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FDI and migration of skilled workers toward developing countries: firm-level evidence from Sub-Saharan Africa

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8th January 2015

Abstract

This paper investigates the determinants of the employment of foreign skilled workers by firms operating in Sub-Saharan African countries. We use cross section firm-level data on a large sample of foreign and domestic firms collected through the UNIDO Africa Investor Survey 2010. We find evidence of a strong complementarity between foreign capital inflows and the employment of foreign skilled workers. Our results also indicate that interventions in improving the working regulation and skilled workers immigration regimes may stimulate foreign skilled workers transfer by firms, and thereby foreign direct investments.

Key words – Skilled migration, Expatriation, Multinational enterprise, FDI
JEL Classification – F21 F22 F23 J61 C31

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1. INTRODUCTION

Increasing global interaction between developed and developing economies has spurred a large number of studies on the links between international factor flows. In particular, many studies have investigated the complementarity/substitutability between incoming FDI from developed to developing countries and outgoing migration flows in the reverse direction. Yet, FDI toward southern countries do also generate inflows of foreign skilled workers, a potentially crucial ingredient for future economic performance. In 2010, North-South migration represented 3% of international migration[1]; about 7 million of people from developed countries were living in developing countries (Laczko & Brian, 2013). Although they represent a marginal part of international migration, these migrants are mainly skilled workers and play a key role in the economic and business development of their host country, by transferring knowledge and managing technological content. To the best of our knowledge, only one theoretical paper shows that FDI can flow toward developing economies along with skilled workers. Jayet & Marchal (2014) show that when capital flows from northern to southern countries in search of a higher remuneration, it generates north-south skilled migration when the recipient country of the investment lacks skilled labour. Thus, capital flows and skilled migration may be complements.

The mechanisms underlying this relation of complementarity are twofold. First, capital intensive companies implement technologies making use of capital and both unskilled and skilled labour. Therefore, when foreign enterprises establish in a country which lacks skilled labour, they strengthen the demand for skilled workers on the local labour market. The increase in demand may cause the return of skilled migrants from abroad or attract young professionals from developed countries in search of new opportunities (Laczko & Brian, 2013). Second, foreign firms, especially vertically integrated multinational enterprises (MNEs), use skilled worker transfers to control and coordinate the head-quarter operations with the subsidiary operations and ensure tacit knowledge transfers (Bonache et al., 2001). Thus, MNEs may generate skilled worker transfers. Usually, an expatriate is either a high skilled technician or a manager endowed with firm specific organisational skills (Tsang, 1999; Kogut & Zander, 2003). Intra-firm mobility is a growing phenomenon. In 2011, 47% of MNEs reported an increase in international assignments over the previous year; 62% of concerned workers spending between one and three years abroad (Brazier, 2012).

We aim to better understand the complementarity between capital flows and skilled labour flows; a topic overlapping the economic and the management literature. To this end, we empirically investigate the determinants of the employment of foreign skilled workers by firms operating in less developed countries where skilled workers are likely to be a scarce resource. We use firm-level data collected through the Africa Investor Survey 2010 of the United Nations Industrial Development Organization, across 19 Sub-Saharan African (SSA) countries. This database presents a set of domestic and foreign firms. The sample includes firms operating in the three main sectors of the economy (agricultural, manufacturing and tertiary sector), with a description of their labour force composition in terms of skills (low, medium, and high skilled workers) and origin (native and foreign workers)[2].

In our study, we find support for complementarity between FDI and skilled migration toward SSA countries. It implies that foreign firms increase the flow of human capital toward the investment destination countries by attracting foreign skilled workers. Our results also indicate that the lack of skilled labour in the destination country induce firms to employ more foreign workers. We find that, over time, foreign firms tend to favour native over foreign skilled workers, in countries more abundant with skilled labour. This result suggests that a replacement of foreigners by natives takes place only when foreign firms find the appropriate skills on the local labour market.

In addition, firms aiming to serve the domestic market, demand more native skilled workers. It suggests that market-oriented firms exploit the capabilities of natives in managing local environment issues, and their knowledge of the language and consumer tastes. We also find a lower usage of foreign skilled workers by foreign firms engaged in joint-venture partnerships with local firms, as compared to majority owned foreign

[1]North-South migration represented 3% of international migration in 2010, following the definition of the North and the South given by the World Bank, which classifies countries according to their income level (GNI/capita).

[2]For more information related to the Africa Investor Survey 2010, we refer the reader to the UNIDO Africa Investor Report 2011, *Towards evidence-based investment promotion strategies* (2012).

firms. This result suggests that partner firms share the right to appoint their own key personnel in high managerial and control positions. Though, in joint-ventures, foreign firms have less discretion to appoint their own staff in top positions. Finally, destination country characteristics can determine the easiness and willingness of foreign workers to migrate toward less developed countries. In particular, we find that an efficient working regulation and a loosen immigration policy regime have a positive effect on foreign skilled worker transfers.

The contribution to the literature of this paper is twofold. Firstly, we provide evidence on the determinants of skilled migration toward less developed countries, contrarily to the bulk of existing literature which has focused on the opposite south-north direction. Secondly, we shed light on the complementarity between FDI and migration using a firm-level analysis in an area of the world, SSA countries, on which only few contributions exist. Our firm-level approach is quite unique in the literature and allows us to exploit the high degree of heterogeneity of firm's employment decisions.

The rest of the paper is organised as follows. In section 2 we better position our work in the economic and the management literature. In section 3 we present the data, especially the UNIDO Africa Investor Survey 2010, and some descriptive statistics. In section 4 we present our econometric model and the variables of interest. In sections 5 and 6 we present our main results and some robustness checks. Section 7 concludes.

2. RELATED LITERATURE

This paper adds to the economic literature analysing the FDI-migration nexus. At first, researchers have been studying the impact of migration on FDI. Some empirical studies emphasise that migrant networks spread information between their origin and their host countries, which strengthens bilateral economic relations. See Rauch (2001), Dolman (2008), Docquier & Lodigiani (2010), and Beine et al. (2011) for their empirical papers and Aubry et al. (2012) for their theoretical framework and empirical validation.

Researchers also consider the reverse causality *i.e.* the effects of FDI on migration flows. The literature shows that FDI entering a developing country generate externalities which can either lessen south-north migration – FDI may participate to the economic development of the migrants' origin country – or strengthen south-north migration – by maintaining or/and creating jobs in the receiving countries, and by conveying information about migration opportunities, FDI may relax the budget constraint of would-be migrants. See Aroca & Maloney (2005), D'Agosto et al. (2006), and Sanderson & Kentor (2008) for their empirical contributions.

Few papers deal with the impact of FDI on skilled migration toward the FDI recipient country. To the best of our knowledge, only one theoretical paper can be related to this issue. Jayet & Marchal (2014) show that capital and skilled migration flows are complements. They develop a theoretical framework analysing the impact of capital flows on migration of high and low skilled workers between a northern and a southern region. The northern region is assumed to be well endowed with capital and skilled labour, and the southern region well endowed with unskilled labour. Two sectors are assumed: a traditional sector which is labour intensive, and a capital intensive sector. The technology of the capitalist sector requires both qualified and unqualified workers. Upon these assumptions, they find a relation of complementarity between capital and skilled labour flows, and a relation of substitution between capital and unskilled labour flows. On the one hand, when capital flows from the north to the south in search of a higher remuneration, it increases the capital stock of the recipient country. This increase in capital strengthens the demand for skilled labour, as the recipient country of the investment lacks skilled labour. Thus, skilled workers flow from the north to the south. On the other hand, when capital is invested in the north, skilled workers remain in the north but unskilled workers migrate to the north as the northern country lacks unskilled labour.

Also, the literature on skilled migration is related to the management literature analysing expatriation within the strategy of MNEs. A large set of papers explains how MNEs use transfers of skilled workers between their establishments to manage specific activities (Tsang, 1999; Bonache et al., 2001; Kogut & Zander, 2003; Williams, 2007). Peterson et al. (1996) using a survey realised in 1992 on 29 MNEs, find that intra-firm transfers of managers represented between 1% and 2% of the MNEs' labour force. There has been no survey conducted in the recent years giving relevant quantitative information on the use of

expatriation by MNEs[3]. A recent survey ranks the most relevant reasons that motivate MNEs to use expatriates (Brookfield, 2010). Among the top ranked assignment objectives are: "to fill a managerial skills gap" (22% of the respondents), followed by "filling a technical skills gap" (21% of respondents) and "transfer knowledge" (16% of the respondents). Thus, the availability of skilled workers in the investment's destination country, possibly reduces the use of skilled expatriates by MNEs. Tung (1982) observes that subsidiaries established in developing countries employ less local managers compared to those established in developed countries; the main reason being the lack of skilled workers in developing countries. Then, some evidence suggests a positive relation between technological and managerial intensive activities and the expatriation of high skilled workers, in countries where there is a shortage of skilled labour. In particular, several papers consider the research and development (R&D) content of the firm and the complexity of their environment, as two crucial determinants of expatriation (Boyacigiller, 1990; Delios & Bjorkman, 2000; Harzing, 2001). The R&D content of the investment, when it is employee-embedded, may explain the need of MNEs to transfer this knowledge through expatriates to the subsidiary. Delios & Bjorkman (2000) measure the technological capabilities of the firms as the R&D expenditure with respect to the total exports. They find evidence that the technological sophistication of Japanese subsidiaries positively affects the use of expatriates when localised in China, conversely to subsidiaries localised in the United States. They argue that the skilled labour endowment in the United States could entail a larger employment of host-country nationals.

3. DATA AND DESCRIPTIVE STATISTICS

In this paper, we use firm-level data from the UNIDO Africa Investor Survey 2010[4], referring to the year 2009. The survey contains information on $6,484$ firms in the agricultural, manufacturing and tertiary sectors[5], in 19 Sub-Saharan African countries[6]. The database we use contains $4,298$ observations collected in 16 SSA countries[7]; among them $1,690$ are foreign firms. Three types of foreign firm are considered: subsidiaries, joint-ventures and foreign individual investments. Notice that in this survey, a foreign firm is defined as a firm having at least 10% of foreign ownership, which is in line with the 4th Edition of the OECD Benchmark Definition of Foreign Direct Investment. Also notice that we have no information to differentiate vertical from horizontal investments. The survey collects information on firms' characteristics such as the value of assets, financial indicators, and the market orientation. It also contains characteristics specific to foreign firms such as the origin country of the investor, the organisational structure, and the market entry mode. This database is suitable for our investigation as it contains detailed information on the workforce composition of the firms, disaggregated in three skill categories: (i) production, manual and sales workers, (ii) clerical and administrative staff, and (iii) managers, supervisory staff and technicians. Henceforth, we refer to these groups as low, medium and high skilled workers. For each skill category of workers, we know the number of native and foreign workers.

Regarding foreign firms, most of them come from Western European countries (641 firms), countries of east Asia (307 firms, excluding China) and SSA neighbouring countries (235 firms); see Table 6 in Appendix. In this database, investors from the north *i.e.* high-income countries represent almost 48% of the foreign investors[8]. The most attractive countries for foreign firms are Uganda (105 northern and 242 southern firms), Kenya (156 and 112 respectively) and Ghana (64 and 79 respectively). Among the 16 SSA countries of the

[3]A survey realised in 2003 and 2004 reports that the 134 respondent firms managed 31,215 expatriates out of a total work force of 4.5 million employees (Brookfield, 2004). Nonetheless, the survey does not report the size of the firms which makes difficult the assessment of the importance of expatriation.

[4]Among others, this database has been used by Amendolagine et al. (2013) who analyse the micro and macro factors explaining the linkages between foreign subsidiaries and local firms, and Boly et al. (2014) who look into diaspora investments and firm export performance.

[5]We exclude from our analysis firms offering financial services.

[6]Burundi, Burkina Faso, Cameroon, Cape Verde, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Niger, Nigeria, Mozambique, Rwanda, Senegal, Uganda, United Republic of Tanzania and Zambia.

[7]We exclude Cape Verde, Niger and Rwanda from our analysis, as one macro control variable important for our analysis is not available for these countries.

[8]We define northern firms as enterprises originating from a high-income economy such as defined by the World Bank *i.e.* with a GNI per capita in 2012 equal to or higher than $12,616.

sample, Kenya and Ghana are the countries with the highest endowment of skilled workers, and medium to high domestic market size (approximated by their populations) and market potential (approximated by the GDP per capita and the GDP growth). Despite no clear difference between these two countries and other SSA countries in terms of labour market regulation or level of corruption, they are the two most attractive SSA countries for foreign investments (cf. Table 1).

Table 2 shows that domestic firms employ in average less foreign workers (1.43% of their total workforce) as compared to foreign firms (9.09%). This is the case for low, medium and high skilled workers. Note that domestic and foreign firms are similar in term of age, while foreign firms are in average larger than domestic ones in term of size measured by the total full-time workforce (respectively 87 and 195 employees). There exist, as expected, huge differences in capital intensity between domestic and foreign firms. The latter have, on average, an asset/employee ratio almost 15 times larger than domestic firms. Moreover, foreign firms are more export-oriented than domestic firms. Sales of foreign firm in foreign markets, on average, amount to almost 18% of the overall sales, while for domestic firms this share is only 6%. Regarding the sectoral repartition, there is not a big difference between domestic and foreign firms. As compared to domestic firms, foreign firms are more engaged in the primary and hard manufacturing sectors. Domestic firms instead, have higher shares in light manufacturing and service sectors. Table 7 in Appendix shows that northern and southern foreign firms are quite similar.

4. MODEL AND SPECIFICATION

Our empirical analysis aims to shed light on the employment of foreign skilled workers by firms established in SSA countries. The complementarity between capital and foreign skilled workers has two simple implications at firm-level: (i) capital intensive firms should hire more foreign skilled workers; (ii) firms should employ more foreign skilled workers when localised in a country lacking skilled workers.

We have no information on the origin country of the foreign workers in the UNIDO Africa Investor Survey 2010. Hence, as Jayet & Marchal (2014), we assume that foreign skilled workers are likely coming from economies where the stock of high skilled workers is relatively more important than in SSA countries. Regarding foreign firms, especially subsidiaries and joint-ventures, part of their foreign skilled employees may be expatriates coming from the country of their headquarter. This hypothesis is in line with the literature on intra-firm transfers of high skilled workers (Peixoto, 2001). Also, skilled workers less likely come from neighbouring African countries. The literature on south-south migration shows that concerned migrants are mainly low skilled workers (Ratha et al., 2011; Shaw, 2007).

Our data imply three cross-section dimensions, the reporting firm n with $n = 1, ..., N$, the investor's origin country i with $i = 1, ..., I$, and the firm's operating country j with $j = 1, ..., J$. In the case of a domestic firm, $i = j$. We use a negative binomial model, in particular the mean-dispersion model referred as NB2 (Greene, 2012), to estimate the determinants of the employment of foreign workers. The model is specified as follows:

$$\Pr\left(Y = y_{nij} | x_{nij}\right) = \frac{\Gamma\left(\theta + y_{nij}\right)}{\Gamma\left(y_{nij} + 1\right)\Gamma\left(\theta\right)} \left(\frac{\lambda_{nij}}{\theta + \lambda_{nij}}\right)^{y_{nij}} \left(1 - \frac{\lambda_{nij}}{\theta + \lambda_{nij}}\right)^{\theta} \quad (1)$$

Our dependent variable is denoted by y_{nij} and represents the number of foreign high skilled workers. x_{nij} denotes a vector of regressors. Γ denotes the Gamma function and θ is the dispersion parameter. The unconditional mean of this model is $E\left(y_{nij}|x_{nij}\right) = \lambda_{nij}$, and the unconditional variance is $\mathrm{Var}\left(y_{nij}|x_{nij}\right) =$

Table 1: Statistics on the firms' operating countries

	GDP per capita PPP ($ 2011)	GDP growth in 2009 (% of GDP)*	Education and Training	Population (in thousands)	Int. migrant stock (% of population)	Corruption Index	Hiring regulation	Total tax rate (% of commercial profits)*
Burkina Faso	1352	2.97	2.62	15,094	5.757	3.42	6.7	44.9
Burundi	722	3.47	2.51	8,926	1.049	2.60	10	279.7
Cameroon	2447	1.87	2.82	20,103	1.168	3.20	7.2	48.8
Ethiopia	968	8.8	2.67	84,838	0.727	4.32	6.7	30.30
Ghana	2906	3.99	3.2	23,691	7.806	4.17	8.9	32.5
Kenya	1980	2.74	3.69	39,824	2.207	2.75	7.8	49.3
Lesotho	2098	3.36	3.23	1,989	0.324	3.79	7.8	19.9
Madagascar	1419	-4.01	2.88	20,495	0.217	3.38	2.23	38.4
Malawi	838	9.04	2.78	14,573	2.157	5.21	5.6	26.3
Mali	1625	4.46	2.66	13,559	1.385	2.50	6.7	51.4
Mozambique	848	6.33	2.54	23,361	1.932	4.35	3.3	37.5
Nigeria	4906	6.93	3.03	1,55,381	0.696	3.23	10	32.2
Senegal	2152	2.42	3.41	12,586	1.953	4.35	3.9	45.5
Tanzania	1487	6.02	2.58	43,639	2.054	3.64	1.1	44.4
Uganda	1264	7.25	2.76	32,864	2.271	3.08	10	35
Zambia	2661	6.04	2.97	12,825	2.505	4.55	8.9	15

*World Development Indicators, World Bank (2014)
The other indicators are presented in Appendix **??**, Table 10.

Table 2: Characteristics of domestic and foreign firms

	Domestic firms				Foreign firms			
	Obs.	Mean	[95% Conf. Interval]		Obs.	Mean	[95% Conf. Interval]	
Total assets (millions of USD)	2,608	4.657	2.816	6.499	1,690	81.6	-36.6	200
Capital intensity (value of fixed assets in USD/empl.)	2,608	53,976.77	15,578.2	92,375.35	1,690	804,406	-506,127.9	2,114,940
Knowledge intensity (intellectual property assets in USD/empl.)	2,413	763.3374	154.5474	1,372.127	1,567	1194.475	421.3728	1,967.577
Export intensity (exports in USD/sales in USD)	2,608	.0605	.0531	.0678	1,690	.1855	.17	.201
Age of the firm	2,608	17.276	16.7422	17.8098	1,690	17.3349	16.59	18.0798
Size (number of full time employees)	2,608	87.8213	79.0954	96.5472	1,690	195.7805	167.3021	224.2589
Foreign employees (% full time workforce)	2,595	1.43	1.19	1.67	1,685	9.09	8.51	9.68
Foreign low skilled workers	2,603	.31	.23	.39	1,684	2.24	1.93	2.54
Foreign medium skilled workers	2,605	.34	.17	.51	1,684	1.67	1.47	1.87
Foreign high skilled workers	2,608	.77	.66	.88	1,690	5.02	4.67	5.37
For. low skilled workers (% low skilled workforce)	2,439	.6	.42	.78	1,586	4.31	3.7	4.92
For. medium skilled workers (% medium skilled workforce)	2,278	2.62	1.18	4.07	1,584	13.48	12.11	14.85
For. high skilled workers (% high skilled workforce)	2,458	5.23	4.55	5.9	1,642	32.45	30.05	34.84
Primary sector (%)	2,608	3.6	2.88	4.32	1,690	7.57	6.31	8.83
Light manufacturing sector (%)	2,608	31.74	29.96	33.53	1,690	25.73	23.65	27.82
Hard manufacturing sector (%)	2,608	20.93	19.37	22.49	1,690	27.33	25.21	29.46
Construction sector (%)	2,608	7.63	6.61	8.64	1,690	7.45	6.2	8.7
Services sector (%)	2,608	36.08	34.23	37.92	1,690	31.89	29.66	34.11

$\lambda_{nij}\left(1+\frac{\lambda_{nij}}{\theta}\right)$[9]. Let us define the vector of regressors as:

$$x_{nij} = \left(1; \ln K_{nij}; \text{Skill}_j; \text{Firm}'_{nij}; \text{MacroControls}'_{ij}\right)$$

Then, the unconditional mean which we estimate is given by:

$$E\left(y_{nij}|x_{nij}\right) = \lambda_{nij} = \exp\left(\beta_0 + \beta_1 \ln K_{nij} + \beta_2 \text{Skill}_j + \gamma_1 \text{Firm}'_{nij} + \gamma_2 \text{MacroControls}'_{ij}\right)$$

where the main explanatory variable is $\ln K_{nij}$ and denotes the logarithm of the capital intensity of the firm, and the main control variable is Skill_j and denotes the endowment of skilled labour in the firm's operating country. We include two vectors of control variables of dimension 1xk. Firm'_{nij} considers the firm's characteristics, and $\text{MacroControls}'_{ij}$ is a set of covariates related to the investor's origin country and the operating country of the firm. β_0 is a constant term, β_1 and β_2 are parameters to be estimated, γ_1 and γ_2 are vectors of parameters to be estimated.

Hereafter we detail the dependent and explanatory variables. Correlation matrices of covariates are presented in Appendix, Tables 8 and 9. The source and definition of each variable are presented in Appendix, Table 10.

(a) *The dependent variable*

y_{nij} refers to the number of foreign high skilled workers employed by the firm n which originates from country i and operates in country j[10]. We refer to foreign skilled workers as full-time foreign workers employed in managerial, technical or supervisory positions. This dependent variable is a discrete count variable, directly measured by the questionnaires of the UNIDO Africa Investor Survey 2010.

Note that a large number of firms do not employ foreign workers. It implies a high number of zeros on the left hand side of our equation. In the sample, about 54.31% of firms do not hire foreign workers, about 61.89% do not employ foreign high skilled workers. Yet the decision of some firms to not employ foreign skilled workers is not assumed to be qualitatively different from the decision to employ foreign workers. Thereby, using a negative binomial model allows us to include the zeros in our analysis, and to account for the over-dispersion of the dependent variable. Notice that a preliminary analysis showed that with respect to the likelihood-ratio test, the negative binomial distribution gives a better result than the Poisson distribution.

(b) *Explanatory and control variables*

Our main explanatory variable is the capital intensity of the firm ($\ln K_{nij}$). It denotes the logarithm of the value of fixed assets per employee in the last financial year. We expect capital intensive firms to use more foreign skilled workers as compared to low capitalised firms.

Our main control variable is the endowment of skilled labour in the firm's operating country (Skill_j). It is approximated by the level of higher education and training (5th pillar), from the Global Competitiveness Report 2009-2010 (Schwab, 2009). This proxy measures both the enrolment ratios and the quality of education. It also takes into account vocational and on-the-job training which is relevant for the business community. This indicator allows us to keep 16 over 19 SSA countries in our study. We expect firms localised in a country having a relatively low index, to employ more foreign skilled workers in order to compensate this skilled labour shortage.

[9] In other words, the NB2 model is an extension of the Poisson model to which we add a stochastic term. Let us denote our conditional distribution function by $\Pr\left(Y = y_{nij}|x_{nij}, u_{nij}\right)$ and the corresponding conditional mean by $E\left(y_{nij}|x_{nij}, u_{nij}\right) = \lambda_{nij} + u_{nij}$, where $u_{nij} = \exp\left(\varepsilon_{nij}\right)$ and denotes the stochastic part of the function, and ε_{nij} denotes the error term. If $u_{nij} = 0$, then our model consists in a Poisson model. If we assume u_{nij} has a Gamma density function we obtain a NB2 model and we can write the unconditional distribution function as in equation (1).

[10] The question asked to the firm in the UNIDO questionnaires was the following: "How many of the total permanent full-time employees were: Production/manual/sales workers, Technical/supervisory/managerial staff, Clerical/administrative staff ?" For each skill category, the firm was asked to report the total number of workers and the number of foreigners.

The richness of the UNIDO Africa Investor Survey 2010 allows us to include a large set of micro control variables that might affect the employment of foreign skilled workers. In particular, for foreign firms we include variables that could influence the intra-firm transfer of skilled workers.

$$\text{Firm}'_{nij} \quad = \quad \left(\ln \text{Size}_{nij}; \ln \text{Age}_{nij}; \text{MultiPr}_{nij}; \ln \text{Exp}_{nij}; \text{Green}_{nij}; \text{Sub}_{nij}; \text{JV}_{nij}\right)$$

$\ln \text{Size}_{nij}$ denotes the logarithm of the size of the firm. The size is measured as the average number of full-time employees in the firm[11]. $\ln \text{Age}_{nij}$ denotes the logarithm of the age. It is measured by the lapse of time between the year of the investment or the firm's creation and the year of the survey (2009). We expect older firms to employ more local employees, as they should be more integrated into their local environment. Over time, firms are expected to gain knowledge on their institutional and business context (Wilkinson et al., 2008). MultiPr_{nij} is a dummy variable taking the value of 1 when the firm produces at least four products. $\ln \text{Exp}_{nij}$ represents the logarithm of the export intensity of the firm, which is measured by the value of exports with respect to total sales. The management literature supports the idea that multi-product firms and export oriented firms may employ more foreign expatriates to deal with the complexity of the production and distribution process (Peixoto, 2001). Thus we expect these types of firm to employ more foreign high skilled workers. Finally, we include 18 industry dummies to control for the sector of activity of the firm. We may also include country dummies controlling for the operating country of the firm. Among other things, these dummies capture possible country-specific restrictions regarding the employment of foreigners.

The following variables are foreign firm specific: Green_{nij} is a dummy variable relating the entry mode of the foreign firm, which takes the value of 1 in case of a greenfield investment, 0 in case of an acquisition of an existing firm. According to Harzing (2001) and Peixoto (2001) start-up businesses require a larger employment of managers and technicians. Thus, we expect greenfield investments to be positively related to the employment of foreign skilled workers. Sub_{nij} and JV_{nij} are dummies accounting for the type of FDI, making the distinction between subsidiary firms, joint-venture firms, and foreign individual investments. Finally, we may include dummies controlling for the origin country or the origin region[12] of the foreign investor.

We also consider a set of macro variables such as demographic and economic characteristics of the firm's operating country.

$$\text{MacroControls}'_{ij} \quad = \quad \left(\text{GDPcap}_j; \ln \text{Pop}_j; \text{Corruption}_j; \ln \text{MigStock}_j; \text{Open}_j; \text{LabReg}_j\right)$$

GDPcap_j denotes the GDP per capita in purchasing power parity of country j in 2009, in constant international dollars of 2011. It is a proxy for the level of wealth of the country. $\ln \text{Pop}_j$ represents the logarithm of the population of country j in 2009, and is a proxy for the market size of the country. We expect these two variables to impact positively both the capital intensity of the firm and its use of foreign workers, as they are known to be pulling factors of both FDI and migration (Buch et al., 2006). Corruption_j relates the level of extra payments, bribes or favouritism actions realised by firms in the country in 2009. Regarding foreign firms, a high degree of corruption may have an ambiguous effect on the employment of foreign high skilled workers. On the one hand, a high degree of insecurity and corruption is an incentive for a foreign firm to employ reliable workers from its origin country. On the other hand, it is an incentive to rely on local employees who have a better knowledge of the local environment. $\ln \text{MigStock}_j$ denotes the logarithm of the stock of international migrants in country j in 2005. This variable controls for the possibility that some foreign workers employed by the firm were already part of the population of migrants residing in country j. It also controls for the fact that networks of migrants foster new migration. Open_j denotes the freedom of foreigners to visit the country in 2009. We expect countries with soft regulations to attract relatively more foreign workers who may easily receive visit or migrate with their relatives. LabReg_j denotes the hiring

[11] In section 6.(b), we control for a possible endogeneity bias between the size of the firm and our dependant variable by using an instrumental variable approach.

[12] Eastern Asia (China excluded), China, Eastern Europe and Central Asia, Western Europe, Latin America and Caribbean, North America, Middle East and North Africa, SSA countries (South Africa excluded), South Africa, and Oceania

regulations in the country in 2009. The effect of strong hiring regulations on the employment of foreign workers is ambiguous. On the one hand, a country ensuring workers protection may attract foreign workers, but on the other hand regulations may limit the employment flexibility.

5. EMPIRICAL RESULTS

Table 3: Demand for foreign skilled workers, sub-sample of foreign firms

	(1)	(2)	(2')	(3)	(4)	(5)
$\ln K_{nij}$	0.0772***	0.0873***	0.222***	0.0949***	0.0954***	0.0939***
	(0.0148)	(0.0147)	(0.0377)	(0.0147)	(0.0147)	(0.0148)
Skill_j	-0.369***	-0.519***	-1.323***		-0.532***	0.306
	(0.0749)	(0.0777)	(0.199)		(0.0790)	(0.240)
$\ln \text{Size}_{nij}$	0.563***	0.587***	1.496***	0.586***	0.586***	0.585***
	(0.0220)	(0.0238)	(0.0656)	(0.0227)	(0.0240)	(0.0237)
$\ln \text{Age}_{nij}$		-0.0198	-0.0506	-0.0725*	-0.0471	0.922***
		(0.0373)	(0.0950)	(0.0371)	(0.0375)	(0.261)
$\ln \text{Exp}_{nij}$		0.457***	1.165***	0.386***	0.472***	0.451***
		(0.138)	(0.353)	(0.137)	(0.138)	(0.138)
MultiPr_{nij}		0.0950	0.242	0.165*	0.153	0.0960
		(0.0944)	(0.241)	(0.0902)	(0.0939)	(0.0940)
Sub_{nij}		-0.0129	-0.0328	0.0663	0.00394	-0.00318
		(0.0634)	(0.162)	(0.0612)	(0.0654)	(0.0632)
JV_{nij}		-0.462***	-1.178***	-0.459***	-0.433***	-0.427***
		(0.0829)	(0.212)	(0.0813)	(0.0833)	(0.0832)
Green_{nij}		0.110	0.280	0.113	0.0810	0.136*
		(0.0761)	(0.194)	(0.0732)	(0.0760)	(0.0761)
$\ln \text{MigStock}_j$		0.443***	1.128***		0.349***	0.426***
		(0.0657)	(0.168)		(0.0672)	(0.0655)
$\ln \text{Age}_{nij} * \text{Skill}_j$						-0.308***
						(0.0845)
Sector dummies	yes	yes	yes	yes	yes	yes
Origin region dummies	no	yes	yes	yes	no	yes
Origin country dummies	no	no	no	no	yes	no
Country dummies	no	no	no	yes	no	no
Constant	-1.293***	-1.810***		-2.668***	-2.045***	-4.374***
	(0.275)	(0.291)		(0.322)	(0.337)	(0.761)
$\ln \alpha$	-0.121**	-0.357***		-0.453***	-0.481***	-0.372***
	(0.0508)	(0.0566)		(0.0573)	(0.0587)	(0.0569)
Observations	1,807	1,690	1,690	1,811	1,690	1,690

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Column 2' presents the marginal effects at mean based on specification 2.

In Table 3, we report the results of our baseline estimations for the sub-sample of foreign firms. First, we observe a positive and highly significant effect of the capital intensity of the firm on its employment of foreign skilled workers. In specification 2', the marginal effect shows that to every increase in the logarithm of the capital intensity by 1 unit corresponds an increase in the use of foreign skilled workers by 22.2%[13]. This result suggests a relation of complementarity between the technological content of the investment and the employment of foreign high skilled workers[14]. It also corroborates the tendency of capital intensive firms to protect their know-how using intra-firm transfers of employees (Argote & Ingram, 2000). This complementarity result is robust after controlling for the firm's sector of activity, which captures industry differences in the usage of high skilled workers. In some specifications, we introduce destination country dummies and origin region dummies in order to control for origin and destination country fixed effects that

[13]Marginal effects are assessed at mean.

[14]Although our study focuses on foreign high skilled workers, we expect to find a higher degree of complementarity between the capital intensity of the firm and its use of foreign skilled workers as compared to its use of foreign unskilled workers. We refer to foreign low skilled workers as full-time foreign workers employed in production, manual and sales activities. In line with what expected, further tests have shown that the complementarity is much stronger between the firm's capital intensity and its use of foreign skilled workers. Results are presented in Appendix, Table 11.

may influence the complementarity relation. In specification 4, we carry out a more detailed investigation by introducing in the estimation origin country dummies. In all specifications, results on the capital intensity variable do not change significantly.

Then, we find strong support that the availability of skilled workers in the firm's operating country has a negative and highly significant effect on our dependent variable. In countries relatively more endowed with skilled workers, *ceteris paribus*, firms rely more extensively on the native skilled workforce, employing less foreign skilled workers. This result is in line with what predicted by Jayet & Marchal (2014). In addition, as stressed by the expatriation literature, the availability of skilled workers in the investment's destination country, reduces the use of costly expatriates by MNEs.

We observe a positive relation between the export intensity of the firm and its use of foreign skilled workers. This result might be due to the fact that exporting firms use foreign qualified staff who have a better knowledge of international markets as compared to native staff. Richards (2001) asserts that expatriates, rather than local managers, are more appropriate to deal with international consumers since they have more international experience. On the contrary, domestic-market oriented firms extensively employ local skilled workers who have a good knowledge of language, local consumer tastes and customs (Peixoto, 2001). Furthermore, foreign investors forming a joint-venture with a local partner use less foreign skilled workers than foreign individual investors. Wang et al. (1998) note that in a joint-venture, the foreign partner has less discretion to appoint home country nationals in control and management positions. Finally, we find weak evidence that firms making greenfield investments use more foreign skilled workers as compared to those making brownfield investments[15].

Gong (2003) argues that, over time, foreign firms tend to replace their foreign technical and managerial staff with local employees. For instance, a subsidiary employs a high number of expatriate staff in the early phase of establishment to set-up and manage the production process. Over time, the role of expatriates tend to decline since firms engage in local staffing development, *e.g.* through training, in order to build the necessary human resource capacities Peng & Beamish (2011). Interestingly, in most of our specifications, we find that the age of the firm has no significant effect on the use of foreign skilled workers. This result could be related to the very low skilled labour endowment in SSA countries which may prevent firms to fill positions with well-qualified local staff. If this intuition is correct, we expect firms operating in countries which are better endowed with skilled workers to employ, over time, more local skilled workers. To test this intuition, we use an interaction term between the age variable and the skilled labour endowment proxy (specification 5). The result shows a negative and highly significant effect of the interaction on the number of foreign skilled workers. In Figure 1 in the Appendix, we decompose the average effect measured by the coefficient, highlighting its significance by level of skilled labour endowment in the destination country. We find that the length of operations in the destination country has: (i) a positive effect on the employment of foreign skilled workers when the skilled labour endowment in the operating country is relatively low (around 20% of the observations); and (ii) a negative effect on the employment of foreign skilled workers when the skilled labour endowment in the operating country is relatively high (around 22% of observations). Thereby, over time, the substitution of foreign by native skilled workers is relevant for firms located in SSA countries which are the most abundant in skilled labour, while firms operating in countries with low endowment of skilled labour use extensively foreign skilled workers. Finally, it is worth noting that the dummies controlling for the sectors of activity of the firms show the expected effect on the use of foreign skilled workers. Though not reported in the estimation tables, we find that, as compared to the agricultural and fishery, highly capital intensive sectors use a higher number of foreign skilled workers. Specifically, these sectors include mining and quarrying, machinery and equipment, construction, retail and motor vehicles sales.

[15]It should be noted, as in Amendolagine et al. (2013), that most of FDI flowing in SSA countries are greenfield (86% of investments). Hence, the result might be conditioned by the low variability of this covariate.

Table 4: Demand for foreign skilled workers, sub-sample of domestic firms

	(1)	(1')
$\ln K_{nij}$	0.183***	0.0433***
	(0.0390)	(0.00926)
Skill_j	-0.389**	-0.0919**
	(0.197)	(0.0466)
$\ln \text{Size}_{nij}$	0.902***	0.213***
	(0.0622)	(0.0171)
$\ln \text{Age}_{nij}$	-0.0202	-0.00478
	(0.0921)	(0.0218)
$\ln \text{Exp}_{nij}$	1.421***	0.336***
	(0.479)	(0.115)
MultiPr_{nij}	0.0498	0.0118
	(0.234)	(0.0553)
$\ln \text{MigStock}_j$	0.935***	0.221***
	(0.171)	(0.0412)
Sector dummies	yes	yes
Origin region dummies	no	no
Origin country dummies	no	no
Country dummies	no	no
Constant	-6.262***	
	(0.768)	
$\ln \alpha$	1.771***	
	(0.0806)	
Observations	2,608	2,608

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Column 1' presents the marginal effects at mean based on specification 1.

Table 5: Demand for foreign skilled workers (introducing macro covariates), sub-sample of foreign firms

	(1)	(2)	(3)	(4)	(5)
$\ln K_{nij}$	0.0874***	0.0899***	0.0935***	0.0895***	0.0940***
	(0.0152)	(0.0149)	(0.0148)	(0.0150)	(0.0149)
Skill_j	-0.391***	-0.342***	-0.542***	-0.426***	-0.489***
	(0.0766)	(0.0834)	(0.0794)	(0.0789)	(0.0788)
$\ln \text{Size}_{nij}$	0.574***	0.578***	0.585***	0.576***	0.577***
	(0.0239)	(0.0239)	(0.0237)	(0.0238)	(0.0238)
$\ln \text{Age}_{nij}$	-0.0243	-0.0192	-0.0287	-0.0306	-0.0370
	(0.0379)	(0.0379)	(0.0372)	(0.0380)	(0.0378)
$\ln \text{Exp}_{nij}$	0.471***	0.433***	0.372***	0.442***	0.429***
	(0.140)	(0.140)	(0.138)	(0.139)	(0.139)
MultiPr_{nij}	0.0795	0.0739	0.115	0.0785	0.0966
	(0.0954)	(0.0954)	(0.0940)	(0.0954)	(0.0951)
Sub_{nij}	-0.0621	-0.0664	-0.0584	-0.0701	-0.0386
	(0.0639)	(0.0638)	(0.0631)	(0.0640)	(0.0639)
JV_{nij}	-0.509***	-0.504***	-0.501***	-0.507***	-0.457***
	(0.0839)	(0.0833)	(0.0823)	(0.0834)	(0.0834)
Green_{nij}	0.0972	0.0951	0.149*	0.0955	0.0754
	(0.0771)	(0.0770)	(0.0764)	(0.0770)	(0.0769)
$\ln \text{Pop}_j$	0.0387				
	(0.0384)				
GDPcap_j		-5.57e-05*			
		(3.36e-05)			
Open_j			0.102***		
			(0.0165)		
Corruption_j				-0.0675	
				(0.0447)	
LabReg_j					0.0421***
					(0.00985)
Sector dummies	yes	yes	yes	yes	yes
Origin region dummies	yes	yes	yes	yes	yes
Origin country dummies	no	no	no	no	no
Country dummies	no	no	no	no	no
Constant	-2.309***	-1.739***	-1.539***	-1.308***	-1.679***
	(0.710)	(0.298)	(0.291)	(0.373)	(0.290)
$\ln \alpha$	-0.313***	-0.314***	-0.351***	-0.315***	-0.331***
	(0.0558)	(0.0558)	(0.0565)	(0.0558)	(0.0562)
Observations	1,690	1,690	1,690	1,690	1,690

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

In Table 4, we follow our analysis looking at domestic firms. Our intuition is that both foreign and domestic firms have to cope with the scarcity of skilled workers in their operating country. Indeed, for both types of firms, we find that the capital intensity affects positively the use of foreign skilled workers. The results show that the effect is stronger for foreign firms. A marginal increase of the logarithm of the capital intensity by 1 unit entails an increase in the use of foreign skilled workers by 22.2% for foreign firms; while it only entails an increase by 4.33% for domestic firms (specification 1'). The stronger effect for foreign firms may be related to the larger access to qualified workers these firms have as compared to domestic firms. For instance, a foreign affiliate, as an alternative to recruiting in the international labour market, may also receive qualified worker transfers from the foreign parent company.

In Table 5, we report the results of specifications including a set of host-country characteristics. In particular, as expected, the stock of international migrants in the destination country is positively associated with the employment of foreign skilled workers. On the one hand, firms may employ foreign workers already present in the country, on the other hand networks may foster immigration of new workers. The degree of openness of the country in terms of freedom to visit for tourists and business purposes, is positively related to the use of foreign high skilled workers. This variable is a proxy for the easiness of establishment of foreign workers and their families in the destination country. The result corroborates the work of De Smet (2013), who shows that the easiness to employ or transfer foreign skilled workers depends on visa restrictions and bureaucratic procedures to obtain a work permit. In specification 5, we include a variable capturing the adequacy of the host-country hiring regulations. We find that, a better system of protection of worker's rights affects positively the employment of foreign qualified workers. The result suggests that generating a favourable working environment may be a useful tool in attracting foreign skilled workers. Finally, in specification 4 we include an index measuring the corruption level in the destination country[16]. That being said, we do not find a significant effect of this variable on the employment of foreign skilled workers.

6. ROBUSTNESS AND ENDOGENEITY CONCERNS

(a) *Robustness checks*

We realise different robustness checks using alternative specifications and alternative empirical models. Results are presented in Appendix, Table 12. In specifications 1 and 2, we approximate the endowment of skilled labour in country j with two alternative proxies: the gross enrolment ratio in the secondary and tertiary education from the World Development Indicators of the World Bank (2014) (Skill2_j), and the Barro & Lee (2013) index that measures the completed secondary and tertiary education over the age of 25 (Skill3_j)[17]. We observe that the sign and the significance level of our main variables remain stable, though we find smaller coefficients for the skilled labour endowment proxies. As compared to our initial proxy, these proxies might be more restrictive to approximate the level of human capital of a country. In developing countries, excluding on-the-job training might eliminate a large share of the actual skilled labour stock.

Second, we test the sensitivity of our analysis to the type of empirical model chosen. As our model presents a large number of zeros and dyadic independent variables, we estimate our baseline equation using a pseudo Poisson maximum likelihood model (Santos Silva & Tenreyro, 2006) (specification 3). In addition, we estimate our baseline specification using a corner solution Tobit model (specification 4). Although this model is more appropriate to continuous dependent variables, it can be used as a robustness test for count data models (Greene, 2012). We find that the sign of the coefficients and the significance level of the main variables are not sensitive to the empirical model chosen.

[16]Note that, the higher the index, the lower the corruption

[17]Using this index decreases the number of SSA countries considered in the analysis from 19 to 14. The missing countries are Burkina Faso, Cape Verde, Ethiopia, Madagascar and Nigeria.

(b) *Endogeneity concerns*

One concern related to our estimation strategy is the possible endogeneity between our dependent variable and the size of the firm measured as the total number of full-time employees. In fact, staffing decisions (number of employees and foreign skilled workers) could be simultaneously taken by the firm. Nevertheless, we need to control for the size of the establishment as it affects directly the number of foreign high skilled workers needed in the production process. To address this issue, we adopt a two-step IV technique estimated by an exponential generalised method of moments (GMM) in order to instrument the size of the firm. Results are presented in Appendix, Table 13.

We first use as instruments the number of full-time low skilled workers employed by the firm, and the operational costs faced by the firm in the last financial year (specification 1). The number of low skill employee is sufficiently correlated with the overall size of the firm (correlation around 86%), and does not include the number of foreign high skilled workers. Functionally, the number of low skilled employees should not depend on the nationality of the firm's managers. Hence, we assume this instrument to be not correlated with the dependent variable. Though the total number of high skilled workers used by the firm could be to some extent functionally correlated with the number low skilled workers (complementarity or substitution in the production process), we claim that this degree of correlation is less serious if we consider only the foreign skilled workers (it is a sub-sample of the whole skilled workers sample). In this respect, endogeneity could be more relevant in extreme cases when the whole skilled workforce of the firm is composed by foreign skilled workers. However, although not reported in the table, results do not change if we drop these firms from the estimation. The second instrument assumes that the operational costs such as rent, telecommunication and establishment maintenance are correlated with the size of the firm (correlation in the baseline sample is around 19%), but not with the number of foreign skilled workers in specific. We perform a Hansen J test to test the exogeneity of the instruments. It is not significant ($p = 0.1685$), confirming the orthogonality of at least one instrument.

Additionally, in specification 2 we test a second set of instruments, *i.e.* the number of mid-skilled workers and the previously used operational costs. The total number of mid-skilled workers (desk clerks and administrative staff) are correlated with firm size but less seriously correlated with our dependent variable. Alternatively to the low skilled workers, in most of the firms they are not part of the production process, since they cover administrative functions within the firm. Again the Hansen J test ($p = 0.2697$) confirms that at least one instrument is exogenous. In all IV estimations, the results on the variables of interest remain robust.

7. CONCLUSION

The attraction of foreign human capital and containment of the "brain drain" phenomenon is of crucial importance for poor countries. In fact, FDI promoting skilled worker transfers increase the human capital base of destination countries, creating preconditions for future economic development. In this paper, we aim to better understand the pulling factors of skilled labour migration toward less developed countries. To this end, we investigate the determinants of the employment of foreign high skilled workers by firms operating in less developed countries, poorly endowed with skilled labour such as Sub-Saharan African countries. In particular, we look at the complementarity between the capital intensity of the firm and its use of foreign qualified workers. We use a cross section dataset built from the Africa Investor Survey 2010, including 16 SSA countries. We exploit both firm and country characteristics to analyse the choice of the firm to hire a foreign *versus* a native skilled worker.

We derive three main results from our analysis. First, at firm-level, after controlling for the availability of skilled labour in the firm's operating country, we find that the capital intensity of the firm positively impacts its use of foreign skilled workers. We find similar results for both foreign and domestic firms, although the relation of complementarity between the capital intensity and the employment of foreign skilled workers is stronger for foreign firms than for domestic ones. Foreign firms are typically more capital abundant, hence more likely to develop job opportunities for skilled workers.

Second, we find that the availability of skilled workers in the firm's operating country has a negative and highly significant effect on its use of foreign skilled workers. In countries relatively more endowed with skilled workers, over time, firms rely more extensively on the native workforce, employing less foreign skilled workers. That being said, we find that firms tend to substitute foreign by native workers when they get more integrated into their local environment. Moreover, governments which want to enhance job creation for native workers may want to favour a certain type of FDI. Our results suggest that firm partnerships and especially joint-ventures employ more native workers as compared to other types of firm. The same result is found for domestic-market oriented firms which get more locally embedded and therefore foster the domestic employment. Notice that governments may also consider that immigrants stimulate the economic activity of their host country, by creating trade and investment opportunities between their host and origin countries.

Third, our study sheds light on the degree of substitution between natives and foreigners. The fact that both foreign and domestic capital intensive firms hire foreign skilled workers suggests that foreign and native workers are not perfect substitutes. Firms aiming access to specific skills are obliged to recruit foreign skilled workers. This is very likely to happen in SSA countries.

Thereby, our study recommends some policy interventions, aimed at increasing the human capital base in less developed countries. Our analysis suggests that governments implementing policies to attract FDI, may adopt appropriate measures to satisfy the increase in demand for skilled workers boosted by foreign capital inflows. In the short run, governments may want to facilitate immigration of skilled workers in order to reduce the skilled labour shortage. For instance, governments could adopt simpler procedures for the free movement of foreign employees, and implement reliable and suitable working regulations. In addition, governments could invest in education and training in order to increase the stock of human capital of their country[18]. Over time, this strategy would, to some extent, stimulate the substitution of foreign by native skilled workers.

Finally, policies attracting FDI in less developed countries could prevent the emigration of qualified workers, or favour the return of those who migrated toward northern economies. Thus, the establishment of foreign firms could reduce the brain drain faced by less developed countries, especially if foreign firms have a preference for native workers. FDI inflows could even induce a brain gain effect if they attract young qualified workers from northern economies.

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[18]See the work of Lincove (2015) on that subject.

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APPENDIX

Table 6: Number of investors by operating country and origin region

	Eastern Asia (China excluded)	China	Eastern Europe & Central Asia	Western Europe	Latin America & Caribbean	North America	Middle East & North Africa	SSA countries (South Africa excluded)	South Africa	Oceania	Domestic firms
Burkina Faso	0	0	0	3	0	0	2	3	0	0	16
Burundi	1	0	0	12	0	0	1	3	0	0	44
Cameroon	4	4	1	74	1	3	9	4	1	1	88
Ethiopia	19	12	4	44	0	19	27	14	2	1	313
Ghana	32	16	4	47	0	10	26	5	3	0	159
Kenya	67	19	2	114	1	25	12	14	11	3	255
Lesotho	3	30	0	3	0	0	0	4	18	0	78
Madagascar	2	5	0	53	0	1	3	32	1	0	89
Malawi	3	0	0	12	0	0	0	4	6	0	51
Mali	0	7	0	37	0	3	11	12	6	1	182
Mozambique	6	1	1	53	3	2	1	5	33	1	117
Nigeria	11	8	5	22	0	6	17	5	1	0	288
Senegal	3	1	0	43	0	3	4	5	0	0	95
Tanzania	35	7	2	28	0	6	7	21	13	0	242
Uganda	107	14	1	74	0	20	13	97	20	1	354
Zambia	14	3	1	22	2	3	7	7	12	1	168
Total	307	127	21	641	7	101	140	235	127	9	2,539

Notice that the origin country of 1,02% of foreign firms is unknown.

Table 7: Characteristics of southern and northern firms

	Southern firms				Northern firms			
	Obs.	Mean	[95% Conf.	Interval]	Obs.	Mean	[95% Conf.	Interval]
Total assets (millions of USD)	874	15.2	7.91	22.4	841	147	-90.2	385
Capital intensity (value of fixed assets in USD/empl.)	874	151,408.7	2,484.782	300,332.6	841	1,440,560	-1,190,155	4,071,275
Knowledge intensity (intellectual property assets in USD/empl.)	809	506.8144	173.8702	839.7585	787	1,848.914	346.6305	3,351.198
Export intensity (exports in USD/sales in USD)	874	.1662	.1455	.1869	841	.1953	.1728	.2179
Age of the firm	874	13.43	12.66	14.2	841	20.65	19.44	21.86
Size (number of full time employees)	874	175.99	144.36	207.62	841	207.76	160.97	254.55
Foreign employees (% full time workforce)	871	11.09	10.20	11.97	838	6.74	6.03	7.45
Foreign low skilled workers	871	2.84	2.39	3.29	837	1.49	1.11	1.87
Foreign medium skilled workers	871	2.09	1.76	2.41	837	1.18	0.97	1.4
Foreign high skilled workers	874	5.93	5.41	6.44	841	3.98	3.52	4.44
For. low skilled workers (% low skilled workforce)	833	5.07	4.18	5.95	779	3.37	2.54	4.19
For. medium skilled workers (% medium skilled workforce)	807	17.31	15.06	19.55	798	9.07	7.62	10.51
For. high skilled workers (% high skilled workforce)	850	38.01	35.64	40.37	816	25.68	21.54	29.82
Primary sector (%)	874	5.37	3.87	6.87	841	9.63	7.63	11.62
Light manufacturing sector (%)	874	28.71	25.71	31.72	841	23.3	20.44	26.16
Hard manufacturing sector (%)	874	29.74	26.71	32.78	841	23.78	20.89	26.66
Construction sector (%)	874	6.52	4.88	8.16	841	8.32	6.45	10.19
Services sector (%)	874	29.63	26.6	32.66	841	34.95	31.72	38.18
Greenfield investments (%)	861	86.41	84.11	88.7	785	84.45	81.91	86.99
Subsidiaries (%)	874	25.05	22.17	27.93	841	32.69	29.52	35.87
Foreign individual investors (%)	874	59.49	56.23	62.75	841	43.51	40.16	46.87
Joint-ventures (%)	874	13.5	11.23	15.77	841	16.64	14.12	19.16
Multi-product firms (%)	874	6.63	4.98	8.28	841	10.1	8.06	12.14
Firms receiving knowledge transfer from their parent company (%)	874	83.86	81.42	86.31	841	77.17	74.32	80.01

Table 8: Correlation matrix, sub-sample of domestic firms (2608 observations)

	Skill_j	$\ln K_{nij}$	$\ln \text{Size}_{nij}$	$\ln \text{Age}_{nij}$	$\ln \text{Exp}_{nij}$	MultiPr_{nij}	$\ln \text{MigStock}_j$	$\ln \text{Pop}_j$	GDPcap_j	Open_j	Corruption_j	LabReg_j
Skill_j	1.0000											
$\ln K_{nij}$	0.0708	1.0000										
$\ln \text{Size}_{nij}$	0.0455	0.1654	1.0000									
$\ln \text{Age}_{nij}$	0.1552	0.1060	0.3077	1.0000								
$\ln \text{Exp}_{nij}$	0.0708	0.0641	0.1833	0.0505	1.0000							
MultiPr_{nij}	-0.0031	0.0170	0.1156	0.0792	0.0033	1.0000						
$\ln \text{MigStock}_j$	0.2187	-0.0149	-0.0608	-0.0049	-0.0065	-0.0318	1.0000					
$\ln \text{Pop}_j$	-0.0677	0.1371	0.2137	0.0590	-0.0151	0.0642	-0.2206	1.0000				
GDPcap_j	0.4031	0.0896	0.0217	0.1370	-0.0246	-0.0919	-0.0506	0.3449	1.0000			
Open_j	0.2429	-0.0489	-0.1943	-0.0017	-0.0116	-0.0339	0.3347	-0.5507	-0.2550	1.0000		
Corruption_j	0.2897	-0.0048	-0.0113	0.0968	-0.0510	0.0197	0.1081	0.1271	0.4269	-0.2029	1.0000	
LabReg_j	-0.1822	-0.0291	0.0852	0.0104	-0.0375	0.0358	0.1125	-0.0556	-0.1365	0.0409	-0.2624	1.0000

Table 11: Demand for foreign unskilled workers, sub-sample of foreign firms

	(1)	(1')
$\ln K_{nij}$	0.0786**	0.0719**
	(0.0334)	(0.0309)
Skill_j	-1.624***	-1.486***
	(0.226)	(0.220)
$\ln \text{Size}_{nij}$	0.703***	0.643***
	(0.0668)	(0.0709)
$\ln \text{Age}_{nij}$	-0.166	-0.152
	(0.108)	(0.0993)
$\ln \text{Exp}_{nij}$	0.149	0.136
	(0.389)	(0.356)
MultiPr_{nij}	-0.0637	-0.0583
	(0.265)	(0.243)
Sub_{nij}	0.00429	0.00392
	(0.184)	(0.168)
JV_{nij}	-0.497**	-0.455**
	(0.222)	(0.204)
Green_{nij}	0.518**	0.474**
	(0.209)	(0.193)
$\ln \text{MigStock}_j$	0.202	0.184
	(0.188)	(0.172)
Sector dummies	yes	yes
Origin region dummies	yes	yes
Origin country dummies	no	no
Country dummies	no	no
Constant	0.288	
	(0.863)	
$\ln \alpha$	1.829***	
	(0.0660)	
Observations	1,691	1,691

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Column 1' presents the marginal effects at mean based on specification 1.

In order to control that the complementarity is stronger between the firm's capital intensity and its use of foreign qualified workers, than between the firm's capital intensity and its use of foreign unskilled workers, we use the number of low skilled workers in the firm as our dependent variable (Table 11 specification 1). Interestingly, we also find a relation of complementarity between the foreign firm's capital intensity and its use of foreign unskilled workers. We find that a marginal increase of the logarithm of the capital intensity of 1 unit entails an increase in the use of foreign unskilled workers by 7.19% (Table 11 specification 1'). Yet, the degree of complementarity is higher between the capital intensity and the use of foreign skilled workers; to every increase in the logarithm of the capital intensity by 1 unit corresponds an increase in the use of foreign skilled workers by 22.2% (Table 3 specification 2'). One may think that this important complementarity between the capital intensity and the use of foreign low skilled workers may be related to MNEs coming from developing countries such as India or China. Those firms show little local integration and few linkages to domestic firms. Morrissey & Zgovu (2011) underlines that Chinese firms settling in Africa import all necessary equipment, skilled and unskilled labour from China, taking low benefits for the local economies. However, our result is not related to the origin country of the foreign firm as we include origin region dummies in our specifications.

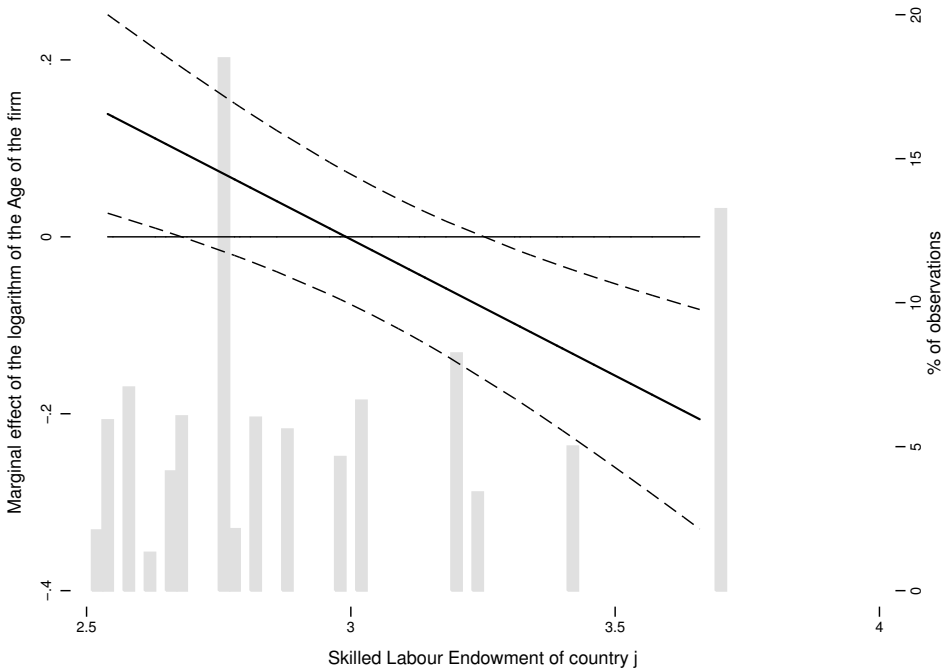
Table 9: Correlation matrix, sub-sample of foreign firms (1646 observations)

	Skill_j	$\ln K_{nij}$	$\ln \text{Size}_{nij}$	$\ln \text{Age}_{nij}$	$\ln \text{Exp}_{nij}$	MultiPr_{nij}	Sub_{nij}	JV_{nij}	Green_{nij}	$\ln \text{MigStock}_j$	$\ln \text{Pop}_j$	GDPcap_j	Open_j	Corruption_j	LabReg_j	$\ln \text{Dist}_{ij}$	Lang_{ij}
Skill_j	1.000																
$\ln K_{nij}$	0.141	1.000															
$\ln \text{Size}_{nij}$	0.121	0.050	1.000														
$\ln \text{Age}_{nij}$	0.113	0.168	0.237	1.000													
$\ln \text{Exp}_{nij}$	0.187	-0.029	0.308	-0.020	1.000												
MultiPr_{nij}	0.136	0.086	0.093	0.064	0.043	1.000											
Sub_{nij}	0.012	0.064	0.197	0.065	0.123	0.069	1.000										
JV_{nij}	0.159	0.098	0.115	0.072	-0.024	0.033	-0.281	1.000									
Green_{nij}	0.037	-0.045	-0.133	0.053	-0.040	-0.032	-0.090	-0.033	1.000								
$\ln \text{MigStock}_j$	0.216	0.069	-0.146	0.017	-0.089	-0.015	-0.094	-0.009	0.018	1.000							
$\ln \text{Pop}_j$	-0.028	0.191	0.008	0.018	-0.121	0.028	-0.100	0.163	0.024	0.019	1.000						
GDPcap_j	0.403	0.052	0.074	0.107	-0.023	-0.000	-0.024	0.061	-0.009	0.114	0.180	1.000					
Open_j	0.311	-0.014	-0.019	0.000	0.090	-0.012	-0.005	0.007	-0.038	0.217	-0.388	-0.173	1.000				
Corruption_j	0.224	0.031	-0.085	0.053	0.000	-0.010	-0.092	-0.022	0.064	0.300	0.105	0.315	0.031	1.000			
LabReg_j	-0.259	-0.110	-0.031	-0.129	-0.110	-0.091	-0.051	-0.080	-0.017	0.144	-0.161	-0.022	-0.040	-0.312	1.000		
$\ln \text{Dist}_{ij}$	0.175	0.046	0.076	0.030	0.033	-0.009	-0.067	0.020	0.010	0.062	0.012	0.145	-0.016	-0.027	0.020	1.000	
Lang_{ij}	0.006	0.002	-0.025	0.088	-0.012	0.052	0.018	0.015	-0.044	-0.047	-0.036	-0.101	0.110	-0.009	-0.165	-0.154	1.000

Table 10: Variables description

Variable	Definition	Source	Expected sign
y_{nij}	Nr. of foreign workers (high skilled, low skilled)	Africa Investor Survey 2010	Dep. variable
$\ln K_{nij}$	log(value of fixed assets/ nr. of full-time employees)	Africa Investor Survey 2010	+
Skill_j	Endowment of skilled labour (5th pillar): level of higher education and training in 2009. Composite indicator assessed using: (a) Secondary enrolment, (b) Tertiary enrolment, (c) Quality of educational system, (d) internet access in schools, (e) availability of research and training, and (f) Extent of staff training etc.	The Global Competitiveness Report 2009-2010, World Economic Forum (2009)	-
Skill2_j	Average of the gross enrolment ratios in the secondary and tertiary education in 2009	WDI, World Bank (2014)	-
Skill3_j	Secondary and tertiary education attainment for population aged 25 and over in 2005	Educational attainment dataset (2014) (Barro & Lee, 2013)	-
$\ln \text{Size}_{nij}$	log(nr. of full time employee)	Africa Investor Survey 2010	+
$\ln \text{Age}_{nij}$	log(nr. of years since the creation of the company)	Africa Investor Survey 2010	-
$\ln \text{Exp}_{nij}$	Export intensity: log(value of exports/nr. of full-time employees)	Africa Investor Survey 2010	+
MultiPr_{nij}	1 if the firm produces at least 4 different products	Africa Investor Survey 2010	+
Green_{nij}	1 if the investment is a greenfield investment	Africa Investor Survey 2010	+
Sub_{nij}	1 if the firm is a wholly owned subsidiary of a foreign firm	Africa Investor Survey 2010	+
JV_{nij}	1 if the firm is a joint-venture between a foreign firm and a local firm	Africa Investor Survey 2010	-
GDPcap_j	GDP per capita in PPP (constant international $ of 2011), in 2009	WDI, World Bank (2014)	+
$\ln \text{Pop}_j$	log(total population in 2009)	WDI, World Bank (2014)	+/-
Corruption_j	Extra payments/bribes/favouritism: based on the Global Competitiveness Report questions: "In your industry, how commonly would you estimate that firms make undocumented extra payments or bribes." Countries with a higher corruption degree are given lower rates.	Economic freedom of the World (2010)	+/-
$\ln \text{MigStock}_j$	International migration stock of the investment in 2005	WDI, World Bank (2014)	+
Open_j	Freedom of the foreigners to visit for tourist and business purposes: It is assessed as the % of countries for which a visa is required. Counties in which it is difficult to enter are given lower rating.	Economic freedom of the World (2010)	+
LabReg_j	Hiring regulation and minimum wage: based on the World Bank's Doing Business "Difficulty of Hiring Index". Counties with higher difficulty of hiring are given lower rating.	Economic freedom of the World (2010)	+/-
$\ln \text{Dist}_{ij}$	Distance in kilometres between the most populated city of the origin country of the investor and the firm's operating country	CEPII (Mayer & Zignago, 2011)	+/-
Lang_{ij}	1 if the origin country of the investor and the firm's operating country share the same official language	CEPII (Mayer & Zignago, 2011)	+/-

Figure 1: The marginal effect of the age in logarithm $\left(\ln \text{Age}_{nij}\right)$ on the number of foreign high skilled workers employed, conditional on the level of skilled labour endowment of the country (Skill_j)



We follow Berry et al. (2012) and Brambor et al. (2006) to interpret the interaction effects we add to our model. The figure above indicates how the marginal effect of the age of the firm in logarithm $\left(\ln \text{Age}_{nij}\right)$ on our dependant variable, changes with the skilled labour endowment of the firm's operating country (Skill_j).

Any point on the solid line is given by $\frac{\partial(\ln \lambda_{nij})}{\partial(\ln \text{Age}_{nij})} = \beta_a + \beta_b \text{Skill}_j$, where β_a is the coefficient of the variable $\ln Age_{nij}$, and β_b is the coefficient of the interaction $\ln \text{Age}_{nij} * \text{Skill}_j$. The dotted lines represents a 95% confidence interval. The variable $\ln \text{Age}_{nij}$ has a statistically significant effect on the employment of foreign high skilled workers (conditional on the variable Skill_j), when the upper and lower bounds of the confidence interval are both above or below the zero line. Note that the vertical axe on the right is for the histogram which depicts the distribution of observations of the variable Skill_j. Here, the variable $\ln \text{Age}_{nij}$ has a significant and positive effect on the employment of foreign high skilled workers, when the endowment in skilled labour is below 2.7. This positive effect declines when the variable Skill_j gets higher. The variable $\ln \text{Age}_{nij}$ has a significant and negative effect on the employment of foreign high skilled workers, when the variable Skill_j is at least equal to 3.3. This negative effect increases when the endowment in skilled labour gets higher.

Table 12: Robustness tests: Demand for foreign skilled workers, sub-sample of foreign firms

	(1) NB2	(2) NB2	(3) PPML	(4) TOBIT
$\ln K_{nij}$	0.108***	0.0713***	0.0944***	0.00386***
	(0.0156)	(0.0154)	(0.0239)	(0.00123)
Skill_j			-0.445***	-0.0367***
			(0.123)	(0.00636)
Skill2_j	-0.0150***			
	(0.00180)			
Skill3_j		-0.0202***		
		(0.00634)		
$\ln \text{Size}_{nij}$	0.571***	0.591***	0.588***	
	(0.0241)	(0.0252)	(0.0346)	
$\ln \text{Age}_{nij}$	-0.0673*	-0.0534	-0.156***	-0.00561*
	(0.0389)	(0.0415)	(0.0500)	(0.00292)
$\ln \text{Exp}_{nij}$	0.249*	0.316**	0.330*	0.0153
	(0.141)	(0.145)	(0.179)	(0.0111)
MultiPr_{nij}	0.146	0.0619	0.130	0.00365
	(0.0923)	(0.100)	(0.142)	(0.00790)
Sub_{nij}	0.0301	-0.109	0.0276	-0.0101*
	(0.0655)	(0.0675)	(0.0868)	(0.00518)
JV_{nij}	-0.443***	-0.591***	-0.484***	-0.0239***
	(0.0840)	(0.0895)	(0.133)	(0.00653)
Green_{nij}	0.0615	0.0477	0.129	0.00937
	(0.0782)	(0.0811)	(0.117)	(0.00621)
$\ln \text{MigStock}_j$	0.578***	0.224**	0.323***	0.0334***
	(0.0730)	(0.0886)	(0.0931)	(0.00505)
$\ln \text{Dist}_{ij}$			0.128***	
			(0.0461)	
Lang_{ij}			0.0710	
			(0.0763)	
Sector dummies	yes	yes	yes	yes
Origin region dummies	yes	yes	no	yes
Origin country dummies	no	no	no	no
Country dummies	no	no	no	no
Constant	-2.665***	-2.561***	-2.670***	0.0576**
	(0.246)	(0.256)	(0.509)	(0.0232)
$\ln \alpha$	-0.385***	-0.411***		
	(0.0599)	(0.0611)		
R-squared			0.371	-0.154
Observations	1,600	1,433	1,646	1,690

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

Note that the dependent variable used in the Tobit model is the share of foreign skilled workers with respect to the full workforce.

Table 13: Endogeneity tests: Demand for foreign skilled workers, sub-sample of foreign firms

	(1)	(2)
$\ln K_{nij}$	0.0989***	0.0987***
	(0.0258)	(0.0252)
Skill_j	-0.442***	-0.411***
	(0.122)	(0.128)
$\ln \text{Size}_{nij}$	0.561***	0.506***
	(0.0448)	(0.0551)
$\ln \text{Age}_{nij}$	-0.108*	-0.0908
	(0.0619)	(0.0607)
$\ln \text{Exp}_{nij}$	0.351*	0.422**
	(0.182)	(0.199)
MultiPr_{nij}	0.0961	0.117
	(0.148)	(0.146)
Sub_{nij}	0.0529	0.102
	(0.0915)	(0.0987)
JV_{nij}	-0.499***	-0.459***
	(0.116)	(0.118)
Green_{nij}	0.117	0.0899
	(0.115)	(0.111)
$\ln \text{MigStock}_j$	0.314***	0.308***
	(0.0881)	(0.0887)
Sector dummies	yes	yes
Origin region dummies	yes	yes
Origin country dummies	no	no
Country dummies	no	no
Constant	-1.639***	-1.525***
	(0.479)	(0.427)
Hansen J test	(p=0.1685)	(p=0.2697)
Observations	1,591	1,591

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

We perform a two steps exponential GMM. In specification 1, we instrument the size by the number of full-time low skilled workers employed by the firm, and its operating costs during the last financial year such as rent and telecommunication. In specification 2, we use the number of full-time mid-skilled workers employed by the firm, and its operating costs during the last financial year. The following table shows the correlation between the chosen instruments, the dependent variable and the initial proxy for the size of the firm.

	dep. variable: nr. of foreign skilled workers	initial proxy: log(nr. of total workers)	operating costs	log(nr. of low skilled workers)	log(nr. of mid-skilled workers)
dep. variable: nr. of foreign skilled workers	1.0000				
initial proxy: log(nr. of total workers)	0.4188	1.0000			
operating costs	0.0799	0.1969	1.0000		
log(nr. of low skilled workers)	0.3517	0.8597	0.1605	1.0000	
log(nr. of mid-skilled workers)	0.2832	0.7149	0.1841	0.4926	1.0000

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