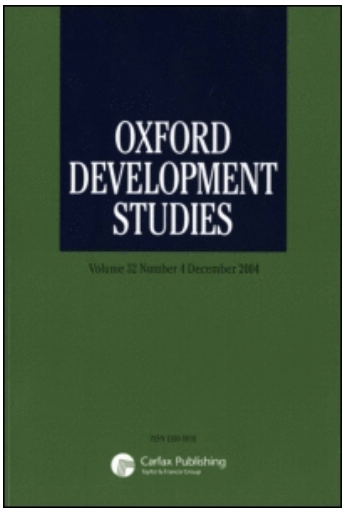

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Foreign Direct Investment and International Skill Inequality

DIRK WILLEM TE VELDE* & THEODORA XENOGIANI

ABSTRACT *This paper focuses on the effects of foreign direct investment (FDI) on skill inequality amongst countries. New growth models and international business studies predict that when countries liberalize their trade and investment regime in an environment of imperfect technology transfers, they will specialize in activities depending on the initial conditions such as skill endowments. Countries with few skills tend to specialize in low-skill intensive production, while countries with a high innovation rate and skill endowment tend to specialize in the production of high-skill intensive goods. The econometric evidence, based on an unbalanced panel for 111 countries over seven 5-year time periods from 1970 to 2000, confirms that FDI enhances skill development (particularly secondary and tertiary enrolment) in countries that are relatively well endowed with skills to start with. There are important policy conclusions for national governments when FDI tends to raise international skill inequalities. In particular, developing countries with low-skill endowments that attract investors would do well to co-ordinate actively their human resources policies with investor needs in order to bring the country to a higher skill path.*

1. Introduction

There is an increased interest in the effects of openness on inequality of skill formation (skill inequality) within and across countries. One strand of thought examines whether openness leads to increased skill inequality within countries; see Wood (1997) on the effects of trade and te Velde (2004) and te Velde & Morrissey (2004) on the effects of foreign direct investment (FDI). Another, less well-explored area is whether openness leads to increased (skill) inequality amongst countries (Grossman & Helpman, 1991). The basic hypothesis is that when countries liberalize trade and investment in an environment of imperfect technology transfers, they will specialize in activities depending on the initial conditions. Countries with few skills would specialize in low-skill intensive production, while countries with a high innovation rate and skill endowment will specialize in the production of high-skill intensive goods. This would increase skill inequality amongst

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countries and leave less well skill-endowed developing countries trapped in a low income–low skill cycle.

Some empirical work has begun to emerge in relation to the effects of trade on international inequality in skill development. Wood & Ridao-Cano (1999) showed that trade has acted to raise inequality in education by raising secondary and tertiary enrolment rates more in high-skill, high-income countries than in other countries. This would imply that trade has raised income per capital levels, but more so in more advanced countries. However, we are unaware of studies that address the effects of FDI on international skills development.

This paper tries to fill the gap. We model enrolment rates as a function of FDI and other factors measuring education opportunities in the country, income and others. We interact initial skill endowments with FDI variables. This enables us to test how FDI affects enrolment rates depending on initial conditions. This is important in assessing whether FDI is likely to raise international inequalities when not counteracted by some (strategic) policy interventions.

We used an unbalanced panel for 111 countries over seven 5-year time periods from 1970. The data came from different sources, such as the World Development Indicators (WDI), UNESCO, UNCTAD and the Barro and Lee data set on educational attainment. The use of these variables permitted the inclusion of a maximum number of developing countries.

The paper is organized as follows. In the following section, the theoretical literature on the impact of globalization on international skill inequality is reviewed, with particular emphasis on the possible transmission mechanisms. In Section 3, the econometric model is presented, and Section 4 discusses the data that will be used to estimate our model. Section 5 presents the econometric results and some specification and robustness checks, and Section 6 presents a discussion on FDI, skills and market and co-ordination failures that are relevant for the policy implications of the paper. Section 7 concludes.

2. Foreign Direct Investment and International Skill Inequality

There are two ways to address the relationship between FDI and international skill inequality, i.e. the dispersion of skill attainment across countries: at the macro level and at the micro level. At the macro level, new developments in trade theory predict how countries will develop following the opening of the economy. The way in which skills development is affected is often indirect, through the incentives for skills development induced by investment in the form of higher taxes, faster technological progress and expansion of sectors. At the micro level, there are various hypotheses about the differences between foreign and local firms with respect to the effects on education. Here, the way in which skill development is affected is more direct, as foreign firms provide education or employ techniques requiring skills. Thus, both macro and micro theories describe mechanisms through which FDI affects skills development, and international skills inequality specifically.

2.1 Foreign Direct Investment and International Skill Inequality at the Macro Level

FDI may affect international skill inequality, as FDI may foster specialization at the macro level. There are conflicting economic theories. Classical trade theory (the Heckscher–Ohlin model) suggests that increased trade would lead developing countries to converge

with developed countries (at least in terms of factor prices). Other theories suggest a specialization leading to differences and inequalities between trade patterns that shift the structure of production in low-skill countries away from sectors of greater productivity growth potential.

For instance, in the new trade theory based on endogenous growth (see Grossman & Helpman, 1991), productivity gains stem from increasing specialization of the production process. This model allows for the possibility of uneven development (or multiple equilibria) after "opening", depending on initial income levels or *ad hoc* factors creating path dependency. High-income countries may end up specializing in skill-intensive sectors (with more learning-by-doing) and low-income countries in traditional manufacturing (assembly) sectors. When countries differ, e.g. in size of initial technology and education level, openness to trade under the presence of imperfect knowledge transfer will lead high-skill countries to specialize in high-skill high productivity sectors and low-skill countries in traditional sectors.

Wood & Ridao-Cano (1999) examined the impact of trade on skill inequality, in a model where trade-induced changes in the relative wages of skilled workers stimulate supply responses that widen the initial gap in skill endowments between the two countries.[1] They found that trade raised inequality in education by raising secondary and tertiary enrolment rates more in high-skill, high-income countries than in other countries. No such evidence exists on the effects of FDI inflows/stocks, but it is straightforward to see the above model in the context of openness to FDI, for instance when both FDI and trade enhance knowledge generation.

2.2 Foreign Direct Investment and International Skill Inequality at the Micro Level

The mechanisms through which FDI affects skill inequality at the micro level are more direct. Multinational enterprises (MNEs), the main carriers of FDI, are involved on the supply side of skills at the micro level through: (1) general education; (2) official training; and (3) informal on-the-job training. Informal on-the-job training is likely to coincide with the skill content of the job, hence MNEs offer more of this when they are more skill-intensive.

The involvement of MNEs in general education is twofold (apart from FDI in business education). First, MNEs provide grants and other assistance at all levels of education on a voluntary basis, though the effects on educational attainment directly and indirectly may differ substantially from case to case. For instance, Shell offers grants to the education sector in Nigeria. CBC (2004) provides three further examples of voluntary involvement of the private sector in education provision: Alcan operates 180 schools world-wide, where students are taught about environmental protection and entrepreneurial skills; BAT provides funds for students from underprivileged backgrounds to follow tertiary education; and Diageo/East African Breweries in Kenya sponsors students to go to university.

Second, MNEs have set up general education centres in part motivated by their own business goals. Such MNEs are often strategic asset-seeking MNEs that hope to develop projects using the skills and knowledge in host countries, and hence they seem more prevalent in the more wealthy developing countries that are already well-endowed with skills. MNEs are involved in setting up education centres or courses at technology centres (e.g. Larrain *et al.*, 2000, for the case of Intel in Costa Rica). Both the setting up

of education centres and the voluntary grants to education are clear examples of mechanisms through which MNEs affect skills development.

The involvement of MNEs in firm-specific and general vocational *training* is more common than in providing general education, perhaps because at least in theory MNEs are more likely to capture benefits directly in the form of increased staff motivation and productivity. The evidence is well known: UNCTAD (1994) and Tan & Batra (1995) discussed evidence that suggests that foreign ownership is associated with increased training in several developing countries. For example, Gerschenberg (1987) found that MNEs offer more training when host-country governments hold part of the equity. Iyanda & Bello (1979) found, in a small sample of Lagos-based firms, that training expenses per employee were five times higher in MNEs compared with indigenous firms, and aimed relatively more at white-collar and relatively less at blue-collar workers. Tan & Batra (1995) found that foreign firms train more in Colombia, Mexico, Indonesia, Malaysia and Taiwan. UNCTAD (1994) further showed that the extent and nature of MNE training practices vary according to size, industry, entry strategy and motivation of the investment. The fact that foreign firms train more than local ones suggests the existence of an important channel through which FDI can affect skills development and skills inequality across countries. It is also cheaper to train workers who already have some basic skills because the productivity effects are greater for training of skilled workers (see Tan & Batra, 1995).

The motivation of investment may also affect the way in which MNEs contribute to training and education activities in addition to other (firm-specific) factors such as size. Dunning (1993) distinguished four types of investment. *Natural resource-seeking* investments are usually labour-extensive, requiring a handful of skilled workers (sometimes ex-patriates) needed to operate the complex extraction methods. *Market-seeking* investments involve some training of local people to exploit the firm-specific advantage. Such MNEs are often replicas of their parents (horizontal MNEs) and may devote training efforts to specific technological or marketing purposes. UNCTAD (1994) discussed how market-seeking investors in Eastern Europe needed to provide training to improve market-orientation skills. Finally, there are e*fficiency-seeking* investors and *strategic asset-seeking investors*. The former type (e.g. garments assembly plants) often invest because of low wages, and will therefore provide only elementary skills training in a few weeks, before moving on to lower cost locations, as they did in the 1960s to the East Asian newly industrialized countries, and since the 1980s, to other countries in Asia, Latin America and parts of Africa. *Strategic asset-seeking* investors, on the other hand, are perceived to be more beneficial to human capital development. For instance, FDI in high-tech manufacturing operations is usually based on the availability of local capabilities such as skills, technology and R&D centres. MNEs' affiliates in this sector are likely to be engaged in developing particular skill needs, as shown by several high-tech investments in Singapore and Malaysia (te Velde, 2002).

The brief review at the macro level suggested that openness to trade and FDI can lead to increased international skill inequality when high-skill countries specialize in high-skill activities. The mechanisms are often indirect, through the incentives for skills development in the form of higher taxes, faster technological progress and expansion of sectors. The micro level review indicated that MNEs are likely to contribute more positively to human capital development in situations where initial conditions are already favourable (e.g. availability of skills for strategic asset-seeking investors) than when initial

conditions are poor (e.g. use of low-skill low wage workers by FDI in the assembly sector). The review at the micro level also shows that training is one obvious mechanism by which FDI affects skills development. Hereafter, we shall test for the effects of FDI on international skills development at the national level, and will therefore be unable to distinguish empirically amongst the above mechanisms.

3. The Econometric Model

This paper estimates a version of the model used by Wood & Ridao-Cano (1999), derived from a skill version of the Heckscher–Ohlin model, with two countries, two factors (skilled and unskilled labour) and two goods (one skill-intensive and one labour-intensive). The developed country has a relatively large supply of skilled labour, whereas the developing country has a relative abundance in unskilled labour, thus its comparative advantage lies in producing the unskilled labour-intensive good. This model consists of two equations. Demand for labour is a function of the number of skilled workers relative to unskilled ones and the openness to trade. Supply of labour is a function of the relative number of skilled to unskilled labour and some education and training proxy or opportunities for skill acquisition. Enrolment rates (*ER*) are modelled as a function of education opportunities (*EO*, proxied by public spending on education and number of pupils per teacher), GDP per capita (*pcy*) and trade (*TR*, trade as a ratio to GDP). This paper extended the equation to FDI.

The Wood–Ridao-Cano model, augmented by the FDI and FDI-factor endowment variables reads as:

$$ER_{it} = \alpha + \beta_1 TR_{it} + \beta_2 (TR_{it}{}^{*} S\tilde{E}_{it}) + \beta_3 (TR_{it}{}^{*} L\tilde{E}_{it}) + \gamma_1 FDI_{it} + \gamma_2 (FDI_{it}{}^{*} S\tilde{E}_{it}) + \gamma_3 (FDI_{it}{}^{*} L\tilde{E}_{it}) + \pi EO_{it} + \theta \log (pcy_{it}) + \xi t + \varepsilon_{it}. \quad (1)$$

We select a parsimonious model that focuses on a number of key factors. For our purposes, we include FDI and interactions between FDI and factor endowments (e.g. *SE* for skill endowments and *LE* for land endowments).

$$ER_{it} = \alpha + \gamma_1 FDI_{it} + \gamma_2 (FDI_{it}{}^{*} S\tilde{E}_{it}) + \gamma_3 (FDI_{it}{}^{*} L\tilde{E}_{it}) + \pi EO_{it} + \theta \log (pcy_{it}) + \xi t + \varepsilon_{it}, \quad (2)$$

where *i* is the country index and *t* stands for time (5-year time intervals). Enrolment rates will be used as independent variables separately for primary, secondary and tertiary (PER, SER and TER, respectively) education. The interaction terms between FDI and skill endowments allow for a differential impact of FDI (or trade) for different types of countries. More specifically, we constructed deviations from the world average skill endowments, as follows:

$$S\tilde{E}_{it} = \frac{SE_{it} - SE_t}{\sigma_{SE_t}},$$

for the skill endowment (*SE*) and where σ_{SE_t} is the cross country standard deviation, and then we interacted these deviations with the FDI variables.

The main interest of this paper is to examine the coefficient on the interaction term between FDI and *SE*. The theoretical overview showed that FDI might lead to increased

international skill inequality. This can be examined by testing whether γ_2 is positive and significant, i.e. that FDI would lead to skill enhancement in those countries already well endowed with skills.

4. Description of the Data

This paper combines data from different data sources, including WDI, UNESCO, UNCTAD and the Barro and Lee educational attainment data set. The dependent variable is the gross enrolment rate in primary, secondary and tertiary education. These separate series were taken from the WDI database and constructed as averages over the relevant 5-year time period (e.g. 1970–74, 1975–79, etc.).

We used various sets of explanatory variables in our econometric model. First, we needed a measure of the stock of human capital or initial skill endowments in the country. This is defined as the average number of years of schooling. We used average years of secondary schooling, but the results were similar when primary or tertiary education was considered and slightly lower. These indicators came from the extended Barro and Lee indicators. Following Wood and Ridao-Cano, we measured initial skill endowment at the beginning of the 5-year interval.

Second, indicators for educational opportunities were proxied by government expenditure on education (government expenditure per student as percentage of GDP per capita: separately in primary, secondary and tertiary education) and public spending on education as percentage of GDP. The ratio of pupils to teachers in primary education was used as a proxy for education quality. Both measures were taken from the WDI.

A third set of explanatory variables consisted of FDI variables. These were taken from three different sources. FDI flows were taken from WDI and used the FDI flow to GDP ratio and FDI net inflows as percentage of gross capital formation. Data on stock of FDI came from UNCTAD, including inward FDI stock as percentage of GDP. Finally, we used the real stock of FDI originating from the USA (Bureau of Economic Analysis) and UK (Office of National Statistics).

The trade variables were taken from the WDI: total exports in goods and services, exports in manufacturing and exports in high-tech manufacturing, all expressed as percentage of GDP. Unfortunately, only the former yielded a sufficient number of observations. GDP per capita (in log) and land endowment, measured as the logarithm of squared kilometre per thousand adults, were both taken from the WDI.

Most of the variables (enrolment rates, trade measures, FDI, pupils/teachers, public expenditure on education) are defined as averages over the current 5-year period. However, the initial skill and land endowments and GDP per capita are defined at the beginning of the 5-year period. It is sometimes argued that education and skill levels determine the incentives and ability to trade, and vice versa, and thus enrolment rates and trade variables are jointly determined. The same may also apply to FDI, thus we used the average number of years of schooling in the population (rather than enrolment rates) measured at the beginning of each of the 5-year periods. While endogeneity was not thought to be a major challenge in Wood & Ridao-Cano (1999), perhaps because education enrolment rates are used as the dependent variable rather than the stock of human capital (a more common determinant of FDI), we shall present and discuss equations that include lagged FDI variables. Lagged FDI variables will not be endogenous to contemporaneous movements in enrolment rates. We are therefore

confident that the above procedures deal with the potential problem of endogeneity bias.

We selected data for 158 low- and middle-income countries for as many 5-year intervals as possible in the period 1970–2003. This left us with a panel data set of 111 countries for seven 5-year time periods. Charts of the data are available from the authors.

5. Estimation Results

This section discusses the estimation results. It first presents pooled ordinary least square (OLS) estimations which can serve as a benchmark and then provides more detailed estimations with different econometric and economic specifications and different explanatory variables to test for the robustness of the results. We add time effects (time dummies to test for the presence of unexplained trends in enrolment rates), allow for within country and time period correlation using "robust" estimators, apply panel data estimation techniques and include more explanatory variables.

Table 1 reports regression results for primary and secondary education estimating equation (2) using pooled OLS, panel estimation with fixed effects and random effects. The upper panel of Table 1 shows the results for primary education where the explanatory variable FDI is measured by the FDI inflow as a percentage of gross capital formation. Columns 1–3 show the OLS results, columns 4–6 show the panel fixed effects estimations and columns 7–9 show the panel random effects estimations. The impact of FDI on primary enrolment rates does not seem to be precisely estimated in all estimations. The OLS estimates found a high correlation between FDI and primary enrolment, but this disappeared once we used additional controls (compare column 1 with columns 2 and 3). We found no significant impact of the interaction between FDI and skill level.

The results for secondary education are different. While the effect of FDI on secondary education enrolment rates was in most specifications negative but insignificant, the coefficient on the interaction term was positive and significant. It was smaller when fixed effects or random effects were used, but overall it was indicative of a positive link between FDI and secondary enrolment for countries with a higher skill endowment. This is important as it implies that FDI enhances skill development in countries that are relatively well endowed with skills initially. The econometric evidence thus suggests that there are significant differences in the relationship between FDI and enrolment rates for different types of education and in variation of that effect with respect to initial skill endowment.

Table 2 reports the results of the same model but with a different measure of FDI: gross FDI as a percentage of GDP. For considerations of space, we report on key explanatory variables only (full results are available from authors). The results in Table 2 are similar to those in Table 1, providing some initial indication of the robustness of the results. We report additional evidence for tertiary education in Table 3, which uses the same FDI indicator as in Table 2. We found a strong positive and significant effect of FDI on tertiary enrolment rates when interacted with initial skill endowment. The estimated coefficients are similar to those estimated for secondary education. In addition, there is a direct correlation between tertiary enrolment rates and FDI; see earlier results by Noorbakhsh *et al.* (2001).

Tables 4 and 5 provide further results in summary format (full results available from the authors). Table 4 reports pooled OLS estimation results for primary and secondary education enrolment, whereas Table 5 presents a summary of the results from panel regressions for primary and secondary education. In these tables, we report results for

Table 1. Primary and secondary education enrolment rates: OLS and panel results

	Primary education enrolment rates								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Panel fixed effects			Panel random effects		
FDI: net inflow as percentage of gross capital formation (GCF)	0.24	0.08	−0.04	−0.13	−0.11	−0.11	−0.08	−0.05	−0.09
	(0.08)**	(0.07)	(0.14)	(0.06)*	(0.06)	(0.10)	(0.06)	(0.06)	(0.09)
Public spending on education		0.02	−0.03		0.89	0.73		0.53	0.42
		(0.39)	(0.43)		(0.35)*	(0.40)		(0.32)	(0.35)
Pupil/teacher ratio		0.12	0.20		0.49	0.52		0.33	0.38
		(0.10)	(0.13)		(0.10)**	(0.13)**		(0.09)**	(0.11)**
log(GDP per capita)		11.8	13.1		5.3	8.5		11.4	14.1
		(1.12)**	(1.47)**		(2.6)*	(3.4)*		(1.4)**	(1.9)**
Skill endowment			*0.14*			*− 0.13*			*− 0.09*
**Net inflow FDI as % of GCF*			*(0.13)*			*(0.09)*			*(0.08)*
Constant	77.1	−4.8	−7.6	73.5	21.3	3.0	80.1	−8.1	−24.4
	(3.5)**	(11.2)	(14.2)	(1.5)**	(17.5)	(23.6)	(2.41)**	(11.3)	(15.2)
Observations	661	504	313	661	504	313	661	504	313
R-squared	0.11	0.30	0.34	0.31	0.37	0.33			

	Secondary education enrolment rates								
	OLS			Panel fixed effects			Panel random effects		
FDI: net inflow as percentage of gross capital formation	0.21	0.03	−0.10	−0.07	0.01	−0.09	−0.05	0.02	−0.09
	(0.11)*	(0.08)	(0.16)	(0.04)	(0.04)	(0.06)	(0.04)	(0.04)	(0.06)
Public spending on education	0.89	0.43		0.74	0.59		0.89	0.55	
		(0.37)*	(0.25)		(0.24)**	(0.24)*		(0.23)**	(0.22)*
Pupil/teacher ratio		−0.72	−0.39		−0.22	−0.29		−0.42	−0.33
		(0.08)**	(0.08)**		(0.07)**	(0.08)**		(0.07)**	(0.07)**
log(GDP per capita)		10.8	10.7		13.5	11.1		13.9	12.3
		(0.88)**	(1.04)**		(1.77)**	(2.02)**		(1.15)**	(1.27)**
Skill endowment			*0.42*			*0.12*			*0.16*
**Net inflow FDI as % of GCF*			*(0.14)***			*(0.05)**			*(0.05)***
Constant	23.3	−21.0	−28.9	57.0	−55.4	−41.5	61.3	−54.7	−25.6
	(2.16)**	(8.48)*	(9.52)**	(1.08)**	(12.3)**	(13.9)**	(2.3)**	(8.7)**	(9.9)*
Observations	638	493	313	638	493	313	638	493	313
R-squared	0.29	0.66	0.64	0.61	0.70	0.72			

*Significance at the 5% level, **significance at 1%; robust estimation.
Note: Standard errors within parantheses.

Table 2. Primary and secondary education enrolment rates: OLS and panel results

	Primary education enrolment rates								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Panel fixed effects			Panel random effects		
FDI: gross FDI as % of GDP	0.44	0.31	−0.27	−1.0	−0.93	−1.08	−0.33	−0.67	−0.95
	(0.13)**	(0.21)	(0.28)	(0.21)**	(0.20)**	(0.25)**	(0.15)*	(0.19)**	(0.24)**
Skill endowment			*1.01*			*− 0.04*			*0.11*
**Gross FDI % GDP*			*(0.28)***			*(0.31)*			*(0.31)*
Observations	597	462	282	597	462	282	597	462	282
R-squared	0.11	0.22	0.33	0.28	0.32	0.32			
	Secondary education enrolment rates								
	OLS			Panel fixed effects			Panel random effects		
FDI: gross FDI as % of GDP	0.19	0.17	−0.16	−0.40	−0.24	−0.31	−0.22	−0.12	−0.30
	(0.29)	(0.27)	(0.27)	(0.16)*	(0.15)	(0.15)*	(0.13)	(0.15)	(0.15)*
Skill endowment			*1.51*			*0.34*			*0.53*
**Gross FDI*			*(0.31)***			*(0.19)**			*(0.18)***
Observations	576	453	282	576	453	282	576	453	282
R-squared	0.2535	0.6121	0.6473	0.5572	0.6323	0.6851			

*Significance at the 5% level, **significance at 1%; robust estimation; other explanatory variables included as in Table 1.
Note: Standard errors within parantheses.

Table 3. Tertiary education enrolment rates: OLS and panel results

	Tertiary education enrolment rates								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS			Fixed effects			Random effects		
FDI: gross FDI as % of GDP	−0.03	−0.07	−0.30	0.13	0.18	0.11	0.04	0.17	0.09
	(0.07)	(0.11)	(0.10)**	(0.09)	(0.09)*	(0.07)	(0.07)	(0.09)*	(0.06)
*Skill endowment *Gross FDI % GDP*			*0.37*			*0.32*			*0.33*
			*(0.15)**			*(0.08)***			*(0.08)***
Observations	522	423	272	522	423	272	522	423	272
R-squared	0.19	0.48	0.56	0.45	0.47	0.58			

*Significance at the 5% level, **significance at 1%; robust estimation; other explanatory variables included as in Table 1.
Note: Standard errors within parantheses.

Table 4. Summary OLS regressions results: primary and secondary education enrolment rates

		Primary education enrolment rates		Secondary education enrolment rates	
	Dependent variable:	(1) FDI net inflow as % of GCF	(2) Gross FDI as % of GDP	(3) FDI net inflow as % of GCF	(4) Gross FDI as % of GDP
OLS, no time dummies and not robust	FDI coefficient	0.18*	0.59*	0.3*	0.84*
	FDI coefficient		X	0.17*	X
	Interaction coefficient (between FDI and skill endowment)		1.22*	0.42*	1.83*
OLS, time dummies and not robust	FDI coefficient		X	X	X
	FDI coefficient		X	X	X
	Interaction coefficient (between FDI and skill endowment)		1*	0.42*	1.50*
OLS, time dummies and robust	FDI coefficient		X	X	X
	FDI coefficient		X	X	X
	Interaction coefficient (between FDI and skill endowment)		1.01*	0.42*	X

*Significance at 5%, robust estimation where indicated; other explanatory variables included as in Table 1; X denotes that coefficient is insignificant.

Table 5. Summary panel regressions results: primary and secondary education enrolment rates

		Primary education enrolment rates		Secondary education enrolment rates	
	Dependent variable:	(1) FDI net inflow as % of GCF	(2) Gross FDI as % of GDP	(3) FDI net inflow as % of GCF	(4) Gross FDI as % of GDP
Fixed effects, no time dummies and not robust	FDI coefficient	0.17*	X	0.33*	0.56*
	FDI coefficient	X	−0.63*	0.22*	X
	Interaction coefficient (between FDI and skill endowment)	X	X	0.13*	0.86*
Fixed effects, time dummies and not robust	FDI coefficient	−0.11*	−0.93*	X	X
	FDI coefficient	X	−1.08*	X	−0.31*
	Interaction coefficient (between FDI and skill endowment)	X	X	0.12*	0.39*
Random effects, no time dummies and not robust	FDI coefficient	0.17*	X	0.31*	0.64*
	FDI coefficient	X	−0.57*	0.23*	X
	Interaction coefficient (between FDI and skill endowment)	X	0.55*	0.17*	1.1*
Random effects, time dummies and not robust	FDI coefficient	X	−0.67*	X	X
	FDI coefficient	X	−0.95*	X	−0.30*
	Interaction coefficient (between FDI and skill endowment)		0.11*	0.16*	0.52*

*Significance at the 5% level, **significance at 1%; robust estimation where indicated; other explanatory variables included as in Table 1; X, coefficient is insignificant.

three different measures of FDI. The panel estimates indicate mixed results for primary enrolment rates. There is a positive and significant relationship between FDI and enrolment rates in OLS estimation, but the coefficient on the interaction variable is negative and significant, which implies that for primary education enrolment the effect of FDI is smaller in countries with higher initial skill level. However, the results for secondary education are different. In all OLS specifications (with/without time dummies, with/without controlling for within country and time period correlation) we found significant and positive effects of FDI on secondary enrolment rates. These coefficients are larger in size and more precisely estimated than in the primary enrolment regressions. In addition, we found that FDI has a higher impact on secondary enrolment in more skilled countries (see interaction term), and this effect is large and significant. The panel regressions confirm these results. The effects of FDI on secondary enrolment rates are positive and significant and are robust to different specifications, and the interaction coefficients on skill endowments are also positive and significant in most specifications.

We tested whether the observed differences (of interaction terms) between primary and secondary enrolment rates were significant by estimating a regression that uses stacked data for both enrolment rates. A summary of these results is reported in Table 6. In these regressions, we added a dummy variable that equalled one if the dependent variable was the enrolment rate in primary education and equalled zero if this corresponded to enrolment in secondary education. Then we interacted this dummy variable with the FDI indicator and the skill endowment and FDI interacted variable. In column 1 we report the results of the OLS model and in column 2 (3) those of the fixed (random) effects model. We focus on the interaction coefficient (Primary × Skill endowment × FDI). The sign suggests that the role of skill endowment in the magnitude of the effect of FDI on enrolment rates is less important when primary enrolment rate is the dependent variable, and conversely the effects of FDI are bigger for secondary enrolment rates when the country is well endowed. The effects are significant only at the 10% level.

Table 6. Primary and secondary education enrolment rates: a test

	Stacked data regressions		
	(1) OLS	(2) Fixed effects	(3) Random effects
FDI: gross FDI as % of GDP	−3.9	−4.3	−4.0
	(0.87)**	(0.56)**	(0.51)**
Primary = 1	7.29	7.29	7.29
* FDI: gross FDI as % of GDP	(0.96)**	(0.59)**	(0.59)**
Skill endowment	1.86	0.78	1.6
*Gross FDI % of GDP	(0.58)**	(0.70)	(0.58)**
Primary = 1	−1.21	−1.21	−1.21
*Skill endowment	(0.77)	(0.70)	(0.71)
*Gross FDI% of GDP			
Constant	−26.9	6.7	−18.8
	(15.5)	(51.5)	(15.9)
Observations	564	564	564
R-squared	0.36	0.28	

*Significance at the 5% level, **significance at 1%, robust estimations.
Note: Standard errors within parantheses.

5.1 Sensitivity Tests and Alternative Specifications

5.1.1 Regressions including trade and FDI variables. The first addition to the standard regression is to include trade variables. Again, we took the average values over the 5-year time period as we did with the FDI indicators. In the first specification we included the trade variable, and not FDI. In a second specification we added the FDI variable. The results from the first specification (the results are available from the authors) suggest that higher exports in GDP are positively correlated with secondary enrolment rates, the coefficient being sizeable and significant in all models, that is, in OLS, the fixed effects and the random effects panel models. This confirms the basic Wood and Ridao-Cano result. In the second specification, where we added an FDI indicator along with the trade variable, the results are less precise. This is because exports and FDI are correlated and in some cases it is the coefficient on trade that remains positive and significant, whereas in other cases the coefficient on FDI is significant and positive.

5.1.2 Regressions with land × FDI and skill × FDI interactions. We have performed additional regressions for primary and secondary enrolment rates. In the first specification we included the interaction between land endowments and FDI as additional regressors and in the second specification we added the interaction between skill and FDI. In the fixed effects model for secondary enrolment rates, we found that the effect of FDI is larger for the countries with more land endowments (the land endowment FDI interaction coefficient is positive and significant). This was confirmed using both FDI measures. When we added the skill endowment interacted with FDI we found that both interacted terms' coefficients were significant (at the 10% level), with the skill endowment interaction being larger in magnitude. This implies that both land and skill endowments matter for the link between FDI and enrolment in secondary education, with skill endowments playing the more important role. In the random effects models, the results remain qualitatively the same; whilst the coefficient on the land FDI interaction term is not significant at standard levels, the skill FDI interaction terms remains positive and significant. Overall, the interaction term between skill endowments and FDI seems robust to including other interaction terms. We also estimated regressions for tertiary education with land endowment interaction terms, with the result that the coefficient on the skill interaction terms became larger and more significant.

5.1.3 Results from dynamic regressions. We have done two types of dynamic regressions. Table 7 presents the coefficient on the relevant interaction term. In the top panel, we take first differences (i.e. subtracting previous 5-year averages from current 5-year averages) of all variables that will sweep out the country fixed effects. The dynamic specification uses two measures of FDI and shows that the results from the static regressions still hold in broad terms. The interaction term is positive and significant in the equation explaining secondary (and tertiary) enrolment rates, though insignificant for primary enrolment rates. In the bottom panel, we use a lagged measure of FDI. It is possible to argue that education and FDI are jointly determined with the possibility of biased estimates. We therefore lagged FDI one period, with the interpretation that FDI (average of a 5-year period) will provide incentives for skill development in the coming 5 years. Importantly, the coefficients on the interaction terms in the secondary and tertiary

Table 7. Primary, secondary and tertiary education enrolment rates: a dynamic specification

	Primary education enrolment rates		Secondary education enrolment rates		Tertiary education enrolment rates	
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Skill endowment *net inflow FDI as % of GCF	−0.02 (0.06)		0.08 (0.03)*		0.04 (0.03)	
Δ Skill endowment *Gross FDI % GDP		0.03 (0.28)		0.22 (0.15)		0.34 (0.11)**
Observations *R*-squared	228 0.12	200 0.12	228 0.13	200 0.15	213 0.06	187 0.15
Skill endowment *Gross FDI % GDP at *t* (1		0.17 (0.31)		1.34 (0.28)**		0.51 (0.23)*
Skill endowment *net inflow FDI as % of GCF at *t* (1	0.18 (0.12)		0.54 (0.10)**		0.25 (0.08)**	
Observations	297	269	291	263	279	251
R-squared	0.30	0.29	0.67	0.67	0.60	0.59

*Significance at the 5% level, **significance at 1%; robust estimation; other explanatory variables included.
Note: Standard errors within parantheses.

enrolment equations are positive, large and significant. We experimented substantially with different and more lags of FDI variables and interaction terms. They turned out to be mostly insignificant, and did not affect the results qualitatively.

6. Discussion: FDI, Skills and Market and Co-ordination Failures

6.1 Co-ordination Failures in Education and Training Systems

Education and training systems, technological development, investment decisions and the interaction between them are associated with co-ordination failures. Many skills relevant for industrial upgrading and competitiveness arise from learning-by-doing and specialization and investment in skill and technology-intensive activities. Lall & Teubal (2001) argued that a market for setting priorities in technology development does not and cannot exist. Technological development is based on learning, and stimulating this process requires the setting of priorities, identification of linkages with education and training provisions and selection of technological promotion. This requires an overall vision of how the economy should be or could be moving forward, something that firms alone cannot do. A failure of co-ordination amongst skill formation policies and industrial or technological policy can prevent an economy from achieving a higher development path. This is because moving into new activities and adopting new technology requires sufficient, good quality and appropriate skilled workers (Bartel & Lichtenberg, 1987; Stewart & Ghani, 1991), while working with new technologies involves learning, acquiring practical experience and informal skills.

6.2 Market Failures in Skill Formation

Good quality and appropriate human capabilities are amongst the main drivers of industrial development. Good quality education provides the best basis for training and the acquisition of skills. It is widely acknowledged that there are market failures in providing education, and the market for training is also characterized by market failures. On-the-job training may be too low, as firms do not have sufficient incentives to invest in worker skills; once trained, workers can decide to work for other firms that can use their skills. Becker (1975) argued that workers have incentives to pay for general training, while firms can recoup investment in firm-specific training. However, some would argue that credit constraints due to market failures in the market for capital mean employees are not able to finance training.

Lall (2001) provides a good overview of instances of market failures in the education and training system relevant for industrial development.

- The *trainee* may not recoup all benefits of educational investments; may not be aware of future values and future need for certain educational investments; may be excessively risk averse; may lack access to certified training and capital markets.
- *Firms* may lack knowledge of best practice in training and be unable fully to appropriate the benefits.
- The *education and training system itself* can lack information on educational needs in industry (co-ordination and complementarities problem); and lack access to capital markets to fund the development of better standards

6.3 Examples

Market and co-ordination failures are also relevant to the discussion in this paper. When left to the market, FDI is more likely to be beneficial for skill development when initial skill endowments are present, but when endowments are low, FDI will have a less beneficial impact. This constitutes a co-ordination failure amongst investors and skill planners and some action is required to co-ordinate investment strategies and skill development.

Appropriate institutions in tune with private sector needs are required to provide better quantity and quality education, thereby co-ordinating the supply and demand of skills with investment decisions. The involvement of the private sector in planning and setting priorities for skills development will improve the relevance of the education and training in terms of scope and volume. The Costa Rican investment promotion agency pointed at the presence of local universities that could produce relevant graduates and a consistent and good education policy over time, which helped to persuade an Intel plant (and other high-value-added firms) to invest in Costa Rica. On their side, Intel and the government have set up joint training and technology institutes, which benefit Intel as well as other firms working in the sector. This will also help to provide a stimulus for skill development throughout the whole education system.

The Malaysian Penang Skills Development Centre (PSDC) is a good Asian example[2] of co-ordinating public and private sectors with respect to post-secondary training. The PSDC was set up in 1989 in response to a growing shortage of skilled labour in the skill-intensive operations (e.g. electronics and IT) of MNEs in the free trade zones and industrial estates. Financed initially through a pooling of public (grants, training materials, equipment and trainers) and private (donations, loan of equipment, furniture, private training facilities) resources, it is now self-financing, offering courses at competitive rates, and is officially recognized as offering technical and managerial skill training and higher education. The centre has a unique position to obtain immediate feedback from the private sector about course content and future training needs. Malaysia has involved the private sector in other aspects of planning for education and training systems (Kiong, 1997).

McGrath *et al.* (2005) examined the relationships between the automotive industry and education and training systems in South Africa. The automotive industry consists of seven MNEs and has gone from being a protected industry under the Apartheid system to being a producer and exporter of top-quality cars. Skills development has been at the forefront (in addition to the incentives programme) in making this industry internationally competitive, and the car producers have taken an active role in the formulation of human resource policies. Key institutes include the public Automotive Industry Development Centre (AIDC), which sees itself as a facilitator between the supply side (public further and higher education and training institutions) and the demand side (the automotive sector). It has signed agreements with a number of higher education providers to develop programmes for which there is a clear industry demand. Between 2001 and 2004, the AIDC invested R28 million in three public providers in Gauteng, leveraging in an additional R16 million from industry to support capacity building. The investments have led to 26 new academic posts and had reached more than 13 000 learners by mid-2004. The industry is now a loyal supporter of human resource policies. While the industry is not representative of the rest of (South) Africa, the account shows that it is possible to build up a competitive industry in the presence of appropriate mechanisms to co-ordinate skills development.

We can also illustrate FDI and skill trajectories over time at the country level. Figure 1 plots FDI (as percentage of total fixed investment) against secondary enrolment rates (similar results for tertiary education). It shows that two relatively low-skill countries, Guatemala and Honduras, have been able to attract some FDI, but this coincided with weak developments in secondary education. There are several accounts of garments firms locating in these countries that exploit low labour costs, do not need highly skilled or well-trained workers, and threaten to move on when wages rise. By contrast, in Costa Rica, which used to be similarly poor, consistent skill development policies have been able to attract not only garment assembly investors, but also electronic investors who, in turn, in co-ordination with local governments and institutes, attempt to develop skills, providing an incentive throughout the whole education system. The government's policies are more in tune with strategies of MNEs (Mortimore, 2004). The examples of Costa Rica and several Asian countries illustrate that countries that were once poor can attract high-quality FDI and develop human resources as long as appropriate policies are in place.

The right panel of Figure 1 plots a similar FDI-skill path, but for Mauritius and Nigeria. These are two very different countries, but that is also the point. Nigeria, which we defined as a low-skill country, did attract a lot of FDI, but this was in petroleum-related activities with few incentives for secondary education. The indirect impact on education through fiscal revenues was also not used sufficiently for investment in human resource development. Mauritius, a small country relatively well endowed with human resources skills, on the other hand, has been able to develop since the 1980s on the basis of foreign and local investment in garments and textiles in the Export Processing Zone (EPZ) programme (UNCTAD, 1999; Subramanian & Roy, 2003). Skills, and secondary enrolment rates in particular, developed further as a result, although currently certain technical skills required to move into high-skill activities such as financial services are under-supplied. Mauritius engaged positively with globalization, which coincided with successful human resource development.

The point is not that countries need to attract certain types of FDI alone, but that certain skills are required to attract certain types of investment and, vice versa, that certain types of investments help to develop certain types of skills. In this context, it is frequently asserted that the attraction of manufacturing FDI and the development of technical skills need to be co-ordinated. From the available but patchy data, we found some evidence for

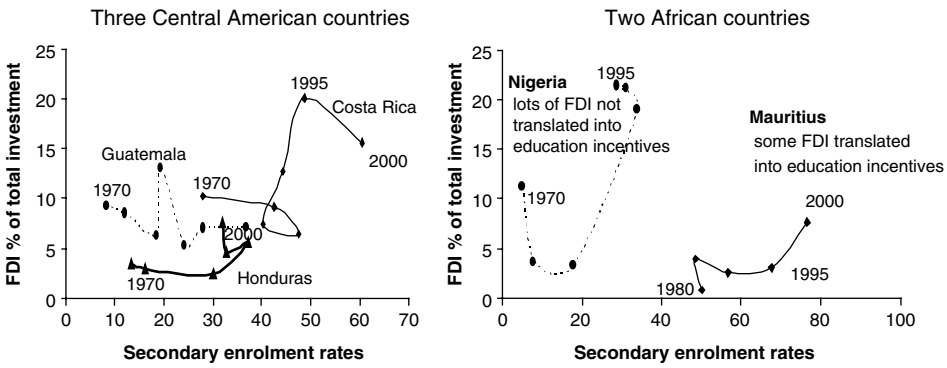

Figure 1. FDI-skill paths (1970–2000). *Source:* World Development Indicators (2004).

this, so that countries wanting to upgrade to a higher value-added path need to pursue an active human resources development and technology policy. For instance: the partial correlation coefficient between the stock of UK manufacturing FDI and the number of PCs installed in education is 0.78 and significant at the 1% level (based on 14 low- to middle-income countries in 2000); there are positive and significant partial correlations between UK (and US) FDI and research and technicians in R&D; and the stock of UK (and US) FDI as a percentage of GDP is positively and significantly correlated (significant only at the 10%b level for the year 2000 only) with ICT spending. Not all countries desire or will be able to attract certain manufacturing FDI, but it is important for all countries that the direction of human resource policy needs to be co-ordinated with and respond to investment decisions, which differ across countries.

7. Conclusions

This paper has focused on the effects of FDI on skill inequality amongst countries. The basic hypothesis is that when countries liberalize trade and investment in an environment of imperfect technology transfers, they will specialize in activities depending on the initial conditions. Countries with few skills would specialize in low-skill intensive production, while countries with a high innovation rate and skill endowment would specialize in the production of high-skill-intensive goods. This would increase inequality amongst countries and leave developing countries less well skill-endowed trapped in a low income–low skill cycle. This hypothesis was presented on the basis of both micro and macro theory. The mechanisms through which FDI affects skills development can be both indirect, through the incentives for skills development in the form of higher taxes, faster technological progress and expansion of sectors, and direct, through the provision of training and education.

We have built on the model developed by Wood & Ridao-Cano (1999), who showed that trade has raised inequality in education by raising secondary and tertiary enrolment rates more in high-skill, high-income countries than in other countries. We have modelled enrolment rates as a function of FDI and other factors measuring education opportunities in the country, income and others. We included initial skill endowment and interacted these endowments with FDI variables. This enabled us to test how FDI affects enrolment rates, depending on initial conditions.

The empirical part found that the coefficient on the interaction term between skill endowments and FDI is positive and significant in explaining secondary (and tertiary) enrolment rates. While varying between specifications, it is indicative of a positive link between FDI and secondary enrolment for countries with a higher skill endowment, while this is not true for primary enrolment rates. This is important as it implies that FDI enhances skill development in countries that are relatively well endowed with skills to start with. The econometric evidence thus suggests that there are significant differences in the relationship between FDI and enrolment rates for different types of education. Unfortunately, the level of analysis did not permit us to distinguish empirically amongst the different mechanisms through which FDI may have affected skills development, and this is clearly an issue for further research.

There are important policy conclusions for national governments when FDI tends to raise international skill inequalities, as we have shown in this paper. In particular, developing countries with low-skill endowments that attract investors would do well to co-

ordinate their human resources policies with investor needs in order to bring the country to a higher skill path. Co-ordination and market failures might keep countries in a low-skill low investment trap. It thus requires a consistent, strategic and market friendly human resource policy designed with the help of appropriate government capacities.

Notes

[1] There is a rapidly emerging literature that deals with the relationship between openness to trade and the demand for skills and education. The determinants of increased wage inequality include openness to globalization processes and technical progress and the associated organizational change. The evidence for the effects of trade on the structure of labour markets has emerged, see, for example, Wood (1997), though there is still comparatively little on the link between FDI and the structure of the labour market. Te Velde (2004) includes a survey of a handful of existing studies on FDI, and provides new evidence for Latin America..

[2] See Ashton *et al.* (1999) and Galhardi (1999) for how Asian governments were able to co-ordinate skill needs with (local and foreign) production for the global market.

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