# Investment in Technology and Export Potential of Firms in Southwest Nigeria

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# Abbreviations and acronyms

| | |
|---|---|
| CAM | Computer-Aided Manufacturing |
| CSAE | Centre for the Study of African Economies |
| EDP | Entrepreneurial Development Programme |
| FBT | Food, Beverages and Tobacco |
| FDI | Foreign Direct Investment |
| GDP | Gross Domestic Product |
| ICT | Information and Communications Technology |
| IDCs | Industrial Development Centres |
| ISI | Import Substitution Industrialization |
| LASEPA | Lagos State Environmental Protection Agency |
| LSI | Large-sized Industries |
| MSIs | Medium-sized Industries |
| MVA | Manufacturing Value Added |
| NAFDAC | National Agency for Food and Drug Administration and Control |
| NEEDS | National Economic Empowerment and Development Strategy |
| NIPC | Nigeria Investment Promotion Commission |
| NISER | Nigerian Institute of Social and Economic Research |
| R&D | Research and Development |
| RPED | Regional Programme on Enterprise Development |
| SAP | Structural Adjustment Programme |
| SMEs | Small and Medium Enterprises |
| SMIs | Small and Medium-sized Industries |
| SON | Standards Organization of Nigeria |
| SPA | Seven Point Agenda |
| TBI | Technology Business Incubator |
| TTS | Training the Trainers Scheme |
| WFYP | Working for Yourself Programme |

# Abstract

This study investigates investment in technology by firms in Southwest Nigeria, and how technology investment-related factors affect the export potential of firms. Data for the study was obtained from a survey of firms carried out between June and August 2008. The results demonstrate that investments in technology among the research sample firms are dominated by imported technologies, and investments in technology are not directly targeted at improving the export potential of firms. 84.4% of firms use either completely foreign technology equipment or equipment that are largely foreign technology. No firm uses completely locally fabricated production facility. Foreign direct investment in manufacturing is rare, and technology collaboration is largely in the form of technical support agreement and technology licensing. The application of ICT is most pronounced in customer relations management and office automation, while only 30% of the sample firms have invested in equipment/machines with computer aided manufacturing function. Only about 10% of the respondents consider improvement of export capacity a most important motive for technology investments. The results also demonstrate that firm size has a strong positive relationship with export potential, and it is the most important factor that affects the export potential of firms. The coefficient of firm size is the only parameter estimate that is consistently statistically significant at 1% level for all four export models estimated. Other technology investment-related factors that impact positively on export potential include skills intensity ratio, investment in skills upgrading, and investment in quality management.

**Key words:** *Technology, export, manufacturing industry, Nige*ria

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# 1. Introduction

The important role of technology in economic development has long been established. Investment in technology became an issue of strategic focus in economic development since the acknowledgement of the Solow residual, later described to be total factor productivity, as essentially a measure of technology input into the production process. This is celebrated in the new growth theory, which deviates from the neoclassical treatment of technology as exogenous and an upward shift in the production function. The new growth theory explains growth by treating technology as endogenous and a factor of production in its own right (Romer, 1990). The contribution of technology to macroeconomic performance explained by growth accounting is nonetheless rooted in investments in technology at the firm level (Nelson and Winter, 1982). It is the microeconomic impact of investment in technology at the firm level that translates into the improvement in the aggregate economy explained by the endogenous growth theory. Several authors have shown that the economic miracles experienced especially among the East Asian economies in the last half century tremendously benefited from policies that actively promoted firm level investments in technology (Mathews and Cho, 2000; Lall and Urata, 2003; Amsden and Chu, 2004). Investment in technology was a major tool of achieving the objectives of the strategy of export orientation as an economic policy. While most countries in sub-Saharan Africa did not go for export orientation early enough, it has now been widely accepted that export of manufactures is an important means of economic diversification and, subsequently, a major contributor to long term sustainable growth and poverty reduction. In Nigeria, the current economic reform espoused by the National Economic Empowerment and Development Strategy (NEEDS) and the Seven-Point Agenda (SPA) emphasizes the importance of growing the private sector of the economy to make it internationally competitive (NPC, 2004; FGN, 2008). The Nigerian manufacturing sector is a major part of this private sector, and to be internationally competitive, there should be a clear understanding of the current state of investment in technology that can stimulate or promote export performance of the manufacturing firms. This study, therefore, investigates the nature of firm-level investments in technology among Nigerian manufacturing firms and their links with the export potential of firms.

## Problem statement and research questions

The ability of firms to harness technological resources to stimulate and improve export performance is a major determinant of national competitiveness. However, the export performance of Nigerian manufacturing firms has been relatively poor, especially since the early 1970s when crude oil became the major source of export earnings. As

explained by Thoburn (2000) and Afangideh and Obiora (2004), the share of exports of manufactures in total export increased in the 1960s and began to decline in the 1970s (especially after the first oil shock in 1973) through to the 1990s. Though the decline has apparently been halted, it has nevertheless remained relatively low. Presently, there is no indication that the recovery process has attained significant proportions, and hence the focus of this study on export potential rather than export performance. Besides, building technological capability in the manufacturing sector has been a major development challenge in Nigeria. Nigerian firms are not known to be major producers of high technology goods. Most of the manufacturing activities have been production of consumer goods for the domestic market. The technological learning effects from the challenges posed by the competitiveness of foreign firms, whose goods often compete with local manufactures, is yet to be understood. While technology is not the only problem of the Nigerian manufacturing, it however remains an important issue not only for non-exporting firms but also for firms that have succeeded in accessing the export market. It is, therefore, important to explore the potential for export among firms, and examine how technological related factors have contributed to improving export potential.

From the foregoing, the key research questions that this study attempts to answer include: What is the nature and type of investment in technology being made by manufacturing firms in Southwest Nigeria? Are these investments linked to export initiatives of the manufacturing firm? What impact do they have on the export potentials of firms? What are the technology investment-related factors that can improve the export potential of firms? What are the constraints on investment in technology and how do firms perceive their links with export performance? What role has Nigeria's current economic policy reform played in stimulating or constraining investment in technology among manufacturing firms? How do firms perceive the impact of the regulatory activities of NAFDAC and SON on firms' potential for export?

## Research objectives

The aim of this study is to examine investments in technology by manufacturing firms in Southwest Nigeria and how technology investment related factors affect the export potential of firms. The specific objectives are to:

i) Identify the type of investments in technology being made by manufacturing firms in Southwest Nigeria;
ii) Identify the constraints on and opportunities for investments in technology as perceived by manufacturing firms;
iii) Ascertain firms' perception of the direction of influence of current economic reform on investment in technology;
iv) Examine the impact of technology investment-related factors on export potential of firms; and,
v) Make suggestions for policy that can help improve firms' capacity to carry out

technological innovations aimed at improving export potential.

## Justification of the study

There are at least three motivations for this study. First, there is a dearth of knowledge on the relationship between technology investment-related factors and export performance of African manufacturing firms. As mentioned earlier, investment in technology is an important input for internationally competitive firms. However, investigation of technological issues in African economies has been limited both from theory and empirical considerations. The notion that Africa is generally underdeveloped and constrained to be a technology user (as opposed to technology producer/innovator) remains prevalent. For Nigeria, the inability to significantly invest in technology that can radically improve firm-level productivity and product quality has retarded the structural transformation of the Nigerian economy and resulted in limited export of manufactures. Previous studies that examined Nigerian manufacturing sector and export issues have not addressed the relationship between firm-level investment in technology and export capability. For example, while Ogunkola (2002) traces the links between technological capability development by Nigerian manufacturing firms, public sector education and firm-level training activities and their productivity impacts, the study says nothing about the relationship between investment in technology and export potential of firms. Another study by Ayonrinde and Olayinka (2002) examined the impact of trade liberalization on technological acquisition at the firm level. The study focused on the impact of reform on building technological capability and not on technology investments' impact on export potential. The report of the Nigeria RPED survey (Marchart et al., 2002), and the report of the CSAE survey of Nigerian manufacturing enterprises (Soderbom and Teal, 2002) also did not give considerations to technology investment-related factors as determinants of export potential of firms. This study, therefore, attempts to contribute to bridging a critical knowledge gap on the links between investments in technology and export potential of Nigerian firms.

Secondly, if Nigerian manufacturing firms would make significant entry into the international market, it is imperative to track the nature of their current investments in technology in order to understand how economic policy can help steer the firms along a path that enables technological upgrading. There is a need to identify the factors that constrain firm-level investment in technology, and the links of these factors with the export potential of firms. This study, accordingly, seeks to provide insights that will be useful for policies that facilitate investment in the upgrading of products and production processes aimed at improving the export performance of manufacturing firms.

Thirdly, an important objective of Nigeria's current economic reform is to diversify the economy by making export of manufactures a significant source of foreign exchange, and thus reduce the dependency on crude oil as the major foreign exchange earner. In this respect, it is useful to examine the direction of influence of current economic reform on firms' investment in technology in order to fine-tune the policy implementation strategy. This study also attempts to provide some insights on this, and help further the ability of current reform to achieve the target of economic diversification and promotion of

export of manufactures.

# 2. The Nigerian manufacturing industry

## Overview of the industrialization process

According to Ekundare (1973) industrialization became a major development objective in Nigeria with the enactment of Aid to Pioneer Industries Ordinance of 1952. Thereafter, several policy initiatives and industrialization programmes have been targeted towards achieving significant structural transformation of the economy. The post-independence Nigeria adopted the import-substitution industrialization strategy (ISI). Helmsing and Kolstee (1993) observed that the Nigerian import-substituting industries were generally of a factory mass-production type, though the scale was much smaller than in Europe or North America. These industries were largely monopolist or oligopolist producers (multinational enterprises or affiliates), either under foreign or expatriate ownership, and/or with considerable expatriate technical and managerial domination. Until the mid 1980s, the Nigerian government assumed a control-oriented policy involving administrative measures, foreign exchange allocation, investment regulation, and the like; the peak of which was the "indigenization of ownership" schemes in the 1970s. These control measures were supposed to stimulate an active participation of the indigenous business community, and thereby enhance the entrepreneurship and technical capabilities of the Nigerian partners of foreign firms (Biersteker, 1987; Forrest, 1994).

Apart from the traumatic experience of the civil war between 1967 and 1970, the post-independence industrial policies nevertheless witnessed considerable economic development based on ISI. In particular, the discovery of crude oil in commercial quantities in the 1960s, and subsequently the oil boom of the early 1970s, significantly improved the economy. The cost of the apparent inefficiency of the ISI policies was paid for by the unprecedented large oil revenues. However, the crash of crude oil prices on the international market in the early 1980s, poor economic management, and the high dependence on imported inputs by the import-substituting industries combined to bring about a drastic economic downturn in the early 1980s. This had profound impact on the Nigerian manufacturing industry. The industry was highly import-dependent for manufacturing inputs. Foreign exchange to purchase machinery and equipment, and critical intermediate products became scarce, and hence there was drastic decline in capacity utilization. Attempts to revamp the economy and put it on the path of sustainable growth brought about the introduction of the World Bank/IMF-led economic structural adjustment programme (SAP) in July 1986 (Moser, Rogers and Till, 1997; Mkandawire and Soludo, 1998). As rightly observed by Ogunkola (2002), under SAP, there was an

overbearing reliance on the role of the market in "getting the price right". Government interventionist approaches were jettisoned for exchange rate and trade liberalization. Ogunkola's analysis demonstrated that the response of the manufacturing sector to the SAP reform was far below expectation. Specific case studies also revealed that many large scale public manufacturing firms failed in spite of SAP. Oyelaran et al (1997) provided illustrations of this for the fertilizer and iron and steel plants, while Adubifa (1990) presents the account of the auto industry. Understandably, the SAPs recognized that through the revitalization of the country's industries, a viable productive base that could serve as a nerve centre of the nation's economic stability and growth would be created. However, SAP did not succeed in this respect. As shown in Table 1, the period from 1960 to 1980 generally witnessed rapid industrial growth largely due to the inefficient ISI, aided by the oil economy. The decade of the 1980s was a period of industrial decline. The average growth rate for industry in the following decade (1990s) shows that the decline might have been halted, but possible improvement appears to be only marginal. To further buttress this, Ayonrinde and Olayinka (2002) also concluded from the findings of their empirical study that the impact of trade liberalization on the Nigerian manufacturing industry has been limited, and increasing the pace of reform may be helpful to stimulate industrial growth.

**Table 1: Growth rates of the Nigerian economy**

| Sector | Average annual growth rate (%) | | | | |
|---|---|---|---|---|---|
| | 1960-70 | 1970-80 | 1980-90 | 1990-99 | 2000-04 |
| Agriculture value added | -0.4 | -0.1 | 3.3 | 2.9 | 5.3 |
| Industry+ value added | 14.7 | 7.3 | -1.1 | 1.7 | 5.1 |
| Manufacturing value added | 9.1 | 5.2 | -1.0 | *n.a.* | 8.8 |
| Services VA | 2.3 | 9.6 | 3.7 | 3.1 | 6.1 |
| Total product (GDP) | 3.1 | 4.6 | 1.6 | 2.4 | 5.4 |

Source: Adeoti (2002); World Bank (2002-05), World Bank (2001-06).
+ The figure for industry includes manufacturing; *n.a.* implies not available

## Industrial policy

The focus of industrial policy in Nigeria has metamorphosed from pre-independence emphasis on cottage and craft industries, through to the import substitution strategies of the 1960s and 1970s; the reform era attempts to promote export orientation. In all stages, Nigeria has remained an open economy and effective protection has always been limited. Prior to 1980, industrial policy was subsumed in the policy thrusts and strategies for the national development plans and budget proposals. The first industrial policy was articulated by the Federal Ministry of Industry in 1980. It was subsequently revised in 1989. The policy document gave particular attention to the development of Small and Medium Enterprises (SMEs).[1] Specifically, this policy contained the following initiatives by government:

- The expansion of the industrial estates concept. The federal government was to assist the state governments with matching grants to establish industrial estates for the promotion of SMEs.

- Intensification and improvement of Entrepreneurial Development Programme (EDP), such as Working for Yourself Programme (WFYP) and Training the Trainers Scheme (TTS).
- Promotion and enhancement of Industrial Development Centres (IDCs).
- Establishment of the Nigeria Investment Promotion Commission (NIPC), whose functions include approval of technology transfer agreements (in terms of assistance in the procurement of machinery, plants, equipment and components, engineering design services, plant installation, and plant commissioning).
- Technology Business Incubator (TBI) project as institutional support for nurturing SMEs.

The latest revision of the industrial policy was done in 2003, and it was aimed at bringing the industrialization vision to be in unison with the objectives of Nigeria's current economic reform agenda. The main thrust of the industrial policy is to increase the pace of industrial development by radically increasing value-addition at every stage of the value chain. It is expected that Nigeria's resources will no longer, in the main, be traded in the primary state. Emphasis is to be placed on total factor productivity by encouraging knowledge and skills-intensive production activities. The target is to stimulate the emergence of 100% export-oriented production units in selected areas, and also encourage technological upgrading in the informal sector (FGN, 2003).

The specific objectives of the new industrial policy are to:

i) Place Nigeria among the ranks of industrially developed countries;
ii) Encourage the private sector to play a pivotal role in the industrial development of the country;
iii) Increase industrial output and linkages for both domestic and export markets;
iv) Increase value addition by creating a few niches of competitive advantage;
v) Increase capacities for entrepreneurship and technical skills in order to create more direct and indirect employment opportunities;
vi) Increase competitiveness of Nigerian manufactures;
vii) Facilitate inflow of foreign capital and technologies; and,
viii) Encourage geographical dispersal of industries.

## Export promotion and structural change

Table 2 shows the key performance indicators of the Nigerian economy in a historical perspective. 1960 was the year of political independence, 1966 was the year of first military adventure into political governance, 1970 was the end of a civil war, 1979 was the beginning of the second attempt at democratic governance, 1986 was the year of the introduction of the World Bank/IMF economic structural adjustment programmes, and 1999 was the beginning of the current democratic rule. The period from 1960 to 1979 generally witnessed rapid industrial growth largely due to the inefficient ISI, aided by the oil economy. As shown in Table 2, the growth rate of manufacturing value added soared in the 1960s and 1970s. The decade of the 1980s was a period of industrial decline. The manufacturing value added growth, which was 46.9% in 1979 declined to -3.9% in 1986 indicative of de-industrialization phenomenon, which was widespread in sub-Saharan

Africa (Jalilian, Tribe and Weiss, 2000). The following decade - the 1990s - shows that the decline might have been halted, but possible improvement appears to be only marginal. By 1999, growth rate of the manufacturing value added had improved to 2.1%. It is also important to point out that structural transformation of the economy remains a major challenge. The manufacturing sector is relatively small and, as indicated in Table 2, its contribution to GDP declined from 4.9% in 1999 to only 4% in 2003. Besides, NPC (2007) reported that there has been no significant improvement in the share of manufacturing in GDP in recent years.

**Table 2: Nigeria key economic performance indicators**

| Key economic performance indicator | 1960 | 1966 | 1970 | 1979 | 1986 | 1999 | 2006 |
|---|---|---|---|---|---|---|---|
| GDP in current US$ (billion) | 4.20 | 6.37 | 12.55 | 47.26 | 20.21 | 34.78 | 115.34 |
| GDP growth rate (annual %) | n.a | -4.3 | 25.0 | 6.8 | 2.5 | 1.1 | 5.2 |
| GDP per capita in constant 2000 US$ | 314 | 326 | 382 | 454 | 342 | 380 | 440 |
| Share of manufactures in total merchandise exports (%) | n.a | 1.27 | 0.72 | 0.46 | 0.02 | 0.60 | 2.07* |
| Share of manufactures in total merchandise imports (%) | n.a | 83.0 | 83.1 | 77.4 | 79.6 | 66.6 | 66.3* |
| Manufacturing, value added (% of GDP) | 3.81 | 5.3 | 3.7 | 8.8 | 8.7 | 4.9 | 4.0* |
| Manufacturing, value added (annual % growth) | n.a | 70.6 | 27.9 | 46.9 | -3.9 | 2.1 | 6.2* |
| Agriculture, value added (% of GDP) | 63.9 | 54.9 | 41.3 | 28.7 | 38.7 | 36.6 | 23.4** |
| Agriculture, value added (annual % growth) | n.a | -7.0 | 17.5 | -3.0 | 9.2 | 5.2 | 8.2** |
| Services, value added (% of GDP) | 28.5 | 32.7 | 45.0 | 33.5 | 35.3 | 28.2 | 19.9 |
| Services, value added (annual % growth) | n.a. | -4.6 | 20.8 | 2.4 | 7.3 | 0.7 | 8.0 |

Data source: World Bank (2008), World Development Indicators, CD ROM
*data is for 2003; ** data is for 2005

The export performance of Nigerian firms has been relatively low especially since the early 1970s when crude oil became the major source of export earnings. As explained by Thoburn (2000) and Afangideh and Obiora (2004), the share of export of manufactures in total export increased in the 1960s, and began to decline in the 1970s (especially after the first oil shock in 1973) through the 1990s. Though the decline has apparently been halted, it has nevertheless remained relatively low. Presently, there is no indication that the recovery process has actually attained significant proportions. Moreover, the manufacturing sector in Nigeria still depends heavily on imports of machinery/equipment, indicative of the relatively underdeveloped state of the engineering sub-sector. Critical raw materials are also largely sourced through imports. Table 2 shows that while the share of manufactures in total merchandise imports is very high (66% in 2003), the share of manufactures in total merchandise exports is very low (2% in 2003) but much lower in previous years. Thus, the manufacturing sector apparently lacks international competitiveness.

# 3. Technology and export potential of firms: A conceptual framework

It is well known that the conventional theory of comparative advantage was originated during an era when international trade was largely separate from industrial production and undertaken by merchant organizations that operated independently from the actual producers. Most of the goods traded were primary commodities and semi-manufactured goods, and international specialization clearly reflected the factor endowments of the countries concerned. The structure of the international economy then afforded the relative factor cost approach to international trade a substantial degree of explanatory power (Soedersten and Reed, 1994; Wangwe, 1995). However, the unprecedented growth in productivity increases in the second half of the last century, and the tremendous economic progress made in some developing countries, especially in East Asia, have not only altered the pattern and structure of international trade but also introduced new elements into factors that determine global competition. From the accounts of Porter (1990) in his famous treatise on competitive advantage of nations, some of these new elements include the emergence of large scale transnational corporations that engage in foreign direct investment in diverse productive endeavours, breakthroughs in technologies that have facilitated great improvements in transport and communication infrastructure, and increased application of scientific principles and new technologies to manufacturing processes. International trade, both in terms of value and tonnage, has experienced a growing trend in the global economy. With increasing trade, many countries (both developed and developing) have realized the neo-liberal expectations (gains of trade) of increased competition, economies of scale, specialization, lower prices, and interdependencies.

The gains of trade are largely realized through firms' active participation in the global economy. The instrument of this participation is exports. Export of manufactures has particularly been an instrument of rapid structural change in the newly industrializing economies where firms have gained considerable potential in exporting. Several factors can determine a firm's potential for export. Lall (2001) argues for a theoretical link between investment in technology and export performance in his analysis of the role of technology in international competitiveness. However, empirical findings on the relationship between export performance and investment in technology have been mixed. While Cotsomitis, DeBresson and Kwan (1991) and Kumar (1990) indicated that the technology variable has no role to play in export performance, more recent studies (e.g. Kumar and Siddharthan, 1994; Basile, 2001) have demonstrated that the technology variable measured in terms of research and development (R&D) expenditure is an important determinant of export performance. The earlier studies measured technology in terms of technology stock (Cotsomitis, DeBresson and Kwan, 1991) and R&D intensity

(Kumar, 1990). In a study of e-business and export performance of small and medium-sized industries (SMIs) in India, Lal (2002) also reported that the adoption of e-business technologies is an important factor in explaining the export performance of Indian SMIs. It thus appears from more recent empirical findings that technology investment-related factors are important in explaining export performance of firms. We accordingly propose in this study that export performance derives its substance from the export potential or capability of the firm, and hence factors that explain export performance will, a priori, provide explanation for the level of export potential. We therefore hypothesize that technology investment-related factors would provide substantial explanation for export potential of firms. As demonstrated by Wakelin (1998) and Soderbom and Teal (2002), other factors determining export may be largely captured by firm size. Drawing on the foregoing and other previous theoretical and empirical evidence on the links between investments in technology, export performance and industrial competitiveness, the following specific hypotheses are proposed for the study:

**i) Investment in technology hardware**

This variable represents firms' implementation of a programme of re-engineering that brings in new production equipment/machines or re-engineering that improves the existing production equipment/machines. We have assigned only a discrete measure (1 for investing; 0 for not investing) to this variable because it is difficult to ascertain the impact of the level of investment in technology hardware on the potential for export. Many Nigerian firms (especially SMIs) use secondhand machines/equipment due to capital constraints, and some even use production equipment that are obsolete (NISER, 2004). It is assumed that an immediate challenge that faces firms that have an interest in exporting would be the necessity to embark on a re-engineering programme that would replace obsolete or inefficient machines/equipment, to improve production performance. Even if the rationale for reengineering is not to embark on export drive, the action would improve the chances of making an export drive. For this study, we hypothesize that investing in technology hardware would have a positive impact on a firm's potential for export.

**ii) Technological collaboration with foreign firm(s)**

Lal (2002) observed that technological collaboration between local and foreign firms can have a positive impact on export performance of firms. Technological collaboration in this respect can be in the form of foreign direct investment in a subsidiary of a multinational firm or technology licensing, technical agreements, trademarks, etc. Following Lal (2002), we propose a binary variable for technological collaboration, and hypothesize that this variable will positively affect the firms' potential for export.

**iii) Skills intensity ratio**

Skills intensity ratio has been defined as the ratio of professional staff employed by a firm to the total workforce (Adeoti, 2001; Lal, 2002). Professional staff in this context include members of the workforce with degrees or higher diploma in scientific,

engineering and management skills required for efficient production activities. Skills intensity ratio is a modest indicator of human capital level. Theoretical models presented by Lucas Jr (1988) demonstrated that export performance can be driven by human capital. Though Kumar and Siddharthan (1994) did not find any impact of skill on exports in several industries in India, they found that skill was an important factor in the export performance of food processing and transport equipment sub-sectors. Moreover, several other studies (e.g. Lal, 1996; Bernard and Wagner, 2001) indicated that firms with high skills intensity are more likely to export. Based on these theoretical and empirical considerations, we hypothesize that skills intensity ratio will have a positive impact on a firm's potential for export.

**iv) Investment in skills upgrading**

For the purpose of this study, we conceive investment in skills upgrading to entail investment in training activities that enable better and efficient operation of machines and equipment. However, skills upgrading is generally reckoned as the outcome of learning mechanisms that enable firms to improve their technological capability endowment. Learning mechanisms include in-house and external training programmes; learning-by-doing; strong networking between various units of the firm; and strong linkages with local suppliers, clients, other firms, industry networks, research institutes, governments, universities, financial institutions, and local or foreign consultants (Biggs et al., 1995). Among all these factors, investment in training is easier to capture in a developing country firm, and hence we adopt it as a proxy for skills upgrading. Skills upgrading fosters cross-fertilization of knowledge, and thus enhances technological innovation. Besides, as earlier mentioned, several other studies (e.g. Lal, 1996; Bernard and Wagner, 2001) indicated that firms with high skills are more likely to export. We therefore hypothesize that investment in skills upgrading will be positively related to a firms' potential for export.

**v) Investment in quality management**

Product quality is an important determinant of access to the export market (Lall, 2001). In the West African sub-region, dumping of manufactured products from Asia has been a major problem. Improving the quality of Nigerian manufactured goods is thus a major challenge that is being tackled by firms not only to satisfy local demand, but also to succeed in export to neighbouring countries. For this study, we hypothesize that investment in quality management will have a positive impact on potential for export.

**vi) Investment in ICT (e-business facilities)**

Investment in ICT is an important factor that has enabled the competitiveness of many successful economies in recent decades. However, while Nigerian firms still lag behind in the use of ICT in the production process, they are beginning to use ICT for operations management and other e-business activities (Adeoti, 2005). Lal (2002) defines e-business to encompass the application of ICT in all business processes such as office automation, production processes, coordination with other

plants, customer relations management, supply chain management, and management of distribution networks. This study adopts this definition of e-business, and will examine the influence of investment in ICTs that enable e-business activities on a firm's potential for export. Following Lal (2002), we consider a discrete measure for investment in ICT, and identify three categories of ICT that can enable e-business. These are offline, online, and portal-based technologies. The first is the electronic messaging system (e-mail). This is relatively less effective than other e-business tools. The second is online website-enabled transactions. The company's website must be dynamic and should have online transaction facilities such as Active Server Pages (ASPs) that allow online transactions. The third is portal-based and is the most effective way of carrying out e-business. In addition to hyperlinks to other URLs, portals fulfil an important role of aggregating contents, services and information on the net. For example, the portal of a company can search, extract, and display information about a particular product from a large product profile. We hypothesize that the presence of one or more of the e-business facilities will increase a firm's export potential.

**vii) Firm size**

There is ample evidence that firm size is an important determinant of the ability to venture into the international market. Krugman (1979) demonstrated that a larger size of operation provides greater risk-bearing capacity, brand names, and price setting power. Several studies (e.g. Kumar and Siddharthan, 1994; Haddad, deMelo and Horton, 1996; Kumar and Saqib, 1996; Wakelin, 1997; 1998) have found a positive relationship between firm size and export capability. Wakelin (1998) showed that large innovative firms are likely to export, and the more innovations they have had, the higher the probability that they will enter the export market. Aggrey and Richard (2007) demonstrated that firm size is a determinant of export propensity among Ugandan manufacturing firms. The result of the Nigerian manufacturing enterprise survey by Soderbom and Teal (2002) also indicated that decision to export is strongly related to firm size. We therefore accordingly hypothesize that firm size will have a positive relationship with potential for export.

**viii) Other factors**

There are other factors that can act as instrument variables that affect the export potential of firms. As indicated by Soderbom and Teal (2002), such factors may include age of firm, age in exporting, destination of exporting (whether to the regional economic bloc or outside) and ownership structure of the firm.

# 4. Research methodology

## Scope of the study

It would have been good to make the sectoral coverage of this study identical to those of two important previous surveys of Nigerian firms by the Regional Programme on Enterprise Development-RPED (reported by Marchart et al., 2002) and Centre for the Study of African Economies-CSAE (reported by Sonderbom and Teal, 2002). This would have provided an opportunity to enrich the RPED and CSAE data and thus increase the analytical possibilities of the study. However, the RPED survey was carried out in March/April 2001 while the CSAE survey was done in July/August 2001. Locating the firms in these surveys would be extremely difficult, and there would be a problem of information recall by respondents interviewed more than eight years ago. We therefore surveyed the Nigerian manufacturing sub-sectors where exports are more highly represented. Table 3 presents the quantities and value of Nigeria's manufactures exports in 2003. The manufacturing sub-sectors in Table 3 include six of the eight sub-sectors covered by the RPED and the CSAE surveys. These six sub-sectors are food and beverages; chemicals and pharmaceuticals; paper/printing/publishing; plastics and rubber products; textiles and garments; and furniture and wood products.[2] A careful examination of the data in Table 3 shows that these six sub-sectors are well represented in the manufactures exports. It is also instructive that 27 out of the top 50 companies listed by the Central Bank of Nigeria as having made non-oil exports in 2006 (see CBN, 2007) were manufacturing firms in these six sub-sectors. We therefore select these six sub-sectors for the study.

**Table 3: Nigeria's manufactured exports, 2003**

| No. | Commodity | Net weight (kg) | Value (FOB) (₦ '000) | % of total value |
|---|---|---|---|---|
| 1. | Vegetable products | 5,512,353 | 200,873 | 2.9 |
| 2. | Animal and vegetable fats and oil | 4,600,090 | 201,615 | 2.9 |
| 3. | Prepared foodstuff; beverages, spirits and vinegar; tobacco | 8,322,257 | 393,655 | 5.7 |
| 4. | Products of the chemical and allied industries (paints, pharmaceuticals, soap and detergents, cosmetics, etc) | 1,338,714 | 1,110,656 | 16.2 |
| 5. | Plastic, rubber and articles thereof | 6,998,289 | 2,725,067 | 39.8 |
| 6. | Goat or kid skin leather, prepared after tanning | 9,271 | 54,075 | 0.8 |

*continued next page*

**Table 3 Continued**

| No. | Commodity | Net weight (kg) | Value (FOB) (₦ '000) | % of total value |
|---|---|---|---|---|
| 7. | Paper making materials, paper and paper board articles | 2,181,695 | 100,422 | 1.5 |
| 8. | Textiles and textile articles (yarn and fabrics, wearing apparel/garments, etc) | 931,684 | 1,338,154 | 19.5 |
| 9. | Footwear, headgear, umbrellas, sunshades, whips, etc | 2,600,826 | 407,201 | 5.9 |
| 10. | Articles of stone, plaster, cement, asbestos, mica, ceramic | 1,521,053 | 81,922 | 1.2 |
| 11. | Miscellaneous manufactured articles (furniture, mattress, mattress support, cushion, etc) | 176,334 | 239,200 | 3.5 |
| Total | | 34,192,566 | 6,852,840 | 100.0 |

Source: NBS (2003)

## Sampling, data collection and sources

For this study, the data gathering procedure included a survey of firms using the instrument of a semi-structured questionnaire. The availability of secondary data on Nigerian industry is poor and relatively unreliable (Mosley, 1992; Thoburn, 2000; Soderbom and Teal, 2002). Thus, it was difficult to plan a stratified sampling for the research sample. We, however, obtained the sampling frame of the RPED survey from the report by Marchart et al. (2002:15). This sampling frame presented in Table 4 for our study sub-sectors shows the distribution of firms in the RPED sample frame according to size, defined by number of persons employed. Following the pattern of the RPED sample, we selected our research sample to include firms employing 20 or more persons. This generally excludes the micro enterprises that dominate the informal sector economy. This is suitable for our study because export barrier to micro enterprises in developing countries is high. The vast majority of micro enterprises produce to satisfy local demands, and they often lack technical capacity to manufacture products that can meet export standards (Helmsing and Kolstee, 1993).

With the RPED sample frame in Table 4 as a guide for each sub-sector, firm selection was done in such a way as to include different scales of operation to ensure heterogeneity among the sampled firms as well as to allow for analysis across scales of operation. Based on available secondary information in the list of establishments obtained from the state offices of the National Bureau of Statistics (NBS), efforts were also made to obtain a fair geographical spread of firms, and to minimize bias in firm size distribution. Thus, with the NBS list of establishments as the starting point, and guided by the distribution of firms by size and sub-sectors in the RPED sampling frame, a sample of 200 firms was selected for the study. Location of firms selected for the study was done with the aid of the NBS list of manufacturing establishments.

A semi-structured questionnaire aimed at addressing the research questions was designed for the study. The pre-test of the questionnaire was carried out in May 2008. The responses were considerably good and only minor refinement was necessary before the full survey, which was carried out in June, July and August 2008. The final revised questionnaire used for the survey is presented in the appendix.

**Table 4: Distribution of firms in the RPED sample frame by size and sub-sector**

| Sub-sector | Number of firms employing | | | Total | Percent |
|---|---|---|---|---|---|
| | 20-49 persons | 50-199 persons | 200 or more persons | | (%) |
| Food and beverages | 218 | 100 | 80 | 398 | 27 |
| Chemicals and pharmaceuticals | 99 | 70 | 28 | 197 | 13 |
| Paper/printing/publishing | 94 | 53 | 18 | 165 | 11 |
| Plastics and rubber products | 80 | 59 | 27 | 166 | 11 |
| Textiles and garments (including leather works) | 236 | 70 | 46 | 352 | 24 |
| Furniture and wood products | 166 | 33 | 12 | 211 | 14 |
| Total | 893 | 385 | 211 | 1489 | 100 |

Source: Extracted from the RPED sampling frame as reported by Marchart et al. (2002:15)

With respect to the geographical distribution of the research sample, it is pertinent to note that manufacturing firms in Nigeria are essentially in three large clusters. These are: the Lagos-Otta-Agbara-Ibadan industrial axis; Nnewi-Aba-Port Harcourt industrial axis; and Kano-Kaduna-Jos industrial axis. These clusters are geographically widely dispersed. However, it is generally acknowledged that most Nigerian manufacturing enterprises are located in Southwest Nigeria, which essentially includes the Lagos-Otta-Agbara-Ibadan industrial axis. Some estimates claim that Lagos State alone has 60%-70% of Nigeria's manufacturing enterprises (Lubeck, 1992:17; LASEPA, 1999). The fieldwork was accordingly restricted to cover only firms located in Southwest Nigeria. Besides making the data collection activities less cumbersome, this enhanced the chances of collecting good quality data, since the research sample was drawn from firms less widely dispersed. The research questionnaires were delivered to the firms by trained enumerators, who also personally retrieved them.

The target respondents were plant managers or operations managers assisted by personnel managers or heads of accounting departments. The respondents were particularly requested to provide information on the nature and type of investments in technology made by the firm in 2006/2007, the rationale for these investments, and whether the firms exported. For exporting firms, information on the quantities and destination of exports were requested. The respondents were also asked to provide information on their perception of the constraints on and opportunities for investment in technology. Respondents were also requested to indicate their perception of the influence of the current economic policy reform in stimulating or constraining investment in technology among Nigerian manufacturing firms, and how firms perceive the impact of the regulatory activities of NAFDAC and SON on firms' export performance.

## Data analysis and the empirical model

The analyses that address objectives (i), (ii) and (iii) of the study are largely descriptive based on the survey data. The logistic regression analyses are applied to address objective (iv). Entry into the export market is not automatic. The challenge of local and international competition has made deliberate effort in building capacity for exporting an important objective of firms. As capacity for exporting is improved, the potential

for exporting increases. Accordingly, the firm's probability of exporting also increases, given that the export market is unsaturated. In this study, we therefore reckon that the export potential of a firm mirrors its probability of exporting. This approach enables us to apply the logistic regression analysis to investigate the links between technology investment-related factors and export potential of firms.

## *Logistic regression*

Following Soderbom and Teal (2000), we specify the logit model as the export model for the study. Drawing on Maddala (1983, 1992), exporting by a firm could be defined by the *log-odds*[3] of the logit model as:

$$log\ \frac{P}{1-P} = b_o + \sum_{j=1}^{k} b_k X_j \qquad (1)^4$$

where,

$P$ is the probability of exporting given the vector (1 x $j$ matrix) of factors determining exporting, $X_j$ ;

The factors determining exporting are listed as explanatory variables in Table 5;

$b_o$, $b_k$ are the parameters to be estimated.

The logit regression framework represented by Equation 1 can be estimated to give the estimated parameters as the change in the log-odds that can be attributed to unit change in an independent variable. However, such estimation results may be relatively difficult to explain because the log-odds is itself an endogenous variable. To get round this problem, using matrix notations, Equation 1 can be rewritten as shown in Equation 2, and then transformed to give the probability of exporting as a non-linear function of $X_j$ shown as Equation 3.

$$log\ \frac{P}{1-P} = b' X_j \qquad (2)$$

where:

$b'$ is the transpose of the matrix of parameters to be estimated.

Thus,

$$P = \frac{\exp(b'X_j)}{1+\exp(b'X_j)} = \frac{1}{1+\exp(-b'X_j)} \quad (3)$$

Using the maximum likelihood estimator, the estimation of the parameters in the logit model (Equation 2) can therefore be carried out, and the conditional probability of exporting $P$, given the vector of independent variables $X_j$, can be obtained.

**Table 5: Explanatory variables and their measures**

| Variable name | Variable description | Measure |
|---|---|---|
| Ebuz | Investment in ICT (e-business facilities) | 1 = invest<br>0 = not invest |
| SIR | Skills intensity ratio | Ratio of the no. of scientists and engineers to total workforce |
| ISU | Investment in skills upgrading | Investment in skills as proportion of sales turnover |
| HDW | Investment in technology hardware | 1 = invest<br>0 = not invest |
| TCF | Technological collaboration with foreign firm(s) | 1 = collaboration<br>0 = no collaboration |
| IQM | Investment in quality management | Investment in quality management as proportion of sales turnover |
| FZ | Firm size | No. of persons employed |
| AGE | Age of firm | Years |
| AGEX | Age in exporting | Years |
| DET | Destination of exporting | 0 = west Africa, 1 = elsewhere |
| OWS | Ownership structure | Percent local equity |

# 5. Empirical results

# Investments in technology

## *The research sample*

As indicated in Section 4, 200 questionnaires were administered to firms across the size distribution, with the RPED sample frame as a guide. At the end of the survey, 109 questionnaires were retrieved. Thirteen of the retrieved questionnaires were not usable due to incomplete information or inadequate responses.[5] This resulted in a research sample of 96 firms distributed across the sub-sectors and firm sizes as shown in Table 6. The mean firm size of the research sample according to number of persons employed is 205, median is 115, minimum is 20 and maximum is 1,502. Following the examples of the RPED survey and previous studies by Lall et al (1994) and Adeoti (2001), we define firms employing 20-49 persons as small-sized, 50-199 persons as medium-sized, and 200 or more persons as large-sized. The research sample is almost evenly spread across the firm sizes, with 30.2% in the small-sized industry (SSI) category, 37.5% in the medium-sized industry (MSI) category, and 32.3% in the large-sized industry (LSI) category. The food, beverages and tobacco (FBT) sub-sector dominates the sample with 31.3% of the sample size.

**Table 6: Distribution of the research sample firms according to size**

| Sub-sector | Number of firms employing | | | Total |
|---|---|---|---|---|
| | 20-49 persons | 50-199 persons | 200 or more persons | |
| Food, beverages and tobacco | 7 | 10 | 13 | 30 (31.3%) |
| Chemicals and pharmaceuticals | 3 | 5 | 7 | 15 (15.6%) |
| Paper/printing/publishing | 4 | 5 | 2 | 11 (11.5%) |
| Plastics and rubber products | 4 | 8 | 6 | 18 (18.8%) |
| Textiles and garments | 5 | 3 | 2 | 10 (10.5%) |
| Furniture and wood products | 6 | 5 | 1 | 12 (12.5%) |
| Total | 29 (30.2%) | 36 (37.5%) | 31 (32.3%) | 96 (100.0%) |

Source: Analysis of survey data

This is expected because FBT firms are known to be relatively more numerous, and contribute more than 25% of the manufacturing value-added (MVA) in most countries of sub-Saharan Africa (UNIDO, 1997). The distribution of other sub-sectors is fairly consistent with the RPED sample frame. About 18.8% of the sample firms are in the plastics and rubber products, 15.6% are in the chemicals and pharmaceuticals, 12.5% are in furniture and wood products, 11.5% are in paper/printing and publishing, and 10.5% are in textiles and garments.

## Type of investments in technology

The composition and origin of the main production machinery/equipment used by the firms revealed that 84.4% of the firms use either completely foreign technology equipment or equipment that are largely foreign technology; no firm uses completely locally fabricated production facility; while only 15.6% of the firms use equipment that are largely locally fabricated equipment. The foreign components of the equipment are imported mostly from Europe, and to some extent also from Asia. These results are indication that Nigerian manufacturing is still dominated by the use of imported technology adapted to local conditions. This confirms the notion that the Nigerian engineering sub-sector, which could fabricate manufacturing facilities, is highly constrained and remains weak.

The mean age of the main production equipment is 8.65 years, median 7 years, mode 10 years, minimum one year, and maximum 30 years. The relatively low mean and median ages suggest that most of the respondent firms carried out substantial re-engineering involving replacement or refurbishing of the main production equipment in recent years, arguably within the past 10 years. Actually, within the past three years, 51.7% of the firms claimed to have made significant changes in the production process; 57.6% have introduced new machinery/equipment, and 29.3% claimed to have added refurbished or secondhand machines to the production system. Compared with the results of the RPED survey as reported by Marchart et al. (2002), investment in equipment is less widespread among the research sample. Almost 80% of the firms in the RPED sample did invest in equipment in the three years prior to the survey, and in 2000 alone, 56% of the firms invested in new equipment. This may be an indication that firms' capability to invest in technology in the past three years is less than in the period 1998-2000, which was covered by the RPED survey.

Moreover, 42.6% of the firms claimed to be involved in technology collaboration (with foreign firms) that could improve the physical capital stock. About 37.7% of the firms mentioned the type of collaboration as mainly technical support agreement, 22.5% claimed technology licensing, 12.5% trademark licensing, and only 2.5% mentioned foreign direct investment (FDI). The type of collaboration is thus largely in the form of technical support agreement and technology licensing.

The type of ICT hardware investment by the respondent firms in the past three years is shown in Table 7. Almost all the firms have made substantial investment in computers in the past three years. About one-third (33.7%) have made investment in electronic inventory monitoring units, 30% have invested in computer-aided manufacturing (CAM), 29.3% have invested in electronic sensors, while 25% have invested in digital cameras. In effect, each of the respondent firms has invested in information and communications technology (ICT) hardware in the past three years. Table 8 presents the type and perception of the importance of ICT application by the respondent firms. The application of ICT is most pronounced in production processes (68.1%), customer relations management (65.9%), and office automation (59.3%). About 47% of the firms used ICTs for managing product distribution networks, 45% deploy ICT for supply chain management, while only 30% of the firms use ICT for coordinating with other plants. The use of ICT in coordinating with other plants is relatively low, apparently because only the affiliates

of multinational enterprises may require coordination with other plants. Virtually all the local firms in the research sample are single-plant manufacturing firms. It was also observed that 32.4% of the firms claimed ICT application in production processes the most important, 31.0% claimed ICT application in office automation most important, while 14.1% of respondents consider ICT application in customer relations management most important. Management of distribution networks, coordination with other plants, and supply chain management are considered most important areas of ICT application by only 12.7%, 7.0% and 2.8% of the respondents, respectively. It thus appears that production processes and office automation are perceived as most important areas of ICT application by firms in the research sample. This may be an indication that firms are more conscious of the need to apply ICT in activities that have direct impact on the improvement of firm's in-house activities. Using ICT in managing supply chain and distribution networks, and in coordinating with other plants, are not perceived as most important by firms possibly because of the relatively poor ICT infrastructure in Nigeria. As the ICT infrastructure improves, firms may have better appreciation of ICT applications in these areas.

**Table 7: Type of ICT hardware investment in the past three years**

| Type ICT hardware | Per cent of respondents* |
|---|---|
| Computers | 95.7 |
| Electronic inventory monitoring units | 33.7 |
| Computer-aided manufacturing | 30.0 |
| Electronic sensors | 29.3 |
| Digital cameras | 25.0 |

Source: Analysis of survey data
*Sum of column is more than 100% because of multiple responses

**Table 8: Application of information and communications technology**

| Type of ICT application | Per cent of respondents | Per cent of respondents that consider ICT application most important |
|---|---|---|
| Office automation | 59.3 | 31.0 |
| Production processes | 68.1 | 32.4 |
| Coordination with other plants | 30.8 | 7.0 |
| Customer relations management | 65.9 | 14.1 |
| Supply chain management | 45.1 | 2.8 |
| Management of distribution networks | 46.7 | 12.7 |
| Total | | 100.0 |

Source: Analysis of survey data

The findings also revealed that though all the firms have access to electronic messaging system (e-mail), 68.8% claimed to use e-mail for business transactions. About 45.5% claimed to have used online website-enabled transaction, while only 9.1% claimed to have engaged in online portal-based transaction. Moreover, 88.7% of the respondents mentioned e-mail as the most important e-business facility for its transactions, 11.3% mentioned online website-enabled transaction as most important e-business, and none of the firms mentioned online portal-based transactions as most important e-business. These

results suggest that the level of sophistication of the use of ICT in business transactions among the sample firms is relatively low. Most of the firms are yet to tap into the opportunities presented by online website-enabled and portal-based e-business facilities. The reason for this could be due to the relatively generally poor information technology infrastructure in Nigeria, and inadequate policy incentives for firms' investment in ICT.

Table 9 presents the motives for technology acquisition as perceived by the respondents. More than half of the respondents claimed "improvement in product quality", "improvement of existing production process", and "introduction of new product" as the motive for technology acquisition. About half (49.5%) of the respondents mentioned introduction of a new production process as the motive for technology acquisition. The rating according to "most important" motive follow a similar pattern except that "to improve export capacity" is at the fourth position while "introduction of a new production process" is fifth. For the rating according to "2nd most important" motive, "improvement of existing production process" is first. In the context of this study, these results suggest that the primary motives for firms' investment in technology are to improve products and production processes without a deliberate target of exporting. Only about 10% of the respondents consider improvement of export capacity as the most important motive for technology acquisition.

**Table 9: Motives for technology acquisition by firm in the past three years**

| Motive for technology acquisition | % of respondents that consider motive | | |
|---|---|---|---|
| | Important | Most important | 2nd most important |
| Improvement of product quality | 82.4 | 39.8 | 19.3 |
| Introduction of a new product | 53.8 | 15.9 | 16.9 |
| Improvement of existing production process | 74.7 | 22.7 | 32.5 |
| Introduction of a new production process | 49.5 | 6.8 | 18.1 |
| To improve export capacity | 17.6 | 10.2 | 3.6 |
| Response to government policy incentives to renew industrial facilities | 12.2 | 2.3 | 1.2 |
| Emission reduction to enable compliance with environmental regulation | 12.1 | 2.3 | 0.0 |
| To adhere to parent company's production standards | 14.3 | 0.0 | 8.4 |
| Total | | 100.0 | 100.0 |

Source: Analysis of survey data

## Human capital outlay

The distribution of the educational qualification of workers in the respondent firms is presented in Table 10. About 43.4% of the workers have higher educational qualification, 45.4% have secondary school education, while 11.2% have only primary school education. The food, beverages and tobacco (FBT) sub-sector has the highest proportion of workers with higher education and the least proportion of workers with only primary education. This is an indication of better skills content of production activities in the FBT sub-sector compared with the other sub-sectors. The chemicals and pharmaceuticals and the furniture and wood products sub-sectors also have relatively high concentration of

workers with higher education. While the case of chemicals and pharmaceuticals could be explained by the requirement of high skills, especially in drug manufacturing, the relatively higher education of workers in the furniture and wood products may be due to increasing emphasis for graduates to adopt vocational skills that enable self-employment. Actually, there have been widespread complaints that Nigerian graduates lack skills required by industry, while graduates complain of lack of job opportunities (see Dabalen, Oni and Adekola, 2001). However, as reported by Adeoti, Odekunle and Adeyinka (2009), in recent years there has been emphasis on entrepreneurship development as an important component of education in Nigerian tertiary institutions. This may be partly responsible for the observed employment of people with higher education in the seemingly less capital intensive furniture and wood products sub-sector that may provide relatively less difficult opportunity for new start-ups or self-employment. The relatively higher levels of secondary education in the three other sub-sectors (paper/printing/publishing; plastics and rubber products; textiles and garments) may be an indication that these sub-sectors have relatively less sophisticated skills requirements. Textiles and garments manufacturing is particularly known to be labour intensive, and characterized by the use of large manpower with low-level education (Mytelka, 1985; UNEP, 1993).

**Table 10: Distribution of educational level of workers in the sample firms**

| Sub-sector | Mean percentage of workers with | | | Total |
|---|---|---|---|---|
| | Primary education | Secondary education | Higher education | |
| Food, beverages and tobacco | 6.0 | 46.0 | 48.0 | 100.0 |
| Chemicals and pharmaceuticals | 14.9 | 40.0 | 45.1 | 100.0 |
| Paper/printing/publishing | 11.9 | 53.7 | 34.4 | 100.0 |
| Plastics and rubber products | 12.1 | 52.4 | 35.5 | 100.0 |
| Textiles and garments | 11.5 | 52.0 | 36.5 | 100.0 |
| Furniture and wood products | 20.0 | 33.5 | 46.5 | 100.0 |
| All sub-sectors | 11.2 | 45.4 | 43.4 | 100.0 |

Source: Analysis of survey data

An analysis of the quality of the human capital as indicated by skill intensity ratio, which is calculated as the proportion of the number of scientists and engineers in the total workforce, is presented in Table 11. For the pooled sample, the mean skill intensity is 0.18, median 0.14, mode 0.10, minimum 0.01, and maximum 0.54. The highest skill intensity (0.54) is found in the chemicals and pharmaceutical sub-sector, while the lowest (0.01) is found in the plastics and rubber products sub-sector. The highest mean skill intensity (0.26) is in the chemicals and pharmaceuticals, followed by 0.22 in the food, beverages and tobacco (FBT); while the lowest mean (0.10) is found in the paper/printing/publishing, followed by a mean of 0.12 in the plastics and rubber products sub-sector. It thus appears that the chemicals and pharmaceuticals and the FBT are the most skill intensive of the sub-sectors, while the plastics and rubber products is the least skill intensive.

**Table 11: Skill intensity according to sub-sector**

| Sub-sector | Skill intensity ratio | | | | |
|---|---|---|---|---|---|
| | Mean | Median | Mode | Mini-mum | Maxi-mum |
| Food, beverages and tobacco | 0.22 | 0.20 | 0.20 | 0.03 | 0.41 |
| Chemicals and pharmaceuticals | 0.26 | 0.20 | 0.05 | 0.05 | 0.54 |
| Paper/printing/publishing | 0.10 | 0.09 | 0.02 | 0.02 | 0.18 |
| Plastics and rubber products | 0.12 | 0.11 | 0.10 | 0.01 | 0.51 |
| Textiles and garments | 0.16 | 0.09 | 0.02 | 0.02 | 0.46 |
| Furniture and wood products | 0.19 | 0.17 | 0.16 | 0.03 | 0.48 |
| All sub-sectors | 0.18 | 0.14 | 0.10 | 0.01 | 0.54 |

Source: Analysis of survey data

## Constraints on and opportunities for technology investments

Table 12 presents the respondent firms' perception of factors that have discouraged or limited firms' investment in technology. These factors are apparent constraints on firms' capability to invest in technology. Most notable among these factors are high cost of technology, poor industrial policy and poor export promotion incentives, which are considered by 76.9%, 75.6% and 45.1% of the respondents, respectively, as factors that have constrained investment in technology. The rating of the factors that discourage technology investments also revealed that these three factors are the most important deterrent to firms' technology investments. For example, 38.4% of the respondents claimed high cost of technology as the most important factor that discouraged technology investments, 25.9% claimed poor industrial policy, while 12.3% mentioned poor export promotion incentives.

**Table 12: Perception of factors that discouraged or limited investment in technology by firm**

| Constraint on technology investment | % of respondents consider constraint | | |
|---|---|---|---|
| | Important | Most important | 2nd most important |
| Poor industrial policy | 75.6 | 25.9 | 22.6 |
| Poor science and technology policy | 30.8 | 4.9 | 3.6 |
| Poor policy on IT | 34.1 | 6.2 | 11.9 |
| Poor export promotion incentives | 45.1 | 12.3 | 14.3 |
| Lack of competition | 4.4 | 0.0 | 0.0 |
| Lack of manpower to operate relevant technology | 20.9 | 0.0 | 6.0 |
| High cost of technology | 76.9 | 38.4 | 26.2 |
| Lack of information on relevant technology | 25.3 | 3.7 | 8.3 |
| Technical limitations in adapting foreign technology | 28.6 | 8.6 | 7.1 |
| Total | | 100.0 | 100.0 |

Source: Analysis of survey data

It is, however, important to caution that factors such as "poor industrial policy" and "poor export promotion incentives" are highly subjective and may just be the respondents'

reaction to inability to access incentives provided under industrial and export promotion policies.[6] Factors such as "lack of competition", "lack of manpower to operate relevant technology", and "lack of information on relevant technology" are not considered by most of the firms as deterrent to investments in technology. It appears from these results that technological information and skills that could result in technology upgrading may exist among the research sample firms. However, lack of financial resources to implement firms' desirable technology investments, and lack of policy incentives are major constraints on technology investment.

Table 13 presents the perception of the respondent firms on factors that have favoured investment in technology. Product quality requirement, competition among local firms and production process requirement were mentioned by 58.7%, 57.6% and 43.5% of the respondents, respectively, as factors that have favoured investment in technology.

**Table 13: Perception of factors that favour investment in technology by firms**

| Factors that favour technology investment | % of respondents consider factor | | |
|---|---|---|---|
| | Important | Most important | 2nd most important |
| Industrial policy | 28.3 | 7.9 | 9.7 |
| Science and technology policy | 15.4 | 2.2 | 6.1 |
| National policy on IT | 10.9 | 3.4 | 1.2 |
| Export promotion incentives | 20.7 | 5.6 | 6.1 |
| Competition among local firms | 57.6 | 36.1 | 15.9 |
| Challenge of access to export market | 13.2 | 0 | 6.1 |
| Production process requirement | 43.5 | 11.2 | 17.1 |
| Product quality requirement | 58.7 | 25.8 | 23.2 |
| Parent company operation standards | 13.0 | 2.2 | 3.6 |
| Need for flexibility in product mix | 23.9 | 5.6 | 11.0 |
| Total | | 100.0 | 100.0 |

Source: Analysis of survey data

The rating of the most important factors that have favoured investment in technology almost followed the same order. About 36.1%, 25.8% and 11.2% of the respondents, respectively, claimed "competition among local firms", "product quality requirement" and "production process requirement" as the most important factors that favoured investment in technology. These three factors were also more frequently mentioned as the second most important factors. The three factors that were least commonly mentioned include "national policy on IT", "parent company operation standards" and the "challenge of access to export market", which were mentioned, respectively, by only 10.9%, 13.0% and 13.2% of the respondents as factors that favoured investment in technology. Moreover, no firm mentioned the "challenge of access to export market" as most important factor, and only 2.2% each mentioned "parent company operation standards" and "science and technology policy" as a most important factor. From these results, it may be inferred that the three major factors that present opportunities for investment in technology as perceived by the respondent firms include (in order of importance)[7]: Product quality requirement; competition among local firms; and production process requirement. The factors considered least important as presenting opportunities for investment in technology include (in order of importance[8]): national policy on IT; parent company

operation standards; challenge of access to the export market; and science and technology policy. Thus, on one hand, improvement in products quality and production processes coupled with the challenge of competition among local firms are perceived as the drivers of investments in technology. On the other hand, the Nigerian industrial, science and technology policies are considered incapable of promoting opportunities for investment in technology. The challenge of gaining entrance into the export market is also not viewed as crucial for technology investments, suggesting that firms in the research sample are yet to develop keen interest in the export market. This supports the findings of Soderbom and Teal (2002), which showed that very few Nigerian firms in the 2001 CSAE survey exported.[9]

## Impact of economic reform on technology investments

Table 14 presents the respondent firms' perception of possible impacts of Nigeria's economic policy reform on technology investment-related factors in the past three years. About 21.3% of the firms consider the reform to have stimulated investment in technology, and only 7.9% of the respondents mentioned this to be the most important impact of the economic reform.

The impact of the economic policy reform identified by at least 40% of the respondents include "regulatory agencies (e.g. NAFDAC and SON) facilitated technology flow", "investments in technology become more expensive", "access to critical raw materials reduced" and "market for products improved", which were mentioned by 62.8%, 54.3%, 42.6% and 40.4% of the respondents, respectively, as observed impacts of the economic policy reform. About 34.9%, 19.1% and 10.1% of the respondents, respectively, claimed "regulatory agencies facilitated technology flow", "investment in technology become more expensive" and "market for products improved" as the most important impact of the economic policy reform. "Investments in technology become more expensive", "market for products improved", and "enabled the introduction of new or improved products" were also perceived as second most important impact of reform by 26.7%, 15.1% and 11.6% of the respondent firms, respectively.

The impact of reform on the regulatory agencies' ability to stimulate technology flow is particularly noteworthy. It appears that the economic policy reform is perceived by the research sample firms as having provided adequate incentives for the regulatory agencies to function. This might have enabled significant technology flow into the firms, as means of achieving compliance with extant regulations. For NAFDAC and SON, the perception of the respondent firms of their influence on firms' technology investment is shown in Figure 1. The regulatory activities of both NAFDAC and SON are considered helpful for investments in technology by at least four-fifths of the respondents.

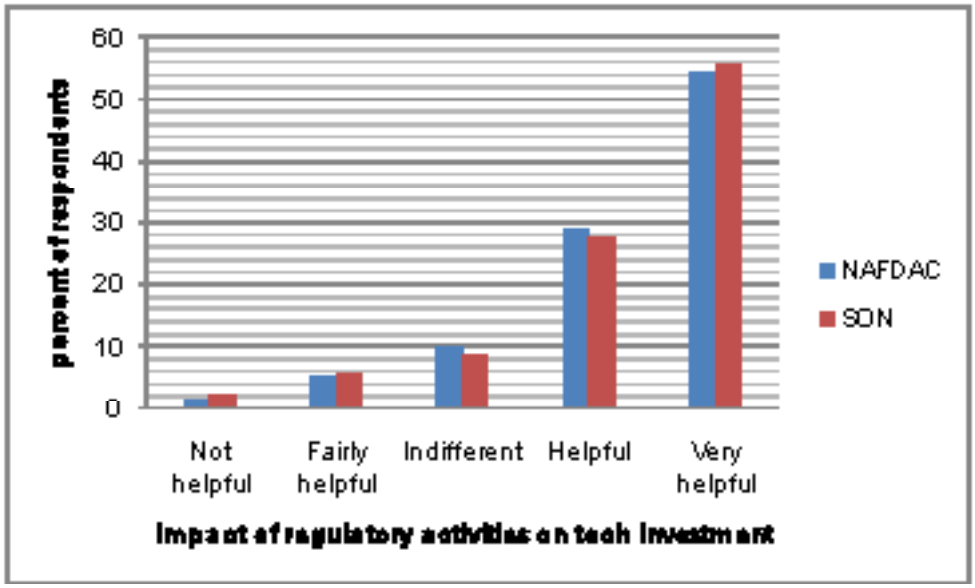
The impression that reform has made investments in technology more expensive could be explained by the fact that the liberalization aspect of the reform might have saddled the firms with some of the costs that were previously borne by government. The improvement in products market may be an indication that the impact of the reform has resulted in improved or new products that are better appreciated by consumers.

**Table 14: Impact of economic reform on firms' technology investment in the past three years**

| Impact of economic policy reform | % of respondents consider impact | | |
|---|---|---|---|
| | Important | Most important | 2nd most important |
| Stimulated investment in technology | 21.3 | 7.9 | 3.5 |
| Investments in technology become more expensive | 54.3 | 19.1 | 26.7 |
| Investments in technology become less expensive | 3.2 | 0.0 | 1.2 |
| Enabled the adoption of new equipment/machine(s) | 20.3 | 5.6 | 7.0 |
| Discouraged the adoption of new equipment/machine(s) | 30.9 | 0.0 | 3.5 |
| Enabled the introduction of new or improved products | 23.4 | 3.4 | 11.6 |
| Discouraged the introduction of new or improved products | 29.8 | 5.6 | 3.5 |
| Access to critical raw materials reduced | 42.6 | 6.7 | 9.3 |
| Access to critical raw materials improved | 14.9 | 1.1 | 3.5 |
| Regulatory agencies (e.g. NAFDAC, SON) hinder technology flow | 3.2 | 0.0 | 2.3 |
| Regulatory agencies (e.g. NAFDAC, SON) facilitated technology flow | 62.8 | 34.9 | 7.0 |
| Market for products improved | 40.4 | 10.1 | 15.1 |
| Market for products decreased | 27.7 | 5.6 | 5.8 |
| Total | | 100.0 | 100.0 |

Source: Analysis of survey data

**Figure 1: Impact of the regulatory activities of NAFDAC and SON on firms' investment in technology**




Source: Analysis of survey data

## Factors affecting export potential of firms

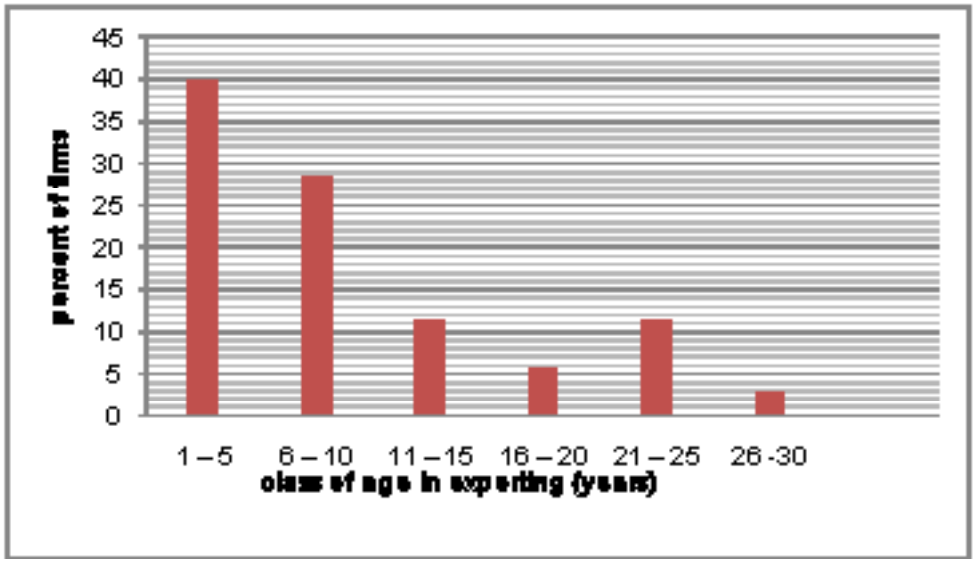
In the analytical framework in Section 4, we specified the logit model as the export model, and hypothesized on factors determining the export potential of firms. In this section, the export model is estimated. As a prelude to this, we discuss the main features and structure of exporting by the research sample firms.

## *Features and structure of exporting*

Thirty-eight or 39.6% of the research sample firms claimed to have engaged in some exporting. While all firms sell to domestic units or consumers, about 11.1% of the firms in the research sample export through distributors, while 33.3% engage in direct exports. The mean age in exporting is about nine years, while the median age of exporting is seven years. The firm with the minimum experience in exporting has only exported for one year, while the firm with maximum experience has engaged in exporting for 28 years. As shown in Figure 2, more than two-thirds (68.6%) of exporting firms in the research sample have engaged in export for not more than 10 years. It thus appears that there is an increasing tendency to export among these firms in the past 10 years. This could be explained as an impact of economic reforms.

As shown in Figure 3, about two-fifths (42.8%) of the firms exported not more than 5% of their output in 2007. It is, however, also noteworthy that at least one-third (34.2%) of the firms exported more than 20% of their outputs in 2007. As shown in Figure 4, the results also revealed that 77.9% of the export went to the West Africa sub-region; 15.9% was exported to Europe; 5.5% was exported to other African regions; 0.4% was exported to North America; and 0.3% was exported to Asia.

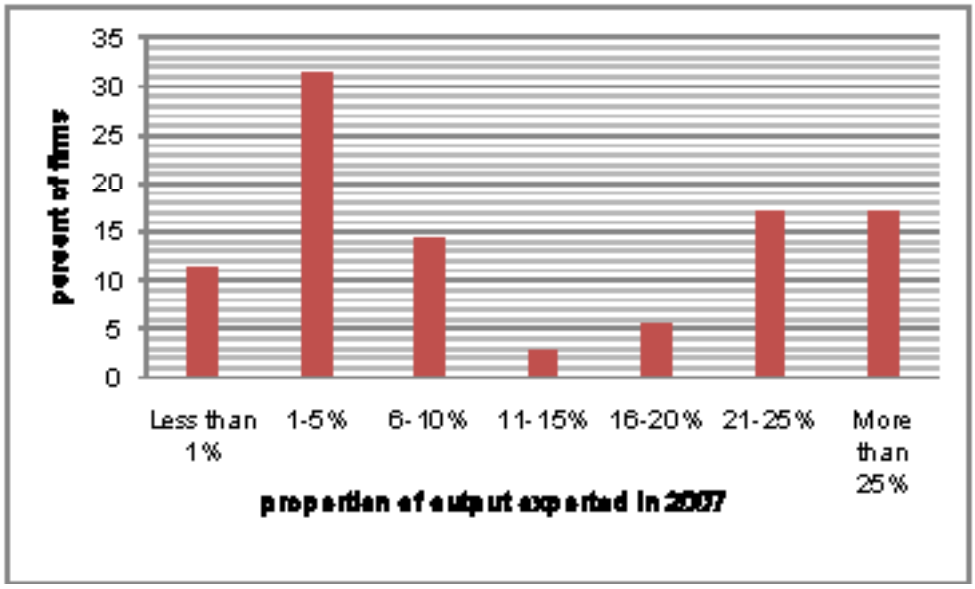
**Figure 2: Distribution of firm's age in exporting**




Source: Analysis of survey data

There are three cases of exporting firms that did not indicate age in exporting, hence this chart is based on a total of 35 firms.

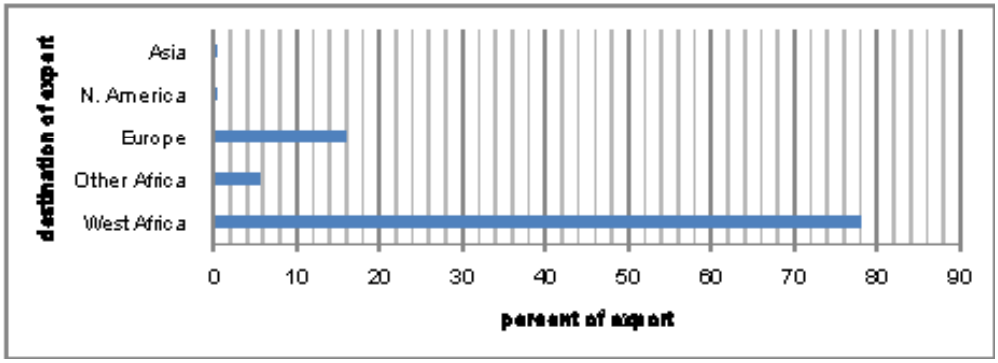
**Figure 3: Export intensity of firms in 2007**




Source: Analysis of survey data

There are three cases of exporting firms that did not indicate intensity of exporting, hence this chart is based on a total of 35 firms.

**Figure 4: Destination of export in 2007**




Source: Analysis of survey data

## *Results of the estimation of the export model*

Table 15 presents the results of the logistic regression for the determinants of export potential of firms. It should be noted that two of the instrument variables identified as determinants of export potential in Section 4 could not fit the model because of the limitation of the sample size. These variables are age in exporting, and destination of exporting. Since there are only 35 exporting firms with data, only 35 cases could

provide data on age, and destination of exporting. Thus, considering the fact that there were nine other explanatory variables, the degree of freedom became inadequate for the interactive process of the logistic regression to run. The first model (model 1) includes all the nine variables, all of which were hypothesized as determinants of export potential in sub-section 4.3. The results demonstrated that all the parameter estimates have the expected positive sign. However, only two out of the nine variables have coefficients that are statistically significant.

**Table 15: Summary of the logistic regression for the determinants of export potential**

**Dependent variable: firm exporting = 1, firm not exporting = 0**

| Variable | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Age of firm (AGE) | 0.057<br>(0.03) | | | |
| Ownership (OWS) | 0.014<br>(0.018) | | | |
| Foreign technology collaboration (TCF) | 1.216<br>(0.830) | 0.897<br>(0.674) | 0.926<br>(0.671) | 0.906<br>(0.670) |
| Invest in e-business (Ebuz) | 0.614<br>(0.933) | 0.157<br>(0.768) | | |
| Firm size (FZ) | 0.006*<br>(0.003) | 0.008***<br>(0.003) | 0.008***<br>(0.003) | 0.008***<br>(0.003) |
| Invest in tech. hardware (HDW) | 0.468<br>(0.987) | 0.608<br>(0.942) | 0.688<br>(0.929) | |
| Invest in skills upgrading (ISU) | 1.448<br>(1.165) | 2.049*<br>(1.193) | 1.995*<br>(1.155) | 2.165*<br>(1.140) |
| Skills intensity ratio (SIR) | 6.376**<br>(3.266) | 4.710*<br>(2.756) | 4.632*<br>(2.708) | 4.719*<br>(2.699) |
| Invest in quality management (IQM) | 0.452<br>(0.322) | 0.612**<br>(0.291) | 0.633**<br>(0.281) | 0.661**<br>(0.278) |
| Intercept | -7.637<br>(2.677) | -5.447***<br>(1.349) | -5.511***<br>(1.298) | -5.051***<br>(1.097) |
| Nagelkerke $R^2$ | 0.613 | 0.604 | 0.617 | 0.612 |
| -2 LogLikelihood | 56.02 | 63.49 | 63.71 | 64.30 |
| Hosmer and Lemeshow test | 0.034 | 0.812 | 0.821 | 0.416 |
| Number of firms, *N* | 74 | 83 | 86 | 86 |
| % correctly classified | 77.0 | 80.7 | 80.2 | 79.1 |

Source: Analysis of survey data
*, ** , *** represent 10%, 5%, and 1% levels of significance, respectively.
Standard errors are given in the parenthesis.

The Nagelkerke $R^2$ is 0.613, the Hosmer and Lemeshow test result is significant only at 3.4% level,[10] and the percentage of cases the model correctly classified as either exporting or non-exporting is 77.0%. To improve the fit of the model, we dropped AGE and OWS from model 1 because their coefficients were not statistically significant, and their inclusion resulted in deterioration of the model fits from earlier trials. In the

resulting model 2, four out of the seven coefficients are statistically significant at various levels, the Nagelkerke $R^2$ declined to 0.604, the Hosmer and Lemershow test result is significant at 81.2% level, and the percentage of cases that the model classified correctly improved to 80.7%. Further attempt to improve the model's fit resulted in model 3, where we have dropped Ebuz because it is the least statistically significant in model 2. The four variables that were statistically significant in model 2 retained their levels of significance, while the Nagelkerke $R^2$ improved to 0.617. The percentage of cases that the model correctly classified is 80.2%, and the Hosmer and Lemershow test result is significant at 82.1% level. To further improve the model fit, we dropped HDW because it is the least statistically significant in model 3. The resulting model 4 did not improve the statistical significance of the variables. Besides, the Nagelkerke $R^2$ declined slightly to 0.612, the percentage of cases that the model correctly classified also declined to 79.1%, and the Hosmer and Lemershow test result is significant at 41.6% level. In models 2 to 4, the coefficient of firm size (FZ) is consistently statistically significant at 1% level. Since the firm size distribution of the research sample has a wide span (minimum firm size is 20 while maximum firm size is 1,502), we replaced firm size with the log of firm size (LnFZ). Consequently, some of the previously significant coefficients become less statistically significant, LnFZ is significant at only 5% level, and the Nagelkerke $R^2$ declined to 0.578. From these results, it is apparent that model 3 is a better fit for the data than any of the other models tried, especially because it has the largest Nagelkerke $R^2$. Model 3 is, therefore, used to discuss the impact of technology investment related factors on export potential of firms.

### *Impact of technology investment related factors on export potential*

The a priori expectation of a positive association of technology investment related factors on export potential of firms was generally supported by the survey data. All the estimated coefficients have a positive sign. However, five of the nine factors hypothesized have coefficients that are not statistically significant. We therefore do not reject the null hypothesis that the coefficients of the factors are equal to zero. These factors include technology collaboration with foreign firms; investment in e-business facilities; investment in physical equipment and machines; age of firm; and ownership structure of the firm. Technology collaboration with foreign firms may not be important for export because the type of collaboration is mainly technical service agreement and technology licensing (as earlier mentioned in Section 5.1), aimed essentially at producing to satisfy the local demand. Foreign Direct Investment (FDI) that may be aimed at producing high quality goods for the global market has been experienced by only 2.5% of the respondents. E-business transactions have no significant relationship with export potential, possibly because the type of e-business identified among the sample firms are mainly the simple e-mail type transactions. Most of the firms in our research sample are yet to be involved in online website-enabled and portal-based transactions that can help them tap into the export market. Investment in equipment and machines have not been so important for export because such investment might have been perceived by the respondents as not essentially aimed at stimulating export or improving export performance. Age of firm may not be associated with export potential in Nigeria perhaps because the vast majority of

the firms are not keen on exporting. Moreover, there is no evidence of well pronounced history of exporting among the exporting firms. Most of the exporting firms have been exporting for not more than 10 years. Ownership structure also does not have a significant relationship with export potential. This may be explained by the relatively low foreign direct investment in manufacturing in Nigeria. Most of the firms are local firms, and even firms with substantial foreign interests are often not primarily export-oriented.

Based on the results in model 3, firm size has a strong positive relationship with export potential, and it appears that firm size is the most important factor associated with the export potential of firms. The coefficient of firm size is the only parameter estimate that is statistically significant at 1% level in three of the four models reported in Table 15. This finding confirms the results of several studies (e.g. Krugman, 1979; Kumar and Siddharthan, 1994; Wakelin, 1998; Soderbom and Teal, 2000; 2002), which have demonstrated a positive relationship between firm size and export capability. For example, the findings of the RPED survey reported by Soderbom and Teal (2000) on the relationship between firm size and export in four African countries (Cameroon, Ghana, Kenya and Zimbabwe) showed that large firms, defined as those employing more than 100 persons, were much more likely to be exporters. The apparent importance of size for export potential could be explained by the scale advantage that size provides, especially with respect to access to formal credit to finance export-related activities. Inability to bear the burden of fixed costs related to exports may deter small firms from exporting. For example, in the analysis of the results of the Nigerian RPED survey, Marchart et al. (2002) showed that large Nigerian manufacturing firms had much better access to formal credit, use bank credit to finance much of their investment, and have much higher rates of investment. The smaller firms had less access to formal credit and use commercial banks for only a small portion of their investment. These results notwithstanding, it is important to note that the positive association of firm size with the propensity to export does not necessarily imply that firm size causes exporting. In fact, successful exporters could also grow and become large, in which case exporting drives the tendency to become a large-sized firm.

At this juncture, it is also good to note that the strong association of firm size with export potential may be an indication of the importance of managerial capability as a determinant of exporting. Unless a firm has the managerial capability required for running relatively large firms, it may not succeed in making significant exports.

Other technology investment-related factors that are positively associated with export potential include skills intensity ratio, investment in skills upgrading, and investment in quality management, with parameter estimates that are statistically significant at 10%, 10% and 5% levels, respectively.

The skills intensity ratio is an indication of the level of skills employed by the firm in terms of the proportion of engineers and scientists in the total workforce. The result thus suggests that the use of high level skills in manufacturing activities has a positive relationship with potential for export. Similarly, investment in skills upgrading activities such as staff training, which enables better and efficient operation of machines and equipment, is also positively associated with improvement in export potential. These results corroborate the findings of earlier studies by Lal (1996) and Bernard and Wagner (2001), which indicated that firms with high skills are more likely to export. Investment

in quality management has a positive relationship with export potential, apparently because only high quality products can make significant debut into the export market.

Generally speaking, the foregoing results demonstrate that only three of the hypothesized technology investment-related factors have a positive association with export potential of firms. This could be an indication of weak association of technological capability with exporting in a developing economy. In an increasingly globalized world, where technologies with expired patents are readily available, it may be that knowledge about how to do business and manage firms are more pressing constraints on firms in poor countries. The important role of managerial capability, though an omitted variable in this study, might perhaps provide additional explanation for the observed trend of weak association of technology investment-related factors with the export potential of the sample firms.

## *Sectoral effects*

It is important to ascertain possible sectoral effects in the research sample. In this respect, using the food and beverages sector as the benchmark, five sectoral dummies were introduced into model 3 to test whether the results will indicate sectoral differences in the influence of the explanatory variables on export potential of firms in the research sample. As shown in Table 16, the results demonstrate that there are no statistically significant sectoral effects in the research sample. This result may also be a reflection of the limitation of the data, which contain only 35 exporting firms.

**Table 16: Details of the final export model with sectoral effects**

**Dependent variable: firm exporting = 1, firm not exporting = 0**

| Variable | Parameter estimate (B) | Significance level |
|---|---|---|
| Foreign technology collaboration (TCF) | 1.083<br>(0.723) | 0.134 |
| Firm size (FZ) | 0.009***<br>(0.003) | 0.008 |
| Invest in technology hardware (HDW) | 0.796<br>(1.043) | 0.446 |
| Invest in skills upgrading (ISU) | 1.684<br>(1.254) | 0.179 |
| Skills intensity ratio (SIR) | 6.369*<br>(3.344) | 0.057 |
| Invest in quality mgt. (IQM) | 0.802**<br>(0.350) | 0.022 |
| D1 (chemical/pharm) | 1.203<br>(1.100) | 0.274 |
| D2 (paper/printing/publ) | 1.880<br>(1.352) | 0.164 |

*continued next page*

**Table 16 Continued**

**Dependent variable: firm exporting = 1, firm not exporting = 0**

| Variable | Parameter estimate (B) | Significance level |
|---|---|---|
| D3 (plastics/rubber) | 1.833<br>(1.215) | 0.131 |
| D4 (textiles/garments) | 0.960<br>(1.451) | 0.508 |
| D5 (furniture/wood) | 1.589<br>(1.292) | 0.219 |
| Intercept | -7.577***<br>(2.021) | 0.000 |
| Nagelkerke $R^2$ | 0.640 | |
| Hosmer and Lemeshow test | 0.538 | |

Source: Analysis of survey data
*, **, *** represent 10%, 5%, and 1% levels of significance, respectively.
Standard errors are given in parenthesis.

# 6. Conclusion, policy implications and

# direction for further research

## Conclusion and policy implications

This study has examined the nature of investments in technology by manufacturing firms in Southwest Nigeria and how technology investment-related factors affect the export potential of firms. The findings of the study generally indicate that investments in technology among the research sample firms are dominated by imported technology hardware and related technical collaboration with foreign partners, investment in ICT are becoming widespread though not evidently deep in manufacturing related functions, and investments in technology are not directly targeted at improving the export potential of firms. The main findings of the study and their policy implications can be summarized as follows:

i) 84.4% of the firms use either completely foreign technology equipment or equipment that are largely foreign technology. No firm uses completely locally fabricated production facility, while only 15.6% of the firms use equipment that are largely locally fabricated. The foreign components of the equipment are imported mostly from Europe, and to some extent also from Asia. These results indicated that there is a need to improve the local content of manufacturing equipment and machines. Addressing this challenge would require support from the engineering sector as a producer of manufacturing equipment/machines that have significant local content.

ii) 42.6% of the firms claimed to be involved in technology collaboration with foreign firms. About 37.7% of the firms mentioned the type of collaboration as mainly technical support agreement, 22.5% claimed technology licensing, 12.5% trademark licensing, and only 2.5% mentioned foreign direct investment. The type of collaboration is thus largely in the form of technical support agreement and technology licensing. Though FDI does not guarantee technology spillovers or acquisition, it can significantly improve opportunities for technological learning. While not discouraging technical service agreements and technology licensing, government investment promotion should emphasize FDI. Moreover, the contents of technical service agreements and technology licensing should be more focused on technology acquisition, and building local technological capability. There is perhaps a need to strengthen the National Office of Technological Acquisition and Promotion (NOTAP) to ensure effective implementation of related extant and new regulations.

iii) Each of the respondent firms has invested in information and communications

technology (ICT) hardware in the past three years. Almost all the sample firms have made substantial investment in computers. About one third (33.7%) have made investment in electronic inventory monitoring units, 30% have invested in computer-aided manufacturing (CAM), 29.3% have invested in electronic sensors, while 25% have invested in digital cameras. The application of ICT is most pronounced in production processes, customer relations management, and office automation. However, the level of sophistication of the use of ICT in business transactions among the sample firms appeared relatively low. Most of the firms are yet to tap into the opportunities presented by online website-enabled and portal-based e-business facilities. It would be good to encourage the use of online website-enabled and portal-based e-business transactions among firms because this would facilitate supply and distribution chains and lead to significant reduction in costs.

iv) Evidence exists suggesting that the primary motive for firms' investment in technology is to improve products and production processes without a deliberate target of exporting. Only about 10% of the respondents consider improvement of export capacity a most important motive for technology investment. It should be a major concern that most firms are not keen on exports. This can be a problem arising from poor export policy incentives, or perverse implementation of export policy. It would be useful to review the existing export policy regime and its implementation. Firms should be actively involved in the policy review process to ensure that their views are taken into consideration in addressing the export challenges. An immediate focus of policy review should aim at reducing the cost of firms' investment in technology, improve incentives for export, and ensure effective implementation of export promotion incentives.

v) Most notable among the factors that are apparent constraints on firms' capability to invest in technology are high cost of technology, poor industrial policy and poor export promotion incentives. The rating of factors that have discouraged technology investments also revealed that these three factors are the most important deterrent to firms' technology investments. In fact, the results demonstrate that most of the firms in the research sample believe current economic reform has not supported investment in technology. This concern should be addressed by ensuring that the role of science and technology in economic development is emphasized in economic policy documents, and the implementation of economic policy should recognize that innovation as a driver of growth takes place at the firm level. While efforts that ensure the macroeconomic environment is investment-friendly should be sustained, focus on the micro determinants of growth must be a major component of economic policy if reform should generate significant investments in technology. Furthermore, firms gave the impression that reform has made investments in technology more expensive. This could be explained by the fact that the liberalization aspect of the reform might have saddled the firms with some of the technology-related costs that were previously borne by government. It is, however, noteworthy that NAFDAC and SON are perceived by firms to have enabled improved flow of technology under the current economic reforms. This should be sustained by further strengthening of these two regulatory agencies.

vi) The results confirmed the notion that Nigerian firms export largely to the West

African sub-region, and to some extent Europe. Exploring other markets could be done by aggressive promotion of the production of high quality products that would be attractive to foreign markets. A major means of achieving this is by improvement on physical infrastructure (roads, electric power supply, water supply, etc) which would enable significant reduction in production costs.

vii) The a priori expectation of a positive impact of technology investment-related factors on export potential of firms was supported by the survey data. All the estimated coefficients have a positive sign. However, five of the nine factors hypothesized have coefficients that are not statistically significant. These factors include technology collaboration with foreign firms; investment in e-business facilities; investment in physical equipment and machines; age of firm; and ownership structure. Firm size has a strong positive relationship with export potential, and it appears that it is the most important factor that affects the export potential of firms. The coefficient of firm size is the only parameter estimate that is statistically significant at 1% level for three out of the four export models estimated. These results demonstrate that larger firms are more likely to have higher export potentials.

viii) Other technology investment-related factors that impact positively on export potential include skills intensity ratio, investment in skills upgrading, and investment in quality management. These results show that technology investment-related factors such as the use of high level skills in manufacturing activities, staff training that enables better and efficient operation of machines and equipment, and investment in quality management are to be deliberately promoted to improve the export potential of manufacturing firms. This suggestion also corroborates one of the two answers provided by the findings of the CSAE survey on how incentives for exporting can be provided for Nigerian manufacturing firms. The first answer as reported by Soderbom and Teal (2002:70) is to design measures aimed at increasing firm-level efficiency, because improved efficiency would help firms attain certain level of international competitiveness necessary for exporting to be sustainable. The second answer, which is beyond the scope of this study, is to design measures aimed at reducing the transaction costs (e.g. handling costs, infrastructure costs, etc) associated with exporting.[11]

## Direction for further research

There are at least two important limitations to this study, which suggest the possibility of further research. First, the data used is a cross-section that does not allow us to analyse the trend in the sample firms' investment in technology and their relationship with the trends in export performance. Besides, the respondents' focus on firm activities in 2007 may not adequately depict firms' activities or performance in a typical or representative year. Linking the data with previous similar surveys by the RPED and CSAE was also difficult because it was not possible to identify the firms that participated in the RPED and CSAE surveys, which took place about seven years before this study. To provide a more robust data for analysing the issues raised in this study, it would be good to have

regular industry surveys that include data on technology investments, innovation and export performance of firms. Such surveys could be done as innovation surveys, with the questionnaire for this study as the starting point for the development of a more elaborate questionnaire that captures various elements of determinants and consequences of technological innovation at the firm level. The innovation survey could be done regularly across selected African countries as a means of understanding and tracking the trends in the development of technological capability among African manufacturing firms.

Secondly, the study's approach to ascertaining the influence of policy on technology investment and export performance has been limited because the questionnaire lacked specific questions that elicit information on firms' perception of the impact of various elements of industrial, technology and export promotion policies. It was originally thought that such detailed framing of questions would make the scope of the study too elaborate. However, results of the study suggest that a further study that entails a detailed analysis of the industrial, technology and export promotion policies and their impacts on technology investment and export performance would enable a deeper understanding of the role of policy in improving technological capability and export potential of firms. This is particularly necessary because current results indicated that firms are not so keen on export; and industrial, technology and export promotion policies are perceived as neither effective in promoting technology investments nor adequate for stimulating exports.

# Notes

1. To date, SMEs predominate and account for about 87% of business activities in Nigeria, but only account for about 10% of total manufacturing output (MAN, 2004).

2. The other two sub-sectors covered by the RPED and CSAE surveys are metals and non-metals.

3. As in Hamilton (1992) and Mukherjee et al. (1998), we define *odds* with respect to this study as the ratio of the probability of exporting to the probability of not exporting the product of a firm: $odds = P / (1-P)$.

4. For detailed proof on the derivation of this relationship of the logit model, see Maddala (1992: 327-328).

5. Six of the rejected questionnaires were outrightly useless due to incoherence in the data supplied. The remaining seven were rejected largely because of the paucity of data on the input and output figures.

6. For example, the CSAE survey of 2001 provided a detailed examination of the issues related to industrial policy and business environment. The findings showed that the most frequently cited weak area of industrial policy impact is physical infrastructure, followed by access to credit, insufficient demand, cost of imported raw materials and lack of skilled labour. When scale of operation is analysed, the most frequently cited main problem of industrial policy among micro/small firms is credit access, while for medium and large firms, it is physical infrastructure (Soderbom and Teal, 2002).

7. To obtain the relative importance of the factors, the score for the three columns were added.

8. To obtain the relative importance of the factors, the score for the three columns were added.

9. From the findings of the 2001 CSAE survey reported by Soderbom and Teal (2002), only 7% of the firms in the CSAE sample exported in 2000.

10. The Nagelkerke $R^2$ is a coefficient of determination similar in intent to the $R^2$ in OLS. It is a measure of the percentage of total variation in the probability of exporting that is explained by the model's explanatory variables. Hosmer and Lemeshow test is a model calibration goodness of fit test. It shows how closely the observed and predicted probabilities match, which is an indication of how reasonably the model fits the data. Normally, the Chi-square level of significance should be more than 10%. In which case, the null hypothesis that there is no difference between the observed and predicted probabilities is not rejected (Hosmer and Lemeshow, 1989; Norusis, 1999).

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11. Collier (2000) as cited in Soderbom and Teal (2002) argued that transaction costs faced by African manufacturing firms are atypically high because manufacturing firms are intensive users of services that are particularly expensive in Africa. It was pointed out that some of the costs are induced by inappropriate government policies, while some are inherent in doing business in economies where the quality of infrastructure services is often very poor.

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# Appendix

**Questionnaire for Manufacturing Industry**

**GENERAL INFORMATION**

FIRM'S NAME: .....

INDUSTRIAL SECTOR: .....

FOUNDATION YEAR: .....

ADDRESS: .....

CITY: .....

PHONE: ..... FAX: .....

E-MAIL: .....

SIZE (current number of employees): .....

Respondent's NAME: .....

POSITION: .....

**EDUCATIONAL BACKGROUND**

***Highest educational level***

UNIVERSITY/SCHOOL: .....

YEAR: .....

DEGREE: .....

FIELD OF SPECIALIZATION: .....

Guidelines

- In case your firm is part of a large corporation or multinational, please answer the questions with respect to your plant. You are requested to focus on your own manufacturing firm or business unit.
- Where data or information is not available for 2007, please provide the data/ information for 2006 and specify so.

**INVESTMENT IN TECHNOLOGY AND PERFORMANCE**

**OF NIGERIAN FIRMS**

## 1. BASIC INFORMATION

1.1 Is your firm a subsidiary or an affiliate of a multinational enterprise?

☐ YES ☐ NO

If ***yes***, please give the name of your parent company:

.....

1.2 Ownership structure of your firm:

Government: ..... % Local private: ……. % Foreign: ……. %

1.3 Capacity utilization

2005: …..….% 2006:…….. % 2007: ……%; currently: ..…….. %

1.4 How many shifts does your firm operate per day?

……. No. of hours per shift ……

1.5 Number of persons employed by your firm:

Male…….. Female ……..... **Total** …….

## 2. OUTPUT AND SALES

2.1 What was your firm's sales turnover in 2007? .....

2.2 Please complete the following table on output and sales information in 2007 with a focus on the **five most important** (by share of sales revenue) **products** sold by your firm.

| Description of output | Quantity produced | Quantity sold | Total value of sales (₦) (including exports) | Percent (%) of exports in value of total sales |
|---|---|---|---|---|
| (a) | | | | |
| (b) | | | | |
| (c) | | | | |
| (d) | | | | |

| | | | | |
|---|---|---|---|---|
| (e) | | | | |

2.3 In 2007, what percent of annual sales revenue of your firm was sold as:

| | | | % | |
|---|---|---|---|---|
| (a) Direct exports | | | | |
| (b) Exports through a distributor | | | | |
| (c) Sales to domestic units or consumers | | | | |

## 3. PRODUCTION INPUTS

***Raw materials***

3.1 Complete the following information about the **five most important raw materials** (in terms of volume of total raw material purchases) for the last financial year (i.e., 2007).

| **Description of raw material** | **Total quantity purchased in 2007** | **Value of total purchases in 2007 (₦)** |
|---|---|---|
| (a) | | |
| (b) | | |
| (c) | | |
| (d) | | |
| (e) | | |

3.2 Approximately what percent of annual purchases of raw materials by your firm was from the following sources in 2007?

| | | **%** |
|---|---|---|
| (a) Your direct imports | | |
| (b) Imported by distributors | | |
| (c) Bought from domestic producers | | |

***Buildings, machinery and equipment***

3.3. How much did the following cost your firm during 2007?

| | Amount in ₦ |
|---|---|
| (a) Rent for machinery and equipment (if owned, please enter value of depreciation using depreciation allowances) | |
| (b) Rent for land or buildings (if owned, please enter value of depreciation) | |
| (c) Royalty or license fee to domestic companies | |
| (d) Royalty or license fee to foreign owned companies | |

3.4 If your firm purchased new (or refurbished) machines/equipment in 2007, how much did your firm invest in the new machines/equipment?

₦ .....

3.5 What was the total book value of your firm's machines and equipment in 2007? ₦ .....

***Labour and training***

3.6 The highest educational qualification of the plant manager is: [*tick the most appropriate below*]

☐ Degree or ☐ Professional ☐ Secondary ☐ Others (*specify*) ———

Higher diploma technical certificate school certificate

3.7 Total number of ***Nigerian*** engineers/technicians and scientists (e.g. chemists, microbiologists, etc) in your firm: .....

3.8 Total number of ***foreign*** (i.e. non-Nigerian) engineers/technicians and scientists (e.g. chemists, microbiologists, etc) in your firm: .....

3.9 Please, give the proportion of your firm's employees with primary, secondary and higher education:

Primary education: .... % Secondary education: .... % Higher education: ....%

3.10 What type of training was carried out for your workers in 2007?

[*Please, tick all the options that apply*]

| | |
|---|---|
| (a) In-house training | ☐ |
| (b) Training in other Nigerian firms | ☐ |
| (c) Training in foreign firms | ☐ |
| (d) Training in Nigerian universities | ☐ |
| (e) Training in Nigerian polytechnics | ☐ |
| (f) Training in Nigerian research institutes | ☐ |
| (g) Training in foreign universities or polytechnics | ☐ |
| (h) Others (*specify*): | ☐ |

3.11 What was your firm's expenditure on workers' training in 2007?

₦ .....

3.12 For your total labour force, complete the following table on the wages or total emoluments in 2007.

| **Category of worker** | **No. of workers** | **Total wages (₦)** |
|---|---|---|
| (a) Management | | |
| (b) Professionals (e.g. lawyers, IT experts, etc) | | |
| (c) Skilled production workers | | |
| (d) Unskilled production workers | | |
| (e) Non-production workers | | |
| (f) Outsourced workers (e.g. security guards, cleaners) | | |
| Total | | |

***Energy and other utilities***

3.13 Complete the table below on your firm's expenditure on utilities in 2007.

| | **Amount in ₦** |
|---|---|
| (a) Electricity bill | |
| (b) Cost of diesel and other fuels | |
| (c) Water bill or water procurement | |
| (d) Communication bill (internet, telephone, fax, etc) | |
| (e) Cost of other utilities (specify type of utility) | |

3.14 Complete the table below on production hours and PHCN electric power supply in 2007

| | |
|---|---|
| (a) Average no. of production hours per day in 2007 | |
| (b) Average no. of production hours per day using power supply from PHCN in 2007 | |

## 4. INVESTMENT IN TECHNOLOGY

4.1. In the past three years, has your firm invested in any of the following re-engineering that brought in new or additional production equipment/ machines into your factory?

| Type of re-engineering | Yes | No |
|---|---|---|
| a) Complete change in production process | ☐ | ☐ |
| b) Introduction of new equipment/machine(s) | ☐ | ☐ |
| c) Introduction of additional refurbished or secondhand equipment/machine(s) | ☐ | ☐ |
| d) Others (*please, specify*): | ☐ | ☐ |

4.2 Where is the source of the *main production equipment/machine(s)* currently used by your firm?

[*Please, tick only the options that apply*]

| | |
|---|---|
| (a) Completely locally fabricated equipment | ☐ |
| (b) Mostly local and some foreign equipment | ☐ |
| (c) Mostly foreign and some local equipment | ☐ |
| (d) Completely foreign technology equipment | ☐ |

Please state the ***main country*** of origin of the foreign equipment component: .....

4.3 How old is the main production equipment? ..... years

4.4 Did your firm invest in any of the following IT hardware or equipment in

the last three years?

| Type of IT hardware | Yes | No |
|---|---|---|
| (a) Computers | ☐ | ☐ |
| (b) Electronic sensors | ☐ | ☐ |
| (c) Digital cameras | ☐ | ☐ |
| (d) Electronic inventory monitoring units | ☐ | ☐ |
| (e) Computer aided manufacturing | ☐ | ☐ |
| (f) Others (*specify*): | ☐ | ☐ |

Which is the most important IT hardware that your firm has invested in? …….. [*fill in letter*]

4.5 Does your firm apply information and communications technology (ICT) in any of the following activities?

| Type of activity | Yes | No |
|---|---|---|
| (a) Office automation | ☐ | ☐ |
| (b) Production processes | ☐ | ☐ |
| (c) Coordination with other plants | ☐ | ☐ |
| (d) Customer relation management | ☐ | ☐ |
| (e) Supply chain management | ☐ | ☐ |
| (f) Management of distribution networks | ☐ | ☐ |
| (g) Others (*specify*): | ☐ | ☐ |

Which is the most important ICT application by your firm? ……...…….. [*fill in letter*]

4.6 Does your firm engage in electronic business (e-business) transactions?

☐ YES ☐ NO

If yes, please identify the type of e-business employed by your firm.

[*Please, tick all the options that apply*]

| | |
|---|---|
| (a) Electronic messaging system (E-mail) | ☐ |
| (b) Online website-enabled transaction | ☐ |

| | |
|---|---|
| (c) Online portal-based transaction | ☐ |

Which is the most important e-business employed by your firm? …….. [*fill in letter*]

4.7 What has been the impact of government economic policy reform on your firm's investment in technology in the past three years?

[*Please, tick all the options that apply*]

| | |
|---|---|
| (a) Stimulated investment in technology | ☐ |
| (b) Made investment in technology more expensive | ☐ |
| (c) Made investment in technology less expensive | ☐ |
| (d) Enabled the adoption of new equipment/machine(s) | ☐ |
| (e) Discouraged the adoption of new equipment/machine(s) | ☐ |
| (f) Enabled the introduction of new or improved products | ☐ |
| (g) Discouraged the introduction of new or improved products | ☐ |
| (h) Access to critical raw materials reduced | ☐ |
| (i) Access to critical raw materials improved | ☐ |
| (j) Regulatory agencies (e.g. NAFDAC, SON) hinder technology flow | ☐ |
| (k Regulatory agencies (e.g. NAFDAC, SON) facilitated technology flow | ☐ |
| (l) Market for products improved | ☐ |
| (m) Market for products decreased | ☐ |
| (n) Others (*specify*): | ☐ |

Which is the *most important impact*? …….. [*fill in letter*]

Which is the *second most important impact*? …….. [*fill in letter*]

4.8. What are the factors that generally favour investment in technology by your firm?

[*Please, tick all the options that apply*]

| | |
|---|---|
| (a) Government's industrial policy | ☐ |
| (b) Government science & technology policy | ☐ |
| (c) Government policy on IT | ☐ |
| (d) Government's export promotion incentives | ☐ |

| | |
|---|---|
| (e) Competition among local firms | ☐ |
| (f) Challenge of access to export market | ☐ |
| (g) Production process requirement | ☐ |
| (h) Product quality requirement | ☐ |
| (i) Parent company operation standards | ☐ |
| (j) Need for flexibility in product mix | ☐ |
| (k) Others (*specify*): | ☐ |

Which is the *most important factor?* ……..... [*fill in letter*]

Which is the *second most important factor?* ……..……... [*fill in letter*]

4.9. What are the factors that have discouraged or limited investment in technology by your firm?

[*Please, tick all the options that apply*]

| | |
|---|---|
| (a) Poor government industrial policy | ☐ |
| (b) Poor government science & technology policy | ☐ |
| (c) Poor government policy on IT | ☐ |
| (d) Poor government's export promotion incentives | ☐ |
| (e) Lack of competition | ☐ |
| (f) Lack of manpower to operate relevant technology | ☐ |
| (g) High cost of technology | ☐ |
| (h) Lack of information on relevant technology | ☐ |
| (i) Technical limitations in adapting foreign technology | ☐ |
| (j) Others (*specify*): | ☐ |

Which is the *most important factor?* ….....……... [*fill in letter*]

Which is the *second most important factor?* ……... [*fill in letter*]

4.10 Is your firm involved in technology collaboration with foreign firms?

☐ YES ☐ NO

If ***yes***, which of the following form of collaboration is applicable to your firm?

[*Please, tick all the options that apply*]

| | |
|---|---|
| (a) Foreign direct investment | ☐ |

| | |
|---|---|
| (b) Technology licensing | ☐ |
| (c) Technical support agreements | ☐ |
| (d) Trademarks licensing | ☐ |
| (e) Others (*specify*): | ☐ |

4.11 What has been the motive(s) for technology acquisition by your firm in the past three years?
[*Please, tick all the options that apply*]

| | |
|---|---|
| (a) Improvement of product quality | ☐ |
| (b) Introduction of a new product | ☐ |
| (c) Improvement of existing production process | ☐ |
| (d) Introduction of a new production process | ☐ |
| (e) To improve export capacity | ☐ |
| (f) Response to government policy incentives to renew industrial facilities | ☐ |
| (g) Emission reduction to enable compliance with environmental regulation | ☐ |
| (h) To adhere to parent company's production standards | ☐ |
| (i) Others (*specify*): | ☐ |

Which is the *most important motive?* …….. [*fill in letter*]

Which is the *second most important motive?* ……..... [*fill in letter*]

4.12 How do you perceive the impact of the regulatory activities of NAFDAC and Standard Organization of Nigeria (SON) on your firm's investment in technology?

| | **Very helpful** | **helpful** | **Indifferent** | **Fairly helpful** | **Not helpful** |
|---|---|---|---|---|---|
| NAFDAC | ☐ | ☐ | ☐ | ☐ | ☐ |
| SON | ☐ | ☐ | ☐ | ☐ | ☐ |

## 5. EXPORT

5.1. Has your firm been able to enter the export market? ☐ YES ☐ NO

If ***yes***, which year did your firm start exporting? ……. If ***no***, GO TO question 5.8

5.2. What proportion of your firm's output was exported in 2007?

[*Please, tick only one option*]

| | |
|---|---|
| less than 1% | ☐ |
| 1 - 5% | ☐ |
| 6 - 10% | ☐ |
| 11 - 15% | ☐ |
| 16 - 20% | ☐ |
| 21 - 25% | ☐ |
| more than 25% | ☐ |

5.3 Please list your firm's main export products in order of importance:

.....

5.4 How were your exports distributed between regions of export destination in 2007?

| **Destination of export** | **% of total export** |
|---|---|
| West Africa | |
| Other Africa | |
| Europe | |
| Asia | |
| North America (USA and Canada) | |
| South America | |
| Others (pls. specify) | |

5.5 Please complete the following table about export-related facilities that exist in Nigeria.

(*Tick only the options that apply for each export facility*):

| **Export facility** | **Does your firm use this export facility?** | | **Compared to when the facility was not available or used by your firm:** | | |
|---|---|---|---|---|---|
| | Yes | No | export more | export the same | export less |
| (a) Manufacture-in-Bond scheme | | | | | |
| (b) Customs duty drawback | | | | | |
| (c) Duty suspension on imported inputs/raw materials | | | | | |

| | |
|---|---|
| (d) Bonded warehouse or similar scheme | |
| (e) Export credit guarantee | |
| (f) Export refinancing scheme (BOU) | |
| (g) V.A.T exemption on manufacturing equipment | |
| (h) Export Expansion Grant Scheme Fund (EEGF) | |
| (i) Export Adjustment Fund Scheme | |
| (j) Foreign Inputs Facility (FIF) | |
| (k) Duty certificates | |
| (l) Others (specify) | |

5.6 If your firm does not use any of the export facilities mentioned in question 5.5, which of the following reasons apply? (*Tick all that apply*):

| | |
|---|---|
| (a) Delay in the process | ☐ |
| (b) Administrative costs is too high | ☐ |
| (c) Don't know about the export facilities | ☐ |
| (d) Other reason(s), please specify: | ☐ |

5.7. What are the motivations for exporting your products?

(*Tick all that apply*):

| | |
|---|---|
| (a) To satisfy parent company demands | ☐ |
| (b) To take advantage of export facilities | ☐ |
| (c) Export market is large and unsaturated | ☐ |
| (d) Improved product quality | ☐ |
| (e) To satisfy a niche market | ☐ |
| (f) To reduce inventory of unsold products | ☐ |
| (g) Other motivation(s), please specify: | ☐ |

Which is the *most important motivation*? …….. [*fill in letter*]

Which is the *second most important motivation*? …….. [(*fill in letter*]

5.8 Why has your firm not been able to export?

(*Tick all that apply*):

| | |
|---|---|
| (a) Export policy incentives are not adequate | ☐ |
| (b) Local market absorb all our products | ☐ |
| (c) Product quality is not up to international standard | ☐ |
| (d) High cost of production makes products uncompetitive | ☐ |
| (e) Other reason(s), please specify: | ☐ |

Which is the *most important reason* against export by your firm? ……..

[*fill in letter*]

## 6. QUALITY MANAGEMENT

6.1. Does your firm practice Total Quality Management (TQM)? ☐YES ☐NO

6.2. Has your firm obtained any ISO certification? ☐ YES ☐ NO

If ***yes***, which and when? .....

6.3. What proportion of your sales turnover was invested in quality management in 2007?

[*Please, tick only one option*]

| | |
|---|---|
| less than 1% | c |
| 1.0 - 1.9% | |
| 2.0 - 2.9% | c |
| 3.0 - 3.9% | c |
| 4.0 - 4.9% | |
| 5% or more | c |

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