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The Impact of China-Africa Trade on the Productivity of African Firms: Evidence from Ghana

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Abstract: Using both firm-level and industrial-regional panel analysis, this study investigates the impact of the Ghana-China trade engagement on the total factor productivity of Ghanaian manufacturing firms and compares that to the impact induced by Ghana-OECD trade. The main findings suggest that there have been evident learning effects emerging after the Ghanaian manufacturing firms engaged in international trade activities. Yet, the strength of such effects depends on the type of trading partners and industry characteristics. The empirical results show that higher intensities of exports and imports with China, yield TFP gains. The learning effects are found to be greater in industries in which the country has comparative advantage than those further away from its comparative advantage.

Key words: Trade, productivity growth, China, Africa

1. Introduction

Against the sluggish recovery of the world economy in recent years, newly emerging economies have been acknowledged as the major force pushing forward the world's economic development. In particular, the deepened Africa-China trade engagement has attracted much attention. By the end of 2010, China concluded bilateral investment treaties with 31 African countries (Ofodile, 2013). Two years afterward, China has become the largest trade partner for Africa and, at the same time, Africa emerges as an important import source and one of the major investment destinations for China. China's rapidly growing presence in Africa has also proliferated geographically, in particular to West African countries. In 2012, the imports from China by West Africa reached USD 18.1 billion while export to China was worth USD 4.3 billion (Agyekum et al., 2015). Accompanied with the this trend, increasing studies (eg. Kaplinsky and Morris, 2009) started moving their focus on the effect of South-South trade on knowledge spillovers and productivity gains. There are, nevertheless, few studies on the firm-level impact of bilateral trade. Especially studies comparing the impact of the trade links between Africa-South and Africa-North are scarce (Elu et al., 2010; He, 2013).

The forging of closer trade links between China and Ghana has become a topic of debate among researchers and policy analysts. In Ghana, imports of Chinese goods moved from 3.7 per cent share of total imports in 2000 to 18.16 per cent in 2012 (Ministry of Trade and Industry, 2012). The total volume of imports from China increased more than ten–fold, from USD 160.5 million to USD 2.2 billion (Ministry of Trade and Industry, 2012). In 2005, China overtook the US as Ghana's second largest trading partner after Nigeria. The bilateral trade between the two countries reached USD 2.8 billion in 2012.

While it is evident that openness to trade has had significant impacts on the economic development of Africa (Edward and Jenkins, 2013), not much has been written about the extent to which Ghana is benefiting from this increased trade. Given the fact that productivity is relatively low and input capital is relatively scarce in the Africa context, the current study attempts to investigate whether China-Africa integration through trade is more beneficial than OECD-African trade as regard to its impact on productivity improvement by recipient economies. First, we explore whether the trade engagement has brought about some positive impact on the productivity improvement of Ghanaian manufacturing firms by merging a firm-level panel with industrial-level trade data. While there are some studies analysing the impact of trade and on productivity in Africa based on sector level analyses (eg. Edwards and Jenkins, 2013; He, 2013; Kaplinsky and Morris, 2009; Amighini and Sanfilippo, 2014), firm-level study is scare in the Africa context. Sector-level analyses, nonetheless, have been criticized for being too aggregated and for ignoring important specific impacts that can be revealed with firm-level methodologies. With firm-level data, we are able to minimize the possible bias and measurement errors with controlling for the firm heterogeneities. As far as we aware, Elu et al. (2010) is one of the few empirical studies in this area based on firm level data. However, they measure trade openness using an aggregate trade-GDP ratio at country level, which failed to distinguish the effects of different trading partners and industry characteristics. Second, we compare the trade between Ghana-China with Ghana-OECD to understand whether trading with different countries at different levels of development exert similar impacts on TFP performance. By differentiate trade partners, this paper contributes to the extant literature by further investigating the productivity effects of trade based on the technology gap theory and the theory of appropriate technology (Fransman, 1984). Third, we also test whether the impact of trade on TFP is contingent on industry heterogeneity, in particular, whether an industry is one that enjoys a country's comparative advantage. While the literature has distinguished the differences in technology transfer between high- and low-technology industries, little has been done to examine whether firms in industries that a country enjoys comparative advantage benefits more from greater trade (imports and exports) openness of the country, and how this varies by trading with different partners. Firms in industries with comparative advantage have greater productive efficiency due to and easier to make a breakthrough in international markets because they are closer to the world productive frontier than firms in other industries in general (Lin, 2013). Translating foreign knowledge embedded products into local production would be more difficult especially in industries that are far away from the country's comparative advantage. For example knowledge diffusion in high skilled labour-intensive industries would be difficult, since the technical requirements are high and local firms possess low degree of technical competencies. Thus, industrial context should also be considered when testing the impacts of trade on TFP.

The empirical analysis relies on a unique dataset that created by compiling firm level and trade-based industry level datasets in Ghana. Therefore, the intensity of trade is measured not using aggregate country level indicator, but instead using firm- and industrial-level trade indicators. The empirical evidence suggest that the TFP of African firms benefits from the trade activities but the effects are subject to conditions such as trading partners and industrial context. Through forming trading relations with China, strong learning effects are uncovered in regard to the productivity improvement. For instance, the findings show that the importing of Chinese products has significantly enhanced the TFP of Ghanaian manufacturing firms. Similarly, exporting to China also enlarges the production capacity and eventually benefits the domestic manufacturing productivity. Regarding the industrial heterogeneity, the learning effects are found to be greater in industries in which the country has comparative advantage than those further away from its comparative advantage.

The rest of the paper is organised as follow. Section 2 reviews the literature on the South-South trade and productivity growth. Sector 3 lays out the model specification. Data description is given in section 4 and section 5 discusses the empirical results. The last section concludes the findings.

2. Literature review

Trade flows increase the likelihood of learning and productivity growth (Grossman and Helpman, 1991; Dollar, 1992; Fu, 2005; Schiff and Wang, 2006). A high level of openness and integrating in the global production chain allow firms in developing and least developed countries to better access the strategic asset (such as technology, skilled personnel and market etc.) that would eventually lead to higher total factor productivity (TFP) and economic development (Grossman and Helpman, 1991). On the one hand, when exporting to the global market, firms are provided with more incentives to upgrade production capacity and improve competitiveness. On the other hand, importing the advanced technology embedded goods creates potential spillovers for the recipient firms. Moreover, internalisation also brings in foreign assets to the developing countries which create another channel for spillovers (Narula and Driffield, 2012). Through interaction with foreign companies, advanced technological or efficient managerial practices are expected to be absorbed by local actors, whereas the presence of foreign competitors also forces domestic firms to improve their productivity and efficiency (Fu, 2012).

Specifically, trade liberalization can affect firm-level productivity through three main channels. Firstly, trade openness allows the in-flow of imported products and exposes domestic producers to foreign competition. The imported capital equipment may be directly used for machinery upgrading and eventually contributes to the productivity improvement in LDCs (Habiyaremye, 2013). Trade increases the availability of intermediate inputs which lead to the change of productivity levels of local firms. A greater variety of intermediate inputs allow domestic producers to choose cheaper, production compatible and technology appropriate inputs that facilitate the improvement of efficiency and productivity (Feenstra et al., 1999; Bernard et al., 2003; De Hoyos and Iacovone, 2012). Incorporating the technologically advanced tangible intermediate inputs gained from exposure to exports into local production process enables firms in developing countries to learn the embedded intangible ideas (Keller, 2004). A group of studies has focused on the rising availability of inputs that may encourage the creation of new domestic varieties in developing countries, such as in the case of Indian (Goldberg et al., 2010) and Chinese (Feng et al., 2012) firms. These authors argue that expanding the set of available inputs will directly influence the productivity level through a quality upgrading effect due to the presence of more diversified imported inputs (Bas and Strauss-Kahn, 2013). A recent study of firms in Ghana finds that imports are reported to be the most important source of external knowledge for African firms (Fu, et al., 2014).

Secondly, with the presence of foreign competition, domestic producers have to seek ways (e.g. technological upgrading) to enhance productivity and cut down the average cost. Increasing competitive pressures would reduce the gap between actual productivity and the maximum productivity (Martin and Page, 1983). Various empirical studies have focused on this channel and shown that the firm-level productivity is positively associated with the level of exposure of the domestic market to foreign competitors. (Pavcnik, 2002; Fernandes, 2007). Pavcnik (2002) investigated the productivity impact of trade liberalization using Chilean plant-level panel data and found evidence of plant productivity improvements due to the competition from abroad during the late 1970s and early 1980s. Using Colombian manufacturing plant-level data, Fernandes (2007) also verifies that exposure to foreign competition generates productivity gains. After controlling for observed and unobserved plant characteristics and industry heterogeneity, the author found a strong negative impact of nominal tariffs on plant productivity. In the model developed by Melitz and Ottaviano (2008), firms' productivity is allowed to respond to import competition with the presence of firm heterogeneities and they show that the increased competition from foreign competitors accelerates the exit of less productive firms and motivates the expansion of more productive ones. Of course, most of these studies are carried out based on an assumption of a well-developed market with effective market entry and exit mechanism. When such a well developed market is not present and when some firms have soft budget constraint, exports and foreign competition may not result in an aggregate productivity growth at the industry level (Fu, 2005).

Yet, foreign competition is a two-edged sword. The economic development of LCDs may also suffer from the intensified trade relation with the South. The economic booming of China and other emerging economies (EEs) will intensify competition in global markets and induce negative impacts on the manufacturing industries in Africa. Without adequate resources and efforts to catch up with EEs, African countries may rather be pushed out from both domestic and global market. Additionally, to sustain the rapid growth of EEs, there have been increased demands for natural resources, and the nature of exporting raw materials does not facilitate the diversification of industries in LDCs. A stream of literature suggests that the imports of Chinese projects to African countries have trivial negative impacts on local employment (Kaplinsky et al., 2007; Alvarez and Claro, 2008; Edwards & Jenkins, 2013) and sector productivity (Stevens & Kennan, 2006; World Bank, 2004). Kaplinsky et al. (2007)

illustrate that a high percentage of locally produced goods in countries like Ghana, South Africa and Ethiopia are experiencing a decline or are being forced to exit the market by imports from China. Such displacement of local production by imported goods also resulted in a significant loss of job. At the plant level, Alvarez and Claro (2008) find that increases in China's market share has negatively affected employment growth and the probability of surviving of manufacturing plants. At firm level, Elu et al. (2010) estimate a panel of the manufacturing firms of five sub-Saharan African countries between 1992 and 2004 and find no direct association between total factor productivity enhancement and trade openness with China. The relevance of this finding may be limited by the fact that the trade ratio is constructed as percentage of the GDP at country level, instead of using trade indicators at the sector or firm level.

Thirdly, learning-by-exporting (Arrow, 1962) is another channel to explain the firm productivity improvement through the engagement of trade (Grossman and Helpman, 1991). Apart from market exploration skills, exporting requires exporters to offer competitive products that meet the quality standards set up by the importing countries. While exporting, firms in developing countries are able to upgrade their technological capability and production efficiencies through acquiring the feedbacks and technical assistances from importers in advanced economies. Through the expansion to foreign market, firms may start exploiting economies of scale and increase their productivity (Fu and Balasubramanyam, 2003; Fu, 2005; Alvarez and Claro, 2008; Amighini and Sanfilippo, 2014). Relying on foreign markets can also help firms to better avoid shocks deriving from domestic demands. In addition, the high degree of competition in the global market will increase the firms' incentive to innovate and become more productive.

Although importing new products provides learning opportunities for importing countries, the extent of knowledge that can be translated into local use would be a function the levels of technology content a trading partner provide, and the technology gap between domestic and frontier firms (Kokko, 1992; Amighini and Sanfilippo, 2014). Compared to the trade with advanced economies, the South-South trade potentially brings much more positive effects to the host economies given that the developing country firms are likely to provide the goods and service that are more accessible to other developing countries (Lipsey and Sjoholm, 2011), providing at the same time more effective technological spillovers due to the smaller 'technology gap' (Gelb, 2005). When African countries follow this pattern in building their knowledge capabilities, similar challenges would appear throughout the process. The technologies produced in the South, such as from China, naturally become easier to adapt for countries from the South (UNCTAD, 2012). In this regard, when the technology gap between domestic and frontier firms is too wide, the knowledge embedded in imported goods may be too advanced for local firms to unwrap and might contribute less to local economic growth (Greenaway and Milner, 1990). Existing studies have already demonstrated that the South-South trade has a greater economic potential than the South-North one, suggesting that it may accommodate dynamic and longer-term benefits to developing countries (Amsden, 1986). He (2013) uses the COMTRADE panel data to illustrate that the impacts of the imports from China, in comparison with those from United States and France, on sub-Saharan African manufactured exports are in general stronger and significantly positive across all sectors. The author suggests that, when the absorptive capacity of the importing country is limited and a sizeable substitution effect of importing intermediate goods on the importing country is present, it is better to import from a Southern country with a superior technology than from a Northern country with a very advanced technology. However, a closer technology gap between trading partners may also means less learning potentials to offer. Therefore, the low level of technological content embedded in the Chinese products may limit the extent of TFP spillovers, especially to firms which aim to catch up and leapfrog the world technological frontier. In such circumstances, a trade off has been emerged between China and OECD counterparts: whether choosing sophisticate but difficult ones from OECD counties or relatively easy but less technological potential ones from China.

Previous literature also emphasized that industry heterogeneity may shape the probability and intensity of trade induced learning (Melitz, 2003; Bernard et al., 2007). In industries where a country is likely to have comparative advantages, relatively more capital and production resources are allocated. The learning effects from trade therefore are likely to be higher especially when technological distance with trading partner is closer. In Ghana, industries with comparative advantages also receive greater policy supports from the government for instance food processing, textile and wood production etc. These industries are normally characterized as low skilled labour-intensive and less knowledge components. Manufacturers in these industries in general have already accumulated production experiences and possessed some degree of technical competencies. Together with the fact that technical requirements in these industries are relatively lower compare to for example high-tech industries, translating the foreign knowledge embedded imports and intermediate inputs into local production would be easier. Edward and Jenkis (2013) founds out that Firms in the labour-intensive industries are more severely affected by the competition effects caused from Chinese imports and may be more responsive to the increased competition through learning that raises productivity. Regarding the exporting firms in these industries, they have built up certain capability to compete with foreign producers and for better responding to external market shocks. Therefore, the learning effect will be greater in industries in which the country has a comparative advantage than those further away from its comparative advantage.

3. Model specifications

3.1 Firm level Productivity

The central question here is to investigate the productivity impact of trade activities. Following the existing literature on trade and productivity, the productivity measure is measured by the total factor productivity (TFP) at firm level. We rely on the approach introduced by Olley and Pakes (1996), further developed Levinsohn and Petrin (2004) to construct the TFP for firms in the sample. Such a method takes into account the potential correlation between unobserved productivity shocks and input choice. Assuming that production takes the form of a Cobb-Douglas production function,

$$Y_{it} = A_{it} Capital_{it}^{\beta_k} Labour_{it}^{\beta_l} Material_{it}^{\beta_m} \quad (1)$$

where Y represents the physical output of firm i in period t, Capital, Labour and Material are the inputs of capital, labour and materials, respectively, and A is the Hicksian neutral efficiency level of firm i in period t. Although the values of output and inputs are all observed by economist, the total factor productivity term A remains unknown. Taking natural logs of equation (1) gives a linear production function,

$$y_{it} - \beta_m material_{it} = valueadd_{it} = a_0 + \beta_k capital_{it} + \beta_l labour_{it} + v_{it} + e_{it} \quad (2)$$

where lower-case letters in equation (2) represent the values after natural logarithm transformation. Material input is subtracted from the output and value added therefore constructed. a_0 measures the average TFP level across all firms i and time periods t. The transmitted productivity comprises two components, v_{it} and e_{it}. e_{it} is an i.i.d term that is uncorrelated with input choices and represents productivity shocks that even the firm does not observe, while v_{it} reflect shocks that are known to the firm when it decides on the level of the inputs and which therefore are correlated to the inputs. It is not observed and may lead to the simultaneity bias in production function estimation. Estimators ignoring this correlation between inputs and this unobservable factor, such as OLS, will yield inconsistent results.[1]

Olley and Pakes (1996) suggested to find a proxy variable that is monotonically related to v_{it} and that also depends on the quasi-fixed input capital and then to invert this relationship to express v_{it} as a function $\emptyset_{it}$ of capital and the proxy variable. They used investment as a proxy. Given the fact that investment levels are not always non-zero, we shall follow Levinsohn and Petrin (2004) and use materials as a proxy. Materials are thus a function of capital, labor and v_{it}. Assuming the relationship between v_{it} and materials to be monotonic, we can invert the function and write v_{it} as a function $\emptyset_{it}$ of labor, materials and capital. Equation (1) can now be rewritten as:

$$valueadd_{it} = \beta_l labour_{it} + \Phi_{it}\,(capital_{it}, Material_{it}) + e_{it} \tag{3}$$

Φ_{it} is a third-order polynomial approximation of capital (k) and material (m) plus the exogenous productivity term a_0. The estimation then proceeds in two stages. First regress y_{it} on a third-order polynomial of capital (k) and labor (l), and then retrieve

$$v_{it}(\beta_k, \beta_m) = \widehat{\Phi}_{it}\,(capital_{it}, Material_{it}) - \beta_k capital_{it} - a_0. \tag{4}$$

Assume that v_{it} follows a first-order Markov process:

$$v_{it} = E[v_{it}|v_{it-1}] + \xi_{it}. \tag{5}$$

We can now estimate the model by GMM by exploiting the orthogonality between ξ_{it} and $capital_{it}$. TFP can be retrieved as $\widehat{a_0} + \widehat{v_{it}}$.

3.2 Trade engagement and total factor productivity

The dynamic process of productivity is determined by trade and other factors. Using the logarithm of TFP obtained in equation (2), the second stage estimation relates TFP to the firm-level trade, industrial-level trade and industrial characteristics.

$$\begin{aligned} TFP_{it} = {} & \alpha + \xi TFP_{it-1} + \beta_{ea} EX^{a}_{it} + \beta_{en} EX^{n}_{it} + \beta_f IMP_{it} + \beta_{fdi} FDI_{ut} + \beta_{hh} HH_{ut} \\ & + \beta_c EXI^{c}_{ut} + \beta_o EXI^{o}_{ut} + \beta_p Comp^{c}_{ut} + \beta_q Comp^{o}_{ut} + \varphi X_{it} + u_i + \varepsilon_{it} \end{aligned} \tag{6}$$

where TFP is computed in the first step. The TFP follows a dynamic process in which several determinants are involved such as the firm's past TFP level, the percentage of foreign asset at industrial level (*FDI*), competition (*HH*) and both firm and industrial level trade variables. *EX* is the firm-level export to sales ratio of firm *i* in year *t*, distinguished by the exporting to African countries (EX^a) and to non-African countries (EX^n). The percentage of imported input

[1] See Olley and Pakes (1996) and Levinsohn and Petrin (2004).

material is captured by variable *IMP* for firm *i* in year *t*. *FDI* measures the asset ratio of foreign owned firms in industry *u* and year *t*. *HH* denotes the Herfindahl index in industry *u*. *EXI* is export to value added ratio of the industry *u* that firm *i* belongs to, the superscripts *c* and *o* denote exports to China and OECD market, respectively. *Comp* is the import penetration ratio (in industrial value added) in industry *u*, *c* and *o* denote the imports from China and the OECD countries, respectively. *X* is a vector of firm and industry level control variables. ξ, β and φ are the corresponding coefficients to be estimated. Then the TFP can be computed by following

$$\omega_{it} = y_{it} - \alpha_0 - \beta_l l_{it} - \beta_k k_{it} - \beta_m m_{it} - e_{it} \tag{6}$$

Where $\omega_{it} = a_0 + v_{it}$ represents the firm's TFP level. a_0 and v_{it} are defined in function (3). In order to broaden the comparison to Ghana-South and Ghana-North trade, we will also use the ratio of exports and imports in industrial value added between Ghana and four emerging economies including Brazil, China, India, Russia and South Africa to compare with that of Ghana-OECD.

3.3 Estimation methodology

There are several econometric issues here. First, the knowledge contained in foreign assets and traded goods may take time to diffuse (Jaffe and Trajtenberg, 1998). Firms' adjustment to the intensity of industry competition also takes time. Lagged trade therefore are used as explanatory variables. Second, there may be omitted variables problem due to data availability. We use a dynamic model including lagged dependent variable as one of the explanatory variables to reduce this problem because the lagged dependent variable is likely to capture the effects of many of the omitted variables. Third, bringing industry level data into firm level estimation may result in downwardness of the estimated standard error. Therefore, the standard errors will be clustered at the industry level.

Because of the likely endogeneity of trade and the omitted variables due to unobserved firm-specific effects, equation (3) cannot produce consistent estimates using the ordinary least squares method. It is reasonable to assume that firms with higher productivity levels have strong competitive advantages which allow them to engage in international trade. Thus, industry-level imports and exports volumes are not independently chosen, but rather determined by the characteristics of the industry, including the efficiency of firms in the industry. This endogeneity problem or simultaneity bias is defined as the correlation between the level of trade and unobserved productivity shocks (De Loecker, 2007). To control for this problem, several estimation approaches can be adopted.

By assuming that u_i is firm or/and industry specific, but time-invariant, using fixed effects estimator (FE) would remove the omitted variable bias (Pavcnik, 2002; Levinsohn and Petrin, 2004). Therefore, equation (5) can be estimated in levels using a least square dummy variable estimator or in the first (or mean) differences. Provided unobserved factors u_i do not vary over time, FE will overcome the simultaneity bias and yield consistent results on estimated coefficients. However, in spite of the wide usage of the FE estimator, it does not perform well in practice (Olley and Pakes, 1996; Wooldridge, 2009; Van Bevern, 2010) due to the strict exogeneity condition imposed on the covariates and idiosyncratic errors at any time t.

An alternative method to achieve consistency of coefficients in equation (5) is to instrument the independent variables (IV) that cause the endogeneity problems (i.e. the trade, competition and trade). Unlike the fixed effect estimator, IV methods do not rely on strict exogeneity of the inputs for consistent estimation (Wooldridge, 2009). The empirical estimation of the current study will mainly rely on the generalized method of moments (GMM) in which both lagged levels and the lagged first-difference of the dependent variables will be chosen as instruments. In empirical practice, using only lagged inputs to instrument for changes in inputs often causes the endogenous coefficient to be biased downwards (and often insignificant) and leads to unreasonably low estimates. Blundell and Bond (1999) suggest that the system GMM estimator using lagged first-differences of the variables as instruments in the level equations often yields more reasonable parameter estimates. Furthermore, in order the test the consistency of estimating TFP and the effect of trade on TFP separately, a one step estimation approach will be used in the robustness check session.

4. Data and variables

4.1 Firm-level panel

The firm-level panel used in the empirical analysis are from two sources: the firm-level data introduced in this section and the aggregated trade data in section 4.3. The firm-level data comprises the manufacturing firms operating in Ghana. The survey was conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, in conjunction with the University of Ghana, Legon and the Ghana Statistical Office[2]. It covers 12 waves and was collected in seven rounds over the period 1991-2002. The sample was intended to be broadly representative of the size distribution of firms across the major sectors of Ghana's manufacturing industry. These sectors include food processing, textiles and garments, wood products and furniture, metal products and machinery. The original sample had a size of 312 firms, for nearly quarter (85 firms) was obtained throughout all waves and the rest (227 firms) only appears in certain segment of the survey period. In light of the estimation methodology requirement, we keep firms that were present for at least three consecutive waves. After cleaning the missing values, we are left with an unbalanced panel consisting of 201 firms and 1710 observations during the period under survey. [3]

The CSAE data covers critical indicators with which the TPF estimation would be able to compute. The dependent variable of function (2) is the output of a firm, which is computed at the real value of the manufactured output at 1991 firms-specific output price (in logarithm). The output of a firm is a function of a series of inputs including physical capital, labour and materials. Reflecting the production capability, physical capital is imputed as the replacement value of plant and machinery (deflated in 1991 price, in logarithm). The total number of employees represents the scales of the firms. Intermediate inputs, material, here is to proxy for unobserved productivity in function (2) and computed as the total costs of raw material at 1991 price (in logarithm).[4] Provided the Levinsohn and Petrin (2004) framework, firm TFP will be constructed and the impact of trade on China-Africa trade on TFP will be extended to function (5).

[2] The data can be found at the CSAE website: www.csae.ox.ac.uk

[3] There are 2019 observations from 312 firms included in the sample across the survey period. 228 observations are dropped due to missing values among firm level variables in equation (3) and (5), and another 81 observations are removed because of appearing less than three consecutive years. The estimation results only include 1464 observations because of lags were included and 246 observation are dropped.

[4] Material inputs here is a function of capital and productivity and subject to a monotonicity condition. Inverting ϕ in function (2) allows one to express unobserved productivity as a function of observables: capital and materials.

To better control the firm heterogeneity, an extra group of firm-level indicators from CSAE is also employed in the estimation of function (5). Firms were asked to give the percentages of output exported within and outside of Africa. Including the trade variables at the firm level, in particular the exports distinguished by the geographical proximity, allows us to find out the effect of intra- and inter- regional trade on the productivity growth of Ghanaian firms. A competitive industry environment would either reinforce the productive firms to become more competitive or crowd the less productive firms out of the market. Thus, the Herfindahl index is to indicate the levels of domestic competition, and is calculated as the sum of squared share of a firm output in the total industrial outputs of sample firms. High degrees of competition are expected to frustrate firms with a low technological capability but encourage the productive firms to become more efficient. Therefore, a mixed effect is expected between Herfindahl and TFP. In addition, the presence of foreign capital would stimulate the technology spillovers and hence foster the growth of productivity of recipient countries. Using the ratio of total assets owned by foreign firms in total industrial assets of the sample firms, we construct the FDI indicator for each industry.

4. 2. Regional-industrial panel

To extend the empirical analysis to more present time period, we have employed additional data sources from World Bank (WB) Investment Survey - Ghana 2006 and 2012 – to construct a regional-industrial panel during 1992 -2012.[5]

The WB data includes two waves in Ghana, 616 firms from 2006 and 720 firms from 2012. The survey covers critical indicators, including capital stock, material input, the total number of employees, and the annual turnover. These indicators can be used to compute TFP based on equation (2). Since the survey in 2013 did not distinguish the trade destinations, we will not use the trade indicators at the firm level. Based on the number of foreign owned firms and the total number of firms in each industry, FDI and the Herfindahl index at industrial level can be calculated. The estimation will follow the same routine in which TFP will be computed in the first stage and the second stage will evaluate the impact of trade activities on productivity.

Given the fact that the firms included in the WB survey are different from that in the CSAE survey, matching two datasets and conducting a firm-level study therefore does not seem to be feasible. One option is to construct a regional-industrial level data in which the sample firms are aggregated according to the industry and region they belong to. The regional-industrial mean values will be calculated for each variable in equation (2). [6] In total, 11 industries and 4 regions can be identified. After aggregating and merging the CSAE data in year 1992, 1995, 1999 and 2002 with the WB data in year 2006 and 2012, the regional-industrial sample comprises an unbalanced panel with 100 observations across 6 waves.

[5] The regional-industrial panel covers the period 1992-2012 but does not include every year in between. It has at least three years gap between each wave and including total 6 waves, comprising year 1992, 1995, 1999, 2002, 2006 and 2012. More information about the WB data can be found at http://www.enterprisesurveys.org/.

[6] The reason that aggregated sums of variables are not used is because the blown-up factors cannot be found for the CSAE dataset. Without the blown-up factors, one would not be able to get the percentage of sample firms in the total population, therefore using the aggregated sums to represent the regional-industrial sums would be biased. The mean values in this case will be more representative if the sample firms are randomly and consistently chosen.

4.3 Industry-level trade indicators

The aggregated trade dataset is a set of bilateral commodity-level trade data collected from COMTRADE.[7] In line with Feenstra et al. (2005), we have taken the importers' reports as the primary source assuming that these are more accurate than reports by the exporter. The exporters' volume will be used only when the corresponding importer volume is unavailable. Specifically, imports of Ghana record the volume from every country in the world, but the exports will use the trading partners reported imports from Ghana rather than the Ghanaian reported exports whenever possible. To match the firm level data, the current study mainly uses the COMTRADE Ghanaian import and export data from the period 1991-2012.

Table 1. Definition of variables and summary statistics: firm-level panel

Variables	Definition	Mean	S.D	Min	Max
For computing firm TFP					
Output	Real value of manufactured output (1991 Firm-specific output price), in logarithm	17.27	2.17	11.49	25.49
Capital	Imputed replacement value of plant and machinery (deflator 1991 Cedis, million), in logarithm	16.13	3.09	9.54	23.64
Material	Total cost of raw materials (1991 Firm-specific output price), in logarithm	3.19	1.39	0.00	7.50
Worker	Total number of employees, in logarithm	16.43	2.16	8.92	24.49
For estimating TFP on trade					
Expfirm_Africa	Percentage of output exported within Africa	0.02	0.09	0.00	1.00
Expfirm_nonAfrica	Percentage of output exported outside Africa	0.06	0.21	0.00	1.00
Impfirm	Percentage of raw materials imported	0.24	0.36	0.00	1.00
Industrial level trade variables					
FDI	Ratio of total assets owned by foreign firms in total industrial assets, calculated with sample firms	0.41	0.29	0.00	0.91
Herfindahl	The sum of squared share of firm output/industrial output, calculated with sample firms	0.30	0.18	0.09	1.00
Exp_China	Industrial level exports volume from Ghana to China, as ratio of industrial value added	0.23	0.43	0.00	4.32
Exp_EE[8]	Industrial level exports volume from Ghana to the emerging economies, as ratio of industrial value added	0.40	0.63	0.00	5.56
Exp_OECD	Industrial level exports volume from Ghana to the OECD economies, as ratio of industrial value added	2.64	6.61	0.00	49.17
Imp_China	Industrial level imports volume from China to Ghana, as ratio of industrial value added	0.25	0.06	0.00	0.44
Imp_EE	Industrial level imports volume from the emerging economies to Ghana, as ratio of industrial value added	0.12	0.29	0.00	3.26
Imp_OECD	Industrial level exports volume from the OECD economies to Ghana, as ratio of industrial value added	8.83	11.16	0.00	57.18

[7] For the detailed commodity-level data construction, please see Feenstra et al. (2005). The data can be found from www.nber.org/data (International Trade Data, NBER-UN world trade data).Feenstra et al. have oarganize the data by the 4-digit Standard International Trade Classification, Revision 2. We have further aggregate the data into SITC 3-digit level in order to match the firm-level data from CSAE industry classification.
[8] EE include BRICS countries: Brazil, Russia, India, China and South Africa

One difficulty here lies in constructing the trade intensity at the industry-level. To do so, aggregated output for each industry is needed. However, only data for 2003 can be found.[9] With the UN Industrial Production Index and the outputs from 2003, it is possible to calculate the aggregated outputs for each industry.[10] Using the ratio of trade volumes in industrial-level outputs will efficiently remove the bias caused by ignoring the weights of each industry in the total manufacturing sectors. Therefore the ratio of trade to output across each industry in the sample will be adopted rather than using the absolute values of trade volume alone.

The industrial trade shares were obtained by aggregating the commodity trade to SITC Rev. 2 using COMTRADE data. Estimating the impact of trade activities on TFP performance (equation 6) considers the TFP as a function of a dynamic process in which the lag TFP level and other lagged trade indicators are present. Exp_China, Exp_EE and Exp_OECD denote the industrial export volumes from Ghana to China, emerging economies and the OECD economies respectively, while Imp_China, Imp_EE and Imp_OECD are the corresponding industrial imports. Differentiating the trade with China/EEs from with the OECD economies allows us to compare the productivity gains of forming trade activities with South and North. The definition and summary statistics of variables are given in table 1.

5. Empirical results and discussions

5.1 Obtaining firm-level TFP indices

Table 2 presents the results of computing TFP by using different approaches for Ghanaian manufacturing firms for the years 1991 - 2002. All reported estimators are obtained from the unbalanced panel and performed in Stata 13.[11] In line with the productivity literature (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; ABBP, 2007), the fixed effects estimator (Model 1 in Table 2) is expected to control for time invariants and the coefficients on the captial inputs are lower compared to the OLS results (Model 2 in Table 2). The last column in table 2 displays the production function coefficients for the semi-parametric estimators of LP. Comparing LP estimates to the OLS estimates in the second column, the coefficients on both capital and labour are lower compared to both FE and LP.[12] Having obtained the coefficients of the production function, the next step is to calculate the firm-level TFP for each firm across the sample years by following equation (4).[13]

[9] The value added 2003 data at industry-level can be found in the UNIDO database. It is the only year that available for Ghana. http://www.unido.org/en/resources/statistics/statistical-databases.html

[10] For the detailed computation of industrial outputs, please see appendix A.

[11] Estimators are generated by using built-in commands *reg*, *xtreg* and *levpet*.

[12] In the estimation of TFP using LP approach, constant term is integrated into the productivity approximation and therefore the estimation results does not give the constant term. Meanwhile, material inputs coefficients are not reported since the value added is used as the dependent variable. The reason to use value added instead of revenue is because of the data availability. More details of the derivation of TFP can be found in Levinsohn and Petrin (2003).

[13] To verify whether these different estimators yield consistent results, we have also checked the correlations between the different TFP estimates. It is evident that the TFP measures obtained using by using OLS, fixed effects (FE) and LP are different but highly correlated. The correlation between FE and LP is about 0.877 and the correlation between OLS and LP is around 0.849. The highest correlation is found between OLS and FE, 0.997..

Table 2. Comparison of estimated coefficients of TFP computation, 1991-2002

Variables	(1) OLS	(2) FE	(3) LP
Worker	0.829***	0.708***	0.367***
	(0.037)	(0.048)	(0.059)
Capital	0.289***	0.322***	0.233***
	(0.016)	(0.025)	(0.082)
Constant[14]	8.915***	8.792***	
	(0.183)	(0.339)	
Observations	1,710	1,710	1,710
R-squared	0.743	0.981	
Number of firm	201	201	201

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

5.2 The productivity effects of trading with China/EE vs. OECD

The following analysis is to understand how the effect of trade with China/EE differs from the trade with the OECD economies in fostering the TFP of Ghanaian manufacturing firms. We estimate the firm level TFP on (i) the past TFP performance to capture the dynamic nature of the process; (ii) the scale of firms that expect to determine the production capacity; (iii) the firm level trade indicators including the exports to African and Non-African countries, as well as imports intensity; (iv) the industrial level indicators including FDI, industrial competition and the industrial-level trade variables. The estimation results are reported in Table 3.

Model 1 to Model 3 in Table 3 present the estimators of the full sample. Although estimated results from three models are in general consistent, differences among coefficients appear due to the potential bias in using OLS and FE. Given the fact that GMM produce more consistent results, the main interpretation will be based on Model 3. As shown in these three models, the past TFP level is significantly associated with the present TFP performance. OLS and GMM generate similar estimated coefficients regarding L.lnTFP (around 0.6). Compared to the panel approach, the corresponding coefficient generated by OLS is slightly higher, about 0.65 per cent of current productivity is explained by TFP in the previous year. The scale effect appears in both OLS and GMM specifications and the positive signs of estimated coefficients imply that there are slightly increasing returns to scale. It seems that engaging in exporting to Africa countries does not create strong impacts on the TFP of Ghana manufacturing firms. Nonetheless, exporting to Africa countries produces a positive impact (at 0.1 per cent significance level) on the improvement of TFP as shown in the GMM. As the estimators of FDI show, the large ratio of total assets owned by foreign firms in the total asset of an industry is positively related with the TFP performance. A high level of foreign assets in an industry enlarges the knowledge pool of domestic market, regarding both technological and managerial knowledge, and provides spillovers for the local firms operating in the same industry. However, the presence of the foreign producers will not necessarily intensify the competition and push the local firms to advance their productivity. Such a competition effect has not been verified by the estimates of Herfindahl, although the coefficients are all positive. A larger number of firms operating in one industry aggravate the competition among the firms in the same industry. Ghanaian manufacturing firms have to rely on TFP improvement

[14] The constant of LP was absorbed in unobserved productivity when taking the third-order approximation of material and capital, while identifying the coefficient of labour.

and innovation to stand out of the competition. As regards the impacts of industrial level trade on TFP performance, it is shown that only exporting to China creates a channel for Ghana manufacturing firms to improve TFP performance while trade engagement with OECD countries does not produce any impacts.

Table 3 The impact of trade on TFP: comparing Ghana-China with Ghana-OECD economies from 1991 to 2002

	Total Sample			GMM	
	OLS	FE	GMM	Ind. group 1	Ind. group 2
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
L.lnTFP (L: lags)	0.645***	0.342***	0.595***	0.655***	0.487***
	(0.023)	(0.048)	(0.057)	(0.053)	(0.090)
Worker	0.016***	0.009	0.019***	0.016***	0.025***
	(0.002)	(0.008)	(0.004)	(0.003)	(0.007)
L. Exp_Africa Firm	0.030	0.007	0.031*	0.013	0.056*
	(0.024)	(0.021)	(0.017)	(0.019)	(0.029)
L.Exp_nonAfrica F.	0.006	0.031	-0.016	-0.001	-0.323
	(0.015)	(0.024)	(0.028)	(0.018)	(0.249)
Imp_Firm	0.009	0.007	0.009	0.004	0.005
	(0.007)	(0.010)	(0.011)	(0.014)	(0.015)
FDI	0.037**	0.041**	0.037***	0.037**	0.003
	(0.017)	(0.016)	(0.014)	(0.017)	(0.113)
Herfindahl	0.025	0.026	0.024	0.002	0.049
	(0.019)	(0.019)	(0.016)	(0.021)	(0.051)
Imp_China	-0.003	0.005	-0.000	0.043*	-0.013
	(0.011)	(0.010)	(0.008)	(0.026)	(0.008)
Imp_OECD	0.001	0.001	0.001	0.046*	0.002*
	(0.001)	(0.001)	(0.001)	(0.024)	(0.001)
Exp_China	0.187***	0.166***	0.180***	0.200***	0.199**
	(0.057)	(0.055)	(0.063)	(0.069)	(0.097)
Exp_OECD	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Constant	0.735***	1.528***	0.850***	0.748***	1.125***
	(0.069)	(0.117)	(0.130)	(0.129)	(0.213)
R-squared	0.584	0.123			
Observations	1,464	1,464	1,464	928	536

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Industry dummies are included. Instruments for the system GMM are industry dummies, lagged levels and differenced values of the right hand side variables. Robust standard errors are in parentheses. The Hansen test of over-identifying restrictions does not reject the validity of the instruments for the GMM models. Arellano-Bond AR tests also indicate that there are no problems relating to serial correlation of the error terms. Ind.group1 includes 928 observations across five traditional industries in Ghana: Food, Furniture, Garment, Textile and Wood. The rest of the sample firms (536) are included in Ind.group2.

Attempting to capture the effects caused by industry heterogeneity, the full sample is divided into two subgroups, taking into account whether the industry belongs to traditional industries in Ghana.[15] The GMM approaches are adopted to estimate both subgroups and results are

[15] The choice of industries with comparative advantages is based on whether the industry is one of the traditional industries in Ghana because these industries normally receive great policy support and possess abundant production resources. Industry contributed about 30 per cent of the GDP in 1999 and absorbed about 15 per cent of the nation's work-force. According to the industrialization policy the following industries are categorized as traditional industry in Ghana and almost all of them began as state-owned enterprises: producing food products, beverages, tobacco, textiles, clothes, footwear, timber and wood products, chemicals and

displayed in Model 4 – Model 5 in Table 3. Ind.group1 includes 928 observations across five traditional industries in Ghana: Food, Furniture, Garment, Textile and Wood. The rest 536 firms are included in Ind.group2. As shown in the comparison of Ind.group 1 and Ind.group 2, the dynamic nature of TFP is more manifest among the traditional industries where approximately 0.65 percentages of the current TFP is explained by the previous period. The differences in the scale effects between two groups suggest that large number of employees would have a higher increasing to scale in the non-traditional industries. The impact of the firm level trade intensity, exporting to non-African countries, on TFP was only confirmed in the non-traditional industries as well. Clear differences are also exhibited between the two groups regarding the *FDI* and Competition indices. With more capital and resources allocating in the traditional industries, the TFP spillovers engendered by the presence of foreign firms would be more likely to diffuse since firms in these traditional industries have already obtained relatively rich production experiences and are equipped with higher learning capabilities compared to other firms. In the non-traditional industries, where technology and production resources are scarce, local firms tend to be crowded out by the presence of foreign competition as reflecting from the insignificant estimate of *FDI* in Model 5. The existing resources structure and the policy orientation from the Ghanaian government at that time tend to promote the development of traditional industries. In such circumstances, more opportunities are created for new firms among those industries to acquire better technologies from foreign companies and upgrade their production capability, eventually pushing up the TFP level.

After differentiating the industry heterogeneity, the impact of the industrial level trade intensity has exhibited an interesting pattern. Forming trading partnership, regardless with China or OECD, significantly contribute to the TFP performance of Ghanaian firms. In particular, trading with China in general create a higher productivity effect comparing trading with OECD countries, reflecting by the greater coefficients in Model 4. Such finding is in line with the previous literature, arguing that the learning effects from trade engagement are likely to be higher in the industries where a country has comparative advantages because of accumulated know-how, learning by doing, possibly related to the abundance of some resource endowments to begin with (Bernard et al., 2007). Among these traditional industries, translating the imports embedded foreign knowledge and intermediate inputs into local production, or learning from exporting activities, would be more straightforward since the technical requirement is relatively low and firms in these industries normally have already established some technical competencies. With respect to the impacts of trade on the TFP across non-traditional industry group, exporting to China performs as a stimulus in fostering TFP growth while the impacts of trading with OECD are faded. It is worth noting that Imp_China and Imp_OECD (Model 5) becomes negative, indicating that the non-traditional industries with less governmental policy supports are likely to be hindered by the present of foreign imports.

One interesting finding is that the trade with China yields broad gains on TFP in a sense the positive gains are derived from both importing and exporting engagements (Model 4), despite

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pharmaceuticals, and metals, including steel and steel products. Considering the industry structure of CSAE data, we chose the top five industries (928 observations from a total of 1464 observations) on the list as industries with comparative advantages in the current study since they were all listed as primarily promoted industries in the industrialization policy in 1999 and, therefore, more capital and resources were expected to flow into these industries. They are Food, Furniture, Garment, Textile and Wood industries. Source: http://www.nationsencyclopedia.com/economies/Africa/Ghana-INDUSTRY.html such pattern only appears in tradition industries. However, trade with OECD economies does not always bring positive impacts for example, exporting to OECD. Compared to trade with OECD countries, forming the trading relation with China creates greater potentials for Ghanaian firms to enhance their TFP performance as shown by the differences in magnitudes of coefficients compared to Ghana-OECD trade. This finding is consistent with the previous literature (Kaplinsky and Morris, 2009; He, 2013), suggesting that South-South trade can promote economic development, which is particularly true for African countries. Trade between countries at similar levels of development is relatively more diversified (in terms of the range of products and activities) and translating these products into the domestic production system would be easier compared to trade between countries with greater gaps of the development levels.

The results have shown that importing from both China and OECD has helped the Ghanaian firms to advance their TFP level. Although a greater variety of imports allows domestic producers to choose cheaper, production compatible and technology appropriate inputs that benefit the improvement of productivity, the importing country also matters considering the technology gap between trading partners and the levels of technology content a trading partner provide (Kokko, 1992). On the one hand, the Chinese goods exported to Africa are generally of decent quality and well–priced, and match the consumption needs of the local market. The relatively closer technology gap with China allows Ghanaian firms to gain a higher potential to acquire the Chinese products' embedded technologies (Lipsey and Sjoholm, 2011). On the other hand, goods from OECD countries contain more of technological advances which would better fulfil the technology needs of the local firms than the Chinese counterpart. The similar magnitudes of Imp_OECD compared to Imp_China (in Model 4) suggest that Ghanaian firms in the traditional industries tend to benefit from both knowledge intensive imports from OECD and the Chinese ones. Meanwhile, it is worth noting that exporting to China yields consistent impact on the TFP for both industrial groups. Through the expansion to Chinese markets, Ghanaian manufacturing firms start exploiting economies of scale and increase their productivity.

The same estimations have been replicated for the specification in which Ghana-China trade variables are replaced with Ghana-EE[16] and the results are given in Table 4. The objective is to cross check the impacts of South-South trade on TFP and comparing such impacts to that of impacts generated by South-North trade. The results based on the whole sample, as shown in Model 1 to Model 3 in Table 4, are in general consistent with the results in Table 3, except that only Imp_EE is positive and significant in FE and GMM specifications. Again it confirms the positive productivity returns from engaging in trade with emerging economies. When the sample is divided into the traditional and non-tradition industries, similar patterns are revealed. The findings verify the argument that the trade significantly contributes to the TFP of Ghanaian manufacturing firms, but such effects are only observed among firms in the traditional industry where a country has built up the comparative advantages. Regarding whether trading with EE or OECD, the results suggest importing from OECD countries turns out yielding the greatest TFP gains and the positive TFP gains from exporting to South countries disappeared.

[16] EE group includes five emerging countries: Brazil, China, India, Russia and South Africa. The trade data between Ghana and EE are obtained by following the same approach discussed in the previous section.

Table 4 The impact of trade on TFP: comparing Ghana-EE economies with Ghana-OECD economies from 1991 to 2002

	Total Sample			GMM	
	OLS	FE	GMM	Ind. group 1	Ind. group 2
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
L.lnTFP (L: lags)	0.640***	0.336***	0.576***	0.646***	0.484***
	(0.023)	(0.049)	(0.058)	(0.053)	(0.092)
Worker	0.017***	0.012	0.020***	0.016***	0.026***
	(0.002)	(0.008)	(0.004)	(0.003)	(0.007)
L. Exp_Africa Firm	0.029	0.005	0.033*	0.014	0.053*
	(0.024)	(0.022)	(0.017)	(0.019)	(0.031)
L.Exp_nonAfrica F.	0.006	0.030	0.001	-0.007	-0.369
	(0.015)	(0.024)	(0.028)	(0.020)	(0.270)
Imp_Firm	0.008	0.006	0.005	0.002	0.006
	(0.007)	(0.010)	(0.011)	(0.014)	(0.016)
FDI	0.029*	0.034**	0.029**	0.031*	0.024
	(0.017)	(0.015)	(0.014)	(0.018)	(0.117)
Herfindahl	0.015	0.017	0.013	0.000	0.043
	(0.019)	(0.020)	(0.017)	(0.021)	(0.052)
Imp_EE	0.012	0.018*	0.015*	0.028*	0.008
	(0.009)	(0.011)	(0.009)	(0.016)	(0.013)
Imp_OECD	0.000	0.001	0.000	0.042*	0.001
	(0.001)	(0.001)	(0.001)	(0.022)	(0.001)
Exp_EE	-0.006	-0.006	-0.008	0.028	-0.002
	(0.016)	(0.013)	(0.012)	(0.057)	(0.015)
Exp_OECD	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Constant	0.759***	1.537***	0.909***	0.778***	1.153***
	(0.069)	(0.119)	(0.132)	(0.127)	(0.220)
R-squared	0.581	0.118			
Observations	1,464	1,464	1,464	782	682

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Industry dummies are included. Instruments for the system GMM are industry dummies, lagged levels and differenced values of the right hand side variables. Robust standard errors are in parentheses. Then Hansen test of over-identifying restrictions does not reject the validity of the instruments for the GMM models. Arellano-Bond AR tests also indicate that there are no problems relating to serial correlation of the error terms. Ind.group1 includes 782 observations across five traditional industries in Ghana: Food, Furniture, Garment, Textile and Wood. The rest of the sample firms are included in Ind.group2.

5.3 Regional-Industrial panel analysis

Ghana's participation in the World Trade Organization (WTO) started from 1 January 1995 and the trade volume has expanded dynamically ever since. The total exports have reached USD 14 billion in 2012 while imports soared to USD 17 billion. According to the WTO report on the trade policies and practices of Ghana (WTO, 2013), trade liberalization has helped Ghana to achieve a higher economic growth, especially after 2001. Nonetheless, the firm level analysis in the previous section only covers the period 1991 – 2003 due to the limited data availability. To extend the empirical analysis to more present time period, we have also conducted a regional-industrial analysis with the panel during 1992 -2012.[17]

The descriptive statistics of computed TFP (in logarithm), firm level and industrial level trade variables are given in the Table 5. A clear expansion of trade volumes is observed after 2002. Since Ghana becomes member of WTO in 1995, the total imports from China have increased rapidly, almost seven-fold in 2012. The exports from Ghana to China also rise but at a slower pace and remain steady after 2002. The trade volumes between Ghana and EE exhibit similar trends compared to Ghana-China trade except that there was a decline from 2006 to 2012 shown in Imp_EE. Notably, Ghana's imports from the OECD economies in 2012 expanded nearly twelve times compared to the same index in 1995 whilst the export to the OECD countries declines significantly in 1999 and another decline was observed from 2006 to 2012.

Table 5 Summary statistics of regional-industrial variables

Year	lnTFP	Imp_China	Imp_EE	Imp_OECD	Exp_China	Exp_EE	Exp_OECD
1992	1.43	0.13	0.27	3.76	0.03	0.07	10.77
1995	1.52	0.26	0.44	4.67	0.01	0.09	10.64
1999	1.60	0.31	0.50	3.76	0.01	0.15	7.94
2002	1.56	0.80	1.19	6.23	0.05	0.43	10.08
2006	1.58	2.80	15.92	23.11	0.05	0.25	37.44
2012	1.35	1.63	7.07	64.91	0.05	0.99	24.65
Total	1.57	0.70	1.18	3.45	0.07	0.24	5.40

The computation of industrial level trade variables with COMTRADE data follows the same procedure as above analysis.

The impacts of trade activities on TFP at the regional-industrial level are estimated with GMM. Model 1 and Model 2 in table 6 are the estimated results based on the six waves[18] while the last two columns are results based on all sampled years, 1990-2002, 2006 and 2012. Estimators are in general consistent with firm level evidence as shown in Table 6. The scale effect was found except for Model 4. The competition indicator, Herfindahl index, is significant and positive, suggesting that intensive competition of domestic market will enhance the TFP. However, the positive spillover from the presence of FDI disappeared from the regression results and, on contrary, negative productivity effects are exhibited.

Turning to the industrial level exports and imports intensity, imports from China or EE always exert positive productivity impacts as shown in Table 6. In particular, importing from China yields the greatest effects on the regional-industrial level TFP among all. Although Export to OECD country also introduces positive productivity spillovers, this finding confirms that trading with countries from South fosters stronger productivity impact. With less than 250 observations, one may argue about the consistency of using GMM and the estimated coefficients. Indeed, the aggregated level analysis somehow will suffer from

[17] The regional-industrial panel covers the period 1992-2012 but does not include every year in between. It has at least three years gap between each wave and including total 6 waves, comprising year 1992, 1995, 1999, 2002, 2006 and 2012. More information about the WB data can be found at http://www.enterprisesurveys.org/.

[18] Years included in the six waves are 1992, 1995, 1999, 2002, 2006 and 2012.

potential bias since the regional-industrial specification ignores the important firm characteristics. Nevertheless, using the thirteen waves panel, the findings in general are consistent with the firm level results. Trade helps the manufacturing industry in Ghana to achieve better TFP performance. Forming the trade relations with South, where technological distance is relatively small, will benefit the manufacturing TFP in comparison to trading with North economies.

Table 6 GMM The impact of trade on TFP: comparing Ghana-EE economies with Ghana-OECD economies at regional-industrial level, 1992-2012

	6 waves		13 waves	
	China	EE	China	EE
VARIABLES	Model 1	Model 2	Model 3	Model 4
Worker	0.160***	0.098***	0.072**	0.051
	(0.033)	(0.017)	(0.035)	(0.037)
FDI	-0.014***	-0.010***	-0.010***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
Herfindahl	0.608***	0.557***	0.353***	0.237**
	(0.104)	(0.090)	(0.135)	(0.103)
Imp_China	0.095***		0.044**	
	(0.018)		(0.020)	
Imp_EE		0.010***		0.010***
		(0.002)		(0.002)
Imp_OECD	-0.001	-0.000	-0.000	-0.000
	(0.001)	(0.000)	(0.001)	(0.001)
Exp_China	-0.404*		-0.050	
	(0.241)		(0.182)	
Exp_ EE		0.003		0.027
		(0.015)		(0.023)
Exp_OECD	-0.000	0.001**	0.001**	0.001
	(0.001)	(0.000)	(0.000)	(0.001)
Constant	0.436***	0.792***	0.994***	1.166***
	(0.168)	(0.073)	(0.205)	(0.200)
Observations	100	100	237	237

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Instruments for the system GMM are industry dummies, lagged levels and differenced values of the right hand side variables. Robust standard errors are in parentheses. The Hansen test of over-identifying restrictions does not reject the validity of the instruments for the GMM models. Arellano-Bond AR tests also indicate that there are no problems relating to serial correlation of the error terms. 6-waves includes year 1992, 1995, 1999, 2002, 2006, and 2012; 13-waves includes year 1992-2002, 2006, and 2012.

6. Conclusions

This research attempts to investigate the impact of trade on the TFP performance of the Ghanaian manufacturing firms and explain why trading with Southern countries creates greater TFP spillovers for less developed economies. In general, internationalization via trade opens up effective channels for the firms in African countries to achieve productivity progress. By engaging in the global production chain, local firms are allowed to better access advanced technologies (Fu 2012). Via importing activities, African firms will be able to enhance TFP by directly applying the imported machinery and equipment into local production. Meanwhile, imports also bring technology embedded goods and services, as well as the technological assistance from actors in the global supply chain. Furthermore, learning can also occur through decomposing the imported products. By means of exporting and exposing to foreign markets, firms in African countries may start exploiting economies of scale that foster productivity growth. Competition in the international market also pushes firms from the South to reinforce their comparative advantages through productivity upgrading.

Using the firm level and trade-based industry level datasets from Ghana, evidence from the empirical analysis has shown that trading with countries sharing similar production capabilities stimulates stronger productivity effects because of the closer technological distance. Compared to the trade with advanced economies, the South-South trade potentially brings much more positive effects to the host economies given that the developing country firms are likely to provide the goods and service that are more accessible to other developing countries. The results also show that importing the technology- embedded goods from China or EE economies is likely to yield stronger TFP spillovers and allows recipient firms to upgrade their technological capability. Although the trade engagement with the OECD economies also produces TFP spillovers, it does not come without conditions. Findings suggest that industry heterogeneity may determine the probability and intensity of learning induced by trade engagement. The learning effects tend to be greater in the traditional industry where relatively more resources are allocated. Firms from the traditional industries in Ghana are found to benefit more from international trade than those belonging to the non-traditional industries.

From the policy perspective, a different set of policy responses is needed to stimulate the TFP spillovers under the trend of intensified international trade. Given the inevitable technology distance from trading partners, the policy-makers of African countries are suggested to instigate effective trade schemes that not only consider the potential knowledge pools and learning opportunities provided by the partner countries, but also, take into account the industrial context such as the production capability and comparative advantages. Foreign competition is a two-edged sword. Promoting learning and upgrading technological capability of both the domestic industries should be considered a priority when designing the industry and trade policies. The productivity growth that is mainly promoted by the exit of unproductive firms (reallocation of resources), but lacks more broad-based driving force from technology upgrading, may fail to sustain the economic growth in the longer term.

Regarding methodology, the estimators generated by different estimation approaches are highly consistent. Adding extra datasets from the WB investment survey allows us to construct a longer panel and extend the analysis to a more present time period. Similar findings are uncovered, and again suggest that trade triggers the TFP spillovers and the trading activities with China yield greater productivity effects on Ghanaian manufacturing firms than that with the OECD economies. It is worth emphasizing that the regional-industrial level results may suffer from potential bias given the small sample size. Larger and more present data sources are required if one attempts to address more robust and recent policy implications. Another limitation of the current research lies in the strong assumption that the share of value added of each industry in the total manufacturing sector remains unchanged during the period under survey. Industrial structure has gone through a dynamic change due to the integration of global value chain and the reallocation of domestic production resources. Ignoring this important issue is likely to reduce the reliability of the empirical findings. Future studies in similar specification should call for a complete data in which the industrial level outputs are used to normalize the trade intensity.

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Appendix A: computing the outputs of each industries in the sample

This section explains how the outputs for each industry during the period under survey were constructed. Computing the trade intensity at the industry-level, which is the ratio of trade volume at each industry in the total industrial output of the corresponding industry, will need the aggregated outputs for each industry. However, only data for the year of 2003 were found.[19] Given the limited data sources, we will use the UN Industrial Production Index (IPI) obtained from the Ghana statistic service to calculate the outputs of each industry for other years.

Comparing to using the aggregated outputs of all industries, adopting the ratio of trade volumes in industrial-level outputs will efficiently remove the bias caused by ignoring the weights of each industry in the total manufacturing sectors. With the UN Industrial Production Index during 1990-2008 and the industrial-level outputs in 2003, calculating the aggregated outputs for each industry becomes possible.

Converting industrial production index (IPI) to industrial output volume (1990-2008)

The UN Industrial Production Index is defined as the change in quantities (or volumes) of a specified basket of goods and services valued at the prices of the reference period 0, the computation of IPI is given as:

$$IPI_{i,t} = \frac{\sum_i p_{i,0} q_{i,t}}{\sum_i p_{i,0} q_{i,0}} = \frac{Output_{i,quantity\ t,price\ 0}}{Output_{i,quantity\ 0,price\ 0}}$$

where *pi,0* denotes prices of products for industry *i* at the base period 0. *qi,0* denotes quantity of products for industry *i* at the base period 0 whereas *qi,t* is quantity for industry *i* at period t.

The aim here is to calculate the aggregate output for industry *i* at price t. First, we convert the 'Outputi,q=2003, p=2003' at the 2003 price into the base year, 1977 price[20] (Outputi,q=2003, p=1977), then the '*Outputi, quantity 0, price 0*' will be computed based on the 'IPIi,2003 and '*Outputi, quantity 2003, price 1977*'.

$$Output_{i,q=1977,p=1977} = \frac{Output_{i,q=2003,p=1977}}{IPI_{I,t=2003}}$$

Second, with 'IPIi,t'and '*Outputi, q=1977, p=1977*', '*Outputi, q=t, p=1977*' can be calculated as:

$$Output_{i,q=t,p=1977} = IPI_{i,t} \times Output_{i,q=1977,p=1977}$$

[19] The value added 2003 data at industry-level can be found in the UNIDO database. It is the only year that available for Ghana. http://www.unido.org/en/resources/statistics/statistical-databases.html
[20] 1997 was chosen as base year because it was given as the reference year in the data obtained from Ghana Statistic Service.

Last, ‘*Outputi, quantity t, price t*’ can be obtained by taking into account the inflation rates of each year and the currency will be converted to US dollar.

Industrial outputs if each sample industry (2008-2013)

However, the IPI were only available to the year of 2008. For the following years, we have adopted another method to compute the industrial outputs. A gross value output of manufacturing for each industry was obtained from The Ghana Statistic Service. It was given in quarterly from 2006 to 2014 and only included data on sampled firms. This means not all the firms in the manufacturing sector were covered. With such given information, we are able to calculate the outputs in after 2008 by taking into account the growth ratios of industrial outputs of sampled firms.

$$Output_{i,t} = Output_{i,t-1} \times \{1 + \frac{(Output_{sample\ i,t} - Output_{sample\ i,t-1})}{Output_{sample\ i,t-1}}\}$$

‘Outputi, t’ denotes the outputs of industry *i* in year *t* (t ≥ 2009) and ‘Outputsample i, t’ denotes the outputs of industry *i* with sampled firms in year *t*. ‘Outputsample i, t’ is proportional to ‘Outputi, t’ and such computation requires that ‘Outputsample i, t’ will well represent ‘Outputi, t’.