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Accounting for Quality Differences in Human Capital And Foreign Direct Investment

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Abstract

In this paper, I empirically investigate how cross-country differences in the quality of human capital, as they are captured by the conventional measures of international test score differences, influence the patterns of foreign direct investment. Using panel data covering 32 countries and the period between 1985 and 2004, I find that a host country's quality of educational attainment plays an independent role in attracting foreign direct investment. In particular, I find empirical evidence in support of the idea that the quality of human capital influences horizontal foreign direct investment even after accounting for the roles of skill and factor endowments, trade costs, investment costs and country-size and income effects.

Keywords: labor skills, international test scores, horizontal FDI, vertical FDI.
JEL Codes: F21, F23, J24, O15

1. Introduction

There exists a vast literature on the determinants of foreign direct investment, which typically documents that differences in human capital attainment play a significant role in influencing the patterns of foreign direct investment across countries over time.[1] At the same time, a strand in the human capital and growth literature has long emphasized how differences in human capital quality can influence economic growth. According to this body of work, measures of human capital based on attainment and enrollment data only are not sufficient for explaining cross-country differences in economic growth and accounting for quality differences in human capital can be important.[2] Despite these findings, the existing literature on foreign direct investment (FDI) has ignored quality differencesw[(diT3rttainm)77suence(capitoces i6]TJ/TT2 ispite these fiFDI))-67(untries8(y)-7(21.1963i0in humafor.3(

$13.4 billion increase in horizontal FDI flows which is 49% relative to average FDI flows per country.

2. Literature Review

Many theoretical and empirical papers study FDI and its determinants. The general equilibrium trade theory of multinational firms is based upon the traditional competitive, constant return model of international trade. The trade theory from the 1980s allows the industrial organization approach and builds upon the increasing returns to scale and imperfect competition. It generates the two branches of the "Vertical" and "Horizontal" model. The vertical model explains that the differences in factor endowments among countries are main determinants of FDI and firms geographically fragment the production by stages (Helpman, 1984, Helpman and Krugman, 1985). Vertical FDI prevails when differences between country characteristics are significant and horizontal FDI dominates when countries have similar country characteristics. The horizontal model shows that firms produce the same goods or services in multiple countries (Markusen, 1984, Markusen and Venables, 1998). Markusen (1997, 2002) combines the vertical and horizontal model. The KK model provides the framework in which firms choose among domestic, vertical and horizontal stages. Carr, Markusen and Maskus (2001) estimate the KK model of the multinational firms to predict the direction and volume of trade and FDI. Blonigen et al. (2003) change the terms measuring differences in human capital abundance of the KK model and find that horizontal FDI dominates vertical FDI motives. Bergstrand and Egger (2005) develop a "Knowledge-and-physical-capital model." They extend the two countries (home, host), two goods (skilled and unskilled labor intensive good), and two factors (skilled and unskilled labor) knowledge capital model to three countries (home, host, the rest of the world), three goods (skilled, unskilled labor intensive good, intermediate good), and three factors (skilled labor, unskilled labor, physical capital) case. The addition of physical capital to the modern knowledge-capital model helps to resolve several puzzles in the international trade and investment literatures.

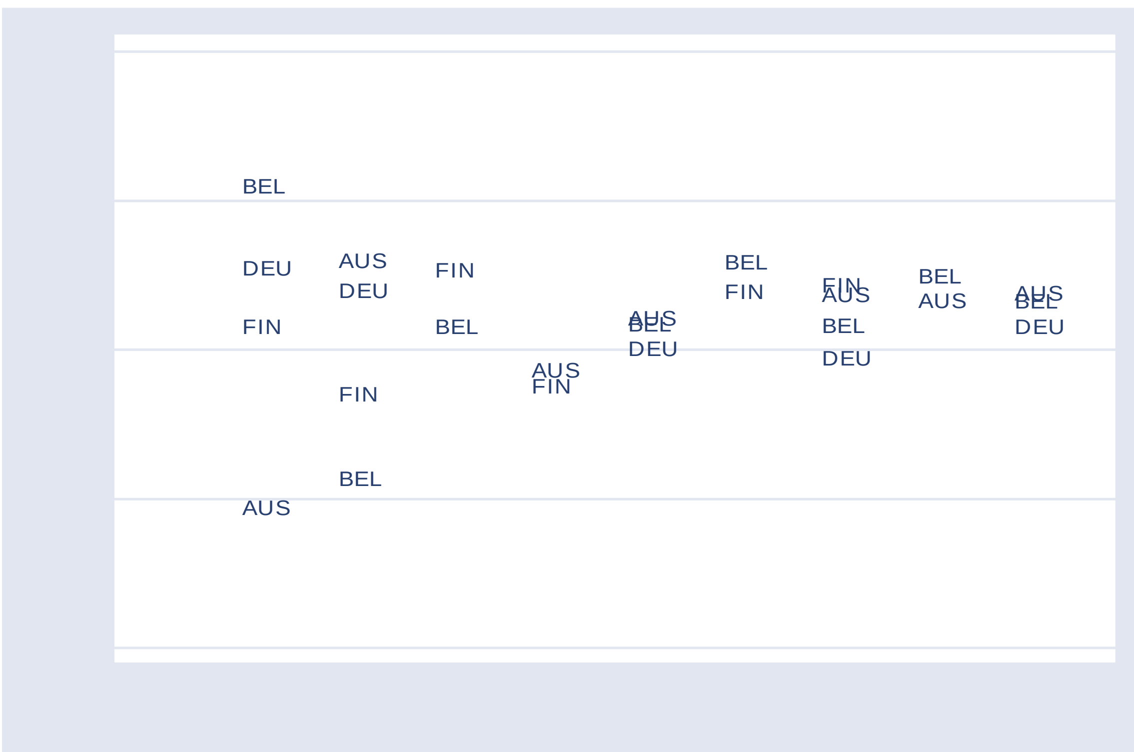
There exist a number of economic literatures that explore the role of quality of human capital in the economic growth of nations. Becker (1993) defines that human capital is any skill that has market value. It can be augmented through investing in a person's knowledge and skills. Barro and Lee (1993) first measured national stocks of human capital by computing the number of years of educational attainment achieved by average person in each country. But this is a crude measure of skill differences. It does not account for quality differences in human capital across countries.

Hanushek and Kimko (2000) use the measure of comparative test scores of mathematics and international test scores of primary and secondary school student achievement in math and science which were conducted over the last three decades as a measure of the comparison of cognitive achievement across countries. International comparison tests of educational achievement in math and science are conducted by the International Association for the Evaluation of Educational Achievement (IEA), the International Assessment of Educational Progress (IAEP), and the Program for International Student Assessment (PISA). The Trends in International Mathematics and Science Study (TIMSS), conducted every four years by IEA, is an assessment of fourth-graders, eighth-graders and twelfth-graders in mathematics and science. The advantage of test scores for younger students is that more of the population is still in school. But it misses differences in skill associated with better secondary or post-secondary schooling. Also, it does not account for differences resulting from immigration. In 1995, TIMSS collected data for 4th and 8th graders. In 1999, TIMMS collected data for 8th grade only. With the 2003 data collection, TIMSS offers the first international trend comparisons in mathematics and science at grades four and eight. In 2003, the United States and a number of other countries partic

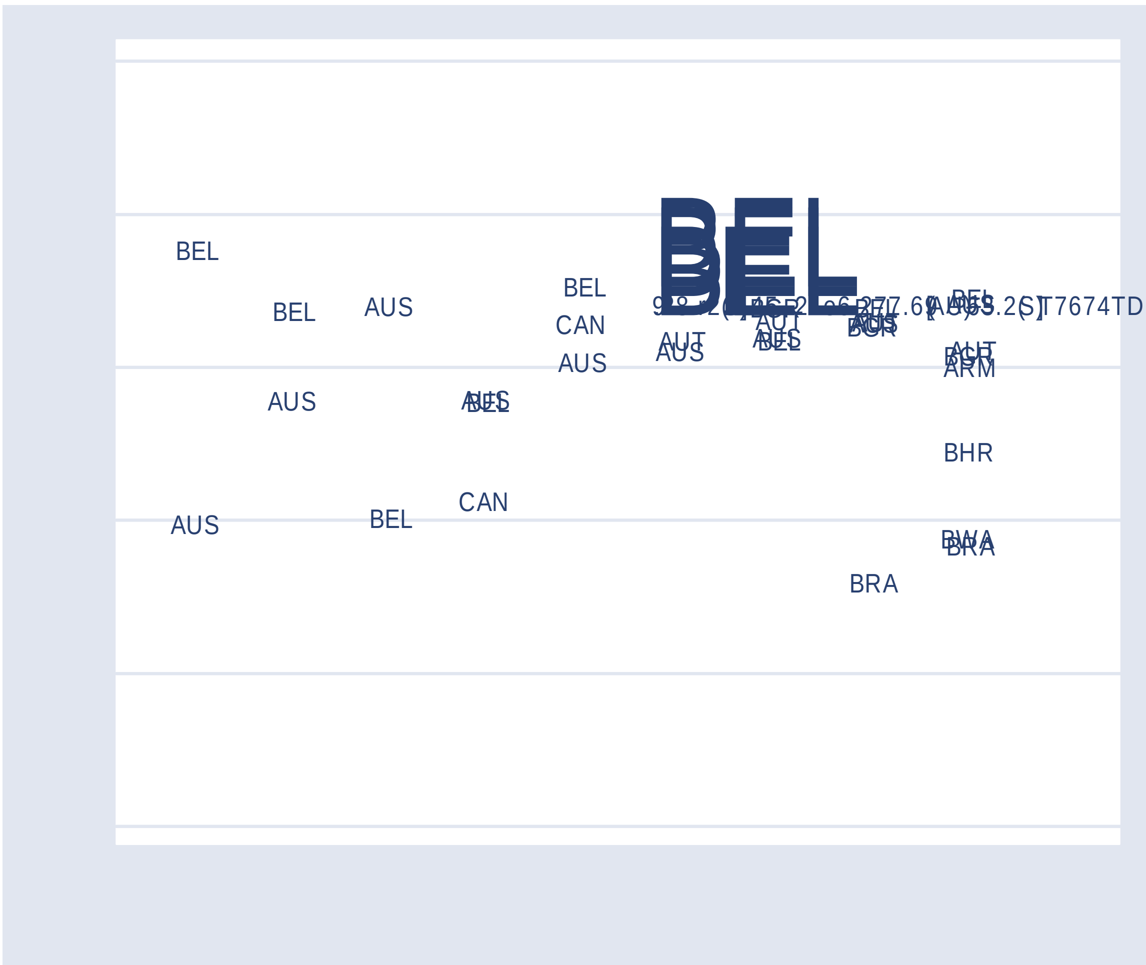
25 nations collected data on fourth-graders and 46 nations collected data on eighth-graders. In Table A, I summarize the international student achievement test (ISAT) scores. My quality of human capital data methodology is detailed in Appendix 1.

There are several features in my quality of human capital data, illustrated in Figures 1 through 4.

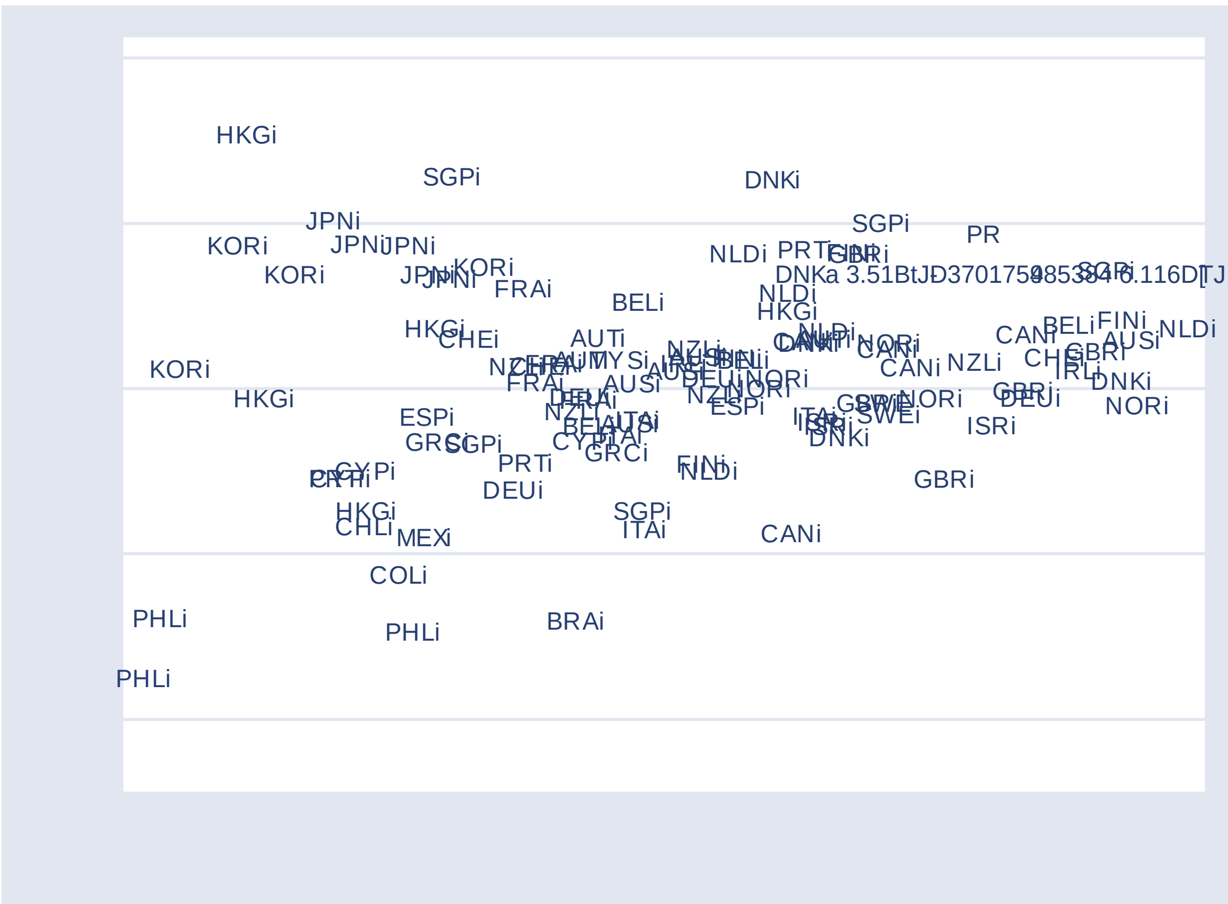
The normalized test score is generated by combining the math and science test score over the different age groups in a given period of time. Figure 1 shows how the normalized ISAT score of each country is distributed within a specific test series and over the different test series. In Figure 1, 73 countries have at least one observation in the normalized ISAT series. Seven countries score high consistently. Japan, Korea, Hungary, Nederland, Hong Kong, Singapore, and Taiwan are the countries in which more than 40% of test scores is higher than 550 which is in the top 16 percent. Seven countries score low consistently. Philippines, South Africa, Brazil, Chile, Morocco, Mexico and Tunisia are the countries in which more than 50% of test scores is less than 430 which is in the bottom 16 percent.



score around 530 over time in the developed countries. Israel, Japan, Belgium, Germany, France, Nederland, United Kingdom, Austria, Sweden, USA, and Finland are the developed countries in Figure 2. There exists a convergence of the quality of human capital among the developed countries. Quality differences in human capital between the developed countries get relatively smaller over time.



block years for 5 year periods from 1965 to 2004. I have 8 different block years.[4] I use this data as a proxy for quality of labor force.[5] I find that a standard deviation of the ISAT score becomes greater as I consider the delay at which the younger students enter the labor force. Japan, Korea, Spain, Singapore, and Taiwan are the countries in which more than 40% of test scores is higher than 566 which is in the top 16 percent. Philippines, South Africa, Brazil, Botswana, Columbia, Ghana, Morocco, Mexico, Nigeria are the countries in which more than 50% of test scores is less than 422 which is in the bottom 16 percent. Quality differences in human capital in Figure 3 are greater than those of Figure 1.



the independent variables which determine the magnitude of FDI of home country in the host country. If these variables are highly correlated then the independent role of quality of human capital may be doubtful because of the possibility of multicollinearity. I use the lagged normalized ISAT scores to draw Figure 4. Skilled labor endowment of each country is obtained by the ratio of skilled occupations in employment to total employment. By observing the correlation between quality of human capital and skilled labor ratio of parent country i in which headquarter is located, I can find some extent of substitutability and complementarity of quality of human capital and quantity of skilled labor endowment. On the one hand, the observations along the 45 degree line of Figure 4 can support the complementarity of qualit

Skilled labor share is defined by the ratio of the International Labour Organization (ILO) occupation categories: 0/1 for professional, technical and related workers, 2 for administrative and managerial workers in employment to total employment in each country. Since the ILO adjusted the classification code after the year 2000, the skilled labor ratio from 2000 to 2004 is calculated by using categories 1, 2, and 3 to total employment.

Trade cost is based on the World Competitive Report (WCR) before the year 2000. After the year 2000, the source becomes the Global Competitive Report (GCR). Trade cost index measures on the scale of 0 to 100. The index 100 indicates most restrictive trade. Investment cost is also obtained from the WCR before the year 2000 and the GCR after the year 2000. It also ranges from 0 to 100 and 100 is the highest investment cost. Distance is measured in kilometers from Washington D.C. to the capital city of each country. Summary statistics are reported in Table B.

3.2 Empirical Strategy

3.2.1 Empirical methodology

Carr et al. (2001) uses the following regression equation to examine the empirical impacts of foreign direct investment determinants on real sales volume:

$$\begin{aligned} RSALES_{ij} = \beta_o &+ \beta_1 * (GDPSUM) + \beta_2 * (GDPDIFSQ) + \beta_3 * (SKDIFF) \\ &+ \beta_4 * ([GDPDIFF]*[SKDIFF]) + \beta_5 * (INVCJ) + \beta_6 * (TCJ) \\ &+ \beta_7 * ([TCJ]*[SKDIFFSQ) + \beta_8 * (TCI) + \beta_9 * (DIS) + u_{ij} \qquad (1) \end{aligned}$$

This specification (1) relates the real volume of affiliate sales ($RSALES_{ij}$) of either US-owned

Table C. The definition of variables and the expected signs of the coefficients

Variables	Definition	Coefficients
$RSALES_{ij}$	Real foreign affiliate sales of country i in country j	

monitoring.

[TABLE 1 HERE]

By using 165 observations for the 32 countries from 1985 to 2004, I replicate the Carr et al.

I expect $\beta_2 = 0$, $\beta_6 < 0$, $\beta_7 > 0$, $\beta_{11} > 0$ in the results of estimation of equation (2) and all the other coefficients signs are same as Carr et al. model. I expect $\beta_2 = 0$ because real sales total is inverted U shape with respect to the GDP difference between parent and host country. Given $\beta_2 = 0$ and $\beta_3 < 0$, the real sales total is maximized at which the GDP difference is zero. β_6 is negative. As the host country quality endowment increases, it will attract the foreign affiliate sales (FAS) of the home country in the host country. β_7 is positive. If there is similarity between the home country and host country in size, a decrease in quality difference between the home country and host country will increase the total affiliate sales of parent in the host country. Therefore the coefficient of interaction between GDP difference and quality difference should be positive. β_{11} is positive: As trade cost into the host country increases, the home country affiliate sales in the host country increase only if there is an increase in quality difference when skill endowment is identical.

I expect that labor force quality difference has negative effects on FAS. If quality difference report results from quality adjusted model with WLS. Additional 35 observations are complete, except that no foreign affiliate sales data are reported. I assume that the missing real FAS data are truncated at a certain point. Thus, I replace those latent real foreign affiliate sales total data of parent country in host country with zeros. I estimate equation (2) with a Tobit regression in column (4). Coefficients in Tobit model are the marginal effect on the unconditional expectation ($\partial E(y|x)/\partial x_j$). I also calculate the marginal effect on the conditional expectation of the expected value of y for the subpopulation where y is greater than zero: ($\partial E(y|y>0, x)/\partial x_j$). The marginal effect of conditional expectation is relatively smaller than the marginal effects of unconditional expectation. Thus, I use

between home and host country are a better proxy than skilled labor ratio differences.

4.4 Unbalanced panel data

Real foreign affiliate sales of parent country i in host country j data is an unbalanced panel. Home countries that do not have the foreign affiliate sales (FAS) data in the USA may have corresponding USA affiliate sales data in the home country. In these cases, number of observations of parent country i real FAS data in host country j is not same as the number of observations of real FAS of country j in country i. The regression of real FAS total of county i in country j on the independent variables includes some cases that only have one way data even though the regression focuses on the bilateral response. To solve this problem, I exclude the real FAS total data if there is only real USA FAS data in the host country but not the corresponding real FAS data of that country as a parent in the USA. I call this the unbalanced data. With the exclusion of the unbalanced data, total number of observations is 128 in 25 countries. Excluding the unbalanced data weakens the effects of all independent variables on real FAS. The results are not reported here. Another way to solve this problem is to replace real FAS total data which do not have parent country affiliates sales in the USA with zeros and use a Tobit regression specification to handle a censored regression. Doing this brings the pair6bTJ20vf the l 5cl habaTJ19.846339 TD0.0007 Tc0.01733Tw[(conced nd usextdenthe pata whset.-5.4(

is about 1/3 of overall variation, the quality difference within variation is relatively higher. Except the USA I use dummy variables for recipient (Host) countries when the USA is parent (Home) country and parent countries when the USA is host country to control for all the fixed effects that do not change over time within a country. In Tables 3 and 4, each equation contains such dummy variables. I include dummy variables for only host countries in column (1). There may exist fixed effects in parent country also. Thus, I contain all dummy variables for home countries and host countries in (2). Columns (3) and (4) are robust regressions of (1) and (2). Coefficients of GDP sum and GDP difference squared are statistically significant and consistent with the predictions of the KK model in Table 3. The sign of the skill difference coefficient is changing with respect to the inclusion of parent country dummy variables. When I control for parent country fixed effects in addition to host country, the sign of skill difference changes from positive to negative. The skill difference coefficient is statistically insignificant except in the robust OLS regression (4). The interaction between GDP difference and skill difference is negative and significant under the robust regression specification. The coefficient of quality difference is negative and significant at the 5% significance level in column (2) and it becomes even stronger and significant compared with the coefficient value obtained in (1) at which the parent country dummy variable is excluded. The interaction between the GDP difference and the quality difference is positive and insignificant in (2) and (4). The coefficient of investment cost host is insignificant and positive in (1) and (2). The host country's trade cost is negative and significant in (2) when all parent and host country dummy variables are included. The interaction between the host country's trade cost and the squared quality difference is negative and insignificant but it is changed to positive significant in (3).

[TABLE 4 HERE]

In Table 4, I conduct the fixed effect estimation with WLS and Tobit specifications. GDP sum and GDP difference squared are statistically significant and the signs are consistent with the prediction of the KK model. GDP difference becomes negative and significant in the Tobit regression of columns (3) and (4). Skill difference is positive and significant at the 1% level in WLS in column (2). The Interaction between the GDP difference and the skill difference is negative and statistically significant except in column (1) and this effect is even stronger when parent and host country dummy variables are included. Quality difference is negative and statistically significant at the 1% level in columns (2) and (4). This effect is stronger compared with (1) and (3). The interaction between the GDP difference and the quality difference is positive and significant at the 10% level in column (2). The coefficient of investment cost of the host is positive over all specifications and statistically sign positive and significant at the 5% level in column (4). The fixed-effect estimates of the quality difference are negative and statistically significant at the 1% level if I include parent and host country dummy variables in column (4) and they are consistently negative in all columns. The interaction between GDP difference and quality difference is positive when controlling for all country dummy variables in columns (2) and (4). The interaction between the trade cost to host country and squared quality difference are positive in WLS. In short, the magnitude and signs of quality difference in the fixed effect estimations are similar compared with the results in Table 4.

4.7 Inclusion of GDP differences

[TABLE 6 HERE]

In Table 1, I get the result that GDP difference is statistically significant and positive. I conduct the regression of Table 1 in the exclusion of GDP difference variable and find that excluding the GDP difference in the estimation equation generates the omitted variable bias. In Table D, the correlation between GDP difference and Skill difference is 52.4% but the correlation between GDP difference and quality difference is -6.46%. If I exclude the GDP difference variable then Skill difference has a positive bias and quality difference has a negative bias. Since the correlation between GDP difference and skill difference is high, the size of the bias in skill difference is high. This result is not reported here. Because of the positive and negative bias associated with the skill differences and quality differences, I prefer the estimations which include GDP difference to those which exclude it. In Table 6, I estimate equation (2) excluding GDP Difference variable from Table 4. Main differences between including GDP difference and excluding it in the fixed effect estimation of quality adjusted model are the relative changes in the effects of skill difference and quality difference on the real FAS. Excluding GDP difference in Table 6 increases the coefficient of skill difference in Tobit. But it decreases the coefficients of quality difference in Tobit. Though there is negative bias in quality difference in (3) and (4), the expected sign and significance of quality difference are very similar to the results shown in Table 4.

5. Interpretation of the Coefficients

Since the KK model is nonlinear, I analyze partial derivatives here and interpret the findings. In doing so, I choose the coefficients from columns (2) and (4) in Table 4 and use the average values of the variables in the entire data set.

5.1 Impact of Host-Country Trade Costs

Partial derivative: (∂Sales/∂Trade cost host)

= B9 + B10 (squared skill difference) + B11 (Squared quality difference)

= -1772.3 -28,658.8*(squared skill difference) + 0.009*(Squared quality difference) < 0 iff quality difference < 477.7 (WLS).

= -453.9 -127.1*(squared skill difference) -0.005* (Squared quality difference) < 0 (Tobit).

Quality difference is between -251.9 and 251.9. For all levels of quality differences, as the host country's trade costs increase the real FAS decreases. If the squared skill difference is zero and the host country's trade costs increase, the real FAS decreases for all level of quality differences. Given the identical skill endowment in home and host country, an increase in quality difference can offset the effect of host country's trade costs (WLS). Given squared quality difference is zero, as the host country's trade costs increase, the real FAS decreases for all levels of skill difference.

Result 1: As host country's trade costs increase home country affiliate sales in host country increase only if there is an increase in quality difference when skill endowment in home and host country are identical.

5.2 Impact of Bilateral Trade Costs

Partial derivative: (∂Sales/∂Trade cost)

= B9+B10(squared skill difference)+B11(Squared quality difference)+B12

= -1772.3 -28,658.8*(squared skill difference) + 0.009*(Squared quality difference) +661< 0 iff quality difference < 393.4 (WLS). For all level of quality differences, as bilateral trade costs increase the real FAS decreases.

= -453.9 -127.1*(squared skill difference) -0.005* (Squared quality difference) +399.1 < 0 (Tobit). For all level of quality differences, as bilateral trade costs increase the real FAS decreases.

Result 2: When bilateral trade costs increase, total affiliate sales decrease. Trade and investment are complements (Tobit). When bilateral trade costs increase, total affiliate sales increase only if quality difference increases and skill endowment in home and host country is identical. Trade and *investment are substitutes (WLS).*

5.3 Impact of Difference in GDP

Partial derivative: (∂Sales/∂GDP diff)

= B2 +2*B3*(GDP difference) +B5(skill difference) +B7(quality difference)

= 0.1-0.002* 2*(GDP difference) -26.8*(skill difference)+0.03*(quality difference) (WLS).

= -1.756-0.001*2*(GDP difference)-6.755*(skill difference)+0.003*(quality difference) (Tobit).

At the average value of skill difference and quality difference, if GDP difference < -76.8 then the

5.4 Impact of Difference in Skill Endowment

Holding quality difference constant, I obtain the following partial derivatives

(∂Sales/∂Skill difference)

= B4 +B5*(GDP difference) +To

human capital influences horizontal foreign direct investment. At the average values of GDP difference (= 1064.6 million $), trade cost host (= 26.4) and all levels of quality difference, as host country quality endowment increase the real FAS of home country in host country increases. Thus, if host country is small (GDP difference > 0) and quality of human capital abundant (quality difference < 0) then a small host country can overcome the relative scarcity of skilled labor by increasing quality of human capital to attract foreign affiliate sales. (WLS, Tobit).

This effect will be weakened as the quality difference increases more (quality difference > 0) if parent country is small (GDP difference < 0) and trade cost to host country is large (trade cost host > 0). In other terms, an increase in the parent country quality endowment (Δquality difference > 0) will increase the real FAS of country i in country j if home country is small (GDP difference < 0), trade cost to host is large (trade cost host > 0) and quality of human capital abundant (quality difference > 0) (WLS).

At the mean of quality difference (= -1.42) and GDP difference, trade cost host, I get (∂Sales/∂Quality difference) = -203 in WLS and (∂Sales/∂Quality difference) = -72.5 in Tobit specification. Ceteris paribus, an increase in the host country quality endowment by one standard deviation of quality difference (66.1) (Δquality difference < 0) will increase the real FAS of home county in host country by $13.4 billion which is 49% relative to average FDI flows per country (WLS).[11]

There are 59 observations in 20 host countries in the data set at which the host country has greater quality endowments and smaller country sizes than the USA.[12] The 20 countries satisfy the following result 4. These host countries have high enough quality endowment relative to the USA to attract US affiliate sales in those countries.

6. Conclusion

Based upon the estimation results, the quality-adjusted KK model suggests that quality of human capital should be taken into account. I find that the role of quality of human capital is statistically significant in the KK model of MNE. Using panel data covering 32 countries and the period between 1985 and 2004, I find that a small host country can overcome the relative scarcity of skilled labor by increasing quality of human capital to attract foreign affiliate sales or to increase outward FDI. I also find empirical evidence in support of the idea that the quality of human capital influences horizontal foreign direct investment, even after accounting for the roles of skill and factor endowments, trade costs, investment cost and country-size and income effects. Ceteris paribus, an increase in the host country quality of human capital by one standard deviation of quality difference increases FDI flows from home country to host country by $13.4 billion which is 49% relative to average FDI flows per country. Accounting for quality of educational attainment and quantity of skilled labor abundance strengthens both horizontal and vertical FDI to rise endogenously.

Predications come from the KK model and the stylized facts of quality differences between countries over time. A new model that embeds quality endowment of human capital into the KK model will enhance the identification of the determinants of FDI. Further research can embed the quality-adjusted KK model in a general equilibrium setting.

References

Barro, Robert J. and Jong Wha Lee. (1993). “International Comparisons of Educational Attainment,” Journal of Monetary Economics, 32(3), pp. 363-94.

Barro, Robert J. and Jong Wha Lee. (1996). “International Measures of Schooling Years and Schooling Quality,” American Economic Review, Vol. 86, No. 2, pp. 218-23.

Barro, Robert J. and Jong Wha Lee. (2000), “International Data on Educational Attainment: Updates and Implications,” CID Working Paper No. 42.

Borensztein, E., J. De Gregorio, and Jong Wha Lee (1998), “How does foreign direct investment affect economic growth?,” Journal of International Economics, 45, pp. 115-35

Becker, Gary S. (1993). “Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education,” NBER. The University of Chicago Press, Chicago.

Bergstrand, Jeffrey H. and Peter Egger. (2005). “A Knowledge-and-Physical-Capital Model of international Trade, Foreign Direct Investment, and Outsourcing: Part I, Developed Countries,” University of Notre Dame, Working Paper.

Blonigen, Bruce A., Ronald B. Davies, and Keith Head. (2003). “Estimating the Knowledge-Capital Model of the Multinational Enterprise: Comment,” American Economic Review 93, no. 3, pp. 980- 94.

Breusch, T.S. and A.R. Pagan. (1979), [illegible]

Cambridge, MA, MIT Press.

Levine, Ross and David Renelt. (1992). "A Sensitivity Analysis of Cross-Country Growth Regression," American Economic Review, 82(4), pp. 942-63.

Markusen, James R. (1984). "Multinational, multi-plant economies, and the gains from trade,"

Table A: The International Student Achievement Tests[13]

	Abbr.	Study	Year	Subject	Age	Countries
1	FIMS	First International Mathematics Study	1963-1967, 1964(C)	Math	13, FS	11
2	FISS	First International Science Study	1968-1972, 1970-1971(C)	Science	10, 14, FS	11, 12, 12
3	SIMS	Second International Mathematics Study	1977-1981	Math	13, FS	17, 12
4	SISS	Second International Science Study	1982-1986, 1983-1984(C)	Science	10, 14, FS	15, 17, 13
5	TIMSS	Third International Mathematics and Science Study	1993-1997, 1994-1995(C)	Math/Science	9(3+4), 13(7+8), FS	24, 38, 21
6	TIMSS-Repeat	TIMSS-Repeat	1997-2001, 1998-1999(C)	Math/Science	14(8)	38
7	PISA 2000/02	Programme for International Student Assessment	2000	Math/Science	15	31
8	TIMSS 2003	Trends in International Mathematics and Science Study	2001-2004, 200235.74 7 76.38 0.96002 , 8 TIMSS			

Table B. Summary statistics (basic sample; N=165, n=59, T=2.8)

Variable		Mean	Std. Dev.	Min	Max
Realsaletot	O	27035	37554	57	163579
GDP sum	O	8442	1597	5385	13202
GDP Difference	O	1065	7367	-9304	9349
GDP difference squared	O	55076784	22292396	6710249	87410736
Skill Difference	O	0.017	0.098	-0.208	0.208
	B		0.104	-0.191	0.194
	W		0.034	-0.087	0.120
Skill Difference Squared	O	0.010	0.012	0.0000002	0.043
	B		0.012	0.0001	0.038
	W		0.004	-0.010	0.022
Quality Difference	O	-1.42	66.05	-251.87	251.87
	B		73.96	-251.87	187.61
	W		34.28	-169.58	105.04
Quality Difference Squared	O	4338	9390	0.0001	63438
	B		11074	0.01	63438
	W		5379	-19774	41618
Quantity Difference	O	0.62	3.30	-7.17	7.17
	B		3.79	-7.17	7.17
	W		0.38	-0.54	2.99
Quantity Difference Squared	O	11.20	11.80	0.005	51.34
	B		14.10	0.04	51.34
	W		1.99	5.08	21.03
Investment Cost Host	O	29.60	8.34	17.72	57.24
Trade Cost Host	O	26.36	9.34	9.84	66.74
Trade Cost Parent	O	25.67	7.88	9.84	54.73
distance	O	8455	3998	734	15958

N: Total number of observations. n: Average number of between country (cross country) observations
T: Average number of within country observation (time period).
O: overall, B:between, W:within

Table D. Correlation Matrix (basic sample; N=165)

	rsaletot	gdpsum	gdpdiff	gdpdifsq	skdiff	skdifsq	qlodiff	qlodifsq	tyrdiff	tyrdifsq	invcj	tcj	tci	dist
Real Sales Total	1													
GDP sum	0.408	1												
GDP Difference	-0.006	-0.121	1											
GDP Diffference Squared	-0.229	0.456	-0.039	1										
Skill Difference	-0.121	-0.120	0.524	-0.020	1									
Skill Difference Squared	-0.151	0.142	0.094	-0.038	0.224	1								
Quality Difference	0.055	0.144	-0.065	0.128	0.015	0.076	1							
Quality Difference Squared	-0.169	-0.063	0.023	0.002	0.071	0.313	-0.132	1						
Quantity Difference	-0.042	-0.160	0.835	-0.060	0.657	0.143	0.021	0.070	1					
Quantity Difference Squared	-0.163	0.014	0.098	0.083	0.168	0.280	0.079	0.408	0.234	1				
Investment Cost Host	-0.116	-0.132	0.511	-0.121	0.514	0.352	0.169	0.060	0.559	0.283	1			
Trade Cost Host	-0.079	-0.265	0.064	-0.451	0.311	0.334	0.089	0.161	0.113	0.066	0.511	1		
Trade Cost Parent	0.040	-0.257	0.043	-0.520	-0.220	0.310	-0.084	0.201	-0.005	0.038	0.042	0.223	1	
distance	-0.367	-0.071	0.014	0.023	0.037	0.206	-0.088	0.215	0.020	0.105	-0.078	0.036	-0.006	1

Table E. Countries (basic sample, number of countries = 32)

Frequency (frequency of the participation in the ISAT)											
1	Colombia	Turkey									
2	Brazil	Greece	Israel	Malaysia	Mexico	Philippines	Portugal				
3	Cyprus	South Africa									
4	Finland	Ireland	Spain								
6	Austria	Belgium	Denmark	Germany	Italy	Switzerland					
7	Korea										
8	Australia	Canada	France	Hong Kong	Japan	Netherlands	New Zealand	Norway	Singapore	Sweden	United Kingdom

Variable	**WLS**
GDP sum	**9.305*** (1.609)**
	1.122 (0.530)**
	-0.001* (0.000)**
Skill Difference	**-120,849.738** (48,879.096)**

Table2- Basic Results of Real Sales Volume of Affiliates with Quality of Human Capital:OLS, WLS and Tobit

Variable	(1) OLS	(2) Robust OLS	(3) WLS	(4) Tobit
GDP sum	14.570*** (1.628)	20.733*** (0.774)	9.130*** (1.547)	13.535*** (12.18)
GDP difference	0.785** (0.388)	0.300 (0.185)	1.301** (0.527)	0.840*** (3.00)
GDP difference squared	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (6.94)
Skill Difference	-9175.763 (29,987.338)	24,016.387* (14,257.670)	-70243.628 (47,730.955)	10452.847 (0.52)
GDP difference* Skill Difference	-7.185 (5.472)	-4.755* (2.602)	-8.915 (7.659)	-5.067 (1.30)
Quality Difference	29.082 (32.950)	0.407 (15.666)	153.661*** (44.204)	17.163 (0.76)
GDPdifference*Quality Difference	0.006 (0.006)	0.001 (0.003)	0.015 (0.010)	-0.000 (0.11)
Investment Cost Host	-550.873 (391.169)	-77.287 (185.984)	-735.230 (585.289)	-378.669 (1.31)
Trade Cost Host	-88.708 (378.469)	-130.129 (179.946)	-1,379.038*** (495.402)	68.827 (0.25)
Trade Cost Host* SquaredSkillDifference	-6134.026 (9,117.025)	-3912.206 (4,334.748)	14844.815 (11,562.343)	-9244.761 (1.45)
Trade Cost Host* SquaredQualityDifference	-0.003 (0.010)	0.006 (0.005)	0.007 (0.014)	0.002 (0.31)
Trade Cost Parent	-242.931 (368.415)	-187.604 (175.165)	-423.398 (558.474)	-157.839 (0.68)
distance	-2.519*** (0.565)	-0.133 (0.269)	-8.124*** (0.989)	-1.742*** (4.39)
Intercept	10175.876 (27,359.790)	-60,391.528*** (13,008.386)	146,908.914*** (39,506.500)	-26338.676 (1.45)
Observations	165	165	165	200
Adjusted R-squared	0.51	0.87	0.55	
Log Likelihood				-1930.80

Standard errors in parentheses in OLS and WLS. In Tobit, Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table3- Fixed Effect Estimation of Quality Adjusted Model: OLS, Robust OLS

	OLS		Robust OLS	
	(1)	(2)	(3)	(4)
Variable	Host country only	Home and Host country	Host country only	Home and Host country
GDP sum	18.831*** (1.795)	24.292*** (3.201)	19.070*** (0.537)	7.160*** (0.293)
GDP difference	1.155 (1.647)	-1.148 (1.389)	0.714 (0.493)	0.014 (0.127)
GDP difference squared	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.0004*** (0.000)
Skill Difference	67,791.82 (40,955.888)	-2,925.06 (38,801.722)	6,145.64 (12,249.490)	-8,175.256** (3,557.376)
GDP difference* Skill Difference	-7.297 (5.265)	-7.354 (5.058)	-5.297*** (1.575)	-1.700*** (0.464)
Quality Difference	-82.859* (42.920)	-96.495** (39.842)	13.362 (12.837)	-4.767 (3.653)
GDPdifference*Quality Difference	-0.001 (0.005)	0.003 (0.006)	0.002 (0.002)	0.001 (0.001)
Investment Cost Host	618.657 (694.570)	485.081 (481.346)	-22.334 (207.739)	-24.777 (44.130)
Trade Cost Host	-534.928 (429.059)	-550.268* (303.328)	40.109 (128.327)	-0.123 (27.809)
Trade Cost Host* SquaredSkillDifference	-487.644 (8,428.264)	-281.334 (6,733.862)	1,964.37 (2,520.808)	-948.268 (617.366)
Trade Cost Host* SquaredQualityDifference	-0.013 (0.010)	-0.011 (0.010)	0.005* (0.003)	-0.001 (0.001)
Trade Cost Parent	-93.497 (269.624)	639.523* (382.489)	-337.145*** (80.642)	-5.279 (35.067)
distance	-1.595*** (0.609)	2.229 (1.598)	-0.194 (0.182)	0.151 (0.147)
Intercept	-36,469.21 (31,830.256)	-163,424.528*** (42,268.551)	-54,650.813*** (9,520.106)	-29,238.907*** (3,875.218)
Observations	165	165	165	164
Adjusted R-squared	0.77	0.89	0.98	1

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table6- Fixed Effect Estimation of Quality Adjusted Model in the Exclusion of GDP Difference: WLS and Tobit

	WLS		Tobit	
	(1)	(2)	(3)	(4)
Variable	Host country only	Home and Host country	Host country only	Home and Host country
GDP sum	24.482***	30.449***	19.715***	23.983***
	(2.798)	(3.528)	(17.26)	(10.37)
GDP difference squared	-0.002***	-0.002***	-0.001***	-0.001***
	(0.000)	(0.000)	(11.52)	(6.49)
Skill Difference	206,355.830**	164,758.076***	69,855.872**	24,172.96
	(84,282.574)	(49,182.901)	(2.55)	(1.10)
GDP difference* Skill Difference	-1.928	-22.139**	-5.202	-7.332**
	(10.929)	(9.471)	(1.37)	(2.06)
Quality Difference	-135.956	-251.337***	-46.624*	-99.984***
	(97.734)	(55.341)	(1.66)	(4.16)
GDPdifference*Quality Difference	-0.005	0.025*	-0.004	0.004
	(0.013)	(0.015)	(1.15)	(0.93)
Investment Cost Host	4,297.522**	2,836.558***	419.791	390.969
	(1,857.633)	(1,019.489)	(0.79)	(1.12)
Trade Cost Host	-1,870.877*	-1,654.439***	-187.887	-404.145*
	(1,125.272)	(568.904)	(0.60)	(1.89)
Trade Cost Host* SquaredSkillDifference	8,090.60	-24,399.167*	-1,565.76	-1,160.77
	(17,547.426)	(14,571.944)	(0.26)	(0.24)
Trade Cost Host* SquaredQualityDifference	0.005	0.007	-0.001	-0.007
	(0.017)	(0.020)	(0.20)	(1.08)
Trade Cost Parent	-549.175*	755.113	-189.557	294.761
	(300.308)	(482.015)	(1.05)	(1.31)
distance	-2.130***	7.751	-1.327***	2.089*
	(0.801)	(43.344)	(3.14)	(1.81)
Intercept	-111,292.96	-265,667.32	-72,358.239***	-134,539.740***
	(71,702.654)	(676,184.935)	(3.60)	(5.39)
Observations	165	165	200	200
Adjusted R-squared	0.75	0.88		
Log Likelihood			-1842.24	-1747

Standard errors in parentheses in WLS. In Tobit, Absolute value of z statistics in parentheses
*** significant at 10%; ** significant at 5%; *** significant at 1%**

Appendix 1

A. Methodology of the data set

Originally there are 26 raw test series. I follow the normalization method of Hanushek and Kimko (2000). The normalization method in detail is following. First step, I convert each test series to the mean of 500 by multiplying 500/(mean of the test). This is based on the assumption of random sampling such that each country is assumed to be randomly drawn and take the test. Each country's test score at a given time period is normally distributed within the test series. The random sampling assumption is problematic, because the mean of the each test does not vary over time, and the score of the different time period can not be comparable. It only tell us how the ranking of the country's test score is changing but the magnitude of the change in the each country test score can not be accounted. Second step, I use the NAEP USA data to solve this problem. I use the NAEP USA test score to drift the mean of the each test score. USA NAEP score can be keyed to the international test score of the USA because NAEP USA test score has used absolute measure to compare how USA math and science cognitive skills change over time. I use the relation between USA ISAT score and NAEP score. I match the data between USA ISAT score and NAEP score by comparing closest time, age group and subtest. By doing so, I get the drift and apply this drift to the mean of the each test series. In short, I construct a normalized score and let the mean of each test drift according to the relative drift of the USA ISAT score with respect to NAEP score The First International Mathematics Study (FIMS) in 1963 and 1964 does not have NAEP comparison, because FIMS is predated in NAEP. I substitute the FIMS test for NAEP in 1963 and 1964. The NAEP adjustment process helps us to account different level of quality over different test. Third step, transforming raw test score by following the first and second steps, I finally use the standard error of each country test score to combine different subtests (math and science) over the same age group in a given period of time. I use weighted averages. Weight is a reciprocal of standard deviation of each country test score in a given test series. I call the data built by applying 1st and 3rd step without conducting 2nd step Quality of Labor force 1(QL1). I call the data obtained by taking 1st, 2nd and 3rd steps Quality of Labor force 2(QL2).

B. Construction of quality stock variable

Hanushek and Kimko (2000) point out the problem of using ITS as a proxy for the labor force quality. By combining all the different test series together, they construct one integrated measure to explain cross country variations of economic growth. But using panel quality data may not be a good proxy for the entire labor force, because labor force quality is a stock variable and it contains all different level of age groups as well as heterogeneity of labor quality within the same age group. To solve this problem, I match the test score data with the educational attainment of labor force by adjusting time lags of test scores, because the achievement change in the observed test performance of current students affect the future labor force quality( ). hievterogene population that are added to the benchmark stocks of schooling attainment. I use this schooling attainment stock variable to convert the quality flow to the quality stock variable. Since schooling attainment data is the fraction of the adult population who get the certain level of education, I adjust the quality of different levels of education to the schooling quality of the entire population who already finished up to the specific level of education. I multiply the quality of specific level of education to the fraction of adult labor force population who finished at the very level of education. Thus, it can be used as a stock of the schooling quality at each education level.

Let fij be the fraction of the adult population who has finished the jth level of education in country i. Let qij be the quality of the jth level of education in country i. The proxy for qij is the weighted averages of math and science test score at the jth level in a given year for country i. Then Qij, the stock variable for schooling quality, is obtained by

$$\mathrm{Q_{ij}} = \mathrm{f_{ij}} * q_{ij} \qquad \text{for } \mathrm{i} = 1,\ldots,142\,,\ \mathrm{j} = 1,2,4,6.$$

i is the countries who have the ISAT score and j is the seven classifications such as no schooling(1), primary school attained(2), primary school complete(3), secondary school attained(4), secondary school complete(5), higher school attained(6), and higher school complete(7). Schooling complete level (fi3, fi5, fi7) is the subset of the some schooling attained level (fi2, fi4, fi6). Thus, Out of 7 different levels, I use 3 levels of quality data, qi2, qi4, qi6 to match with fi2, fi4, fi6. For the no school level fi1, qi1, I assume that those who have no schooling (1) have same lowest level of quality across countries.

I set the scale of Qij from 0 to 1000 and normalize the quality of the no schooling level (1) to 100

Wijt with each quality stock Qijt and sum up for the different grade levels of quality stock at country i in five year period. If t stands for eight sub-periods, p goes from the beginning year to ending year in the sub-periods. For example, if t is sub-period 2 then the year variable, p, goes from 1970 to 1974. σ_{ijt}