Foreign Direct Investment as a Catalyst for Human Capital Accumulation

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I. Introduction

This paper explores the plausibility of foreign direct investment as a catalyst for human capital accumulation. Given the large body of literature dedicated to the positive effects of education and training on growth, human development and income equality, their drivers merit exploration. On a micro level, there is a large body of literature that explores the returns to schooling and numerous other factors as driving forces behind an individual's decision to pursue schooling. Yet on the macro level, the rate of human capital accumulation of an economy is taken largely as exogenous b

y growth studies.

Numerous studies within the growth literature empirically explore the effects of human capital on economic growth. Lucas' (1988) expansion of the definition of capital in the neoclassical growth model to include human capital set off a series of examinations into the correlation between human capital and growth. While demonstrating a convincing correlation between human capital and growth, these studies are not necessarily convincing about the causality. More recent studies such as those by Bils and Klenow (1998) question the assumed direction of causality from education to economic growth. In fact, Bils and Klenow postulate and present a convincing argument, using micro analysis, that anticipated economic growth (functioning through observed present and past growth) leads to faster human capital accumulation.

This paper will present a theoretical framework and evidence showing that foreign direct investment leads to higher rates of human capital accumulation. Functioning through two separate but interrelated mechanisms, foreign direct investment increases the incentives for individuals to pursue further education and therefore accelerates human capital accumulation in the economy as a whole. The primary mechanism is a signaling of future growth process much like that of the anticipated growth of the Bils and Klenow model. However, unlike domestic investment or other factors, which may play a similar signaling role, foreign direct investment also introduces a factor of accelerated technological change, which further increases incentives for individuals to seek formal training.

II. Theoretical Framework

Human Capital in the Growth Literature

Studies by Barro (1991), Levine and Renelt (1992), Benhabib and Spiegel (1994) and Barro, Mankiw and Sala-i-Martin (1995) have shown a positive correlation between country schooling and economic growth rates. Barro's studies (1991) demonstrate a positive correlation between levels of school enrollment and economic growth, while Benhabib and Spiegel's studies (1994) point to the significant impact of the level of secondary and higher education attainment on the rate of productivity growth.

These authors offer contrasting explanations for the correlations. Following the implications of the Lucas (1988) model, where human capital is treated as another form of reproducible capital, Barro, Mankiw and Sala-i-Martin (1995) postulate that transitional higher rates of human capital accumulation will lead to higher growth rates.[1] As with physical capital, faster accumulation of human capital leads to an acceleration of the economy's progress toward higher levels of output. The Benhabib and Spiegel (1994) argument, on the other hand is that the countries that possess a sufficiently high level of human capital will be able to achieve higher growth rates by having the ability to assimilate new technologies more efficaciously. In their model, which follows the work of Nelson and Phelps (1966), sufficiently high levels of human capital are a precondition for achieving growth via technological change and total factor productivity growth.

These two schools of thought, while offering different analyses of the channels from human capital to growth, are not necessarily incompatible. It is possible that an economy grows in tandem with the increasing growth of its human capital stock, as Barro and others propose and that once a higher level of human capital stock is achieved, it provides the necessary capacity to create and adopt technology so as to drive growth in a more enduring manner, even in the absence of further increases in human capital. While taking different approaches to explaining the channel from increased human capital to growth, both sets of models take increases in human capital to be exogenous. This is in contrast to the treatment of physical capital, whose accumulation is determined in neoclassical growth models by endogenous variables such as savings rates. Furthermore, these models all share the fundamental assumption that the direction of causality is from human capital to economic growth and not the other way around.

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[1] Also see Mankiw, Romer and Weil's (1992) extension of the Solow model's production function framework that includes educational capital as an input.

We can view human capital accumulation as a form of savings as well, but with dynamics that are quite different from those of physical capital. While investments in physical capital tend to be long-lived, bearing fruits through multiple generations and thus suitable for analysis in a continuous infinitely-lived dynasty framework. Investments in human capital, such as education and training, are relatively short-lived. Since the bulk of returns to investment in education or training accrue to the individual obtaining such education, such returns are largely limited to the span of that individual's life. This short-lived nature of human capital investment makes it more suitable for analysis under a model with finite-lived individuals.

An individual's choice to invest in education and forego income will largely depend on the opportunity costs, discount rate and expected returns for such investment. In this framework, the models of of Mincer (1974), Rosen (1976) and Bils and Klenow (1998) tell us that an individual will decide whether on not to pursue additional schooling based on the present value of that additional schooling compared to the opportunity cost (in terms of foregone wages and decreased present consumption) of pursuing it. Bils and Klenow specifically work future income levels into this calculation.

We will assume a production function of the following form, where Y(t) is the level of output of the economy at time t, K(t) is the level of physical capital, A(t) is the level of technology, and H(t) is the level of human capital.

$$Y(t) = K(t)^{a} \left(A(t)H(t)\right)^{1-a}$$

We will also assume that technology (A) is exogenous, but is affected by multiple factors, namely technology transfer, which is in turn affected by the level of foreign direct investment in the economy. Human capital is the stock of the human capital in the economy, measured by aggregate number of years of education in the population. Thus the total stock of human capital will grow, even if the population does not, as educational attainment increases in the population.

If we assume that labor's share of income (1-a) remains constant over time, and income grows due to increased levels of physical capital then holding constant technology (A), the return per unit of human capital will also increase. An individual who at time t is faced with the choice of foregoing current income to pursue further education will face an opportunity cost as that is a function of the rate of return per unit of human capital and the units of human capital she possesses at time t. The benefit from the "education option" will be the net present value of the incremental returns she will receive from attaining the additional units of human capital. As the individual perceives the return per unit of human capital increasing in time t+n, the value of the education option increases.

Thus levels of investment and consequent growth will be key factors in an individual's decision of whether or not to forego current income in order to pursue education and attain further human capital. Higher levels of investment and economic growth imply an increasing net present value of the education option relative to current income. Such an increase in the relative value of "the education option" will induce a larger number of individuals to pursue further education and thus increase the rate of human capital accumulation in the economy. Bils and Klenow (1998) demonstrate that while the evidence for human capital accumulation leading to economic growth is weak, there is strong evidence that growth, particularly technology-driven growth, leads to higher rates of human capital accumulation. A recent cross country study (Princhett, 1999) finds scant evidence for increases in educational attainment leading to increased economic growth. Another study uses analysis based on Barro's studies, to show that schooling enrollment in 1975 is more correlated with past growth (the period from 1960 to1975) than it is with future growth (the period from 1975 to1990). (Bils and Klenow, 1998)

Since an individual's decision to forego current income and invest in education is made prospectively, she must rely on signals of anticipated growth in order to assess and compare the present value of her options. In this context, investment and technological change play important roles as signaling mechanisms to induce individuals to pursue schooling. Individuals are able to observe increasing levels of investment directly and they are able to observe technological change through changes in the wage structure of the labor market, as described below. If we accept that increased levels of investment in the economy signal faster future economic growth, such higher levels of investment should trigger the higher demand for schooling. Technological change has similar effects.

In our model, increasing levels of technology have a result similar to that of increased levels of investment—they increase output, and consequently the return per unit of human capital. If we make the additional assumption that new technology increases the demand for workers with high levels of human capital relative to those with low levels, then the technological change further increases the present value of the "education" option. Such skill-biased technological change would further increase the incremental returns to the attainment of human capital for an individual, by pushing up future wages for individuals with high levels of human capital. Foster and Rosenzweig (1996) find evidence that the channel from growth to schooling is more pronounced when the growth is induced by skill-biased technological change. It would thus follow that investment that brings about skill-biased technological change would serve as a powerful catalyst for increased school enrollment. Foreign direct investment presents an example of such investment.

Complementarity of Foreign Direct Investment and Human Capital

Foreign direct investment (FDI) plays a key role in fostering economic growth through various channels. Foreign investment, whether in the form of portfolio investment, foreign lending or direct investment, increases the amount of savings available to a country for investment. For developing countries, where the paucity of domestic savings is often a barrier to long-term growth, foreign investment can be a crucial factor in escaping a poverty trap. The higher levels of investment made possible by foreign investment will lead such countries to steady states at higher levels of capital and per capita income and transitionally accelerate growth. By increasing the capital to labor ratio in the economy, the higher levels of capital will also lead to increases in labor productivity, and consequently to higher shares of income for labor. Furthermore, studies have shown that that the positive growth effects of FDI are much higher than equivalent amounts of domestic investment.[2]

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[2] DeGregorio (1992) shows in a panel data of Latin American countries that FDI is about three times more efficient than domestic investment.

In addition to these benefits, FDI, as opposed to portfolio investment or other types of foreign investment, has the added benefit of technology transfer. Borensztein, De Gregorio and Lee (1995) postulate that FDI is an important vehicle for transfer of technology from more developed countries to less developed ones, making it an important factor for growth—one whose contribution to growth is relatively greater than domestic investment. As foreign enterprises or multinational corporations (MNCs) invest in developing countries, they introduce capital whose effects are multifold. Beyond the primary effects of capital stock augmentation, there are secondary "capital deepening" effects that come from the introduction of new varieties of capital goods and more advanced technologies to the recipient economy. Given that MNCs possess advantages that allow them to introduce these more advanced technologies at lower costs than domestic enterprises, investment by foreign firms contributes more to growth than equivalent investment by domestic firms.

However, these secondary growth benefits from FDI achieved through the technology transfer channel accrue only to economies that possess a sufficient human capital base to absorb the advanced technology. In fact, Borensztein, De Gregorio and Lee (1995) find that below a certain threshold of human capital,[3] FDI has a negative effect on growth. These findings seem to support the growth literature that stresses the necessity of high levels of human capital in order to effect growth through technological change.[4] The authors also suggest that given FDI's role as a vehicle for the adoption of new

[3] The threshold estimated by the Borensztein, De Gregorio and Lee model is a male population above 25 years of age with an average of 0.45 years of secondary schooling.
[4] Such theories have been proposed and tested by Benhabib and Spiegel (1994)

technologies, it should positively affect the rate of human capital accumulation. However, they do not explore possible channels through which this effect might occur. They leave the matter for further research.

One likely channel is the role that FDI plays as a signaling mechanism to workers in the recipient country. There are several ways that FDI can play this role. The most evident for workers will be prices in the labor market. The new technology and new types of capital introduced by the MNCs will lead to production methods that are more skill-intensive that those of existing firms. Such an increase in skill-biased production will in turn cause an increase in relative demand for skilled labor. With the supply of skilled labor inelastic in the short run, this will lead to an increase in the wages of skilled workers relative to those of unskilled workers. These wage changes need not be immediate to induce workers to pursue education. As with any asset, the present value of the education option is affected by its expected future price. Thus a worker need only expect that technological change will affect relative wages in the future to change her behavior today.

A worker will also perceive FDI as a signal of higher overall levels of investment in the economy and faster future economic growth. In a Mincerian framework, this will increase the present value of future returns to education. As with the expected change in relative wages caused by technology, the expected faster growth will increase the present value of pursuing education and training for individuals, inducing a greater number of them to forego current income and seek schooling instead. Thus through these various signaling channels, FDI will lead to a higher overall demand for education in the economy, and given a sufficient supply response, should lead to higher rates of human capital accumulation

III. Data and Results

The empirical analysis in this paper will show that FDI does in fact accelerate the accumulation of human capital. The study is based on a panel of data on educational attainment, FDI flows, domestic investment and education spending in five-year intervals from 1965 to 1995 for 138 countries. We will also demonstrate how FDI has affected the labor markets in Mexico and Ireland over the past few decades as these countries have experienced heavy inflows of FDI. We will then demonstrate how the increasing wage differentials between skilled and unskilled workers caused by higher FDI inflows have accelerated school enrollment rates in these countries.

The Data

The dependent variable in these studies is the rate of human capital accumulation, as measured by Barro and Lee's (1993) *International Comparisons of Educational Attainment* and the recently published (2000) addendum to this data set. Barro and Lee's educational attainment data describes the educational stock of a country over a series of years. The educational stock is measured as the average number of years of schooling completed by people over the age of 15 in the population. Barro and Lee present such figures for total years of schooling and for the various levels of schooling (i.e. primary, secondary, tertiary). Our study will focus on the effects of FDI on educational attainment in general (as measured by Barro and Lee's total years of schooling variable) and on secondary schooling in particular (as measured by Barro and Lee's years of secondary schooling variable). The reasons for the focus on secondary schooling are enumerated below.

Since the authors present the data for levels of educational attainment in five-year intervals, we measure the growth of human capital by taking the log difference between two data points and dividing by the number of years between the two data points. This gives us the annual growth rate of schooling attainment over the period of analysis. Since the data begin in 1960 and extend through 1999, we are able to obtain up to six observations for growth rates over five-year periods for any given country. However, as dependent variables are lagged to the period preceding the period of analysis and corresponding observations of these dependent variables are not readily available for periods prior to 1965, we are limited in practice to four observations per country for growth rates over five-year periods and three observations per country for growth rates over ten-year periods.

The data on FDI is from the World Bank's *World Development Indicators 2000 CD-ROM*. While there are other sources for such data, namely the Organization for Economics Cooperation and Development's (OECD) *Geographical Distribution of Financial Flows to Aid Recipients*, that Borensztein, De Gregorio and Lee (1995) use in their study, such data are not available for periods before the late 1980s and thus are not sufficient to obtain the multiple observations necessary for a panel analysis. Furthermore, such data are only for FDI flows from OECD countries to developing countries and therefore are limited in scope. The World Bank compiles data on FDI mainly from balance of payments data reported by the International Monetary Fund, and supplements this with data from the OECD and official national sources.

As we are looking to analyze sustained levels of FDI flows, and the data for FDI are quite erratic from year to year due factors such as currency fluctuations, political factors and project specific bursts, there is need to smooth out such flows. To coincide with the five-year interval nature of our data for changes in human capital, we have calculated five-year averages of FDI flows, so as to have these data coincide with the human capital data. We also use gross domestic investment (GDI) figures from World Bank sources as a control variable in our study. We adjust raw gross figures reported by the World Bank by subtracting out the corresponding FDI figures to obtain a figure for gross domestic investment net of foreign direct investment, since FDI makes up part of GDI and we want to separate its effects from those of domestic investment and avoid double counting of investment. The figures are then smoothed out over five-year periods as with the FDI figures. The remaining variables for education spending as a percentage of GDP, and per capita income levels also come from World Bank sources. Education figures are also smoothed out over five year periods to coincide with the five-year intervals of the educational attainment data.

The following is a summary of the data:

TABLE 1

Variable	No. Obs.	Mean	Std. Deviation	Minimum	Maximum
SecYrsSch	913	1.21	1.14	0.01	5.09
TotYrsSch	903	4.59	2.90	0.04	12.25
SecYrsSch60	900	0.67	0.83	0.01	4.59
TotYrsSch60	864	3.39	2.53	0.07	9.56
Log(SecYrsSch60)	900	-1.13	1.31	-4.42	1.52
Log(TotYrsSch60)	864	0.82	1.05	-2.60	2.26
?SecYrsSch5	707	3.94	5.29	-15.93	36.60
?SecYrsSch10	605	4.26	3.88	-10.18	24.96
?TotYrsSch5	697	2.43	3.19	-17.75	30.08
?TotYrsSch10	595	2.57	2.52	-6.64	26.79
FDI/GDP	507	1.46	2.23	0.00	16.52
DomInv/GDP	501	21.52	7.66	0.31	77.00
EdSpend/GDP	746	4.20	1.81	0.38	10.86
GDPPerCap60	909	2451.39	2315.00	313.00	9895.00
Log(GDPPerCap60)	590	7.90	1.15	5.42	10.37

Our basic empirical model is an ordinary least squared model, which is as follows for a five-year period of analysis:

$$?HumCap_i = ß_1 + ß_2 \ln(InitPerCapGDP_i) + ß_3 \ln(InitHumCap_i) + ß_4(EdSpend/GDP_{i,\,t-5}) + ß_5(FDI/GDP_{i,\,t-5}) + ß_6(DomInv/GDP_{i,\,t-5}) + e_i$$

Where the change in human capital is the annual growth rate of average years of schooling over a five-year period and the initial per capita income and initial stock of human capital is the respective level in 1960 for the country being observed. Education spending, FDI and domestic investment figures are five-year averages lagged to the five-year period immediately preceding the five-year period of analysis. This same model is used for ten-year period analyses, and in those cases, the education, FDI and domestic investment figures are from the immediately preceding five-year period.

We also study the effects of FDI in a cross-sectional time-series analysis framework. For most countries, we have multiple observations representing different five or ten-year time periods. For this model, we exclude variables that control for initial conditions and our basic model is as follows:

$$?HumCap_{i,t} = ß_1 + ß_2(EdSpend/GDP_{i,\,t-5}) + ß_3(FDI/GDP_{i,\,t-5}) + ß_4(DomInv/GDP_{i,\,t-5}) + e_{i,t}$$

Where *t* is the observation for time period *t* and *i* is the observation for country *i*. As with out OLS model, the dependent variables are lagged to the period immediately preceding the period of analysis and this same model is used to analyze growth rates over ten-year periods, with lags adjusted accordingly.

Empirical Results

If individuals are using investment levels in the economy to make decisions about the pursual of further education, then we should find a positive correlation between the levels of investment immediately preceding a period of analysis and the increase in total years of schooling in the population for that period. If we take education spending to be a proxy for supply of educational opportunity in the economy then we should find a similar positive correlation between education spending and the increase in schooling.

We control for initial levels of schooling, for a number of reasons. First, we assume that given the limited lifespan of individuals, and the fact that investments in education must be recovered over some time after education ends, there is a limit in the average number of years of education that a population can achieve. Thus the rate of human capital accumulation among countries with already high levels of schooling will be lower than that of countries with low levels of schooling. Furthermore, in countries with high stocks of human capital, increases in demand for human capital created by increased investment and technological can be more easily accommodated than in countries where skilled labor is scarce. Thus the wage effects in such countries will be muted and the incentives for pursual of further education will be less pronounced than in the skilled labor-scarce country. Finally, Bils and Klenow's (1998) studies based on Psacharopoulos' (1994) estimates of Mincerian returns[5] to education for 56 countries demonstrate that countries with higher levels of schooling display lower Mincerian returns to education, suggesting that there are diminishing returns to education at the margin and therefore lower incentives for cadres of individuals with already high levels of education to pursue further education. Thus we should expect to find a negative correlation between initial educational attainment and subsequent rates of human capital accumulation.

The first set of regressions (Table 2) seeks to find such correlations in five-year periods. We test for correlation between levels of investment and education spending in a given period and the change in educational attainment of a subsequent period. Given the intertemporal nature of this correlation, it is logical to assume that the investment and spending would lead to the subsequent changes in educational attainment. The alternative explanation that the prospect of increased educational attainment in the future would affect investment levels is more difficult to explain. However, the causation of educational spending could perhaps be explained in this way, where anticipated increases in demand for schooling (perhaps signaled by the concurrent higher investment levels) leads policy makers to increase educational spending. We discuss the alternative interpretations of this causality below.

[5] The internal rate of return on investments in education is often referred to in the labor economics literature as Mincerian returns, after the seminal work of Jacob Mincer (1974). Mincer's studies on schooling, experience and earnings are based on the theory that individuals undertake the costs associated with pursuing education because such investment will raise the level of the deferred income streams. Thus, at the time such investment is undertaken, "the present value of real earnings streams with and without investment are equal only at a positive discount rate. This rate is the internal rate of return on investment." (Mincer, 1974, p. 7). Psacharopoulos (1994) has compiled such internal rates of return for 56 countries.

Our first regression in Table 2, shows that initial levels of educational attainment, as measured by the average total number of years of schooling, is negatively correlated with subsequent accumulation of human capital as measured by school attainment. This result, which matches our predictions, demonstrates that there is convergence in the levels of educational attainment among countries, with human capital poor countries accumulating human capital faster than human capital rich ones. Also, as we expected, there is a positive correlation between education spending and subsequent growth rate in educational attainment, with each additional percentage point of GDP that is spent on education increasing the growth rate of educational attainment by 0.13 percentage points. While there is no significant correlation between net domestic GDI, there is a correlation between FDI and the growth rate in human capital, with each additional percentage point of GDP that is comprised by FDI increasing the growth rate of human capital by 0.12 percentage points. We also find that there is no correlation between initial level of income per capita and subsequent growth in school attainment. The effects of differing levels of development are perhaps captured by the highly significant correlation between initial level of school attainment and subsequent growth in school attainment.

TABLE 2

	(1) ?TotYrsSch5		(2) ?SecYrsSch5		(3) ?TotYrsSch5		(4) ?TotYrsSch5	
Log (TotYrsSch60)	-1.415	***			-1.405	***	-1.352	***
	(-6.628)				*(-6.602)*		*(-8.392)*	
Log (SecYrsSch60)			-0.912	***				
			(-2.909)					
Log (GDPPerCap60)	0.026		-0.575	*	0.101			
	(0.154)		*(-1.656)*		*(0.451)*			
FDI/GDP $_{t-5}$	0.123	**	0.214	*	0.104	*	0.111	**
	(2.208)		*(1.818)*		*(1.857)*		*(2.106)*	
DomInv/GDP $_{t-5}$	0.027		0.075	**	0.024		0.024	
	(1.382)		*(2.025)*		*(1.209)*		*(1.197)*	
EdSpend/GDP $_{t-5}$	0.136	*	0.131		0.133	**	0.140	**
	(1.949)		*(0.921)*		*(2.008)*		*(2.106)*	
Africa Dummy					0.315		0.208	
					(0.566)		*(0.468)*	
LatinAmCar Dummy					0.089		0.042	
					(0.311)		*(0.16)*	
East Asia Dummy					0.633		0.610	
					(1.063)		*(1.03)*	
Constant	2.015		5.172	*	1.355		0.068	
	(1.535)		*(1.707)*		*(0.724)*		*(0.724)*	
No. of Observations	277.000		283.000		277.000		277.000	
R2	0.298		0.126		0.302		0.302	

Numbers below estimates in italics are robust t-statistics.
*Significance indicated by *** (1%), **(5%) and *(10%)*

Our second regression in Table 2 measures the effect of these same variables on the accumulation of human capital as measured by the average number of years of secondary schooling in the population. We find a convergence effect very similar to that of the first regression—a negative correlation between the initial levels of secondary school attainment and subsequent growth rates in secondary school attainment. In addition to this convergence effect, we find that there is an effect of initial income levels on growth of secondary schooling, an effect we did not see for total schooling. Poorer countries have higher levels of growth in secondary schooling attainment, above and beyond the convergence effect of lower initial levels of secondary schooling attainment. Surprisingly, in this case, we find that education spending is not correlated with growth in human capital. As for investment, we find that there is a significant positive correlation between domestic investment and growth in human capital, but this effect is much smaller than the effect of FDI, which is also positively correlated with human capital growth. For each additional percentage point of GDP that is comprised by FDI, the growth rate of human capital increases by 0.21 percentage points as opposed to only 0.075 percentage points related with an equivalent increase in domestic investment. However, whereas our model explains nearly 30% of the variance in growth rates of total schooling attainment, it only explains 12.6% of the variance in growth rates of secondary schooling attainment.

We expand the examination of growth in total years of schooling by introducing regional dummy variables. From the third regression in Table 2, we find that regional peculiarities have no significant effects on the growth rates of schooling attainment and the effects of FDI persist across regions, if with a less statistically significant correlation. In the fourth regression in Table 2, we drop the initial per capita income variable, given that its effects are insignificant on growth rates of total schooling. The model maintains its explanatory value at 30.2% and the positive effects of FDI on schooling growth once again become significant at the 5% level.

When we change our examination to ten-year time periods, we find evidence of many of the same effects as in out five-year period analyses. The convergence effect persists in all of our regressions in Table 3, with a negative correlation between the initial level of schooling and the subsequent growth rate. Initial income levels, on the other hand are not significantly correlated with the growth rate of schooling. In the case of education spending, there is not a statistically significant correlation with the subsequent growth rate in schooling attainment in all of our studies. Regressions 2 and 5, which measure the effects on the growth rate of secondary schooling attainment, show no significant effect of education spending. However, there is a significant positive effect of education spending on human capital growth in regressions 1, 3 and 4, which measure its effect on the growth rate of total years of schooling. In these latter cases, for each additional percentage point of GDP spent on education, there is approximately a 0.1 percentage point increase in the growth rate of average total years of schooling in the population in the subsequent ten-year period. It is also interesting to note that when we drop the variable for initial income levels, in regression 3, we observe a significant positive trend in the growth rate of schooling of approximately 2% per annum.

TABLE 3

	(1) ?TotYrsSch10	(2) ?SecYrsSch10	(3) ?TotYrsSch10	(4) ?TotYrsSch10	(5) ?SecYrsSch10
Log (TotYrsSch60)	-1.453 ***		-1.398 ***	-1.448 ***	
	(-8.895)		*(-11.242)*	*(-8.841)*	
Log (SecYrsSch60)		-1.180 ***			-1.232 ***
		(-5.167)			*(-3.564)*
Log (GDPPerCap60)	0.075	-0.152		0.104	-0.115
	(0.599)	*(-0.67)*		*(0.65)*	*(-0.318)*
FDI/GDP $_{t-10}$	0.131 ***	0.301 ***	0.134 ***	0.117 ***	0.234 **
	(3.482)	*(3.11)*	*(3.578)*	*(2.989)*	*(2.192)*
DomInv/GDP $_{t-10}$	0.035 **	0.060 **	0.036 **	0.030 *	0.072 **
	(2.158)	*(2.027)*	*(2.27)*	*(1.775)*	*(2.217)*
EdSpend/GDP $_{t-10}$	0.101 **	0.011	0.105 **	0.106 **	0.010
	(2.121)	*(0.122)*	*(2.207)*	*(2.148)*	*(0.095)*
Africa Dummy				0.137	1.361 *
				(0.375)	*(1.69)*
LatinAmCar Dummy				0.038	0.198
				(0.169)	*(0.446)*
East Asia Dummy				0.685	1.118
				(1.802) *	*(1.44)*
Constant	1.546	2.046	2.073 ***	1.329	3.472
	(1.558)	*(0.976)*	*(4.864)*	*(0.99)*	*(1.103)*
No. of Observations	192.000	196.000	192.000	192.000	192.000
R2	0.562	0.334	0.562	0.570	0.3386

Numbers below estimates in italics are robust t-statistics.
*Significance indicated by *** (1%), **(5%) and *(10%)*

In these ten-year period analyses, the effects of investment on subsequent schooling growth rates is more pronounced than in our five-year studies. The first regression in Table 3 demonstrates once again that domestic investment levels have a positive impact on the subsequent growth of human capital, when this is measured by average total years of schooling in the population. This is in contrast to our five-year period studies, in which there was no significant effect of domestic investment. In this case, each additional percentage point of GDP comprised by domestic investment corresponding to a growth rate of human capital that is 0.035 percentage points higher. In this study, FDI has an effect very similar to that of the previous studies, with each additional percentage point of GDP comprised by domestic investment corresponding to a growth rate of human capital that is 0.131 percentage points higher. The model in regression 1 explains 56.2% of the variation in the annual growth rates of average total years of schooling in the population across countries and time.

Shifting the focus to the growth rates of secondary schooling attainment, we find results that are very similar, but where the effects of investment levels are more pronounced than in the growth of total schooling. It is important to note that levels of average secondary schooling are very low for much of our sample. The mean average level of secondary schooling in 1960 for the countries in our sample was a mere 0.67 years, with Niger's population possessing an average of less than two months. With such low initial levels, it is possible to achieve very high growth rates with even small improvements in the level of education, as several African countries did in the 1960s and 1970s.[6] However, given that many of the countries in our sample have a very small percentage of the population that attains any secondary schooling, even small absolute increases in Barro and Lee's secondary school attainment variable can indicate increases of several years for this small portion of the population.[7] Keeping this in mind, we find that the effects of domestic investment on the secondary education growth rate are nearly double that of its effects on the growth rate of schooling in general, as measured by the average total years of

[6] See Table 1 for statistics on this variable as well as other human capital variables. Togo's average annual growth rate between 1975 and 1980 was 36.6% and Ghana's average annual growth rate between 1965 and 1970 was 34.2%.

schooling in the population. Each additional percentage point of GDP that is made up by domestic investment is correlated with an increase of 0.06 percentage points in the growth rate of secondary schooling attainment. Similarly, each additional percentage point of GDP that is made up by FDI is correlated with an increase of 0.3 percentage points in the growth rate of secondary schooling attainment, more than double its effect on schooling in general.

When we adjust our model to take into account the possible effects of unobserved regional variances, in regressions 4 and 5, we find that there are some marginally significant effects. In particular, East Asian developing countries demonstrate a higher overall rate of growth in their levels of human capital, as measured by the average total years of schooling in the population. This incremental growth is on the order of 0.68% per annum. We cannot observe this effect, however in the growth of secondary schooling. In the case of secondary schooling, it is the sub-Saharan African countries that demonstrate a higher overall growth rate, on the order of 1.36% per annum. While sub-Saharan Africa's initial levels of secondary schooling are lower on average than the rest of the world, our model controls for these lower initial levels. The difference must therefore be explained by peculiarities of the education systems, which perhaps place more emphasis on higher levels of education than other systems or the higher Mincerian returns to education which exist in many of these countries.

[7] For example, in Borensztein, De Gregorio and Lee's sample country with only 10% of the population with any secondary school attainment, a 0.28 year increase in secondary school attainment would indicate an additional 2.8 years of schooling on average for this subset of the population.

Our final analysis is a cross-sectional time series analysis using maximum-likelihood random effects estimators. When we analyze the effects of FDI and domestic investment on the growth rates of schooling attainment in subsequent five-year periods in Table 4, regression 1, we find no significant correlations. We find the same with other cross-sectional models, including random effects and fixed effects estimators. Focusing on growth in secondary schooling and analysis over ten-year periods, we obtain results that corroborate our earlier findings. From the second regression, we find that there is a positive and significant correlation between FDI and subsequent growth rates in secondary schooling attainment. The estimated effect is very similar to that of our other models, where each additional percentage point of GDP comprised by GDP is correlated with an increase of 0.229 percentage points in the growth rate of secondary school attainment.

TABLE 4

	(1) ?SecYrsSch5	(2) ?SecYrsSch10	(3) ?TotYrsSch10
FDI/GDP $_{t-10}$	0.092	0.229 **	0.115 *
	(0.736)	*(2.123)*	*(1.72)*
DomInv/GDP $_{t-10}$	0.039	0.011	-0.008
	(0.99)	*(0.354)*	*(-0.401)*
EdSpend/GDP $_{t-10}$	-0.154	-0.244 *	-0.108
	(-1.01)	*(-1.859)*	*(-1.272)*
Constant	3.594 **	4.401 **	2.926 **
	(3.525)	*(5.085)*	*(5.494)*
No. of Observations	287.000	198.000	198.000
No. of Groups	90.000	87.000	87.000
Avg No. Obs. Per Group	3.200	2.300	2.300
Prob > Chi2	0.564	0.085	0.238

All estimates based on maximum-likelihood random-effects model
Numbers below estimates in italics are z-statistics.
*Significance indicated by *** (1%), **(5%) and *(10%)*

To put into perspective the impact of the variances in growth of the human capital variables we have examined, we turn to sensitivity analysis. While the effects of investment on the growth rates of human capital appear small, it is important to note that the levels of domestic investment as a percentage of GDP range between 0.3% and 46.2% in the sample time period. The levels of FDI as a percentage of GDP vary between 0% and 16.5% in the same period.[8] Thus the difference between the two extremes in the case of domestic investment results in a growth rate differential of 1.6% per annum in total years of schooling and of 2.75% per annum in secondary schooling, using the estimators from regression 2 in Table 3. Even more striking, is the difference between the two extremes in FDI, which result in growth differentials of 2.14% per annum in total years of schooling and 4.95% per annum in secondary schooling. Adding such a level of incremental growth resulting from FDI inflows to the incremental growth resulting from a lower initial level of human capital, a country at our sample's mean initial level of secondary schooling of 0.67 years, would converge with the country with the highest level of secondary schooling (4.59 years) in just over 21 years.[9]

The pronounced effect of FDI on the growth rate of secondary schooling levels in our studies are consistent with an abundance of literature[10] that points to secondary schooling's key role in technology absorption and diffusion. However, our studies also

[8] Botswana had average gross FDI flows of 16.51% of GDP in the period between 1971 and 1975, while countries such as Sudan and Ethiopia had no registered FDI flows for multiple periods. Algeria had an average ratio of 46.28% domestic investment to GDP between 1975 and 1980, while Mauritius had an average ratio of 0.313% between 1975 and 1980.
[9]The incremental growth resulting from the lower initial level of secondary schooling is 4.62% and when added to the 4.95% incremental growth from the higher level of FDI, the difference in secondary schooling levels is made up in 21.1 years of compounded growth.
[10] See Romer (1993), Cohen (1993) and Borensztein, De Gregorio and Lee (1995)

show that there is a positive effect of FDI on schooling in general, and this finding corroborates studies showing that even a primary level education provides benefits in terms of capacity building for a worker seeking to assimilate new technologies.[11] Thus FDI positively affects the growth rate of human capital in general, but its effects are concentrated in the acceleration of secondary schooling attainment. An interesting finding that appears in the literature on this topic is the possibility of a technology and investment related poverty trap. Borensztein, De Gregorio and Lee (1995) describe a threshold of secondary school attainment (0.45 years) that is necessary to benefit from infusion of foreign technology. Since our studies do not address the impact of FDI or education on growth, such a phenomenon is beyond the scope of our study.

The data in our study show that there are multiple factors at work affecting the rate at which a country's schooling level increases over time. The first and perhaps most intuitive is the levels of spending that a country dedicated to education. This phenomenon can be simply explained by a supply and demand analysis of the schooling market. Increasing the level of education spending will increase the supply of schooling opportunities and therefore lower the total opportunity cost for an individual to pursue education. This in turn will put the cost of education below the threshold for a larger number of individuals, thereby increasing schooling in the population as a whole. Secondly, the initial level of schooling affects the subsequent growth in educational attainment. Much as in with the corollary relationship between physical capital and

[11] See Rosenzweig (1994) and Foster and Rosenzweig (1996)

income levels in the Solow growth model, human capital poor countries tend to grow their human capital stock faster conditional on certain factors.

Finally, as predicted by our hypotheses, increased investment levels, and increased inflows of FDI in particular, also positively affect the accumulation of human capital in an economy. The effects of FDI are much more pronounced than that of equivalent levels of domestic investment, with an impact ranging from three to six-fold. By signaling faster future growth and faster skill-biased technological change, FDI increases the present value of the education option for individuals, putting the benefit of such an option above the cost threshold for a larger number of individuals, once again increasing schooling in the population as a whole. In the case of FDI, these effects appear in a relatively short period of time, affecting schooling growth rates in the immediately subsequent five-year period. However, this effect increases over time, as FDI's effects on schooling growth rates are greater over the subsequent ten-year period are larger than in the first five-year period alone. Likewise, the effects of domestic investment are latent, with its effects on growth in total years of schooling appearing only over a subsequent ten-year period. The reasons for this latency phenomenon could be multifold.

One possible explanation is the lack of an immediate supply response. Even if the increase in demand for education happens in a relatively short time period following increased flows, the increase in supply of education may not be as immediate. Thus there could be a shortage of educational opportunity in an economy. A further possible explanation is a limited demand response for education. Even if the effects of FDI on the labor markets are immediate (as the following studies will show), the benefits of a higher return per unit of human capital will largely accrue to workers with a sufficiently long period of time in which they can recover their investment. Thus, older workers who have a shorter period of future earnings and for whom the opportunity cost of foregoing income is higher will not be as likely to pursue further education as young individuals who have not yet entered the labor force. If this is the case, the effect on the education market will be immediate and would be concentrated among the young, manifesting itself through increasing enrollment rates. However, this flow of increased human capital may be small enough relative to the entire labor force of the economy so as to take a prolonged period to manifest itself in higher overall schooling levels of the population as a whole. In order to ascertain this, we must study more closely the effects of FDI in the labor markets and school enrollment.

IV. Evidence of Effects of FDI on the Labor Markets

Our cross country data analysis points to a clear link between levels of FDI and subsequent growth in schooling attainment. However, the chain of causality from FDI flows to growth in schooling attainment merits further examination. According to our theory, individuals are forming perceptions about future growth rates and the pace of technological change in the economy and using these perceptions to make decisions about schooling. If this is the case, we must find evidence of the signals that individuals might use to form these perceptions. Individuals may be able to directly perceive increased levels of overall investment in the economy, but perceiving skill-biased technological change is a bit more difficult. Wages may serve a valuable role in this effort, however.

Wages are the values that any potential worker is constantly ascertaining in making her decision on whether or not to pursue further education. A perception of high wage growth in the future will make her more willing to sacrifice relatively low current wages for higher wages in the future. Likewise, a perception of a growing differential in the wages for skilled versus unskilled workers will make her more likely to forego current income at low unskilled wages in hopes of obtaining increasingly higher wages in the future. In the case of FDI, where the investment is introducing not only increased growth potential, but also skill biased technological change, we should see evidence of both. Given that the latter is the effect that differentiates FDI from domestic investment, we will focus our analysis on signals for such skill biased wage differentials.

Evidence in Mexico

Mexico presents an interesting case study, because it is a country that has radically shifted its economic model from one of import substitution industrialization to an export oriented one. Its proximity to the United States coupled with preferential trade treatment and relatively low wages have made it an ideal launching ground for exports to the consumer markets of North America. The country has become the second largest developing country recipient of FDI since 1985, with over $44 billion in cumulative FDI inflows between 1985 and 1995.[12] The initial growth in export oriented manufacturing,

[12] Only China ranks above Mexico by this measure, with $130.2 billion in cumulative FDI inflows. Mexico ranks as the 10th largest recipient country overall and on an FDI per capita basis, Mexico ranks 5th among developing countries, with Singapore, Hong Kong, Malaysia and Argentina ranking higher. Source: Blackhurst and Otten (1996).

and export oriented FDI was highly concentrated geographically, in the states that border the United States in in-bond foreign assembly plants called *maquiladoras.*

The geographic concentration of these FDI inflows presents an interesting case for an empirical study into the effects of FDI on wage differentials. If FDI speeds technological change and introduces more skill-biased production methods into the economy at a faster pace than domestic investment, we should find evidence of higher demand for skilled workers in regions that experience high inflows of FDI. This demand will manifest itself, as higher wages for skilled workers relative to unskilled workers in the short run. This is true because in the short run, the supply of skilled labor is relatively inelastic. Increasing the supply of skilled labor requires training of unskilled workers or migration, two options which present cost barriers and time lags. There is evidence that while the North of Mexico, even while increasing its educational stock, continues to suffer shortages of skilled labor, the South of the country, which still lags educationally, continues to suffer high unemployment rates.

Feenstra and Hanson's (1995) studies show that there is indeed evidence of FDI leading to increasing wage differentials between skilled and unskilled workers. By using the change in the ratio of *maquiladoras* to total number of plants as an indicator of the changing intensity of FDI in the economy of each of Mexico's 32 states, the study measures the effects of such changes in FDI intensity on wage differentials between skilled and unskilled workers. The study finds that there has been an increase in relative wages of skilled workers in Mexico since the 1980s, when the government dramatically relaxed restrictions on foreign investment. Their studies show that FDI is associated with an increase in the relative demand for skilled labor, which in turn leads to an increase in its relative wage share. They also show that the output elasticity of labor demand is higher for skilled labor than it is for unskilled labor, with increases in value added increasing skilled labor's share of the wage bill. [13] (Feenstra and Hanson 1995)

We test for the effects of increasing wage differentials on school enrollment growth through a model with the following specification and the results are reported as regression 1 in Table 5:

$$\text{?SecSchAbsorp}_i = \beta_1 + \beta_2\text{SecSchAbsorp70}_i + \beta_3\text{?RelWage}_i + e_i$$

The magnitude of FDI flows to Mexico has been sufficient to have substantial effects on that country's labor market. Furthermore, the regional concentration of these FDI flows allows us to see the differences between regions in the country that are FDI rich and those that are FDI poor. The regional differences in relative wages and the change therein with the flow of FDI support our hypotheses. The border region[14], which has received the highest inflows of FDI, as measured by the change in the ratio of *maquiladoras* to total number of plants, has had the largest increase—averaging 1.38% per annum between 1975 and 1988—in wage differentials between skilled and unskilled workers.[15]

[13] See Table 2 below for regression results
[14] The border region of Mexico, as defined by Feenstra and Hanson includes the following states: Baja California Norte, Chihuahua, Coahuila, Nuevo Leon, Sonora, Tamaulipas. For a full listing of the regional breakdown of states and for data on FDI inflows and schooling by region, see Appendix B.
[15] In accordance with other labor market studies, Feenstra and Hanson use wage and employment data on production and non-production workers in select manufacturing industries as proxies for unskilled and skilled workers.

TABLE 5

	(1) ?SecSchAbsorp			(2) ?SkillWageShare	
SecSchAbsorp70	-0.3065	***	?Log (MaquilRatio)	4.7314	***
	(-4.133)			*(4.12)*	
?RelativeWage	1.3508	***	?Log (DomInvest)	0.0004	
	(8.158)			*(0.5714)*	
Constant	0.4599	***	?Log (ValueAdded)	0.4257	***
	(11.67)			*(3.6292)*	
			?Log (PopDensity)	0.2979	
				(1.7062)	
			?Log (RelAltWage)	-0.0018	
				(-0.1176)	
R2	0.667			0.066	
No. of Obs.	32			392	

Numbers below estimates in italics are robust t-statistics.
Second regression is from Feenstra and Hanson (1995)
*Significance indicated by ***(1%), **(5%) and *(10%)*

Following the causality chain of our hypotheses, we should then find higher rates of growth in school attainment in the border region given the higher rates of FDI inflows and increasing wage differentials between skilled and unskilled workers. In line with these predictions we find that the border region had, in 1990, one of the highest rates of secondary school absorption (defined as the percentage of primary school graduates who enroll in secondary school), lagging only behind the Mexico City region. The border region's 87.4% average absorption rate compares favorably to Mexico City's 88.9% average rate, especially when we take into account the border region's initial absorption rate of 57.1% and compare it to the Mexico City region's initial rate of 60.2%.

Running a cross-state regression of the growth in secondary school absorption between 1970 and 1990 against the average annual change in real wage differentials between 1975 and 1988 (Feenstra and Hanson's period of analysis), we find that nearly 67% of the variance in secondary absorption rates can be explained by initial absorption rates and changes in the relative wages of skilled labor. Given that our measure of schooling attainment growth is based on secondary school absorption as opposed to enrollment ratios, it is possible that changes and variances in these figures are due to interregional migration. However, as secondary school in Mexico begins at the age of 12, it is unlikely that there would be a marked migratory pattern for this age group, and any general migratory phenomenon is as likely to affect children in their last year of primary school as those in their first year of secondary school. It is thus unlikely that interregional migration would bias our measure of schooling attainment growth.

As with our cross-country analysis, the initial level of school attainment (in this case the absorption rate in 1970) is negatively correlated with subsequent growth in schooling. The regions with the lowest initial levels of school attainment (the North and the South) had the fastest overall growth in secondary school absorption. However, when we hold this initial level of schooling constant, we find that there is a very strong correlation between the average annual change in skilled-unskilled wage differential and growth in secondary school absorption. A one percentage point increase in the annual growth rate of the wage differential leads to a 1.35 percentage point increase in the rate of secondary school absorption over the twenty-year period of analysis.

There are further studies that confirm the pattern of increasing wage disparities between the skilled and unskilled in Mexico. These studies point to the increased premium to education in recent years due to the large inflows of FDI that have resulted from the economic opening of the country. The short-term fixed supply of skilled labor, coupled with rapid skill biased technological change induced by FDI, a declining cost of capital and foreign competition and has worsened income inequality largely through increasing premia for skilled labor. (Meza Gonzalez, 1999) This phenomenon has led to worsening income inequality between regions and within regions between the educated and the uneducated. The capacity constraints posed by shortages of skilled labor have also begun to fetter the dynamism of the export-led economy in the border region.

Evidence in Ireland

Ireland, like Mexico is a country that has experienced heavy inflows of FDI in recent years. Ireland has experienced several years of stunning economic growth, averaging 9 percent per year in the period 1994-1998, with massive inflows of FDI as one of the key drivers of this growth. In 1997, Ireland ranked fifth in the world as a destination of United States FDI outflows, a spectacular feat for a country with a GDP of only $77 billion. By 1999, foreign-owned manufacturing firms produced over a quarter of Ireland's GDP, generating everything from electronics to pharmaceuticals largely for export to the European and American markets and beyond. (OECD, 1999) The magnitude of FDI inflows and the technologies involved in the manufacturing operations of the MNC plants in Ireland have led to a technological shock and to a transformation of the labor markets in the country.

There is extensive evidence of skill-biased technological change in the Irish economy. Between 1979 and 1990 the ratio of skilled to unskilled workers increased in over 80% of industrial sectors (Barry 1996) and during the same time period, the wages of skilled workers rose faster than the wages of unskilled workers.[16] The fact that in most industries, wages and employment levels for skilled labor rose concurrently, contrary to conventional theory, points to a technology shock in the economy that has raised demand for skilled labor, which is in short supply.[17] Foreign-owned firms in Ireland have led the way in this increased demand, maintaining higher ratio of skilled to unskilled labor in their operations throughout this period.

In Table 6, we test for the effects of FDI on the change in relative wages of skilled workers and on secondary enrollment rates in Ireland for the period between 1974 and 1998. Our first regression shows there is a positive correlation between the ratio of FDI to GDP, lagged by one year, and the change in the ratio of skilled wages to unskilled wages. We find that for every additional percent of GDP made up by FDI, the ratio of skilled to unskilled wages increases by approximately one percent. This relationship holds true even when we control for economic growth. When also test for the effects of the interaction of economic growth and GDP on the relative wages of skilled workers and find that there is a strong positive correlation of this variable and the ratio of skilled wages to unskilled wages. An additional percentage growth in GDP when accompanied by a one percent increase in the FDI to GDP ratio is associated with an increase of 0.39 in the ratio of skilled wages to unskilled wages.

[16] The ratio rose from 1.16 to 1.39 between 1979 in 1997 in the construction sector according to the Ireland Central Statistics Office. See Appendix C for the associated data.
[17] If the shock were instead a supply shock, the quantity of skilled labor contracted would fall as its wage rose. See Appendix D for graphical explanation.

TABLE 6

	(1) ?HrWageRatio	(2) ?HrWageRatio	(3) ?HrWageRatio	(4) ?SecSchEnroll
FDI/GDP $_{t-1}$	0.0107 *	0.0072 *	-0.018	
	(1.943)	*(1.85)*	*(-1.373)*	
?RealGDP $_{t-1}$		0.2972	-0.6404	-0.5078
		(0.883)	*(-1.178)*	*(-0.063)*
?RealGDP $_{t-1}$ x FDI/GDP $_{t-1}$			0.3904 *	
			(1.956)	
EdSpend $_{t-1}$				-1.1072
				(0.7335)
?HrWageRatio $_{t-1}$				13.3169 ***
				(3.327)
Constant	-0.011	-0.0181	0.0288	0.0288
	(-0.96)	*(-1.088)*	*(1.148)*	*(1.148)*
R2	0.201	0.203	0.38	0.2929
No. Obs.	23	23	23	21

Numbers below estimates in italics are robust t-statistics.
*Significance indicated by ***(1%), **(5%) and *(10%)*

Irish economic growth greatly accelerated in the late 1990s, hitting double-digit growth rates in 1997. This acceleration of growth coincided with a boost in the already healthy levels of FDI, which rose to above 5% of GDP in 1995, and pushed employment in foreign firms to nearly 140,000 by 1998.[18] During this same time period, the ratio of skilled to unskilled wages began experiencing a sustained increase, reaching 1.39 by 1998 from a relatively stable level of 1.2, which had prevailed until 1992.

Finally, in the fourth regression, we test for the effects of this increasing wage differential on changes in secondary school enrollment. As with Mexico, Ireland's level of educational attainment is high enough that primary enrollment is more or less universal throughout or period of analysis and thus secondary school enrollments are the most appropriate. We test for correlation between the effects of changes in the ratio of skilled to unskilled wages and changes in secondary school enrollment. When we hold education spending (as a percentage of GDP) and GDP growth constant, we find that an increase in the relative wages paid to skilled workers is strongly correlated with an increase in secondary school enrollment in the subsequent year. A one percent change in the ratio is associated with a 0.13 percent increase in the secondary school enrollment ratio. Once again we find strong evidence for the chain of causality from FDI flows to skill-biased change in the labor market to increased school enrollments.

An interesting point that comes from the FDI studies on Ireland is that this skill-biased increase in labor demand has a corresponding decrease in demand for unskilled labor. (Barry 1996). This decrease in demand for unskilled labor could, in theory, be a strong catalyst for the increased secondary enrollments. In addition to the fact that Ireland has consistently had higher labor market returns to additional education than in the average OECD country in the form of higher earnings (OECD, 1999), young potential entrants into the labor market may find that the decreased demand for their low-skill labor is so low as to prompt them to stay in school for lack of other options.

Like Mexico, Ireland is facing shortages in skilled labor. Relative to Mexico, however, Ireland began its FDI boom period with a relatively high level of school attainment and has rapidly moved to accommodate the higher demand for education, increasing education spending from 8.4% of GDP in 1988 to 13.5% in 1997.[19] Due to the wider

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[18] Industrial Development Agency (IDA) Ireland figures
[19] UNESCO figures

geographic distribution of FDI in Ireland and the larger share of the population with the ability to participate in the surging skilled labor market, the benefits of FDI have been shared among a larger share of the population.

V. Concluding Observations

Recent growth literature that has focused on the importance of human capital to effect growth seems to focus on only half the story. While there appears to be evidence for the need of a minimum level of human capital in order to absorb technology and effect growth through technological change, the evidence for transitional growth caused by the transitory increase in human capital seems to be weak. While the correlation between growth in schooling levels and economic growth holds empirically, the evidence points to growth leading to increased schooling, and not the other way around.

Our studies show that there is convergence in schooling attainment occurring among countries, with human capital poor countries growing their human capital faster than human capital rich countries. Such convergence is conditional on several factors, including levels of spending on education and investment levels in the economy, with FDI playing an especially important role. As any other type of investment it serves as a signaling mechanism for future growth and therefore increases the perceived value of pursuing further education. However, the role of FDI goes beyond this simply signaling of growth. FDI serves as a powerful catalyst for technological change and in that role, its signals to the labor force are even clearer than other types of non-technologically biased types of investment. The effects of changing technologies in production are immediate in the labor markets, shifting demand away from workers unable to adapt to the new skill-biased production methods and toward the skilled workers in the economy.

In extreme cases, such as those in the Mexican North and in Ireland, where the flows of FDI are concentrated, both in geography and time, these effects are rapid and pronounced. The skill-biased technological change, and subsequent labor market bias in favor of skilled workers brought about by FDI has a substantial impact on individual's decisions on whether to pursue further education and training.

In Mexico, the geographical concentration of FDI flows has led to a geographical concentration of human capital. In Ireland, the chronology of FDI inflows has closely followed the chronology of increased enrollments in secondary school. However, today both of these FDI-rich regions suffer from shortages of skilled labor and increasing wage disparities between the skilled and unskilled. This situation presents a chicken and egg sort of dilemma for policy makers. Should they first create a policy environment to foster FDI and technology transfer or should they instead seek to raise the stock of human capital in the economy to a sufficient level so as to cope with the increased demand once the FDI inflows begin? The former seems to be the path that Mexico has taken, and the country is now faced with many problems: skilled labor shortages in its industrialized North, persistent poverty and underdevelopment in its South, and worsening income inequality. Mexico must meet the challenges of quickly increasing educational opportunity and increasing the stock of human capital in its economy all while continuing to absorb technology. Failing to do so will bring a quick end to the FDI inflows as the country faces capacity constraints and looses its labor cost advantage.

However, the other option is problematic as well. How does a country create incentives for individuals to pursue further education when there are no signs in the market to lead individuals to consider such an investment profitable? The government can subsidize education, so as to lower the opportunity costs to a point where it attractive, but there is still the problem of employing the educated in an economy with low demand for such workers, especially if anticipated demand never materializes. Many countries that heavily subsidize education end up having to subsidize the employment of the overeducated for lack of opportunity in the private sector. Egypt, which guarantees every secondary and tertiary graduate employment and acts as employer of last resort for these individuals employed 70 percent of all university graduates in that country in 1998. (Princhett, 1999) Educating a workforce without creating economic opportunity does not seem to be a prudent path either.

The balancing act for policy makers, perhaps better performed by Ireland than Mexico thus far, is the concurrent augmentation of human capital stock and economic growth through increased investment and technology transfer. Neither is easy, as the former requires budgetary and human resources often beyond the capacity of many fiscally strapped governments. The latter often requires sweeping structural reforms so as to make investment attractive not only for domestic business but for MNCs that have the ability to deepen the capital stock of a country by introducing new technologies. Political economy obstacles often keep governments from implementing such reforms.

The positive externalities of education are many, and as such education should not be seen solely in the context of the labor market and demand for skilled labor. Basic education, in particular, bestows many social and humanitarian benefits to individuals outside of the realm of the markets, and thus should not be considered solely for its economic benefits. Furthermore, if education poverty traps exist as some studies have shown, then countries that lie below the threshold of necessary human capital to achieve benefits from investment and technology transfer face a peculiar challenge. These countries must push their levels of human capital beyond the threshold is if they are to compete in the rapidly globalizing economy and reap the benefits of foreign investment and technology transfer. The challenge for these countries lies once again in the obstacles of fiscal and human resource limitations.

Bibliography

Barro, Robert J. and Jong-Wha Lee, "International Comparisons of Educational Attainment," NBER Working Paper No. 4349, 1993

Barro, Robert J. and Jong-Wha Lee, "International Data on Educational Attainment: Updates and Implications," Harvard University Center for International Development Working Paper No. 42, 2000

Frank Barry and John Bradley. "FDI and Trade: The Irish Host-Country Experience." *Economic Journal.* Vol. 107, No. 445, November 1997, pp. 1798-1811.

Frank Barry and Aoife Hannan. "Education, Industrial Change and Unemployment in Ireland." Centre for Economic Research Working Paper WP96/18, University College Dublin, May 1996

Jess Benhabib and Mark Spiegel, "The Roles of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data," *Journal of Monetary Economics*, Vol. 34, October 1992, pp. 143-173

Mark Bils and Peter J. Klenow, "Does Schooling Cause Growth or the Other Way Around," NBER Working Paper 6393, 1998

Richard Blackhurst and Adrian Otten, "Trade and Foreign Direct Investment," World Trade Organization Report, October 1996.

Eduardo Borenstein, Jose de Gregorio and Jong-Wha Lee, "How Does Foreign Investment Affect Economic Growth?" NBER Working Paper No. 5057, March 1995.

Zhaohui Chen and Mohsin Khan, "Patterns of Capital Flows to Emerging Markets: A Theoretical Perspective," IMF Working Paper WP/97/13, January 1997

Department of Education and Science, Government of Ireland, *Annual Statistics Report 1996/97,* (Dublin: The Stationary Office, 1998)

Robert C. Feenstra and Gordon H. Hanson, "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras." NBER Working Paper No. 5122, May 1995

Andrew Foster and Mark Rosenzweig, "Technological Change and Human-Capital Returns and Investments: Evidence from the Green Revolution," *American Economic Review* 86 (4), September 1996, pp. 931-53

Costas P. Katrakildis, Nikolaos M. Tabakis and Nokos C. Varsakelis, "Macroeconomic Environment and Foreign Investment Net Inflows: An Empirical Approach." *RISEC: International Review of Economic and Business,* Vol. 44, No. 2, June 1997, pp. 375-389.

Robert E. Lucas, Jr., "On the Mechanics of Economic Development," *Journal of Monetary Economics,* XXII (1988), pp. 3-42.

N. Gregory Mankiw, David Romer and David N. Weil, "A Contribution ot the Empirics of Economic Growth," *The Quarterly Journal of Economics,* May 1992, pp. 407-437.

Liliana Meza Gonzalez, "Cambios en la estructura salarial de Mexico en el periodo 1988-1993 y el aumento en el rendimiento de la educación superior." *El Trimestre Económico*. Vol. 66, No. 2, April-June 1999, pp. 189-226

Richard R. Nelson and Edmund Phelps, "Investment in Humans, Technological Diffusion and Economic Growth." *The American Economic Review,* Volume 56, Issue 1, March 1966, pp. 69-75.

Organization for Economic Cooperation and Development, *Geographical distribution of financial flows to aid recipients,* Vol. 93-97 (Paris : Organization for Economic Cooperation and Development, 1998)

Organization for Economic Cooperation and Development (OECD), *Economic Survey of Ireland 1999,* (Geneva: OECD, 1999)

Lant Pritchett, "Where has all the education gone?" World Bank Manuscript, October 1999

Mark R. Rosenzweig, "Why Are There Returns to Schooling?" *The American Economic Review,* Vol. 85, Issue 2, May 1995, p. 153-158

APPENDIX A: Variables and Definitions

Tables 1, 2, 3, 4:

?TotYrsSch5	The average annual percentage change over a five year period in average schooling years in the total population above 15 years of age. Calculated as ?TotYrsSch5=(ln(tyr15$_t$)-ln(tyr15$_{t-5}$))/5 where tyr15 represent average schooling years data for two time points five years apart. Source data from Barro and Lee Human Capital Updated Files 2000, Harvard University Center for International Development.
?TotYrsSch10	The average annual percentage change over a ten year period in average schooling years in the total population above 15 years of age. Calculated as ?TotYrsSch10=(ln(tyr15$_t$)-ln(tyr15$_{t-10}$))/10. Source data same as ?TotYrsSch5 above.
?SecYrsSch5	The average annual percentage change over a five year period in average years of secondary schooling in the total population above 15 years of age. Calculated as ?SecYrsSch5=(ln(syr15$_t$)-ln(syr15$_{t-5}$))/5 where syr15 represent average years of secondary schooling data for two time points five years apart. Source data same as ?TotYrsSch5 above.
?SecYrsSch10	The average annual percentage change over a ten year period in average years of secondary schooling in the total population above 15 years of age. Calculated as ?SecYrsSch10=(ln(syr15$_t$)-ln(syr15$_{t-10}$))/10. Source data same as ?TotYrsSch5 above.
TotYrsSch60	The average schooling years in the total population above 15 years of age for each country in 1960. Source data same as ?TotYrsSch5 above.
GDPPerCap60	The gross domestic product per capita for each country in 1960. Source: World Bank World Development Indicators 2000 CD-ROM.
FDI/GDP	The average gross foreign direct investment as a percentage of GDP of a country over a five year period that coincides with the five-year intervals in the Barro and Lee data used for ? TotYrsSch5 above. Source: World Bank as GDPPerCap60 above.

APPENDIX A: Variables and Definitions

Tables 1, 2, 3, 4 (cont.):

DomInv/GDP	The average gross domestic investment as a percentage of GDP of a country, adjusted by subtracting out FDI, over a five year period that coincides with the five-year intervals in the Barro and Lee data for ? TotYrsSch5 above. Source: World Bank as GDPPerCap60 above.
EdSpend/GDP	The average total public spending on education as a percentage of GDP of a country over a five year period that coincides with the five-year intervals in the Barro and Lee data for ? TotYrsSch5 above. Source: World Bank as GDPPerCap60 above.
Africa Dummy	Sub-Saharan Africa dummy variable
LatinAmCar Dummy	Latin America and Caribbean dummy variable
EastAsia Dummy	East Asia dummy variable

Table 5:

SecSchAbsorp70	The percentage of students completing primary education who enroll in secondary school in a given state in 1970. Source: Secretaria de Educación Pública (SEP), Mexico. Statistics available online at http://www.sep.gob.mx
?SecSchAbsorp	The change between 1970 and 1990 in the percentage of students completing primary education who enroll in secondary school. Source: SEP, as SecSchAbsorp70 above
?RelativeWage	The change between 1975 and 1988 in the ratio between the non-production wage and the production wage in a given region. Source: Feenstra and Hanson (1995) based on data from the Mexico Industrial Census, various years.
?SkillWageShare	The change in non-production wage share in state-industry. Source: Feenstra and Hanson (1995)
?Log (MaquilRatio)	The change in log (1+number of maquiladoras in state/number of manufacturing establishments in state). Source: Feenstra and Hanson (1995)

APPENDIX A: Variables and Definitions

Table 5 (cont.):

?Log (DomInvest)	Change in log of cumulative national industry domestic investment. Source: Feenstra and Hanson (1995)
?Log (ValueAdded)	Change in log national industry value added. Source: Feenstra and Hanson (1995)
?Log (PopDensity)	Change in log relative population density. Source: Feenstra and Hanson (1995)
?Log (RelAltWage)	Change in log relative alternative wage. Feenstra and Hanson (1995)

Table 6:

FDI/GDP	Gross foreign direct investment as a percentage of GDP. Source: World Bank World Development Indicators 2000 CD-ROM
?RealGDP	Change in real GDP year over year. Calculated as nominal GDP/consumer price index. Source: Central Statistics Office (CSO) Ireland. Statistics available online at http://eirestat.cso.ie
EdSpend	Total public spending on education as a percentage of GDP. Source: World Bank as FDI/GDP above.
?HrWageRatio	Change in (hourly wages of skilled workers/hourly wages of unskilled workers). Calculated year over year from 4th quarter figures. Source: CSO as ? RealGDP above.
?SecSchEnroll	Change in net secondary school enrollment year over year. Based on enrollment figures from UNESCO statistics available online at http://unescostat.unesco.org/

APPENDIX B: Data on Mexican FDI and Schooling by Region

Region	Year	Ratio of Non-Production Wage to Production Wage		Secondary School Absorption	
		Level	% Annual Change	Level	% Change
Border	1970			0.571	
	1975	2.104			
	1988	2.517	1.379		
	1990			0.874	42.625
North	1970			0.492	
	1975	1.963			
	1988	2.085	0.464		
	1990			0.820	51.021
Center	1970			0.517	
	1975	1.838			
	1988	1.884	0.190		
	1990			0.810	44.791
Mexico City	1970			0.602	
	1975	2.145			
	1988	2.137	-0.029		
	1990			0.889	39.009
South	1970			0.501	
	1975	2.090			
	1988	1.699	-1.593		
	1990			0.787	45.090

Listing of Mexican States by Region:

Border: Baja California Norte, Chihuahua, Coahuila, Nuevo Leon, Sonora, Tamaulipas

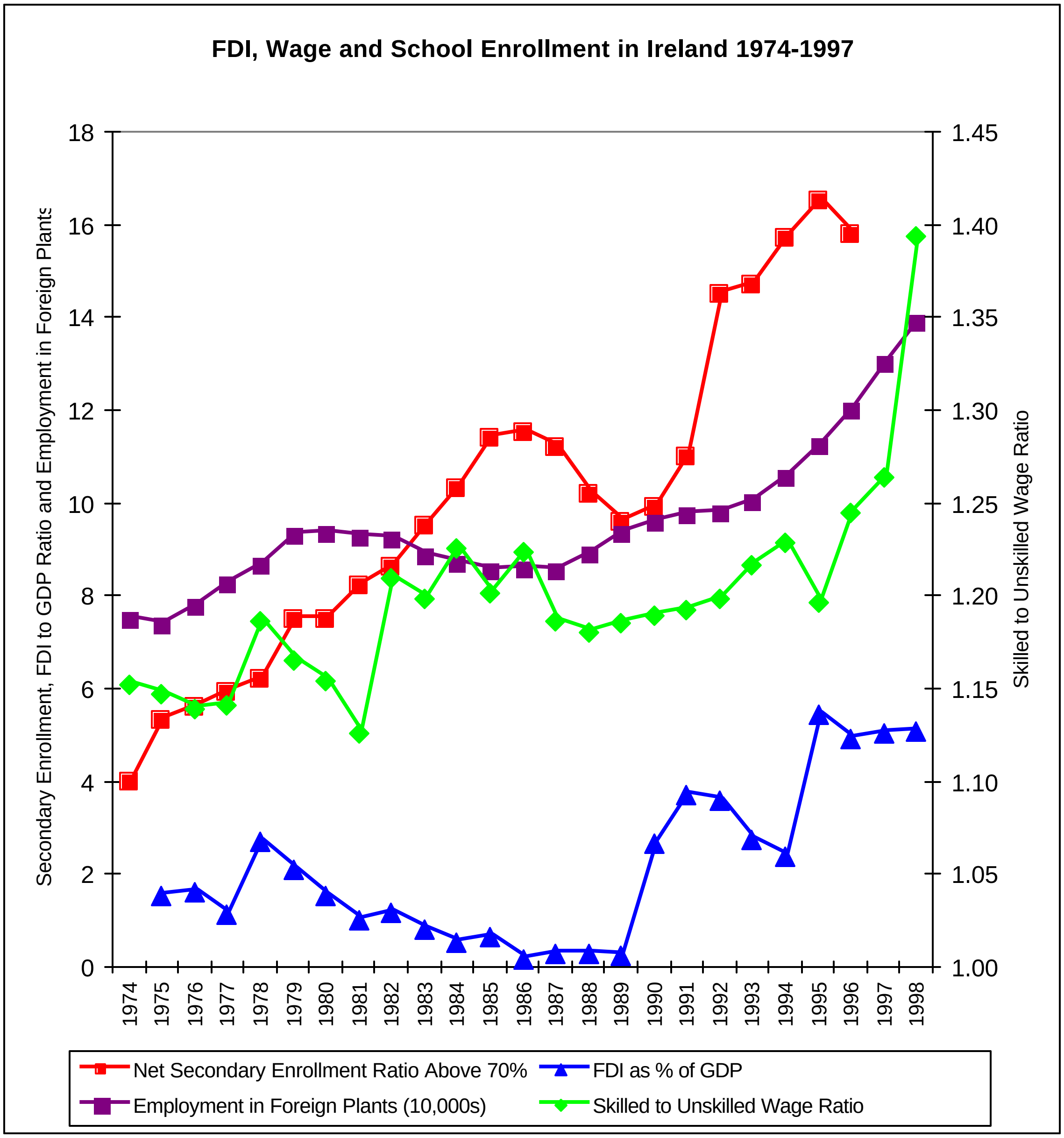
North: Caja California Sur, Durango, Nayarit, Sinaloa, San Luis Potosi, Zacatecas

Center: Aguascalientes, Guanajuato, Hidalgo, Jalisco, Morelia, Puebla, Queretaro, Tlaxcala, Veracruz

Mexico City: Distrito Federal, Mexico

South: Campeche, Chiapas, Colima, Guerrero, Michoacan, Oaxaca, Quintana Roo, Tabasco, Yucatan

APPENDIX C: Data on Ireland FDI Inflows, Wages and Schooling



APPENDIX C: Data on Ireland FDI Inflows, Wages and Schooling

Year	Net Secondary Enrollment (%)	Ratio of Skilled Wage to Unskilled Wage	FDI as % of GDP	Employment in Foreign Plants
1974	74	1.15		74,942
1975	75.3	1.15	1.52	73,614
1976	75.6	1.14	1.61	77,601
1977	75.9	1.14	1.14	82,501
1978	76.2	1.19	2.70	86,745
1979	77.5	1.16	2.09	92,854
1980	77.5	1.15	1.55	93,436
1981	78.2	1.13	1.00	92,490
1982	78.6	1.21	1.15	92,138
1983	79.5	1.20	0.81	88,640
1984	80.3	1.23	0.53	87,110
1985	81.4	1.20	0.65	85,266
1986	81.5	1.22	0.15	85,863
1987	81.2	1.19	0.29	85,247
1988	80.2	1.18	0.27	88,821
1989	79.6	1.19	0.24	93,415
1990	79.9	1.19	2.66	95,968
1991	81	1.19	3.69	97,347
1992	84.5	1.20	3.59	97,688
1993	84.7	1.22	2.75	100,155
1994	85.7	1.23	2.38	105,341
1995	86.5	1.20	5.44	112,364
1996	85.8	1.24	4.92	119,906
1997		1.26	5.03	129,907
1998		1.39	5.07	138,938

APPENDIX D: Labor Market Figures

Figure 1: Skilled labor market before and after technological shock

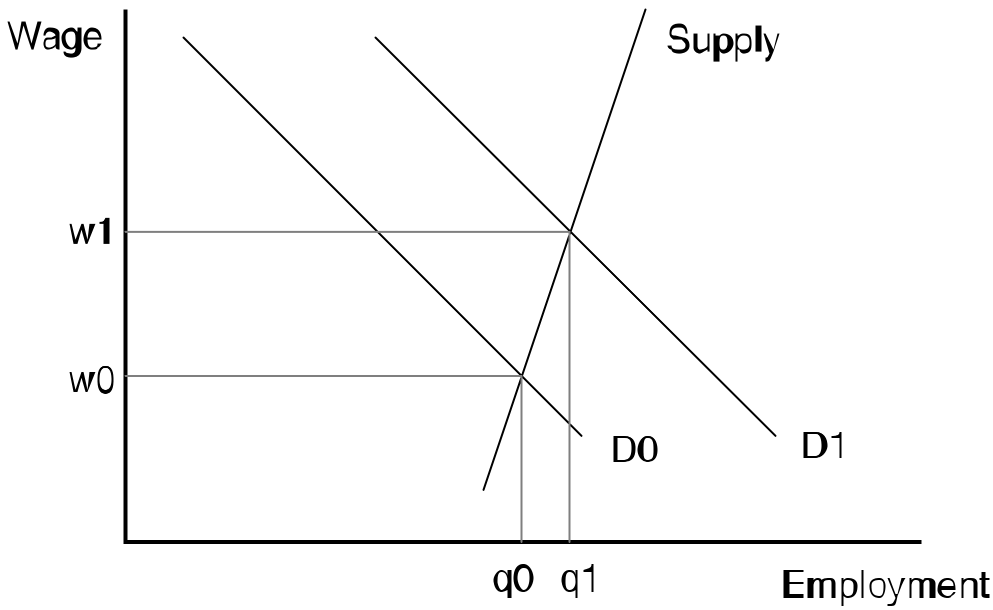
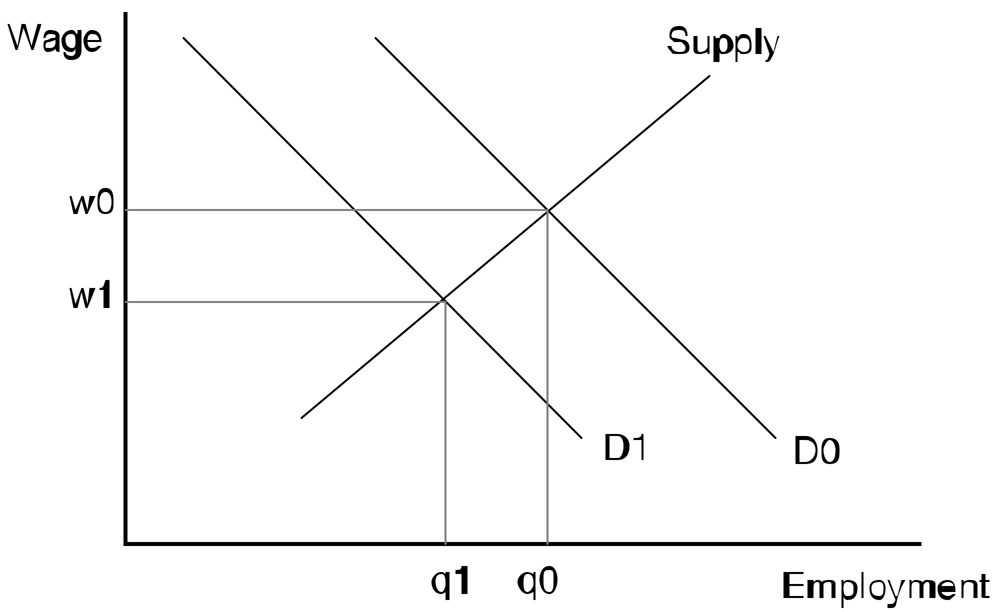
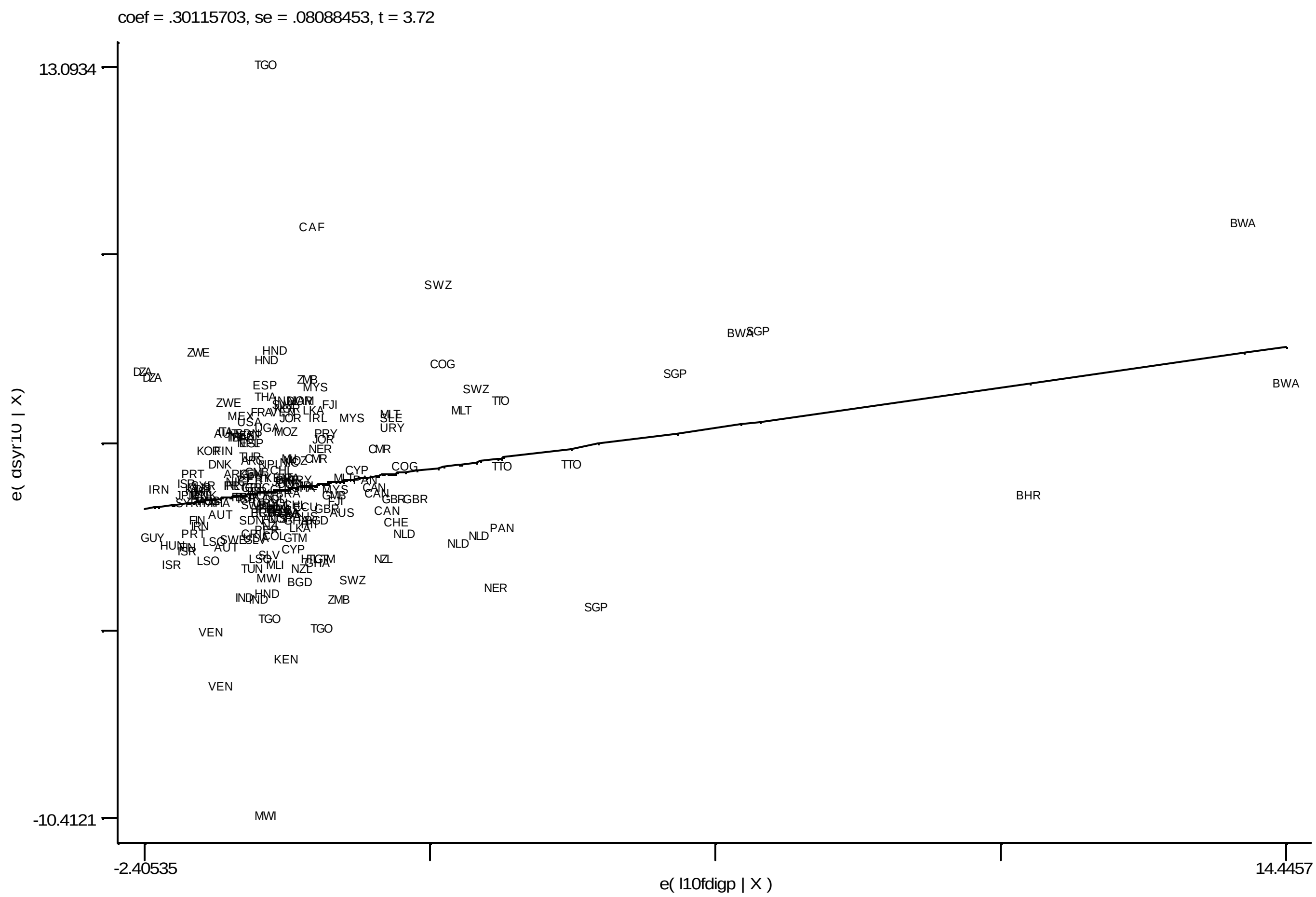


Figure 2: Unskilled labor market before and after technological shock



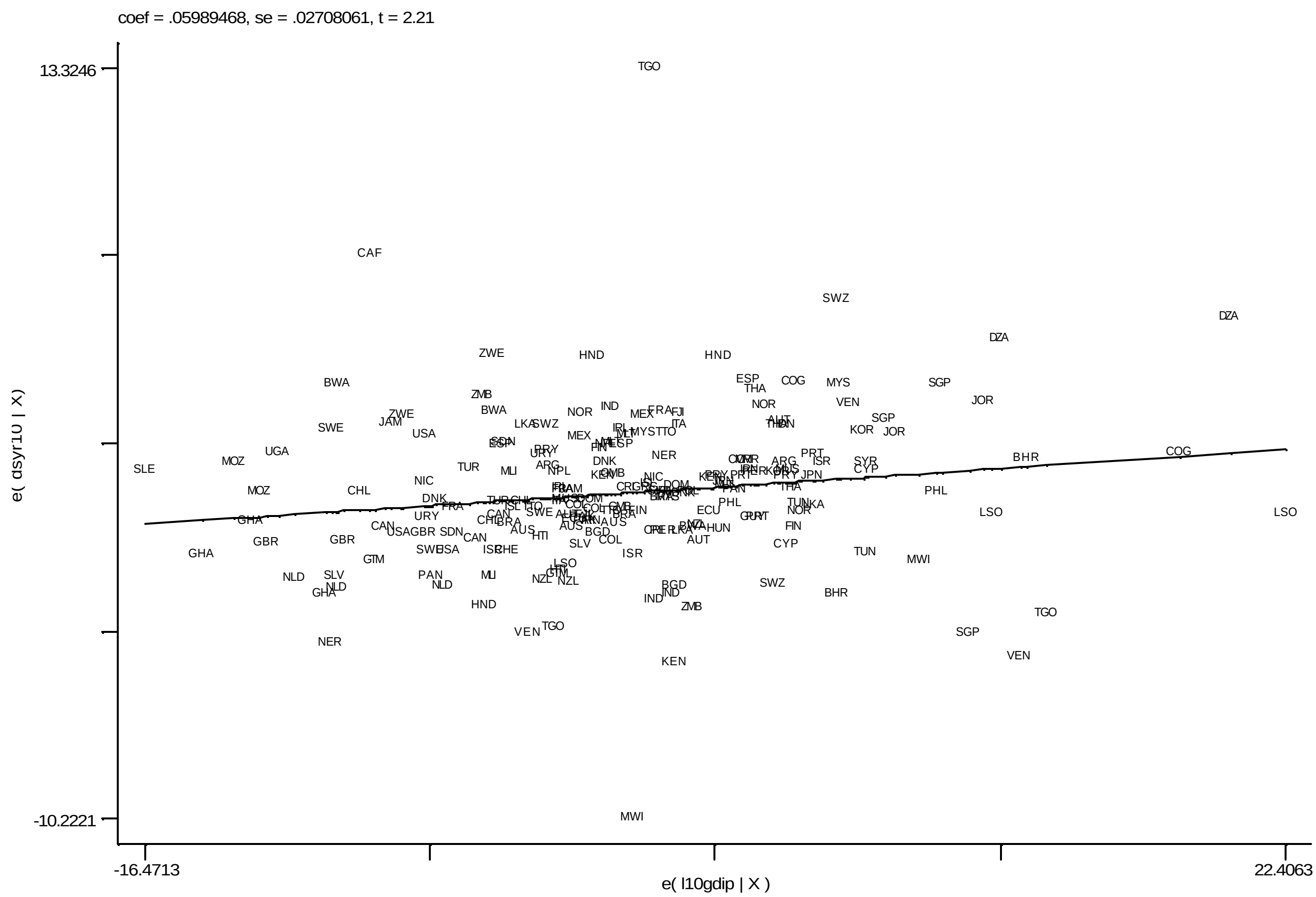
APPENDIX E: Plots of partial correlations

Plot 1: ?SecYrsSch v. FDI/GDP$_{t-10}$ from Table 3 Regression 2



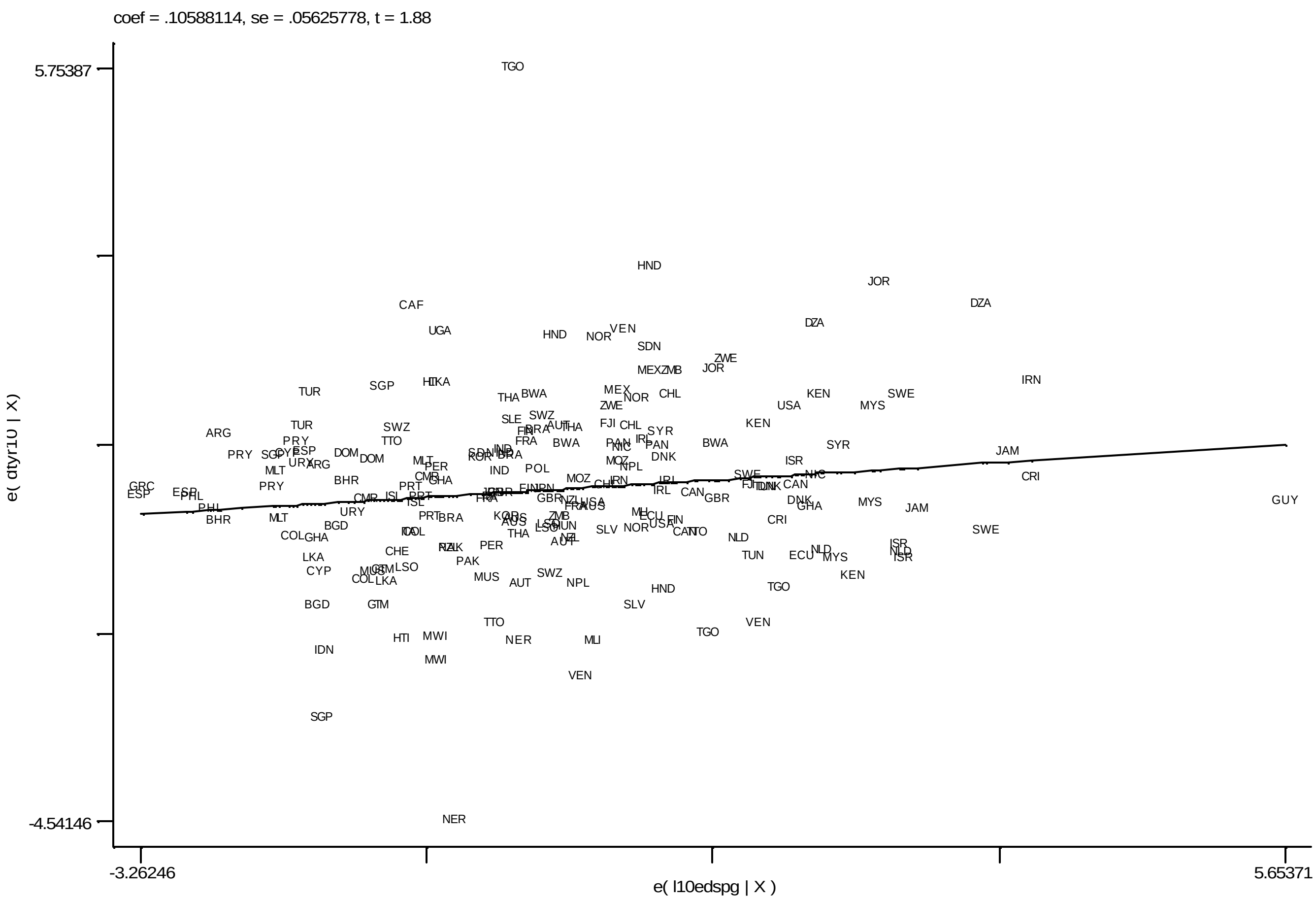
APPENDIX E: Plots of partial correlations (cont.)

Plot 2: ?SecYrsSch v. DomInv/GDP$_{t-10}$ from Table 3 Regression 2



APPENDIX E: Plots of partial correlations (cont.)

Plot 3: ?TotYrsSch v. EdSpend/GDP$_{t-10}$ from Table 3 Regression 4



APPENDIX E: Plots of partial correlations (cont.)

Plot 4: Predicted combined effect of initial levels of schooling (TotYrsSch60) and the constant positive growth trend on subsequent growth rates in schooling (?TotYrsSch10) from Table 3 Regression 3.