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*Full Length Research Paper*

# Spillover effects enhancing sales, production and competitiveness of South African manufacturers

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**With the surge of globalisation, economic systems became integrated across borders and it became easier for firms to share knowledge and improve their global competitiveness. This study examined the connections between firms in the manufacturing industries with regard to knowledge and innovation spillover effects on a regional, national and international basis. The contributions of spillover effects, improving competitiveness of firms, were also investigated. The role of education in facilitating spillover effects also received attention. The results showed a significant interconnectedness between firm growth and knowledge sharing on all levels. The importance of a productive human capital base was also confirmed.**

**Key words:** Production, spillovers, foreign direct investment (FDI), technology, sales, industrial development, competitiveness.

## INTRODUCTION

As globalisation integrates technologies and processes across borders, technological knowledge spillover effects between economic agents, increase. This study therefore aims to quantitatively and qualitatively analyse the effect of such spillovers on firm competitiveness and growth, as well as human capital improvement, which will translate into regional, national and international improvement of production processes and ultimately, economic growth and development.

In an effort to increase productivity and competitiveness and to maximise profits, firms need to enhance their technological and knowledge bases to gain competitive advantages, which may be facilitated with the help of spillovers from other firms, industries, regions or countries. The purpose of knowledge creation and sharing lies in the determination of firms to achieve individual goals, which cannot be procured efficiently without the gains of new knowledge (Ding and Huang, 2010). This knowledge creation and sharing might eventually also improve the productivity of industrial, regional, national and worldwide processes. The initial focus should therefore be on the individual firm and how knowledge flows make its way to the rest of the region and nation. New knowledge can lead to new or improved products or services, as well as new skills to improve income per capita and address poverty alleviation directly. Overall, technological progress and innovation are seen as imperative determinants of industrial development, economic growth and development domestically (Cabrer-Borrás and Serrano-Domingo, 2007).

It is important to address the channels through which knowledge creation and sharing take place so that interconnections between economic agents may be streamlined, unwanted knowledge sharing may be prevented and overall competitiveness and production processes may be improved to sustain national economic growth. This study is therefore a micro-economic study that concentrates on the knowledge diffusion developments among firms in the manufacturing sector, as concentration is high, defined as a small number of firms accounting for a large portion of economic activity (Fedderke and Simbanegavi, 2008). Primary data was

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gathered through the use of questionnaires issued to firms in the manufacturing industry, as well as secondary data gathered by previous studies on the same topic.

This study is compiled as follows: Literature on knowledge and export spillovers will provide a literature study into the competitiveness effects as a result of knowledge sharing, regional and national spillover effects, as well as export spillovers from multi-national corporations (MNCs) situated in South Africa. Specific attention will also be given to the role of education. Thereafter, the study focuses on the theory underlying the topic of competitiveness with specific regard to the Porter analysis of competitive advantage, as it is most aligned with the objectives of this study. Attention will also be given to knowledge spillover effects occurring on regional, national and international level. Furthermore, the study concentrates on the empirical study done on spillover effects and will evaluate the role of education on the sales and consequent competitiveness and growth of firms. This is followed by the policy implications involved in spillover effects and market concentration for competition, including recommendations. Finally, the findings of the study are summarised and concluded. The literature study will now be reviewed first.

## LITERATURE ON KNOWLEDGE AND EXPORT SPILLOVERS

According to Holod and Reed (2004), linkages between suppliers and consumers within similar industries have intensified as a result of technology improvements worldwide. Attention should therefore be directed towards the competitive implications of such developments, as well as how they will affect the region, nation and ultimately the world, because, according to Giuliani and Bell (2004), knowledge spillover effects are interrelated across borders. There exists little reason why the process of learning should be limited to a specific location or territory.

With regard to competitiveness, Fedderke and Simbanegavi (2008) specifically considered market concentration as they saw a positive relationship between competition and concentration. Four measures were used, namely the concentration ratio, the Herfindahl-Hirshman index, the Rosenbluth index and a Gini coefficient. Evidence found was inconclusive, as the Gini coefficient is rather used to measure inequality, the Rosenbluth index showed lower values than expected and both the concentration ratio and Herfindahl-Hirshman index have not been employed in the manufacturing sector of South Africa. There is evidence, however, that South Africa is among the top fifty countries in the world with regard to competitiveness (ITRISA, 2008). Together with concentration, price controls imposed and barriers to enter the market should be taken into consideration when measuring competition and market share.

In terms of knowledge spillovers on regional level, research and development inputs can be regarded as production inputs, similar to modern machinery and equipment, financially supported by grants and enhanced by a skilled human capital base. It was found that the structure and level of economic activity of regions are important underlying factors of knowledge spillover effects and may contribute to differing performance of innovation in different regions (Cabrer-Borrás et al., 2007). The study also indicates that regional innovation also depends on internal research and development activities, its human capital base and its innovative tradition, also emphasising the importance of education enhancement. Locational decisions are also important to facilitate knowledge creation and the sharing process.

Additionally, inherent regional levels of economic development, proxied by total factor productivity (TFP), were found to have an impact on knowledge sharing, as well as the formulation of policies regarding research and development efforts. Less developed regions specialise, for example, in low to medium-level technology obtained from previous periods of knowledge creation and are not as active in new scientific research and development efforts (Cabrer-Borrás et al., 2007). Nevertheless, a cluster of firms will be better able to benefit from knowledge spillovers, rather than undertaking it individually. A study by Giuliani and Bell (2004), using an analysis of social networking to identify the roles of cluster firms and the structure of the information system, found that new innovation ideas travel easily among firms in the same industrial cluster due to the favourable social and geographical proximity. This ultimately enhances collaborative and collective innovation efforts. Firms in a cluster will also benefit from the pool of skilled labour that is available (Marshall, 1890; Krugman, 1991).

The role of absorptive capacity is just as important; it was found that knowledge will flow within a strategic core group of enterprises showing high levels of absorptive capacity (Giuliani et al., 2004). Eventually, the entire country benefits from increased absorptive capacity.

Considering knowledge spillovers on national level, its interdependency with regional innovation efforts is of crucial importance. It was found that the benefits from spillovers on the national economy will be greater if they emanate from regions that have achieved a certain level of development. There may be factors of structural importance determining the capacity of the region to create innovation. It was found that the effect of expenditure on research and development is greater in richer regions, which confirms the need for regional development to benefit the national knowledge base (Cabrer-Borrás et al., 2007). Other national entities may also affect innovation efforts. Activity of innovation will not only be enhanced by a single firm's knowledge, research and development creation, but also by the knowledge creation of other research institutions domestically, such as universities or other public research institutions

(Cabrer-Borrás et al., 2007).

Knowledge spillovers may also emanate from international sources such as multi-national enterprises. According to Alvarez (2007), becoming a permanent exporter depend on spillovers from multi-nationals and being situated close to where multi-nationals are concentrated. This increases productivity and experience with regard to exporting. The study, however, found little evidence to support the existence of "learning by exporting". Another study by Cabrer-Borrás and Serrano-Domingo (2007) found that import suppliers can positively contribute to a region's innovation efforts, but to a lesser extent than internal research and development efforts within the region itself. Local industries will also benefit from FDI, which may also increase exports and promote employment. Spillovers of research and development from FDIs in the form of imitation activities, relationships between business partners and training of the human capital base, have become increasingly important in the literature and have been included in the development processes of new growth models (Motohashi and Yuan, 2010). There are, however, some underlying factors that influence the distribution of FDI. It is also a means of reducing the technology gap between countries and may lead to greater international competitiveness and development.

Considering spillovers, Kleynhans and Zwedala (2012) found a positive relationship between competitiveness and research and development, especially with regard to capacity utilisation, foreign licensing and international quality certification, while the cost of training is detrimental, probably due to limited absorptive capacity. On the other hand, the relationship between competitiveness and foreign ownership is negative, as with FDI and technology, while more expenses on information technology (IT), especially the Internet, lead to more spillovers.

Considering educational aspects, a sufficient pool of skilled labour and emanating technology spillover effects, as well as the co-location of customers and suppliers among firms within similar industries, generate increasing returns to scale and promote final production (Kleynhans and Drewes, 2008). On regional level, spatial spillovers, which may be defined as the interconnections that exist across geographical spaces, will be the result of increased investment in higher education (Cabrer-Borrás et al., 2007). Kleynhans and Zwedala (2012) found that the degree of managerial experience and the level of education of labourers contributed positively to competitiveness in South Africa, but contributed to a decline in spillovers, probably because workers learn to protect the concerns of the company. On the other hand, spillovers increase as the number of employees increase, leading to a decline in competitiveness.

A sufficient human capital base is also important on an international level for effective export practices and participation (Alvarez, 2007). Promotion of the human capital base deserves extensive attention for future studies on this topic.

## THEORIES OF INNOVATION SPILLOVERS UNDERLYING COMPETITIVENESS AND GROWTH

Spillover effects occur over time, space or industry. Temporal externalities imply that current production will be affected by previous collected stocks of physical and human capital (Morrison, 2002). Current investment decisions will therefore depend on previous capital accumulation decisions. Capital investments like machinery, training of employees and patents may have an influence on the flexibility of production processes, as enhanced flexibility benefit the production process, as it will become more adjustable to new techniques and production methods that can increase productivity growth.

The capital-output ratio and Harrod-Domar model may be used to determine the required level of capital investment. In the basic growth model, output is a function of capital (K) and labour (L), given as $Y = f(K, L)$. The capital-output ratio will differ across countries, as different technologies are used to produce the same good and or as a different mix of goods is produced (Perkins et al., 2006). Together with spillover effects, capital investment may lead to increased ability for innovation as well as an increase in flexibility.

Spatial linkages imply interdependencies between regions and spaces as activities in one region may have an impact on the activities of neighbouring regions. In modern times, however, it becomes increasingly easier to find and network with suppliers and other contacts globally, facilitated by the process of globalisation, which may reduce the importance of spatial spillovers (Morrison, 2002).

Sectorally-bound or industrial spillovers also exist, implying that supply and demand side components are at work to influence the spillover process and all channels affect each other. Innovation at lower levels of the production process will be transferred to higher levels, while changes in demanded products with regard to quality and composition have an impact on lower levels of the production chain. These linkages are becoming increasingly important because of expanded horizons of entities to promote production and the decision-making process brought on by globalisation and enhanced information technology (Morrison, 2002).

Spillovers may also occur horizontally or vertically. Horizontal spillovers are intra-industry spillovers, implying that they occur across firms in the same industry and are of equal origin; for example, domestic firms. Spillovers on horizontal level may be the result of human capital turnover or technology sharing. Vertical spillovers are inter-industry spillovers, meaning that firms gain knowledge from suppliers or international knowledge sources

(Motohashi et al., 2010).

There are a number of different spillover theories, but the most important and relevant for this study is the Porter spillover theory, stating that the close proximity of specialised industries that are competitive would have the greatest influence on enterprise growth and competitive advantages (Marshall, 1890; Anon, 2010; Porter, 1998; Kleynhans and Drewes, 2008; Krugman, 1991). It is relevant for South Africa in that the country's industrial sector is relatively highly concentrated and is characterised by specialisation (Fedderke and Simbanegavi, 2008).

There exists a positive relationship between knowledge spillovers and productivity, as knowledge spillovers may motivate innovation efforts to increase firm competitiveness and thus, raising productivity growth and ultimately, economic growth. The innovation process may be facilitated from in-house research-and-development efforts, from knowledge gained from external sources, as well as knowledge gained during collaboration efforts with other firms.

Ultimately, information components rely on human and physical resources, communication abilities and support company logistics to effectively attain process, store and diffuse relevant knowledge. The costs in time and energy are also important aspects in the transferral and absorption of new knowledge (Ding et al., 2010).

With regard to competitiveness, there exists a positive relationship between competitiveness and productivity, as increased competition in product and service markets has positive effects on growth in productivity in an effort by firms to gain market share and remain or become market leaders (Fedderke et al., 2008). International competitiveness depends on the availability of needed factors of production, linkages to other industries like suppliers and government trade units, as well as effective strategies for international market share and business operations (ITRISA, 2008). Mark-up prices will also influence competitiveness. These prices are defined as the ratio of price (P) to marginal cost (MC) and may be represented by the formulation: $\mu = P/MC$; where $\mu$ is mark-up. If $\mu = 1$, perfect competition in the market prevails (as $P = MR = MC$), and if $\mu > 1$, there are monopoly or oligopoly conditions in the market with accompanying barriers to entry (Fedderke et al., 2008). Ultimately, knowledge will only lead to a competitive advantage if it is scarce, difficult to imitate and valuable (Ding et al., 2010).

Focusing on a regional base, spillovers are of the utmost importance, as it will translate to greater innovation efforts locally and eventually promote regional and domestic economic growth, through an increase in competition by similar firms. On the other hand, the advantages from greater diversity of activities, brought on by complementary information exchange of complementary industries, will yield greater returns to new knowledge and innovation efforts, thereby promoting growth (Cabrer-Borrás et al., 2007). The initial level of development has also been found to be of importance to facilitate future innovation efforts (Cabrer-Borrás et al., 2007). Firms in the same region are more likely to undertake collaborative innovation efforts; however, firms should be careful not to expose information to other parties it did not intend to share, as it may reduce an individual firm's competitive advantages (Ding et al., 2010). Unwanted externalities like the foregoing may be protection from patents – keeping sacred the initial innovation ownership before collaboration started. Firms not engaged in collaboration efforts should also issue patents to protect intellectual property (Varian, 1992).

With regard to the possible negative and harmful effects of spillovers, Kleynhans and Zwedala (2012) found that spillovers are positively related to the volume of Internet communication, the number of temporary workers, corruption, crime, theft and disorder, which also curb competitiveness. New suppliers can serve as a source of information due to more spillovers, but this declines as suppliers become known to a particular firm in the longer term, as loyalty develops over time. When expenditure on security increases, spillovers decline, which also enhances the competitiveness of firms.

On a national level, knowledge spillovers tend to be country- and firm specific, for example, low-income countries mainly specialise in low value-added goods like commodities, limiting the need for innovation efforts (Alvarez, 2007). On the other hand, high-income countries, like Japan, produce high value-added goods, like software, and are therefore, constantly in need of new ideas to remain competitive.

The absorptive capacity levels of firms are another important factor to take into account, which constitute the level to information that can be absorbed by an enterprise. The higher the absorptive capacity is, the more likely it is for new information to lead to more new inventions (Motohashi et al., 2010). Internal training may be presented to employees, or knowledge may be gained from external sources, although certain policies will then have to be adhered to. It is also indicated that the largest gains in growth originate from national economic integration, rather than global coordination (Holod et al., 2004).

International knowledge diffusion may be enhanced through globalisation activities and foreign direct investment initiatives. Spillover effects following new FDI were, however, found to be limited in South Africa (Kleynhans and Zwedala, 2012). There remain several questions surrounding the role of multi-national enterprises (MNEs) and knowledge gains through export activities on the diffusion of knowledge domestically (Cypher and Dietz, 2009). Channels of international knowledge diffusion to the local economy include: Trade across borders, foreign investment in research-and-development capacities and imported inputs of technology (Cabrer-Borràs et al., 2007).

On the positive side, for domestic firms, MNE investment could improve production, growth and competition

prospects of especially less-developed countries through the transferral of information and technology, and the improvement of domestic understanding of international markets (Alvarez, 2007). The traditional beneficial characteristics of MNEs, like superior technology and managerial skills, may also not be fully protected, presenting local firms with the opportunity to internalise the leakage of information emanating from foreign investment (Franco et al*.,* 2010).

On the negative side, a loss of independence may be experienced by domestic firms and a significant portion of profits and market share may have to remain with the multi-national firm that made the initial investment (Motohashi et al., 2010). The spillover effect of MNEs is mediated through three channels, namely the demonstration effect as a result of the MNEs' superior expertise emanating from their operations in foreign markets; an imitation effect or research-and-development effect; and a competition effect forcing firms to enhance their productivity and export performance (Franco et al*.*, 2010).

With regard to the role of human capital in this process, the importance thereof has been frequently emphasised. It is therefore an imperative that a skilled domestic labour force be trained and made available. Local and international firms can assist the enhancement of the knowledge base by providing bursaries to prospective students, thereby committing the knowledge and innovation possibility to the firm.

The following section reports the main findings of the empirical study that was conducted on firm level concerning knowledge and technological spillovers.

## EMPIRICAL INVESTIGATION ON SPILLOVERS

### The survey and data utilised

An empirical analysis was concluded and results interpreted. The specific objectives of this study included the evaluation of knowledge spillover effects on regional, national and international level; the elaboration of the impact of knowledge spillovers on competitiveness; and the assessment of the role of education in knowledge creation and diffusion among firms and the impact on domestic economic growth and development. The research data primarily utilised the World Bank's Enterprise Survey (2011), as well as secondary data sources.

## EMPIRICAL RESULTS

The most important findings of the empirical research were as follows: Firm-level cross-sectional data was used to conduct an empirical regression model consisting of 276 observations. The large size of the sample led to an effective and significant model.

The log of sales was used as the dependent variable as it represents firm growth, productivity and competitiveness in the estimated regression model. The independent variables included direct exports (direx), the log of the number of competitors (comp), the log of cost of communication (com) (which was used as a proxy for spillover effects in knowledge creation efforts), the log of cost of machinery and equipment (mac), the log of the number of skilled production workers (skill) (which will be the proxy for education), and a dummy variable representing the undertaking of new projects by the firm (newproj), which was the proxy for innovation and the percentage of private domestic ownership (priv).

The best final estimated output regression model reflected a positive relationship with direct exports, cost of communication, costs of machinery, skilled production workers and new projects undertaken – as was expected. A negative relationship to competitors and privately-owned firms was also expected and concluded. Variables significant on the 5% level included direct exports, cost of communication, cost of machinery and equipment and skilled production workers. Significant variables on the 10% level included new projects and private-domestic ownership.

The coefficient on competitors was found to be insignificant, but according to the strong theory surrounding competitors in the market place, it has been included in the model. The best estimation of the regression equation was therefore:

$$\ln(\text{sales}) = \underset{(6.038)}{6.038} + \underset{(0.008)}{0.022}\,\text{direx} + \underset{(0.536)}{0.536}\,\ln(\text{com}) - \underset{(0.105)}{0.133}\,\ln(\text{comp}) + \underset{(0.290)}{0.29}\,\ln(\text{mac}) + \underset{(0.241)}{0.241}\,\ln(\text{skill}) + \underset{(0.246)}{0.246}\,\text{newproj} - \underset{(0.002)}{0.003}\,\text{priv}$$

The $R^2$ is equal to 0.81 meaning that 81% of the variation of the variables was declared by the model and the overall fit is very good. The adjusted $R^2$ was also very close to the $R^2$, indicating that sufficient variables were included in the model and the specifications were correct. The F-statistics indicated a model, which is statistically significant as a whole.

The results of the empirical analysis revealed a positive relationship between firm growth and direct exports, communication investments and investments in machinery and equipment, as well as investment in the skills of production workers and new projects undertaken. The growth of firms was, however, impeded by new competitors in the market and private-domestic ownership of a firm, confirming the benefits of multi-national investments.

The findings of this study are in line with previous studies, suggesting the same relationships of firm growth and competitiveness with communication capabilities, the presence of competition in the market, new project undertakings, which serve as a proxy for innovation, skilled workers, the role of MNEs in domestic firm growth because of their knowledge spillovers, and the acquisition

of new, modern technology and machinery.

## POLICY IMPLICATIONS AND RECOMMENDATIONS

The results of this research led to several policy implications and recommendations. It is important to formulate and adjust development strategies for different industries and a laissez-faire trade approach (with little or no government interference) regarding the import of key elements in the production process. It can be recommended that universities and other research institutions should be involved in an effort to improve innovation and competitiveness on regional level. This may result in industrial development, which is the ultimate goal of innovation policy (Motohashi et al., 2010).

It is also assumed that multi-national enterprises (MNEs) can contribute to knowledge flows from external markets and as such, there is a role for government, especially in developing countries, to be more active in the process of knowledge diffusion to particularly industries in which MNEs are scarce, as well as to support domestic firms with low levels of absorptive capacity. Therefore, also, firm characteristics, as well as knowledge and technology spillovers form MNEs and exporting firms, are important for market participation (Alvarez, 2007).

It is also important that firms themselves engage in knowledge creation efforts in order to benefit from knowledge spillovers, as their absorptive capacities will be enhanced with greater internal research and development efforts. This also necessitates sufficient human capital endowments to carry out these developments. Therefore, enhancement in terms of training and education should be encouraged by suitable policies. This will also lead to poverty alleviation, and an increase in foreign direct investment and infrastructure promotion. When engaging in joint knowledge creation efforts with other firms, an optimal ratio between prior and current knowledge attained through joint ventures should be achieved and maintained for joint ventures to be successful (Ding et al., 2010).

In essence, policies that will enhance regional development and education are crucial as they will eventually spill over to local markets and also across national borders. Trade liberalisation and investment in local markets by MNEs should also be encouraged.

## SUMMARY AND CONCLUSION

Knowledge spillovers may have important effects on firm growth and competition. It is therefore important to identify the elements that affect the transferral of knowledge between firms such as clustering. This study focused on the knowledge spillover effects and competition in the manufacturing sector on regional, national and international level occurring as a result of increased market integration with the surge of globalisation.

Different types of spillover effects exist and the most relevant type to this study was Porter spillovers, which state that a country is able to create the necessary factor endowments, like skilled labour and a strong technology base.

Previous research emphasises the importance of prior knowledge protection through patents as well as the importance of internal research and development efforts to encourage investment from MNEs, as well as FDI. The importance of an educated human capital base was also researched in this study and found to be of utmost importance for industrial development. Joint knowledge creation efforts may also be undertaken to encourage industrial development.

Using data from manufacturing firms in South Africa, this study found a significant relationship between sales figures and expenses on communication, and the number of skilled workers and innovation, while the numbers of competitors and private ownership are detrimental to sales, emphasising the role of MNEs and FDI. These findings are in line with existing literature studies.

Policies that encourage cooperation between firms as well as cooperation with research institutions should be formulated to improve industrial development. Competition policy will have to address issues that limit internal research and development efforts. The role of the government, especially in developing countries, is important to protect key industries and stimulate knowledge creation and innovation efforts, as well as to stimulate investment from MNEs.

This, however, necessitates a certain level of development, already emphasising the need for internal research and development. Education should be a primary goal to facilitate the knowledge creation and innovation process of a country.

This study revealed much about the interaction between spillovers and competitiveness, using sales as a proxy. It revealed much new information, but the determination of spillovers still remains a difficult task. Availability of data restrictions is always a problem. Further research should attempt to improve the conceptualisation and measurement of spillovers, and should also take the time factor into consideration. Investments and other aspects in the production process and management probably take some time to take effect, which cannot be indicated using cross-sectional data and regressions. Some time lag might be built into the model utilising panel data.

Overall, the important role of knowledge spillovers to encourage industrial development and competition, which occur regionally, nationally and internationally, was emphasised in this study. More research studies in this field will, however, have to be undertaken to maximise policy priorities.

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