FDI, Spillovers and Firm-level Heterogeneity: Identifying the Transmission Channels

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Abstract

This paper investigates transmission channels of FDI spillover effects and analyses empirically to identify the channels for the occurrence, sign and magnitude of spillover effects. Our empirical strategy recognizes the FDI spillover effects should not be interpreted with a single foreign share presence alone as is common in the literature. Using detailed panel data from Sub-Saharan's African (SSA) firms, the study investigates how spillover effects are actually emerge. The main findings are fourfold. First, imitation-determined spillovers are found to be absorbed by all group of firms except by low technology firms. Second, competition-determined spillovers are absorbed by local firms with small technological difference, high absorptive capacity and located in geographic proximity to foreign counterparts. Third, labor mobility-determined spillovers are utilized only by firms in the low technology group. Fourth, smaller technological difference between SSA firms and FDI, higher absorptive capacity of SSA firms, geographical proximity between SSA firms and foreign affiliates and majority-foreign-owned firms within the host economies enhance the workings of the spillover channels. Results are robust to construction of spillover and outcome variables, introduction of additional explanatory variables and an alternative estimation method.

Keywords: FDI, spillovers, heterogeneity, imitation effects, labor mobility, competition effects, Sub-Saharan African

1. Introduction

FDI is widely associated with productivity gains. Attracting FDI is assumed to improve the productivity of domestic firms. When foreign firms invest in a host country, they often bring their proprietary technology (Hymer, 1976; Rugman, 1980; Dunning, 1981; Mebratie and Bedi, 2013). On assumption that local firms will be able to benefit from the knowledge transfer, many governments carried out policies that encourage FDI by offering a range of incentives (Aitken and Harrison, 1999; Merlevede et al., 2014). The evidence on the actual spillovers is however sobering.

We systematically reviewed 74 studies on the impact of FDI in developing countries. This research produced much empirical evidence, but with inconsistent results that continue to be disputed in the literature. The result suggests only about one-third of the cases find significant positive results, whereas one in six are significant negative effects. About, 51% report indistinguishable from zero effects. Leaving aside the policy relevance, so far, empirical evidence provide mixed results.

The literature distinguishes the FDI spillover effects into two groups: the knowledge spillover and the competition-determined spillover. Knowledge spillover occurs via skilled *labor mobility* and also where it *demonstrates* the feasibility or enables the *imitation* of new technologies. Competition-determined spillovers arise from the *competitive* pressures to improve local efficiency using existing technology and resources more efficiently or even adopting new technology. This defines the three theoretical transmission channels of intra-industry spillovers: worker mobility, imitation and competition effect.

However, the 74 empirical studies merely investigate at the aggregate level whether the productivity of local firms is affected by FDI presence. They have not investigated the channels by which the effects come about. They commonly investigate the overall spillover effects in a framework of a production function. Productivity of domestic firms regressed on various explanatory variables that introduce one spillover variable in terms of the foreign share of the industry. More specifically, three measures of FDI presence are commonly used. Approximately, 18% use the foreign share in equity, 35% the foreign share in employment and 47% the foreign share in output or sales. One of the three variables used to interpret the

effect of FDI presence. For instance, 30% and 20% of the foreign share in output/sales find significant positive and negative effects, respectively.

These three measures of FDI presence seem to capture much of the effects of demonstration or contagion spillovers type (Kokko, 1996; Hamida, 2013). They cannot hold the whole information that are determined by worker mobility (Hamida, 2013) and competition effects (Kokko, 1996). In fact, the theoretical model by Wang and Blomström (1992) indicate spillovers from competition are not necessarily determined by the share of FDI presence alone, but rather largely by the interaction between domestic and foreign firms. Tain (2007) suggests the share of foreign presence offers only a partial picture of spillover effects, and thus cannot capture the overall influence of FDI. Therefore, the implicit assumption that the share of FDI presence alone can aggregate the overall spillover effects is inappropriate or disregard certain channels. Furthermore, the treatment of the foreign share alone to represent the overall spillover effects may result in biased estimates, as the error term will consist part of the non-included spillover channels.

Further, the significance and sign of the resulting estimates systematically mainly depend on the specification of the explanatory variables that could mediate the effects (Demena and Bergeijk, 2016). The empirical design of the studies, however, recognize the importance of factor input and its quality but fail to include some important firm-level heterogeneity. For instance, about 90% of the specifications fail to consider the technological levels and absorptive capacity of the domestic firms. Just as the treatment of aggregate spillovers resulting from the foreign share are not automatic outcome of FDI, so as the channels by which they emerge.

Set against these backgrounds, this study aims to make an effort on hypothesizing that the share of FDI presence alone cannot represent the complete picture of spillover effects. To do so, we allow the FDI spillover effects to vary according to the transmission channels and the nature of firm-level heterogeneity in Sub-Saharan African (SSA) countries. The reason is clear: SSA appeared to be highly underrepresented in the empirical investigation of the 74 studies. To our knowledge,

our main motivation is that, this the first to study FDI-induced spillovers with respect to the transmission channels for developing countries.

The rest of the paper continues as follows: Section 2 summarizes the theoretical perspectives on transmission channels and firm-level heterogeneity and sets out the hypotheses to be examined. Section 3 discusses the data and empirical approach used. Section 4 gives the detailed results and Section 5 concludes.

2. The Framework: Theoretical Perspectives and Hypotheses Formulation

As noted above, an impressive number of empirical studies have investigated the intra-industry productivity spillovers from FDI. However, despite the host countries interest and policy relevance, the spillover effects are not well understood. In addition, empirical studies are not able to investigate the diverse channels by which the effects come about. Because of this, no attention has been given to the interaction between the channels and the firm-level heterogeneity. This Section first discusses the theoretical perspective of the intra-industry spillover channels to set a framework for the analysis. Second, it highlights the firm-level heterogeneity related to the absorptive capacity and technological level. Finally, it suggests issues for geographical proximity and ownership structure. In each sub-sections, we set out testable hypotheses.

2.1. FDI spillovers and transmission channels

The FDI-induced intra-industry spillover effects are understood to occur via three channels: imitation, mobility of worker, and competition effects. The theoretical channels distinguish the nature of spillover effects into technological and pecuniary spillovers. The former operates through the direct effect on production process caused by the flow of knowledge from one firm to another firm that is not captured by the market mechanism (Papandreou 1994; Jordaan, 2012). While, the latter may result from the indirect effect driven by the market mechanism (Scitovsky 1954, Smeets, 2008).

Firstly, the imitation/demonstration channel is probably the most typical technological spillover assumed to occur through the non-market mechanism (Blomström and Kokko, 1998). The imitation of new products and processes

provided by FDI in the host market assumed to speed up the access and utilization of technologies by domestic firms. In its simplest form, the argument hypothesize that exposure to superior technology of foreign affiliates can lead to productivity or efficiency gains for local firms in the host country through enhancing their production methods. Hence, the intuition is to capture the knowledge of processes and products available in the local market through FDI presence.

Second, the worker mobility channel works through the pecuniary or technological spillovers. On the one side, technological spillover occurs, when a domestic firm hires workers having previously worked for or were trained by foreign affiliates, allowing a domestic firm to benefit from the experience and knowledge acquired in the foreign firms (Saggi, 2002). Technological spillover also emerge when locals previously working for foreign subsidiaries setup their own business. Local workers, therefore, are more likely to acquire the tacit knowledge through training, social interaction and experience while working for foreign counterparts (Liu et al., 2014).

On the other hand, foreign firms may attract skilled local workers by paying higher wages than that of domestic firms. The wage differentials between foreign and domestic firms can change the potential for technological spillovers outlined above into pecuniary spillovers in two ways. First, the additional experience and knowledge acquired by local workers while working for foreign affiliates might be available to the domestic firms at a price equivalent to this wage premium. Second, the presence of higher wage may put upward pressure on the overall industry wage rate, resulting in a negative effect on profits of the domestic firms. These may put pressure on domestic firms to be more efficient, thereby generating positive pecuniary spillovers as the effect occur through the market mechanism.

Third, the competition channel assumed to emerge through the market mechanism, yielding pecuniary spillovers. Competition in the local market can be interpreted as an incentive for domestic firms to use existing technology and resources more efficiently or even to adopt new technology, generating positive pecuniary spillovers. Whereas, negative pecuniary spillover effects may result from the existence of market loss effect. Foreign firms may lower the market share of

domestic firms through taking part of the local market. Further, if domestic firms are unable to compete, foreign firms may push them out of the local market, known as crowding out effect (Smeets, 2008).

Over the last four decades, a wide range of literature has developed the theoretical concept of intra-sector spillover effects. Too often, the existing theoretical models do not offer a complete picture of the channels outlined above. In the theoretical models of Koizumi and Kopecky (1977), Findlay (1978), and Das (1987), spillovers are determined by foreign share of the industry alone: the imitation-determined or contagion-spillovers type. Whereas, in the Wang and Blomström (1992), spillovers are assumed to emerge endogenously resulting from the technological competition between foreign and local firms: the competition-determined spillovers. Moreover, in the Kaufmann (1997), Fosfuri et al. (2001), and Glass and Saggi (2002), spillovers are expected to occur through the movement of workers worked for or trained by foreign affiliates: the worker mobility-determined spillovers. Hence, we believe that the combination of the three spillovers theoretical models provides better understand the complete picture of spillover effects. Hence, our main hypothesis follows as:

Hypothesis 1: The occurrence, sign and size of spillover effects vary with respect to the channels through which they emerge.

2.2. Spillover Channels and Firm-level Heterogeneity

Although spillover effects from FDI require disentangling the transmission mechanisms by which they occur, firms differ in terms of technological competence and absorptive capacity (Hamida, 2013). In this case, spillovers may not appear to emerge evenly across firms or equally valuable to all firms (Buckley et al., 2007b; Merlevede et al., 2014). An important lesson that come out of the literature, most studies attempted to test spillover effects regardless of the nature of firm-level heterogeneity. For instance, they largely ignore the heterogeneity related to absorptive capacity and technological levels of domestic firms. Specifically, only 10% of the regressions control these kinds of heterogeneity, a point already stressed by Mebratie and Bergeijk (2013) regarding absorptive capacity. In this case, about two out of three of the regressions show the importance of technological levels.

Hence, the characteristics of domestic firms cannot be ignored, but rather, seem to mediate the expected magnitude and sign of spillover effects.

2.1.1. Spillover Channels and Technological level

With regard to technological levels, there are two opposing arguments based on economic theory. One group hypothesis that a large technology gap, low technology level of host country may increase the likelihood of spillover gains. The original model of technology spillovers by Findlay (1978) and another by Wang and Blomström (1992) puts forward the catch-up hypothesis: a positive relationship between the size of technological gap and the likelihood of spillovers. The original speculative thinkers of this viewpoint are first Veblen (1915) followed by Gerschenkron (1962), referred to as Veblen-Gerschenkron effect. Specifically, this theoretical assumption supports that faster technological transfer takes place with relatively greater technological disparity levels. On the other hand, the other group theorizes that smaller technology gaps may lead to potential spillover benefits. The models by Lapan and Bardhan (1973), and Cohen and Levinthal (1989) fall in this category. This group maintains the technology accumulation hypothesis, that is, a similar technological level between local and foreign technology results in larger spillover effects. Hence, a certain technological level seems to be important for spillovers benefit.

According to Mody (1989), firms that are characterized by a relatively high technological group/small technological gap have a sufficient capacity to gain from FDI presence via imitation and/or competition channels. Whereas, firms in low technological group may unable to gain from FDI presence via imitation and/or competition channels as such firms lack sufficient level of human capital that enable them to exploit available foreign technologies. Firms in low technological group rather may benefit from spillovers through the worker mobility channel, as this channel can provide technical assistance that allow them to understand and use better available foreign technology (Mody, 1989; Hamida, 2013). Further, firms in a small technological gap can be affected negatively through the competition channel, as such firms may face high-level direct competition from foreign presence (Jordaan, 2005). Accordingly, our next hypothesis follows as:

Hypothesis 2: The workings of the spillover channels (so as the size) by which they occur vary with respect to domestic technological levels and is larger for SSA firms with smaller technological difference vis-à-vis the foreign counterparts.

2.1.2. Spillover Channels and Absorptive Capacity

With regard to absorptive capacity, spillovers are hypothesized more likely to depend on the existing capacity of the domestic firms to efficiently exploit external source of knowledge (Cohen and Levinthal, 1990; Narula and Marin, 2003; Hamida, 2013). The concept of absorptive capacity includes the ability of a firm to internalize the value of new external information, modify it to fit into their own application, and process it productively (Cohen and Levinthal, 1990). In this case, absorptive capacity is not purely only about imitation. This is because, firms cannot reap the benefit of external knowledge unless they invest in their own absorption capacity as this can be specific to the originating firm (Narula and Marin, 2003). Consequently, the ability to assimilate and use external source of information is highly related with the level of firm's prior knowledge. The occurrence and extent of potential spillover effects in turn may depend on these collective firms' abilities, known as absorptive capacity.

Accordingly, high absorptive capacity firms can benefit spillovers via imitation and competition channels as such firms invest in the quality of their human capital. This would largely allow them to obtain specific foreign techniques through both the implementation of foreign technologies and the development of existing one (Hamid, 2013). Conversely, firms with low absorptive capacity may only benefit through imitation effects, as these firms may not possess a required skilled human capital that would help them to cope and fiercely compete with foreign rivals. In this case, they may unable to work harder through using their existing resource and technology more efficiently. Hence, our third hypothesis follows as:

Hypothesis 3: The workings of the spillover channels (so as the size) by which they occur is larger for SSA firms that invest in building their absorptive capacity.

2.3. Spillover Channels and Geographic Proximity

The workings of the spillover channels are also associated with geographical proximity (e.g., see Girma, 2005; Jordaan, 2005; Hamida, 2013). More specifically,

Girma (2005) summarizes three main reasons for geographical dimension of the channels. First, imitation effects at least initially benefit physically nearby domestic firms or that operate in the same region as foreign firms. The imitation of production of a new product or an efficient production of existing product is more likely to takes place when both firms are located in proximity (Jordaan, 2005). Second, labor mobility is likely to be confined in the same locality. In this regard, it appears unreasonable to assume that it is easier for local firms to identify and attract workers trained by or worked for foreign affiliates if such workers are in another region. Third, the theory of economic geography indicates that the potential for spillovers are more pronounced when both types of firms are within geographic proximity. Jordaan (2005) adds that the imitation and worker mobility channels are likely to generate positive spillover when the two types of firms are located in geographical proximity, whereas the competition channel is ambiguous as proximity enhances both the occurrence of negative and positive spillovers.

Further, in SSA countries, foreign investment projects tend to concentrate on the largest and capital cities where the financial, infrastructural, human capital and institution systems are well developed (Kinda, 2013). This provides a better geographical proximity or distance between domestic firms and foreign rivals that in turn may enhance the flow of information than firms located elsewhere or in less concentrated regions. More specifically, physical distance proximity that results from the concentration of firms on main cities may facilitate the workings of the transmission channels (Jordaan, 2012). Hence, our fourth hypothesis follows as:

Hypothesis 4: The workings of the spillover channels by which they occur is tend to enhance when the two types of firms located geographically in the same region or in proximity.

2.4. Spillover Channels and Ownership Structure

With regard to ownership structure, for instance, a recent study by Müller and Schnitzer (2006) hypothesize spillover effects to vary with the degree of foreign ownership. This has been in the background of the theoretical models of the imitation-determined spillovers only to show that the extent of foreign activities in

host countries increase the potential spillovers. Müller and Schnitzer (2006) argue that the transfer of technology from parent company largely basis on the extent of foreign ownership in host countries. A higher degree of ownership and thus better managerial control may reduce the extent of uncontrollable technology leakage to domestic counterparts. Similarly, Takii (2005) argues majority subsidiaries enhance the transfer of advanced foreign technology in the host country, thereby a large potential for spillovers but may impede the extent of potential leakage. Conversely, a higher local participation as in the case of minority foreign subsidiaries provides the opportunity for local firms to become acquainted with foreign advanced technology as this allows easier access to specific knowledge, and thus enhance spillovers (Blomström and Sjöholm, 1999). However, the incentive to transfer new technology on the part of the foreign subsidiaries may reduce with a higher local shared ownership (Crespo and Fontoura, 2007). In this regard, foreign subsidiaries may prefer a higher majority ownership to protect the extent of important firm-specific knowledge and technology leakages. However, Takii (2005) argues foreign subsidiaries may not sufficiently control the extent of knowledge and technology leakages. If so, the occurrence and extent of spillovers is likely to come about from majority foreign subsidiaries than minority foreign subsidiaries, as the fear of technology leakages on the latter part may not transfer advanced technology from parent company. Hence, our last hypothesis follows as:

Hypothesis 5: The occurrence and size of spillover effects mainly driven by the majority foreign owned firms.

The theoretical perspectives discussed above have various restrictions for empirical investigations. For instance, too often the empirical examination for the relative importance of labor mobility channel (both either technological or pecuniary spillovers) is difficult to investigate since it requires tracking workers employed or trained by foreign firms as well as setup their own business. Further, the literature is largely restricted to enquiring a linear form relationship between spillover effects and foreign presence. This is mainly due to the theoretical expectation that spillover effects are largely depend on the extent of foreign presence alone, particularly in the theoretical models of the imitation-determined spillover. However, the relationship

can also be curvilinear in that spillovers might increase or decline beyond a certain point (e.g., see Buckley et al., 2007b). In this regard, we also examine the possibility of non-monotonic nature of spillover effects. Hence, the empirical investigation will take the hypotheses to be tested towards a better understanding of the of FDI intra-industry spillover transmission channels for SSA firms. Importantly, it lends the lessons from the meta-analyses (Essay I and II).

3. Data and Empirical Approach

3.1. Data and Descriptive Analysis

We use a firm-level panel dataset obtained from the World Bank's Regional programme on Enterprise Development. The World Bank enterprise surveys are designed to provide longitudinal datasets through stratified sampling approach (World Bank, 2014). The top priority of the surveys is to provide rich datasets to investigate changes in business environment that affect productivity at the firm level both over time and across countries. The Surveys cover the non-agricultural formal private sector and employ the same sampling methodology and survey instruments across all countries using three levels of stratification, namely, region, sector and firm size.[1] Business sectors are defined in accordance with the non-agricultural formal International Standard Industrial Classification (ISIC) Rev. 3.1 2-digit classification.[2] Based on data availability, this study uses data from eight SSA countries (Congo Democratic Republic, Ghana, Kenya, Malawi, Senegal, Tanzania, Uganda and Zambia) spanning the period 2006–2014.

Table 2. Distribution of Private Enterprise According to Ownership

Year of survey	Local firms		Foreign firms		Total	
	All	Panel	All	Panel	All	Panel
2006	3,129	670	503	125	3,632	795
2014	4,393	676	779	119	5,169	795

Source: Author's compilation using World Bank Enterprise Surveys

Table 2 presents the ownership distribution of the firms. These surveys comprise firm-level information for 8,801 in both the survey years of the data (3,632 in 2006

[1] For a thorough presentation of the sampling methodology: http://www.enterprisesurveys.org/~/media/GIAWB/EnterpriseSurveys/Documents/Methodology/Sampling_Note.pdf
[2] For a detailed discussion of the ISIC: http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=17

and 5,169 in 2014). Of the panel sample, about 85% are domestic firms. Leaving aside the relatively smaller sample size from Malawi, approximately all the countries have similar sample distribution of 10-15% (Table 3). In 2006, 3,632 firms were interviewed, but only 795 again in 2014. Thus, 2,837 firms were surveyed only in 2006 and 4,374 firms were surveyed only in 2014. Of the 4,374 firms surveyed only in 2014, 72.9% (3,188) of the firms commenced operations before 2006. So that a large number of firms started operation before 2006 but were not included in the 2006 survey.

Table 3. Distribution of Private Enterprise by Country and Ownership

Country	Local firms	Foreign firms	Total		%
			All	Panel	
DRC	740	148	888	184	10
Ghana	1,074	140	1,214	262	14
Kenya	1,212	158	1,370	166	15
Malawi	520	153	673	174	8
Senegal	1,007	100	1,107	276	12
Tanzania	1,055	87	1,142	150	13
Uganda	1,025	178	1,203	174	14
Zambia	886	318	1,204	204	14

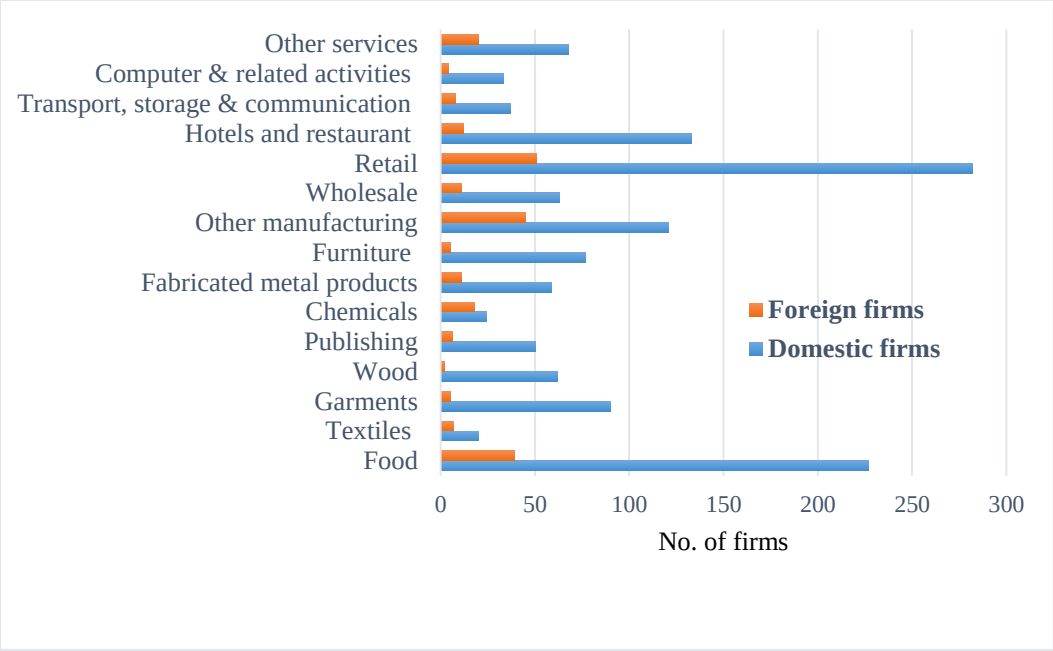
Source: Author's compilation using World Bank Enterprise Surveys

Another concern is whether the 2,837 firms interviewed only in 2006 and not included in 2014 were excluded due to exit from their industry or because of other systematic or non-systematic random factors. In the sample if firms that drop out differ systematically from firms that continue, then the information from the continuing firms is no longer representative. Hence, investigating the spillover effects only on continuing firms is not likely to provide consistent findings. In this case, we need to examine whether the attrition[3] is systematically associated with firm characteristics or is entirely random. To do this, we provide an attrition probit model where the dependent variable takes the value 1 for firms which dropout after the first wave and 0 otherwise. Results of the attrition probit are provided in Table A1. The probit regression indicates that attritted firms are not systematically different from retained firms at any conventional levels, as none of the firm characteristics is statistically significant.

[3] Attrition is described as a nightmare for panel researchers as firms who drop out from a panel may differ systematically from firms who continue that may result in non-representative of the original population of firms, making interpretation of estimates problematic (Winkels and Withers, 2000).

Figure 2 shows a breakdown by ISIC (International Standard Industrial Classification) two-digit industry level for the domestic and foreign firms (panel sample). Both foreign and domestic firms have strong similarities in terms of industrial distribution as roughly they dominate in manufacturing of food products and beverages, chemical and chemical products, retail trade, and fabricated metal products. Domestic firms are also most likely to operate in the manufacturing of garments, wood, publishing, and furniture industries.

Figure 2. ISIC 2-Digit Distribution of Private Enterprise by Sector and Ownership



Source: Author's compilation using World Bank Enterprise Surveys
Notes: Other manufacturing include manufacturing of tobacco, leather, paper, refined petroleum product, plastic and rubber, non-metallic mineral products, basic metals, machinery and equipment, electrical machinery, electronics, transport machines, and precisions instruments. While other services include services of motor vehicles, and construction.

Table 4A and 4B lists summary statistics and Table A2 definition of the variables. The commonly stylized facts found in the literature of FDI spillovers are also confirmed in our sample of panel data. Foreign-owned firms tend to be more productive, higher in terms of employment and formal training provision, operate longer period, better in exports, and have higher technological level. For instance, labor productivity is higher in foreign firms. Another key difference is the size of technological gap. While the bulk of the domestic firms (77%) fall in the category of large technological gap, only 39% of the foreign firms fall in this category. Foreign

firms on average have 138 workers as compared to 42 workers of the domestic firms. All these differences are statistically significant at 1%. Moreover, foreign firms are likely to operate longer period (on average 20 years). In terms of firm size, foreign firms appear to operate approximately equally in all the three categories. In sharp contrast, the bulk of domestic firms (67%) fall in the category of small-sized firm. However, both domestic and foreign firms are likely to be similarly endowed in terms of capital intensity.

Table 4A. Summary Statistics control and outcome variables (panel)

Variable	All firms *N=1578*		Domestic firms *N=1336*		Foreign firms *N=242*		t test for two-sample difference
	Mean	SD	Mean	SD	Mean	SD	
Labor productivity	15.54	2.23	15.31	2.12	16.82	2.37	9.96
Exports	0.08	0.27	0.06	0.24	0.19	0.39	6.58
Foreign-owned	0.15	0.36	-	-	-	-	-
Firm size (5-19)	0.62	0.49	0.67	0.47	0.34	0.48	-9.77
Firm size (20-99)	0.26	0.44	0.24	0.43	0.35	0.48	3.50
Firm size (100+)	0.12	0.33	0.09	0.29	0.31	0.46	9.61
Firm age	16.65	13.41	15.96	12.83	20.46	15.79	4.85
Formal training	0.26	0.44	0.24	0.42	0.37	0.48	4.39
Technological gap	0.71	0.45	0.77	0.42	0.39	0.49	-8.98
Capital intensity	2.06	2.89	2.06	2.97	2.07	2.41	0.03
Human capital	57.00	216.4	42.19	155.28	138.63	406.04	6.49

Source: Author's compilation using World Bank Enterprise Surveys

Table 4B offers an idea about summary statistics for the spillover channels. The statistics are based on eight countries (Table 3) and 27 industries (Figure 2) clustered analysis. The statistics show that the majority foreign owned firms explain the bulk of values of the spillover variables, except for the competition channel. The latter indicates that the existence of high competition within majority-owned firms as opposed to minority-owned firms. This is because competition in the local market is calculated as the difference between sales and costs over total sales so that a value close to 0 indicates heightened competition, where firms' prices reducing towards costs (e.g., see Narula and Marin, 2003).

Table 4B. Summary Statistics for Spillovers Channels (clustered by country and industry)

Spillover Channels	All foreign firms: *N=242*		Majority foreign owned: *N=188*		Minority foreign owned: *N=54*	
	Mean	SD	Mean	SD	Mean	SD
Demonstration	0.39	0.26	0.41	0.27	0.31	0.25
Labor mobility	33.9	0.21	41.9	73.6	5.70	27.86
Competition	0.18	4.90	0.07	5.55	0.58	0.47

4. **Source:** Author's compilation using World Bank Enterprise Surveys

3.2. Empirical Approach

We design to model spillover effects within the context of a production function framework in which output as a function of capital, labor and access to technology. With regard to the outcome variable, empirical strategy use a production function of either a one-step direct approach (e.g., see Aitken and Harrison, 1999; Hamida, 2013, Mebratie and Bedi, 2013) or a two-step indirect estimation technique (e.g., see Waldkirch and Ofosu, 2010; Merlevede et al., 2014). The former employs a direct approach of foreign presence effect using labor productivity, output or value added as the dependent variable. While, in the latter uses an indirect approach of total factor productivity (TFP). We note that there is no consensus on the appropriateness of the one-step versus the two-step approach. However, Demena and Bergeijk (2016) suggest a one-step approach given the literature of FDI-spillover effects are influenced by selection bias towards positive estimates. Hence, we opted for a direct approach of labor productivity[4].

The empirical approach is estimated using the baseline equation 1:

$$\ln(LP_{ijt}) = \beta_0 + \beta_1 T_t + \beta_2 I_j + \beta_3 C_x + \beta_4 FDI_{ijt} + \beta_5 FDIs_{jt} + \beta_6 AC_{ijt} + \beta_7 TG_{ijt} + \alpha \sum X_{ijt} + \varepsilon_{ijt} \text{.....(1)}$$

The subscript *i*, *j*, and *t*, represent firm, industry and time respectively. The inclusion of time dummy (T_t) accounts for any possible regional trends and economic events. Likewise, the inclusion of industries fixed effects (I_x) accounts for unobservable time-invariant effects that may drive changes in labor productivity, for instance, attractiveness of a particular industry. A full set of countries fixed effects is

[4] Buckley et al. (2007a), and Mamood (2008) also point out that the use of labor productivity is appropriate outcome variable, as it has potential importance in improving the living standard and wages in the domestic economy.

included to capture for any possibility of unobservable time-invariant heterogeneity in countries, for instance, better infrastructure presence in a given country or attractiveness of a particular country in general. The inclusion of time dummy, country and industry fixed effects addresses the econometric concerns of omission of unobserved variables that may breakdown the exogeneity condition relevant to obtain unbiased and consistent estimates.

Unlike existing studies where $FDIs_{jt}$ is measured with the foreign share alone that assumed to provide the overall spillover effect, this study disaggregates spillover measures into the three channels outlined. This allows to capture the possibility of different spillover effects according to the channels they emerge and uncovers missing information about the channels. Thus, we include three channels of spillover in Eqn. 1 clustered by industry and country. First, the imitation effects measured as the share of total sales accounted by foreign firms (e.g., see Hamida, 2013).The imitation effects works via the direct contact between local and foreign firms. This effect captures the knowledge of processes and products available in the domestic market by foreign firms. After observing a new product or process innovation and also recognize their feasibility, domestic firms may strive to copy and use it (Meyer, 2004; Crespo and Fontoura, 2007). The idea is to examine the contribution of foreign firms to a product innovation or process on the assumption that the more availability of new processes and products in the local market, the higher the potential for demonstration or imitation effects.

Second, the worker mobility channel measured with the interaction term between foreign presence and human capital in terms of domestic employees (e.g., see Meyer and Sinani, 2002; Hamida, 2013). This variable assumed to measure the combined effect of the presence of foreign share in the industry and the level of human capital at the domestic firms on the productivity of the latter. This interaction investigates the worker mobility-determined spillover in the domestic market that supposed to co-determine by the interaction of this two variables. Alternatively, this can be measured by the relative weight of foreign firms in total employment (e.g., see Narula and Marin, 2003; Haskel et al., 2007). This captures the possibility of hiring local workers that were trained by or worked for foreign firms by domestic

firms. However, as outlined in Section 2, the approach of the foreign share alone cannot describe the whole picture related to worker mobility as it only captures potential spillover from workers working in the foreign affiliates and eventually expected to move. For this reason, we prefer the combined effect of the interaction of foreign presence and human capital.

Third, following Chung (2001) and Narula and Marin (2003), the competition effects measured by firm's price markup. We use the differences between a firm's total sales and costs over total sales to measure price markup. It is considered that firm level price markup is appropriate to measure and capture the level of competition (Hamida, 2013). When the price markup is close to 1 or high markup, competition is low. On the contrary, when it is close to 0, low markup, competition is higher. A decrease in the markup is therefore heightened competition. This follows a negative coefficient associated with a decrease in markup (increased competition), followed by an improvement in domestic productivity (Chung, 2001).

To test for a curvilinear (a U-shaped or an inverted U-shaped) impact of foreign presence on spillovers, we include the squared terms of the three spillover variables in Eqn. 1. Indeed, this will help to test whether the linear or curvilinear specification is better as linear specification is nested in the full model (Buckley et al., 2007b).

We also include a set of control variables (X_{ijt}), measure of foreign ownership (FDI_{ijt}), absorptive capacity (AC_{ijt}), and the level of technological gap (TG_{ijt}) outlined in Table A2 and the time-variant error term (ε_{ijt}). With regard to the level of technological gap, we use the ratio of average productivity of foreign-owned firms to domestic firms own productivity in a given industry and country (e.g., see Haddad and Harrison, 1993; Haskel et al., 2007). To split our sample between small and large technological gap, we use a dummy variable that takes a value 1 if the domestic firm productivity is below the average productivity of foreign firm in a given industry and country and 0 otherwise (e.g., see Jordaan, 2005; Hamida, 2013). When a dummy is 1, the gap is high, whereas when a dummy is 0, the gap is small. For absorptive capacity, we measure using a dummy variable that takes a value 1 when the domestic firm provide formal training programs for their employees and 0 otherwise. Note that although recently Chung and Lee (2015) report absorptive capacity measured

through its origin, i.e., licensing of foreign technologies but they do acknowledge the importance of on-the-job training programs for alternative way to build absorptive capacity. We do not contain variables that would adequately capture licensing of foreign technologies in our data.

In terms of empirical estimation, given the two-period panel data at hand, we performed a set of econometrics test to provide better model estimation. First, we adopt the Breusch-Pagan Langrange multiplier (BP-LM) test. The BP-LM, which is a chi-squared with one degree of freedom revealed the test for random effects to be 280.88 with a p-values less than 0.001, significant at any conventional level. Hence, we claim the null hypothesis that pooled OLS is efficient is rejected in favor of the random effects model. Next, we apply the Hausman test that suggested the random-effects model is not appropriate, indicating the appropriateness of fixed-effects (test for fixed-effects to be 99.33 with a p-valueless than 0.001).

Following the empirical strategy and estimation outlined above, several concerns are addressed in terms of econometric issues. First, the omission of unobserved variables. We address this issue by including time-invariant fixed effects as well as time dummy and a set of time-variant firm-level heterogeneity variables. Second, related to endogeneity or potential selection bias in a sense that if a foreign firm invested selectively. For instance, if a foreign firm gravitates into most productive industry, then the observed result of productivity spillovers will overstate the impact from FDI. The best way to address this possibility is to estimate a fixed–effects, or difference-in-differences (Konings, 2001, Hale and Long, 2011; Hanousek et al., 2011; Mebratie and Bedi, 2013). In addition to the usual methods of econometrics of panel data, estimation of fixed effects is, therefore, likely to mitigate the possibility of reverse causality from domestic productivity to foreign investment. Third, we conduct a set of further analysis and several robustness check for sensitivity of our results as well as for any possibility of measurement errors through alternative specification and model (Section 4.4). For instance, according to Beck (2001) in presence of explanatory variables that have slowly changing variables or little variation over-time, fixed-effects estimation may be a cumbersome. In light of this view, we use fixed-effects model as preferred estimator and for the sake of robustness

checks and comparison, we also report estimates from random-effects. All these empirical approach can improve over existing empirical studies through considering several econometric concerns that may have biased the estimates of previous researches.

Table 5. Spillovers Effect from FDI according to the Transmission Channels

Variable	Panel A:			
	Linear		Curvilinear	
	(1)	(2)	(3)	(4)
Imitation (*I*)	1.438**	1.290**	1.457**	1.518*
	[0.485]	[0.506]	[0.439]	[0.774]
Imitation^2 *(I^2)*	-	-	-0.108	-0.544
			[1.129]	[1.595]
Labor mobility (*LM*)	0.001***	0.205	0.002	-0.024
	[0.006]	[0.358]	[0.001]	[0.827]
Labor mobility^2 *(LM^2)*	-	-	0.001 [a]	1.015 [a]
			[0.002]	[1.956]
Competition (*C*)	0.007 [a]	0.007 [a]	-0.147** [a]	-0.148** [a]
	[0.008]	[0.009]	[0.059]	[0.059]
Competition^2 *(C^2)*	-	-	-0.000**	-0.000**
			[0.000]	[0.000]
$\bar{R}^2$ *(R^2)*	0.93	0.93	0.93	0.93
F-statistics	296.55***	153.22***	177.26***	169.03***
AIC	688.02	697.34	669.52	679.22
N	1,576	1,576	1,576	1,576

Notes: Results are from fixed-effects estimates. Robust standard errors in brackets are clustered at country level. * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is logarithm of labor productivity of domestic firms. Regression include time, country and industry dummies. Control variables included are medium-sized firm, large-sized firm, firm age, capital intensity, exports, FDI firm, human capital, absorptive capacity, and technological gap. Panel A2 and A4 estimated using the foreign share in employment instead of the combined effect of the foreign presence and human capital variables (A1 and A3). In order to avoid multicollinearity and ensure better estimates, all continuous variables used for interactions are centered by subtracting the full sample means (Aiken and West, 1991)[5]. [a]Coefficients and standard errors are multiplied by a thousand to make the figures easier to read. We report the within *R*-squared in brackets when it is different from the adjusted *R*-squared.

4. Estimation Results and Discussion

4.1. Spillover Transmission Channels

A set of different estimations are presented in this section. First, we test whether the three spillover channels should be included separately or simultaneously in Eqn. 1. The Wald test justifies the simultaneous estimation of the three channels at the 1% statistical significance level. Second, we check between the two spillover variables related to worker mobility channel in Table 5. In fact, the share in foreign employment holds information about potential spillover effects alone is sufficient to

[5] For instance, the correlation between the share of foreign presence, human capital and their interaction are 0.206 and 0.815 before centering and 0.086 and 0.480 after centering, respectively.

prefer for the combined effect of foreign presence and human capital specification in Panel A1. The existence of a significant labor mobility channel in Panel A1 as compared to Panel A2 is better to reject the use of the foreign share in employment. To better visualize the results and keep the table manageable, we report only results of the channels (estimations that include all variables are provided in the Appendix).

Table 5. Spillovers Effect from FDI according to the Transmission Channels

Variable	Panel A:			
	Linear		Curvilinear	
	(1)	(2)	(3)	(4)
Imitation (*I*)	1.438**	1.290**	1.457**	1.518*
	[0.485]	[0.506]	[0.439]	[0.774]
Imitation^2 *(I^2)*	-	-	-0.108	-0.544
			[1.129]	[1.595]
Labor mobility (*LM*)	0.001***	0.205	0.002	-0.024
	[0.006]	[0.358]	[0.001]	[0.827]
Labor mobility^2 *(LM^2)*	-	-	0.001 [a]	1.015 [a]
			[0.002]	[1.956]
Competition (*C*)	0.007 [a]	0.007 [a]	-0.147** [a]	-0.148** [a]
	[0.008]	[0.009]	[0.059]	[0.059]
Competition^2 *(C^2)*	-	-	-0.000**	-0.000**
			[0.000]	[0.000]
$\bar{R}^2$ *(R^2)*	0.93	0.93	0.93	0.93
F-statistics	296.55***	153.22***	177.26***	169.03***
AIC	688.02	697.34	669.52	679.22
N	1,576	1,576	1,576	1,576

Notes: Results are from fixed-effects estimates. Robust standard errors in brackets are clustered at country level. * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The dependent variable is logarithm of labor productivity of domestic firms. Regression include time, country and industry dummies. Control variables included are medium-sized firm, large-sized firm, firm age, capital intensity, exports, FDI firm, human capital, absorptive capacity, and technological gap. Panel A2 and A4 estimated using the foreign share in employment instead of the combined effect of the foreign presence and human capital variables (A1 and A3). In order to avoid multicollinearity and ensure better estimates, all continuous variables used for interactions are centered by subtracting the full sample means (Aiken and West, 1991)[6]. [a]Coefficients and standard errors are multiplied by a thousand to make the figures easier to read. We report the within *R*-squared in brackets when it is different from the adjusted *R*-squared.

Table 5 gives the results from the fixed-effects model testing our first hypothesis[7]. We report the estimated effect of both linear and curvilinear models of Eqn. 1. We conduct *F-tests* and Akaike's information criterion (AIC) to determine between linear and curvilinear specification. The *F-tests* suggest the curvilinear specification is better as compared to the linear one at 1% significance level. Most

[6] For instance, the correlation between the share of foreign presence, human capital and their interaction are 0.206 and 0.815 before centering and 0.086 and 0.480 after centering, respectively.

[7] Due to some missing data for the technological gap, markup, labor productivity and absorptive capacity variables, the regression uses a sample of only 1,576.

importantly, the AIC supports the curvilinear specification as lower AIC represent little information loss in the model. Indeed, the existence of a significant competition effect in the curvilinear specification alone is adequate to reject the linear model.

Estimation of our preferred curvilinear specification (Panel A3) gives significant imitation and competition effects. Imitation channel indicates a significant positive spillover. The presence of FDI creates positive spillover influence on the productivity of domestic firms. More specifically, a 10% point increase in foreign presence is associated with a 15% increase in labor productivity of domestic firms, indicating the presence of technological spillovers. The findings supports theory position that foreign affiliates speed up the access and transfer of new product and process in the host economies (e.g., see Wang and Blomström, 1992; Mayer, 2004).

The result of the competition channel that points the non-linear specification show that an increase in competition generated by FDI presence enhances the productivity of domestic firms. This indicates the presence of positive and significant pecuniary spillovers. The relative lower estimated effect size of the C^2 as compared to C shows a decreasing spillover effects when the level of competition past beyond certain point due to an increase in FDI presence. This means that they demonstrate the presence of non-monotonic relationship with FDI presence where in positive effects are dominant when there is low or moderate foreign presence, and exceeding some level of higher foreign presence, spillover effects begin to decrease. This might indicate the existence of market stealing effects when the level of competition due to an increase in FDI penetration is past certain point.

Results of Panel A, therefore, corroborate our first hypothesis that the occurrence, sign and size of spillover effects vary with respect to the channels through which they emerge. This important finding may help to explain why the resulting estimates using the share of foreign presence alone cannot describe the whole picture of spillover effects. It is highly relevant to investigate the three spillover channels simultaneously in order to capture the overall influence of FDI presence. Next, the study goes further to separate domestic firms according technological levels and absorptive capacity.

4.2. Spillover and Technological Level of Domestic Firms

We estimate two separate regressions for our measure of technological gap. Table 6 gives the results. To test the second hypothesis, Panel B1-B2 and Panel C3-C4 present the results for small technological gap and large technological gap, respectively. Again, we conduct *F*-tests and AIC for linear versus curvilinear specifications in both small and large technological gap groups. Our findings again support the curvilinear specification (B2) is preferable than the linear one (B1) in small technological gap group. In contrast, in the large technological gap group, the linear specification (C1) is superior to the curvilinear one (C2).

Table 6. Technological Level and Spillovers Transmission Channels Effects from FDI

Variable	Panel B: Small gap		Panel C: Large gap	
	Linear	Curvilinear	Linear	Curvilinear
	(1)	(2)	(3)	(4)
Imitation (*I*)	24.063**	26.736 **	-2.460***	-2.381***
	[7.102]	[7.938]	[0.610]	[0.420]
Imitation^2 *(I^2)*	-	0.000	-	0.068
		[0.000]		[2.375]
Labor mobility (*LM*)	-0.002	-0.006	0.003***	0.004**
	[0.004]	[0.007]	[0.001]	[0.001]
Labor mobility^2 *(LM^2)*	-	-0.001 [a]	-	0.054** [a]
		[0.006]		[0.017]
Competition (*C*)	0.051***	-0.030***	0.002***	0.016
	[0.009]	[0.005]	[0.0001]	[0.009]
Competition^2 *(C^2)*	-	0.007***	-	0.007 [a]
		[0.000]		[0.004]
$\bar{R}^2$ *(R^2)*	0.18 (20)	0.26 (29)	0.12 (14)	0.14 (16)
F-statistics	53.69***	38.45***	46.96***	51.61***
AIC	826.99	774.82	1937.78	1996.27
N	441	441	1,135	1,135

Notes: See Table 5.

Our main findings seem to confirm that spillovers are a positive function of the level of technology. Higher technological domestic firms seem to experience significant positive spillover effects from the imitation channels (Panel B versus Panel C). Firms with small technological gap are better to identify and exploit the introduction of new technological opportunities into a local market associated with the presence of FDI. This can be an indication that these firms are not far from the average technological frontier of a given industry and have sufficient scope for potential imitation-determined spillovers. Conversely, relatively large technological gap domestic firms seem to be hit significantly by the presence of foreign counterparts or fall to reap the imitation spillover benefits.

With regard to labor mobility, in the large technological gap group is positive and significant, indicating that the combined effect of foreign presence and human capital result in an increase in domestic productivity. This confirms the results of Hamida (2013) in that such kinds of firms can benefit greatly via the worker mobility channel as this can contribute to technical assistance that can allow such firms to better understand and use better foreign technologies.

C becomes significant for both technological groups, but negative for small gap firms and positive for large gap firms, indicating the presence of pecuniary spillovers. Small technological gap firms appear to benefit spillovers through competition channel as a decreased in markup (heightened competition) is followed by increase in productivity. In contrast, large technological gap firms seem to unable to cope with the competition from foreign presence, suggesting the occurrence of market-stealing effects. C^2 is positive and significant for small technological gap firms, demonstrating that the benefits from competition effects emerge when the level of foreign presence is lower or moderate. Once foreign presence past some level, pecuniary spillovers start to fall as intense competition creates market-losing effects, suggesting a curvilinear relationship. This confirms theoretical expectations that high-level of foreign presence intensifies competition that even hurts the relatively high technological firms. The findings also confirms what we find for the full sample in Table 5 is that the high technology firms appear to dominate the spillover benefits. This corroborates our second hypothesis that the workings of the channels and thus the size of effects vary according to the technological levels of domestic firms and the benefit is much larger for SSA firms with smaller technological difference vis-à-vis the foreign counterparts. Large technological gap firms appear to benefit from spillovers only through the labor mobility channel. This group of firms is better to invest in hiring local workers who have worked for or trained by foreign affiliates, such as by offering a higher wage as long as the marginal benefit of recruiting is larger than its marginal cost in order to offset the market-losing effects from the competition channel.

Our evidence is against the original theoretical formulation of Gerschenkron (1962) and Findlay (1978) that indicate technological effects will takes place faster

when there is a greater relative technological gap between domestic and foreign firms, indicating the catch-up hypothesis. This was the basic theoretical assumption that a number of developing countries government policies based in attracting FDI in high technology industries (Fan, 2002). On the contrary, our evidence indicate that this was not a valid assumption of government policy towards FDI. Rather, SSA's domestic firm productivity appears to benefit from foreign entry when the technological gap is smaller, supporting the theoretical assumption of Lapan and Bardhan (1973) among others.

4.3. Spillover and Absorptive Capacity of Domestic Firms

Table 7 gives results of the spillover transmission channels that vary in terms of absorptive capacity testing the third hypothesis. Again we conduct the *F*-tests and AIC and find the linear specification is superior to the curvilinear one in both the low and high absorptive group.

Table 7. Absorptive Capacity and Spillovers Transmission Channels Effect from FDI

Variable	Panel D: Low absorptive capacity		Panel E: High absorptive capacity	
	Linear	Curvilinear	Linear	Curvilinear
	(1)	(2)	(3)	(4)
Imitation (*I*)	1.313*	1.512**	2.525 ***	2.601***
	[0.579]	[0.475]	[0.330]	[0.322]
Imitation^2 *(I^2)*	-	-1.515	-	0.000
		[1.469]		[0.000]
Labor mobility (*LM*)	0.001	0.002	-0.001	0.003
	[0.0004]	[0.002]	[0.001]	[0.002]
Labor mobility^2 *(LM^2)*	-	-0.002 [a]	-	0.004 [a]
		[0.004]		[0.002]
Competition (*C*)	-0.039 [a]	-0.001***	-0.004**	-0.016
	[0.086]	[0.0002]	[0.001]	[0.018]
Competition^2 *(C^2)*	-	-0.0007*** [a]	-	-0.020 [a]
		[0.0002]		[0.029]
$\bar{R}^2$ *(R^2)*	0.94	0.94	0.95	0.95
F-statistics	35.81***	118.91***	1233.06***	2456.34***
AIC	-114.91	-199.85	-14.85	-22.85
N	1,171	1,171	405	405

Notes: See Table 5.

It appears that domestic firms with relatively higher absorptive capacity internalize spillover gains more efficiently. The magnitude of the spillovers benefit related to imitation (*I* in E3) for the high absorptive capacity is about twice larger than the corresponding low absorptive capacity (*I* in D1). This suggests firms in high absorptive capacity group are better to understand and imitate foreign knowledge. Somewhat related reported by Kathuria (2001) using a sample of Indian

manufacturing firms. He reports significant positive effects for Indian manufacturing firms only for relatively high absorptive capacity. In his case, neither for overall sample nor for relatively low absorptive capacity avail spillover effects. Our imitation results indicate by no matter the available stock of foreign technology for product and process, domestic firms hardly understand and absorb it unless they invest in their absorption capacity. An alternative explanation, domestic firms need to decode and interpret specific context of foreign firms' technology to that of local context and apply specific knowledge for spillover effects to take place (Cantwell, 1994; Meyer, 2004).

Further, *C* is significant for high absorptive firms, whereas insignificant for low absorptive firms, suggesting industries in the latter group do not seem to have any spillover benefits through competition effects (D1 versus E3). Hamida (2013) highlights the competitive pressure generated by foreign presence encourage domestic firms with high absorptive capacity to work harder to exploit existing resources and technology more efficiently to improve productivity via the competition effects. In line with this, negative and significant *C* in E3 implies that decreased markup (heightened competition) is followed by increase in domestic productivity, i.e., positive pecuniary spillover effects.

Again, the findings are consistent with estimated effects for the full sample, but it is the high absorptive group dominate the spillover effects observed in the full sample. Firms with high absorptive capacity attempt to gain spillover benefits through the imitation and competition channels – the size of the benefits from imitation is much larger than the competition effects. The ability of these kinds of firms to absorb foreign technologies is largely determined by the quality of their human capital as these firms spend in training their employees that allow them to acquire specific foreign technologies. The findings confirms that high absorptive capacity firms able to cope and fiercely compete with foreign counterparts that induce them to use their existing technology and resources more efficiently and imitate advanced foreign technologies. Results are in line with the absorptive capacity hypothesis and empirical results of Kathuria (2001), Narula and Marine (2003) and Hamida (2013).

4.4. Further Investigations and Robustness Checks

In this section, we look into further analyses to test the fourth and fifth hypotheses and several robustness checks related to our findings outlined above. The former deals with the question of ownership structure and geographical concentration or proximity of firms. The latter explores the sensitivity of our findings to the: (1) construction of the spillover variables; (2) construction of the outcome variable; (3) introduction of a set of industry-time interaction dummies; and (4) estimation method.

Table 8. Further Investigation of Spillover Effects from FDI: (ownership structure of foreign firms)

Variable	Panel F: Majority-foreign-owned firms		Panel G: Minority-foreign-owned firms	
	Linear	Curvilinear	Linear	Curvilinear
	(1)	(2)	(3)	(4)
Imitation (*I*)	1.456**	1.329*	-0.551	-7.627
	[0.430]	[0.638]	[1.200]	[4.120]
Imitation^2 *(I^2)*	-	-0.586	-	18.819
		[1.166]		[11.983]
Labor mobility (*LM*)	0.589*** [a]	0.001	0.011 [a]	0.002
	[0.108]	[0.001]	[3.279]	[0.013]
Labor mobility^2 *(LM^2)*	-	0.0004	-	-0.014 [a]
		[0.0003]		[0.085]
Competition (*C*)	0.008**	0.028	-0.210	-0.177
	[0.003]	[0.034]	[0.146]	[0.112]
Competition^2 *(C^2)*	-	0.295 [a]	-	-0.131**
		[0.479]		[0.043]
$\bar{R}^2$ (R^2)	0.93	0.93	0.93	0.93
F-statistics	212.78***	265.76***	102.27***	163.11***
AIC	671.85	680.59	712.85	720.79
N	1,576	1,576	1,576	1,576

Notes: See Table 5.

a) Further investigation: spillover effects and ownership structure

In Table 8, we allow the construction of spillover channels to vary in terms of minority- and majority-foreign-owned firms. We do this by dividing the previous version of foreign-ownership variable into two versions. In Panel F, we use the majority foreign ownership with 50% or more and set to zero if foreign ownership is less than 50%. Similarly, Panel G presents the minority foreign ownership with smaller than 50% (but at least 10%). The *F*-tests and AIC support the linear specification against the curvilinear one.

Our finding corroborate the view that the advanced technology of majority-foreign-owned firms mainly drives the spillover benefits. A possible explanation is that foreign investors can be more inclined to bring with them their proprietary

technology when they have majority ownership control over subsidiaries operations. However, majority-owned firms somewhat impairs benefit from the competition channel. This may suggests, although advanced technologies of majority subsidiaries offer larger possibility for spillovers, they may impede knowledge spillovers through market-losing effects. In other words, market-losing effects of foreign presence can hamper the scope for competition-determined spillovers. An alternative explanation could be domestic firms encounter the presence of a high negative competition effects from majority-owned foreign firms than the minority-owned foreign firms.

Panel G3, on the other hand, shows that minority-foreign-owned firms do not appear to induce any spillover benefits. This may be an indication that the minority foreign investors are unwilling or unable to take along their most advanced technologies to the host countries, and thus causing the scope of spillovers to be limited. This thesis is consistent as indicated by Merlevede et al. (2014) and supports the hypothesis that the occurrence and size of spillover effects predominantly driven by the majority foreign owned firms.

b) Further investigation: spillover effects and geographic proximity

To examine geographical proximity that may arise from geographical concentration, first we provide estimation for only firms located over the eight largest and capital cities alone (Panel H in Table 9). Again, we conduct *F*-tests and AIC that support the curvilinear specifications (H2 and I4) better fit the data than the linear one (H1 and I3). In terms of both sign and significance of the channels, H2 corroborates the corresponding estimates in A3 of Table 5 estimated across the eight SSA countries. The current magnitude of estimated spillover effects are much larger and statistically highly significant and also the differences are statistically significant. This is in line with the notion that geographical proximity or concentration of industries enhances the magnitude of spillover effects through the workings of the imitation and competition channels.

Table 9. Further Investigation of Spillover Effects from FDI: (regional distribution of firms)

Variable	Panel H: Largest & capital cities		Panel H: Outside largest & capital cities		Panel I: geographical dispersion: full sample	
	Linear	Curvilinear	Linear	Curvilinear	Linear	Curvilinear
	(1)	(2)	(3)	(4)	(5)	(6)
Imitation (*I*)	3.193***	3.184***	-0.518	2.292 ***	1.450**	1.475**
	[0.832]	[0.743]	[0.387]	[1.071]	[0.484]	[0.432]
Imitation^2 *(I^2)*	-	0.257		-9.257 ***	-	-0.175
		[0.870]		[2.242]		[1.127]
Labor mobility (*LM*)	0.647** [a]	0.001	-0.001	-0.001	0.477*** [a]	0.142 [a]
	[0.235]	[0.001]	[0.001]	[0.001]	[0.121]	[0.680]
Labor mobility^2 *(LM^2)*	-	-0.000		0.011 [a]	-	0.0001 [a]
		[0.000]		[0.009]		[0.0002]
Competition (*C*)	-0.006 [a]	-0.156*** [a]	-0.001	0.082	0.006 [a]	-0.147*** [a]
				[0.057]		
	[0.004]	[0.044]	[0.001]	0.021 [a]	[0.008]	[0.059]
Competition^2 *(C^2)*	-	-0.000***		[0.014]	-	-0.000**
		[0.000]				[0.000]
Gini	-	-			0.005	0.006**
					[0.002]*	[0.002]
$\bar{R}^2$ *(R^2)*	0.94	0.94	0.94	0.95	0.93	0.93
F-statistics	779.33***	686.63***	1621.41***	103.80***	282.57***	185.45***
AIC	32.35	11.28	156.03	133.08	687.54	668.91
N	942	942	634	634	1,576	1,576

Notes: See Table 5.

In line with the concentration of firms on the largest and capital cities, Grether (1999) and Jordaan (2008) provide a measure of geographical distribution of an industry. In this sense, they find positive association of labor productivity of Mexican firms and the level of geographical distribution of an industry. This indicates the importance of controlling for distribution of firms over geographical location. The level of geographical distribution of industries over the regions of the establishment of the SSA countries included in the dataset is captured through the variable *Gini*. Even though, the *Gini* coefficient is usually used to measure the level of income inequality, we follow Grether (1999) and Jordaan (2008) to obtain an indication of the level of distribution of industries over geographical regions. Accordingly, we capture the variable *Gini* using the share of a regional industry in regional total employment over the share of a national industry in national total employment. In this sense, a high *Gini* coefficient suggests a high level of geographical agglomeration of industries.

Panel I6 gives the estimates that includes the variable *Gini* to capture the level of geographical distribution of industries in terms of the regions of the establishment within the eight SSA countries. First, consistent with Grether (1999) and Jordaan

(2008), the *Gini* coefficient is significant. This indicates the level of geographical agglomeration of industries have a significant association with the measured labor productivity of SSA countries firms. This is in line with the notion that geographical concentration of economic activity (industries) can facilitate the existence of agglomeration economies. For instance, firms located in close proximity relative to firms located elsewhere may benefit from the existence of agglomeration economies that in turn associate with advantages in their productivity (Marshall, 1980). More specifically, this can better lead to the creation of information spillovers. Second, the current estimated spillover effects corroborate the corresponding findings of Panel A3 in Table 5. This is can be an indication that the initial omission of the Gini variable is not causing (is corroborating the absence of) an omitted variable bias, as the estimated spillover effects remain unaltered.

In relation to the workings of the transmission channels, firms located in close proximity appear to enhance the spillover effects than firms located elsewhere. In line with theoretical predications of Girma (2005) and Jordaan (2005), the current findings indicate a larger positive spillover effects when firms geographically located in close proximity (Panel H2 versus Panel A3). The main difference is that the effectiveness vary in terms of the channels as observed in the estimated effects of Panel H2. First, the labor mobility channel more likely to generate insignificant effects. Second, the workings of the competition channel enhances spillover effects when geographical proximity is taken into account. However, the workings of the imitation channel is in line with the theoretical expectations of Girma (2005) and Jordaan (2005). The results support the hypothesis that geographical proximity or concentration is likely to enhance the workings of the channels, but only for imitation and competition effects.

c) Robustness Checks

The robustness checks using various sensitivity analyses uniformly confirm our main findings. Frist, in Table 10, Panel J, introduces the dummy instead of the share version of the spillover variables and Panel K, replaces the separate industry and time dummies with a set of industry-time interaction dummies. The curvilinear specification is preferred over the linear one for similar reasons indicated earlier. The

spillover results of J2 and K4 corroborate the corresponding findings of Panel A3 in Table 5. However, unlike the estimate of Panel A3, *I* in J2 appears to generate insignificant effect.

Table 10. Spillovers Effect from FDI: Robustness Tests (spillover & industry-time dummies)

Variable	Panel J: Dummy version of spillover variables		Panel K: Industry-time dummies	
	Linear	Curvilinear	Linear	Curvilinear
	(1)	(2)	(3)	(4)
Imitation (*I*)	0.985**	0.337	1.434*	1.536**
	[0.388]	[0.607]	[0.610]	[0.567]
Imitation^2 *(I^2)*	-	0.822	-	-0.868
		[1.042]		[1.091]
Labor mobility (*LM*)	0.487*** [a]	0.127 [a]	0.215*** [a]	-0.210 [a]
	[0.128]	[0.670]	[0.059]	[0.670]
Labor mobility^2 *(LM^2)*	-	0.001 [a]	-	0.002 [a]
		[0.002]		[0.002]
Competition (*C*)	0.007 [a]	-0.147*** [a]	0.008 [a]	-0.133** [a]
	[0.008]	[0.058]	[0.006]	[0.051]
Competition^2 *(C^2)*	-	-0.000***	-	-0.000**
		[0.000]		[0.000]
$\bar{R}^2$ *(R^2)*	0.93	0.93	0.93	0.93
F-statistics	217.11***	214.42***	1060.54***	655.30***
AIC	697.52	677.66	766.52	749.67
N	1,576	1,576	1,576	1,576

Notes: See Table 5.

Next, in Table 11, Panel L[8] and Panel M, replaces the definition of our outcome variable and uses estimation of the random-effects method, respectively. Again, in both Panel L and M the curvilinear specifications are preferred. L2 uses the value added per worker rather than the sales per worker definition of labor productivity. Our main findings of spillover results are again confirmed, except now *C* insignificant and I^2 is significantly positive for the first time. Generally, the results are an indication that the use of either of the definition of labor productivity does not much matter for spillover analysis. In another robustness checks, Panel M4 replaces the fixed-effects with the random-effects in our spillover estimation method. Again, our main findings of Panel A are confirmed once more.

[8] Because of missing information, 52 domestic firms are dropped when we replace the sales per worker definition of the labour productivity with the value added per worker.

Table 11. Spillovers Effect from FDI: Robustness Tests (outcome variable and estimation method)

Variable	Panel L: Value added per worker		Panel M: Random-effects	
	Linear	Curvilinear	Linear	Curvilinear
	(1)	(2)	(3)	(4)
Imitation (*I*)	1.857***	1.715***	0.880***	1.065***
	[0.384]	[0.409]	[0.284]	[0.364]
Imitation^2 *(I^2)*	-	1.871*	-	-0.922
		[0.928]		[0.956]
Labor mobility (*LM*)	0.463** [a]	0.129 [a]	0.200 [a]	-0.137 [a]
	[0.182]	[0.873]	[0.130]	[0.742]
Labor mobility^2 *(LM^2)*	-	0.001 [a]	-	0.001 [a]
		[0.002]		[0.002]
Competition (*C*)	-1.310* [a]	0.002	0.004 [a]	-0.111*** [a]
	[0.646]	[0.001]	[0.004]	[0.042]
Competition^2 *(C^2)*	-	-0.006* [a]	-	-0.000***
		[0.003]		[0.000]
$\bar{R}^2$ *(R^2)*	0.75	0.75	(0.93)	(0.93)
F-statistics	180.76***	114.50***	1693.52***	1621.15***
AIC	2672.55	2670.26		
N	1,524	1,524	1,576	1,576

Notes: See Table 5.

5. Conclusion

One main motivation and special attention for host countries policy makers to encourage FDI, is the expected valuable spillover gains (Buckley et al., 2007b; Hamida, 2013). The substantial increase in FDI penetration in developing countries in turn, has spawned a large empirical study in order to seek for spillover effects. The literature has mainly attempted to measure the overall influence of FDI related spillover effects using the foreign share alone. According to Hamid (2013), the approach of foreign share alone appears to capture only much of the effects of imitation or contagion spillovers type. Tain (2007) indicates that the share of foreign presence offers only a partial picture of spillover effects, and thus cannot capture the overall effects. Kokko (1996) and Wang and Blomström (1992) argued that the competition-determined spillover effects cannot be represented by the presence of foreign share alone. Hence, the approach of foreign share alone cannot describe how spillover effects actually emerge, mainly as it disregards other channels. Correspondingly, the literature largely presumes that spillovers occur evenly across firms, for example nine in ten of the effects are considered to emerge irrespective of the role of absorptive capacity and technological level of domestic firms.

To overcome the existing gap, this paper allows spillover effects to vary according to the transmission channels, which in turn coupled to separate domestic

firms in terms of their technological level and absorptive capacity. Further, in all the examinations, we incorporate the functional form (linear versus curvilinear) that the spillover effect takes. Using unexplored recent panel data from SSA industries, our results are consistent with existing theory, economically intuitive and noteworthy for different reasons. First, domestic firms productivity appear to benefit differently with respect to the channels they actually emerge. In the full sample, FDI presence generates significant spillover benefits through both imitation and competition channels, but fail to do so through labor mobility channel. The findings of the competition channel supports the curvilinear relationship signaling the occurrence of market-losing effects counteracting the initial spillover benefits when local competition due to foreign penetration is low or moderate. The magnitude of the spillover effects are economically larger from the imitation relative to the competition, and the difference is statistically significant as well as remained stable across several specifications.

Second, a similar spillover pattern appeared for firms in small technological difference group, reflecting industries with high technological levels predominately contribute the nature of spillover effects found for the full sample. It also implies that market-losing effects are stronger in small technological gap industries after the initial level of competition past certain points where higher foreign penetration intensifies the level of direct competition. Industries in large technological gap appeared to gain spillovers only through labor mobility channel. This may be an indication that these industries can only understand and use foreign technology through this channel as this provides with ability or skills to implement foreign technology. The findings do not support the VG theoretical assumption. Rather, it supports the technology accumulation hypothesis.

Third, both low and high absorptive firms benefit through the imitation-determined spillovers, but the magnitude of the latter is about twice larger and the difference is statistically significant. However, only local firms with relatively high level of absorptive capacity absorb the competition-determined spillovers. This is in line with the theory that absorption is not purely about imitation (Narula and Marine,

2003; Hamida, 2013). Instead, only firms that have invested significantly in their absorptive capacity are able to internalize the FDI spillover gains more efficiently.

Fourth, the findings point out that the advanced technology of the majority-owned firms, which accounts for a higher industry share in SSA's case, mainly drives the spillover benefits from foreign entry. Whereas, the smaller foreign industry share, minority-foreign-owned firms appear to cause the scope of spillover effects to be very limited. This may be an indication that they are unwilling or unable to bring their advanced technologies to the domestic economy as lower degree of managerial control may reduce the incentive to transfer technology to their subsidiaries. Last, the effect of geographical proximity or concentration enhances the magnitude of spillover effects and somehow influences the workings of the transmission channels differently. This is consistent with the notion that geographical proximity enhances the existence and magnitude of positive spillovers but somewhat against the theoretical predictions of Jordaan (2005) and Girma (2005) for the workings of both labor mobility and competition channels.

The findings recognize that FDI-related spillovers empirical inquiry is complicated process and challenging issue. Each of spillover transmission channels need to identify clearly and each of the effect of the channels should be investigated carefully before any meaningful and robust conclusions about spillover effects are reached. More future efforts for other countries should explore this line of research by which spillover effects actually emerge. Future efforts should also direct the investigation towards the approach that allows the channels to vary according to the length of time a foreign company has been present in the host countries. Unfortunately, our dataset do not allow to identify time since foreign entry. Along the firm-level heterogeneity of domestic firms, the foreign firms technological characteristics, the types of foreign mode of entry, the country or nationality of FDI source, the motives for foreign production need future investigation.

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Appendix

Table A1.

Testing for Sample Attrition: Probability of dropping out of the sample

Exports	-0.090
	[0.109]
Foreign-owned	-0.129
	[0.144]
Firm size	-0.088
(20-99 workers)	[0.122]
Firm size	-0.257
(100+ workers)	[0.228]
Firm age	0.001
	[0.001]
Formal training	-0.016
	[0.014]
Technological gap	0.463
	[0.420]
Capital intensity	0.015
	[0.009]
Human capital	0.000
	[0.000]
Constant	0.162
	[0.295]
N	2,586

Notes: Robust standard errors in brackets are clustered at country level. The explanatory variables are used from the 2006 survey only. The dependent variable is a dropout dummy that takes the value one if the firm is not observed in the 2014 survey and zero otherwise.

Table A2.

Definition of Dependent and Independent Variables

Variable	Description
Exports	Firm is exporting
Foreign-owned	Foreign-owned firm if foreign participation is at least 10%
Firm size (5-19 workers)	Size of the firm is Small: 5-19 workers
Firm size (20-99 workers)	Size of the firm is Medium: 20-99 workers
Firm size (100+ workers)	Size of the firm is Large: 100 workers and mote
Firm age	Firm age: number of years they have been in operation
Formal training	Formal training programs for employees
Technological gap	The ratio of average foreign productivity to domestic productivity in the same country and sector
Capital intensity	The logarithm of expenditure on Machinery, vehicles, and equipment per worker
Human capital	The total number of employees in a firm
Demonstration	Share of total sales in a given industry accounted for foreign firms
Labor mobility	The relative weight of foreign-owned firms in total employment in a sector
Competition	Price markup at firm level through the differences between firm's total sales and costs over total sales
labor productivity	Logarithm of firm annual total sales per its worker