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MANUFACTURING RESPONSE IN A NATIONAL SYSTEM OF INNOVATION: EVIDENCE FROM THE BREWING FIRMS IN NIGERIA

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ABSTRACT

Employing empirical data, this study examines the innovation response of private Nigerian brewing firms to a state-induced crisis. We found that size, ownership, manufacturing skills, and technical affiliation were decisive factors in the innovation success of firms that survived and prospered under a decidedly turbulent industrial environment. State action, which was equally decisive but measured and based on scientific evidence, was accompanied by appropriate incentives and penalties. Firms with superior innovative performance recorded strong economic performance. The large firms with strong technical and financial support from foreign partners were able to tap into wider knowledge bases locally and broad and subsequently prospered.

Keywords: Nigeria, breweries, innovation systems, manufacturing, size, and skills.

1.0 INTRODUCTION

Market leadership and the scope of firms' activities depend on the human and financial resources the firm is able to mobilize. In particular, manufacturing skills as different from general-purpose capabilities and firm size, tend to be related to innovative capability, since internal assets limit firm capacity, (Penrose, 1987; Teece et al, 1994). Size is a particularly strong differentiating factor in an environment with weak institutions for technical and financial support. This is the case in most developing areas where there is considerable bias against small firms by financial institutions. Small firms also face severe legal and regulatory constraints, and little institutional support is available for them for innovation and hardly no export support, (Levy, 1993; Liedholm, 1992).

Important characteristics such as technical affiliations, network capacity and ownership are crucial factors in the economic performance and innovative behavior of firms. While a large body of empirical data exist on the influence of firm size and in-house capabilities on the relative performance of firms in industrialized countries, considerable work remains to be done in understanding the role of such factors on enterprises performance in Africa. This study examines the innovation response of private Nigerian brewing firms to a state-induced crisis. We found that size, and manufacturing skills were decisive factors in the innovation success of firms that survived and prospered under a decidedly turbulent industrial environment. Firm affiliation to foreign technical partners, and Multinationals (MNCs) foreign equity in local affiliates were decisive factors for the success of firms that succeeded.

The remaining sections of this paper are organized as follows: In section two we review concepts and propose a framework for analyzing skills, learning and capability formation in late industrialization; and in section 3, we review the brewing sector and its performance at the time. Section four states the research problem, and in section five we briefly outline the actions of the state in provoking firm-level response. Section six analyzes firm-level response while the final section concludes and derives some policy implications.

2.0 TECHNOLOGICAL CAPABILITY AND LEARNING IN FIRMS: A FRAMEWORK

Firms accumulate production knowledge from different sources prominent among which are: firms internal production activities which could be technical and non-technical; firm R&D broadly defined and not limited to frontier activities but including routine factory changes that raise productivity. Firms also produce knowledge through interaction with external agents such as Research and Development institutions, suppliers of machinery and equipment and technical partners. The objective of a firm in the acquisition of new knowledge is to generate new processes, products and better organization. In doing this firms require skills, knowledge and experience. In order words, firms require certain base of knowledge and skills to produce new forms of knowledge and possibly, higher level of skills that lead to innovation. The process by which firms accumulate and form new capabilities is referred to as technological learning. Ever since the seminal work of (Arrow, 1962) , we have had a better understanding of the processes of learning in firms, (Ernst et al, 1998; Malerba, 1992). There are different modes of learning, 'learning by imitation', (Kim, 1997), 'learning to learn' (Stiglitz, 1987), and a host of other ways by which firms accumulate technological capabilities. However, the acquisition of technological capabilities takes place within the national systems of innovation and proceeds over a long period of time.

2.1 Systems of Innovation and Manufacturing Performance

The concept of the National System of Innovation (NSI), allows us to position firm activities within the national and global contexts. The systemic view of economic and technical exchanges emphasizes the ways in which economic agents and institutions are in interaction with each other. The overall aim is to foster innovative activities. Contemporary analysis of NSI widens the sets of institutions to include those engaged in formal education and training, as well as networks of physical and scientific/engineering infrastructure. Lundvall and Christensen (1999) and Freeman (1987) identify three separate approaches and definitions of the national systems of innovation. The first one, put forward by (Nelson, 1993) is the US-approach, which focuses on the hi-tech with firm-university interaction as its defining character. The second approach advanced by Freeman (1987) takes a broader perspective including "national specificities in the organization of firms". Best (2001) gives a variety of models of industrial organizations defined by such national specificities. The third approach espoused by the

Aalborg group, conceptualizes the national systems of innovation "as rooted in the production system", with emphasis on institutions, as well as human resources development (Lundvall, 1999).

The concept of NIS is particularly suited to the kinds of technological activities carried out in African industry precisely because it emphasizes the systemic and continuous processes that lead from investment, production to design capability, rather than take R&D as the starting point of innovation. According to Freeman (1987), a national system of innovation is defined as "…the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies."

African countries, given this definition of the innovation process, are simply following in the path of the late industrializers. Nelson (1993) also made the point that: "innovation involves more than R&D, and the set of institutions that influences the technological capability of a nation and how these are advanced extends far beyond those that directly impinge on innovation."

The NIS is concerned with the ways in which information about technology flows within national boundaries among enterprises and institutions. However, significant market segmentation in underdeveloped countries gives certain categories of enterprises greater access to funds. For instance, large firms are more likely to obtain loans than small firms (Oyelaran-Oyeyinka, 1996). Even in such circumstances, this kind of access may be limited to routine operation-type technological activities. Larger firms also possess more skilled human resources that allow them to better gain superior knowledge of inputs and product markets.

2.2 Types of Innovation Response of Firms

Firms respond in broad and specific ways to economic crisis and competitive pressure given their technological assets, the socio-economic context, competitive environment, and their ownership structure (domestic or foreign). The forms and nature of response may well be to carry out innovation in the following broad domains: process technology, technical skill adjustment, market, organizational capability, and product innovation; and finally, fostering greater domestic and external inter-firm linkages. A firm may be able to perform one or more, or even none of the above activities. A firm may in fact exit the sector if the competitive pressure proves to be too intense.

We assume that firms respond to competitive pressures through a competition adjustment process, which we define as a systemic innovation process carried out by firms involving inputs, products and process regimes of the firm. In doing this, the following domains are involved:

- Raising the level of product and packaging quality;
- Development of new products and improvement on the old;
- Improvement on process technology through adaptations and imports of machinery and equipments;
- New marketing techniques through acquisition of marketing capability;
- Change in organizational modes and acquisition of new capabilities;
- Raising the quantum of engineering and technical skills, and/or improving on existing skills through training;
- Improvement in delivery times to customers;
- Greater conformity to standards (quality and environmental e.g. ISO 9000 and ISO 14,000);
- Adjustment in price of goods.

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2.2.1 Product and Process Innovation

Firms undertake process and products innovation in order to achieve greater plant efficiency. Innovation may be major or minor and may involve a variety of investment decisions. A major innovation may involve investment in new vintages, import of machinery and equipment, and employment of technical assistance. Minor innovations pertain to routine technical change that occurs on a daily basis at the factory level. Small and medium manufacturing enterprises in low-income countries most often carry out incremental technical changes and tend to rely on local engineering capacity for survival and growth, (Lall, 1992; Oyelaran-Oyeyinka, 2001). Firms reduce the cost of process technology innovation by investing in used machines.

Firms in early industrialization are largely imitative innovators drawing on a variety of market mechanisms or formal sources such as joint ventures, licensing and informal sources such as reverse engineering, learning-by-doing, (Kim, 1997). As is widely reported in the literature, while these firms may not engage in frontier technologies, the dynamic and evolutionary technical change processes in which they are engaged constitute important sources of learning and do lead to substantial productivity growth (Bell and Pavitt, 1993; Mytelka, 2000, Ernst, Mytelka and Ganiatsos, 1998).

An imitative innovation strategy in the African or any context demand considerable explicit efforts on the part of firms and the process of modifying processes and products, lead firms on uncertain but clearly a learning and competitive trajectory. In this paper we make the proposition that the most competent firms in Africa are technological imitators that import, modify and adapt technologies. Freeman & Soete (1997) identified and rated firm-level activities within a spectrum of the innovation process. Using an adaptation of the innovation strategies and framework proposed by them, we suggest that firms in Africa carry out the six

functions listed in Table 1.We identify three categories of firms operating within a network of economic agents in a national system which are dynamic, emergent and static. Table 1 is further elaborated in Table 2 showing the firm technological capability with network capability in four quadrants. The classification represents tendencies and is rather fluid since we deal with dynamic agents. We suggest that dynamic firms are successful dynamic imitators; emergent firms and clusters adopt a dependent strategy and tend to react to threats rather than voluntarily imitate and innovate. Static firms and clusters adopt a traditional strategy of non-innovative adoption of production technology. None of the firms in clusters in Africa could be classified an advanced cluster, quadrant A.

2.3 National Innovation Systems

In addition to internal firm-level capabilities, firms need to develop network capabilities for a number of reasons. First, competitive pressures, which alter the nature of markets and the required technical conditions, induce firms to reach for knowledge bases outside of themselves in order to reinforce extant sources in-house. Secondly, growing firms need to re-invent themselves through the acquisition of new skills and new knowledge and technical information. Third, the need to honour obligational relationships, for instance in a subcontracting or supplier relationship, compels firms to develop linkage capacity for feedback on products and services. In sum, a knowledge network with which this paper is concerned enhances a firm's ability to do product, and process innovation. Reasons for the formation of knowledge networks will vary a great deal depending on the technological capability and strategic focus of firms, the extent and type of market segments and product; and the structural characteristics of network agents within the National system of Innovation.

Table 1: Firm-level Scientific and Technical Functions

		In-house	Scientific & Technical Functions within Firms			
Cluster Strategy	Applied Research	Experimental Development	Design Engineering	Production Engineering and quality control	Technical Services & Training	Product forecasting &product development
Dynamic (imitative)	2	3	4	5	3	3
Emergent (Dependent)	1	2	3	5	2	3
Static (traditional)	1	1	1	5	1	1

Adapted from Freeman & Soete (1997) 1 = weak or non-existent; 5 = very strong

Table 2: Typology of Firms and Clusters in National Systems of Innovation

Quadrant	Firm/Cluster description	Network transaction	Product/market
A	Advanced cluster High rate of learning & knowledge creating in firms	Knowledge networking (H) Technological learning (H) R&D intensive	High product specialisation & complexity Globally competitive Global linkages (H)
B	Dynamic Firms and cluster	Knowledge networking (A) Imitative innovation Propensity Strong linkage Capability	Competitive global/domestic Growing product Specialisation Emerging global but strong domestic linkages
C	Emergent Firms and cluster	Knowledge network (L) Imitative innovation & learning Average linkage capability largely domestic	Locally competitive Low global but Average domestic linkages
D	Static/Traditional Firm and Cluster	Knowledge networking (None) Poor Learning Supplier networking Mainly agglomerative Benefits Very weak linkage Capability	Not Competitive May be declining

H = High; A = Average; L = Low; N = None

2.4 Technical Skills Size Factor in Innovation Systems

Central to a firm's innovative efforts is the nature, and level of skills of its engineers, and technicians. According to (Kim, 1997), "the prime actors in the process of organizational learning are the individuals within the firm". Skills are acquired from different sources and are employed for different purposes. The best-known sources of formal skill creation are: the universities, technical and vocational schools that equip the individual with scientific and technical knowledge. However useful and necessary these types of skills are, they cannot substitute for the idiosyncratic, technical and organizational requirements of modern enterprises. Firm-level capabilities comprise complex and diverse range of knowledge and experiences. This body of assets is represented in the broad categorization of technological capabilities that include: investment, production, innovation and marketing (Ernst et al, 1998). Each of these categories requires specific experiences, skills and knowledge, although a firm rarely requires the full complements of all these skills in-house.

However, industrial skills acquisition is a heuristic, time-consuming and evolutionary processing skills upgrading. In addition to the need for progressive addition of skills as a country becomes more industrialized, a developing country needs to maintain an industrial momentum that foster learning. In order words, time is not the only factor, the opportunity to fosters skills upgrading from the lower to higher levels is important for consistent industrial progress. Technological learning and skills formation trajectory progress from the simple to complex industrial production. Considerable explicit investment in learning and technological capability building is required on a consistent and sustained basis.

According to (Enos, 1991):

> "To operate modern equipment requires the least training and experience; to improve upon operation requires more; to specify and procure individual pieces of equipment, still more; and to design entire plants and processing schemes the most of all".

The industrial sector exists in developing countries but most have been unable to progress to more complex manufacturing stage; production is based on price, as the key factor for competitiveness. However, "in addition to keener pricing, which is now simply an order-qualifying market-entry requirement, greater emphasis is being placed on a large number of non-price competitive factors" (Kaplinsky and Morris, 1999; Katz, 2001; Fleury, 1995). Firms have had to pay close attention to quality, in addition to cost-reduction innovations. According to Fleury (1995), "the aggregate response of Brazilian industry to new patterns of demand and to manufacturing-based competition

has been a more serious utilization of the traditional quality control approach". Competing on quality terms require relatively greater skills.

The positive relation between technological capability acquisition and firm size is based on the proposition that large firms are able to attract higher, general and specialised technical manpower and tend to enjoy greater scale economies. Econometric analyses employing a variety of data sets from developing countries (Wignaraja, 2001); Westphal et al, 1990; Romijn, 1999), report positive correlation between firm size and capability. Chudovsky (2001) and Yoguel et al (2000) reported in separate studies, that large and foreign firms carried out more innovations than small locally-owned firms.

According to Kaufmann and Todtling (2002) larger firms innovate at a lower resource intensity than smaller firms particularly in the number of skilled manpower deployed.[2] They found SMEs less engaged in research than larger firms and in general, "SMEs are confronted with serious size-specific barriers restricting the potential to do research: lack of financial resources, a small product range…few or insufficient qualified personnel, ..lack of advanced technical know-how, and limited search capability."

The other variables reported showing different levels of significance with capability acquisition are entrepreneur's education level, technical manpower, external assistance and foreign equity.

[2] They found that in Upper Austria, average innovation budget per turnover , and average innovation staff to total employment are 11.0% and 15.6% for small firms ; and 10.3% and 8.3% respectively for larger firms.

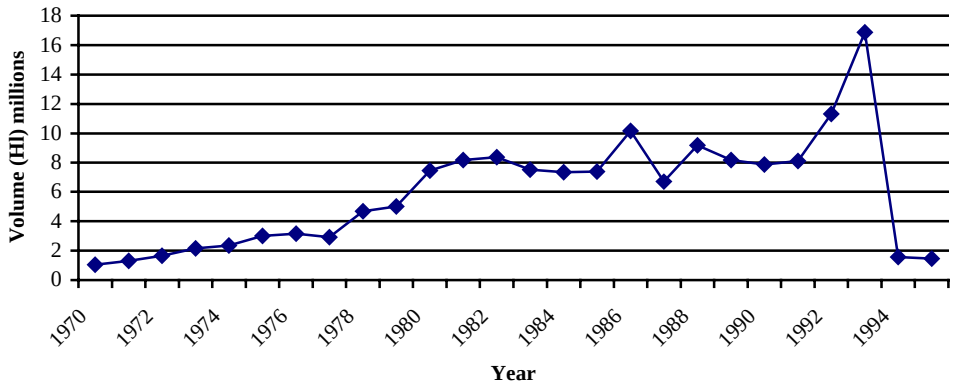
3.0 THE BREWING INDUSTRY IN NIGERIA

Commercial production of beer in Nigeria started in 1949 when the Nigerian Breweries Ltd. (NBL) established its first (of four) brewing plant at lganmu in Lagos. Local competition did not start until the early 1960s with the establishment of Golden Guinea (1962), Guinness (1963), West African Breweries (1964) and the North Breweries (1970).

A phenomenal growth in the number of breweries occurred in the second half of the 1970s; induced partly by government's decision to ban the importation of beer into Nigeria. Starting in 1972, with only four breweries producing a total of 1.65 million hectoliters per annum, production grew dramatically leading to the establishment of to 22 brewing plants by 1982. The total installed capacity was 11.5 million hectolitres per annum. By 1990, a total of 33 brewing plants had been established with a total installed capacity of approximately 20 million hectolitres. But while installed capacity grew in the 1990s, a significant number of breweries closed down. By 1994, only eleven breweries remained in operation; capacity utilization had fallen substantially while several of the plants had been taken over by the industry leaders.

Beer production, which had somewhat steadily increased since 1970, became erratic from 1985 and declined steadily beginning from 1988 till 1991. It however increased, even to an astronomical level in 1993, only to drop sharply to pre-1973 values in 1994 and 1995. The steady increase in the 1970s could be associated with the phenomenal growth of breweries in the mid-1970s, while a logical explanation of the post 1990s decline could be the effects of SAP and the massive devaluation of the Naira. Figure 1 presents the trend of beer production in Nigeria between 1970 and 1995.

Figure 1: Trend in Beer production in Nigeria, 1970-1995



In terms of structure, the brewing industry in Nigeria was always concentrated. This concentration was reduced somewhat but only briefly- in the mid - 1970s -with the explosion in the number of new breweries. However, the exit of many breweries in the 1990s returned the industry to its earlier degree of concentration, a development not totally unconnected with the effect of local raw material sourcing policy. By the early 1990s, the two industry leaders, the Nigerian Breweries Plc and Guinness Plc, accounted for 33% of the installed brewing capacity in Nigeria, while the Nigerian Breweries Ltd. was responsible for 48% of actual beer production in 1994.

In the context of the oligopolistic structure in the brewing industry, there exists considerable product competition especially between the two industry leaders. Initially, Guinness controlled the Stout market until the introduction into the market of competing *Stout* by Nigerian Breweries. In the malt drink market, both firms introduced new products. Malt, a major raw material in beer production was imported at great costs in foreign exchange, Table 3. The Naira cost of importation of barley malt was increasing yearly; this resulted in the struggle for import licenses, and delays in the remittance of funds. The combination of these problems ultimately resulted in a drastic reduction in production.

Table 3: Malt importation into Nigeria (1975 - 1985)

Year	Quantity (Kg)	Value (Naira)
1975	59,432,958	17,519,885
1976	55,568,836	14,577,609
1977	66,312,095	20,874,603
1978	89,277,215	25,430,883
1979	97,353,913	30,185,497
1980	98,418,462	35,829,810
1981	140,990,231	48,445,420
1982	139,690,936	59,652,249
1983	135,169,802	59,652,247
1984	135,169,802	64,514,077
1985	161,042,810	71,670,342

Source: Nigeria's Trade Summary, Federal Office of Statistics.

The growth in manufacturing production of beer, including stout, is also shown by the index of manufacturing production in Table 4. At 162.5 (1985 = 100), the index of manufacturing for beer (including stout) increased by 4.8 per cent in 1996. This is lower than the 33.7 per cent, 16.7 per cent and 8.5 per cent increases in 1989, 1992 and 1995 respectively, but quite a significant increase compared with 1988, figure which fell sharply by 24 per cent. Manufacturing output also increased marginally in 1991 and 1994.

Table 4: Index of manufacturing production (Beer & Stout)

(1985 = 100)

Year	Beer (including stout)	Percentage change
1988	76.0	-24.0
1989	101.6	33.7
1990	97.8	-3.7
1991	100.7	3.0
1992	117.5	16.7
1993	93.5	-20.4
1994	95.2	1.8
1995	103.3	8.5
1996	108.3	4.8

Sources: 1. Central Bank of Nigeria (CBN) Annual Report & Statement of Accounts (1993-1995);
2. CBN Statistical Bulletin, Vol. 6, No.1, 1995.

4.0 THE RESEARCH PROBLEM

The problem of the brewing sector in Nigeria was conceptualized by the government as a failure by private firms to apply extant technical knowledge to the solution of a rising volume of import of an intermediate input, barley malt. Experimental and limited applied research had proved that malt from sorghum and grits from maize-both local cereals- could be substituted for barley malt that hitherto was being imported. Government then out rightly banned the import of barley malt, within a given time limit, and at the same time, instituted a regime of incentives for firms willing to undertake the conversion process. From 33 firms, the number of operating firms declined to a dozen in a relatively short time. Only firms that were technologically capable of switching to local cereals survived, with different degrees of production success. We therefore define the problem as the study of the strategic response of firms to an external (to the firm) crisis. This study of innovation in firms will be carried out within the framework of the National Systems of Innovation. The NSI is a network of institutions in the public and private sectors. Their “activities and interactions initiate, import, modify and diffuse new technologies", (Freeman, 1987). This definition places institutions at the centre of the technical change process. For Dahlman and Nelson (1987), "Technological *capacity is embodied in people and institutions and requires networks and interactions among many types of information and agents* - public/private, local/foreign. The three categories of agents and institutions that are involved in this study are:

a) Formal training and research institutions and universities, technical institutions;
b) Formal Public Research and Development Institutions (RDIs) carrying out research outside the structure of firms;
c) private firms in the brewing sector

In terms of size structure and ownership of firms, there are three broad types, which are:

d) Domestic local enterprises wholly owned by Nigerians;
e) Domestic local enterprises partly owned by Nigerians;
f) Affiliates of multinationals that may be large or medium size.

We examine the innovative behavior of these firms given their defining characteristics and how these influence response to external thereat. In specific terms, we consider variables such as: firm size, technical skills, ownership and equity, age in business, foreign and domestic technical assistance. Appendix Table 1 shows a sample of firms and their defining characteristics.

4.1 Data Collection Instruments

The main methods and instruments used to collect data were as follow:

* Desk study

* Fieldwork that covered interviews of:

  - Professional associations within the brewing industry;
  - Selected brewing firms;
  - Relevant government ministries[3];
  - Selected research institutes.

The desk research involved search for relevant documents and information. Through this, we were able to identify sources of data/information relating to the history and development of the brewery industry in Nigeria, highlighting the various changes that had taken place. Similarly, we identified sources of information on the implication of these policies on firm performance as well as their innovation responses. For the fieldwork, three methods were employed[4]:

- Visit to conduct pilot tests using survey guide;
- Preliminary visit to selected breweries;
- Survey of:
  * Breweries
  * Government ministries/agencies and
  * Research institutes

These visits were made to elicit response to questionnaires and to conduct in-depth interviews using a list of active and surviving firms in the sector. Follow up visits were made to selected breweries to have a broad overview of their operations and to collect preliminary information on their innovative activities. The following categories of firms were selected out of the ones that survived:

- Industry leaders - Nigeria Breweries Plc and Guinness Plc
- the moderately sized breweries: International Breweries Ltd., Ilesha and Premier Brewery, Onitsha
- Those not performing well: Standard Brewery, lbadan and Associated Brewery, Lagos.

[3] The National Agency for Science and Engineering Infrastructure (NASENI) which co-ordinated the conversion project, gave me unrestricted access to project files and the correspondence between the FMS&T and other stakeholders. These proved invaluable in understanding the ways in which the various economic agents interacted.

[4] The primary data used in this study draw largely from the field data collected with colleagues at the Nigerian Institute of Social and Economic Research (NISER) and the University of Ibadan, Nigeria in 1994-95. Additional data was collected with grant from the NASENI, while the final report was written at UNU/INTECH.

The questionnaire for government ministries focused on the management of policy. Officials in the following four government ministries were interviewed:

- The Federal Ministry of Industries;
- The Federal Ministry of National Planning;
- The Federal Ministry of Science and Technology;
- The Federal Ministry of Finance.

Three research institutes were selected for information on technology development and they were:

- Federal institute of Industrial Research, Oshodi (FIIRO)
- Project Development Institute (PRODA)
- Institute of Agricultural Research (Zaria or lbadan)

Primary and secondary data sources were collected at each agency for the study while questionnaires were distributed to the 6 firms. The primary data were cross-sectional, covering the six breweries. Annual reports and statement of accounts of relevant firms were used as secondary sources to obtain data on impact receiving variables. Data were collected and analysed in respect of the six breweries. For the purpose of confidentiality, A, B to F represent these companies, with the alphabetical order not corresponding to the arrangement of company names. Questions that were asked in the questionnaire bother on issues relating to pre-policy and post-policy state of affairs of relevant firms. For instance, ownership structure, pre- and post-policy sources of most important materials, foreign relationship of firms as well as questions bothering on the performance of firms were addressed in the questionnaire.

4.2 Study Hypotheses

The following hypotheses are tested:

g) Successful process adaptation is significantly related to higher level of output (capacity utilization as proxy);

h) High manufacturing skills within firms are significantly related to innovation;

i) Strong technical and financial support from foreign technical partners significantly related to successful firm-level innovation;

j) Firm ownership structure, and firm size are positively related to propensity to innovate;

k) Firm performance is significantly related to firm size, and ownership.

4.3 Research Objectives

The broad objective of the study is to examine the innovative behaviour of firms in late industrialisation given firm characteristics (size, skills and ownership) under conditions of policy-imposed crisis. In doing this we have the following specific objectives:

a) Examine the relationship between innovation and firm output performance;

b) Examine the relationship between manufacturing skills and firm innovative response;

c) Examine the contribution of economic agents, within and outside the National Innovation System to firm innovative efforts (technical partners and local RDIs);

d) Evaluate the relationship between firm size and ownership and the propensity to innovate;

e) Examine the relationship between firm size, and ownership and overall performance.

5.0 THE ROLE OF THE STATE AND ITS INSTITUTIONS

After issuing the policy directive to ban barley-based brewing, the Government set up a Committee to ensure the success of the malting conversion process. In its deliberations the Committee specified the following evident conditions for the successful implementation of a substitution programme:

i) The state will ensure availability of appropriate variety of sorghum grains in the required quantity;

ii) Facilitate acquisition of facilities for processing sorghum grains into malt locally.

The Committee fixed 1990 as the target date for total substitution and thereafter apportioned responsibilities for the various Ministries to ensure successful implementation of the programme. The functions and mandate of the agencies under each ministry are outlined in Table 5. Notably, it proposed a regime of incentives and penalties as follow:

5.1 Incentives for the Sorghum Substitution Programme

For firms that establish malting facilities, the incentives were as follows:

i) Priority in granting all approvals required for the establishment of malting facilities;

ii) Priority in granting import license for bringing in all malting machinery and equipment;

iii) Exemption of tax for a given period for all malting companies (pioneer business status).

And for breweries involved in the exercise:

i) Exemption of tax on all capital expended by any brewery in modification (if any) of its manufacturing machinery and equipment during the process of converting to 100% sorghum beer; and

ii) Priority in granting import license for any other inputs besides malt which cannot be obtained locally and are required for the change over in the technology of brewing.

5.2 The penalties for non - compliance with the Sorghum substitution programme

a) Absolute prohibition of importation of barley malt; and

b) Closure of any brewery, which fails to achieve total substitution within one year after 1990.

Essentially, the Committee viewed the proposed replacement of barley malt with Sk5912 sorghum variety in the Nigerian beer brewing as a process of technology substitution. In this regard, it recommended that:

(i)Royalty payment to overseas technical partners on brewing technology/process in any form be discontinued after 1990. This was because all breweries in Nigeria at the time were built on a turnkey basis and had some kind of technical agreement with overseas partners;

(ii)All breweries operating in Nigeria were to pay 1% of their turnover as royalty to the Government for the use of sorghum malt technology as from the time of change over;

(iii)The money was to be dedicated to further research and development work of brewing technology in Nigeria.

Regarding quality and standards, the Standard Organization of Nigeria redefined beer as follows[5]:

> "Beer - the alcoholic product resulting from the fermentation, by yeast culture, of the solution prepared from a mash of suitable malted cereal/cereals and hops or hop preparation with or without other un-malted cereals or other carbohydrate source".

Given the range of inter-agency participation, it is evident the Government of Nigeria did all that was feasible and necessary for a quick and full implementation of total substitution of barley malt with local Sk5912 sorghum variety in beer brewing. Following from these, the Government decided to stop as from January 1, 1988, importation of barley for brewing beer and for malted barley- based production. All breweries and malted barley – based industries were to convert to the use of sorghum or other local substitutes. The decision was based on the conviction of government, based on experimental evidence, that malted sorghum could replace malted barley in its entirety in lager beer brewing.

One immediate challenge to achieving the substitution objective was the absence of commercial malting facilities in the country, although sorghum malting techniques had been developed by both FIIRO and PRODA. The two institutes produced malted sorghum from pilot plants developed by them in limited quantities in the past. PRODA constructed a 2 model-malting plant: a 3-ton cycle malting plant and a 40-ton per day malting plant. Based on these models, much of the materials of construction were obtainable locally, and only the instrumentation was to be imported. However, this capacity was far below the need of breweries, and plant scaling up, which was considered within the engineering capability of brewing firms, was all that was required[6].

Evidently, modification would be needed in brew house equipment to enable a change over from barley brewing to sorghum brewing.

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[5] This definition widened the range of beer raw materials to include local cereals rather than being derivable only from barley.

[6] Among the alternatives, the Government felt that the “floor malting” technology; a technology, which was already in extensive use in Nigeria, was the simplest and most

Table 5: The Role and Mandate of Government Agencies

Agency	**Role in Substitution Project**
Federal Ministry of Agriculture, Water Resources and Rural Development	Raise farmers' awareness of market potential for SK 5.912 sorghum variety as well as the sources of seeds for this variety. These measures were to promote the cultivation of sorghum SK 5912 so as to ensure its availability for industrial use.
Federal Ministry of Science and Technology	Ensure steady annual supply of 4 tonnes of foundation seeds of SK 5.912 sorghum variety by funding IAR, Zaria, for that purpose. This would was to ensure continued production of seeds of the particular sorghum variety needed for successful programme implementation. Also, the Ministry was to intensify efforts at developing other varieties of local grains with adequate malting characteristics in order to diversify the source of local malting grains.
Federal Ministry of Industry	Ensure that all necessary approvals were given promptly for the establishment of commercial malting facilities, if and when applications were made. The Ministry was to take into consideration the total malt requirements of Nigerian breweries that were about 320,000 tonnes.
Federal Ministry of Trade	Ensure necessary licenses (if required) for importing malting machinery and equipment were given priority attention

cost effective and could be adapted to sorghum malting. Preliminary estimates at the time for a 10,000 ton /year malting plant using this technology was ₦1.2 million.

6.0 EVIDENCE OF FIRM-LEVEL RESPONSE

In what follows we provide analysis of responses of firms to the ban on barley malt, bringing out the hypothesised relationships between relevant variables.

The changed economic environment that led to the policy on local sourcing of raw materials induced different responses. Firms' responses evidently reflected firm assets and dynamic characteristics. Table 6 presents firm characteristics that include size, ownership structure, sources of technology, management structure, and linkages with other firms within the NSI and outside the country.

For the breweries, the strongest inducements to innovation was the potential loss of market by the ban of imported barley malt. In selecting the most important substitute, the following factors were identified in order of importance by the breweries: Research findings, availability of suitable grain varieties, access to malting technology, and affordability of price.

In our study, all firms acknowledged the need for innovative response which took several forms; but the most prominent were product and process innovations.

From our interviews, it was evident that the market leaders had taken certain proactive technical and administrative steps in anticipation of the expected government policy change, among which were:

1. Commissioning of product and process centres with active support from technical partners;
2. Acquisition of buffer raw materials to see them through the conversion period;
3. Establishment of well-equipped laboratories;
4. Setting-up of organisations to carry out R&D, cultivation of farms, purchase, transportation, storage and milling of local sorghum and maize; and
5. Large-scale purchase of raw materials in the open market.

The medium sized breweries had no farms and thereby purchase their own raw materials from the open market. Firms employed new skills, some created R&D centres, while some conducted staff training, or do all of these. In effect, a few of these breweries initiated far-reaching technical and organizational innovations long before the ban took effect in 1988. While Nigerian Breweries Plc initially resisted the switch to local grains, once it was persuaded of government's resolve, deployed all its resources to achieving innovation success.

In sum, market leaders in the brewing sector that control a significant portion of the market seem to have acquired considerable skills for marketing their products, both in the domestic and

in foreign markets The medium sized breweries serve restricted niches and their knowledge bases tend to be fairly limited.

Table 6: Selected Firm Characteristics

Structure	Firm Size	Sources of Technological capability	Management Structure	Linkage Behaviour & tendency	Performance
Private Majority owned Foreign Subsidiary (PFS)	Asset base	Fully depend on foreign sources	Composition of board & management	Fully outward (weak Internal)	Profitability
Private Minority owned foreign participation (PMF)	Manpower size	Partial Dependence on Foreign partners	composition of technical groups	Partial linkage	Turnover
Independent Endogenous private (IEP)	Physical output (hectoliters)	Endogenously Driven technology Effort	composition of skilled workforce	Significance linkage	Reserves
State-owned (SON) majority Nigerian	Turnover	Linkages with local RDIs or universities			Output

Note: Reading is vertical, no meaningful horizontal inferences are expected

6.1 Process Innovation and Firm Performance

Under this heading we test the hypothesized linkage between process innovation and output represented by capacity utilization[7].More specifically, we propose that the more successfully a firm adapts existing process for conversion to local cereals, the higher the level of capacity utilization. We found that 100% substitution was achieved for sorghum and maize by all sample firms. While Firms A, B and E achieved 100% substitution in sorghum earlier (1986, 1987 and 1987 respectively), Firms C and F achieved it in 1990. For maize, all firms achieved 100% substitution level in the late 1980s, except Firm C, which lagged behind, achieving the level in 1990 **(Table 8).** Also, data shown in **Table 7** show that all firms sourced 100% of sorghum and maize locally. 50% of firms' source sugar locally while the remaining 50% relied on imports. In addition, only Firm C achieved 30% of local sourcing for hops. The other firms continued to utilise hops from foreign sources. These findings show that while a switch to domestic sources of local raw materials was foisted on the sector, only a limited number of firms had the capability to make the switch. This is evident from the considerable time taken by some of the

[7] Capacity utilization = Qc/Qt, where Qc is current output, and Qt is the installed capacity.

firms and the fact that some firms were unable to achieve total or partial conversion in the end. Apart from capability and resources constraints, delay in conversion stemmed from organizational resistance to change. For instance, one of the industry leaders for long resisted the change to local cereals and was persuaded only in the face of the threat posed by potential input shortage and subsequent loss of market to rivals that made the switch[8].

Consistent with production behaviour of plants, capacity utilization of firms declined in the early years. This is a result of firm learning difficulties, and uncertainty in the product market. For instance, capacity utilization of firm A declined from one million hectolitres to 45%, 35% and 30% levels respectively in 1991, 1992 and 1993. For Firm E, which had 750,000 hectolitres as installed capacity, capacity utilization fell from 500,000 hectolitres in 1989 to 350,000 and 180,000 hectolitres in 1993 and 1994. With time, firms successfully adopted the techniques of processing maize to brewers' grit and sorghum malting technique, which up till then had only been proven feasible on a pilot scale by one of Nigeria's Research and Development Institutes (RDIs).[9]

In addition to firm-level factors, the Nigerian economy had entered into a depression. There was a general negative growth in manufacturing production, and industrial capacity utilization was below 37% between 1992 and 1995 (Ilori et al., 2002). This was brought partly by the adverse impacts of deregulation, devaluation, and liberalization that created a harsh economic environment for firms. The effects of these factors, which led to high costs of imports and low consumer purchasing power, may well account in large part, for the failure to achieve higher levels of capacity utilization.

[8] Long after the feasibility of soghum-malted beer was demonstrated, a scientist from this firm insisted at a policy dialogue organized by the government that beer brewing from inputs other than barley was an "impossible proposition", (FMST files, Abuja).

[9] The Federal Institute of Industrial Research , Oshodi (FIIRO) based in Lagos had demonstrated the feasibility of malted sorghum technique but the Institute was unable to produce on a commercial level. Neither was any of the many interested local SMEs, due to the considerable resources required and the scale economy required for a profitable venture. This innovation was eventually achieved by these MNC affiliates that had the in-house technical expertise and external technical and financial support.

Table 7: Sources of Raw Materials (%)

Materials / Firms	Sorghum		Maize		Sugar		Hop	
	Local	Foreign	Local	Foreign	Local	Foreign	Local	Foreign
A	100		100		100*			100
B	n.a	n.a	n.a.	n.a	n.a	n.a	-	-
C	100		100		100		30	70
D	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
E	100		100		-	100		100
F	100		100		10	90	-	100
% of Company in local sourcing	100		100		50	-	25	-
% of Company in foreign sourcing						50		75

Utilise yeast instead of sugar

n.a. did not provide percent source of materials

Source: Field Survey.

Table 8: Levels of substitution achieved (%)

Company	Sorghum (%)	Year of Subst.	Maize (%)	Year of Subst.	Sugar (%)	Year Of Subst.	Hops (%)	Year Of Subst.	Yeast (%)	Year Of Subst.
A	100	1986	100	1986						
B	100	1987	100	1987	n.a	n.a	n.a	n.a		
C	100	1990	100	1990	100	no change	30	n.a		
D	100	n.a	100	n.a	n.a	n.a	n.a	n.a	n.a	n.a
E	100	1987	100	1987	-		10	no subst.	10	no subst.
F	100	1990	100	1986	10	n.a	10	no subst.	-	

Source: Field Survey.

6.2 Innovation as Production Plant Modifications

The next hypothesis established a strong linkage between changes in process variables and modifications to machinery and equipments. This is a necessary step in the innovation process. **Table 9** provides data on production line changes and modification induced by changes in the characteristics of inputs.. While some firms established new production lines, some did not,

preferring only substantial modification to existing production lines. About 33.3% of the firms established new production lines, while majority of them, 66.7% modified existing lines. Companies that established new lines as well as modified existing ones constitute 33.3%. Two firms, (E and F) established new lines and modified existing ones. Firms C and D only carried out modification on their existing production lines while Firms A and B neither established nor modified existing plants.

Newly established lines by Firms E and F include malting sorghum lines and fermentation, sorghum supplementary unit, kettle filter and heater. Modified production lines include mash filter, malt plant, brewing kettle, barley malt line and mash tun among others.

Apart from production process changes proxied by production lines changes, other characteristics also signify different firm level responses to local sourcing of raw materials policy. These include the establishment of own agricultural farms, and the use of contract farmers. The richer firms were able to acquire and cultivate large acreages of farmland particularly in the Savannah area of Northern Nigeria to grow sorghum and maize[10].

The extent of integration is shown in Table 10. From Table 10, the source(s) of the most important materials are indicated. Three of the firms obtained materials from the open market only. One firm, Firm A, utilized own farm and open market inputs while another, Firm F, made use of own farm and contract farmers. Firm E alone obtained its materials from the three indicated sources i.e. own farm, contract farmers and open market sources. Neither of them used contract farmers alone nor own farm source alone. Moreover, none of the firms obtained materials from a combination of open market and contract farmers alone.

In terms of in-plant technical change, new production lines were created and significant modifications were made to existing ones. Most especially, the malting and fermentation process as well as the filtration and brewing were affected. Through R&D, two process aiders were identified and introduced at the pertinent stages of brewing by one of the breweries. The effect of these aiders was to reduce the starch content of the grains to fermentable carbohydrates. The introduction of the hammer mill to effect fine size reduction of sorghum to the desired particle size is an important step that enhances gelatinization, liquefaction and saccharifocation processes of enzymes. Changes were also made in the brew-house to the Lauter Tun (used to filter the mash, which becomes wort at 78^{o}C); Trub tank (no longer

[10] For manufacturing firms this was terra incognita, and a risky undertaking that commits firms to substantial sunk costs and an uncertain outcome. Only firms with strong asset base, the ability to organize such an endeavour and with access to technical support were able to integrate backwards into large-scale farming.

employed because they were used in the production line alongside the Lauter Tun); and the Weak wort tank (serves as a reservoir for remnants).

The mash filter (MF) plate and frame was added to the production line due to the different structure of the local grains. Another unit, the Hot Wort filter (Filtrax) was designed to filter hot wort at about 90 - 100^{o}C before chilling commences. The essence is to improve the flavour of the beer at the final stage of production. However, most of the medium sized firms carried out only minor innovations in the production line, while some established no new production lines.

Table 9: Production Process Change

Firm	**Established New Production lines**	**Modified existing production lines**
A B C D E F	None None None None Sorghum supplementary unit, kettle filter and heater Malting sorghum lines and fermentation	None None Filtration Machinery The Grist Case Barley malt line and kettle filter Filter mesh, malt plant and brweing kettle.
% Change of firms which established new lines or modify	33.3% 66.7%	66.7% 33.3%

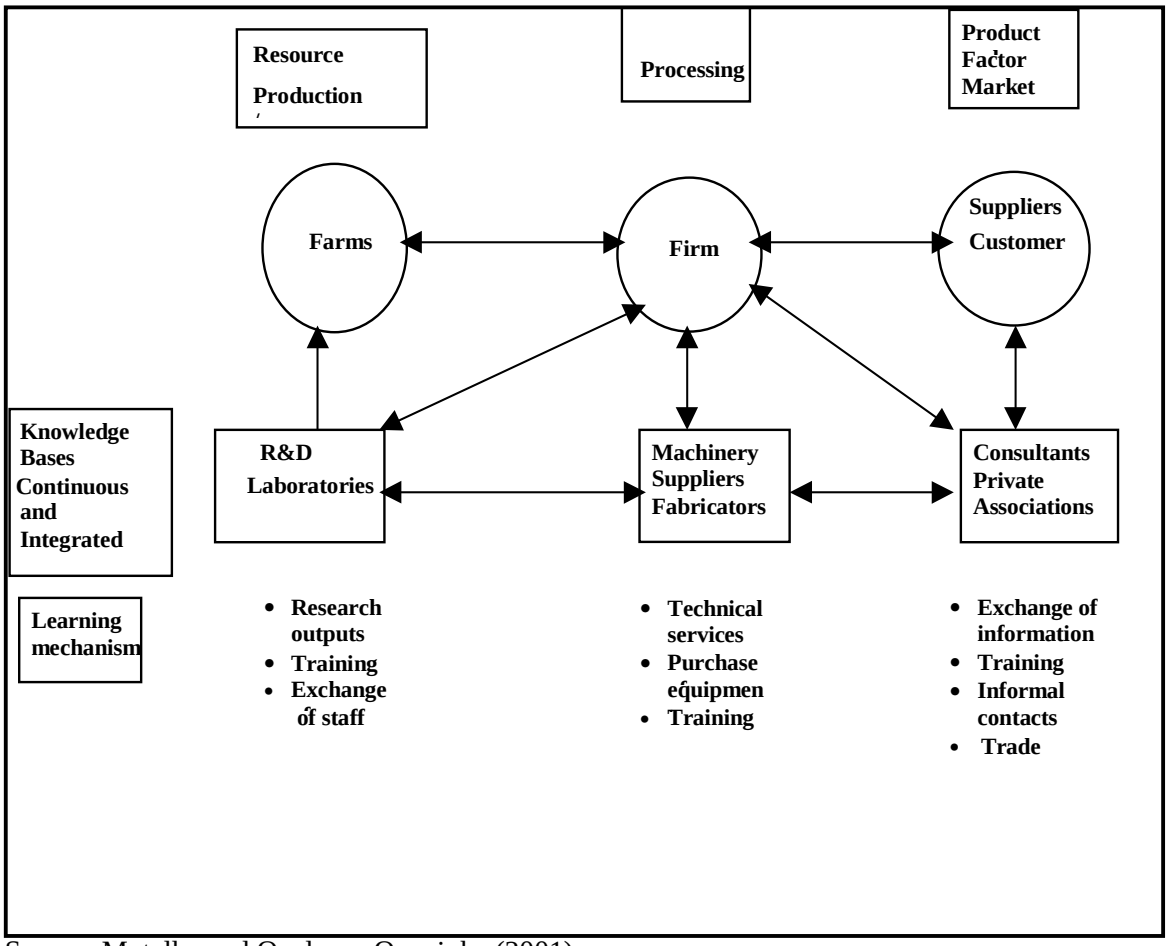
Source: Field survey

Table10: Source(s) of Raw materials.

Source(s) Firm	Own Farm	Contract Farmers	Open Market
A	1	0	1
B	0	0	1
C	0	0	1
D	0	0	1
E	1	1	1
F	1	1	0

Key: *1* = *Yes*
0 = *No*
Source: *Field Survey.*

Figure 2: Knowledge Bases and Learning in the national system of innovation



Source: Mytelka and Oyelaran-Oyeyinka (2001)

6.3 Manufacturing Skills, Research and Development

Crucial to the success of firms' innovative efforts was the establishment of hitherto non-existent departments, particularly, R & D as well as the acquisition of new skills. Developmental work was vitally important to validate laboratory results and to assure a confident progression to the pilot scale. Pilot plants are costly and scientists and engineers are needed to manage the extremely uncertain and risky process of scaling up to commercial phase, equally scarce. Only firms with the resources and technical support were able to create these departments and attract the requisite manpower. In addition to FIIRO, a number of science and engineering faculties in Nigeria's higher institutions were carrying out research work on sorghum malting and brewing. However none of them were equipped for activities beyond the laboratory, neither did they have practical experience in brewing. What they possessed was sound theoretical knowledge and the breweries contracted some of these researchers. Another source of technical training was staff training at the facilities of technical partners, particularly in Germany, The Netherlands and the United Kingdom. Evidently, only those with such partnership were able to tap into this

knowledge base. Figure 2 shows knowledge bases within the national systems and the ways in which the farm, firm and markets form a continuum in the process of innovation.

Table 11 shows the skills intensity of firm E that is similar to that of F. The skill intensity ratio of the leading firm is more than 0.6.o in the years 1985 to 2000, which is very high compared with sectoral average(11)

From Table 12, half the firms created new departments to cope with materials policy change. These are firms D, E and F. All the firms retained existing departments. In a related issue, 66.67% of firms employed new skills to cope with policy change. These include C, D, E and F. Nearly all, 83.33%, provided training (in-house and/or overseas) for existing skills in their respective firms.

Table 11: Skills Intensity in Firm E

Category	1985	1989	1990	1999	2000
Management	343	231	248	350	296
Engineers &Technicians	2748	2625	2586	2519	1979
Total	3998	3903	3942	3673	2884
Skill Intensity	0.687	0.670	0.66	0.685	0.686

Source: Annual Report and Accounts 1985-2000

The two industry leaders were able to deploy human and financial resources to overcome the ban and achieve conversion. The moderately and badly performing firms could not. The last two categories had close to 100 percent local ownership and did not enjoy the support of quality technical support provided by the MNCs to their affiliates. Local support systems proved inadequate for these firms. Traditionally, there is a bias against small firms by institutional lenders, and as such this group of enterprises rely mostly on own revenue, which may well be inadequate to finance innovation activities. This is because of the uncertain outcome of the process of innovation. Broadly there are four key steps in the innovation process which are:

a) Conception of an idea;
b) Experimental research;
c) Prototype development and design; and
d) Commercialization.

While (a) and (b) may take no more than 10 per cent of overall cost, step (c) consumes about 70 - 90 per cent of development cost. This stage of the innovation process tends to be the most demanding in terms of finance, skills and know-how. Since RDIs are not set up to build

prototypes and whole plants, firms are the agents to carry through the process. Small firms are also unable to carry the innovation process through due to their limited resources. Figure 3 describes roughly the way in which stage (c) becomes the innovation rate - determining step. The steep rise in cost often constitutes an obstacle to commercialization. Evidence from literature suggests that while small firms perform well in inventive activities (stages a and b), large firms achieve far greater success in bringing products to the market, (Freeman and Soete, 1997).

The large firms tend to develop strong international linkages and consult with indigenous Research and Development Institutes only when compelled to do so, as clearly demonstrated in this study. Given the nature of inventive outputs, it is clear that most of the medium and large firms employ technologies that are superior and relatively more complex than the RDIs have the experience and skills to deal with. Large firms again consider RDIs risky partners, given their bureaucratic nature; a point supported by the perceived isolationist tendencies of RDIs.

Figure 3: Steps in the Innovation Process

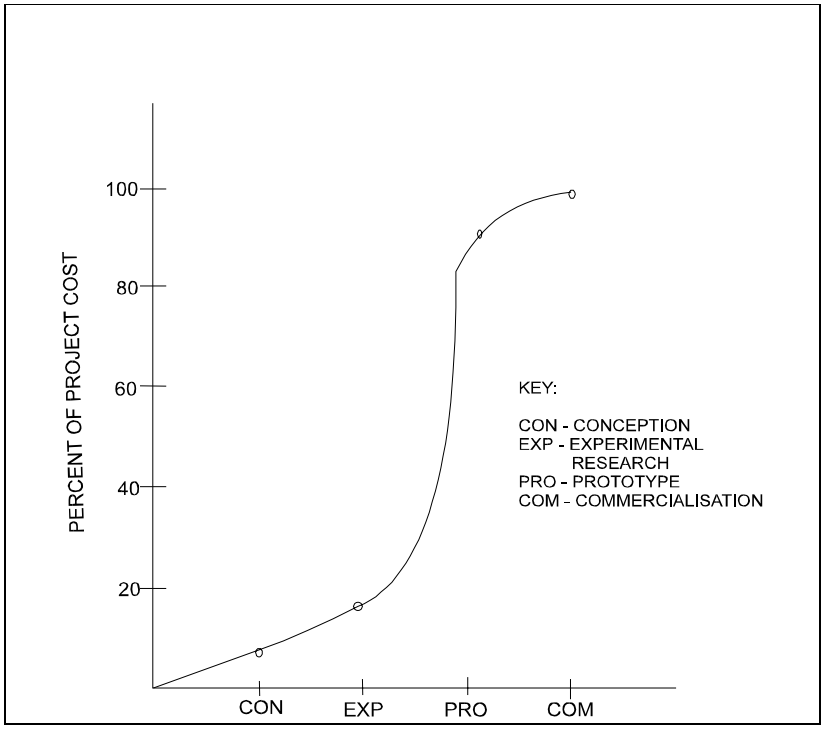


Table 12: Organizational Changes and Skill formation in Firms

Measures Firm	Create new departments	Close Existing departments	Employ new skills	Training of existing skills
A	0	0	0	1
B	0	0	0	n.a
	0	0	1	1
D	1	0	1	1
E	1	0	1	1
F	1	0	1	1
Create New Department %	50	-	-	-
Retained existing Department %	-	100	-	-
Employ New Skills %	-	-	66.7	-
Train existing Skills %	-	-	-	83.33

Key: 1 = Yes; 0 = No
Source: Field Survey

6.4 Quality, Pricing and Product Acceptability

Following changes to production process and use of local raw materials, we expected changes in quality, taste, colour and prices of beer produced. We accordingly sought information to evaluate consumer reaction to them. According to Table 13, 50% of customers liked the quality of beer produced from local cereals, 33.3% of them do not like the quality while 16.7% were indifferent. Also, half the customers provided information that the beer taste is good and a third were indifferent. Only 16.7% thought the taste were not as good as beer made from imported materials. Majority of the customers (83.3%) believed that beer colour and prices were good. This is in line with earlier reports that there was no significant difference in the flavour, aroma, mouth feel and overall acceptability between the commercial barley beers and sorghum beers (Ilori et al 1991).

In view of the responses of firms relating to materials conversion through the establishment of new or modified production processes, creation of new departments and acquisition of new skills, we conclude that the effect of materials policy change was strong on firm-level innovation, manufacturing skills acquisition and manpower upgrading.

In a broader sense the crisis induced by changes in domestic materials policy, according to empirical evidence, has brought about substantial technology development to the brewing industry. Accumulated knowledge and experience were deployed in the learning process particularly by large firms in a situation of crisis.

Table 13: Consumer information feedback

Firm	Beer Taste	Beer Colour	Beer Prices	Overall Beer Quality
A	0	+	+	- Quality
B*	+	+	+	+ None
C	+	+	+	0 None
D	-	+	+	+ Taste
E	+	-	n.a	+ Colour
F	0	+	+	- Quality
% like very much	50	83.3	83.3	50
% do not like	16.7	16.7	-	33.3
% indifference	33.3	-	-	16.7

Key. *(+) = like very much*
(-) = do not like
(0) = indifferent
(*) = *Quality, Taste, Colour and Price of Malt Drink*
Source: Field Survey.

6.5 Learning in Firms and Performance

While the impact of local sourcing of raw materials policy induced considerable technological accumulation overall, capacity utilisation declined. While data showed substantial new production lines establishment and old lines modification, capacity utilisation fell consecutively from 45% level in 1991 to 35% and 30% levels respectively in 1992 and 1993 for Firm A. In addition, Firm E experienced fall in capacity utilisation from 500,000 hectolitres in 1989 to 350,000 hectolitres in 1993 and 180,000 hectolitres in 1994. Empirically then, technology efforts did not induce immediate output increases represented by capacity utilization, Table 14 and Figure 4. The reason for the decline in the short term was linked to the pains of adoption as well as the economic constraints external to the firm. However, considerable technological learning took place as all the firms indicated. This led to greater dynamism reflected in the degree of product diversification in the sector. Some of the firms moved into the export market while some came out with what was considered a truly “good” beer. We suggest that the

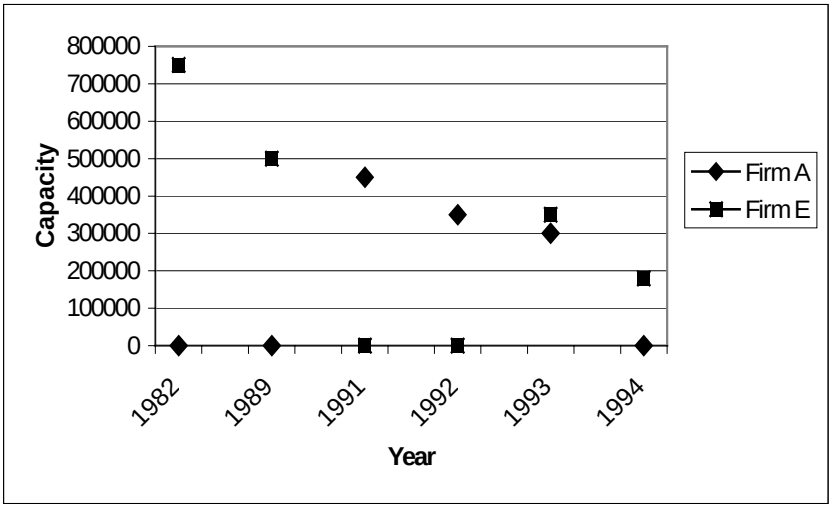
learning efforts and the subsequent confidence gained by the production teams played an important part in the new found dynamism of the firms[11].

Table 14: Capacity utilization for selected years in hectolitres.

Year	Firm F	Firm E
Capacity	1,000,000	750,000
1982	n.a	750,000
1989	n.a	500,000
1991	450,000	n.a
1992	350,000	n.a
1993	300,000	350,000
1994	n.a	180,000

Source: Field Survey.

Figure 4: Capacity utilization for selected years in hectolicters



[11] One of the two industry leaders the Nigerian Breweries was given the award of the "Quoted Company of the year" by the Nigerian Stock Exchange. It emerged the best out of the over 186 quoted companies that entered into the competition, The Nigeria Thisday newspaper, December 5, 2001, (www.thisdayonline.com/business)

6.5.1 Economic Performance of Firms

The economic performance of firms is proxied with value added and product diversification. The performance of the two industry leaders is used for the industry since they have the most reliable data[12].

The data on value added presents similar unstable yearly growth for the two firms. Firm F grew by 15%, 1 % and 17% respectively in 1987, 1988 and 1989. The year 1990, 1991 and 1992 also witnessed some relatively stable growth, 31%, 47% and 30% respectively, after which it fell to 16% in 1993 and peaked at 58% the following year.

The growth rate of the real value of turnover of Firm E exhibited successive increases in the three years following the change in raw materials policy. Though Firm E had achieved 100% substitution for maize and sorghum in 1987, the effect did not manifest until 1989 when turnover grew moderately by 5%, then increased phenomenally by 25% in 1990 and peaked in 1991 at 43%. Considering all the years together, the growth trend was unstable, reaching negative values in 1988 and 1992 respectively, Figure 5.

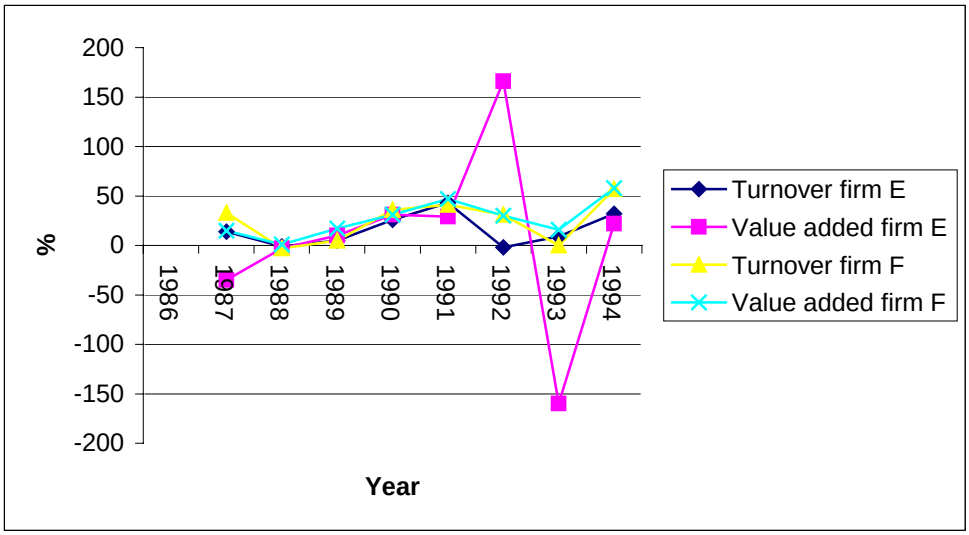


Figure 5: Turnover and Value added of firm E and F

Value added showed increases in the four years following the year of imported materials ban. It reached its peak in 1992 at 166% and its trough in 1993 at 160%. In between these extreme rates, average growth rates range between 10% and 31 %.

[12] Values were taken from the Annual Reports and Accounts of the firms. Nominal values were deflated by the consumer price index to retain their real values. 1988 is the base year used in the analyses as it corresponds to the year of total import restriction of raw materials. The period of analyses is 1986 to 1994

Table 15: Size Structure, Foreign Affiliation and strategies of firms

Brewery/ Location	Firm Size	Foreign Technical Assistance	Technical training prior to substitution exercise	Market/ Management strength
E–Lagos	About 5000	Research & Development of new process and purchase.	Quality control, and sorghum & maize brewing technology; skills acquisition and development.	Market leader/ Strong techno-managerial base
F –Lagos	about 3000	Research & Development.	New product and process development; skills development.	Market leader/ Strong techno-managerial base
D –Ijebu-ode	medium -sized*	Research & Development.	Product and Process change; training and local consulting assistance.	Serves fairly restricted markets niche/ Weak techno-managerial base
C –Sango-otta	medium	Provision of Yeast, spare parts.	Process and Product change development.	Serves fairly restricted markets niche/ Weak techno-managerial base
B – Agbara	medium	Raw material procurement, spare parts and R&D projects.	-	Serves fairly restricted markets niche/ Weak techno-managerial base
A – Ibadan	medium	Nil.	Product lines changed and kettle expansion.	Serves fairly restricted markets niche/ Weak techno-managerial base

Source: Survey
* Medium only in respect of the large firms, and not by the strict definition of SMEs, which places some of these firms in the large category

6.5.2 Product Diversification

The changes in the range of products of sample brewing firms are shown in Table 16. Nigerian Breweries and Guinness added two new products each to their range. These are Rex lager beer and Amstel Malta in the case of Nigerian Breweries, and Satzenbrau Larger Beer and Malta Guinness in the case of Guinness. Consolidated and Standard Breweries maintained their pre-materials policy product range. Sona Breweries and Vitamalt have respectively lost one and two Larger Beer after policy change.

Table 16 : Products Diversification.

Firm	Before Policy	After Policy	Difference
Nigerian Breweries Pic	Star Lager Guider lager Maltina	Star lager Guider lager Rex lager Maltina Amstel Malta	Rex Lager Amstel Malta (+2)
Guinness Nigeria Plc	Stout Harp lager Merit lager	Stout Harp lager Satzenbrau Malta Guinness Merit lager	Satzenbrau Malta Guinness (+2)
Sona Breweries Plc	Gold lager Tusklager Wilfort Dark Ale Maltonic	Tuskiager Wilfort Maltonic	Gold lager 1)
Consolidated Breweries PIC	"33" lager beer Hi – malt	u33" lager Hi - malt	(0)
Vitamalt Breweries Plc	Toplager Baron lager Vitamalt	Vitamalt	Top lager Baron lager (-2)
Standard Breweries Plc	Club lager Club Malta	Club lager Club lager	 (0)

Source: Field Survey.

6.5.3 Costs of Production

Table 17 depicts the production cost effect of change in production processes induced by materials policy change. About 67% of the firms experienced higher costs of production as a result of the substitution exercise, 40% of which carried 20% - 30% additional cost. Only one firm, reported lower production costs, with the reduction being less than 10%. Given that production process change required the establishment of new facilities such as new departments, own farms, new production lines, employment of new skills as well as retraining of existing skills, the higher production costs are explained by these factors.

Table 17: Production Costs

Firm	**Production** Cost Changes	**Percentage** Change (%)
A	Lower	Less than 10
B	n . a	n . a
C	Higher	30
D	Higher	20-30
E	Higher	20-30
F	Higher	10-20

Source: Field Survey.

6.6 Innovation and firm characteristics.

In this section we examine the hypothesis that firm characteristics significantly influenced the innovative behaviour of firms. Evidence from the study show that both variables tend to move in opposite direction in some cases, and directly in others, and thus is inconclusive. Tables 15, and 16, and Appendix Tables 2-6 show firm characteristics of ownership pattern, foreign assistance, type of foreign relationship, type of foreign technical support, foreign technical staff assistance, and relationship with local R & D institutions.

6.6.1 Firm Size Affiliations and Innovation Strategies

Firms E and F had on the average, a combined staff strength of about 8000 people while the middle-sized firm has a staff strength of between 400-600. These large firms have skills, and resource advantages over the medium-sized firms. Firms E and F have all the requisite foreign administrative and technical support, including that of local R & D institutions, and thus have very strong foreign technical relationship.

6.6.2 Ownership and Innovation

Ownership of firms correlates strongly with innovation and market performance. Firms with strong and long-standing technical collaboration with foreign MNCs had greater access to technical and financial resources and were able to manage the transition relatively smoothly. They also possessed an ownership structure that is more foreign than say, Firm C, which also had very strong foreign technical relationship. Therefore, on the one hand, we have a strong foreign technical relationship with strong foreign ownership (Firms E and F), and on the other a strong foreign technical relationship with weak foreign ownership (Firm C).

In other words, foreign affiliation traditionally perceived by policy makers as an encumbrance to local sourcing and hence detrimental to the speed of technology development is not borne out by facts. Another situation exists where greater Nigerian ownership that is perceived to possess fewer encumbrances to policy implementation that would hasten the pace of technology development is not also borne out by available facts. Thus, though firm characteristics are perceived to influence technology development, the direction of causality is inconclusive. In other words, ownership per se was not the issue but the attitude and practices of firms, and they ways in which they deployed the technological assets available to them, in this situation of production crisis.

Table 18 Ownership pattern (%)

Company	Nigerian Shareholding	Foreign Shareholding
A	n.a	n.a
B	n.a	n.a
C	78	22
D	60	40
E	60	40
F	60	40

Source: Field Survey

7.0 CONCLUSIONS AND POLICY IMPLICATIONS.

The firms in our study responded to threats induced by state policy through a number of innovative strategies. The scope for productive technological learning and innovation was as wide as the variety of choices to be made. These include market expansion, new vintage investments and modification of existing plants in which the skills of engineers we re tested and utilized. Firm-level innovation took several forms: introduction of new processes or products, organizational changes, and undertaking of R&D (broadly defined and not limited to basic research).

For developing countries, the opportunity for industrial learning as a result of unexpected changes in the economy may be limited, but not totally absent. State intervention sought to influence the pace of industrial development and in the process created a crisis environment for firms. For certain categories of firms, the *opportunities for change* became a threat to the survival of the firm, for some it was simply a threatening of market leadership, while for others, it signaled exit.

But "crisis could also be a *galvanizing* event with organization-enhancing outcomes", (Loveridge and Pitt, 1990). Firms that survive such galvanizing events respond by innovating. According to (Freeman and Soete, 1997), "not to innovate is to die". The defining denominator in the type and robustness of response was firm-level capabilities including financial and organizational resources The broad range of strategies adopted by firms depended on firm assets, habits and practices, management and technical capabilities, and sometimes serendipity, confirming much of what the literature had to say about these issues, (Freeman and Soete, 1997; Ernst et al, 1998; Nelson and Winter, 1982).

This study evaluated the responses of firms in the brewing sector to the policy of local sourcing of raw materials. It also examined the way policy was managed and the impact of policy on the brewing industry. Finally, in the process, it uncovered variables or factors, which establish the relationship between policy and responses and between policy and performance. There are important policy implications that are pertinent in each of these areas.

The policy to promote local sourcing of key raw materials in the brewing industry was accomplished through the banning of the importation of these inputs. Evidence presented in this study revealed that the policy succeeded broadly in achieving its primary objectives. The wholesale adoption and acceptance of the policy was predicated on the number of favourable features and characteristics of policy itself. In other words, the firms found it largely in their

own interest to adopt the policy because of the cost, convenience and foreign exchange savings arising from it. Also, the policy provided sufficient lead-time for many of the firms to reorganise many of their production processes in accordance with the requirement of the use of the locally sourced materials. In short, the consonance between government's and firms' objectives assured the success of the materials policy. The main lesson here is that the policy which takes explicit account of the interests of those it affects is more likely to elicit the expected range of responses.

The policy itself resulted from a careful determination of what is feasible technologically. Research studies, production using raw materials in a pilot scheme, planting grains (e.g. sorghum and maize), all were done to confirm the feasibility of the local sourcing of raw materials years before the imposition of the ban and hence of the local sourcing of raw materials policy.

The logical planning and design of this policy as well as the consultation between government and the affected sectors of the private sector promoted a fuller understanding of the limit of technical feasibility, the implications for technology acquisition, the availability of local substitute and the financial implications of the policy prior to its implementation. In any case the thorough understanding of the technical and conceptual processes on the government side made it difficult for government to succumb to pressure for a reversal of that policy. In all, it seems clear that the process of designing and managing this policy exhibited a number of strong features that enhanced its success.

This policy was implemented at a very difficult time for the Nigerian economy. Although, the firms upon which this policy directly impacted responded eagerly and in the appropriate direction the generally depressed condition of the Nigerian economy led to a number of unexpected results. For instance, a 'shake-out' occurred in the industry: the number of breweries fell drastically from around thirty to less than twenty; while capacity utilization among the surviving breweries also declined. Perhaps, it is conjectural to suggest that the survivors remaining are because of the policy. In other words, it would be incorrect to ascribe this undesirable result to the policy itself. We do know that the share prices of these companies are doing well on the stock market indicating that the companies are individually liquid and profitable. For instance, the share prices of one of the firms rose from 380 kobo in January 1992 to 497 kobo in January 1994, while for another, the share prices rose from 578 kobo in January 1992 to 890 kobo in 1994. An important policy lesson may be that major policy changes are more likely to achieve their objectives without some initial negative effects if they were implemented in more accommodating and political environment.

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APPENDICES

Appendix Table 1: Breweries: Input, Ownership and Age of Firms

Firms	Capacity in HL and Cap/employee	Year of est. and Age in 1994	No of emp.	Raw materials in 1993	Brand and Rating of Technical Partnership L=Low; H=High	Nigerian owner ship
Africana breweries Ibadan	150,000	1997 (3)	-	-	castel	-
Associated breweries Lagos	600,000 (1.0)	1975 (19)	600	sorghum	baron, top (LOW)	100
Benue breweries Makurdi	200,000 (1.18)	1982 (12)	170	-	More (LOW)	80
Champion breweries Uyo	500,000 (2.73)	1974 (20)	183	malted sorghum	champion-lager, malta; (LOW)	97
Consoli-dated breweries Ijebu-ode	750,000 (1.88)	1971 (23)	400	sorghum maize grits	‘’33’’ export (HIGH)	60
Dubic breweries Aba	150,000 -	1979 (15)	-	-	dubic special (LOW)	-
Golden guinea breweries Umuahia	600,000 (0.78)	1962 (32)	767	sorghum	bergedorf eagle stout (LOW)	95
Guiness nig. plc Lagos	1,500,000 ( )	1950 (44)	-	sorghum	Guiness stout Malta; (HIGH)	60
International breweries & beverages ind Kaduna	500,000	1982 (12)	-	-	kronen-bourge (LOW)	-
International breweries Ilesa	250,000 (0.83)	1971 (23)	-	-	Trophy (LOW)	94
Jos International Breweries Jos	1100000 (1.49)	1975 (19)	740	sorghum maize grits	Rock (LOW)	75
Life Breweries Onitsha		1983	-	-	life continental	
Nigerian Breweries Lagos	3,100,000 (0.7)	1946 (48)	4500	-	Star, guilder rex,legend, maltina greensands (HIGH)	60

North Breweries Kano	800,000 (2.0)	1965 (29)	402	maize sorghum	Double crown Power stout (LOW)	100
Olympic Drinks co. ltd Anambra	250,000	1982 (12)	-	-	Canon (LOW)	100
Pabod Breweries Port-harcourt	250,000 (0.98)	1978 (16)	255	malted sorghum	grand beer, ‘’ malt (LOW)	95
Pal Breweries Anambra	250,000	1981 (13)	-	-	pal beer (LOW)	92
Premier Breweries Onitsha	750,000 (0.83)	1978 (16)	900	maize sorghum	premier, master, multimalt (LOW)	100
Superbru ltd Lagos	330,000 (0.83)	1974 (20)	400	maize sorghum	skol, super malt (LOW)	100
Standard Breweries Ibadan	NA	1971 (23)	329	hop pellet sorghum	club beer, africola (LOW)	60

source: Manufacturers Association of Nigeria

Appendix Table 2 : Foreign Assistance

Company	Technical Partner	Type of Relationship	Type of Tech. Assistance
A	None	None	None
B	Formerly XYZ. Now None	Use of Brand Names	None
C	Y Ltd, Europe	Equity participation Brand Names Technical Support	* Spares and Components * R&D for new processes and production * Plant Refurbishment * Major Annual Maintenance * Raw Materials
D	X of D, Europe	Use of Brand Names	* Spares and Components * Plant Refurbishment * Provision of Yeast
Company	Technical Partner	Type of Relationship	Type of Tech. Assistance
E	IB of B, Europe	Equity participation Brand Names Technical Support	* Spares and Components * R&D for new processes and production * Plant Refurbishment * Major Annual Maintenance * Raw Materials
F	H H, Europe	Equity participation Technical Support	* Spares and Components * R&D for new processes and production * Plant Refurbishment * Major Annual Maintenance * Raw Materials

Source: Field Survey N. B. Real Name of technical partners arecoded to For confidentiality

Appendix Table 3: Types of Relationship

Company	Equity Participation	Use of Brand Name	Technical Support	Total
A	0	0	0	0
B	0	1	0	1
C	1	1	1	3
D	0	1	1	2
E	1	1	1	3
F	1	0	1	2

Key: 1 = Yes; 0 = No; Total Column: 0 = Very weak; 1 = weak
2 = Strong; 3 =Very Strong

Sources: Field Survey

Appendix Table 4: Types of Technical Assistance

Company	Spare parts and Components	R & D for new: process and production	Plant Refu-rbishment	Major Annual Maintenance	Raw Materials	Total
A	0	0	0	0	0	0
B	0	0	0	0	0	0
C	1	1	1	1	1	5
D	1	0	1	0	0	2
E	1	1	1	1	1	5
F	1	1	1	1	1	5

Key: 1 = Yes; 0 = No; Classification on Total Column: 0 =Very weak; 1 = weak
2 = Strong; 5 = Very Strong

Appendix Table 5: Foreign Technical Staff Assistance

Company	Type of Assistance	Number of Staff
A	None	None
B	None	None
C	Engineers	6
D	Engineers and Technicians	5
E	Technical and Production Manager	5
F	Product Developers	3

Appendix Table 6: Relationship with Local R & D Institutions

Company	R & D Institution	Nature of Linkage	Incentive behind Linkage
A	None	None	None
B	None	None	None
C	None	None	None
D	None	None	None
E	Ministry of Science	Policy Negotiation, Pilot Scale	
	and Technology	New Product Development	None
F	Federal Institute	New Product Development	New Product Development
	of Industrial Research		

Source: Field Survey

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