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Empirical Analysis and Policy Options for National Growth: Innovation, Technological Learning and Investment

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Abstract: *It is known that comparative advantages associated with location and natural resources no longer translate robotically to development. Rather, these factors need to be catalysed in the presence of technological learning, innovation and investments. In this paper, we explored the relevance of these catalysts to national competitiveness and further examined innovation policies with a view to finding the way forward for developing nations in particular Nigeria. Our data were sourced from the Global Competitiveness Report, the World Economic Outlook Database and a manufacturing innovation survey in Nigeria. The results show that technological innovation, learning and investments are still relevant to national competitiveness. But there is an emergent dynamism in the factors that influence competitiveness, especially as measured by employment. The policy implications from the results suggested the adoption of a dynamic approach to science and technology policy making, creating sustainable funding structures and strengthening fiscal controls. This paper concluded that concentrating on market liberalisation and FDI inflows are not important for manufacturing innovation as they have been made to appear.*

Keywords: *technological learning, innovation, investments, policy,*

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I. Introduction

It is no longer a robotic relationship between countries' location and natural resource advantages and their national competitiveness. But, nations now realise that a dynamic combination of technological innovation, learning and in some quotas investments, are required for them to transform their comparative edge into competitive advantage. In the presence of these factors, the advantages associated with the location of a country and its natural resources could be catalysed to become key sources of competitiveness. According to a tutor, a professor of technology management, he opined that for national industrialisation to be achieved, the citizens of that particular country need to engage in learning (Ogbimi, 1990; 1999). Only through this can technology capabilities be developed and sustained through innovation. Furthermore, his position of a nation emphasising on investment either on infrastructure is associated with a mere acquisition of depreciating assets which does not promote sustainable growth (Ogbimi, 2003).For rapid industrialisation, this necessitates tapping into the global pool of knowledge and diffusion of the imported technology in the course of experimentation as well as the ongoing learning process which involves continuous interaction among different actors, institutions and networks (Gebreeyesusand Iizuka, 2011).

This is what nations at the frontier of science and technology (S&T) have achieved; and a host of other rapidly emerging ones have numerous success stories, largely deriving from a commitment to S&T. The story of how sugar cane has been made a major driver of global competitiveness in Brazil (Goldemberg, 1998) and the more recent discovery of the flower industry in Ethiopia (Gebreeyesusand Iizuka, 2011)are illustrative of this. Consequently, latecomer nations and regions have also devoted much attention and resources to the deployment of S&Tas a major agent of competitiveness. However, as more nations explore, new knowledge is being developed, new experiences are being acquired and new economic hubs keep emerging to the extent that today's world is characterised by globalisation (which has significantly eliminated trade barriers) and technology-driven growth.

In spite of the abundance of knowledge that globalisation has endowed, nations are still virtually divided based on their ability to develop, acquire and exploit knowledge. It is indeed apparent that the growth of a nation now depends largely on its ability to learn, innovate and make the necessary investments as pre-conditions for itscompetitiveness. In this paper, our aim is to assess the extent to which these pre-conditions influencenational wealth and growth in terms of per capita GDP and employment. Specifically, this paper seeks to investigateon the following:

i. the relationship that exists between innovation, technological learning and investments and national growthin terms of competitiveness; and
ii. in the case of innovation how should a developing nation proceed towards facilitating it in the industrial sector?

The paper is divided into 4sections. After this introductory section, the data and methodology employed to address the objectives of the paper are discussed. This is followed by the results and discussion in Section 3. The paper concludes in Section 4.

II. Data and Methods

The first question addressed in this paper focuses on the drivers of growth. By definition, competitiveness measures the relative efficiency at which a nation generates its outputs.We approximate competitiveness by taking measures from the Global Competitiveness Report (GCR) 2008-2009 (WEF, 2008). Details on how each measure was obtained are contained in the full report but for our own analyses, we selected specific indices related to the three issues of concern: innovation, technological learning and investment (Table 1). Focusing on 20 economies in the Global Competitiveness Report, with Nigeria included as a sub-Saharan African representative of the developing world, we checked the impact of these indices on competitiveness and growth through a linear regression model, taking unemployment rate and GDP per capita as the proxies for growth, one after the other. Our data for unemployment rate and GDP per capita was sourced from the World Economic Outlook 2008 database[1].

Table 1: The measures of competitiveness

Measure	Indices	Computation
INNOVATION	innovation; goods market efficiency	Sum
INVESTMENTS	financial market sophistication; infrastructure	Sum
TECHNOLOGICAL LEARNING	technological readiness; higher education & training	Sum

Data sources: World Economic Forum, 2008

For the second question which focuses on policy options to enhance industrial innovativeness, we use data from a manufacturing innovation survey implemented by the National Centre for Technology Management (NACETEM, 2009). The survey was based on the Oslo Manual guidelines and relied heavily on the methodologies proposed by UNU-INTECH (2004). Thus, a total of 250 firms were examined with about 86% response rate – data from the survey represents a reliable source of information on manufacturing innovation in Nigeria. In the survey instrument, firms were asked a set of unique questions that is not common to other innovation surveys. The questions, which we selected for our descriptive analyses in this paper, are as follows:

i. Did your firm make use of government support in its innovation activity? Yes/No
ii. Please rate the importance of the following government support programmes for innovation in your firm (1- not important to 4 – very important): R&D Funding, Training, Subsidies, Tax Rebates, Technical Support/advice, Infrastructure support, Loans and Grants, Others (please specify)
iii. Is there any policy of government that hinders your firm's innovation activities? Yes/No
iv. Please give a few examples of such policies (for firms that answered Yes to the preceding item)
v. Please give any suggestions on how government can encourage innovation in your industry.
vi. In the light of all of your responses, please give your own brief perception of the concept of innovation and its importance for the firm.

III. Results and Discussion

3.1 Innovation, technological learning and investments as drivers of competitiveness

We found that the three predictors that we assessed, viz innovation, technological learning and investments, are strongly associated with one another (Table 2). On the one hand, innovationshows a 73% likelihood of increasing with increasing investments in infrastructure and sophistication of the financial market. On the other hand, higher education and training and technological readiness show 79% likelihood to increase with increasing investments. Innovation and technological learning are also positively associated. This is a pointer to the fact that when a nation seeks to excel in one of these, it invariably gets enhanced in attaining excellence in the others. This, indeed, is a key policy lesson for African nations.

[1] http://www.imf.org/external/pubs/ft/weo/2008/02/weodata/index.aspx; October 2008

Table 2: Descriptive and correlation statistics of the measures of growth and competitiveness

	Mean	SD	1	2	3	4	5
GDPPC	4.76E4	2.04E4	-				
UNEMPLOYMENT	4.46	1.92	-0.19	-			
INVESTMENT	11.09	1.18	0.46*	0.13	-		
TECHNOLOGICAL LEARNING	10.78	1.19	0.64**	-0.33	0.79**	-	
INNOVATION	10.12	0.76	0.32	-0.01	0.73**	0.79**	-

** Correlation is significant at the 0.01 level, 2-tailed

Our regression results show that the factors of innovation, learning and investment contribute significantly to growth (Table 3). They jointly account for 91.1 percent of the variation in GDP per capita and 83.9 percent of the variation in unemployment rates (Table 3) among the cohort of countries that we assessed. Of course, we conclude that our results are indicative for a broad spectrum of countries. Quite interestingly, we found that GDP per capita was particularly responsive to innovation and technological learning but not to investments. It follows, then, that a more sophisticated financial market and adequate infrastructure will not necessarily translate to more wealth within an economy. This finding is intuitive because macro-level investments are not ends in themselves, but means to an end – they only translate to wealth when institutions, businesses and individuals make use of them. The issue to be taken up by policy makers here is how to create effective mechanisms to facilitate the deployment of macro-level investments for wealth-creation.

Also very interesting is the fact that unemployment rate turned out not to be significantly influenced by any of investment, technological learning and innovation, as we measured them. This would suggest that the direct influence of these factors on unemployment is rather weak and not readily observable. For policy making, this implies that reducing unemployment requires interventions that go beyond the macro-level issues that we have addressed here. The key challenge for national leaders and policy makers lies in identifying what factors actually drive unemployment. Some of the factors we already know but others, which may be business environment specific, need to be identified – and that is clearly beyond the scope of this paper.The importance of technological learning and innovation to national wealth tells us that these factors are still very relevant as key drivers of the process of growth. This is consistent with the literature on growth and development, which advance the argument that the rate of knowledge uptake influences a nation's quest towards the attainment of growth and competitiveness.

Table 3: Results of the linear regressions on national wealth (GDP per capita) and growth (unemployment rate)

GDP per capita	B	SE	t	Sig.
INVESTMENT	193.872	4869.860	0.040	0.969
TECHNOLOGICAL LEARNING	17445.999	5353.988	3.259	0.004
INNOVATION	-14099.839	5536.358	-2.547	0.020
R^2= 0.911				
Unemployment Rate	B	SE	t	Sig.
INVESTMENT	0.689	0.623	1.107	0.284
TECHNOLOGICAL LEARNING	-0.911	0.796	-1.144	0.269
INNOVATION	0.653	0.895	0.729	0.476
R^2=0.839				

3.2 Government Action in Support of Innovation

We now focus on innovation as a policy issue. It is considered very beneficial to understand policy issues from the point of view of manufacturers who are generally at the receiving end of policies aimed at fostering industrial innovation. Every firm was asked to give a definition of innovation and/or indicate how important they think it is. Only 43 firms (about 30% of innovators) responded to this question and their responses were sorted separately into definitions and perception of importance (Table 4).

Table 4: Definitions and Importance attached to innovation by manufacturing firms

Definitions of innovation advanced by firms	**No. of firms**
Improved manufactured goods to compete with foreign ones	3
Innovation makes 70% of people to know what is going on	2
It has to do with new ways of doing things for positive outcome	1
Steps taken to enhance productivity or reduce cost of production	1

Repositioning of firms and production in the market	1
A means through which products/process can be improved	1
Firms' perception of the importance of innovation	
It is the key to survival of a firm in a competitive environment	10
It makes the economy grow faster	5
It boosts production efficiency	2
Improves on quality of the product	2
Enhances profitability	2
It enhances quality and quantity of an output at cheaper cost	2
It brings about change	1
Any organisation that wants to be profitable needs to engage	1
It boosts sales and improve marketing strategy	1
It keeps one above competition	1
Promotes efficiency, creativity, productivity and stability	1
Boost production efficiency for maximum profit	1
It is necessary when we are to gain more market shares profit	1
It gives new dimension to production and quality of products	1
It is the launching pad of development	1
It is at the core of our strategy and facilities our NPD	1

Source: NACETEM, 2009

Six different definitions were advanced by the firms, four out of which have to do directly with products, processes, production and/or productivity. This suggests that more manufacturing firms seem to perceive innovation from a technological perspective rather than relating to a broad gamut of firm-level activities. This is further amplified by the fact that none of the definitions explicitly presented innovation from the demand or market perspective. On the importance of innovation, firms seemed to place more emphasis on the impact of innovation on economic survival and economic growth relative to other positive impacts. Product quality and profitability also generate attention among the firms.

It is important to note that government's role in supporting innovation could be played not only through institutions but also via several mechanisms, ranging from funding support, incentives and knowledge provision.[2] Firms indeed attach importance to these "soft" support forms. This is evidenced in the fact that only about a quarter of the manufacturing firms had used government support to innovate (Table 5) but over 30% consider government loans and grants, tax rebate and infrastructure provision as very important (Figure 1). It is instructive to note that the low levels of availability of support from government is undesirable and calls for urgent policy action.Based on the results contained in Figure 1, a very important implication for policy can be inferred. More firms actually rated loans and grants, tax rebates and infrastructure support as very important forms of support that government should provide. This implies that, from the standpoint of manufacturing firms, reduced cost of capital in the form of loans and grants as well as reduced tax burdens are much more critical for improved innovativeness than government-driven R&D funding. We note that while taxation is a necessary and unavoidable cost for firms, the real problems in Nigeria – and perhaps in many other African nations – relates tomultiple taxation, poor infrastructure and high cost of capital.

Table5: Awareness and Use of Government Support for Innovation by Innovating Enterprises

Government	**Percent innovators**
Used government support in innovating	25.2
Aware of any government policies that support innovation	32.9

Source: NACETEM, 2009

[2] See Oyelaran-Oyeyinka (2007) for a more thorough argument on this.

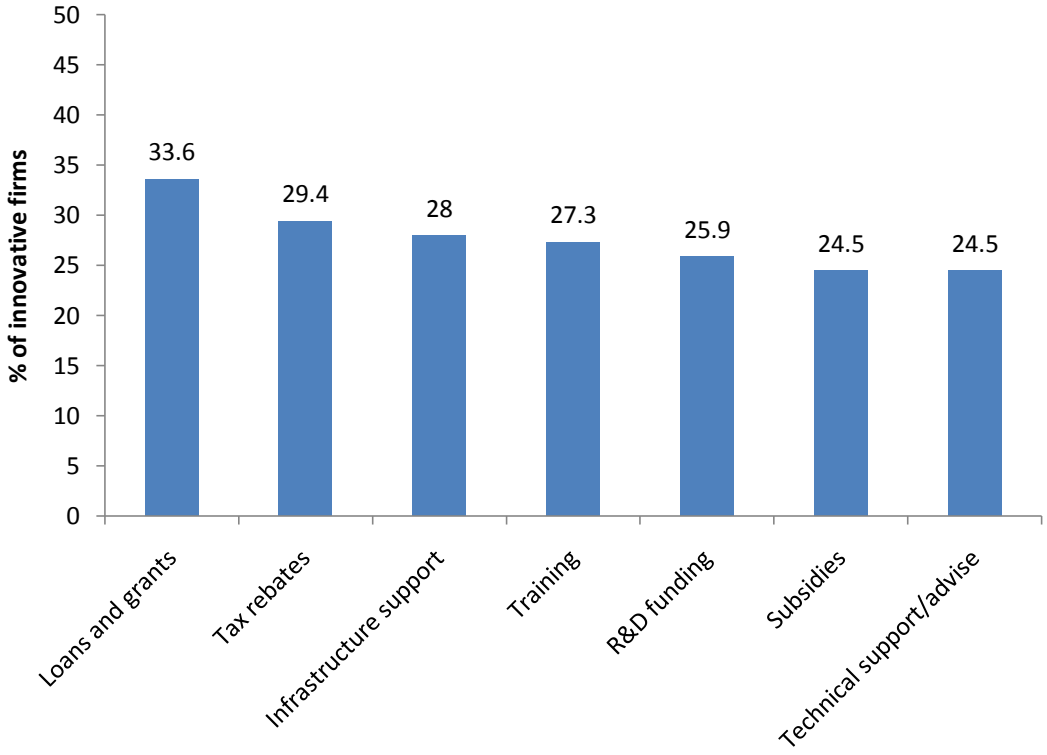

Figure 1: Government support actions rated as very important by innovative firms
Source: NACETEM, 2009

3.3 Policy Optionsin Support of Innovation

The results of the two explicit policy-relevant items are summarised in Figures2 and Table 6. First, firms were directly asked to identify specific policy areas that they are aware of which hinder industrial innovativeness. About a third (29.4%) of all the Nigerian firms sampled indicated the existence of certain policies of government that hinder innovativeness. A breakdown of the broad policy areas that they identified is shown in Figures2. Infrastructure and taxes top the list of policy issues that are of importance to the manufacturers. It is instructive to note that power supply and communication are still considered problematic despite much concerted efforts by government.

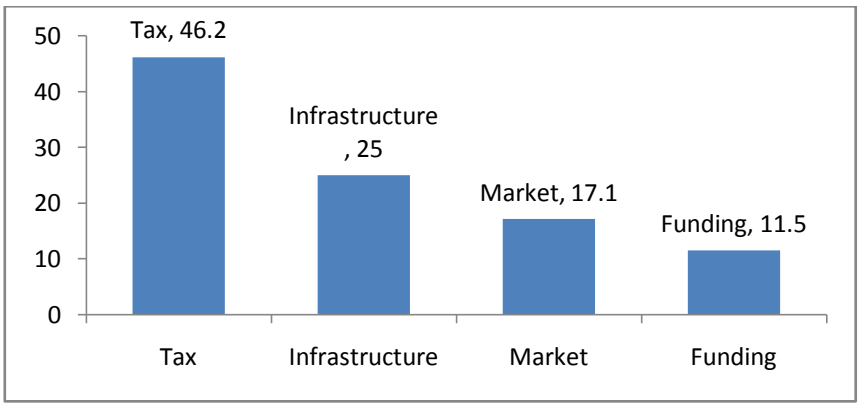

Figure 2a: Summary of broad policy areas identified as problematic by firms

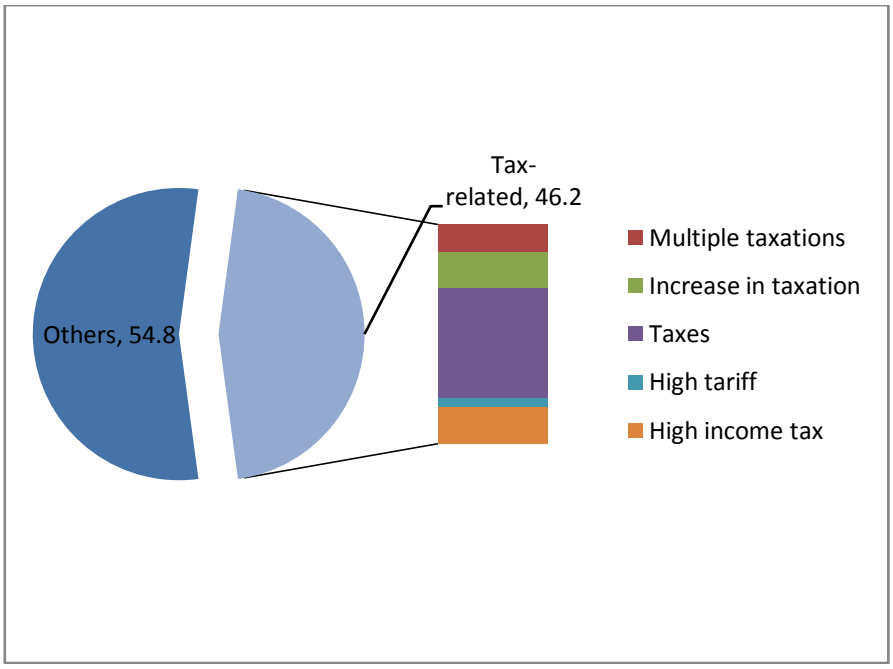

Figure 2b: Details of tax-related issues

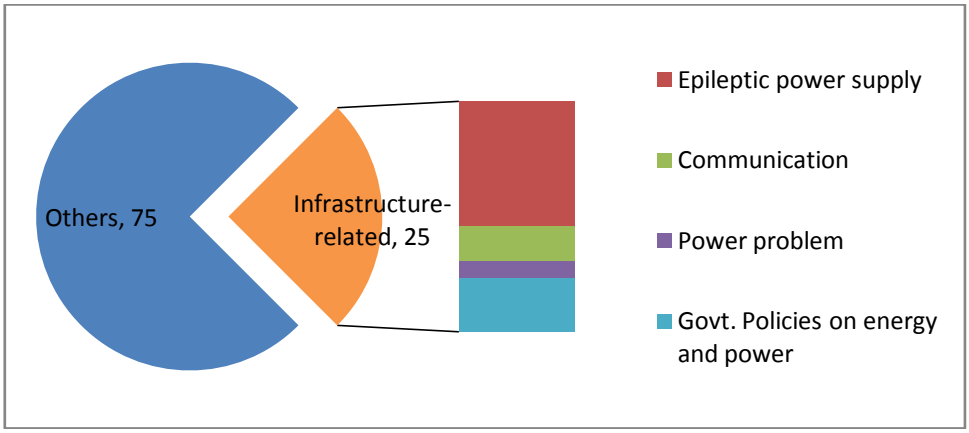

Figure 2c: Details of infrastructure-related issues

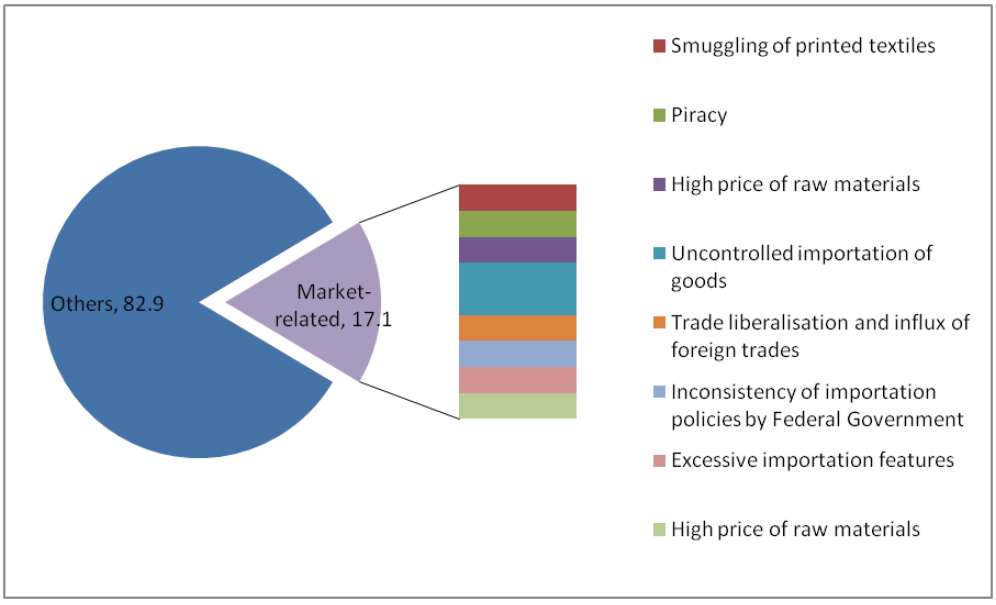

Figure 2d: Details of market-related issues

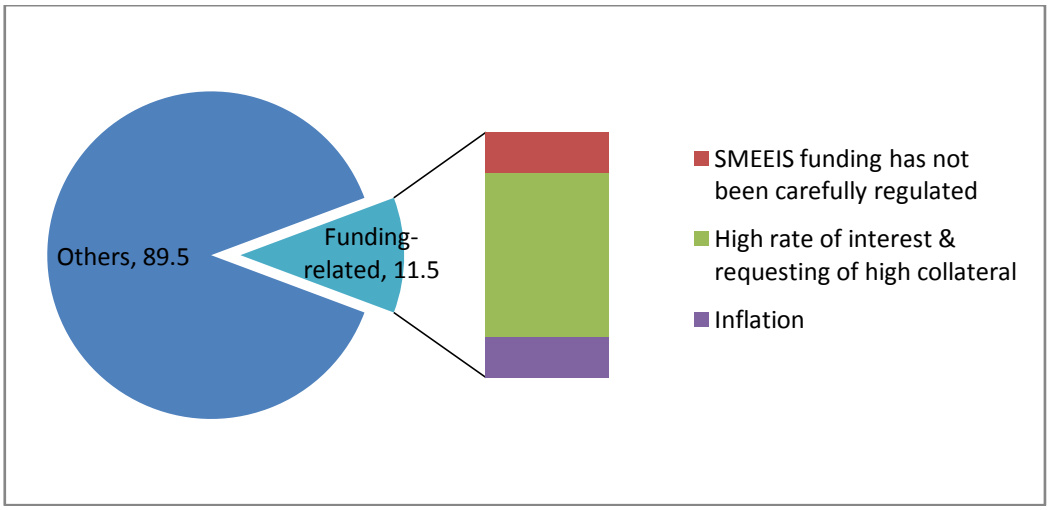

Figure 2e: Details of funding-related issues

Source: Plotted with data from NACETEM, 2009

Secondly, the firms were asked to make specific policy suggestions for enhanced innovation performance. In Table 6, a summary of the suggestions that firms made is presented. Again, tax-related concerns top the list, followed by the use of government procurement to encourage local manufacturers. The relative non-importance of market liberalisation to manufacturers is also indicated.

Table 6: Firms' policy recommendations for enhancing firm-level innovation

Policy Suggestions	Percentage
Tax and tariff reduction	18.8
Government procurement to encourage local producers	6.5
Capacity building	5.9
Improved power supply	4.7
Improved funding and venture capital	4.7
R&D support	4.1
Macro-economic/general improvements	2.9
Improved infrastructure	1.8
Market liberalisation	0.6

Source: NACETEM, 2009

IV. Conclusions

We conclude, based on our results that innovation, technological learning and investments are relevant to the achievement of national growth as they collectively serve to reduce unemployment and increase per capita GDP. However, for maximum effects, it is important to harness their power of association by stimulating parallel efforts in attaining excellence in all of them.It is worth noting that the drivers of competitiveness might be changing, suggesting that policies need to be dynamic and responsive to evolving trends. We also conclude, based on the Nigerian experience, which the industrial sector expects a lot from government but government action has not been particularly satisfactory as most firms have not accessed any form of support from government. This, however, is not to say that the government has not been making efforts. Interestingly, the results also show that market liberalisation is not considered as important to innovation by manufacturing firms as against lower cost of capital, adequate infrastructure and proper fiscal control.

A number of recommendations could be pulled together on the basis of the results in this paper. To start with, it is fundamentally important for government to create an ambience that is favourable for manufacturing growth. Stable and favourable policy and political regimes as well as strong and focused institutions would go a long way in facilitating sustained manufacturing activity and national innovativeness. Similarly, the roles that government plays in the support of manufacturing outfits should be significantly increased. Of note is the need to create structures for effective funding support, reduced cost of capital, technological learning, enhanced access to inputs and markets as well as proper fiscal control. Finally, following Costa and Filipov (2007), we recommend that African governments should first concentrate on enhancing innovativeness and development of existing foreign-owned affiliates before striving to attract higher volumes of

FDI inflows.This will be achieved through the creation of effective mechanisms for endogenous capacity and capability building to the extent that top-quality human capital becomes more readily available in a sustainable and less expensive manner.[3]Besides creating incentives for these multinationals to 'stay in', it also facilitates the attraction of FDI as more multinationals see the incentives for entry.

For future studies, two implications can be pointed out from our regression results. On the one hand, the relatively non-significant contribution of technological learning,innovation and investment to unemployment calls for further exploration as it appears to be counter-intuitive. The same goes for the negative contribution of innovation to GDP per capita. On the other hand, these patterns may be pointing out the emergence of new paradigms in the factors that account for growth and competitiveness. Similar future studies need to further examine this.

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Table 1: Detailed data on the selected countries

						INVESTMENTS		TECH. LEARNING		INNOVATION	
Country	GCR Index Rank	Population (millions)	Unemployment Rate	GDP* (billions)	GDP per capita**	Infrastructure	Financial Market Sophistication	Higher Education and Training	Technological Readiness	Goods Market Efficiency	Innovation
United States	1	304.82	5.62	14334.03	47025.3	6.1	5.61	5.67	5.57	5.32	5.84
Switzerland	2	7.31	2.56	492.55	67378.87	6.4	5.26	5.6	5.76	5.34	5.54
Denmark	3	5.49	1.8	369.58	67386.89	6.01	5.82	5.98	5.87	5.39	5.09
Sweden	4	9.22	6.62	512.89	55623.77	5.71	5.65	5.83	5.99	5.34	5.42
Singapore	5	4.67	2.1	192.77	41291.12	6.39	5.94	5.56	5.65	5.83	5.08
Finland	6	5.27	6.19	287.62	54577.85	5.94	5.51	6.07	5.46	5.22	5.57
Germany	7	82.12	7.43	3818.47	46498.66	6.65	5.35	5.15	5.22	5.19	5.22
Netherlands	8	16.7	2.81	909.47	54445.06	5.71	5.57	5.52	6.01	5.39	4.82
Japan	9	127.68	4.05	4844.36	37940.48	5.8	4.75	5.08	5.11	5.13	5.52
Canada	10	33.23	6.16	1564.08	47072.9	6.12	5.58	5.52	5.61	5.18	4.82
HongKong	11	7.03	3.5	223.76	31849.05	6.32	6.19	4.78	5.6	5.71	4.11
United Kingdom	12	61.02	5.4	2787.37	45681	5.52	5.81	5.27	5.62	5.05	4.66
Korea, Dem. Rep.	13	48.55	3.1	953.49	19637.99	5.63	4.85	5.51	5.51	5.00	5.18
Austria	14	8.29	4.18	432.4	52159.18	5.86	5.01	5.28	5.34	5.38	4.68
Norway	15	4.69	2.5	481.15	102524.6	4.99	5.51	5.52	5.81	5.05	4.6
France	16	62.03	7.68	2978.12	48012.01	6.54	5.19	5.37	5.16	5.01	4.67
Taiwan	17	23.17	3.89	424.06	18306.11	5.46	4.45	5.46	5.34	5.19	5.23
Australia	18	21.32	4.33	1069.34	50150.35	5.33	5.76	5.44	5.21	5.29	4.46
Belgium	19	10.74	7.06	530.61	49430.28	5.62	5.25	5.63	5.01	5.22	4.69
Iceland	20	0.32	2.2	19.02	60121.73	5.6	5.31	5.69	5.65	4.89	4.62
Nigeria	94	147.81	.	220.31	1490.49	2.24	4.53	3.13	2.87	4.37	3.16

* estimated at current 2008 prices in US dollars; Data Sources: Global Competitiveness Report, 2008-09; World Economic Outlook 2008 Database

[3] Presently, based on field interviews and interactions with industry players, we know that many multinationals complain that university graduates in Africa are expensive to recruit because they have to be re-trained in almost all cases; an exercise which costs the firms much money to undertake. This contrasts sharply with the situation in countries like India, China, South Korea and Singapore.