1.2	1.7	2.7	1.1	0.9	1.0	0.4	1.4

Source: UNCTAD (2010) *UNCTAD stat Online,* http://unctadstat.unctad.org/ReportFolders/reportFolders.aspx

FIGURE 1
AVERAGE IMPORT PRODUCTIVITY VS. THE RATIO OF FDI TO GFCF, 1980-2007



Sources: UNCTAD (2009), *World Investment Report*: http://www.unctad.org/en/docs/wir2009_en.pdf
The World Bank (2011), *World Development Indicators* (WDI), *Online Database,* http://data.worldbank.org/data-catalog/world-development-indicators

Figure 1 reported the relationship between the ratio of inward FDI to GFCF and average import productivity growth over the period 1980-2007. The results suggested that there was generally a negative correlation between the FDI/GFCF ratio and import productivity, however, there were outliers. Trinidad and Tobago and Bolivia had a high FDI/GFCF ratio but moderate import productivity, while Argentina and Brazil had high import productivity, but relatively low FDI/GFCG ratios. The broad result suggest that import productivity growth was not posititvely related to FDI investment and the estimation strategy should determine why this was so.

For many developing countries, FDI is an important source of foreign exchange inflow and dramatic declines in FDI may affect the financing of the current account of the balance of payments. In table 6 the composition of foreign exchange, made up of export earnings, overseas development assistance (ODA) current transfers and FDI was examined for the period 1990-1999. The largest share of foreign exchange came from export earnings, followed by current transfers and FDI with ODA having the smallest share of foreign exchange in the period. The average share of FDI in total flows was 19.5% which is relatively large. For some countries the share of foreign exchange was above this average and among these were Argentina 21.7%, the Dominican Republic 23.7%, Ecuador 23.3% and some 60% for Trinidad and Tobago. Table 7 reported the FDI share in foreign exchange inflows for the period 2000-2009. The FDI average share for the sample was 19.4% which was similar to the share in the period 1990-1999. Among the countries above this average were Bolivia 30.7%, the Dominican Republic 43.3%, Panama 73.5% and Trinidad and Tobago 36.1%. Comparing Tables 6 and 7, the result showed that for half the countries, the average FDI share of foreign exchange inflows increased between the two sub-periods 1990-1999 and 2000-2009 respectively. Generally, however, in the last sub-period (2000-2009) the contribution of FDI to foreign exchange inflows was quite significant and much larger than overseas development assistance, in most cases.

TABLE 6
AVERAGE FOREIGN EXCHANGE INFLOWS, 1990-2009
(Percentages)

Country	1990-1999					2000-2009				
	FDI	Current Transfers	Export Value	ODA	Total	FDI	Current Transfers	Export Value	ODA	Total
Argentina *	21.7	3.4	74.2	0.6	100	9.0	2.7	88.1	0.2	100
Barbados	11.4	64.4	21.3	2.9	100	30.7	30.7	33.1	5.5	100
Bolivia *	17.4	11.8	43.2	27.7	100	7.6	16.3	63.2	12.9	100
Brazil *	17.4	3.9	78.3	0.3	100	13.5	2.8	83.6	0.2	100
Chile *	14.3	3.7	81.2	0.8	100	9.8	4.6	85.5	0.2	100
Colombia *	12.7	10.6	75.4	1.3	100	13.7	13.7	70.6	1.9	100
Costa Rica *	36.9	19.0	36.3	7.8	100	43.3	20.0	35.6	1.2	100
Dominican Republic	23.7	66.3	4.4	5.5	100	29.3	64.7	3.8	2.2	100
Ecuador *	23.3	25.0	41.6	10.0	100	4.1	18.6	75.9	1.4	100
El Salvador	8.0	66.0	9.2	16.8	100	12.1	73.0	9.9	5.0	100
Guatemala	14.4	47.1	17.3	21.2	100	9.9	75.2	8.0	6.9	100
Haiti **	1.8	94.2	4.0	0.0	100	22.3	65.3	12.4	0.0	100
Honduras	9.0	35.0	12.0	44.0	100	18.2	57.1	6.6	18.1	100
Jamaica	17.4	59.6	12.3	10.7	100	25.3	66.7	6.4	1.5	100
Mexico *	14.6	7.5	77.5	0.4	100	13.3	13.3	73.3	0.1	100
Panama	59.5	25.6	7.2	7.7	100	73.5	20.3	5.8	0.4	100
Paraguay *	11.3	9.6	70.8	8.3	100	4.7	11.5	81.3	2.5	100
Peru *	20.7	9.6	63.9	5.8	100	13.0	8.2	77.0	1.8	100
Trinidad and Tobago	60.6	4.7	32.3	2.4	100	36.1	4.9	58.8	0.2	100
Uruguay *	4.6	2.7	90.4	2.3	100	18.1	2.8	78.6	0.5	100
Venezuela, RB*	9.2	2.2	88.4	0.2	100	0.8	0.7	98.4	0.1	100
Average	19.5	27.2	44.8	8.4	100	19.4	27.3	50.3	3.0	100

Source: The World Bank (2010), *World Development Indicators* (WDI), *Online Database,* http://data.worldbank.org/data-catalog/world-development-indicators
IMF (2010), *International Financial Statistics Online,* http://www.imfstatistics.org/imf/
* excludes ODA for the year 2009
** excludes ODA

IV. Estimation of the import productivity model and interpreting the results

The methodology employed was a panel fixed effects approach with the sample period averaged every two years, to reduce the variability of FDI at the annual level. That resulted in a total of 14 observations for the 21 countries[3]. Hansen's (1999) threshold panel effects model was computed using a balanced sample[4] that is the time period used was the same for every country in the sample. A number of f formulations were employed to ascertain the robustness of the results which were reported in table 8.

In the first column, the variables were reported followed by the coefficients for the various formulations. The 't' statistics were in brackets the variables preceded by deltas were the log changes and the results were for robust errors estimation. The first formulation assumed no threshold effects and the log changes in employment and FDI were significant at the 5% level, while domestic investment was almost significant at this level.

A quadratic relation, $\Delta k^2_{d_{it}}$, was tried for domestic investment to capture non-linear effects, but that was highly insignificant. The log change in the ratio of m2 to GDP was significant with a negative coefficient, while the level of openness was positive and significant at the 5% level.

[3] The time series properties of the data were examined to determine if they were stationary. The results for a variety of panel unit root tests suggested that the variables were all I(1), but tests for co-integration proved inconclusive which then allowed the modelling of import productivity growth as a short run relationship.

[4] This model was computed using Winrats 7.30.

TABLE 7
PANEL FIXED EFFECTS, REGRESSION RESULTS
(Measurement unit)

	Dependent variable, log change in import productivity			
Independent variables	Δy_{it} (1)	Δy_{it} (2)	Δy_{it} (3)	Δy_{it} (4)
Δl	.377 (9.27)	.382 (9.96)	.37 (9.42)	.379 (9.58)
$\Delta k_{f_{it}}$	.033 (2.16)	-.09 (-1.04)	-	-
$\Delta k_{f_{it}} * H_{it}$	-	-	-.07 (-1.67)	-.08 (-1.74)
$\Delta k_{d_{it}}$	.253 (1.93)	.232 (1.74)	.257 (1.89)	.288 (4.19)
$\Delta k^2_{d_{it}}$	-.097 (-.41)	-0.08 (-0.39)	-0.10 (-0.44)	-
$\Delta k_{d_{it}} * H_{it}$	.115 (.280)	.213 (.495)	.11 (0.26)	-
$H_{it} \leq \lambda_1$	-	-0.25 (-3.09)	-0.12 (-4.33)	-.126 (8.59)
$H_{it} > \lambda_1$		0.12 (1.39)		
$\lambda_1 < H_{ij} \leq \lambda_2$	-	-	0.036 (2.56)	.038 (2.35)
$\lambda_2 < H_{ij}$	-	-	.061 (2.52)	.06 (2.88)
thresh 1	-	.0228 (1 st pctile)	.0228 (1 st pctile)	.0228 (1 st pctile)
thresh 2	-	-	.2278 (99^{th} pctile)	.2278 (99^{th} pctile)
H_{it}	-	0.38 (1.92)	-	
Δm2gdp	-.099 (3.08)	-0.09 (-3.01)	-0.09 (-2.67)	-.09 (-2.70)
lopen	.006 (2.71)	.003 (0.99)	.006 (2.78)	.004 (3.50)
$\overline{R}^2$	0.39	0.39	.394	.395

All variables except the last three are divided by imports.

In the second formulation, a single threshold value was found at the 1 percentile of the sample with a value of .022 years of education. The change in the labour force was positively and significantly related to import productivity growth, but the change in FDI stock was found to be insignificant. Domestic investment was not significant at the usual 5% level but the coefficient was positive, while the

human capital variable[5], H, was almost significant at that level. The log change in the ratio of m2 to GDP was significant and negative while openness (lopen) was not.

In the third formulation, two threshold values were found with the second threshold at .2278 years of education reported at the 99th percentile of the sample. In addition, the results showed that the threshold effects were confirmed at low levels of education as negative, but positive and highly significant at higher levels of education.

In the final formulation, the coefficients $\Delta k^2_{d_{it}}$ and $\Delta k_{f_t} * H_{it}$ were restricted to be zero and the hypothesis that they were insignificant was accepted at the 5% level of significance. As a result, those coefficients were dropped. The final results showed even stronger effects for the threshold values, suggesting that human capital variables had a strong impact on the efficacy and importance of FDI in raising import productivity growth.

[5] The average number of years of tertiary education.

V. Conclusions

The threshold model results revealed that there was a strong relationship between changes in inward FDI and import productivity growth in Latin America and the Caribbean. The impacts, however, varied with the level of human capital. For example, at low levels of human capital development, inward FDI was found to have negative impacts on import productivity growth while the reverse was true at higher levels of human capital development. These so-called, threshold effects were found to be highly significant.

A variety of reasons were offered to explain the negative impact of change in FDI on growth. One explanation was that higher levels of FDI might lead to inequality which might negatively impact growth when human capital development was low. On the other hand, it might be that highly sophisticated FDI flows were unproductive in countries that did not have the capacity to absorb such investment, or take advantage of the technologies they embodied and, at the same time, there was likely to be limited technology spillover to other sectors and industries outside of FDI activities. This is the idea that FDI was not a complement to local domestic activity and operated as economic enclaves such as in mining or agriculture. Thus, intersectoral linkages with the rest of the economy were weak. Another explanation for low import productivity due to FDI might also be that such investment crowded out local domestic activities and firms that were unable to compete, thus, lowering overall growth.

The analysis of this paper was done for aggregate FDI in Latin America and the Caribbean and should be done at the sectoral level to determine what industries are more import productive relative to others and to identify particular constraints.

The World Bank in its publication "A Time to choose, Caribbean development in the 21st Century", pointed to severe gaps in local systems of education to produce the range of skills necessary for Caribbean development. In addition, it is now recognized that emphasis should be placed not only on the idea of a knowledge economy, but the extent to which there could be learning workers, learning firms and learning regions (Lundvall et al 2002). Hausmann et al (2006) and others suggest that for countries that have exported successfully, ultimately it was not how much they exported, but also what they exported, that is, it was their export quality and technology structure that determined long term growth. If this is so, then more targeted approaches to attracting FDI, linked to building local capability within a national and regional system of innovation seem to be the best strategy to adopt.

These conclusions are very important because they challenge the view that FDI without complementary investment in other forms of capital including domestic capital may be of lesser importance to developing countries. The implication of the study is that significant investment in local domestic capital is necessary if FDI is to be effective. This means that public policy towards raising the productivity of investment will be more effective through providing complementary services to FDI and focusing on determining the appropriate forms of such capital rather than relying on broad range fiscal incentives to attract FDI[6].

The implication is that government promotion agencies charged with attracting FDI would be more effective in helping to raise the productivity of imports, if much more emphasis is placed on raising local capacity to complement FDI. This implies a more targeted approach that is results oriented.

Part of the difficulty is that there is intense competition at the regional level as countries seek to attract as much FDI as possible. A regional approach to identifying and attracting appropriate FDI and offering a uniform set of incentives will avoid the zero sum game approach to attracting FDI that persists at the moment. The harmonization of FDI policy and procedures will immediately send a message that the region is focused on attracting an appropriate set of FDI partners.

The overall results suggested that there were positive effects between changes in FDI and import productivity growth, provided that there was an appropriate level of human capital. The implication was that more emphasis should be placed on a faster investment in human capital rather than the current approach of giving excessive incentives to raise the level of FDI.

[6] The World Bank came to similar conclusions with respect to the strategy of investment promotion in the Oraganisation of Eastern Caribbean States in its publication, "Oraganisation of Eastern Caribbean States towards a New Agenda for Growth", 2005.

Annex

This section lays out the theoretical approach to examining the relationship between FDI and growth in Latin America and the Caribbean. The traditional modelling approach is to establish a relationship between a measure of the growth of inward FDI and output usually defined as GDP. The approach taken here however examined the relationship between FDI and import productivity growth for several reasons. First, for many developing countries, BOP constraint is perhaps the most binding in terms of the need to finance the current account of BOP. Thus, raising the productivity of imports improves the efficiency of foreign exchange use. Secondly, given the openness of these economies, imports are an important input to production and taking account of this makes explicit the role of openness in this analysis.

In order to examine the relationship between import productivity growth and inward FDI, an economy producing goods along the following lines of a production function was assumed:

$$(1) \quad Y_t = A\varphi\left(K_t^{\mu} L_t^{\alpha} H_t^{\beta} M_t^{1-\alpha-\mu}\right)$$

Y= total output.

A=efficiency of production

K= total capital stock

L= total employed labour

H=level of human capital

M= imports of goods other than consumer goods

The indices on capital, labour, imports and human capital were constructed to show increasing return to scale among the variables such

that $\mu + \alpha + \beta + (1-\alpha) = 1 + \beta + \mu > 1$, for $\beta > 0$. At the same time, there were constant returns among capital, labour and imports. Rewriting

(1) in terms of imports per unit of output allowed the relationship to be stated as,

(2) $y_t = \frac{Y_t}{M_t} = A\varphi\left(k_t^{\mu} l_t^{\alpha} H_t^{\beta}\right)$,

where k is capital per unit of imports, *l* is the labour force per unit of imports and H is the level of education. Thus, the relationship was written in terms of output per unit of imports or import productivity. It was assumed that the total capital stock per unit of imports, K/M was made up of domestic capital k_d and foreign capital k_f measured in units of imports. In addition, the level of human capital H was a function of the level of capital employed. Thus, in

(3) $k = k_d + k_f$, where $k = K/M$, $k_d = K_d/M$ and $k_f = K_f/M$.

This led to equation

(4) $H = \left[k_d k_f^{\delta}\right]^{\eta}$,

where δ and η were the marginal and inter-temporal elasticities of substitution between domestic capital and foreign capital goods per unit of imports. Thus, there were complementarities between the two types of capital which both affected H. Given that imports were also a part of k_f the elasticity with respect to that variable might not be the true elasticity. If we substituted for k_t and H into equation (2) the following expression is arrived at:

(5) $y_t = A\varphi\left(k_{f_{it}}^{\mu+\delta\eta\beta}\ k_{d_{it}}^{\mu+\eta\beta}\ l^{\alpha}\right)$

When (5) was rewritten in an estimation context to take account of the panel nature of the data set, the following was arrived at:

(6) $y_{it} = A_{it} k_{f_{it}}^{\mu+\delta\eta\beta}\ k_{d_{it}}^{\mu+\eta\beta}\ l^{\alpha}\varepsilon_{it}$

Taking the log difference in equation (6) gave (7) which was the growth rate of income per unit of imports, y_{it}, such that I = 1…21 referred to the country index and t = 1..n referred to the time period.

(7) $\Delta y_{it} = \Delta A_{it} + (\mu + \eta\beta)\Delta k_{d_{it}} + (\mu + \delta\eta\beta)\Delta k_{f_{it}} + \alpha\Delta l + \Delta\varepsilon_{it}$

It was assumed that ΔA_{it}, the growth of technology could be specified as a function of the following form:

(8) $\Delta A_{it} = \gamma_0 + \gamma_1 H_{it} + \gamma_2 H_{it}\Delta k_{d_{it}} + \gamma_3 H_{it}\Delta k_{f_{it}}$

Where the ΔA_{it} depended on an exogenous technology level, γ_0, while the variables $H_{it}\Delta k_{dit}$ and $H_{fit}\Delta k$ captured spillover effects represented by the relationship between the level of human capital and changes in domestic and foreign investment per unit of imports. In that case, the level of technology diffusion depended on both domestic and foreign investment. That relationship might also
contain institutional variables which help or hinder or promote the development of technical progress. Equation (8) could be modified to account for sectoral spillover effects in the relationship between the level of human capital and investment. The overall formulation after substituting equation (8) into

equation (7) was as follows:

$$(9)\quad \Delta y_{it} = \gamma_0 + \gamma_1 H_{it} + \gamma_2 H_{it}\Delta k_{it} + \gamma_3 H_{it}\Delta k_{f_{it}} + \gamma_4 \Delta k_{d_{it}} + \gamma_5 \Delta k_{f_{it}} + \gamma_6 \Delta l + \Delta\varepsilon_{it}$$

Equation (9) was the equation estimated and in this formulation

$$\gamma_4 = \mu + \eta\beta,\ \gamma_5 = (\mu + \delta\eta\beta),\ \gamma_6 = \alpha$$

That relationship suggested that the growth in output per unit of imports was related to the level of human capital, the interaction between the level of human capital and the growth in domestic and foreign capital stock per unit of imports, the changes in domestic and foreign capital stock and the growth in the labour force per unit of imports. The constant γ_0 which was exogenous technical progress might also be proxied by variables picking up fixed and time effects including financial variables and variables reflecting macroeconomic uncertainty. The final formulation was as follows:

$$(10)\quad \Delta y_{it} = \gamma_0 + \gamma_1 H_{it} + \gamma_2 H_{it}\Delta k_{it_d} + \gamma_3 H_{it}\Delta k_{it_f} + \gamma_{4_{it}}\Delta k_d + \gamma_{it5}\Delta k_f + \gamma_6 \Delta l + \gamma_7 \Delta m2GDP_{it} + \gamma_8 lopen_{it} + \Delta\varepsilon_{it}$$

The last two variables were the log changes in m2 to GDP ratio and openness (lopen) defined as the log ratio of exports plus imports to GDP. An important consideration in the analysis was that there may be non-linearities among some of the variables of interest. One approach to model these variables might be to estimate the thresholds by linear splines, except that the thresholds were not known a priori.

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