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Human Capital and the Quality of Foreign Direct Investments

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Abstract

The purpose of this study is to analyse to what extent the difference between the quantity and quality of Human Capital (HC) is relevant to the quantity and quality of inward Foreign Direct Investments (FDI). Most developing economies keep attracting multinational enterprises (MNEs) with short-term goals in labour-intensive industries, with little or no embodiment in the local environment. As such, low-value-adding investments erode the national HC base, leading to the vicious cycle of low-quality investments. The legitimate policy question is whether countries are unable to attract high-quality investment due to the low quality of HC. This study, which combines traditional and more advanced proxies of HC, considers a sample of 54 developed and developing countries. It is found that the role of HC quality in FDI attraction is industry-specific and that it varies depending on the country's level of development. The quality of HC seems to matter relatively more for high-quality FDI than for overall FDI.

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1. Introduction

This paper investigates the importance of human capital (HC) for the attraction of inward Foreign Direct Investments (FDI). In particular, it explores how differences in the quality of human capital relate to the quality of FDI. Throughout the paper high-quality of human capital refers to the high quality of education, since human capital is a result of cognitive skills acquired through schooling and the education system of the country, which has both a quantitative component (empirically measured by the average years of schooling of the workforce in the country) and a qualitative component which refers to the cognitive abilities of the workforce (measured by the scores that country achieves in international standardised tests such as Programme for International Student Assessment - PISA) (Harmon & Walker, 2000).

These two components have been extensively used to explain the country's economic growth but rarely to explain the country's inward FDI. Indeed, the literature on human capital and FDI did not reach a consensus. Some studies argue that HC does not have an independent role in attracting FDI, while others stress that they do matter for developed countries because in those countries MNEs operate in more technologically advanced industries, which requires more educated workers (Blomstrom and Kokko, 2003).

The paper builds on those arguments to propose a framework in which differences in countries' education systems relate to differences in FDI. It is argued that high-quality FDI, such as those in technologically advanced industries require better cognitive abilities to master the more frequent non-routine activities. Hence, countries, where FDI are predominantly of the high-quality type (such as most developed countries), will benefit more from the education system that produces more high-quality human capital – workers with better cognitive abilities. On the other hand, the lack of a skilled workforce enfeebles the capacity of many countries to attract inward investments (Becker et al., 2020).

The empirical research which tackled the opposite issue – the impact of FDI stock on the level of education suggests that the expected positive contribution of FDI to education quality (in the observed Central Asian countries) does not hold. This is explained by the structure of initial FDI, which may not require advanced technology and skilled labour, alongside insufficient human capital for spillover effects. It is, therefore, suggested that FDI in technologically advanced sectors attract more educated workers (Yildirim & Tosuner, 2014).

According to OECD (2017), those are workers with high cognitive ability and complementary organizational and communication skills who can complete long and complex sequences of tasks and adapt quickly to the technologically changing environment. On the other hand, workers with low cognitive ability are employed in jobs with high routine intensity. This is the main difference between high and low-quality HC.

Those conjectures are tested with the use of data from 56 countries worldwide for the period from 2000 to 2015. The results suggest that education quality is a significant determinant of FDI in developed countries while the quantity of education is relevant in both, developed and developing countries.

The contribution of this study to the literature is dual. Firstly, it advances our understanding of the concept of human capital by making a clear difference between its quantitative and qualitative aspects. Secondly, there is empirical contribution as this is one of the very few studies that used qualitative measures of HC in the context of FDI attraction. This is an indication of the cognitive ability of HC which is crucial for the greater attraction of high-quality FDI. Workers with better cognitive ability, on average, have less routinized jobs and are less exposed to the risk of job displacement.

The findings inform economic policymakers in several ways. First, it clarifies why the quality of FDI matters and how to attract high-quality FDI. Second, it questions the contemporary policy approach to quantitative measures of HC and explains how to leverage the quality aspect of HC for FDI attraction. Finally, it provides implementable policy recommendations – steps that countries can take to increase the quality of HC and FDI.

The rest of the paper is organised as follows: Section 2 discusses the theory of multinational enterprise and the theory of human capital and provides a review of the empirical literature focused on FDI and HC. Section 3 discusses the methodology and data. Section 4 provides econometric analysis and results. Finally, sections 5 and 6 provide results, concluding remarks and some policy recommendations.

2. Literature Review

The literature review section is structured around four pillars of the paper. Firstly, the foundation of the research question is the theory of multinational enterprise. Secondly, the theory of human capital is discussed. The third pillar deals with the different dimensions and measurements of human capital. In the fourth pillar, the quality of foreign direct investments and the quality of human capital are discussed, including the meaning of those terms and the different ways in which human capital and FDI interact.

2.1. The Theory of Human Capital

The concept of capital has important antecedents in the work of Adam Smith and Karl Marx. Marx (1981) suggested that capital represents not just the aggregate of physical and created production assets but is defined by the control and ownership of production resources by a distinct segment of society, shaping the outcomes and dynamics of labour. Capital can be understood as a combination of material and immaterial assets.

Becker and Chiswick (1966) defined human capital as the accumulated stock of education, knowledge and skills. The extension of this view of HC and a more comprehensive definition was provided by Ehrlich & Murphy (2007), where HC is defined as an intangible asset that represents a wealth of knowledge and skills, including education, information, health, entrepreneurship, and innovation. It is built through investments in schooling, training, healthcare, research, and informal knowledge sharing.

The theory provided grounds for the expansion of higher education and, while it does not consider capacities that, for example, parents pass to their children, it argues that in the first instance, higher education can be primarily understood as preparation for work and career. The education itself, not family income, cultural attributes or social networks, is the starting point for an explanation of career outcomes and earnings (Marginson, 2019).

According to Becker and Chiswick (1966), on average, better-educated labour will be earning more than labour with lower educational attainments. Studies have shown that individuals with high school and college education typically earn significantly higher incomes and that the wages of those with higher education levels are consistently above average (Becker, 1994). This is also confirmed by OECD (2017), in a report finding that more skilled workers enjoy better job security and higher earnings.

Becker and Chiswick (1966) point to the role of education in employability. It is considered that the fast development of the tertiary industry in the US and the UK required creativity and skills, which significantly changed the view of labour as just another factor of production. The main proposition was that labour cannot be viewed only in terms of the number of individuals available for work or hours worked. The new focus is on knowledge and skills acquired within work that constitutes the core of HC.

The literature suggests that there are numerous factors influencing labour competencies, those can be direct, supported by employers or formal institutions, and indirect, social attitude towards education, which can be supportive or discouraging. Studies that have tackled this issue produced consistent findings of the impact of labour educational attainments on the country's location advantage. There is a consensus that more educated labour in the host country means more investments (Choi, 2015; Gittens & Pilgrim, 2013; Hanushek and Woessmann, 2008; Kapstein, 2002).

2.2 Measuring Human Capital

The focus of this study is on the education component of HC, which has been measured mostly by "quantity of education" or the average years of schooling. However, some literature has questioned that approach. The quality of education has been recognised as a key element in attracting FDI. It has been suggested that it

provides a clear indication of the skill differentials across countries that were absent from the prior discussion of school attainment (Hanushek, 2013). It is also found that international test scores are correlated with country-level IQ data (Hafer, 2017).

The different use of the term "human capital" created confusion in scientific circles since there is less understanding of what empirical research is trying to measure when talking about human capital (Hodgson, 2014). Therefore, it is important to eliminate any doubt about how human capital is measured in this study. The focus is on the cognitive ability of pupils acquired by education and measured by international standardised tests.

The data used in this study capture the quality of education as well as the quantity of education, through international standardised tests. International test scores provide consistent measures of aggregate differences in cognitive skills across countries. As such, they do not attribute all differences in cognitive skills to the schools in different countries.

A common approach to HC measures in the current literature is based on the quantity of schooling as a direct measure of HC, without much discussion about the disadvantages of this benchmark. Most of the empirical research in labour economics has followed the approach of Becker (1962) and Mincer (1958), who set the foundations for the research of labour skills. They have set a framework to measure the impact of investments in education on future earnings. However, the suggestion by Mincer (1958) that schooling affects general labour skills and therefore accounting for the years of schooling as a measure of human capital has its limitations.

For the purpose of this study, PISA is considered to be a good proxy for the quality of education, it aims to measure the ability of students to the functional application of knowledge. The problem-solving skills, which are tested by PISA are more generic and more demanded in the era of fast technological change. Owings et al. (2012) discussed the direct impact of PISA on economic performance suggesting that if OECD countries increased their average PISA score by 25 points over the next 20 years that would have doubled their collective GDP.

2.3 FDI Quality and Human Capital

According to OECD (2017) high-quality FDI or technologically and knowledge-intensive FDI, come from industries like aerospace, alternative/renewable energy, biotechnology, consumer electronics, electronic components, engines and turbines, financial services, semiconductors, software & IT services, space & defence. According to Burgel and Murray (2000), technologically intensive industries are characterised by rapid innovation and knowledge intensity, that requires continued effort in research and a solid technological base.

Since advanced technology requires complementary human skills to operate efficiently, it is often hypothesized that skilled labour availability is one of the factors that influence the location of FDI (Gao, 2002:2). Benhabib and Spiegel (1994) see the role of HC in economic development through the lenses of absorptive capacity, i.e. through the role of HC in absorbing foreign technologies. Nonetheless, countries do not make productive use of high-quality labour at all stages of development. For example, countries at the pre-caching-up stage in the absorptive capacity concept[1] will have little use of the education system which provides a great number of engineers and scientists.

Choi (2015), argues that HC, measured by pupil performance in math and science in international tests, is in a positive relationship with labour productivity and therefore correlated with higher inward FDI (measured by foreign affiliate sales). When it comes to the qualitative aspect of HC, Choi (2015) suggests that different quality of HC across countries explains the structure (quality) of FDI in the first instance, but also the quantity of FDI.

First of all, this is explained by the lower costs of employee training in countries with already developed HC, which makes investing abroad cheaper and more attractive. The labour that has developed advanced IT skills, and numerical and inductive reasoning within the education system will be ready to work without substantial employer investments in training. OECD (2017) suggests that the education system in high-income countries teaches skills that provide a foundation for effective and successful participation in the social and economic life of advanced economies.

3. Methodology and Data

The empirical analysis of this paper is based on 54 countries (developing and developed)[2], which have participated in the OECD PISA assessment over the period from 2000 to 2015. The study examines how the average PISA score, reflecting the quality of human capital, and average years of schooling, reflecting the quantity of human capital, affect inward foreign direct investment (FDI) as a percentage of GDP. It also investigates their impact on the number of technologically intensive FDI projects compared to overall projects, which serves as a measure of FDI quality. The dependent and independent variables (except for World Governance Indicators and high-quality FDI projects) are expressed as a natural logarithm. This will allow interpreting coefficients as elasticities. The full list of all variables is provided in Appendix Table A1.

[1] See Narula (2004) for a detailed explanation of the stages in the absorptive capacity concept.

[2] The country categorization (developed vs developing) is based on the country's GNI per capita in 2000. Based on the World Bank's Atlas method, countries with a GNI per capita of less than $12.475 are developing and those with more than that are considered developed. Appendix Table A3 for the full country list.

3.1. Dependent variables

First, as a dependent variable, the natural logarithm of inward FDI[3] stock as a percentage of GDP is used. This is a commonly used measure when studies need to capture cumulative FDI inflows, especially as the independent variable effect on FDI is with several years lag since PISA scores change every three years. The FDI flow data is too volatile to be used with an independent variable that changes very slowly, which is the case with PISA. The same logic is applied by Vollmecke et al. (2017), who estimated the impact of FDI on the GDP growth rate, with the use of FDI stock. Additionally, according to Nielsen et al. (2017), flow data is more relevant when studies try to capture the entering decision or the change of the number of firms, while the stock data have predominantly been used in studies that analyse the location choice of FDI in relation to host country characteristics, which is the case in this study.

Second, to investigate the role of HC in the attraction of different quality FDI, this study considers the industrial composition of FDI in relation to PISA. Therefore, a dependent variable used for this purpose is the number of high-quality FDI projects as a percentage share in the total number of FDI projects received by a country in a given year[4]. The distinction between low and high-quality FDI projects is based on the OECD industry classification by technological intensity. The OECD classification distinguishes between four levels of technological intensity: the high-technology industries, and medium-high technology industries (the combination of the two in this study is referred to as high-quality FDI). The low-technology industries, and medium-low technology industries (the combination of the two in this study is referred to as low-quality FDI). The full list and classification of industries are provided in Appendix Table A2. The correlation coefficients and descriptive statistics are provided in Tables 1 and 2, respectively.

3.2. Independent variables

The main independent variable is the average PISA[5] score in reading, math and science by the country for the period from 2000 to 2015. If the PISA score was missing in one year it was mirrored from the most recent previous testing year. OECD developed PISA to measure student cognitive skills and conducts the testing in OECD member countries as well as partner countries every three years since 2000 (the test scores being available for 2000, 2003, 2006, 2009, 2012, 2015). The use of this measurement of cognitive skills as a function of HC is important as it portrays the

[3] The value for Serbia for the period from 2000 to 2007 and for Montenegro for the period from 2000 to 2009 is calculated based on each country's share in the joint value of FDI stock for Serbia and Montenegro (formerly one country) for the period from 2000 to 2007.

[4] FDI projects are obtained from fDi Markets, a database produced by fDi Intelligence, a division of the Financial Times Ltd., which tracks cross-border greenfield investment projects across different industries and countries worldwide.

[5] The Programme for International Student Assessment (PISA) is a triennial international survey that aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students.

change in knowledge absorption that schools are trying to teach. The science and numeracy skills of students essentially determine their competitiveness when they become available in the labour market. (Hanushek & Kimko, 2000).

Table 1. Descriptive statistics

All countries					
Label	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
log IFDI	324	3.55	0.80	0.31	5.88
ln PISA	324	6.14	0.11	5.79	6.32
ln GDP_PC	324	9.73	0.96	7.47	11.58
ln EXPORTS	324	3.66	0.60	2.20	5.44
WGI	324	0.62	0.77	1.19	1.97
ln SCH	324	2.29	0.21	1.57	2.56
ln EDU	324	1.53	0.25	0.73	2.14
ln TERT	324	3.95	0.46	2.04	4.74
All countries					
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
HQ_IFDI	216	64.00	14.01	22.60	95.10
ln PISA	216	6.14	0.11	5.79	6.32
ln GDP_PC	216	9.74	0.95	7.72	11.54
ln EXPORTS	216	3.67	0.58	2.20	5.44
WGI	216	0.62	0.76	-0.93	1.97
ln SCH	216	2.29	0.21	1.57	2.56
ln EDU	216	1.54	0.26	0.73	2.14
ln TERT	216	3.97	0.44	2.34	4.70

Table 2. Correlation coefficients

	log IFDI	ln PISA	ln GDP_PC	ln EXPORTS	WGI	ln SCH	ln EDU	ln TERT
log IFDI	1.0000							
ln PISA	0.1339*	1.0000						
ln GDP_PC	0.2557*	0.7281*	1.0000					
ln EXPORTS	0.6553*	0.3381*	0.1986*	1.0000				
WGI	0.3351*	0.7203*	0.8794*	0.3001*	1.0000			
ln SCH	0.1762*	0.5908*	0.6034*	0.1935	0.5296*	1.0000		
ln EDU	0.2156*	0.3444*	0.4370*	0.1543	0.4886*	0.2893*	1.0000	
ln TERT	0.0406	0.4826*	0.4742*	-0.0851	0.4134*	0.5128*	0.2535*	1.0000

The cognitive element of HC is, therefore, considered to be crucial when measuring HC quality. Hanushek and Kimko (2000) find that high scores on international tests such as PISA are directly related to high productivity. To avoid the possible bias of particular tests such as PISA, the study also accounted for the results of the International Association for the Evaluation of Education Attainment (IEA) or The International Mathematics and Science Study (TIMSS). Those are the tests that ought to provide homogenous measures of educational outcomes. To develop a unified

measure of HC results from different tests were combined, but the outcomes were the same as if the results of one test were used.

Since measures of cognitive skills have shown to be generally applicable, and that they allow understanding of differences in education quality, cognition can be understood as a micro-measure of HC. It allows particular insight into the differences in student capabilities who have the same years of schooling. Those capabilities are relevant for the labour market as they influence productivity, while years of schooling and enrolment rates provide more quantitative, macro-measures of HC, which do not make differences between different qualities of education systems. However, the best way to reconcile those two approaches is to use cognitive skills test scores and add years of schooling.

3.3. Control variables

The validity of results is strengthened by accounting for control variables. It is controlled for the quantity of education with the average years of schooling and other country characteristics normally used to explain FDI, such as exports of goods and services (as a percentage of GDP), GDP per capita (in constant US dollars), total government expenditure on education (as a percentage of GDP)[6], gross enrolment ratio in tertiary education (as a percentage of the population, for both sexes)[7], the worldwide governance indicators, which are the World Bank's indicators of institutional quality. For the full list of variables, explanations and sources of data, see Appendix Table A1.

A fixed-effect model will be estimated on the group of 54 countries (26 developed and 28 developing) in the sample, which includes only PISA testing years (2000, 2003, 2006, 2009, 2012, 2015). The PISA score will be observed in testing years only, while the value of inward FDI stock in testing years is taken as an average of inward FDI stock (as a percentage of GDP) in non-testing years until the next testing year. For example, FDI stock as a percentage of GDP reported in 2000 is the average over the years 2000, 2001 and 2002. The value reported in 2003 would include 2003, 2004 and 2005, and so on. All the other control variables are observed in PISA testing years only.

A fixed-effect model will be estimated on the share of high-quality FDI projects in overall FDI projects. Due to the lack of data for the dependent variable, PISA will be observed in only four testing years (2003, 2006, 2009, 2012). The value of the dependent variable (the share of high-quality FDI projects per country) in testing years is taken as a sum of high-quality FDI projects in non-testing years until the following testing year. For example, the share of high-quality FDI projects in 2003 is

[6] For the countries that are missing data sporadically, the average of the existing data is applied to the missing values. Out of 324 observations, 58 were missing.

[7] For the countries that are missing data sporadically, the average of the existing data is applied to the missing values. But as most countries were missing data for 2015 only, the 2014 data is applied to 2015. Out of 324 observations, 59 were missing.

the sum of high-quality FDI projects in 2003, 2004 and 2005. In 2006, it is the sum of values for 2006, 2007 and 2008, and so on.

There are 54 countries observed (developed and developing) over the period from 2000 to 2015, while other control variables are taken into account, they are fixed over time or have very little variation but play an important role in FDI attraction. Based on the theoretical and empirical arguments discussed above, several explanatory variables are included.

To prove stationarity for this dataset, we can apply the Augmented Dickey-Fuller (ADF)[8] test to key variables of interest. The ADF test is a common method used to test for the presence of a unit root in a time series sample, which would suggest non-stationarity. All the variables listed in Appendix Table A1 proved to be stationary as the p-value ranges from 0.003 to 0.012 which is below the common threshold (e.g., 0.05), indicating that we can reject the null hypothesis of a unit root.

The illustration of the net average share of high-quality projects in two groups of countries is provided in Figure 1.

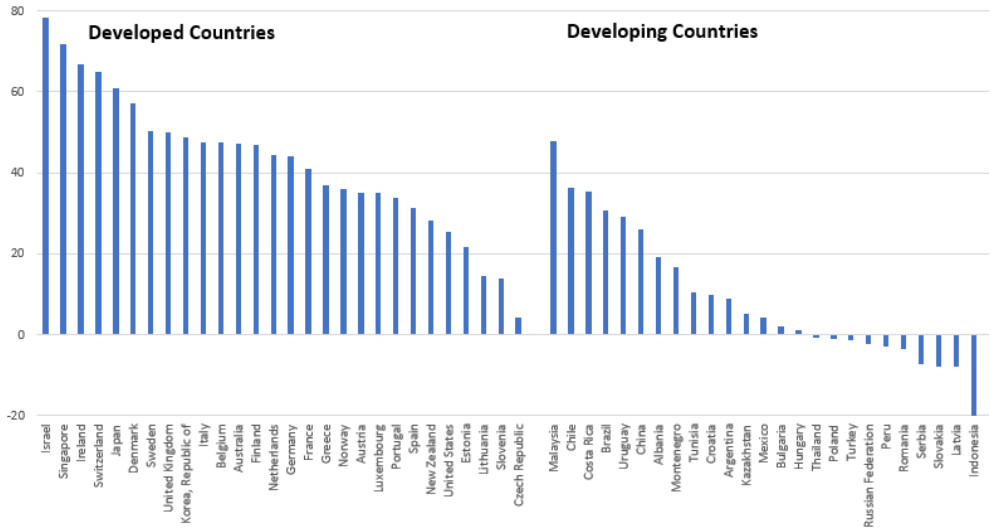

Figure 1: The net average percentage of high-quality FDI share in the overall FDI from 2003 to 2012

Source: Author's illustration based on FDImarkets data

[8] The ADF test offers a systematic and statistically rigorous method to assess the stationarity of a time series. It uses hypothesis testing where the null hypothesis posits the presence of a unit root (non-stationarity), and the alternative hypothesis suggests stationarity. The test statistic generated by the ADF test, compared against the p-value, informs us whether to reject the null hypothesis in favour of stationarity.

For comparisons, Figure 1 shows the percentage shares of high-quality FDI projects minus the percentage share of low-quality FDI projects in overall FDI projects by country It is noticeable that developed countries, on average, experience more high-quality FDI projects than developing countries.

Figure 1 shows that it is not about how much high-quality FDI the country has, it is about the difference between high and low quality which indicates the dominant type of FDI. We can see that the difference between the share of high-quality FDI projects and low-quality FDI projects in the overall FDI is much higher in developed than in developing countries. Although there are certain outliers in both groups of countries, like the Czech Republic in the developed group and Malaysia in the developing group of countries, there is a big difference between the share of high and low-quality FDI projects in overall FDI.

On average, high-quality FDI share in developing countries is 9% while it is 42% in developed countries. Some developing countries even have a negative net average percentage of high-quality FDI share in the overall FDI because the calculation is based on the difference between high and low–quality share. For example, the logarithm of high-quality FDI share in the overall FDI in Latvia is 5.0 while the share of the low–quality FDI is 5.1 which leads to the -0.1 net average high-quality FDI share in the overall FDI.

3.4. The validity of PISA scores

To add credibility to explanations emerging from regressions in this paper, it is a good idea to provide additional indicators of the quality of education, apart from PISA. The OECD provides a framework to assess adult skills (unfortunately only for several high-income countries and only for the year 2015). A decade after the publication of results from the first round of the Programme for International Student Assessment (PISA), its seminal assessment of the knowledge and skills of 15-year-olds, the OECD has conducted its first Survey of Adult Skills, which extends the assessment of skills to the adult population.

According to OECD (2013:4) “the survey, a product of the OECD Programme for the International Assessment of Adult Competencies (PIAAC), focuses on skills – literacy, numeracy and problem-solving – similar to those assessed in PISA; but the two studies use different assessment tasks, reflecting the different contexts in which 15-year-old students and older adults live. The surveys have complementary goals: PISA seeks to identify ways in which students can learn better, teachers can teach better, and schools can operate more effectively; the Survey of Adult Skills focuses on how adults develop their skills, how they use those skills, and what benefits they gain from using them”.

“PIAAC assesses the proficiency of adults from age 16 onwards in literacy, numeracy and problem-solving in technology-rich environments. These skills are key information-processing competencies that are relevant to adults in many social

contexts and work situations, and necessary for fully integrating and participating in the labour market, education and training, and social and civic life. Respondents are also asked whether their skills and qualifications match their work requirements and whether they have autonomy over key aspects of their work" OECD (2013:4).

Although there is variation between countries when PISA and PIAAC scores are compared, in both tests all countries fall into the same competence level (level 5). As it is shown in Figure 2 the two measures are highly correlated. The advantage of PISA in the context of this work is that it is available for a longer period.

Literacy proficiency at level 5 requires the respondent to search for and integrate information across multiple, dense texts; construct syntheses of similar and contrasting ideas or points of view; or evaluate evidence-based arguments. They often require respondents to be aware of subtle, rhetorical cues and to make high-level inferences or use specialised background knowledge. Numeracy proficiency at level 5 requires the respondent to integrate multiple types of mathematical information where considerable translation or interpretation is required; draw inferences; develop or work with mathematical arguments or models; and critically reflect on solutions or choices (OECD, 2013). Therefore, it can be reasonably assumed that PISA captures skills which are later valued in the labour market.

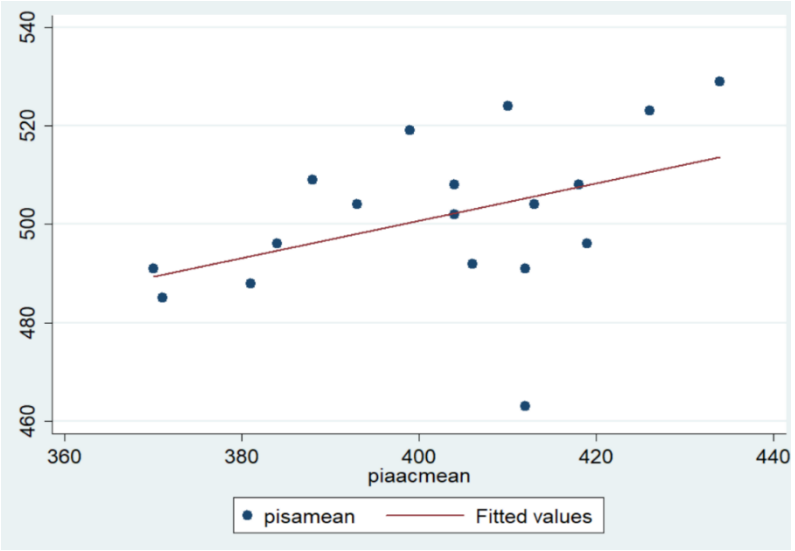

Figure 2. The average PISA and PIAAC scores for the year 2013
Source: Author's illustration based on OECD (2013) data

4. Econometric analysis

The longitudinal dimension of the dataset used in this analysis, suggests estimation techniques that allow accounting for unobserved individual country heterogeneity,

using fixed-effect econometric models. A Hausman test of the random effects vs. fixed effects specification, supports the latter, as shown in the test results in Table 3.

Table 3. The bivariate regression and Hausman test

Variables	ln ifdi	ln ifdi
ln PISA	4.337***	2.513***
	(0.806)	(0.762)
ln SCH		2.346***
		(0.296)
Constant	-23.09***	-17.25***
	(4.950)	(4.525)
Hausman test	8.24***	39.84**
Observations	324	324
R-squared	0.097	0.268
Number of id	54	54

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

A basic equation (1) takes the following form:

$$\ln(ifdi)_{it} = \alpha + \beta_1 \ln(pisa)_{it} + \beta_2 \ln(\text{gbp\_pc})_{it} + \beta_3 \ln(\text{exports})_{it} + \beta_4(\text{wgi})_{it} + \beta_5 \ln(\text{sch})_{it} + \beta_6 \ln(\text{edu})_{it} + \beta_7 \ln(tert)_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

Where the subscript i refers to countries and the subscript t refers to the year under observation, ε is an error term and μ refers to country-fixed effects. At this stage, the goal is to observe the impact of PISA on inward FDI stock as a percentage of GDP, pooling all 54 countries.

Lastly, the same model is estimated but with the use of a share of high-quality FDI projects as the dependent variable (equation 2):

$$\text{hq\_ifdi}_{it} = \alpha + \beta_1 \ln(pisa)_{it} + \beta_2 \ln(\text{gbp\_pc})_{it} + \beta_3 \ln(\text{exports})_{it} + \beta_4(\text{wgi})_{it} + \beta_5 \ln(\text{sch})_{it} + \beta_6 \ln(\text{edu})_{it} + \beta_7 \ln(tert)_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

All regressions are estimated for the whole sample of countries and developed and developing countries only.

5. Results and discussion

The results from equation (1) in Table 5 suggest that when all countries are observed together, the average years of schooling, as the quantitative measure of human capital, is significant in explaining overall inward FDI stock. The qualitative measure, the PISA score is not statistically significant in explaining the dependent variable, in the presence of all control variables, in all countries' samples. The same applies to the developing countries sample.

Table 4. The multivariate regression: The impact of PISA on FDI (all countries)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln PISA	4.337***	1.686**	1.932***	1.658**	0.865	0.878	0.887
	(0.806)	(0.748)	(0.724)	(0.714)	(0.689)	(0.686)	(0.662)
ln GDP_PC		1.083***	0.943***	0.826***	0.346**	0.348**	0.0212
		(0.112)	(0.112)	(0.115)	(0.138)	(0.137)	(0.151)
ln EXPORTS			0.443***	0.424***	0.306***	0.328***	0.276***
			(0.0973)	(0.0956)	(0.0927)	(0.0931)	(0.0905)
WGI				0.463***	0.848***	0.837***	0.822***
				(0.135)	(0.144)	(0.144)	(0.139)
ln SCH					1.963***	1.860***	1.592***
					(0.345)	(0.348)	(0.341)
ln EDU						0.291*	0.197
						(0.155)	(0.151)
ln TERT							0.415***
							(0.0917)
Constant	-23.09***	-17.34***	-19.12***	-16.52***	-11.26***	-11.64***	-9.204**
	(4.950)	(4.313)	(4.181)	(4.167)	(4.049)	(4.035)	(3.930)
Observations	324	324	324	324	324	324	324
R-squared	0.097	0.330	0.378	0.405	0.470	0.477	0.514
Number of id	54	54	54	54	54	54	54

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5. The summary results of PISA impact on overall and high-quality FDI

		(1) ln ifdi		(2) hq_ifdi
Variables	**All countries**	**Developed**	**Developing**	**All countries**
ln pisa	0.887	1.832*	0.972	56.22**
	(0.662)	(1.113)	-0.905	-26.76
ln gdp_pc	0.0212	0.886***	-0.0901	21.73***
	(0.151)	(0.310)	(0.201)	-5.922
ln exports	0.276***	0.198	0.302**	9.733**
	(0.0905)	(0.153)	(0.124)	-3.817
wgi	0.822***	0.134	0.977***	-0.0941
	(0.139)	(0.214)	(0.193)	-5.745
ln sch	1.592***	1.252***	1.345**	23.87**
	(0.341)	(0.407)	(0.573)	-11.77
ln edu	0.197	0.237	0.214	15.45***
	(0.151)	(0.231)	(0.207)	-5.793
ln tert	0.415***	0.190	0.479***	9.640**
	(0.0917)	(0.150)	(0.127)	-3.93
Constant	-9.204**	-22.23***	-7.815	-645.4***
	(3.930)	(7.780)	(5.200)	-159.6
Year dummies	yes	yes	yes	yes
Observations	324	156	168	216
R-squared	0.514	0.464	0.559	0.542
Number of id	54	26	28	54

Notes: Robust heteroscedastic standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Exports as a percentage of GDP and WGI indicators are more significant in explaining FDI than PISA in developing countries. Those findings confirmed previous studies, like Narula (1996) that overall FDI in developing countries are not driven by developed human capital, as factors like institutions and average years of schooling play a more important role. Those findings also confirm earlier studies that developing countries do not benefit from increased investment in education at the same rate as developed ones do unless other economic and institutional factors are in place (Gruber and Kosak, 2014).

When it comes to developed countries, the situation is slightly different. The fixed-effect regression suggests that the impact of PISA on overall inward FDI stock in developed countries is significant, at the threshold level, P=0.1 (probability value measure used to determine the statistical significance of a coefficient). A 1% increase in the average PISA score would result in an approximately 1.8% increase in overall FDI. As we can see, in the developed countries sample, PISA is a more relevant determinant of FDI than in the developing countries sample and its coefficient is larger in magnitude than of average years of schooling, which remained significant.

Kosack (2012) also confirms this point, suggesting that the highest return on tertiary education is achieved in developed countries, where demand for quality HC is continuous. Moreover, Kosack (2012) finds that overall higher per-student spending in high and upper-middle-income countries results in better student performance in international tests, such as PISA.

Therefore, equation (1) shows that overall inward FDI stock as a percentage of GDP in developing countries is not determined by the qualitative measure of human capital such as PISA but rather by a quantitative measure such as average years of schooling, while in developed countries both quantitative and qualitative measures of human capital are significant in explaining inward FDI. This means that the quality of education, labour cognitive problem-solving skills matter, in addition to the quantity of education such as average years of schooling.

A tentative explanation for this finding is that in developed countries the share of high-quality FDI is higher. To the extent that the overall inward FDI is tilted more towards high-quality FDI, it is not surprising that the quality of the education system is more important among this group of countries. Indeed, as shown in Figure 1, in developed countries the share of high-tech FDI is systematically much higher than the share of FDI in low-tech industries. Conversely, in developing countries, this difference is much smaller and in a few countries is even negative, suggesting that the share of FDI in low-tech industries is higher than that in high-tech ones. However, within the developing countries group, there is some degree of heterogeneity, with some countries showing shares of FDI in high-tech industries in line with developed countries. To test this conjecture more directly, the share of high-quality FDI in overall FDI is used as the dependent variable in the last column of Table 5.

The key aspect of the analysis is equation (2), where the impact of human capital is estimated specifically on high-quality FDI. It is noticeable that the PISA score, a qualitative measure of human capital, is highly significant as a determinant of the share of high-quality FDI projects in the overall FDI project. This is true for all countries and it is in line with Amoroso et al. (2015) who argued that skilled labour is a relevant determinant for greenfield FDI in knowledge-intensive projects but not in efficiency-seeking FDI.

Another important finding is that average years of schooling, as a quantitative measure of HC have not been rejected as determinants of FDI even for high-quality projects but the coefficient for PISA is twice as big in magnitude as the number of years of schooling (SCH). Indeed, PISA makes a difference when high-quality FDI are observed. A 10% increase in the PISA score would increase the share of high-quality FDI in the overall FDI project by about 5.6 percentage points.

The findings to a large extent confirm those presented by Choi (2015), who concluded that the role of HC quality is significant in explaining inward FDI. However, not exclusively, as this study confirmed, measurement of education requires a combination of qualitative and quantitative proxies.

6. Conclusion and policy implications

In this paper, it has been argued that there is a need to disentangle between quantitative and qualitative measures of HC. The arguments presented here suggest that qualitative measures of the educational component of HC should be considered when analysing the economic relevance of HC together with quantitative measures. The reviewed literature suggested that the most appropriate proxies for the quality of education, which is the key part of HC, are international standardized tests that mirror cognitive skills, such as PISA. The empirical analysis showed that the role of cognitive skills concerning inward FDI varies depending on whether countries are developed or developing.

In developed countries, an average 1% growth of overall PISA score would lead to approximately over 1.8% increase in overall inward FDI stock (as a share of GDP). On the other hand, this is not so in developing countries.

An important contribution of this study is that it extends our understanding of the role of HC in FDI attraction, as it is now differentiated between HC quantity and quality. It is clearer that the quality of education matters more in developed countries for overall FDI than in developing ones and quantity of education is relevant for overall FDI regardless of the country's level of development.

The contribution here is that the quality of education is more important for high-quality FDI. The effect of PISA is twice as large as the effect of average years of schooling. In developing countries, the quality of education is not as significant for overall inward FDI as the share of high-quality FDI in overall FDI is, on average, lower.

The limitation of the paper is that it distinguishes between different FDI qualities based on knowledge and technological intensity of the industry and not on knowledge and technological intensity of the activity within the industry, even though there is a high propensity among MNEs to import technologically advanced products and use them as inputs in assembly lines in host countries. Eventually, countries may also export high-tech products but that is no evidence of the technological capability of the local economy, but more of a "statistical illusion".

Although the activity of FDI is not captured here, and I acknowledge this limitation to measuring FDI quality, some segments of the economy stand out in terms of technological and knowledge intensity. According to Marsili (2001), those are aerospace, pharmaceuticals, ICT, electronic components, engines and turbines. The empirical literature shows that technologically advanced products are among the biggest product groups in international trade and some studies used this approach in measuring FDI quality, like Amoroso et al. (2015). The information about FDI industry concentration is more available than information about their activity, which is why studies often relied on industry-level data,

The main policy recommendation in terms of the relevance of education for FDI is that in developed countries, the improvement of labour cognitive skills and investment in education, would, on average, lead to an increase of overall inward FDI stock. For both, developing and developed countries the most important is the quality of education and improvement of cognitive abilities of students and PISA scores to attract a greater share of high-quality FDI projects in overall FDI projects. Therefore, those countries that manage to teach, through the education system, skills measured by PISA also manage to have a relatively greater share of high-quality FDI in overall FDI.

There are several policy-oriented lessons from this study relevant to policymakers:

- MNEs operating in certain industries, such as software & IT services, renewable energy, industrial machinery, or financial services, are very much interested in HC quality when making decisions about investments in developing countries. Therefore, the investments made to improve student performance in PISA are not wasted. Although it will not help increase an overall inward FDI stock in developing countries, it will be crucial for increasing the share of high-quality FDI in overall FDI, and that is the point. An increase in the number of high-quality investments, not necessarily overall investment leads to the productive use of cognitive skills.
- The countries that invest in both quantity and quality of education make the best use of HC. Therefore, making secondary education compulsory (in countries where this is still not the case) should positively contribute to the quantitative aspect of HC development. At the same time, schools should be distancing from a rigid information-memorising approach and encouraging student creativity and problem-solving skills, since this leads to the development of a qualitative aspect

of HC. The education system should provide HC which is able not only to attract foreign technologies but also provide innovations of their own.

- Governments should provide regulatory and financial support to domestic companies that are engaged in cooperation with MNEs either through backward or forward linkages. The support will enable the domestic sector to offer more technologically intensive goods and services to MNEs and therefore employ more educated and skilled labour.
- As noted by Becker et al. (2020) there is a growing demand and return on educated labour – high-quality HC since many countries focus on attracting technologically-intensive FDI. At the same time, MNEs will choose locations that offer skilled rather than cheap labour. Therefore, education systems focusing on the cognitive skills of students and their performance in international tests, such as the PISA, will signal potential investors to where they can find highly skilled labour.

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Appendix Table A1 The full list and explanation of variables

Variable explanation	Variable meaning	Variable name	Label	Source
Dependent	The natural log of total inward FDI stock received by a country as a share of GDP.	Inward FDI stock as % of	ln IFDI	UNCTAD
Dependent	The percentage share of inward FDI projects in high-tech industries as a share of total FDI projects	The number of high-quality inward FDI	hq_IFDI	fdimarkets.com
Independent	The natural log of PISA score. PISA score in reading, math and science (an average of countries' scores in three fields). The Programme for International Student Assessment (PISA) is a triennial international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students.	PISA score	ln PISA	OECD
Control: **Market demand.** Many studies have found that market demand can be an important determinant of FDI, like Janicki and Wunnava, (2004), Bevan and Estrin, (2004), and Walsh and Yu, (2010), it is usually measured as GDP per capita. According to Nielsen et al. (2017), this measure has been used in 85 out of 115 sample studies, that estimated market demand or purchasing power as a determinant of FDI, where the relationship was positive. This is a sign that high GDP per capita means higher purchasing power and therefore higher potential profits for companies (Chung and Alcacer, 2002).	The natural log of gross domestic product in current international dollars, purchasing power parity PPP adjusted)	GDP per capita constant US dollars	ln GDP_PC	World Bank
Control: **Economic openness**. Trade or economic openness measures a country's ability to attract investment. Free trade is important for knowledge and technology transfer between headquarters and subsidiaries as well as for inputs sourced from abroad (Dunning et al., 2001).	The natural log of exports of goods and services (% of GDP). Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.	Exports of goods and services (% of GDP)	ln EXPORTS	World Bank
Control: **Institutions.** One of the crucial factors that drive the nexus between FDI inflows, and its developmental effects is the quality of institutions. The main elements of the institutional quality are summed up in high private property rights protection, easy contract enforcement, firm rule of law, low corruption and high political stability. Slesman et al. (2015) also argue that FDI effects on the economy are directly linked to the country's threshold level of institutional quality, finding that countries with institutions at below the threshold level attract investments with negative effects on economic growth.	1. Voice and Accountability, Political stability, and Government effectiveness, 2. Regulatory quality,3. Rule of law, 4. Control of corruption World Governance Indicator is created as one variable, as a yearly average of all elements that compose WGI. Every element weighs -2.5 to 2.5.	The Worldwide Governance Indicators 2015	WGI	World Bank
Control: **Education.** Studies that analysed the relationship between economic growth and education, used average years of schooling as a proxy for the educational component of HC, for example, Krueger and Lindahl (2001). A small number of those that analysed the impact of HC on FDI like Yeaple (2003), also relied on average years of schooling. From the theoretical point of view, education impacts economic growth through its effects on HC. It increases labour productivity, innovative capacity and ability to absorb foreign knowledge and technology. At the same time, it should be noted that average years of schooling per se, are not a suitable control variable as it evolves very slowly in a quite predictable manner.	The natural log of average years of schooling. An average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level.	Average years of schooling	ln SCH	
	The natural log of government expenditure on education, total (% of GDP). General government expenditure on education (current, capital, and transfers) is expressed as a percentage of GDP. It includes expenditures funded by transfers from international sources to the government. The general government usually refers to local, regional and central governments.	Government expenditure on education, total (% of GDP)	ln EDU	World Bank and UNESCO

Appendix Table A2: The list and classification of industries

Industry	Quality 1=high; 0=low
Aerospace	1
Alternative/Renewable energy	1
Automotive Components	0
Automotive OEM	0
Beverages	0
Biotechnology	1
Building & Construction Materials	0
Business Machines & Equipment	1
Business Services	1
Ceramics & Glass	0
Chemicals	1
Coal, Oil and Natural Gas	0
Communications	1
Consumer Electronics	1
Consumer Products	0
Electronic Components	1
Engines & Turbines	1
Financial Services	1
Food & Tobacco	0
Healthcare	0
Hotels & Tourism	0
Industrial Machinery, Equipment & Tools	1
Leisure & Entertainment	0
Medical Devices	1
Metals	0
Minerals	0
Non-Automotive Transport OEM	0
Paper, Printing & Packaging	0
Pharmaceuticals	1
Plastics	0
Real Estate	0
Rubber	0
Semiconductors	1
Software & IT services	1
Space & Defence	1
Textiles	0
Transportation	1
Warehousing & Storage	0
Wood Products	0

Appendix Table A3: The list of countries

Developed countries (26)	Developing countries (28)
Australia	Albania
Austria	Argentina
Belgium	Brazil
Czech Republic	Bulgaria
Denmark	China
Finland	Chile
France	Costa Rica
Germany	Colombia
Greece	Croatia
Ireland	Estonia
Israel	Hungary
Italy	Indonesia
Japan	Kazakhstan
Korea, Republic of	Latvia
Luxembourg	Lithuania
Netherlands	Malaysia
New Zealand	Mexico
Norway	Montenegro
Portugal	Peru
Singapore	Poland
Slovenia	Romania
Spain	Russian Federation
Sweden	Serbia
Switzerland	Slovakia
United Kingdom	Thailand
United States	Tunisia
	Turkey
	Uruguay