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Market Structure, Technological Spillover and Productivity in Ghana.

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Abstract

This paper examines market structure and technological spillover effect on the productivity of local manufacturing firms in Ghana. By using a firm level panel data of eight subsectors in the Ghanaian manufacturing industry, the paper examines labour productivity of local firms by following the methodology of Kohpaiboon (2005) which begins with the Cobb Douglas production function. An appropriate diagnostics are carried out for the adoption of the empirical model to be estimated. The regression result reveals that the monopolistically competitive nature of the Ghanaian manufacturing industry and technological spillover affect local manufacturing firms' productivity. High competition in the Ghanaian manufacturing industry helps revive laggard local firms to perform better by adopting advance technology introduced by foreign firms. Technological spillover also benefits local firms because technological advance helps increase value added and productivity.

Keywords: Market Structure; Technological Spillover; Productivity

1. Introduction

The relationship between technological spillover and productivity has been an attractive area of research. The type of a country's market determines the state of competition in the market.

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In a highly competitive market, there is the likelihood of lower profits or higher profits record by firms depending on their ability to stay in competition. A firm's ability to invest in improved and high technology in a competitive market will lead the firm to experiencing higher profits and efficient productivity. The authors in [1] demonstrated a positive correlation between competition and productivity growth. By using a step-by-step innovation procedure, they observed that in a highly competitive market, technological laggards cannot overtake technological leaders. The technological laggards need to catch up before they can become leaders and this process in itself creates competition in the market which serves as an incentive for innovation and productivity improvement.

Competition may not all the time foster efficient productivity. In a highly competitive market, firms who adopt advance technology incur additional cost which can lead to lower profits and firms who are not able to adopt advance technology may stay out of the market. The authors in [1] offered some qualifications for a negative correlation between competition and growth. They developed a model whereby the manager of a firm in a highly competitive market faces the private cost of adopting new technologies which include training and reorganization cost among others in order to benefit from being in control of the firm. They established that competition provides a disciplinary device to ensure the adoption of advanced technologies.

Many studies have been conducted in the area of technological spillover and productivity especially in developing countries but most of them looked at technological spillover as an effect of FDI. They considered technological spillover as the introduction of advanced technology brought into local firms by foreign presence in the local market which benefits both the affiliated firms and non-affiliated firms. The nature of the Ghanaian market structure is that of a competitive type due to technological spillover effect which introduce advance technology to the local market. It is expected that with the market structure being that of a competitive nature with more foreign presence, local firm would benefit by experiencing higher and efficient productivity to confirm the findings of various researchers like the authors in [2, 3, 4] who found that foreign presence benefits local manufacturing firms but that is not the case.

Ghana has witnessed the shrinking of local firm's market share due to the fact that these local firms are not able to withstand the kind of competition brought into the local market as a result of technological spillover effects. This is mostly due to the fact that the local firms are not able to cope with the additional costs such as cost of training and reorganization brought on them as a result of high competition as stipulated by the authors in [1, 5] . Instead of the market structure; which is competitive in nature and technological spillover helping to revive the laggard local firms for them to be able to withstand the competition and increase productivity, it is rather kicking most local firms out of business.

As a result of the situation in the country whereby local firms are not able to cope with high competition, it became interesting for such a study on the impact of market structure and technological spillover on local firms productivity to be conducted.

2. Ghanaian Industrial Sector

Ghana has a large and very active Consumer & Industrial Products and Services sector that provides products and services to the Ghanaian economy and the West African sub-region as well as the entire world. The sub-sectors within the industry are manufacturing, mining and quarrying, construction and electricity and water. Looking at the contribution of the various sectors in GDP, the author in [6] asserts that between 1985 and 1992, the GDP at purchasers' price was estimated at constant 1975 prices, while between 1993 and 2006 the GDP at the purchasers' value was estimated at constant 1993 prices.

The contribution of the manufacturing sub-sector was far and above that of the other three sub-sectors. It has remained around 9%, a margin most economists perceive as not good enough if the objective to become an industrialized nation is to be achieved. If we consider the three major sectors in the economy, that is, Agriculture, industry and service, Agriculture continues to dominate, followed by services and industry in that order. This is as a result of the fact that manufacturing which dominates in terms of contribution of sub-sectors in industry to GDP, did not show much improvement over the period of 1985 – 2006 as it stagnates around 9%. The author in [6] stresses that the unbridled trade liberalization policies pursued over the period is believed to have had a negative effect on the manufacturing sector. If the vision to become an industrialized nation is still the focus of Ghana, then the author in [6] trusts that the contribution of industry must not just dominate the major sectors in the economy, but must be much higher, may be a doubling or tripling of the current rates.

Over 30% of the manufacturing activities, representing over 50% of value added, are located in the area. As at 1984 there were about 2400 industrial units out of which only 20 employed over 500 persons, 39 had between 200 and 499 employees, and another 39 with 100 – 199 employees. Seventy-five percent (75%) of the jobs were in small-scale industries, while 91% of the industries employed 30 persons or less (30 is the upper limit for small-scale industries).

3. A Selective Review

This section talks about the empirical and theoretical literature review on the topic. We present literature on the effects of market structure and technological spillover on local manufacturing firms' productivity.

3.1 Market Structure and Productivity

The concept of market structure is central in every discipline. The structure of a country's market has an impact on the country's productivity. One of the measurements of firms' performance is productivity. Competition is useful because it reveals actual customer demand and induces the seller to provide service quality levels and price levels that buyers want, typically subject to the seller's financial need to cover its costs. In other words, competition can align the seller's interests with the buyer's interests and can cause the seller to reveal his true costs and other private information. Studies have shown that high competition in a market does foster productivity growth. The authors in [1] offer some qualification for a positive correlation between competition and productivity growth. By using a step by step innovation procedure, they found that high competition in a market provides appropriate incentive for innovation and productivity growth.

The authors in [7] conducted a study on market structure, technological spillover and persistence in productivity differential by using 17 OECD countries and they found that persistence in productivity differential is positively correlated with the market structure which was measured by price cost margin.

Market structure may also affect productivity of firms negatively. This normally has to do with the additional cost brought on local firms as a result of high competition. Most firms are not able to cope with cost of R&D and reorganization cost that high competition presents. The authors in [1] demonstrated a negative correlation between market structure and productivity growth in a similar study conducted by them.

3.2 Technological Spillover and Productivity

The gap between foreign firms' and local firms' technology has an impact on firms productivity. Technological advancement which comes about as a result of improved R&D and foreign direct investment either benefits local manufacturing firms' productivity or shrink the market share of local manufacturing firms. The authors in [1] were able to prove this fact when they discovered that costs associated with technological advancement may lead to lower profits of local manufacturing firms and at the same time, technological advancement may help revive laggard local firms to perform better in the market as a result of the high competition that technological advancement comes along with. The authors in [7] asserts that the international transmission of technological know-how is an important medium for the technologically underdeveloped economies to gain the knowledge needed for the enhancement of productivity and economic growth. They go further to say that the technological know-how can be acquired through various venues such as imitation. The authors in [8] have shown that imitation in itself also promotes innovation. This is as a result of the fact that the more firms imitate each other, the more ideas gained to move a step further and be ahead of their competitors. The authors in [9] observed that technology generated locally and foreign innovation benefit growth. The authors in [10] conducted a study to investigate into the role of technology diffusion as a contributing factor to conditional convergence and they found that technological diffusion diminishes productivity differentials and leads to convergence.

Theoretical and empirical literature identifies two major concepts of technological spillovers: rent-spillovers and knowledge-spillovers. The authors in [12] cited the work of the author in [11] in their study; technological spillovers and productivity in Italian Manufacturing that theoretical and empirical literature identifies two major concepts of technological spillovers as rent-spillovers and knowledge spillovers. They explained that rent spillovers occur when new goods are purchased at prices below those that would fully reflect the value of technological improvements from R&D investments. They go further to explain that rent spillovers can be considered as a pecuniary externality from upstream industries, whose competitive market structure may not allow firms to fully transform higher quality into higher prices. Knowledge-spillovers according to them are derived from technology's incomplete excludability. That is innovation by one firm is adopted by "adjacent" firms, thus enhancing their productive and innovative capabilities. This supports the idea of the authors in [8]. Knowledge spillovers arise exclusively as an intangible transmission of ideas; in principle, they are not embodied in traded goods, and thus they do not necessarily require economic transactions. The authors in [12,13] believes that in practice, such mechanisms as the transactions of intermediate or capital goods and the mobility of high-skilled workers are generally responsible for inter-firm knowledge transfers.

Going through the literature on technological spillover by various writers, it can be noticed that positive technological spillover has only been found in some few countries. Most research conducted in this area basically identifies negative technological spillover effects on local manufacturing firms. This spillover too is mainly seen to be as a result of FDI which most Authors have found to be killing local manufacturing industries. Technological spillover is not automatic but depends on country-specific factors and policy environment as found by the author in [4]. This Author realized that country-specific factors like trade policy regime might lead to negative spillover effects on local manufacturing industries. He captured the technological spillover effect by considering the gap between local and foreign firms technology.

4. Data

We employed the Regional Programme on Enterprise Development (RPED) data for our analysis. RPED data was collected in five rounds over the period 1992 to 1998. The first three rounds were annual surveys, that is, Waves I – III, as part of the Regional Program on Enterprise Development (RPED) organised by the World Bank. The fourth and fifth rounds of the data each cover two year periods. The original sample of 200 firms, which were first surveyed in 1992, was drawn on a random basis from firms contained in the 1987 Census of Manufacturing Activities. The firms constituted a panel which 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. It has been possible to obtain data over the waves for the majority of the original sample of firms, but, where necessary, firms that have dropped out of the survey (for a variety of reasons) have been replaced in the sample by similar firms.

5. Model Estimation

The study uses a two equation model that regress productivity determinants on market structure and technological spillovers. This assumes that market structure and technological spillover are determinants of efficient productivity.

5.1 Measuring Productivity

The study measured productivity by beginning with the Cobb-Douglas production function as used by the authors in [4, 5]. This production function was used to determine the value added per worker or productivity of locally owned manufacturing firms in Ghana. The study adopted some other explanatory variables from the authors in [7, 14] to be part of the model to enable us capture the relationship between Market structure, technological spillover and productivity.

The first explanatory variable was technological gap (TECH) between local and foreign firms technology. TECH is used to determine the degree of technological spillover. TECH is proxied by the ratio of average value added per worker between foreign and local firms net of capital intensity and firm size as used by the author in [4]). We expect that technological spillover should have a positive impact on local manufacturing firms'

productivity. This is because, as firms invest more in technology, value added is expected to increase for productivity to also increase.

To capture market structure in the model, we use price-cost margin as a proxy for market structure. PCM is commonly used to gauge the degree of monopolistic behavior or market competitiveness as elucidated by the authors in [15, 16, 17]. For industry i at time t , as defined by the authors in [17], PCM is defined as:

$$PCM_{i,t} = (VA_{i,t} - W_{i,t}) / F_{i,t} \quad (1)$$

Where W is the labour compensation, VA is value added and F is the value of total production. A high value of PCM reflects a low degree of competition in the industry.

We decided to square the PCM in order to find the non-linear relationship between PCM and LP. If PCM is squared, we arrive at equation (2):

$$PCM_{i,t} = [(VA_{i,t} - W_{i,t}) / F_{i,t}]^2 \quad (2)$$

This study also included quality of labour as one of the explanatory variables. $QL_{i,t}$ is the log of labor quality of the i th firm proxied by sum of the firm level weighted average of education and tenure for each employee, multiplied by the number of employees as measured by the authors in [5, 18]. A high quality of labor is likely to contribute to an increase in value added per worker.

Firm age (Firmage) is also included as one of the explanatory variables. Firm age is measured by the number of years a firm has been in business. The author in [19] avers that experienced gained by older firms in the market helps them to reduce cost and become more productive. Firm age is thus seen to have a positive impact on productivity. As a result, a positive sign is expected for this variable.

This study introduced some subsector dummies, location dummies and time dummies just like the authors in [20] did to ensure sector specific effect. In the RPED data, eight subsectors were used. They included textiles, chemicals, wood, machine, garment, bakery, furniture and metal. Each subsector's dummy = 1.

The size (SIZE) of a local manufacturing firm is very important in determining whether a firm can cope with increasingly high competition and technological advancement in the manufacturing industry. SIZE was measured by the log of firms' total assets. The size of a firm is expected to be directly related to productivity efficiency because firms with high total assets are expected to use the assets to increase productivity more than firms with small total assets. As a result of this, a positive relationship is expected between LP and SIZE.

5.2 The Model

This study estimates productivity by using equation 3 which has been specified below:

$$LP_{i,t} = \alpha_0 + \beta_1 (K_{i,t} / Li,t) + \beta_2 K_{i,t} + \beta_3 PCM_{i,t} + \beta_4 (PCM)^2_{i,t} + \beta_5 TECH_{i,t} + \beta_6 FOR_{i,t} + \beta_7 QL_{i,t} + \beta_8 SIZE_{i,t} + \beta_9 FMAGE_{i,t} + \lambda t + \theta t + \mu j + \varepsilon_{i,t} \quad (3)$$

Where:

- $LP_{i,t}$ is the log of labour productivity of locally owned *ith* firm.
- α_0 is the intercept of the regression equation
- β is the coefficient of the variables
- $K_{i,t} / Li,t$ is the log of capital–labor ratio of locally owned *ith* firm
- $K_{i,t}$ is the log of capital stocks of locally owned *ith* firm
- $PCM_{i,t}$ is the price–cost margin, a proxy for market structure.
- $TECH_{i,t}$ is the technology gap between local and foreign firms.
- $FMAGE_{i,t}$ is the firm age. How old a firm is, determines productivity. We included this variable because older firms are expected to have more experience which gives them advantage over younger firms; so older firms are expected to increase productivity more than younger firms.
- $QL_{i,t}$ is the Quality of labour. This variable was included because firms which invest more in their labour force are expected to increase productivity because skilled labours are able to work hard to improve upon productivity.
- $FOR_{i,t}$ is the log of foreign presence proxied by the share of foreign output to the *ith* firm. Foreign presence (FOR) is measured by the output share of foreign firms to total industry as used by the author in [4].
- $SIZE_{i,t}$ is the size of firms in the manufacturing industry. Size was measured as the log of firms' total assets. We included size because we believe that the size of a firm which is measured by total assets determines productivity. Firms with more total assets are expected to perform well and increase productivity than firms with small total assets.
- $\lambda t, \theta t, \mu j$ are the dummies for time, location and sector respectively. Location was included because firms in different locations in Ghana are not expected to perform in the same direction. In the RPED data, four locations were used. They are Takoradi, Kumasi, Accra and Cape Coast. Firms in Takoradi and Cape Coast may incur little cost on production than firms in Accra and Kumasi. This is as a result of the different standard of living in these areas.
- $\varepsilon_{i,t}$ is the error term
- Subscript *i* and *t* denote the locally owned manufacturing firm and time respectively.

6. Empirical Results

6.1 Estimation of the productivity model

Hausman specification test was performed on the variables to know the appropriate effect to use for running the regression equation. That is whether firm fixed effect or random effect and it emerged after the test that firm fixed effect is appropriate to be used for a panel data of this kind because the hypotheses proved to be consistent under both the null and the alternate hypothesis for the fixed effect. The result of the Hausman specification test has been reported on the regression tables. The regression results of the model have been reported in table 6.1. We included eight sub-sectors in the Ghanaian manufacturing industry. They are the bakery, furniture, chemicals, wood, textiles, machinery, metal and garment sub-sectors. Four locations were chosen. They are Cape Coast, Takoradi, Accra and Kumasi. We included PCM^2 in the regression equation to determine the non-linear relationship between productivity and price cost margin. It can be noticed from table 6.1 that the three key independent variables, that is, PCM , PCM^2 and $TECH$ attained the right signs and are all significant at 1% and 5% levels of significance respectively. The negative coefficient recorded for PCM means that productivity increases as PCM falls and PCM falling means there is high competition in the market and thus high competition brings productivity increment. On the other hand, productivity decreases as PCM increases and PCM increasing reflect low competition in the manufacturing industry. The findings of this study has shown that the market structure of the Ghanaian manufacturing industry is that of monopolistic competition (that is low PCM) and the negative coefficient attained in the regression equation shows that competition has a good impacts on local firms' productivity. Competition helps revive laggard local firms to perform well in order to stay in the market. This evidence is in agreement with the findings of the authors in [1, 7] who predicted that competition enhances the catch-up process. PCM^2 recorded a negative theoretical sign as expected. The regression result proves that as PCM^2 decreases, labour productivity increases but not necessarily by the same percentage as would in the case of linear relationship (that is, PCM). $TECH$, the proxy for technological spillover between local and foreign firms in the Ghanaian manufacturing industry also recorded a positive coefficient which also implies that the technological gap between foreign firms and local firms affects local manufacturing firms' productivity. $TECH$ obtaining the expected theoretical sign of positive means that as competition in the market intensifies as a result of low PCM which implies high competition in the market, domestic firms may be forced to reform their management styles and update production technology in order to increase their competitive capacity and thereby increase productivity. This result is also in conformity with the findings of the authors in [1, 5, 7].

The regression result proves that capital and capital-to-labour ratio are significant at 1% and 5% levels of significance respectively in table 6.1. This means that more capital allow firms in the manufacturing industry to develop their labour as well as invest more in technological advance in order to increase productivity. The result of the two variables in the equation conforms to the findings of the authors in [4, 5].

We control for quality of labour to see if the caliber of employees in foreign firms and local manufacturing firms has an impact on productivity and the result met our expectation. Quality of labour obtained the expected theoretical sign of positive and was significant at 1% level of significance. The measurement of quality of

labour takes into account education and experience of employees and the positive sign attained here means that well trained and experience employees are likely to increase productivity. This results agrees with the findings of researchers like the authors in [4, 5].

The size of a firm matters when looking at the productivity of a firm. Size, another control variable was measured as log of total assets of firms in the RPED data. The theoretical sign of positive for size was attained and was also significant at 1% level of significance. This means that firms with high value of total assets are expected to perform better in terms of productivity, than firms with low total assets.

Firm age is one control variable we included to see its impact on productivity of local manufacturing firms. We had the expected sign of positive and firm age was significant at 1% level of significance. The age of a firm is an important variable when looking at productivity. Older firms tend to perform well in the market in spite of all the competition because after being in the market for so long, they gain experience and familiarize themselves with whatever is going on in the market and that helps them not to repeat previous mistakes unlike the younger firms.

6.2 Table

Table 6.1^a: Regression Result: Determinants of Labour Productivity ($LP_{i,t}$) of Local Manufacturing

Firms in Ghana		
Variables	Coefficient	Standard Errors
Intercept	4.89***	0.91
Cap/Lab Ratio	0.15***	0.04
Capital	-0.11**	0.06
PCM	-0.24**	0.09
PCM ²	0.15***	0.04
Tech. Spillover	0.02**	0.01
SIZE	1.01***	0.06
Foreign Presence	-	-
Lab Quality	0.05***	0.01
Firm Age	0.04***	0.01
Location Dummies	Yes	

^a Source: Author's computation done with STATA Software. *, **, *** represents 10%, 5% and 1% levels of significance respectively.

Subsector Dummies	No
Observation	868
R²	0.56
F (.)	52.74
Prob. > F	0.00
Hausman Test: Chi2(9)	86.63
Prob>chi2	0.00

7. Conclusion

The study examined market structure and technological spillover's impact on productivity of local manufacturing firms in Ghana. It used a sample of some selected firms in the major subsectors of the manufacturing industry in Ghana namely textiles, garment, wood, machinery, bakery, furniture, metal and chemical. The prime objective of the study was to determine the market structure of the Ghanaian manufacturing industry and its impact on local manufacturing firms as well as technological spillover's impact on the productivity of local manufacturing firms in Ghana. The RPED data was employed for the analysis.

The regression results revealed a significant market structure and technological spillover effect on local manufacturing firms' productivity. It was found that the proxy for market structure, that is, price cost margin has an effect on local manufacturing firms' productivity. This finding is in line with the results of the authors in [1, 7].

All the control variables except FDI which was omitted from the regression equation, proved to have significant effect on local manufacturing firms' productivity. This means that if local manufacturing firms improve upon their labour quality, size and stay long in the market they are likely to improve upon their productivity.

It is hoped that further studies in this area will employ a more detailed data on Sub-Saharan African countries to conduct the study in order to see the impact of technological spillover and market structure of the Sub-Saharan African countries on local African firms' productivity.

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