INNOVATION AND ICT IN EXPORTING-PRODUCTIVITY LINK AMONG MANUFACTURING AND SERVICESFIRMS IN NIGERIA

MUSEFIU ADEBOWALE ADELEKE
B.Sc. (Econ) and M.Sc. (Econ) Ibadan,
Matriculation Number: 139087

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CERTIFICATION

We certify that this work was carried out by Musefiu Adebowale ADELEKE under our supervision in the Department of Economics, Faculty of Economics and Management Sciences, University of Ibadan, Nigeria.

ADEOLU O. ADEWUYI
Chairman, Thesis Supervision Committee
Dip. Coop. Studies (Ibadan),
B.Sc. (Econ), M.Sc. (Econ), Ph.D. (Ibadan)
Professor, Department of Economics
University of Ibadan, Nigeria

MUSIBAU A. BABATUNDE
Member, Thesis Supervision Committee
B.Sc. (Econ.), M.Sc.(Econ.) and Ph.D. (Ibadan)
Professor, Department of Economics
University of Ibadan, Nigeria

SOLOMON A. OLAKOJO
Member, Thesis Supervision Committee
BEd. (Economics/Geography), M.Sc. (Econ.)and Ph.D. (Ibadan)
Lecturer, Department of Economics
University of Ibadan, Nigeria

DEDICATION

To my parents

MR. K. A. ADELEKE (Late) andMRS. W. ADELEKE

Who appreciated education and struggled so hard to give me one

And to my darling wife and daughters (Twin)

TAIWO ADELEKE (My Treasure)

HAMIDAH ADELEKE AND HALIMAH ADELEKE

For their understanding and absolute support for this project

To my Brother and only friend

ADEGOKE IBRAHIM ADELEKE (PhD)

For his untiring support and encouragement for this project

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No single leaf will fall without the permission of Allah. I affirm that there is no deity worthy of worship except Almighty Allah and that the best of mankind, Mohammad (SAW) is His messenger.

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ABSTRACT

The shares of manufacturing and services trade in Real Gross Domestic Product in Nigeria are low. The sectors, respectively averaged 10.21% and 11.61% in 1981 and 8.56% and 12.22% in 2013, while exports share (% of merchandise exports) fluctuated between 0.14% and 2.06% within the same period. These developments have led to a surge in studies on the Exporting-productivity (EXPP) link. Although extantstudies investigated EXPP link, little attention is paid to the role of innovation and Information and Communication Technology (ICT), which have the potential to improve the quality and processes of goods and services, reduce the costs of business transactions, and enhance information dissemination, thereby improving firms' productivity. This study was, therefore, designed to investigate the role of Innovation and ICT in EXPP link among aggregate, manufacturing and services firms in Nigeria.

The Heterogeneous Firm Trade Theory provided the framework. The Standardised Structural Equation Model was employed withInnovation (measured by a new or improved product or process), ICT (measured by access to email, website ownership and internationally recognised quality certification), firm age, manager's experience, and loan access as determinants of EXPP. Productivity was measured by input-output ratio and exporting by the percentage of sales that was directly or indirectly exported.Firm-level data were obtained from the *2014 World Bank Enterprise Survey,* covering a total of 2,676 firms sampled from April 2014 to February 2015. However, 1,092 exporting firms were suitable for analyses. These firms were classified into manufacturing (529) and services (563) sectors. Estimation with Maximum Likelihood technique was done at both aggregate and sectoral levels. Root Mean Square Error of Approximation (RMSEA), Coefficient of Determination (CD), and Tucker-Lewis Index (TLI) tests were used to confirm the goodness of fit for the model at $\alpha \leq 0.05$.

The productivity of firms at both aggregate and sectoral levels were low. Aggregate productivity of firms was 0.11, while that of manufacturing and services were 0.13 and 0.32, respectively. There was a negative EXPP link at both aggregate (-1.40%) and sectoral levels (-0.97% and -3.01% for manufacturing and services sectors, respectively). The negative coefficient of EXPP link implies absence of learning by exporting and self-selection hypothesis. This results in poor learning ability, low competitiveness, and reduced technology adoption among firms. However, both Innovation and ICT offset the negative EXPP link respectively from -1.40% to 0.82% and 0.12% for aggregate firms, -0.97% to 0.14% and 0.23% for manufacturing firms, and -3.01% to 1.01% and 0.26% for service firms. Firm age ($t(26) = 4.41$), manager's experience ($t(26)=3.67$) and loan access ($t(26) = 2.31$) were the main EXPP determinants. The coefficients of RMSEA (0.06), CD (0.95), and TLI (0.92) were indicative of a good fit.

Innovation and Information and Communication Technologyhad a positive impact on exporting-productivity link for manufacturing and services firms in Nigeria. Firms need to accelerate these components in order to strengthen the exporting-productivity link. Efforts should also be made by the government to improve the technology infrastructure in the country.

Keywords: Exporting-productivity, Structural equation model, Manufacturing and services firms in Nigeria

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The links between exporting and productivity, especially at the firm level are becoming increasingly recognised in development economics and international trade literature. The research on the links has, however, taken another dimension since the pioneering work of Bernard and Jensen (1999), and further development by Melitz (2003) and Chaney (2008) that brought into focus the extraordinary qualities of exporting firms.

Generally, in the literature, there are two strands (the self-selection and the learning-by-exporting) on why exporting firms can be more productive than non-exporting firms (Bai, *et al.,*2017; Lee, 2011; Bernard and Jensen, 1999;Roberts and Tybout 1997;and Bernard and Wagner, 1997). The first strand, termed self-selection hypothesis, details reasons why more productive firms enter into export markets. One of these reasons is the ability to offset additional costs of selling goods in the foreign markets. The extra costs include transportation costs, distribution or marketing costs, advertisement, assembling of information on foreign markets, product quality upgrading and establishing new marketing channels in modifying current domestic products for foreign consumption. These are sunk costs that provide an entry barrier which less productive firms may not overcome. In addition, competition could be severe outside home market, a feature that would again allow only the most productive firms to do well abroad.

The strand coined learning-by-exporting hypothesis relates to the role of learning in foreign business. The knowledge that flows from international buyers and competitors help to improve the post-entry performance of export beginners in exporting business. Thus, firms that are participating in international markets have access to information that helps them to improve faster than firms who sell their products only domestically.

The importance of innovation[1] and ICT[2] in firms' productivity[3], exporting and national development has well been documented in the development literature (Adeoti, 2011; Griffith *et al.,* 2006; Parisi, *et al.* 2006; Aghion, 2006; Botazzi, *et al.,* 2001; and Crépon, *et al.,* 1998). The use of ICT is essential for improving productivity because it directly increases labour productivity and boost economic growth (Diaz-Chao, *et al.*, 2015; Díaz-Chao, *et al.*,, 2013; Jorgenson, *et al.*, 2008; and Jorgenson and Vu, 2007), while also complementing innovation activities that help improve total factor productivity (Ceccobelli, *et al.*, 2012; Jorgenson, *et al.*, 2011, Adeoti, 2011). According to Koellinger, (2005) innovation and ICT have the potential to improve the quality of goods or services and reduce the costs of the business transaction, improve business processes, information dissemination and hence simultaneously increase consumer demand for firm product resulting from efficiency gains which in turn encourage innovation.

In Nigeria, efforts have been made by successive government to develop the innovation and ICT sector – including National System of Innovation (NSI) Policy, Nigerian Science, Technology and Innovation Policy of 2011 and National

[1] According to the OSLO manual, (2018) innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)

[2] This study employed four different measures of ICT (1) percent of firms with an internationally-recognized quality certification, (2) percent of firms using technology licensed from foreign companies, (3) percent of firms having their own Website and (4) percent of firms using e-mail to interact with clients/suppliers

[3] Here productivity refers to the input-output ratio of firms

Telecommunications Policy (NTP) 2000. The World Bank (World Bank Development Indicator - WDI, 2017-online) put the total number of fixed telephone line subscribers at 187,155 people in 2015, while it was estimated at 0.102 per 100 people. The use of ICT can be seen as a general purpose technology that makes it relatively easy and cheap to innovate (Gretton *et al.,* 2004). According to World Bank Enterprise Survey (2014), in terms of usage of ICT among Nigerian firms, only 17.2% of firms own website, 6.5% own technology that are licensed by foreign companies, while 22.4% had an email for communicating with customers. Further analysis of firms' innovation activities in the survey showed that only 32.84% are exporters engaging in product upgrading, 30.12% in process innovation, while another 32.20% and 31.33% engaged in organisational structure innovation and marketing upgrading respectively.

Against the above background, this study examines whether innovation and ICT have a role to play in exporting-productivity link among Nigerian firms.

1.2 Statement of the Problem

A major factor that has been attributed to Nigeria's poor economic performance over time is the over-reliance on the fortunes from oil and failure to achieve significant economic diversification. The over-reliance of the economy on the oil sector led to the low contribution of the non-oil sector (especially manufacturing) to aggregate Gross Domestic Product (GDP) and export since the early 1970s. Despite several government policies, incentives, and programmes designed to boost non-oil export, the growth rate of the sector has remained generally low.

Manufacturing sector contribution to real GDP has not been encouraging, it peaked at 11.78% in 1982 and dropped to 9.20% in 2018 (CBN, 2018). Also, Nigeria's manufactured export (% of total merchandise exports) has fluctuated over the years

ranging between 0.13% and 4.39% during 1981 and 2015 (WDI, 2017). This is lower, when compared with a country like South Africa where manufactured export (% of total merchandise exports) recorded 17.55% and 49.37% for the same period. The poor performance of Nigeria's manufacturing export sector is largely attributed to inadequate trade related infrastructure and poor business and policy environment leading to low productivity and high production cost. Other factors include poor administration of export incentives provided to the exporters, low quality of manufactured goods which does not meet international standard and obsolete equipment in the form of technology and ICT which are used in production and marketing (Adewuyi, *et al.,*2017). Specifically, several government efforts have been made to diversify the country's economic and export base so as to promote productivity, exporting and growth. Among the government policies and programmes are foreign exchange retention scheme, export licensed waiver, export credit guarantee and insurance scheme, Export Expansion Grant (EEG), export adjustment schemes grant, rediscounted of short-term bills for export, tax relief on interest income and repayment of technology fees. The recent industrial strategies of government as contained in the Nigerian Industrial Revolution Plan (2014) and Economic Recovery and Growth Plan (2017) emphasise export promotion via industrialization. These strategies were designed to address production and exporting challenges with a view to diversifying the productive base and increase export earnings. However, despite these plethora of incentives, most Nigerian manufacturing firms are not seeking foreign markets for export (Adewuyi, *et al.,* 2014).

Analysis of the characteristics of these firms based on the Nigerian Enterprise Survey (2014) provides some clues to their status in terms of innovation activities and usage of ICT. In Nigeria, exporting enterprise firms are highly deficient in terms of creativity as only 868 firms representing 32.84% are exporters engaging

in product upgrading, 796 (30.12%) involved in process innovation, while only 851 (32.20%) and 829 (31.33%) engaged in organisational structure innovation and marketing activities respectively among all the 2,676 firms surveyed. These low levels of innovation among enterprise in Nigeria constrain productivity as there would be high production cost and little improvement in the quality of goods or services, which implies lack of both local and international competitiveness.

There is also evidence that only 438 (32.84%) firms are exporters that are certified in Internationally Recognized Quality Certification (IRQC), while another 163 (30.12%) firms are technologically licensed by foreign companies. Similarly, poor use of ICT inhibit firms from the potential of reducing transaction costs, improve business processes and facilitate coordination with various actors and information dissemination to both customers and other business associates. Only 459 (32.20%) firms own their website and email address for communicating with their customers. Against the above background, the emerging issues and question is

- What is the role of innovation and ICT on Productivity among Nigerian enterprise firms;
- What is the role of innovation and ICT on Exporting of Nigerian enterprise firms and
- Do the levels of innovation and ICT usage by the Nigerian enterprises firms affect exporting-productivity relationship?

These are the pertinent questions that this thesis seeks to provide answers.

1.3 Objectives of the study

The main objective of this study is to examine the role of innovation and ICT on the link between exporting-productivity of firms. Specifically, this study seeks to determine the:

a. impact of innovation and ICT on productivity of firms at aggregate and sectoral levels
b. effect of innovation and ICT on exporting of Nigeria firms at aggregate and sectoral levels
c. mediating effect of innovation and ICT in exporting-productivity relationship at aggregate and sectoral levels

1.4 Justification for the Study

The justification for this thesis arises from its contribution to theoretical, methodological, and empirical literature in the area of international economics. Although, the new-new trade theory (free market entry model) predicts exporting – productivity link by stating how more productive firms participate in the foreign market via self-selection or learning-by-exporting, it does not provide a role for innovation and ICT in the exporting-productivity link. This study extends the new-new trade model of Roberts and Tybout 1997 by incorporating innovation and ICT in the market entry model.

In terms of methodology, previous studies have utilised different estimation techniques with an overwhelming application of probability model (Probit and Tobit regression) as the major tools for capturing exporting-productivity relationship. However, the estimated coefficient may be difficult to interpret, due to the non-normality of the error term and when the estimated coefficient exceed one (Gujarati, 2003). In order to address the problem of non-normality of the error term, studies[4] have used Ordinary Least Squares (OLS). However, the OLS

[4]Babatunde, (2017); Strobel, (2016); Lee, *et al.,* (2015); Ceccobelli and Mancuso, (2012); Adeoti (2011); Commander, *et al.,* (2011); Lee, (2011) and Beveren and Vandenbussche, (2010)

techniques also suffered from the problem of either perfect multicollinearity, endogeneity and or heteroskedasticity (Greene, 2003).

Beside, studies have also used nonparametric[5] test like Chi-square, Kolmogorov-Smirnov and Wilcoxon-Mann-Whitney test to analyse the productivity differentials between exporting and non-exporting firms (Leon, *et al.,* 2016; Kusumaningtyas and Suwarto, 2015; Cassiman, *et al.,* 2010; Bellone, *et al.,* 2009; Cassiman and Golovko, 2007; and Huergo and Jaumandreu, 2004). Still, the use of nonparametric tests lack power as compared with more traditional approaches and the parameter estimates are unobserved.

In other to overcome some of the problem inherent in the previous techniques identified above, this study fills the gap by adopting Structural Equation Modeling (SEM). The choice of this technique is premised on the fact that it consists a set of linear equations (such as Regression models, Simultaneous models, Factor analysis and Path analysis) and with both latent (theoretical) and categorical variables together in one model.

With respect to the indicators for measuring innovation and ICT, previous studies assumed that both indicators are the same and are treated as simply innovation. For instance, some of the studies that have measured innovation by mainly focusing on either process innovation (Lin and Tang, 2013; Movahedi and Gaussens, 2011 and Basile, 2001), product innovation (Marzabal *et al.*, 2016 and Nassimbeni, 2001) or a combination of both (Yang and Chen, 2012; Moreal-Perez *et al.,* 2012; Lee, 2011 and Cassiman *et al.,* 2010; Beveren and Vandenbussche, 2010; Caldera, 2010). Specifically, ICTs are concerned with the storage, retrieval, manipulation, transmission or receipt of digital data, while innovations entail realization of new

[5]Non-parametric test are used to check if two independent samples are from populations within the same distribution

ideas, products, services and processes. Although, ICTs have opened a variety of innovation potentials, it however, differs from innovations. For example, the use of ICT enables firms to restructure their organisations (like levelling of pecking order and assigning tasks), to re-engineer business processes (like introducing just-in-time management or engaging in E-commerce) and to develop completely new products (such as online services). However, ICT require additional expenses for re-organisations and re-training workers before it can be termed as innovations.

Therefore, this thesis separate innovation activities from ICT usage of firms following the work of Diaz-Chao, *et al.,* (2015) and also considered two other additional measures of innovation activities like marketing and organisational innovation. Marketing innovations activities include market research and market testing, methods for pricing, product placement and product promotion, while organisational innovation refers to activities of business practices, distribution of responsibilities and external relations. All these are also required by firms along production techniques, delivery and logistics in order to achieve market trends, gain a competitive edge, ensure long-term success, bring in more customers and ensure profitability for businesses. Thus, this study include the two additional innovation (marketing and organisational) components, so as to see the disaggregated impact of each component on Nigerian firms' exporting-productivity link and also to inform a comprehensive policy analysis.

Lastly, empirical results from previous studies appear to be uniform with overwhelming support for firms' specific factors like age, labour productivity, access to loan and infrastructure as the main determinants of exporting-productivity link. However, Sharma and Mishra, (2015) and Mez-Castillejo *et al.,* (2010) revealed a weaker interlink between trade and productivity for Indian and Spain manufacturing firms respectively. In the case of African countries, few studies exist on the role of innovation and ICT on the link between exporting and

productivity. Although, some studies such as Mengistae and Catherine (2004); Biesebroeck, (2004) and Bigsten, (2000) have only focused on determinants of exporting without underscoring the role for innovation and ICT. It is against this background that this study fill the gaps by examining the role of innovation and ICT usage on exporting-productivity relationship in Nigeria. In addition, this study is also premised on investigating empirically, if the modification made in the theory is important in understanding the exporting - productivity link in Nigeria.

Findings from this study have the potential to be used to raise awareness on the need to increase firms intra industry uses of ICT and hence innovation among entrepreneur firms. In so doing, firms with low uses of ICT and or innovation activities could potentially becomemore productive and then start to export. Furthermore, the study results may provide firms managers and other stakeholders with information that potentially can be used to address the trade related infrastructure constraints and lower the cost of exporting among firms.

1.5 Scope of the Study

In the literature, issues on exporting-productivity link are wide in scope. However, the scope of this study is limited to only Nigeria enterprise firms. The study determines the exporting-productivity link of the firms and underscores the role of innovation and ICT in the link. To determine this, the study employed data retrieved from the Nigeria Enterprise Survey in 2014[6], where business owners and top managers were interviewed from April 2014 through February 2015. The areas covered in Nigeria Enterprise Surveys include infrastructure, trade, finance, regulations, taxes and business licensing, corruption, crime and informality, finance, innovation, labour, and perceptions about obstacles to doing business in

[6]Nigeria Enterprise Survey, 2014 is a World Bank enterprise survey that is obtained from World Bank, UK Department for International Development,

Nigeria. In terms of sample size, the cross-sectional survey covers firms[7] ranging from small (1,753), medium (734) and large (189) that make up a total of two thousand, six hundred and seventy-six firms (2,676). Similarly, the Nigerian enterprises surveyed covered firms in food (504), garment (362), furniture (147), Services of motor vehicle (167), wholesale (118) and Retails services (452), hotel and restaurants (350), transport services (162), printing and publishing (138), non-metallic mineral products (149) and fabricated metal products (127).

1.6 Plan of the Study

This thesis is structured into five (5) main chapters. Following the introductory chapter that contain the problem statement, objectives, justification and scope of the study, Chapter two discusses the stylized fact of Nigerian enterprise firms with focus on their exporting, productivity, innovation and ICT. The chapter further provides the review of related literature in terms of theoretical, methodological and empirical review. Chapter three addresses the theoretical framework and methodology of the study, while Chapter four presents the analysis and discussion of the empirical results. The study is concluded in Chapter five with summary, conclusion and policy recommendation for the study.

[7]Employment band classification was used in the 2014 world Bank Enterprise survey with Small firms having between 5 and 19, Medium had between 20 -99, while Large firms had above 100 employee within the survey.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Features of Nigerian Enterprise Firms

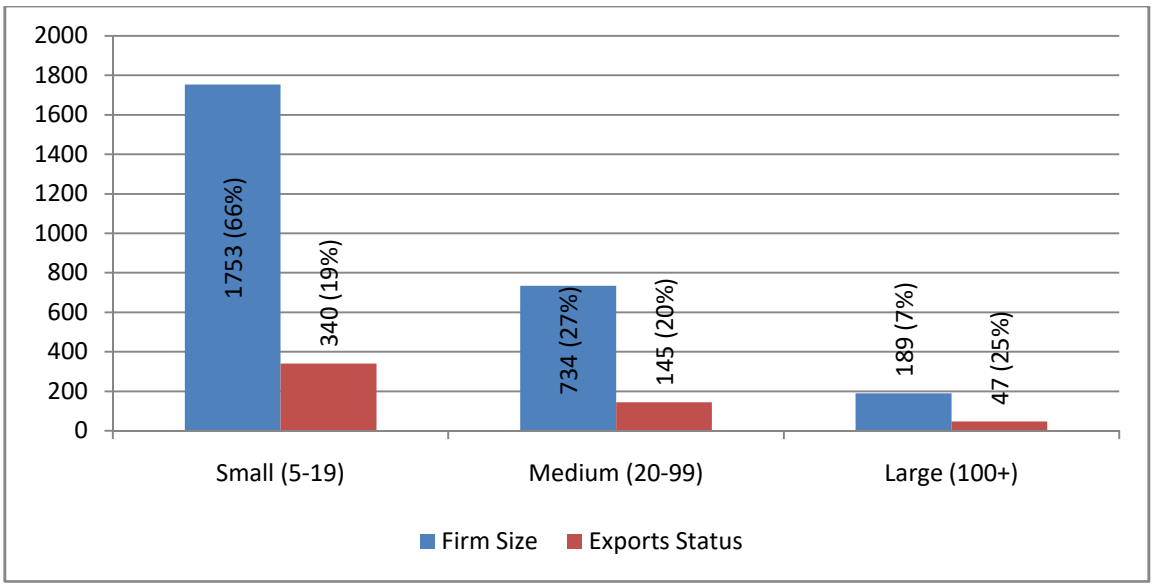
This section looks at firm status and characteristics, and documents various aspects of firm performance, focusing on firm age, ownership, experience, human capital and export behaviour and size. It critically analyses the growth and productivity of Nigerian enterprise firms of different sizes and ownership types using the 2014 enterprise survey data.

Figure 2.1 shows the sample size and exporting status of the enterprise firms in Nigeria. The cross-sectional survey covers firms ranging from small (1,753), medium (734) and large (189) firms that make up a total of two thousand, six hundred and seventy-six firms (2,676).

In terms of exporting across firms size, 340 (19.4%) firms are classified as small-scale firms, while 145 (19.7%) and 47 (25.1%) are medium and large-scale firms respectively, making a total of five hundred and thirty-two firms (532, 19.9%) of the total surveyed enterprise firms.

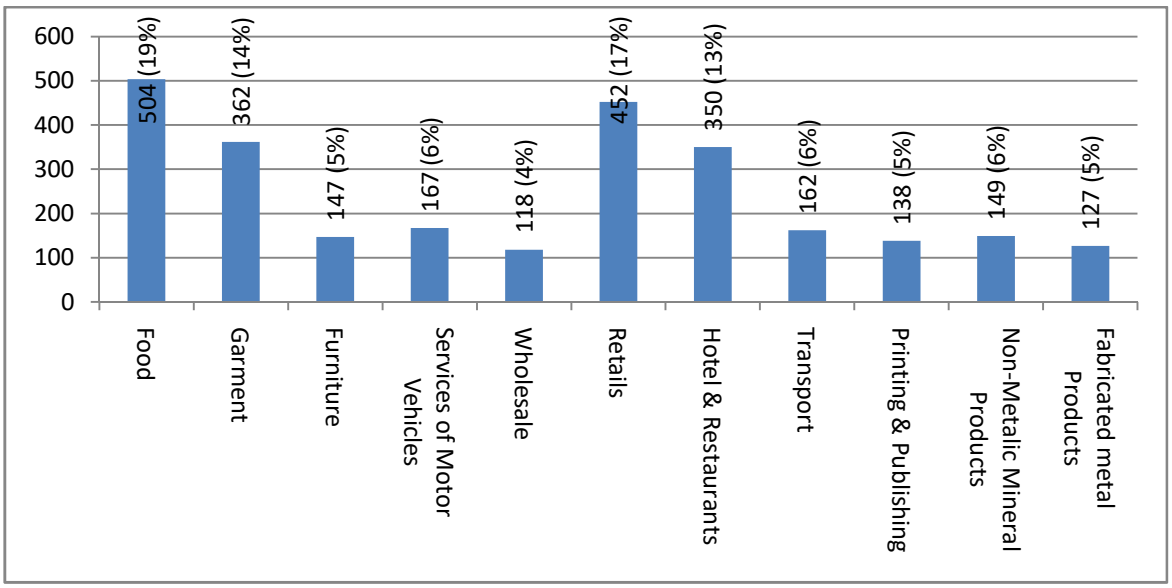
Similarly, the 2014 Nigerian enterprise firms survey; covers firms in food (19%), 362 (14%) are garment, 147 (5%) in furniture, 167 (6%) are in services of motor vehicle, 118 (4%) in wholesale and 452 (17%) are in retails services. Others include; 350 (13%) are into hotel and restaurants, 162 (6%) are into transport services, 138 (5%) are into printing and publishing, 149 (6%) are into non-metallic mineral products and 127 (5%) into fabricated metal products respectively. Figure 2.2 shows business sectors of the Nigerian enterprise firms. The Figure revealed that Nigerian enterprise firms' production varies along business sector.

Figure 2.1: Nigerian Enterprise Firms Sample Size and Exporting Status, 2014



Source: *Computed by the author from data from* *Nigeria Enterprise Survey, 2014*

Figure 2.2: Nigerian Enterprise Firms Business Sector in 2014



Source: *Computed by the author from data from* *Nigeria Enterprise Survey, 2014*

In Nigeria, around 73.6% of the surveyed small-scale private domestic owned, which are classified as small firms with an employment band of between 5 - 19 workers (Table 2.1). The rest are private foreign-owned enterprise (2.8%) and state-owned enterprises (1.6%).

Further, the percentage of medium scale enterprises that are owned domestically was 58.4 percent, while the remaining are private foreign-owned enterprises (3.3%) and state-owned (2.6%).

Table 2.1a: Age, Ownership Structure and Legal Status of Nigerian Enterprise Firms[8]

Subgroup Level	Average Age (years)	Private Domestic ownership (%)	Private Foreign ownership (%)	State Ownership (%)	Majority Ownership (%)
Small (5-19)	15	60.7	2.8	1.6	96.6
Medium (20-99)	18	58.4	3.3	2.6	90.6
Large (100+)	25	72.2	9.5	6.2	83.9
Legal Status					
	Public Listed Firms (%)	Private LLC (%)	Sole Proprietorship (%)	Partnership (%)	
Small (5-19)	3.6	1.9	81.7	5.2	
Medium (20-99)	1.4	7.9	59.9	22.1	
Large (100+)	6.9	6.6	47.6	12.2	

Source: ***Computed from Nigeria Enterprise Survey, 2014*****; Note: LLC means Limited Liability Companies.**

[8]The firms are re-classified as; Manufacturing Firms that consists of food, garment, non-metallic products, fabricated metal products and furniture, while services consists of hotel and restaurant, transport, motor services, wholesales and retails services.

Also, 72.2% of large enterprises (employed over 100 workers) are privately owned, while the rest are foreign-owned (9.5%) and state-owned (6.2%).

In terms of legal status, sole proprietorship dominates the small-scale business (81.7%) in Nigeria, with few firms registered as partnership (5.2%) and public listed firms (3.6%). Similarly, sole proprietorship constitutes a significant proportion of medium scale enterprises (59.9%), partnership (22.1%), private limited companies (7.9%) and public limited firms (1.4%). Moreover, the large enterprises are spread across sole proprietorship (47.6%), private limited liability companies (6.6%), partnership (12.2%) and public listed firms (6.9%).

Table 2.1b depicted the sectoral distribution of age, ownership type and firm legal status of Nigerian Enterprise. 59.1% of the surveyed food manufacturing firms are privately own domestic firms. The rests are private foreign-owned (3.5%) and state-owned enterprises (1.3%).

Also, the percentage of manufacturing firms in the garment sub-sector that is owned domestically by private firms is 83.0%, while the remaining are private foreign-owned (2.2%) and state-owned (0.3%). Also, 73.8% of firms are in the wholesale services, while 1.4% and 1.3% are owned by foreign and state respectively in Nigeria. In terms of the legal status of firms across sub-sectors, Sole proprietorship dominates along food, garments, wholesale and retails services.

Table 2.1b: Sectoral Distribution of Age, Ownership Structure and Legal Status of Nigerian Enterprise Firms

Subgroup	Average Age (years)	Private Domestic Ownership (%)	Private Foreign Ownership (%)	State Ownership (%)	Majority Ownership (%)
Food	14	59.1	3.5	1.3	94
Garments	10	83	2.2	0.3	96.8
Wholesale	16	73.8	1.4	1.3	95.8
Retail	15	74.6	1.5	1.1	98.4

Legal Status				
Subgroup	Public Listed Firms (%)	Private LLC (%)	Sole Proprietorship (%)	Partnership (%)
Food	0.8	6.4	74.4	12.5
Garments	0.5	2.8	84.7	7.6
Wholesale	0.5	1.2	77.1	4.8
Retail	1.1	1.7	85.5	2.5

Source: ***Computed from Nigeria Enterprise Survey, 2014;*** **Note: LLC = Limited Liability Companies**

Firms' owners that are classified as sole proprietorship, partnership, public listed, and private limited liability companies in the food manufacturing sub-sector in 2014 are 74.4%, 12.5%, 0.8% and 6.4% respectively. Moreover, firms' owners who are sole proprietorship along garment, wholesale and retail services are 84.7%, 77.1%, and 85.5%, while firms along that chain of distribution in the public listed company are 0.5%, 0.5% and 1.1% accordingly.

Table 2.2, showed the sectoral performance of Nigerian enterprises; it is clear from the Table, that in 2014, manufacturing sector on average had a capacity utilization of 74.0% and employment growth rate of 9.7% with a declining annual sales and labour productivity growth rate of 6.5% and 9.8%. This implies a contraction in the sector sales and earnings in that year.

Moreover, the services sector recorded annual average sales growth of -9.1%, employment growth of 9.7% and a negative labour productivity growth of 17.0%. In terms of performance at sub-sectoral levels, garments sub-sector had the highest capacity utilization and employment growth, with an average of 73.9% and 15.2% in 2014. Food sub-sector had 71.3% and 4.8%, while other manufacturing sub-sector had 80.5% and 9.7% capacity utilization and employment growth respectively. In the services subsector, retail service dominated the services with 5.6% and 13.5% as annual sales and employment growth, while the value of its labour productivity growth rate decline from the previous survey by 16.0% (Table 2.2).

Table 2.2: Nigerian Enterprises Sectoral Performance Indicators in 2014

Subgroup Level	Capacity Utilization (%)	Real Annual Sales Growth (%)	Annual Employment Growth (%)	Annual Labour Productivity Growth (%)
Reported Manufacturing				
Manufacturing	74.0%	-6.5%	9.7%	-9.8%
Sub-Manufacturing Sectors				
Food	73.9%	-17.0%	15.2%	-24.4%
Garments	80.5%	1.4%	9.7%	-5.3%
Reported Services				
Wholesale	...	5.6%	13.5%	-16.0%
Retail	...	-11.2%	9.6%	-13.9%

Source: ***Computed from Nigeria Enterprise Survey, 2014***

2.2 Exporting and Productivity Status of Nigerian Enterprises

2.2.1 Exporting Status of Nigerian Enterprises

The Nigerian Enterprise Surveys, 2014 provided information on the operational constraints faced by exporters and also quantifies the trading activity of firms. The survey features set of indicators like number of days required to clear exports through customs, the number of exporting firms, domestic sales and the extent to which firms that trade considers customs and trade regulations as a constraint. Intuitively, the average number of days to clear customs for imports and exports among Nigeria enterprise firms creates additional costs to the firm and can interrupt production, interfere with sales, and result in damaged supplies or merchandise. Based on the data, small firms on average used 6.5 days to clear direct exports through customs, while medium and large-scale firms used 4.3 and 7.0 days on average to clear direct exports through customs respectively.

In terms of exporting, out of 1,753 small-scale firms, only 19.4% are exporters, while 19.7% and 25.1% are exporting firms belonging to medium and large-scale firms. Domestic sales of small-scale firms in Nigeria stood at 88.5% of output produced in 2014, while that of medium and large-scale firms' amount to 88.0% and 89.2% respectively (Table 2.3a). The other set of indicators show the value of customs and trade regulations as constraint reflecting the difficulties faced during the export process.

Table 2.3a: Nigerian Enterprises Exports Indicator along Firms Scale, 2014

Subgroup Level	Days to clear direct exports through customs	Percent of firms exporting directly or indirectly (at least 1% of sales)	Proportion of total sales that are domestic sales (%)	Percent of firms identifying customs and trade regulations as a major constraint
Small (5-19)	6.50	19.40	88.50	11.20
Medium (20-99)	4.30	19.70	88.00	26.40
Large (100+)	7.00	25.10	89.20	10.20

Source: ***Computed from Nigeria Enterprise Survey, 2014***

Export indicators along different classified sectors showed that on average, manufacturing firms used 6.6 days to clear direct exports through customs, while food and garment sector used 5.9 and 2.4 days on average to clear direct exports respectively (Figure 2.1). The services sector, requires about 4.2 days to clear direct exports. Thus, manufacturing firms used more number of days than other sectors to clear direct exports through customs.

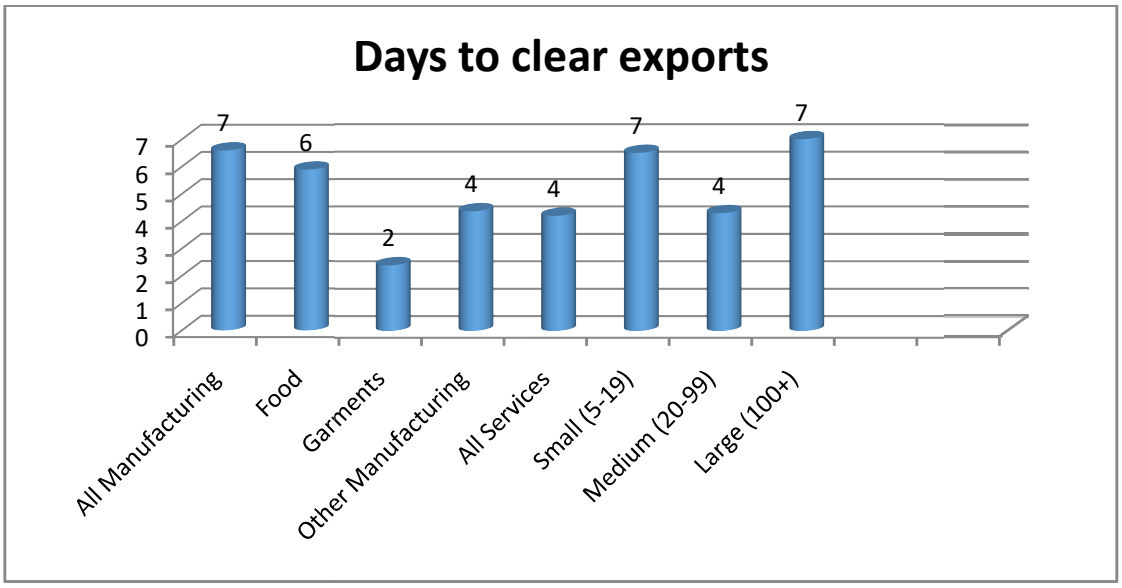
The survey showed evidenced that 25.2% firms are exporters along manufacturing production line, while another 33.7% and 5.0% are exporting firms in food and garment industries respectively. Exporters within the services sector are 16.4%, while 15.1% and 16.4% are those in wholesale and retail services sub-sector accordingly.

Table 2.3b: Nigerian Enterprises Exports Indicator along Sectoral Distribution, 2014

Subgroup Level	Days to Clear Direct Exports through Customs	Percent of firms exporting directly or indirectly (at least 1% of sales)	Proportion of total sales that are domestic sales (%)	Percent of firms identifying customs and trade regulations as a major constraint
Manufacturing	6.6	25.2	85.5	11.6
Food	5.9	33.7	79.6	21.4
Garments	2.4	5.0	97.3	8.8
Other Manufacturing	4.4	20.9	89.1	7.7
Services	4.2	16.4	90.1	15.6
Wholesale	…	15.1	92.1	15.8
Retail	…	16.4	89.3	7.2
Other Services	…	17.1	90.3	25.9

Source: ***Computed from Nigeria Enterprise Survey, 2014***

Figure 2.3: Days to Clear Exports among Nigeria Enterprise Firms[9]



Source:*Computed by the author from the underline data from* ***Nigeria Enterprise Survey, 2014***

[9]Data for days to clear direct exports through customs are not available for wholesale, retail and other services sub-sector respectively.

2.2.2 Productivity Status of Nigerian Enterprise Firms

Measure of productivity proposed in this study derives from Cobb-Douglas production function with three factors of production; capital, labour and intermediate inputs. In this study, firm sales are used to measure output; capital is measured by addition of costs of machinery, vehicles, and equipment, labour is measured in value terms as the cost of labour/workers including wages, salaries and bonuses and intermediate inputs are determined by the cost of raw materials. Therefore, productivity growth is the net change in output due to efficiency and technical change (Grosskopf, 1993). The inputs cost are discussed in the following.

Table 2.4 showed average Nigerian enterprises total sales and associated costs across different firms' structure, legal status and exporting status. On average non-exporting firms sales value worth N28 million in 2014, while the exporting firms sold goods worth N21.6 million. During that same period of 2014, small enterprises sales was N8.2 million, medium enterprise sales was valued at N53.7 million, while large enterprises had N5.1billion with a minimum (N7.0million) and maximum (N3.7billion) sales across firms respectively. On average, non-exporting and exporting firms paid N4.4 million on average as labour costs, while small, medium and large enterprise paid N1.3, N9.0 and N76.0 million respectively as labour costs within the year, 2014 (see, Table 2.4).

Table 2.5 showed total sales and other costs of Nigerian enterprise firms across sectors. On average all manufacturing firms' total sales worth N35 million in 2014, while the services sector sold goods to the tune of N21 million. During that same period, food manufacturing sub-sector costs of goods sold was valued at N23.9 million, while firms in the garment manufacturing sub-sector sold goods worth N5.9 million.

Table 2.4: Average Nigerian Enterprises Total Sales and Associated Costs, 2014 (Million, ₦)

	Small (5-19)	Medium (20-99)	Large (100+)	Sole pro.	Private	Public	Partners.
Total Sales (₦)	8.2	53.7	514.3	21.1	58.8	280.0	59.0
Minimum	0.1	0.1	7.0	0.1	0.1	30.5	0.1
Maximum	2500.0	1100.0	3700.0	3018.8	3000.0	670.0	3700.0
Cost of Raw Material (₦)	5.2	26.2	249.3	11.0	30.9	86.7	31.2
Minimum	5.0	20.0	7.5	5.0	11.0	43.2	20.0
Maximum	1200.0	700.0	2000.0	1969.0	1000.0	175.0	2000.0
Cost of Labour (₦)	1.3	9.0	76.0	3.7	7.6	68.3	6.5
Minimum	0.7	6.0	12.0	0.7	3.5	25.0	6.0
Maximum	3.9	44.0	50.0	904.8	63.5	120.0	50.0
Cost of Machines (₦)	2.0	23.3	147.1	6.8	25.7	208.3	9.0
Minimum	1.0	4.3	4.0	1.0	10.0	60.0	4.3
Maximum	0.1	165.0	500.0	19.0	490.0	80.0	500.0

Source: ***Computed from Nigeria Enterprise Survey, 2014***

Table 2.5: Average Nigerian Enterprises Total sales and its associated Costs across Sectors, 2014 (Million naira)

	Total Sales (₦)	Cost of Raw Materials (₦)	Cost of Labour (₦)	Cost of Machines (₦)
All Manufacturing	34.453	19.777	6.127	16.560
Food	23.950	14.153	5.532	17.993
Garments	5.997	3.942	2.284	1.592
Other Manufacturing	57.036	32.188	8.592	23.468
All Services	21.285	9.236	2.638	2.149
Retail	26.738	19.223	1.399	1.115
Other Services	17.354	2.037	3.531	2.894

Source: ***Computed from Nigeria Enterprise Survey, 2014***

For the services sub-sector, the retails services costs of goods was value at N26.7 million, while other services sales stood at N17.4 million in that same year.

On average, cost of raw material for all manufacturing firm was N19.7 million in 2014, while the services sector spent over N9.2 million on purchases of raw materials. Firms operating in the food manufacturing sub-sector spent around N14.2 million on raw material, while those in the garment sub-sector spent N3.9 million. For the services sub-sector, the retails services sub-sector spent the highest cost on raw material to the tune of N19.2 million, while other services spend N2.0 million only on raw materials input in 2014 (Table 2.6).

2.3 Innovation and Use of ICT among Nigerian Enterprise Firms

In order to survive and prosper in a competitive market, firm must innovate and increase their productivity. A sound business environment encourages firms to experiment and learn. In 2014, enterprise surveys data provided indicators that described several dimensions of technological efficiency and innovation. In this context, innovation encompasses the development or upgrade of product lines, the introduction of new production technologies, improvement in organisational structures or management practices and as well as compliance with improved marketing methods.

Specifically, Table 2.6a showed responses of the Nigerian enterprises' firms across different type of innovation structure in 2014. In terms of the product upgrade, 143 (5.40%) firms within the food and beverage industry indicated their involvement in product innovation, 151 (5.71%) in process innovation, while only 110 (4.16%) firms indicated improvement in their organisational structure and management.

The tobacco industry had only 2 (0.08%) each firm indicating their involvement in product innovation, process, and organisational innovation, while only 1 (0.04%) firm involve in Marketing upgrading in 2014. Retail services recorded 216

(8.16%) firms involving in process innovation, 189 (7.14%) involve in process innovation, 143 (5.40%) in organisational, while only 59 (2.23%) firms indicated improvement in their marketing activities. Also, 128 (4.84%) firms within the hotel and restaurant industry indicated their involvement in product innovation, 123 (4.65%) involved in process innovation, while only 116 (4.38%) and 33 (1.25%) firms indicated improvement in their organisational structure and marketing innovation activities. Firms within the IT sector claimed that only 47 (1.78%) respondents are involving in product innovation, 33 (1.25%) involved in process innovation, while only 32 (1.21%) and 15 (0.57%) respectively indicated improvement in their organisational structure and marketing activities in 2014. In general, retails firms engaged more in product, process, organization, and marketing innovation types than any other firms within the Nigerian Enterprise firms in 2014.

In summary, among all the firms surveyed (2,676), only 868 firms representing 32.84% are exporting firms engaging in product upgrading, 796 (30.12%) involved in the process, while only 851 (32.20%) and 829 (31.33%) are engaged in organisational structure innovation and Marketing innovation activities.

The second set of indicators demonstrates the use of ICT in business transactions. Information Communication Technology, such as the use of internet access and mobile phones, are important tools for all firms because they provide even the smallest of enterprises with the ability to reach national and international markets at low cost. The third set of indicators captures the access to foreign technology in the country presenting the share of firms that adopt foreign technology in the production.

Table 2.6b showed the responses of the Nigerian enterprises' firms across different type of ICT use in business transactions in 2014. In terms of firms owning IRQC, 1,334 are classified as manufactured while 1,139 are into services Those certified

in the food industry are 167 (11.4%) firms, garment had 125 (4.7%), while other manufacturing firms had 2734 (6.04%). Similarly, firms owing IRQC within the services industry are; wholesale 109 (3.8%), retails 200 (0.8%) and other services sector 390 (9.08%). Also, firms owning a website and email are also shown in the Table.

Table 2.6a: Nigerian Enterprises Innovation Indicators, 2014

	Product			Process			Organisation			Marketing		
Sector	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
Food	143	129	**272**	151	121	**272**	110	162	**272**	48	224	**272**
Tobacco	2	0	**2**	2	0	**2**	2	0	**2**	1	1	**2**
Textiles	25	21	**46**	28	18	**46**	22	24	**46**	9	37	**46**
Garments	101	63	**164**	100	64	**164**	57	107	**164**	26	138	**164**
Leather	17	11	**28**	15	13	**28**	11	17	**28**	7	21	**28**
Wood	11	46	**57**	14	43	**57**	11	46	**57**	4	53	**57**
Paper	3	4	**7**	4	3	**7**	1	6	**7**	1	6	**7**
Publishing and Printing	82	74	**156**	89	67	**156**	65	91	**156**	30	126	**156**
Refined petroleum product	7	7	**14**	3	11	**14**	5	9	**14**	4	10	**14**
Chemicals	14	25	**39**	18	21	**39**	18	21	**39**	13	26	**39**
Plastics and Rubber	10	16	**26**	11	15	**26**	7	19	**26**	10	16	**26**
Non-Metallic mineral	79	102	**181**	90	91	**181**	82	99	**181**	42	139	**181**
Basic metals	14	28	**42**	17	25	**42**	14	28	**42**	4	38	**42**
Fabricated metal	79	71	**150**	79	73	**152**	60	92	**152**	30	122	**152**
Machinery and equipment	10	10	**20**	9	11	**20**	5	15	**20**	5	15	**20**
Electronics	5	7	**12**	2	7	**9**	5	7	**12**	4	8	**12**
Precision instrument	2	2	**4**	3	2	**5**	1	3	**4**	0	4	**4**
Furniture	103	88	**191**	114	77	**191**	73	118	**191**	26	165	**191**
Recycling	3	0	**3**	1	2	**3**	5	0	**5**	1	2	**3**
Construction	27	25	**52**	27	25	**52**	28	24	**52**	14	38	**52**
Services of motor vehicles	73	106	**179**	68	111	**179**	65	114	**179**	27	152	**179**
Wholesale	59	93	**152**	58	94	**152**	53	99	**152**	19	133	**152**
Retails	216	231	**447**	189	258	**447**	143	304	**447**	59	388	**447**
Hotel and Restaurant	128	116	**244**	123	121	**244**	116	128	**244**	33	211	**244**
Transport	45	53	**98**	49	49	**98**	49	49	**98**	19	79	**98**
IT	47	19	**66**	33	27	**60**	32	30	**62**	15	49	**64**
Total	1305	1347	**2652**	1297	1349	**2646**	1040	1612	**2652**	451	2201	**2652**
Exporter	**868**	**1775**	**2643**	**796**	**1847**	**2643**	**851**	**1792**	**2643**	**829**	**1814**	**2643**

Source: ***Computed from Nigeria Enterprise Survey, 2014***

Table 2.6b: Nigerian Enterprises Use of ICT Indicators, 2014

Subgroup Level	IRQC (%)	TLFC (%)	Own Website (%)	E-mail (%)
All Manufacturing	8.1	6.5	17.2	22.4
Food	11.4	6.4	19.7	25.7
Garments	4.7	3	23.4	28.1
Other Manufacturing	6.04	6.54	13.12	16.6
All Services	6.4	...	25.3	24.1
Wholesale	3.8	...	11.7	19.1
Retail	0.8	...	13.9	19.3
Other Services	9.075	...	43.625	43.35
Small (5-19)	6.4	3.4	14.8	18.9
Medium (20-99)	7.1	11.2	48.2	35.5
Large (100+)	29.9	52.3	69.8	78.6
Exporters	10.1	13.7	24	35
Non-exporter	6.4	5.4	23.7	23

Source: ***Computed from Nigeria Enterprise Survey, 2014***:**Note**: IRQC = Internationally-Recognized Quality Certification (%), TLFC = Technology Licensed from Foreign Companies

2.4 Policy Developments in the Nigerian Export Sector

ThereisnodoubtthatseveralpositiveinterventionsweremadebytheNigerian government toaddress the challenges confrontingthe export promotion and productivity improvement among firms.TheNigeriangovernmenthasovertheyearsemployed different strategies totackletheincessant bureaucracy towards improving export and productivity among firms in Nigeria.

Among the strategiesare but not limited to;the establishment of Nigerian Export Promotion Council (NEPC), export licensed waiver, export credit Guarantee and insurance scheme, export development fund, export expansion grant, export adjustment schemes grant, rediscounted of short-term bills for export, tax relief on interest income, foreign currency facility, foreign exchange market, repayment of technology fees and the recent Nigerian industrial Revolution Plan of 2014.

The NEPC was established through the promulgation of the "NEPC Decree No. 26 of 1976". This Act was amended by Decree No. 72 of 1979 and further amended by the Nigerian Export Promotion Decree No. 41 of 1988 and complemented by the Export (Incentives and Miscellaneous Provisions) Decree No. 18 of 1986. Furthermore, the NEPC (Amendment) Decree No. 64 and 65 of 1992 was promulgated to enhance the performance of the Council (NEPC, 2011). The Council is the leading Federal Government Agency charged with the responsibility of promoting non-oil export in Nigeria. The key objectives and function of the council include; the promotion, development, and diversification of Nigeria's export trade while spearheading the creation of appropriate export incentives and actively articulating the implementation of export policies and programmes of the Nigerian government (NEPC, official website). The council provides various export incentives and financing services to exporters such as export development fund, duty suspension scheme, duty drawback scheme, export expansion grand fund, Abolition of export licensed, export credit guarantee and insurance scheme, currency retention scheme, rediscounted of short-term bills, capital depreciation scheme, tax relief on interest income among others.

2.4.1: Policy Developments in the Area of Innovation and ICT in Nigeria

Governments and other policy stakeholders in an attempt to promote innovating activities and use of ICT in Nigeria have intervened and employed different strategies towards improving Innovation and ICT within the country. Among the strategiesare but not limited to;

- National System of Innovation (NSI) Policy: This refers to the flow of technology and information among people, enterprises, and institutions which is key to the innovative process on the national level. The policy framework involves setting up of innovation councils at all levels of government to fast-track the process of innovation in the country. This framework seeks to create a strategy for fostering innovation at the National, Sectoral, Regional, State, and Local levels by focusing on five key parameters: Platform, Inclusion, Ecosystem, Drivers, and Discourse. This is targeted at redefining innovation to go beyond formal R&D parameters, but to include platforms for innovative solutions that lead to inclusive growth for the people and by the people; foster an innovation eco-system across domains and sectors to strengthen entrepreneurship; focus on key drivers to ensure green growth, multidisciplinary approach, sustainability, durability and quality and expand the space for dialogue and discourse on innovation. A high-level organ called the Federal Innovation Council will be involved in facilitating sectoral, regional, state, and local level innovation. This will create an eco-system to boost innovation performance in the country. The over goal is to make Nigeria the first choice in innovation outsourcing globally.
- The Nigerian Science, Technology and Innovation Policy: Build a strong Science, Technology and Innovation capability and capacity needed to evolve a modern economy. The 2011 Science, Technology and Innovation (STI) policy was designed in tandem with the objectives and pillars of the Nigeria Vision 20:2020 so as to resolve practically the long term disconnect between economic planning and science and technology. The new policy on STI thus has as its core mission the evolution of a new Nigeria that harnesses, develops and utilizes STI to build a large, strong, diversified, sustainable and competitive economy that guarantees a

high standard of living and quality of life to its citizens. Specifically, the new STI policy was designed to provide a strong platform for science, technology and innovation engagement with an economic transformation that is citizen-centred.

- National Telecommunications Policy (NTP): In the year 2000, the Federal Government of Nigeria adopted NTP policy to guide the development of the telecommunications industry in Nigeria. This was followed by the enactment of the Nigerian Communications Act (NCA) 2003 to give legal effect to the NTP. Previously, the National Mass Communications Policy recommended the creation of a regulatory body to regulate Broadcasting and this led to the promulgation of Decree 38 of 1992 that established the National Broadcasting Commission (NBC). In a similar vein, the National Information Technology Policy was approved in 2000 to guide the IT industry in Nigeria and was followed by the enactment of the National Information Technology Development Agency (NITDA) Act 2007 which became the legal platform for the creation of NITDA. It is noteworthy that there has never been a national postal policy, however, Decree No. 41 of 1992 established the Nigeria Postal Service (NIPOST) to provide postal services in Nigeria.
- Establishment of Ministry of Communications Technology: The Ministry of Communications is a Ministry created in 2011 as Ministry of Communication Technology. It was created to foster a knowledge-based economy and information society in Nigeria. The Ministry was created to facilitate ICT as a key tool in the transformation agenda for Nigeria in the areas of job creation, economic growth and transparency of governance. To facilitate universal, ubiquitous and cost-effective access to communications infrastructure throughout the country. Promote the utilisation of ICT in all spheres of life to optimise the communications infrastructure – digital content creation, domestic software applications and the delivery of private and public services over the internet. Promote and facilitate the development of the ICT industry and increase the contribution of the ICT industry to GDP. Utilise ICT to drive transparency in governance and improve the quality and cost-effectiveness of public service delivery in Nigeria.

- **National ICT Policy (2002):** The goal of the policy is to provide a framework for streamlining the ICT sector and enhancing its ability to help address some socio-economic and development challenges while facilitating the transformation of Nigeria into a knowledge-based economy. In addition, the ICT policy shall be used to develop action plans, sub-sectoral policies and specific implementation guidelines as appropriate (NIP, 2012).

In summary, the Nigerian ICT sector is guided by the following policies and enabling laws:

I. The National Telecommunications Policy (NTP) 2000;

II. National Mass Communication Policy;

III. National Broadcasting Commission (NBC) Act 1992 (as amended)

IV. Nigerian Communications Act, 2003;

V. Nigerian Postal Service Act 2004 Cap 127 Laws of the Federation of Nigeria;

VI. National Information Technology Policy 2000;

VII. NITDA Act 2007; and

VIII. The Wireless Telegraphy Act, Laws of the Federation 1990

IX. Nigeria Internet Registration Authority (NIRA) in 2006

2.5 Theoretical Literature Review[10]

This section presents the review of theoretical literature in the area of international trade. Perhaps it is relevant to mention from the outset that the international trade theories can broadly be classified into three; namely, the traditional trade theories, the new trade theories and the new-new trade theories of firms' heterogeneity from which the hypotheses on the link between exporting status of firms and productivity are developed.

[10] The step-by-step derivation of the relevant theories is presented. This enables the reader see the contribution of this thesis later in the theoretical framework. To avoid repetition, few steps that are excluded in this review are later specified in the theoretical framework.

2.5.1 The Classical Trade Theory: Ricardian Trade Theory

International trade literature shows that economies engaged in trade for two main reasons and each of which contributes to their gains from trade. Thus, countries trade because of differences among them, in terms of resources and capacity to produce. David Ricardo, (1772 - 1823) contributions to the field of international trade have been so important with the formulation of Ricardian theory. In fact, the classical trade theory is sometimes referred to as the Ricardian theory of comparative advantage. The theory of comparative advantage is perhaps the most important in the international trade literature (Krugman and Obstfield, 2003). Ricardo intuition was that in a two country and two goods world, trade is advantageous even when a single country has an absolute advantage[11] in the production of two goods. According to him, what matter is not the absolute advantage but comparative advantage. Ricardian model assumes two countries (**j** and **k**) and two products (biro and book) and that both products are produced with labour as the available production input. Thus, in country **j**, the total resource defined as **L** which is shared to produce the goods ($L = Q_{ij} + Q_{ik}$). Hence, any of the two countries has limited resource which limits what it can produce and there are always trade-off (to produce more of one good, the economy must sacrifice some production of another good). The model further assumes constant returns to scale in production, full employment, existence of competitive firms and no role for institution and government policies.

The Ricardian model focuses on labour productivity as the main determinant of trade. According to the model, a_{ij} represent labour unit requirement (the inverse of productivity), for sector **i** in country **j** such that;

$$a_{ij} = \frac{L_{ij}}{Q_{ij}} \quad \text{..... (2.1)}$$

[11] It follows that each country will benefit from specialization in those commodities in which it has an absolute advantage (i.e. can produce at lower real cost than another country), exporting them and importing other commodities that it produces at a higher real cost than does another country. This theory was propounded by Adam Smith in his book titled "The Wealth of Nations". Real cost," for Smith, meant the amount of labour time required to produce a commodity. His analysis was based on the labour theory of value, which treats labour as the only factor of production and holds that commodities exchange for one another in proportion to the number of hours required for their production.

Where Q_{ij} is the value addition of sector **i** in country j, and L_{ij} represents unit of labour employed by sector **i** in country **j**. The marginal product of labour is equal to $(1/a_{ij})$, and hence unit of labour requirement a_{ij} , is assumed to be constant with respect to variations in L_{ij}. Furthermore, the assumption of constant marginal product is not in itself critical, but productivity difference between countries must be large enough that they are not eliminated by trade. Meanwhile, competitiveness of sector **i** in country **j** compared with country **k** also depends on wages (w_{ij} *and* w_{ik}) and the bilateral exchange rate (e_{jk}), which determine relative unit of labour cost c_{ijk} (usually expressed in common currency).

$$c_{ijk} = a_{ij}w_{ij}/a_{ik}w_{ik}\, e_{jk} \qquad (2.2)$$

Where $a_{ij}w_{ij}$ and $a_{ik}w_{ik}$ are the opportunity costs of production in both countries such that country **j** will specialise in goods where $c_{ijk} < 1$ and import goods where $c_{ijk} > 1$. The model assumed that labour is homogeneous and perfectly mobile between sectors. Hence, wages are equal across sectors within a country. The Ricardian model concludes that, a country **j** is said to have comparative advantage in the production of a good (say, biro) if it can produce it at a lower opportunity cost than another country **k**. The opportunity cost of biro production is defined as the amount of book that must be given up in order to produce one more unit of biro. Thus, a country has comparative advantage in biro production relative to another if it gives up less book to produce an extra unit of biro than the amount of book that the other country gives up to produce an extra unit of biro.

The model demonstrates that under a free trade regime, countries could specialise and trade based on their patterns of production in accordance with the comparative advantage which also reflects in wages and productivity among competitive countries of the world. Although the Ricardo's trade model is very simple some of its assumptions are found to be unrealistic which leads to the development of the neo-classical trade theory.

2.5.2 The Neo-classical Trade Theory: Heckscher-Ohlin (H-O) Theory[12]

Trade economists have developed more sophisticated trade models which links the patterns of trade to differences in factor endowments in the context of the neo-classical trade theory. As assumed in the Ricardian model that labour is the only factor of production, comparative advantage will arise only because of international differences in labour productivity. However, in the real world, while trade is partly explained by differences in labour productivity, it is also explained by differences in other resources endowment. Therefore, a realistic view of trade must allow for the influence of other important input factors apart from labour such as land, capital and mineral resources. The factor proportions theory of trade is attributed to two Swedish economists, Eli-Heckscher and Bertil Ohlin (hereafter refers to as H-O). The H-O model differs from the Ricardian model in two basic areas. First, rather than focusing on the single input, labour, the H–O model allows for additional inputs (capital) and recognizes that different goods require these inputs in different proportions. Secondly, differences in technology across countries are no longer assumed, but the H–O model distinguishes countries by the availability of factors of production, that is, by their factor endowments (Dunn and Mutti, 2004).

The H-O model assumes a Constant Return to Scale (CRS) in production with differences in countries factor endowments. There is no factor-intensity reversal within each country and preferences are identical and homogenous, while both inputs (Labour and capital) are homogeneous and mobile across industries, but not across countries.

The novelty introduced by H-O model implies that the production possibility frontier is concave and hence reflects increasing opportunity costs. As a result, complete specialization, in the Ricardian model, is not very likely to hold in the H-O model and intrinsically, trade will cause redistribution of income between labour and capital. The H-O model suggests that a country will export goods that use its abundant factor intensively.

The basic insight of the H-O model is that traded commodities involve movement of services of factors (land, labour, and capital) such that the exchange of commodities across border is indirect factor arbitrage, transferring the services of otherwise immobile

[12]This section draws mainly from the work of Krugman and Obstfield, (2003) and Dunn and Mutti, (2004).

factors of production from locations where these factors are abundant to locations where they are scarce (Leamer, 1995). Therefore, under some circumstances, the indirect arbitrage can completely eliminate factor-price differences among countries. In the empirical literature, H-O model was initially used to determine the effects of the various forms of growth factors and international trade. Then, the focus was on the volume and pattern of trade, terms of trade, and welfare gain analysis. The unrealistic assumption of trade under perfect competition in the world where imperfect competition exists lead to the development of the new trade theories.

2.5.3 New Trade Theories

New Trade Theories (NTT) focuses on the role of increasing returns to scale and monopolistic in trade, which was recognised in the late 1970s and early 1980s (Krugman, 1979 and 1980). These theories underscores the idea that even when two countries are ex-ante identical there could be benefits from trade.

The models emanating from the NTT differs from the traditional trade models in that monopolistic competing firms exist and their products are likely to be differentiated, generating deviations from a competitive model. The NTT disproves the predictability of traditional trade theories as true predictor of the pattern of trade across nations on the basis of pre-trade commodity and factor prices. Also, the NTT questions the rigid framework of earlier trade theories and attempts to introduce the scale economies in production (Sen, 2005). According to this theory, increasing returns to scale which could determines the pattern as well as on the mutual benefits arising from international trade is important. Another related point is that the size of firms and the market structure, which are intricately linked to the possible economies of scale, demand attention in the trade literature. Domestic firms who enjoy economies of scale are usually in a better position to influence the market by exercising control over prices as well as the market share. This position of control could result in different forms of an imperfect market such as monopolistic competition, oligopoly, or monopoly. Thus, trade models have been modified to incorporate the direct competition among firms producing the same good using a monopolistic competition framework (Melitz, 2003 and Melitz and Ottaviano,

2008). This line of modification is usually referred to as the new-new trade theory or firm heterogeneity model. The assumption is that each firm produces its own distinctive differentiated good and therefore, firm heterogeneity is modelled into the one-sector models of NTT.

2.5.4 Firm Heterogeneity Theory

Following from the empirical modification of the NTT, theoretical research in international trade are increasingly emphasizing the decisions of firms in understanding the causes and consequences of aggregate trade. This new-new theoretical emphasis is a response to empirical studies using micro data, which revealed a number of features of producer behavior that were not well explained by pre-existing theories of international trade. There is substantial heterogeneity in productivity, size and other economic characteristics even within narrowly-defined industries (Redding, 2011). Participation in international trade is relatively rare and is associated with superior values of productivity and other measures of economic performance. Trade liberalization is accompanied by reallocations of resources within industries, which raise average industry productivity, as low productivity suppliers exit and high productivity suppliers expand to enter international markets (Melitz and Redding, 2015). Trade liberalization is also accompanied by endogenous changes in firm productivity, which in turn influence within-industry resource allocation. Thus, firms are expected to face sunk costs of entry into the foreign market (Melitz, 2003) and variable costs (Chaney, 2008) along with uncertainty concerning their future productivity (or also possibly the quality of the differentiated good that is under development). Upon entry, each firm instantaneously learns about its productivity level and because of the nature of sunk costs of entry, firms with dissimilar productivity and high quality levels will remain active and continue in production. On the other hand, the least productive firms are unable to face intense competition which leads to negative profits and therefore exit. As exporting is costly, only the relatively more productive firms (among those surviving) choose to export, while the remaining firms only serve their domestic market. This idea is termed “self-selection and learning by exporting hypotheses” under the free market entry model.

In summary, the new-new trade theory states how more productive firms' participate in foreign market via self-selection or learning-by-exporting. The theory assumed that firms are not identical even when operating within the same industry. According to Redding, (2011) heterogeneity occur in productivity, size, and other firms characteristics and as such exporters are likely to record a higher productivity relative to non-exporters.

2.5.4.1 Free Market Entry Theory (Self-selection and Learning by Exporting)

2.5.4.1.1 Self-Selection Hypothesis

The self-selection hypothesis is based on the model of foreign market entry developed by Roberts and Tybout (1997). This model stresses the role of entry (sunk) costs in the firms' decisions to enter the export market. There are two conditions which make firms to engage in exporting activities; (1) expected profits from such activities must be non–negative and must exceed expected profits when not exporting. (2) Firms that wish to export not only face variable cost (such as transport costs and tariffs) but also some fixed costs that do not vary with export volume and that are sunk. These costs include costs of modifying the existing production process and product lines to satisfy foreign demand, advertising to improve awareness of products in the foreign market, gathering information about the foreign market and its regulations and/or setting up of distribution network abroad (Chaney, 2008; Melitz, 2003 and Robert and Tybout, 1997). Therefore, firms which export are likely to set higher prices in the foreign markets to reflect the increased marginal cost of serving these markets (Melitz, 2003). Unless, the productivity of such firms is high enough to cover both the increased marginal cost and competitive profits.

Suppose that at period t, firm i produces and sells its product in both domestic and foreign markets. The firm's profit-maximizing output level for both local and foreign sales is given as q_{it}. According to Robert and Tybout, (1997), the firm's pricing rule in both markets will be;

$$P_{d_{it}}(q_{it}) = w/\rho q_{it} = (1/\rho)q_{it} \text{ and } P_{x_{it}}(q_{it}) = \beta P_{d_{it}}(q_{it}) \text{ respectively} \qquad (2.7)$$

Where w = common wage rate within the sector, which is assumed equal to one (1)

$P_{d_{it}}$ = price charged in the domestic market

$P_{x_{it}}$ = price charged in the foreign market

(q_{it}) = Quantity of good sold in either market

$(1/\rho)$ = profit-maximizing mark–up,

β = Increased marginal costs arising from input costs

The expected revenue (r_{it}) of the firm from both markets will be;

$$r_{d_{it}}(q_{it}) = q_{it}/pq_{it} \text{ and } r_{x_{it}}(q_{it}) = \beta P_{d_{it}}(q_{it})q_{it} \text{ respectively} \quad (2.8)$$

While the expected profit (π_{it}) of the firm from both markets will be;

$$\left.\begin{aligned} \pi_{d_{it}}(q_{it}) &= {r_{d_{it}}(q_{it})}/{\sigma} - C_{dit}, \\ &\text{and} \end{aligned}\right\} \quad (2.9)$$

$$\pi_{x_{it}}(q_{it}) = {r_{x_{it}}(q_{it})}/{\sigma} - C_{x_{it}}$$

Where σ = constant elasticity,

$\left[{r_{d_{it}}(q_{it})}/{\sigma}\right]$ = expected revenue in the domestic market,

$\left[{r_{x_{it}}(q_{it})}/{\sigma}\right]$ = expected revenue in the foreign market,

C_{dit} = Overhead production cost

$C_{x_{it}}$ = Production and Trade cost when exporting

$\pi_{d_{it}}$= Profit in the domestic market

$\pi_{x_{it}}$= Profit in the foreign market

The firm will export if and only if $\pi_{x_{it}}(q_{it}) \geq 0$ and $\pi_{x_{it}}(q_{it}) > \pi_{d_{it}}(q_{it})$. The combined expected profit of the firm can be given as;

$$\pi(q_{it}) = \pi_{d_{it}}(q_{it}) + \max[0, \pi_{x_{it}}(q_{it})] \quad (2.10)$$

Likewise, the total expected revenue of the firm is given by

$$r(q_{it}) = r_{d_{it}}(q_{it}) + r_{x_{it}}(q_{it}). \quad (2.11)$$

Thus, equation (2.10) can as well be expressed as

$$\pi(q_{it}) = \left[{r(q_{it})}/{\sigma} \right] - \left[C_{it} + C_{x_i} \right] \quad (2.12)$$

where w denotes common wage rate which is assumed equal to one (1), (1/ρ) represents profit-maximizing mark–up, β is regarded as the increased marginal cost which induces the higher price charged for selling at the foreign market, σ is constant elasticity, $[r(q_{it})/\sigma]$ is expected variable profit, C_{it} is overhead production cost and C_{x_i} is trade cost which consists of both variable trade cost ($CV_{x_{it}}$)and fixed trade cost (CF_{x_i}). We assume that both C_{it} and $CV_{x_{it}}$have been accounted for when charging price on the firm's products at both domestic and foreign markets and have been incorporated into the firm's expected revenue.

Let X_{it} denotes the export status of the firm which takes the value of 1 if the firm exports in period t and 0 if otherwise. Therefore, the firm expected profit at period t will be expressed only with the existence of fixed trade cost (most often regarded as a sunk cost) as;

$$\pi(q_{it}^*) = X_{it} \left[\left({r(q_{it}^*)}/{\sigma} \right) - CF_{x_i}^* \right] \quad (2.13)$$

With an unbounded series of export quantities, the firm will maximise expected present value of profit which is expressed as;

$$V_{it}(\Omega_{it}) = \max_{q_{it}^*} E_t\left(\sum_{n=t}^{\infty} \delta^{n-t}(r(q_{it})|\Omega_{it})\right) \quad (2.14)$$

Where δ is the one-period discount rate, and expectations are conditioned on the firm-specific

information set, Ω_{it} . The value of the firm's current export status can be specified thus;

$$V_{it}(\Omega_{it}) = \max_{q_{it}^*}(\pi(q_{it}^*) + \delta E_t\left[V_{it+1}\left(\Omega_{it+1}\right)|q_{it}^*\right]) \quad (2.15)$$

E_t symbolises expected values conditioned on the information set, Ω_{it}. Based on equations (2.13) and (2.15), the firm will participate in the export market in period t if and only if;

$$\pi(q_{it}^{*}) \geq CF_i^{*} \tag{2.16}$$

Against the above background, the firm will engage in exporting activities under the following condition;

$$\begin{aligned} &1.\ \text{if } \pi(q_{it}^{*}) - CF_{x_i}^{*} \geq 0 \\ &2.\ X_{it} = 0 \ \text{if otherwise} \end{aligned} \tag{2.17}$$

These conditions imply that expected profits from exporting must be non–negative and must exceed expected profits when not exporting, otherwise the firm will not export.

2.5.4.1.2 Learning-by-Exporting Hypothesis[13]

Learning-by-exporting hypothesis states that since knowledge that flow from international buyers and competitors help to improve the post-entry performance of export firms, therefore, firms participating in international markets are exposed to more intense competition and need to improve faster than firms who sell their products domestically only (Clerides, *et al.,* 1998).

According to De Loecker, (2013), learning-by-exporting refers to the mechanism whereby firms improve their performance (productivity) after entering export markets. The hypothesis points to the importance of learning from foreign markets both directly and indirectly through buyer-seller relationships and through increased competition from foreign producers. In particular, exporters can learn from foreign customers and rivals by improving product quality, shipment size, or, even more directly, by undertaking specific investments.

In modeling learning-by-exporting hypothesis, De Loecker, (2013) allows past export experience to potentially impact the current productivity of firms. The starting point is to assume a production function for firm í at time t of the form as follow;

[13]This framework draws mainly from the work of De Loecker, (2013) on detecting learning by exporting

$$Y_{it} = B_i L_{it} + B_k K_{it} + w_{it} + \epsilon_{it} \quad (2.18)$$

Where $\boldsymbol{Y_{it}}$ is output, $\boldsymbol{L_{it}}$ is the labour input, $\boldsymbol{K_{it}}$ is the capital input, $\mathbf{w_{it}}$ denotes productivity (by subsuming the constant term) and $\epsilon_{\mathbf{it}}$ refers to a standard independent and identically distributed **(i.i.d)** error terms capturing unanticipated shocks to production and measurement error. One important assumption of the equation (2.18) is that productivity enters in a Hicks-neutral fashion[14]. Therefore, allowing for learning-by-exporting to take place or, more formally, include export information in the productivity process (g(·)) can be stated as

$$w_{it+1} = (w_{it}, E_{it}) + \varepsilon_{it+1} \quad (2.19)$$

Where E_{it} is a vector measuring firm's export experiences. The vector E_{it} can be extended to capture export intensity (measured by export sales), the number of export markets, and how long the firm has been exporting, among others factors. Thus, the production process then suggests that firms entering exporting markets do expect an impact on their future revenue through either increased demand and/or decreased cost of production. Unexpected effects from exporting, which materialise in higher output, are captured by ε_{it+1}.

In summary, it is evident that the link between exporting-productivity decisions of firms is largely driven by firms' productivity status and firm-specific factors. Alternatively, an export decision could drive productivity, in the sense that knowledge that flows from international customers, buyers and competitors may help firms to improve their post-export market entry performance compared to non-exporting firms. However, firms' innovation that leads to increased productivity through investments in Research and Development and human capital as argued in the new trade theories are neglected. Also, all these theories (both traditional and new trade theory) fail to recognise the role of ICT (especially through the use of the mobile network, Internet usage) and innovation among firms in the exporting decision.

For instance, innovation (product, process, organization and marketing) and use of ICT (internets, mobile telecommunication and website) as a mechanism through which firms improve their performance in the form of product or process upgrading for quality

[14] Hicks-neutral technology or factor augmenting production function takes the form: Y=AF (K, L). The implication is that the technology is neither capital saving nor labour.

improvement and obtained feedback from export markets was not addressed by previous studies. Therefore, the issue of firms' involvement in innovation and ICT as a process of influencing productivity and exporting decision of firms needs to be addressed in the trade literature.

2.6 Methodological Literature Review

Empirical literature underscoring the role of ICT and innovation in the exporting-productivity link has followed broadly two main approaches namely; Non-parametric test and Econometric techniques. Each of these two techniques is discussed and their relative strength and weaknesses are identified in the following.

2.6.1 Nonparametric Approach

A nonparametric model is one in which no assumption[15] is made about the functional form of the joint distribution. The only assumption made about the observations is that they are independent identically distributed (i.i.d.) from an arbitrary continuous distribution. As a result, the nonparametric statistics is also called distribution-free statistics. There are no parameters in a nonparametric model.

The use of nonparametric models are insensitive to model assumptions such that both hypothesis testing and the estimated variance from such model do not adjust to the assumption of the model. Apart from the usual Chi-Square goodness of fit test, researcher oftentimes employed Kolmogorov-Smirnov tests. Studies using Kolmogorov-Smirnov nonparametric test to analyse the role of ICT or innovation in exporting-productivity link include Leon, *et al.,* (2016); Kusumaningtyas and Suwarto, (2015); Cassiman, *et al.,* (2010); Bellone, *et al.,* (2009); Cassiman and Golovko, (2007); and Huergo and Jaumandreu, (2004), among others. Advantages of nonparametric tests include fewer assumptions, used scale data, easy computation and does not need to involve population parameters. However, it may lead to waste of information through the process of

[15] Unlike the parametric statistical model where the functional form of the joint distribution is assumed to be known and the only unknowns in the model are the parameters.

converting data from ratio to ordinal scale. It requires more data sample than the econometric techniques before estimated results can converge to almost the same coefficients.

In summary, nonparametric statistics, require fewer assumptions about the data and consequently will prove better in situations where the true distribution of the data is unknown or cannot be easily approximated using a probability distribution.

2.6.2 Econometrics Techniques

Another prominent approach used in the literature on the role of innovation and or ICT in exporting-productivity link is econometrics approach, which largely dominate regional and firm level studies; using country and firm-level panel data (see, Strobel, 2016; Lee, *et al.,* 2015; Ceccobelli and Mancuso, 2012; Commander, *et al.,* 2011 and Chadha, 2009, among others). Among the econometric approaches often employed are Ordinary Least Squares (OLS), Two-Stage Least Squares (2SLS), General Methods of Moments (GMM), Panel fixed and Random model and discrete choice model.

In econometric, OLS or linear least squares is a method for estimating the unknown parameters in a linear regression model, with the goal of minimizing the sum of the squares of the differences between the observed responses in the given dataset and those predicted by a linear function of a set of explanatory variables. The linear regression method is the single most useful tool in econometric analysis (Greene, 2003). The econometric technique remain the tools used to begin almost all empirical research. The regression OLS method model to be estimated with assumed linearity in parameters, while data are random samples of the population. Furthermore, errors generated from the estimated sample are expected to be statistically independent with the expected value of the errors being equal to zero. This estimation technique is appropriate in situations where there is no problem of perfect multi-collinearity and heteroscedasticity (unequal variance). All these assumptions ensure that the OLS estimators are Best Linear Unbiased Estimator (BLUE) i.e. the expected estimator possesses the quality of minimum variance in the class of linear unbiased estimators.

Omitted-variable bias in modeling that usually results from data generating process, especially when the process is not directly measurable or when no good proxies can be

found; will lead to the problem of endogeneity. That is, there is a correlation between the regressor and the error term. To correct for this problem and estimate a consistent model, the Instrumental Variables (IV) methods are often employed, as the most widely known solution to endogenous regressors. The IV methods provide a way to nonetheless obtain consistent parameter estimates. To use the IV approach with endogenous regressors x_i, there is the need for an observable variable z_i, that is not in the original regression equation that satisfies two conditions. First z_i, must be uncorrelated with the error term; that is the $\text{Cov}(z_i, \varepsilon) = 0$. This condition is known as the exclusion restriction. Secondly, the estimate of z_i, must be non-zero-that is z_i is correlated with the endogenous variable. A typical example of the IV methods is the two-stage least square (2SLS) and GMM technique. We can also state that the OLS is a class of IV where the instruments are also the regressors.

Generalized Method of Moments (GMM) is an estimation procedure that allows economic models to be specified while avoiding unwanted or unnecessary assumptions, such as specifying a particular distribution for the errors (Greene, 2003). This lack of structure means GMM is widely applicable, although this generality comes at the cost of a number of issues, the most important of which is questionable small sample performance. Generalized Method of Moments (GMM) extends the classical setup in two important ways. The first is to formally treat the problem of having two or more moment conditions which have information about unknown parameters.

GMM allows estimation and inference in systems of equations with P unknowns, P ≤ Q. The second important generalization of GMM is that quantities other than sample moments can be used to estimate the parameters. GMM exploits laws of large numbers and central limit theorems to establish regularity conditions for many different “moment conditions” that may or may not actually be moments. These two changes produce a class of estimators that are broadly applicable

The advantages of GMM over 2SLS are that if heteroskedasticity is present, the GMM estimator is more efficient than the simple IV estimator (2SLS), whereas if heteroskedasticity is not present, the GMM estimator is no worse asymptotically than the

IV estimator. Studies using either GMM or 2SLS to empirically investigate the role of ICT or innovation in exporting and productivity include Chadha, (2009), Woerter and Roper, (2010), Commander, *et al.,* (2011), Yang and Chen, (2012), Sharma and Mishra, (2015), Amable, *et al.,* (2016), and Bertschek and Niebel, (2016).

Moreover, in time series models, the dependent variable is usually quantitative while the regressors (unexplained variable) can be purely quantitative, qualitative or a mixture of both. These qualitative categories of data sets are oftentimes represented by dummy variables which take the value of zero (0) or 1. However, suppose we intend to capture a real-life phenomenon where the regressand cannot be quantified but rather can be represented in qualitative terms, such a model used in this regard is referred to as Qualitative Response Models (QRM). The simplest form of QRM is the binary choice models where the responses are binary i.e. the regressand is a binary or dichotomous variable. However, when the regressand has more than two outcomes, the multiple response models are used (Greene, 2003). Whenever the variable that we want to model is binary, it is natural to think in terms of probabilities, for instant, what is the probability that an export firm will engage in innovation activities?, If some variables such as use of ICT changes by one unit, what is the effect on the probability of exporting? Essentially, there are three approaches to developing a probability model for a QRM

1. The Linear Probability Model (LPM)
2. The Logit Model
3. The Probit Model

Although, both logit and Probit are very similar in the estimated coefficient, however, Linear Probability Model (LPM)[16] differs in that it works like a normal linear regression model, but the interpretations change because now the variable (Y) is binary. Therefore, in order to solve the problem of LPM, researchers oftentimes employed Probit and Logit models (Llaudet, 2010).

In general, Logit has slightly fatter tails than Probit. It is approximately equivalent to using a student "T" with 7 degrees of freedom instead of the Normal "T" as in the Probit.

[16]Moreso, the LPM observed disturbance term can also take two values and, therefore, it cannot be normally distributed and the error can be heteroskedasticity.

This makes it very slightly more robust to outliers' series, which is generally a good thing. However, a fitting Probit model is easier to model and interpret. However, when the probability interval falls outside the range of "0 and 1", then the observed estimated coefficients are meaningless and somewhat misleading (Greene, 2003).

In the literature, several studies had employed probability models to assess the impact of innovation and use of ICT in exporting-productivity link. Examples of studies in this category include Lee, (2011); Beveren and Vandenbussche, (2010); Caldera, (2010); Cassiman and Martinez-Ros, (2007) and Basile, (2001).

Therefore, to overcome some of the problem[17] inherent in the previous techniques identified above, this study employs Structural Equation modeling (SEM). The choice of this technique is premised on the fact that it consists of a set of linear equations (such as Regression models, Simultaneous models, Factor analysis and Path analysis) and with both latent (theoretical) and categorical variables together in one model. SEM has distinctive features over other identified techniques in the literature, that make it a suitable analysis tool in this thesis: (a) SEM admits the explicit inclusion of measurement error in the estimation process for as many variables as necessary; (b) it allows simultaneous estimation of the parameters of a series of dependence relationships, thus, dependent variable in one equation can serve as independent in others; (c) it can display reciprocal causes in recursive and non-recursive models; and (d) it is also suitable for prospective analysis with additional out-of-the-sample data (Coughlan, and Mullen, 2009). Investigating the role of ICT and Innovation in firm productivity in Spain, Diazo-Chao (2015) employed SEM for a sample of 464 firms based in Girona, while the same method is used by Cuevas-Vargas, *et al.,* (2016) and Pla-Barber and Alegre, (2007) for sample of

[17]As observed, previous studies that employed aggregate data approach have been dominated by cross section empirical studies. However, this has been criticized, based on the fact that countries obviously are heterogeneous along many dimensions and this heterogeneity cannot be completely controlled by including observed attributes. Although, studies have overcome this problem by employing the use of panel data and including fixed effects for countries to soak up the influence of unobserved country-specific effects. Although this to a larger extend have been addressed in recent studies by adopting the system GMM estimator which relies partly on within country variation but does not entirely ignore cross-country variation. Nonetheless, secondary data approach cannot account for the peculiarity of the firms in question. Thus the need to use the Nigerian enterprise firms' data of cross-sectional survey makes the use of secondary data alone ineffective in addressing the fundamental link between ICT, Innovation and export-productivity.

288 manufactured MSMEs in Mexico and 121 surveyed firms in biotechnology industry in France.

2.7 Review of Empirical Literature

The literature is quite recent and scanty on ICT, innovation and exporting-productivity link and the few existing ones have investigated the relationship differently. Observably, the empirical evidence provided by most of these studies have been mixed, and a consensus has not yet emerged. This can partly be attributed to the approach adopted for the studies.

Moreover, existing literature, using firm-level data, can be classified into three different strands; (a) those that focus on the relationships between exporting-productivity link (b) studies that focus on innovation and exporting-productivity link and (c) studies that investigated the link between ICT and productivity. Therefore, given these three strands of the literature, this section contains a review of studies on each of these strands.

2.7.1 Firm level Exporting-Productivity Link

Studies associating exporting and productivity are more pronounced especially at the aggregate level (Biesebroeck, 2004; Alvarez and Lopez, 2005 and Crespi and Zuniga, 2012, among others). However, starting from the pioneering work of Bernard and Jensen, (1999), Bernard *et al*. (2003) and Melitz (2003); only have empirical studies being developed at the firm-level. In these studies, intra-industry trade model that is designed to match a set of stylized facts about exporting firms is analyzed. Melitz, (2003) introduced the concept of sunk cost into exporting decision of firms, while Chaney, (2008) modify the work by claiming that exporting activities entails both fixed and variable costs in the form of transport costs and tariffs.

However, since then a new line of research has emerged; believing that the link between exporting and productivity is not exogenous is attributed to Bernard and Jensen, (1999). Relatively, studies using firm level data are more concentrated in developed countries, with only a few exceptions in developing countries as shown in the summary Table of the literature review (Table 3.4.1, Column 3). Studies around this area in developed countries include Bai *et al.,* (2017); Bellone *et al.,* (2014); Robert and Tybout, (1997); Bernard and Jenson, (1999); Yang and Chen, (2012) and Le and Valadkhani, (2014), among others, while those from developing countries are Babatunde, (2017), and Adeoti (2011).

In terms of empirical findings, Babatunde, (2017) revealed that firm age, labour productivity, access to loan and infrastructure are robust determinants of export propensity among Nigerian firms, while firm age, labour productivity, capital intensity, skill intensity, access to loan, managerial experience, and infrastructure increase the export intensity. Adeoti, (2011) investigated how technology investment-related factors affect the export potential of firms in Southwest Nigeria. The results demonstrated that investments in technology among the sample firms are on imported technologies, while such investments are not directly targeted at improving the export potential of firms.

Bai *et al.,* (2017) using data on China state-owned enterprises covering 1998 to 2007, showed that demand and productivity evolve more favourably under direct exporting, through the fixed/sunk costs. Using Indian manufacturing firms, Sharma and Mishra, (2015) revealed that a weaker interlink between trade and productivity exists for the period of 1994 and 2006. Specifically, they found that more productive firms self-select themselves into the exporting as well as importing markets. The learning effects of importing on productivity growth turn out to be more favourable for labour productivity than for total factor productivity (TFP), while there is a positive relationship between R&D and labour productivity. Similarly, Haidar, (2012) employed firm level data on 33,510 Indian manufacturing firms between 1991 and 2004 to investigate the relationship between exporting and productivity. He found out that more productive firms become exporters but it is not the case that learning by exporting is a channel fuelling growth in Indian manufacturing. In the same vain, De Loecker, (2007) revealed that export entrants become more productive once they start exporting, while the productivity gap between exporters and their domestic counterparts increases further over time.

Table 2.7a: Summary of Literature on Firm level Exporting-Productivity

S/No	Studies	Sample/Scope	Theoretical Framework	Methodology		Empirical Results
				Estimation Methods	Variables	
1	Chadha, (2009)	131 Indian Pharmaceutical firms (1989–2004)	Employed a dynamic production function	GMM	X, Unit price index, dummy, R&D.	R&D by foreign patent rights has a + X
2	Haidar, (2012)	Employing 33,510 Indian manufacturing firms between 1991 and 2004.	Self-Selection and learning-by-Exporting Hypothesis	OLS and Matching Sample	TFP, XP, K, S, L/Y	More productive firms become exporters but it is not the case that learning by exporting is a channel fuelling growth in Indian manufacturing.
3	De Loecker, (2007)	6391 Slovenian manufacturing firms operating in the period 1994–2000	model of foreign market entry	Matching Sampling Techniques, OLS	W, X, S, K, EM	X entrants become more productive once they start X. The Y gap between Xers and Non-Xers increases further over time.
4	Sharma and Mishra, (2015)	Indian Manufacturing Firms (1994 - 2006)	Foreign market entry model	System GMM	Y, L, K, R&D, RM, sales, X and IM	More productive firms self-select themselves in the exporting as well as importing market. The learning effects of importing on productivity growth turn out to be more favorable for labour productivity than TFP, while there is a positive relationship between R&D and Labour Productivity.
5	Bai *et al.,* (2017)	State-owned	Foreign market	Dynamic	Ownership, age,	Demand and productivity evolve more

		enterprises in China (1998 - 2007)	entry model	Discrete Choice Model	L, K, REV, X	favorably under direct exporting, though the fixed/sunk costs.
6.	Bellone *et al.,* (2014)	French and Japanese manufacturing industries	Learning-by-exporting	Kolmogorov–Smirnov test	TFP, X and Non-X	International productivity gaps are sensitive to the export status of firms. Also, productivity differences exist between French and Japanese exporters and it's vary across export destinations.
7	Robert and Tybout (1997)	4 Colombian manufacturing plants (1981-1989)	Self-Selection Hypothesis	Dynamic Probit Model	X, W, XP, X price, K, and region	Prior export experience increases the probability of exporting by as much as 60 percentage points.
8	Bernard and Jenson (1999)	US manufacturing firms (1983-1992)	Foreign market entry model	VAR and Granger-causality	Real output per hour, MFP and X	Causality runs from productivity to exporting and not the reverse. Exporting is associated with reallocation of resources from low to high productive industry.
9	Yang and Chen, (2012)	Using a sample of 38,637 observations during 1999-2000 for Indonesian manufacturing firms	model of foreign market entry	2SLS	LP, XIN, FS, SIN, FGR, R&D Intensity, and FO.	X + FS, R&D. The simultaneous estimates suggested that R&D + on both Y and X.
10	Le and Valadkhani, (2014)	543 manufacturing SMEs in Australia	Self-Selection Hypothesis	Maximum Likelihood Estimation (MLE) method	Y, K, L, M, and TE	Manufacturing SMEs improved their technical efficiency levels over time, particularly the exporting ones. Among firms of the same size, non-exporting SMEs

						tended to have lower efficiency levels compared to their exporting counterparts.
11	Aw, (2002)	Cross-sectional data on Taiwan SMEs (1981 - 1986)	foreign market entry	OLS	Sales, K, L M and Firm age	Firms with higher initial levels of productivity are more likely to survive and grow in size. The growth in productivity in several industries is positively related to firm size.
12	Babatunde, (2017)	349 Nigerian SME firms	foreign market entry	Probit and OLS	EIN, EP, Firm age, size, OWN, R&D and LoanA,	Firm age, labour productivity, access to loan and infrastructure are robust determinants of export propensity. In addition, the results confirmed that firm age, labour productivity, capital intensity, skill intensity, access to loan, managerial experience, and infrastructure increase the export intensity.

Source: Compiled by the Author;Note: RM = Raw Materials; F = Power and Fuel; X = Export; XP = past export; M = Intermediate inputs; K = Capital Stock; R&D = research and Development; SK = Software capital; HK = Hardware capital; QAHW = Quality adjusted hours worked; GFA = Gross fixed asset; ORG change = Organisational Change O = Ownership Types, FA = Firm Age; FS = Firm Size/ plant size; HDI= Human Development Index; IN= Innovation; P =Product Innovation; PR= Process Innovation; Y = productivity; GMM = Generalized method of moments; EM = Employment; TFP = Total Factor Productivity; XIN = Export intensity; EXC = Exchange Rate; TS = Technological Sector; LOC = location; MP = Market Position; + = positive relationship between; XPRO = Export Propensity, QC = Quality Control; XP = Export Premium; S = Sales; L/Y = Unit labour cost (obtained by dividing total labour cost by value of real output); KIN = Capital Intensity; IM = Import status; Bi-directional causality = ↔; Uni-directional causality = → ; LP = Labour productivity; SIN = Skill intensity; FGR = Firm growth rate; FO = Foreign ownership; BA = Barrier to innovation and absorptive capacity; ININ = Investment Intensity; FEX = Firm Experience; EDU = Education, FAN = Finance; PROF = profitability; ICTA= ICT adoption; ICT=ICT Skill; ICTU= ICT use; IV = instrumental variable; MPRG = multifactor productivity growth; PMR = product market regulation; PI = patenting intensity; and CWTF = Closeness to the world technology frontier; XINT = export intensity; Employ = Number of employment; INN = Innovator; HEMP = hours worked by employee, KGFCG = Gross capital stock, KICT = ICT gross capital stock; KNonICT = Non ICT gross capital stock, VA = Value added, PPP = Purchasing Power Parity; LP = log of labour productivity, EUMI = % of Employee using Mobile internet, INT = Investment, REA = Remote Email Access, LQE = Low qualified employees, HQE = % highly qualified employees, EXD = export Dummy; ICT = ICT stock, Non ICT = Non ICT stock, MP = Management Practice; ICTIN = ICT Innovation; YPOPD =Income population density; DR&D = Diversity of R&D funding; NRe = Number of researchers; BBNI = Broadband network infrastructure; OIT = Openness to international trade and EDU = Education.

2.7.2 Innovation and Firm level Export-Productivity Link

Studies on the role of innovation in export-productivity link are found to be increasing over time especially for developed countries while, this subject remains relatively unexplored in developing countries as shown in the summary Table of the literature review (Table 3.4.2, column 3). Studies around this area in developed countries include Lin and Tang, (2013); Yang and Chen, (2012); Moreal-Perez et al., (2012); Lee, (2011); Cassiman et al., (2010); Huergo and Jaumandreu, (2004); Roper and Love, (2002); and Woerter and Roper, (2010) among others.

Generally, empirical papers have investigated the role of exports in promoting growth in general[18] and productivity in particular, using aggregate data for countries and industries for a long time. However, only recently have comprehensive cross-sectional data at the firm level been used to look at the extent and causes of productivity differentials between exporting and innovating status of firms.

In terms of past studies spread, innovation and exporting-productivity related studies have been at the country levelincluding those from Spain (Cassiman, *et al.,* 2010; Cassiman, and Martinez-Ros, 2007; Caldera, 2010; Monreal-Perez *et al.,* 2012; Cassiman, and Golovko, 2007), Indian (Chadha, 2009; Chandan and Ritesh, 2011; Haidar, 2012), Malaysia and Slovenian (Lee, 2011; De Loecker, 2007; Damijan, Kostevc, and Polanec, 2008), Belgium and Germany (Becker and Egger, 2009; Beveren and Vandenbussche, 2010). Others include those from France (Pla-Barber and Alegre, 2007; Bellone *et al.,* 2009; Movahedi and Gaussens, 2011), Italy (Parisi *et al.,* 2006; Sterlacchini, 1999; Nassimbeni, 2001), Indonesian (Yang and Chen, 2012), China (Lin and Tang, 2013), UK (Greenhalgh *et al.,* 1994; Harris and Moffat, 2011), and Australia (Palangkaraya, 2012). These studies are characterised by mixed results following the theoretical ambiguity in the direction at which the relationship was examined.

In terms of methodology used to investigate the relationship between innovation and exporting-productivity link, related studies (such as Lee, 2011; Beveren and Vandenbussche, 2010; Caldera, 2010; Cassiman and Martinez-Ros, 2007; and Basile, 2001; among others) have use probability models to assess the link. Also, some studies

[18] Another line ofresearch - i.e. Amin and Haidar (2011), Haidar (2009),- looked at the impact of export facilitation and export costs on economicgrowth

used Kolmogorov-Smirnov nonparametric test to analyse innovation and exporting-productivity link (Cassiman, Golovko and Martinez-Ros 2010; Bellone, Guillou and Nesta, 2009; Cassiman and Golovko, 2007; and Huergo and Jaumandreu, 2004). Another approach used is the econometrics approach in regional studies; using firm-level data from unbalanced panels (Woerter and Roper, 2010 and Chadha, 2009).

Empirical results from these studies have been mixed and there is no consensus in the literature. For instance, Lee (2011), in attempt to examine the relationships between trade, productivity and innovation used firm-level data from three innovation surveys in Malaysia for the period 1997–2004. He found that the link between exporting and productivity is a weak one in Malaysia. According to him, productivity is driven mainly by capital intensity and human capital which do not necessarily translate into export dynamism. He noted that innovation (product or process) is likely to be the key driver of exporting. Also, Movahedi and Gaussens, (2011) analysed the relationship among Small Medium Enterprises (SMEs) in France by classifying SMEs into exporting (innovative) and non-exporting (non-innovative) firms in terms of productivity. The study noted that conscious self-selection in export markets is revealed by simultaneously endogeneizing productivity and innovation output based on the recursive non-linear model.

Further, Long, Raff and Stahler, (2011) examined how trade liberalisation affects the innovation incentives of firms, and industry productivity. For this purpose, they developed a reciprocal dumping model of international trade with heterogeneous firms and endogenous R&D. Their results showed that in the short run when there is no entry, and in the long run under free entry; trade liberalisation increases aggregate R&D when trade costs are low and decreases R&D when trade costs are high and concluded that expected industry productivity rises as trade costs fall. Moreover, Cassiman, Golovko, and Martinez-Ros (2010) focused on innovation, exporting and productivity among Spanish manufacturing firms and employed a panel of SMEs from 1990-1998 (1479 firms). They found strong evidence that product innovation and not process innovation affects productivity and induces small non exporting firms to enter the export market.

Table 2.7b: Summary of Literature on Innovation and Firm level Export-Productivity

S/No	Studies	Sample/Scope	Theoretical Framework	Methodology		Empirical Results
				Estimation Methods	Variables	
1	Lin and Tang, 2013	311,223 Republic of China firms	model of foreign market entry	Matching Sampling Techniques,	R&D intensity, R&D level, X, K, IN, EM & TFP	X have a smaller impact on IN, while a rise in R&D expenditures increase X.
2	Basile, 2001	Micro-data survey of Italy covering the period of 1989-1997 (4000 firms)	model of foreign market entry	Probit Model and 2SLS Estimation	FS, R&D(proxy for IN) strategies, Investment strategies, EM, XIN & EXC.	IN are very important competitive factors and help explain heterogeneity in X behaviour among Italian firms
3	Huergo and Jaumandreu, (2004).	unbalanced panel data sample of more than 2,300 firms surveyed during the period 1990–1998	Framework which relates Productivity growth	Semi-Parametric Methods	FS, Y, R&D, FA & Merger,	Firms enter X market experiencing high Y growth, but also that Y growth of surviving firms converges. IN (PR) at some point lead to extra Y growth.
4	Cassiman, Golovko and Martinez-Ros (2010).	Using a panel of Spanish manufacturing firms 1990-1998	model of foreign market entry	Kolmogorov-Smirnov test	X, IN (P & PR) & Y	Positive association between firm productivity, export and innovation
5	Beveren and Vandenbussche, (2010)	Belgium, 2000 and 2004	model of foreign market entry	Linear Probability Model	TFP, IN (P & PR), FA, FS	Only IN (P & PR) and Y increases the probability of becoming an exporter
6	Cassiman and	Spain, 1990-1999	model of foreign	Probit Model	IN (P & PR), FA & FS	Particularly, IN (P) increases the

	Martinez-Ros (2007).	(SME/large enterprise)	market entry			probability of becoming exporter more significantly for the SMEs
7	Caldera, (2010)	Spain, 1990-2000	model of foreign market entry	Probit Model	X, TFP, IN (P & PR), FA, & FS	IN (P & PR) and Y increases the probability of becoming an exporter
8	Mez-Castillejo, Rochina-Barrachina and Sanchis-Llopis (2010)	Spain, 1990-2000	model of foreign market entry	Tri-variate Probit Model	X, TFP, IN (P & PR), FA, & FS	No significant relationship among variables
9	Bellone, Guillou and Nesta (2009)	France, 2005-2008 (SMEs/large enterprise)	model of foreign market entry	Kolmogorov-Smirnov Test	TFP, IN (P & PR), FA, FS	Absence of premium for the IN(P & PR) in SMEs
10	Movahedi and Gaussens (2011)	Randomly selected 86 SMEs in France, (2006-2008)	Employed a dynamic production function	OLS regression and Mann-Whitney-Wilcoxon tests	IN, X, TFP, FS, & TS	These results showed that the self-selection and learning effects are likely to occur in accordance with what is expected especially for technological innovation.
11	Greenhalgh et al. (1994)	31 sectors in UK net exporting firms	model of foreign market entry	Probit Model	Net export volumes, export prices, patents and IN.	Evidence suggests that in half the sectors considered, net exports gained from either intra-sectoral or inter-sectoral innovation.
12	Nassimbeni, (2001)	165 SMEs in Friuli-Venezia Giulia, the north-east region of Italy.	Production function	Logit and Tobit Model	XPRO, XIN, & QC	XPRO of small units to export is strictly linked to their ability to IN, while it is less related to the technological profile.
13	Palangkaraya,	Using 8,626 firms in	model of foreign	Correlation and	IN (P & PR), Y, EM, KIN,	+ correlation between X & IN (P & PR). ↔

	(2012)	Australia	market entry	probit model.	& IM	IN(PR) & X, in the services sector. IN (P) may lead to a higher probability of becoming 'new' exporter in the current period.
14	Lee, (2011)	Malaysian Manufacturing firms 1997-2004	model of foreign market entry	Probit Model	X, O, FS, K, HDI & IN(P & PR)	The link between X and Y is a weak one in Malaysia. IN (P or PR), is likely to be the key driver in X.
15.	Marzábal *et al.,* (2016)	213 Galicia (Spain) firms	foreign market entry	Probit and Logit model	R&D, N-R&D, IN, Marketing and Non-marketing IN, Size	Results suggest that there are new evidences supporting the existence of a positive relationship between innovation and exporting and that some factors (particularly, variety of innovation and marketing innovation) are critical.
16	Harris and Moffat, (2011)	Using three waves of the UK Community Innovation Survey (CIS) carried out in 2005, 2007 and 2009, covering activities in 2002-2004, 2004-2006, and 2006-2008.	production function of Self-Selection hypothesis	Probit model	R&D, IN, XIN, KIN, LP, FS, FA, diversification, FO, BA.	In both Manufacturing and Services sectors, X increased the probability that an establishment was engaged in spending on R&D.

17	Monreal-Perez, Aragon-Sanchez, and Sanchez-Marin, (2012)	Using a longitudinal analysis of 14,142 observations of an annual average of 1,767 manufacturing Spanish firms during the period from 2001 to 2008.	model of foreign market entry	Random Effect Probit of Panel Estimate	XIN, XP, R&D, IN, Public support for R&D, Y, FS, FA and KIN.	IN induces firms to increase their X. Nevertheless, firms do not experience any learning-by-exporting effects on the obtaining of IN (P and PR) and Y does not modify any of these relationships.
18	Parisi, Schiantarelli, and Sembenelli, (2006)	Using sample of 465 firms in Italy between 1992 and 1997 period	model of foreign market entry	Random Effect Logit Model	R&D, TFP, IN, XIN, KIN, ININ, FS, FA, O, and Absorptive capacity.	IN (PR) has a large impact on Y. R&D is + with the probability of introducing a new product, whereas KIN increases the likelihood of introducing a IN (P).
19	Pla-Barber and Alegre, (2007)	Using a questionnaire to survey a sample of 121 firms in the French biotechnology industry	model of foreign market entry	Structural Equation Modeling	IN(P and PR), XIN, FS and FEX	FS is not a determinant for IN or XIN. However, there is + link between IN and XIN.
20	Woerter and Roper, (2010)	Using panel data for two small open economies–Ireland and Switzerland over the sample period 1994–2005.	Augmented Cobb-Douglas production function with IN (P and PR)	GMM	IN (P & PR), weighted market growth, FS, FO, EDU, R&D, FA, and FAN	Results showed little evidence of any significant market demand effects, with innovation performance instead determining largely by firm-level capability effects and characteristics.
21	Long, Raff and Stahler, (2011)	Mathematical Derivations	Mathematical Derivations	Mathematical Derivations	IN (P and PR), S, X, R&D, and PROF	Both in the short run when there is no entry, and in the long run under free entry; trade liberalization increases aggregate

						R&D when trade costs are low and decreases R&D when trade costs are high. Expected industry productivity rises as trade costs fall.
22	Amable, *et al.,* (2016)	Unbalance panel of 17 OECD countries, 13 industries spanning from (1977–2005)	Innovation-based endogenous growth theory	IV and GMM	MPRG, PMR, PI and CWTF	The find support no evidence for the innovation-boosting effects of liberalization policies and that the leading edge are systematically not supported by the data.
23	Arnold and Hussinger (2005)	Unbalanced panel of 389 German firms (1992-2000)	model of foreign market entry	matching technique	TFP, XINT, Employ, INN, R&D and FA	Evidence showed that causal link from high productivity to presence in foreign markets.
24	Bertschek and Niebel, (2016)	2143 German Firms (2014)	Production Function	OLS and 2SLS	LP, EUMI, INT, REA, HQE, EXD and SALES	Analysis showed that firms' labour productivity significantly increases with the share of employees with mobile internet access. Our instrumental variables approach suggests that mobile internet use does cause higher labour productivity.

Source: Compiled by the Author;Note: All variables are as defined in Table 3.4.1 above

Cassiman and Golovko (2007) also explored the relationship using a panel of Spanish manufacturing firms for 1990-1998, by employing nonparametric tests. They found that firm innovation status is critical in explaining the positive exporting-productivity association, while product innovation, in particular, seems to explain this positive association between exporting and productivity.

De Loecker (2007) employed matched sampling techniques to analyze whether firms that start exporting become more productive. He used micro-data of Slovenian manufacturing firms (1994–2000) and find that export entrants become more productive once they start exporting. According to him, the productivity gap between exporters and their non-exporters increases further over time and that productivity gains are higher for firms exporting towards high income regions. Chudnovsky, Lopez, and Pupato (2006) analysed the determinants of innovative inputs and outputs and their impacts on manufacturing firms' productivity in Argentina. Employing panel data from innovation surveys with information for 1992–2001, their results showed that in-house R&D and technology acquisition expenditures have positive payoffs in terms of enhanced probability of introducing new products and/or processes to the market. In turn, innovators attain higher productivity levels than non-innovators. The results also showed that large firms have higher probability of engaging in innovation activities and of becoming innovators. Arnold and Hussinger (2005) examined the causal relationship between productivity and exporting in German manufacturing, by employing an unbalanced panel of 389 firms for 1992-2000. Applying matching technique, they found a mix results and concluded that high-productivity firms self-select themselves into export markets, while exporting itself does not play a significant role in the productivity of German firms.

Roper and Love (2002) used comparable plant-level surveys to demonstrate the determinants of export performance among 1700 UK manufacturing plants and 1300 German plants. They found that, product innovation, however measured, has a strong effect on the probability and propensity to export in both countries. Specifically, in the UK, the scale of plants' innovation activity is also related positively to export propensity. In Germany, however, where levels of innovation intensity are higher but the proportion of sales attributable to new products is lower, there is some evidence of a negative relationship between the scale of innovation activity and export performance. Sterlacchini

(1999) considered the role of innovation in the export performance of 143 SMEs in non-R&D intensive sectors in Northern and Central Italy. His approach is diverse, considering both firms' product innovation activities as well as the technological and financial dimensions of firms' capital stock and organisational and market position. His results suggested that even in non-R&D intensive industries innovation is an important determinant of firms' export performance. He further explained that investment in innovative capital goods, and the importance of such goods in the firms' capital stock matter as does size and the position of the firm in the value-chain (i.e. whether or not they are a sub-contractor).

Wakelin (1998) also adopted an approach from the technology gap tradition in the examination of sectoral trade flows for 22 industries and nine Organisation for Economic Cooperation and Development (OECD) countries. According to him, innovation in engineering sectors may have a direct benefit for machinery exports but may also generate spill-over benefits for the export potential of other manufacturing sectors. Wakelin's results also provide general support for a positive relationship between innovation and export flows, although this result proves sensitive to the use of different technology and innovation indicators.

Anderton (1999a) also considered the impact of R&D and patenting activity on trade volumes and prices arguing that both technology indicators act as proxies for the quality and/or variety of goods being produced. Investments in technological development or innovation then allow countries to make technological improvements to their products, climbing a 'quality ladder' and shifting their export demand curve outwards and their import demand curve inwards. Again, the technology variables prove important in determining import volumes but unlike Wakelin (1998) and Anderton (1999a) does find some evidence that relative R&D expenditure and patenting activity are more important in technology intensity industries. However, Anderton (1999b) observed no difference between the importance of R&D and patenting activity between segmented and fragmented sectors, and no consistent differences between the effects of relative R&D spending or patenting activity on import volumes in the UK and Germany. Sterlacchini, (1999) celebrated a positive relationship between the technological level of firms' capital

stock and their export propensity. He observed a positive but non-linear relationship between export propensity and plant size.

In summary, little or no studies has been done for developing countries especially in Nigeria to underscore the role of innovation and ICT in exporting-productivity link.

2.7.3 ICT and Productivity Link

Studies linking ICT and productivity are evolving overtime particularly in developed countries as shown in the summary Table of the literature review (Table 3.4.3, Column 3). Studies around this area in developed countries include Ceccobelli and Mancuso (2012); Cardona *et al.* (2013); Castiglione and Infante (2014); Cuevas-Vargas *et al.* (2016); Leon *et al.* (2016); Edquist and Henrekson (2017a), Edquist and Henrekson (2017b) and Strobel (2016) among others.

In terms of past studies spread, ICT and productivity related studies have been evaluated at both country and firm level. Studies at the firm level include Edquist and Henrekson, (2017b); Cuevas-Vargas *et al.* (2016); Leon *et al.* (2016); Strobel (2016); Kusumaningtyas and Suwarto (2015); Castiglione and Infante (2014) and Commander *et al.* (2011), while, studies using aggregate data at the countries level include Lee *et al.* (2015); Ceccobelli and Mancuso (2012) and Jalava and Pohjola (2007).

Generally, studies have been done for Italy (Castiglione and Infante, 2014), Mexico (Cuevas-Vargas, *et al.,* 2016), Northern Spain (Leon, *et al.,* 2016) and Sweden (Edquist and Henrekson, 2017a). All these studies are characterised by mixed results following the direction in which the relationship was examined. However, only the work of Diaz-Chao, *et al.,* (2015) had introduced innovation activities of firms, while focusing on the generality of the firms in Girona (Spain).

In terms of empirical findings, Castiglione and Infante (2014) found that ICT returns on Technical Efficiency (TE) are influenced by management practices, labour organisation and R&D. Using a survey of one hundred and ninety-six SMEs, Kusumaningtyas and Suwarto (2015) showed difference of ICT adoption, skill and use on age and education level, while there is no difference according to the respondent gender. Ceccobelli and Mancuso (2012) found that ICT positively contribute to the generation of convergence

clubs in the evolution of labour productivity. Similarly, Tarute and Gatautis (2014) concluded that ICT impacted on the improvement of external and internal communication and that for best performances to be achieved within the firm, it is important to align ICT investments with internal capabilities and organisational processes. In a recent study, Cuevas-Vargas *et al.* (2016) showed that innovation and ICT substantially impact on the performance of businesses. Leon *et al.* (2016) showed that diversified companies have a higher level of ICT use and this positively affects the degree of international diversification and the degree of relationship of business. Edquist and Henrekson, (2017a) found that R&D is significantly associated with contemporaneous TFP growth, while, there is no significant association between ICT and TFP.

Table 2.7c: Summary of Literature Review on ICT and Productivity Related Literature

S/No	Studies	Sample/Scope	Theoretical Framework	Methodology		Empirical Results
				Estimation Methods	Variables	
1	Castiglione and Infante, (2014)	18,601 Italian Manufacturing Firms (1995–2006)	Production Function	Panel Probit Model	Sales, K, ICT, NonICT, HQE, LQE, Age, size, R&D, EXD and MP	Results indicated that ICT returns on TE are influenced by certain firm Characteristics such as management practices, labour organisation, R&D.
2	Kusumaningtyas and Suwarto, (2015)	196 survey SMEs using Simple Random sampling		Independent T-test Kolmogorov-Smirnov and Manova Test	Gender, Age, educational level, ICTA, ICT and ICTU	Results revealed that there is difference of ICT adoption, skill and use based on age and education level, while there is no difference according to the respondent gender.
3	Ceccobelli and Mancuso, (2012)	14 OECD members countries (1995 and 2005)	Production Function	DEA, Bootstrap decomposition	HEMP, KGFCF, KICT, KNonICT, VA and PPP	The results confirm that ICT technologies positively contribute to the generation of convergence clubs in the evolution of labour productivity.
4	Tarute and Gatautis, (2014)	Literature Survey	Literature Survey	Analysis of Literature	Direct and Indirect Impact assessment	Results confirm that ICT has impact on the improvement of external and internal communication and that for best performances it is important to align ICT investments with internal capabilities and organisational processes.
5	Cuevas-Vargas, *et al.,* (2016)	288 manufacturing MSMEs in Mexico		SEM	ICT, INN (Man, P and Pr), business performance	Results showed that innovation and the use of ICT substantially impact in the performance of the businesses studied

6	Leon, *et al.,* (2016)	95 SMEs companies in Basque country	Resource Theory	Descriptive statistics and Kolmogorov-Smirnov test	Online Questionnaire (September to November, 2015)	It is evident that diversified companies show a higher level of use of ICT and this resource positively affects the degree of international diversification and the degree of relationship of business.
7	Edquist and Henrekson, (2017a)	47 Swedish industries (1993 - 2013)	Neoclassical production function model	OLS	Value added (TFP), QAHW, ICT, R&D, SK and HK	R&D is significantly associated with contemporaneous TFP growth, while, there is no significant association between ICT and TFP. Thus, R&D affect TFP much faster than ICT-investments.
8	Commander, *et al.,* (2011)	1,000 firms from Brazil and India (April and May, 2005).	Augmented production function model	2SLS and GMM	EMP, Materials, GFA, ICT, ORG change and ICT Adoption	The study established a strong positive association between ICT capital and productivity in both countries. Results further showed that poorer infrastructure quality and labour market policies are associated with lower levels of ICT adoption.
9	Jalava and Pohjola, (2007)	Finland (1995-2005)	Augmented growth theory that incorporate ICT through capital input	Growth accounting from both input and output side	Multi-factor productivity, capital services and GDP at the market prices	ICT accounted for 1.87% of the observed labour productivity growth at the average rate of 2.87%. The contribution from increases in ICT capital intensity was 0.46%. The rest is attributed to multi-factor productivity growth in ICT production, especially in telecommunications production.
10	Lee, *et al.,*	40 selected countries		Fixed effect	ICTIN, YPOPD, DR&D,	The study found that high-levels of

	(2015)	(1999 - 2013)		regreesion model	NRe, BBNI, OIT and EDU.	broadband infrastructure and the R&D factors from triple helix collaboration were associated with high-levels of ICT innovation. Therefore, innovation infrastructure and the socio-economic factors of nations could be significant determinants of ICT innovation.
11	Strobel, (2016)	Germany and U.S manufacturing sectors (1991 - 2005)	Augmented Growth Accounting model	Random and fixed effects estimation	TFP, ICT, NICT, L, imported and non-imported ICT material.	The findings suggest that imported intermediate inputs played a more dominating role in Germany, particularly imported non-ICT and ICT materials. In the US, main drivers were domestically produced non-ICT services and ICT materials, even though imported ICT materials were on the upraise post 1995.
12	Cardona *et al.,* (2013)	Literature Survey	Literature Survey	Literature Survey	Literature Survey	The majority of previous studies indicate that the productivity effect of ICT is indeed positive and significant. However, methodological approaches of how to appropriately estimate the ICT affect matter. While, aggregate and sectorial growth accounting exercises suggest stronger differences of the ICT effect between US and Europe, firm-level analyses suggest no significant country differences.

13	Diaz-Chao, *et al.,* (2015)	Using 2009 survey data for 464 firms based in Girona in Spain.	Augmented Growth accounting model	OLS and SEM	Firm Size, firm ownership, workers training, innovation (R&D, staff, P), level of ICT usage, sales and destination of sales.	Results evidenced that wage is the main determinant of labour productivity, while firm's co-innovation has an indirect effect on labour productivity. A direct causal relationship between co-innovation and productivity was also observed.
14	Goedhuys and Veugelers, (2012)	1,563 Brazilian Manufacturing firms (2000 – 2002)	Growth Accounting model	Probit model	INV(P and PR), AC, Foreign leakages, CP, and FIN	The results showed that the combination of product and process innovation significantly improves firm growth, while both innovation and growth performance are supported by access to finance.
15	Hwang and Lee, (2010)	123 ICT firms in Korea (using 2005 survey)	Two dimensions of External knowledge search	Tobit model	INMARK, INFIRM, LP, EXBRE, Firm size and R&D intensity	R&D intensity + with INMARK. EXBRE +INFIRM. Other results showed that EXBRE is strongly linked to productivity.
16	Lee *et al.,* (2005)	20 countries (1980 – 2000)	augmented neoclassical growth of Solow	OLS (12 countries are not co-integrated), Johansen's co-integration test; Granger Causality tes and ECM	SR, GDP, K, L, ICT investment	Results showed that ICT contributes to economic growth in many developed countries and newly industrialized economies, but not in developing countries.

Source: Compiled by the Author;Note: All variables are as defined in Table 3.4.1 above

2.7.4 Gaps in the Literature

In terms of literature gaps, there is a dearth of information on the role of ICT and innovation in enhancing firms' exporting-productivity link. Similarly, studies on these three strands of literature reviewed (especially those conducted at the firm level) laid more emphasis on firms' age, firms' size and sales characteristics as the major causes of exporting-productivity link. However, studies have not focused on firms' involvement in ICT (internet and website) and innovation (process, product, organization and marketing) that can aid both productivity and exporting decision of firms. Firms involvement in these activities are also required along production techniques for adequate business delivery and logistics in order to achieve market trends, gain a competitive edge, ensure long-term success, bring in more customers and ensure profitability for businesses. Therefore, the issue of ICT, innovation and other firms characteristics like firm age, ownership structure and manager experiences that influence productivity and exporting decision of firms are addressed in this thesis.

2.8 Conceptual Review

2.8.1 Measuring Productivity

Productivity[19] is commonly defined as a ratio of a volume measure of output to a volume measure of input use. While there is no disagreement on this general notion, a look at the productivity literature[20] and its various applications revealed that there is neither a unique purpose for, nor a single measure of productivity. In the literature (Syverson, 2011; Aspen, 1990; Baily and Gordon, 1988 and Rogers,

[19]Several objectives are given in the literature for measuring Productivity to include; to trace technical changes, Efficiency purposes, real cost of savings, to account for living standards and Benchmark for production processes.

[20] Douglas, et al., (1982); Olley and Pakes, (1996), Levinsohn and Petrin, (2003); and Ackerberg et al., (2007), among others.

1998), there are several approaches to measuring productivity. The choice between these approaches largely depends on the purpose of productivity measurement and, in many instances, on the availability of data at the disposal of the researcher.

However, productivity measures can broadly be classified into two major groups;

1. Single Factor Productivity Measures (relating a measure of output to a single measure of input)
2. Multi-Factor Productivity Measures (relating a measure of output to combined inputs).

The two classifications above assume that all firms were fully efficient and therefore, they operate on the production frontier and select optimal quantities of each input.

However, the above two approaches neglect one of the key objectives for measuring productivity and therefore, only focuses on productivity measures with no mention of efficiency. Efficiency refers to the ability to avoid wasting materials, energy, efforts, money and time in producing the desired output. Technical inefficiency occurs if a firm is not obtaining maximal output from a set of inputs. Allocative inefficiency occurs when a firm fails to choose the optimal balance of inputs given input prices; even though it may be obtaining maximal output from the inputs actually used (Coelli, 1995).

2.8.2 Measuring Innovation and ICT

ICT largely depend on several indicators and they are usually broader terms referring to the level of computing (both software and hardware), telecommunications (mobile, fixed, and internet broadband) and broadcasting. Use

of ICT can also be measure using the level of information system[21] within and outside the firm (see, World Bank Investment Climate Survey manual, 2003 and Research ICT Africa data, 2008). ICT play a substantive role in the generation, storage and transmission of information and in the reduction of market failures related to information asymmetries.

On the other hand, innovation refers to a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process) (OECD/Eurostat, 2018). Measuring innovation at the firm level often time employed questions soliciting firms responses about whether the firm has introduced into the market any new or significantly improved products (goods or services) and or production processes to include but not limited to the methods of supplying services and ways of delivering the product.

[21] Percent of firms with an internationally-recognized quality certification, percent of firms using technology licensed from foreign companies, percent of firms having their own Website and percent of firms using e-mail to interact with clients/suppliers

CHAPTER THREE

METHODOLOGY

This chapter contains the theoretical framework and the methodology employed in the thesis. This chapter is divided into four major sections. Section 3.1 concentrates on the theoretical framework, while section 3.2 focus on model specification. Section 3.3 discusses the Structural Equations Modeling techniques employed for the study.

3.1 Theoretical Framework

The review of theoretical literature in Chapter 2, section 2.5 on page 36 reveals that there are basically two plausible theoretical views on the relationships between exporting and productivity. These are the Ricardian trade theory (on page 37) and the new-new trade theory (on page 41 through 46) from which self-selection and learning by exporting hypotheses emanate. Studies such as Bernard *et al.,* (2003) and Eaton and Kortum, (2002) analysed the link between trade liberalisation and productivity by incorporating firm-level productivity differences through the Ricardian model. On the other hand, studies (Clerides, *et al.,* 1998, Melitz, 2003, Melitz and Ottaviano, 2008, Atkeson and Burstein, 2005, Bernard, *et al.,* 2006, Helpman, *et al.,* 2007, Chaney, 2008, De Loecker, 2013) have modelled the link between exporting and productivity using a modification of either the self-selection and/or learning by exporting hypothesis of foreign market entry model. This study prefer the new-new trade theory over the Ricardian trade theory due to its ability to explain new trend and differences among firms within the same industry of the same country. The theory also help researchers in identifying the

importance of firms rather than sectors towards understanding the challenges and the opportunities countries face in the age of globalization (Melitz and Ottaviano, 2008). Therefore, this study incorporates the role of innovation and ICT into Roberts and Tybout, (1997) model of free market entry (new-new trade theory)[22]. This was done in order to underscore the mediating role of ICT and innovation in exporting-productivity link. This is because firms' level of innovation and ICT can potentially improve the quality of goods or services, has the potential of reducing transaction costs, improve business processes, information dissemination and hence simultaneously increase consumer demand.

Figure 3.1 depicts the diagrammatic framework explaining the mediating role of innovation and ICT in exporting-productivity link. Specifically, the Figure shows the direct and indirect relationship between each of the variables. Thus, it shows direct link between (a) exporting and productivity; (b) productivity and ICT; (c) innovation and productivity; (d) innovation and exporting; (e) exporting and ICT. It also indicates the indirect relationship between productivity and exporting through innovation and ICT.

[22] The full theoretical framework of Ro[illegible] presented on page 42 through 44

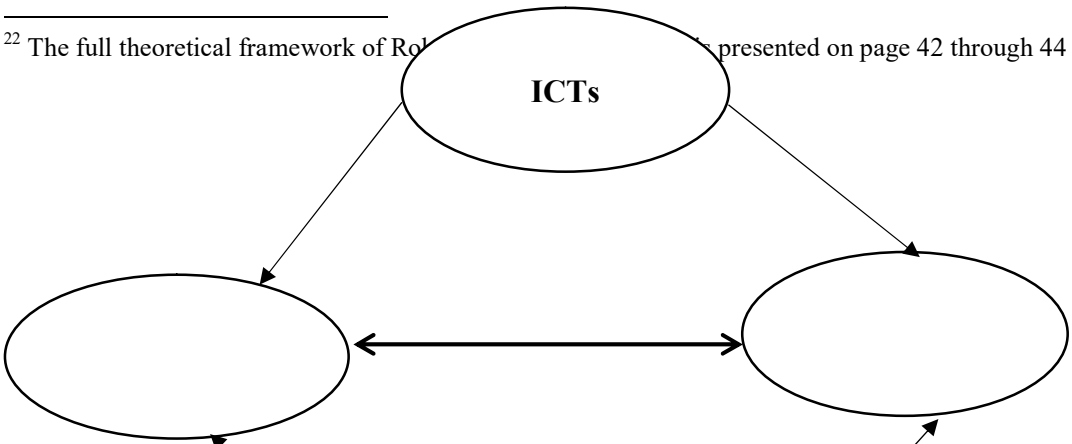


Figure 3.1: Framework on the mediating role of innovation and ICT in exporting-productivity Link.

Source: Author's compilation

3.1.1 Assumptions of the Model

Following from the production function presented in equation 2.18 on page 45. This study modified the production functionand assumed that there are large numbers of identical (homogeneous) firms; with each having access to the production function.

$$Y_{it} = F(K_{it}, AL_{it}, R_{it}) \quad \text{(3.1)}$$

Where Y is the volume of output produced, K and AL are the capital and the effective labour employed while, R is the unit of raw materials employed. AL are assumed to enter the production function multiplicatively. The production function here differs from that of Melitz, (1999), Melitz, (2003) and Eaton and Kortum, (2002) in that enterprise firms' requires raw materials for further production. These authors neglect other inputs (K and R) because of data unavailability.

The production function given in equation 3.1 satisfies constant return to scale (CRS)[23]. This assumption of CRS is important because the Nigerian enterprises industry is relatively large (2,676 firms) enough that the gains from specialisation have been exhausted. The firms produce a homogenous product and behave competitively, taking prices in both output and input markets as given. This thesis neglects the demand side analysis because consumer preferences and their demand patterns are not revealed in the Nigeria enterprise firms surveyed in 2014.

3.1.2 Setup of the Model: Production Technology

Assuming that at period **t**, firm **i** produces and sells its product in both domestic and foreign markets. Its expected gross profits when exporting differ from when

[23]The production function exhibit CRS in its three arguments, capital, effective labour and raw materials; thus, doubling the quantities of capital, effective labour and raw materials (for example) doubles the amount produced.

not exporting by the amount $\boldsymbol{\pi_i(p_i, s_{it})}$. Where $\boldsymbol{p_i}$ is a vector of market-level forcing variables that the firm takes as exogenous (for instance, the exchange rate, foreign market and demand conditions) and $\boldsymbol{s_{it}}$ is a vector of state variables specific to the firm such as financial access, ownership structure and level of innovation activities, among others.

There is a competitive frontier of potential entrants into the foreign market that have to pay both fixed **($\boldsymbol{f_e}$)** and variable **($\boldsymbol{V_e}$)** costs of entry (Chaney, 2008). Once the sunk entry cost is paid, a firm productivity **($\boldsymbol{\varphi}$)** derived from both fixed and variable distribution **g($\boldsymbol{\varphi}$)**. Productivity only remains fixed after entry, but firms face a constant exogenous probability of death **($\boldsymbol{\delta}$)**, which induces steady-state entry and exit of firms in the model. Thus, the costs required to produce **q($\boldsymbol{\varphi}$)** units of a variety is therefore;

$$c_i^h(\mathrm{q}) = f_d + \frac{\boldsymbol{w_i}\,\boldsymbol{\tau_i^h}}{\boldsymbol{\varphi}} q + \frac{\boldsymbol{\pi_i}\,\boldsymbol{\omega_i^h}}{\boldsymbol{\varphi}} q \qquad (3.2)$$

Firms are price takers and they all have access to similar technology. Thus, if firms decide to export, they face both fixed cost in the domestic market **($\boldsymbol{f_d}$)** and iceberg variable costs of trade, such as transport and customs & trade regulation, such that $\boldsymbol{\tau}$> 1 units of each variety must be exported for one unit to arrive in a foreign country. Otherwise, in the presence of only variable trade costs, all firms would export.

3.1.3 Production and Exporting Decisions of Firms

The firm's profit-maximizing output level for both local and foreign sales is given as q_{it}. According to Roberts and Tybout, (1997), the firm's pricing rule in both markets is;

$P_{d_{it}}(q_{it}) = w/pq_{it} = (1/p)q_{it}$ …….. (3.3a)

and

$P_{x_{it}}(q_{it}) = \beta P_{d_{it}}(q_{it})$ …….. (3.3b)

respectively

Where w = common wage rate within the sector, which is assumed equal to one (1)

$P_{d_{it}}$= price charged in the domestic market

$P_{x_{it}}$ = price charged in the foreign market

(q_{it}) = Quantity of good sold in either market

(1/ρ) = profit-maximizing mark–up,

β = Increased marginal costs arising from input costs[24]

Given that revenue is a function of price and quantity sold, then the expected revenue of the firm from both markets is;

$r_{d_{it}}(q_{it}) = q_{it}/pq_{it}$ …….. (3.4a)

and

$r_{x_{it}}(q_{it}) = \beta P_{d_{it}}(q_{it})q_{it}$ …….. (3.4b)

Therefore, the expected profit (**π**) of the firm from both markets will be;

$\pi_{d_{it}}(q_{it}) = {}^{r_{d_{it}}(q_{it})}/_{\sigma} - C_{it}$, …….. (3.5a)

and

$\pi_{x_{it}}(q_{it}) = {}^{r_{x_{it}}(q_{it})}/_{\sigma} - C_{x_{it}}$…….. (3.5b)

[24] The input costs are responsible for inducing the higher prices charged for selling at the foreign market

Where σ = constant elasticity,

$[r(q_{it})/\sigma]$ = expected revenue,

C_{it} = Overhead production cost and

C_{x_i} = Trade cost which consists of both production costand trade costs (fixed and variable)

Following Roberts and Tybout, (1997), this study also assumes that both C_{it} and $CV_{x_{it}}$have been accounted for when charging price on the firm's products at both domestic and foreign markets and have been incorporated into the firm's expected revenue.

Therefore, firm will export based on two conditions:

(1) if $\pi_{x_{it}}(q_{it}) \geq 0$ and

(2) $\pi_{x_{it}}(q_{it}) > \pi_{d_{it}}(q_{it})$.

The first condition implies that expected profits from exporting must be non–negative, and must exceed expected profits when not exporting (second condition). However, the combined expected profit of the firm can be given as equation 3.6;

$$\pi(q_{it}) = \pi_{d_{it}}(q_{it}) + \max[0, \pi_{x_{it}}(q_{it})] \quad (3.6)$$

Likewise, the total expected revenue of the firm is;

$$r(q_{it}) = r_{d_{it}}(q_{it}) + r_{x_{it}}(q_{it}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7)$$

Equation (3.6) can as well be expressed as;

$$\pi(q_{it}) = \left[r(q_{it})/\sigma \right] - [C_{it} + C_{x_i}] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8)$$

Now, let X_{it} denotes the exporting status of the firm which takes a value of 1 if the firm exports in period t and 0 if otherwise. Therefore, the firm expected profit at

period t will be expressed only with the existence of fixed trade cost (most often regarded as the sunk cost) as;

$$\pi(q_{it}^{*}) = X_{it}\left[\left(r(q_{it}^{*})/\sigma\right) - CF_{x_i}^{*}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.9)$$

With an unbounded series of export quantities, the firm will maximize expected present value of profit which is expressed as;

$$V_{it}(\Omega_{it}) = \max_{q_{it}^{*}} E_t\left(\sum_{n=t}^{\infty} \delta^{n-t}(r(q_{it})|\Omega_{it})\right)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.10)$$

Where δ is the one-period discount rate and expectations are conditioned on the firm-specific information set, Ω_{it} . The value of the firm's current exporting status can be specified thus;

$$V_{it}(\Omega_{it})^{*} = \max_{q_{it}^{*}}(\pi(q_{it}^{*}) + \delta E_t\,[V_{it+1}\,(\Omega_{it+1})|q_{it}^{*}])\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
(3.11)

E_t symbolises expected values conditioned on the information set, Ω_{it}. Based on equations (3.9) and (3.11), the firm will participate in the export market in period t if and only if;

$$\pi(q_{it}^{*}) \geq CF_{i}^{*} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.12)$$

Against the above background, the firm will engage in exporting activities under the following condition;

$$\begin{cases} 1 \text{ if } \pi(q_{it}^{*}) - CF_{x_i}^{*} \geq 0 \\ 0 = X_{it}, \text{ if otherwise} \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.13)$$

Equation (3.13) implies that firms will only export when the total revenue minus both costs (fixed and variable) is strictly greater than zero. Since the focus of the thesis is on exporting firms, only the first condition is considered and thus, converting firm profit function to firm's specific exporting characteristics in exporting market by linearizing the function to capture variables on firms' decision to export as follows;

$$\pi(q_{it}^{*}) - CF_{x_i}^{*} = \alpha_1' Z_t + \alpha_2' N_{it} + \varepsilon_{it} \qquad (3.14)$$

Equation (3.14) is linearized to include both time-specific and firms specific exporting determinants (variables).

Where Z_t is the vector of annual time-specific effects, which reflect temporal variations in export profitability and start-up costs that are common to all firms. It includes industry or macro-level changes such as trade-policy conditions, exchange rates, credit-market conditions and other time – varying factors[25]. N_{it} is the vector of firm-specific determinant of current operating profits and start-up costs to include but not limited to firm size, age, manager experience, ownership structure, innovation and ICT among others.

Thus,

$$N_{it} = F(ICT_{it}, INN_{it,} OWT_{it}, AGE_{it}, MANEXP_{it,} LoanA_{it}, FIRS_{it}) \qquad (3.15)$$

Substituting equation 3.15 into equation 3.14 yield equation 3.16 which captures the determinants of firms' revenue from exporting including its productivity (self-selection)

$$r(q_{it}^{*}) - CF_{x_i}^{*} =$$
$$\alpha_1 + \alpha_2 ICT_{it} + \alpha_3 INN_{it,} + \alpha_4 OWT_{it}, + \alpha_5 AGE_{it} + \alpha_6 MANEXP_{it,} + \alpha_7 LoanA_{it} +$$
$$\alpha_9 FIRS_{it} + \alpha_{10} Product_{it} + \varepsilon_{it} \qquad (3.16)$$

[25]The Zt is linearized to equal to one in the final analysis, given that all firms faced the same market condition in terms of input prices and exchange rate.

Similarly, since increases in the level of firms' productivity can make firms' to become an exporter (Learning by exporting), thus, equation 3.16 will yield 3.17

$$Product_{it} = \alpha_1 + \alpha_2 ICT_{it} + \alpha_3 INN_{it,} + \alpha_4 OWT_{it}, + \alpha_5 AGE_{it} + \alpha_6 MANEXP_{it,} + \alpha_7 LoanA_{it} + \alpha_9 FIRS_{it} + \alpha_{10} r(q^*_{it}) - CF^*_{x_i} + \varepsilon_{it} \quad (3.17)$$

Where;

ICT_{it} = Information and Communication Technology Usage

INN_{it} = Innovation Activities

OWT_{it}= Ownership Structure (Sole Proprietor, Partnership and Limited)

AGE_{it} = Firm Age

$MANEXP_{it,}$= Manager's education experience

$LoanA_{it}$= Loan Access

$FIRS_{it}$= Firms Size (Small, Medium and Large)

$Product_{it}$= productivity is computed[26]

$r(q^*_{it}) - CF^*_{x_i}$ = revenue from exporting which is a measure of export market participation (EXPP).

ε_{it} = Error term.

i and *t* represent firm and year respectively.

$\alpha_1, \alpha_2, \ldots \alpha_{10} > 0$

The foregoing shows that export decision is driven by productivity status, innovation, ICT usage, access to finance and firm-specific factors. Alternatively, the export decision could drive productivity, in the sense that knowledge that flows from international customers, buyers and competitors via ICT may help firms to

[26] See section 4.3.3

improve their post-export market entry performance. Similarly, firms' innovation leads to increased productivity and exporting via investments in Research and Development and human capital as argued in the modern growth theory.

Table 3.1: Variables Name, Definition and Measurement

Name	Variables	Variable Definition and Measurement
	Exporting Status variables	
Exporting Participation	EXPP	Export Propensity that measures the percentage of sales that are directly or indirectly exported.
	Innovation Variables	
Product Innovation	PI	PI that measures whether the firm has introduced new or significantly improved products or services. **1 = Yes and 0 = No**
Process Innovation	OI	OI is a variable that indicates whether the firm has introduced any new or significantly improved organizational structures or management practices. **1 = Yes and 0 = No**
Organisational Innovation	PRI	PRI is a variable that indicates whether the firm has introduced any new or significantly improved methods of manufacturing products or offering services. **1 = Yes and 0 = No**
Marketing Innovation	MI	MI is a variable that indicates whether the firm has introduced new or significantly improved marketing methods. **1 = Yes and 0 = No**
	ICT Variables	
Email Ownership	MAIL	Mail is a variable that indicates whether the firm currently communicates with clients and suppliers by E-mail. **1 = Yes and 0 = No**
Website Ownership	WEB	WEB is a variable that indicates whether the establishment has its own website. **1 = Yes and 0 = No**
Technology licenced from Foreign Companies	TLFC	TLFC is variable that indicates whether the firm is technology licensed by a foreign-owned company. **1 = Yes and 0 = No**
Internationally-recognized quality certification	IRQC	IRQC is a variable that indicates whether the firm has Internationally-recognized quality certification. **1 = Yes and 0 = No**
	Productivity Variable	
Productivity	Product	Product is the normal distribution stochastic frontier model that is estimated with the use of STATA. The productivity measurement is discussed in section 3.3.2
	Control Variables	
Firm Size	FIRS	FIRS is a variable that indicates the employment band of the firm. **0 = medium (20 – 99 employees), 1 = Small (5-19 employees), 2 = Large (100 employees and more)**
Firm Age	AGE	AGE refers to the number of years since the establishment of the firm.
Manager's Experience	MANEX	MANEX refers to the number of years of managerial experience of the top manager working in the sector
Ownership Type	OWT	OWT is a variable that indicates the legal Status of the firm. **0 = Partnership, 1 = Sole Proprietorship, 2 = Listed firm**
Loan Access	LoanA	LoanA is a variable that indicates whether the firm currently has a line of credit or loan from a financial institution. **1 = Yes and 0 = No**

Source: Author's computation. **Note:** All information are Extracted from World Bank Enterprise Survey, 2014

3.2 Methodology of the study

3.2.1 Structural Equation Modeling

Structural equation modeling (SEM) is applied to examine if there is a causal relationship between exogenous variables (Ownership structure, loan access, age, export, productivity) and endogenous variables (innovation, and ICT). SEM is carried out in two stages – the measurement and structural model analysis. Measurement model analysis tests the reliability of the observed items in determining whether items adequately measure the variables represented. The model takes into account measurement errors which reduce the bias in the SEM model. Structural model analysis tests relationship between endogenous and exogenous variables as well as relationship among endogenous variables. STATA 15 software is used to analyse the SEM model and to test the causal relationship between the variables. A maximum likelihood (ML) estimator will be employed for the estimation.

In this study, we will develop our structural equations model using five steps (Bollen and Long, 1993). These steps are:

Model Specification: SEM begins with the specification of a model to be estimated. Models are specified based on a theory or prior research. It is very common to specify models using path diagrams. Squares or rectangles are used to represent observed (dependent) series while circles or ovals are used to represent

latent (independent) variables and error terms. Thus, exhibit two types of relationships among variables: direct and indirect.

Direct or directional relationships represent hypothesized linear relationship that influence of one variable on another. Directional effects between variables are specified using single-headed arrows,

Non-directional or indirect relationships represent hypothesized correlational associations between variables (MacCallum and Austin, 2000). In-directional effects between variables are specified using double headed arrows.

a) **Model Identification:** Model Identification focuses on whether or not there is a unique set of parameters that are consistent with the sample data. In model identification, each parameter in a model must be specified to be either a free parameter, a fixed parameter, or a constrained parameter. A free parameter is a parameter that is unknown and needs to be estimated. A fixed parameter is a parameter that is not free but is fixed to a specified value, typically either 0 or 1. A constrained parameter is a parameter that is unknown but is constrained to equal one or more other parameters.
b) **Model Estimation:** After specifying and identifying a model, the third step is to estimate model parameters. The parameters of SEM are regression coefficients and variance/covariance of exogenous variables. The three most commonly used estimation approaches are: Maximum Likelihood (ML), Generalized Least Square (GLS), and Asymptotic Distribution Free (ADF). Making choicesbetween these approaches is often guided by the characteristics of the data, including sample size and distribution. ML is the most commonly used approach in SEM because it requires less sample size

(at least 200). It assumes multivariate normality. GLS assumes multivariate normality but GLS estimates are likely to be negatively biased (Browne, 1974). ADF does not assume multivariate normality but it requires a sample size above 2,500 to generate accurate estimates (Hoyle, 1995). Therefore, the ML will be used to estimate parameters in the model in this study.

c) **Testing Model Fit:** Once the model parameters are estimated, it is often reasonable to check the robustness of the model. Doing this require model fit. If the fit is good, then the specified model is supported by the sample data, whist if the fit is poor, then the model needs to be re-specified to achieve a better fit. This test can be performed at two levels either at the level of individual parameters or at the level of entire model.

   i. To test the fit of the individual parameters, two steps are required. The first step was to determine the feasibility of their estimates values. The assessment focused on whether their estimates values are in the admissible range or not. These include negative variance, correlation exceeding one, and non-positive definite correlation matrix (Cheung and Rensvold, 2002). The second step in assessing the fit of individual parameters was to test their statistical significances.

   ii. The second procedure in evaluating the fit of the model was to assess the fit of the entire model. The STATA software program provides a number of fit indices such as Chi-square (χ^2) test, the Normed chi-square (χ^2/df), Goodness-of-Fit index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA).

Model Modification: The final step is model modification. If the fit of the hypothesized model is less than satisfactory, then the model can be modified to improve its fit. There are two ways to improve the fit of the model. One is to delete parameters that are not significant. However, if they are important in the theory, they should remain in the model (Schumacker and Lomax, 2004). The second way is to include additional parameters. In STATA program there are three techniques to modify the model: the modification index (MI), the expected parameter change statistic (EPC), and the standardised residuals (Byrne, 2006). The MI indicates the expected drop in overall χ^2 values if each fixed parameter was to be freely estimated in a subsequent run. Larger MI for a particular fixed parameter would suggest that a better model fit by allowing this parameter to be free. The EPC statistic indicates the estimated change in the magnitude and direction of each fixed parameter if it was to be free. The standardised residuals are like Z scores. Larger values indicate that a particular relationship is not well explained by the model. As a rule of thumb, Jöreskog and Sörbom (1988) suggest values greater than 2.58 be considered large

3.2.2Model Specification

Equation 3.16 showed the link between exporting and productivity and other firms' specific characteristics to include innovation and ICT, while equation 3.17 relate exporting, innovation, ICT and other firms' characteristics as a major determinant of productivity. However, for estimation purposes only, the following models are estimated in addition to equation 3.16 and 3.17 for aggregate and sectoral levels of enterprise firms in Nigeria.

Model 1 estimate the impact of innovation and ICT on productivity. The model is presented in Figure 3.2. The Figure presented the effect of firm age, firm size, manager experience, loan access and ownership type on productivity, while also showing the impact of innovation and ICT on productivity of firms. Thus, firm characteristics constructs like age, firm size, manager experience loan access and ownership type have direct effects on productivity, while innovation and ICT also affect productivity.

In Algebraic form, the above model is as follows:

$$Product_{it} = \beta_0 + \beta_1 ICT_{it} + \beta_2 INNO_{it} + \beta_3 AGE_{it} + \beta_4 OWT_{it} + \beta_5 MANEXP_{it} + \beta_6 LOAN_{it} + \beta_7 FIRS_{it} + \varepsilon_{it} \quad 3.18$$

Where, β_{ij} are parameters to be estimated, while ε_i represents the error terms for the model.

Note: Both Innovation and ICT are latent variables and as such are measured using four different subscales: Process (PI); Product (PRI); Organisational (OI) and Marketing (MI) innovation, while ICT is measured using Internationally-recognized quality certification (IRQC); Email (Email); Website (WEB) and Technology licensed from Foreign Companies (TLFC) respectively.

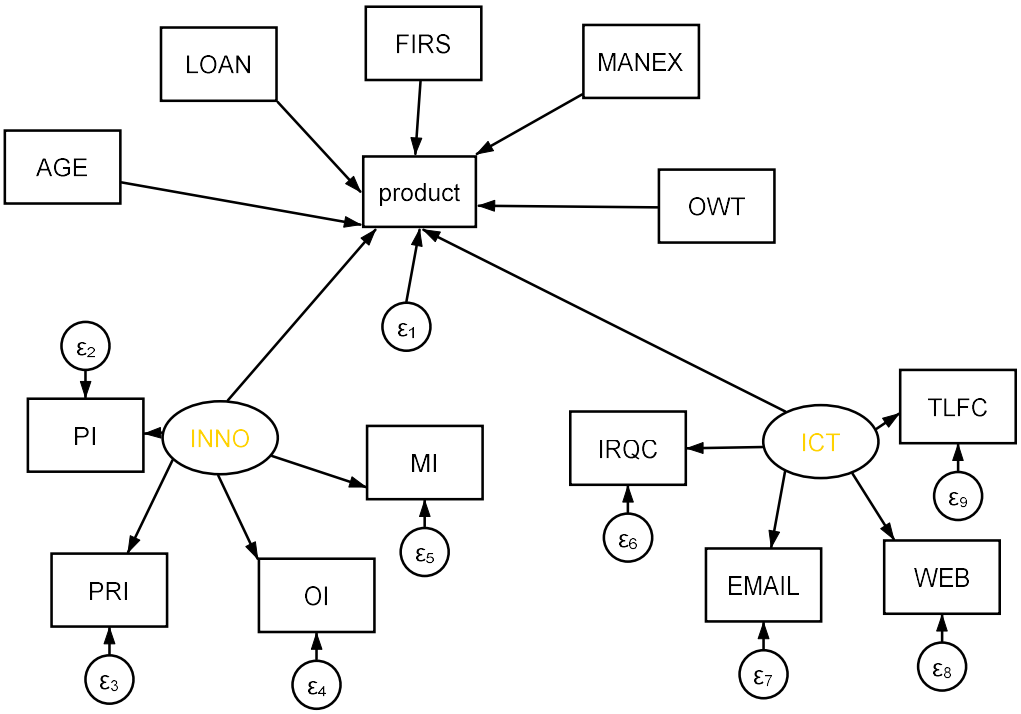


Figure 3.2: *Path diagram for Model 1* – Showing the impact of innovation and ICT on Productivity of firms. *Source: Author's compilation*

Model 2 assess the impact of innovation and ICT on exporting. The model is presented in Figure 3.3. The model presented the effect of firm age, firm size, manager experience, loan access and ownership type on exporting, while also showing the impact of innovation and ICT on exporting of firms. Thus, firm characteristics constructs like age, firm size, manager experience, loan access and ownership type have direct effects on exporting, while innovation and ICT also affect exporting.

The model is expressed in econometric form as follows:

$$EXPP_{it} = \beta_0 + \beta_1 ICT_{it} + \beta_2 INNO_{it} + \beta_3 AGE_{it} + \beta_4 OWT_{it} + \beta_5 MANEXP_{it} + \beta_6 LOAN_{it} + \beta_7 FIRS_{it} + \varepsilon_{it} \quad 3.19$$

Where, β_{ij} are parameters to be estimated, while ε_i represents the error terms for the model.

Note: Both Innovation and ICT are latent variables and as such are measured using four different subscales: Process (PI); Product (PRI); Organisational (OI) and Marketing (MI) innovation, while ICT is measured using Internationally-recognized quality certification (IRQC); Email (Email); Website (WEB) and Technology licensed from Foreign Companies (TLFC) respectively.

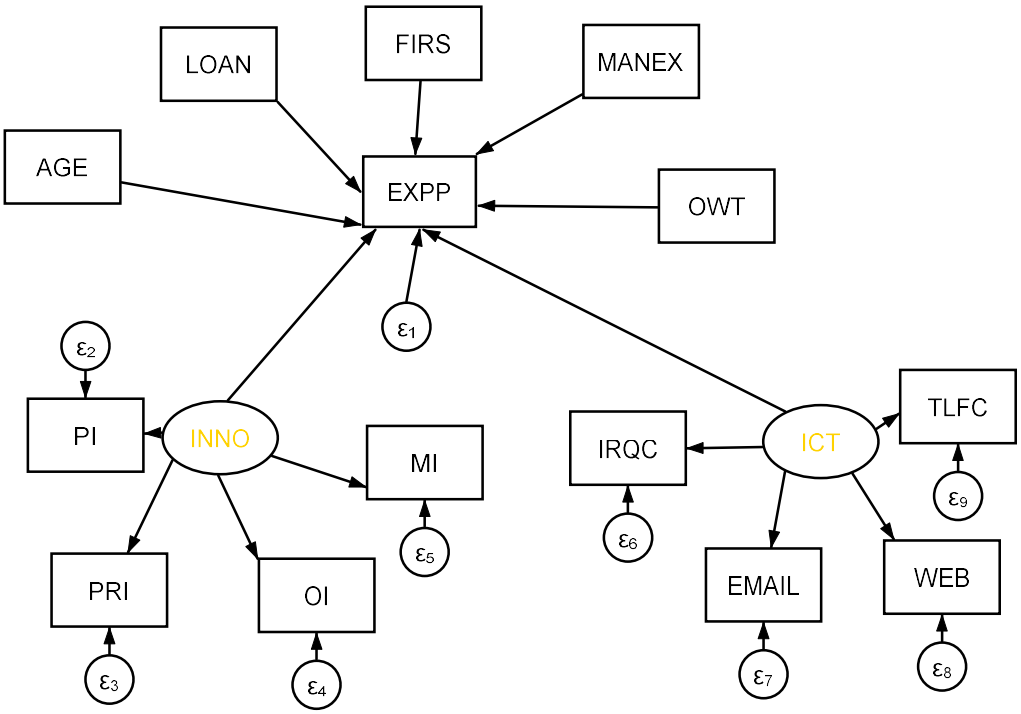


Figure 3.3: Path diagram for Model 2 - Showing the impact of innovation and ICT on Exporting of firms.*Source: Author's compilation*

Model 3underscore the mediating effect of innovation and ICT in exporting-productivity relationship. The focus here is to examining how ICT and innovation constructs intervene exporting-productivity link (Figure 3.4).

The algebraic model expressing figure 3.4a and b are as follows:

$$Product_{it} = \beta_0 + \beta_1 ICT_{it} + \beta_2 INNO_{it} + \beta_3 EXPP_{it} + \beta_3 AGE_{it} + \beta_5 OWT_{it} + \beta_6 MANEXP_{it} + \beta_7 LOAN_{it} + \beta_8 FIRS_{it} + \varepsilon_{it} \quad 3.20a$$

$$EXPP_{it} = \beta_0 + \beta_1 ICT_{it} + \beta_2 INNO_{it} + \beta_3 Product_{it} + \beta_3 AGE_{it} + \beta_5 OWT_{it} + \beta_6 MANEXP_{it} + \beta_7 LOAN_{it} + \beta_8 FIRS_{it} + \varepsilon_{it} \quad 3.20b$$

Note: Both Innovation and ICT are latent variables and as such are measured using four different subscales: Process (PI); Product (PRI); Organisational (OI) and Marketing (MI) innovation, while ICT is measured using Internationally-recognized quality certification (IRQC); Email (Email); Website (WEB) and Technology licensed from Foreign Companies (TLFC) respectively. *Source: Author's compilation*

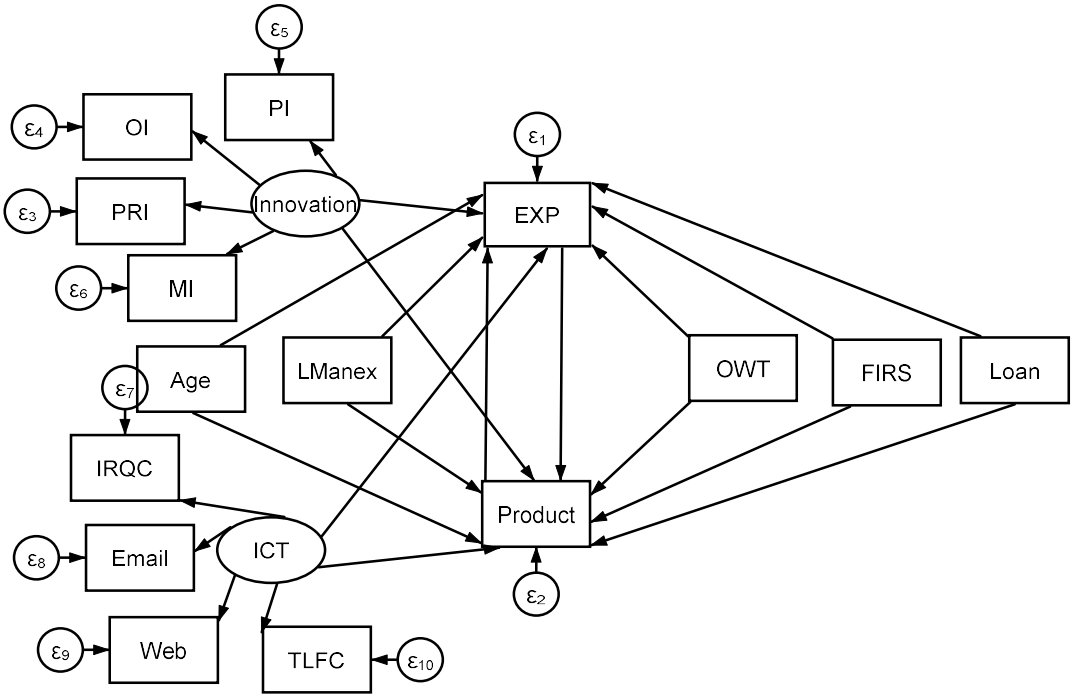


Figure 3.4a: Path diagram for Model 3 - Showing the mediating effect of innovation and ICT in Exporting - Productivity link of firms.

To further exploit the link between exporting-productivity relationships, this study re-grouped[27] firms as follows;

a. Firms using ICT only
b. Firms without ICT
c. Firms with innovation only
d. Firms without innovation
e. Firms with both ICT and Innovation
f. Firms without both ICT and Innovation

The above grouping was done in order to evaluate whether exporting-productivity link exist with or without firms' uses of ICT and Innovation.

Note: All analysis wereestimated at three (3) basic levels as;

a. Aggregate firms
b. Manufacturing Firms
c. Services Firms

[27] For the grouping - Email and Website ownership are used for ICT classification of firms, while product and Process innovation jointly were used for Innovation. Therefore, any firms that indicated the uses of both Email and Website are classified as ICT firms, while those that indicated product and Process innovation are classified as innovating firms.

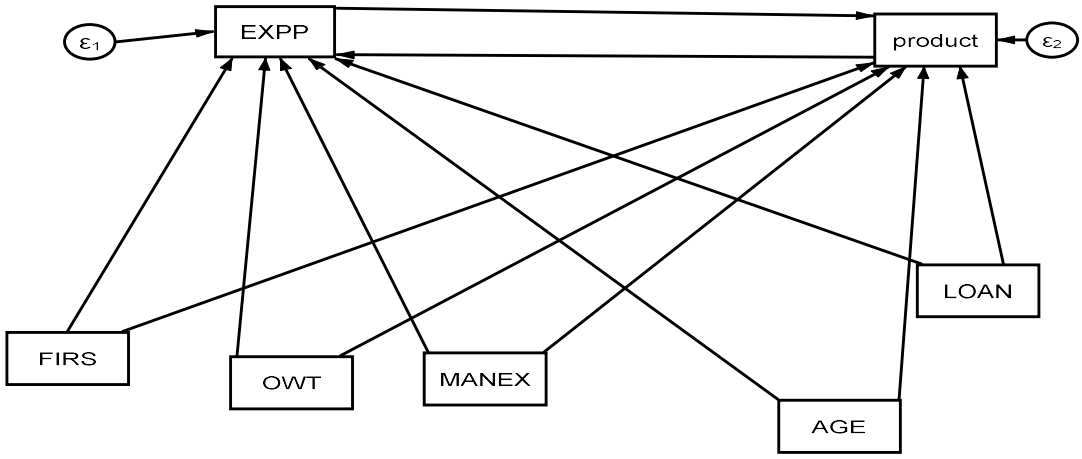


Figure 3.4b: Path diagram for Model 3 - Showing the mediating effect of innovation and ICT in Exporting - Productivity link of firms. *Source: Author's compilation*

3.2.3 Data and Sources

The firm-level datasets used for this thesis are obtained from the 2014 World Bank, Enterprise Surveys for Nigeria. The datasets cover small, medium, and large companies with fieldwork duration between April 2014 and February 2015. The Enterprise Surveys focus on many factors that shape the decisions of firms to invest, innovate and their level of ICT and output performance. The sampling methodology for Enterprise Surveys is stratified random sampling. The survey employed homogeneous groups and simple random samples techniques to selectgroups of firms within each group. The sampling weights take care of the varying probabilities of selection across different strata. The strata for Enterprise Surveys are firm size, business sector, and geographic region within a country. Firm size levels are 5-19 (small), 20-99 (medium), and 100+ employees (large-sized firms).

Results from the surveys are published and are publicly available at the official website of the World Bank[28]. Moreover, all variables are as measured and defined in Table 3.1 on page 86. In terms of sample representativeness, the cross sectional survey covers two thousand, six hundred and seventy-six (2,676) firms. This study filtered out only exporting firms based on the focus of the study from the survey dataset and as such 1,092 exporting firms were suitable for analyses and then classified into manufacturing (529) and services (563) sectors for sectoral analysis.

3.3.4 Measure of Inputs and Output (Productivity)

This thesis modifies Schmidt and Lovell (1979) and Battese and Coelli (1988) where Cobb-Douglas technical efficiency was estimated, by incorporating raw

[28] Data is available at https://www.enterprisesurveys.org/en/enterprisesurveys

materials input as additional input variable (see equation 3.1 on page 78, section 3.2.1). A firm is said to be technically efficient if a firm is producing the maximum output from the minimum quantity of inputs, such as labour, capital and technology. Here, firm sales are used to measure output; cost of Machinery, vehicles and equipment is used to measure capital, labor is assessed by the cost of labour/workers including wages, salaries and bonuses; and intermediate goods are determined by the cost of raw materials. Productivity is estimated as the stochastic frontier models; that allow us to analyze the technical efficiency in the framework of production functions. This is done since, the production units of firms under study are assumed to produce according to a common technology, and reach the frontier when they produce the maximum possible output for a given set of inputs. Therefore, productivity growth is the net change in output due to changes in efficiency and technical change and as such, efficiency is a component of productivity (Grosskopf, 1993).

The Productivity values used in this thesis is the logarithmic Cobb-Douglas production function with capital, labor and materials as input factors; the dependent variable used is the value of the firm total sales. This approach to the computation of the productivity is known as the normal distribution stochastic frontier model (see appendix 1 for the result).

CHAPTER FOUR
RESULT AND DISCUSSIONS

This chapter provides a comprehensive analysis and interpretation of empirical results on the role of innovation and ICT in exporting-productivity relationship among Nigerian enterprise firms. The chapter examines the properties and characteristics of the cross sectional data employed in this study using descriptive statistics, correlation analysis and interpret results of the structural Equation Models.

4.1 Preliminary Analysis[29]

4.1.1 Descriptive Statistics

The descriptive statistics of the variables used in the estimation of SEM is summarized in Table 4.1. The statistics, on average, showed that about 55.8, 56.4, 45.8 and 60.5 per cent of the sampled firms engaged in product, process, and organisational and marketing innovation respectively. Also, 0.09, 0.28, 0.19 and 0.04 per cent of the total 1,092 firms analysed have internationally-recognized quality certificate, Email, Website and Technology licensed by Foreign Companies.

[29] The STATA Codes used for the complete analysis are presented in appendix 2

Table 4.1: Descriptive Statistics of the Variables used in the SEM Analysis

Name	VARIABLES	N	Mean	St. deviation	Min	Max
Exporting Participation	EXPP	1,092	62.32	36.13	5	100
Productivity	Product	1,092	15.12	2.730	9.620	27.63
Innovation						
Name	**Variables**	**YES**		**NO**		
		Freq	%	Freq	%	
Product Innovation	PI	609	55.77	483	44.23	
Process Innovation	PRI	616	56.41	476	43.59	
Organisational Innovation	OI	500	45.79	592	54.21	
Marketing Innovation	MI	661	60.53	431	39.47	
ICT						
Internationally-recognized quality certification	IRQC	93	8.52	999	91.48	
Email Ownership	Email	306	28.02	786	71.98	
Website Ownership	Web	211	19.32	881	80.68	
Technology licensed from Foreign Companies	TLFC	60	5.49	1035	94.51	
Control Variables						
		Small		Medium		
Firm Size	FIRS	1014	92.86	78	7.14	
		Partnership		Sole Proprietorship		
Ownership Type	OWT	114	10.44	978	89.56	
Firm Age	AGE	1,092	17.10	11.87	3	116
Manager's Experience	MANEX	1,092	12.77	8.251	2	72
Loan Access	LOANA	99	9.07	993	90.93	

Source: Computed Using STATA 15 from the underlying Enterprise Survey, 2014. ***Note:*** *Freq. = Frequency and % = percentage of the frequency*

4.2 Factors items, Factors loading, Variance Explained and Item reliability Statistics

This study further explores the characteristics of the data set since the final analysis is based on exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Results of the EFA is considered on factor loadings of each item and item-total correlation coefficients - each factor needs to be strictly greater than 0.5 to guarantee validity and reliability of the survey data employed (Nunnally, 1978 and Jöreskog and Sörbom, 2002).

Starting with the factor loading coefficients, the association of each variable with the underlying factor is expressed in Table 4.2 (column 3 - factor loading). The results shows the factor analysis of innovation and ICT indicators represented by four variables for each level of analysis carried out (Aggregate, Manufacturing and Services).

At the aggregate firm level, all measures of innovation and ICT have strong association with their underlying latent construct, except Technology licensed from Foreign Companies (TLFC) as a measure of ICT. Product (PI), Process (PRI), organisational (OI) and marketing (MI) innovation have strong correlation with innovation with a factor loading value of 0.873, 0.754, 0.825 and 0.714 respectively. Also, Internationally-recognized quality certification (IRQC), Email, Web and Technology licensed from Foreign Companies (TLFC) have relatively better factor loading coefficients of 0.530, 0.819, 0.807, and 0.516. Overall, these factors (measures) load well and thus, reflect strong strength for measuring innovation and ICT in the analysis.

Table 4.2: Factors Items, loading, Variance Explained and Item Reliability Statistics

	Constructs	Items	Factors Loading	LR test	Variance Explained	Item Reliability (R2)	Mean[30]	St.D.
1.	**All Firms: Number of Observation = 1,092**							
A.	Kaiser-Meyer-Olkin[31](Innovation Variables)					0.768 (0.000)		
I	Innovation	PI	0.873	1384.63 (0.000)	63.002	0.536	1.44	0.497
Ii		PRI	0.754			0.422	1.44	0.496
Iii		OI	0.825			0.562	1.54	0.498
Iv		MI	0.714			0.513	1.40	0.489
B.	Kaiser-Meyer-Olkin (ICT Variables)				0.575 (0.000)			
I	ICT	IRQC	0.530	559.40 (0.000)	44.43	0.469	1.92	0.279
Ii		Email	0.819			0.219	1.72	0.449
Iii		Web	0.807			0.216	1.81	0.395
Iv		TLFC	0.516			0.307	1.96	0.188
2.	**Manufacturing Firms; Number of Observation = 529**							
A.	Kaiser-Meyer-Olkin (Innovation Variables)					0.759 (0.000)		
I	Innovation	PI	0.760	627.490 (0.000)	61.76	0.423	1.46	0.499
Ii		PRI	0.825			0.319	1.41	0.492
Iii		OI	0.768			0.411	1.55	0.498
Iv		MI	0.789			0.377	1.39	0.489
B.	Kaiser-Meyer-Olkin (ICT Variables)				0.614 (0.000)			
I	ICT	IRQC	0.538	315.406 (0.000)	47.56	0.711	1.91	0.290
Ii		Email	0.801			0.359	1.77	0.419
Iii		Web	0.782			0.389	1.84	0.366
Iv		TLFC	0.601			0.639	1.93	0.249
3.	**Services Firms; Number of Observation = 563**							
A.	Kaiser-Meyer-Olkin (Innovation Variables)					0.766 (0.000)		
I	Innovation	PI	0.853	769.904 (0.000)	64.321	0.382	1.42	0.495
Ii		PRI	0.786			0.273	1.46	0.499
Iii		OI	0.761			0.420	1.53	0.499
Iv		MI	0.805			0.352	1.40	0.490
B.	Kaiser-Meyer-Olkin (ICT Variables)				0.558 (0.000)			
I	ICT	IRQC	0.509	254.059 (0.000)	42.483	0.682	1.92	0.269
Ii		Email	0.850			0.275	1.67	0.471
Iii		Web	0.849			0.276	1.77	0.418
Iv		TLFC	0.012			0.059	1.99	0.094
4.	**Exporting Firms; Number of Observation = 253**							
A.	Kaiser-Meyer-Olkin (Innovation Variables)					0.718 (0.000)		
I	Innovation	PI	0.779	250.561 (0.000)	57.775	0.393	1.40	0.491
Ii		PRI	0.810			0.344	1.38	0.486
Iii		OI	0.724			0.476	1.40	0.492
Iv		MI	0.724			0.476	1.26	0.440
B.	Kaiser-Meyer-Olkin				0.556 (0.000)			
I	ICT	IRQC	0.500	168.611 (0.000)	46.308	0.418	1.89	0.314
Ii		Email	0.866			0.183	1.71	0.456
Iii		Web	0.797			0.157	1.80	0.399
Iv		TLFC	0.566			0.368	1.94	0.244

Source: Author's estimates based on data obtained for Nigerian enterprise survey, 2014. Note: The chi-square value are reported for likelihood ratio (LR) test with number of estimated parameter equal to 6

[30] Measured on a two-point scale, ranging from 1 = Yes to 2 = No

[31]Measure of Sampling Adequacy

For manufacturing firms, our measures of innovation and ICT variable have strong association with their underlying latent construct. Thus, Product (PI), Process (PRI), organisational (OI) and marketing (MI) innovation have strong association factor with innovation with a factor loading value of 0.760, 0.825, 0.768 and 0.789 respectively, while IRQC, Email, Web and TLFC also exhibit a similar strong factor loading coefficients of 0.538, 0.801, 0.782, and 0.601 respectively. Overall, these factors (measures) load well and thus, explained about 61.76 and 47.32 per cent variations in their underlying latent construct. However, the services firms' factor (TLFC) does not load well under ICT.

Further, this study presents the standardised factor loadings in Table 4.3. The coefficient were found to be statistically significant in most cases and thus confirm convergent validity. The reliability of the indicators was also examined through Squared Multiple Correlation (SMC) values that is expected to be greater than 0.20 (Hooper et al., 2008; pg. 56). A higher SMC value, denotes a higher level of reliability. Process (PRI) and Marketing (MI) were identified as the most reliable indicators of innovation, with SMC values of 0.48 and 0.40 respectively. For the ICT construct, "Email" and "Web" appeared to be the most reliable indicators, with SMC values of 0.35 and 0.34 respectively.

Table 4.3: Model measurement for the Latent construct

Items	Latent construct variables		SMC
	Innovation	ICT	
All Firms			
PI	0.618*		0.391
PRI	0.791*		0.477
OI	0.642*		0.362
MI	0.705*		0.398
IRQC		0.312*	0.081
Email		0.678*	0.347
Web		0.615*	0.340
TLFC		0.205*	0.052
Manufacturing Firms			
PI	0.671*		0.366
PRI	0.803*		0.448
OI	0.595*		0.359
MI	0.676*		0.389
IRQC		0.342*	0.104
Email		0.618*	0.356
Web		0.555*	0.346
TLFC		0.419*	0.128
Services Firms			
PI	0.642*		0.427
PRI	0.879*		0.514
OI	0.613*		0.371
MI	0.695*		0.412
IRQC		0.285*	0.059
Email		0.764*	0.335
Web		0.728*	0.332
TLFC		0.007	0.002
Exporting Firms			
PI	0.726*		0.396
PRI	0.799*		0.428
OI	0.505*		0.282
MI	0.557*		0.282
IRQC		0.346*	0.088
Email		0.701*	0.450
Web		0.385*	0.412
TLFC		0.324*	0.081

Source: Author's estimates based on data obtained for Nigerian enterprise survey, 2014. Note: items with * are Significant at 1*%. SMC = Squared Multiple Correlation*

Moreover, reliability of measurement models was assessed by computing the Cronbach's alpha and item total correlation analysis. The majority of measures showed reliability scores over 0.5, which is above the acceptable level. Also, scale validity were evaluated by using convergent and discriminant validity[32]. In Table 4.4, the Cronbach's alpha scores are desirable with alpha coefficients strictly greater than 0.5 for all our level of analysis, which further suggests a reliable construct for measuring innovation and ICT.

[32] Convergent validity is the extent to which the individual items of a construct share variance, while Discriminant validity examines whether the constructs are uni-dimensional (by comparing the maximum shared variance (MSV) and average shared variance (ASV)).

Table 4.4: Convergent and discriminant validity of measurement models

Constructs	Cronbach's α	CR	AVE	MSV	ASV	Results of convergent validity AVE > 0.5	Results of discriminant validity MSV < AVE
All Firms							
Innovation	0.804	0.785	0.629	0.479	0.793	YES	YES
ICT	0.581	0.520	0.544	0.202	0.450	YES	YES
Manufactured Firms							
Innovation	0.793	0.783	0.677	0.517	0.786	YES	YES
ICT	0.629	0.553	0.546	0.463	0.681	YES	YES
Services Firms							
Innovation	0.814	0.804	0.511	0.442	0.801	YES	YES
ICT	0.544	0.532	0.599	0.308	0.555	YES	YES
Exporting Firms							
Innovation	0.755	0.747	0.633	0.576	0.759	YES	YES
ICT	0.611	0.496	0.516	0.421	0.670	YES	YES

Source: *Author's estimation and computation using STATA 15;* **Note:** CR refers to the composite reliability, AVE refers to the average variance extracted, MSV refers to the maximum shared variance and ASV refers to the average shared variance.

4.3 The Structural Model Analysis

Resulting from the pre-estimation analysis which shows high level of validity and reliability of the measurement models, this study proceeds to estimate the standardised structural equation model. This is done in order to estimate the structural relationships between exporting and productivity, while underscoring the role of innovation and ICT in the relationships. In this study, the links among variables are shown using arrows going from unobserved constructs to observed or manifest indicators. We estimated the models presented in Figures 3.2, 3.3 and 3.4 under section 3.3 using the maximum- likelihood method.

4.3.1 The Role of Innovation and ICT in Productivity (All firms)

Following the usual approach of measurement model assessment, this study employed several index criteria to evaluate the goodness of fit, to include Root mean square error of approximation (RMSEA), Coefficient of determination (CD), Tucker-Lewis index (TLI), Comparative fit index (CFI) and Standardised root mean squared residual (SRMR) with a baseline critical value that is less than or equal to 0.95, among others. In our model, a RMSEA value of 0.064, TLI (0.918) and CD value of 0.953 are indicative of a good fit of the model with the data (Table 4.5).

Table 4.5: Fit indices for the Structural Model of Exporting-productivity in Nigeria

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)[33]	142.472 (26)		
p	0.000	< 0.05	Good Fit
RMSEA	0.064	<= 0.06	Good Fit
CD	0.953	>= 0.50	Good Fit
TLI	0.918	< = 0.9	Good Fit
CFI	0.941	< = 0.9	Good Fit
SRMR	0.068	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

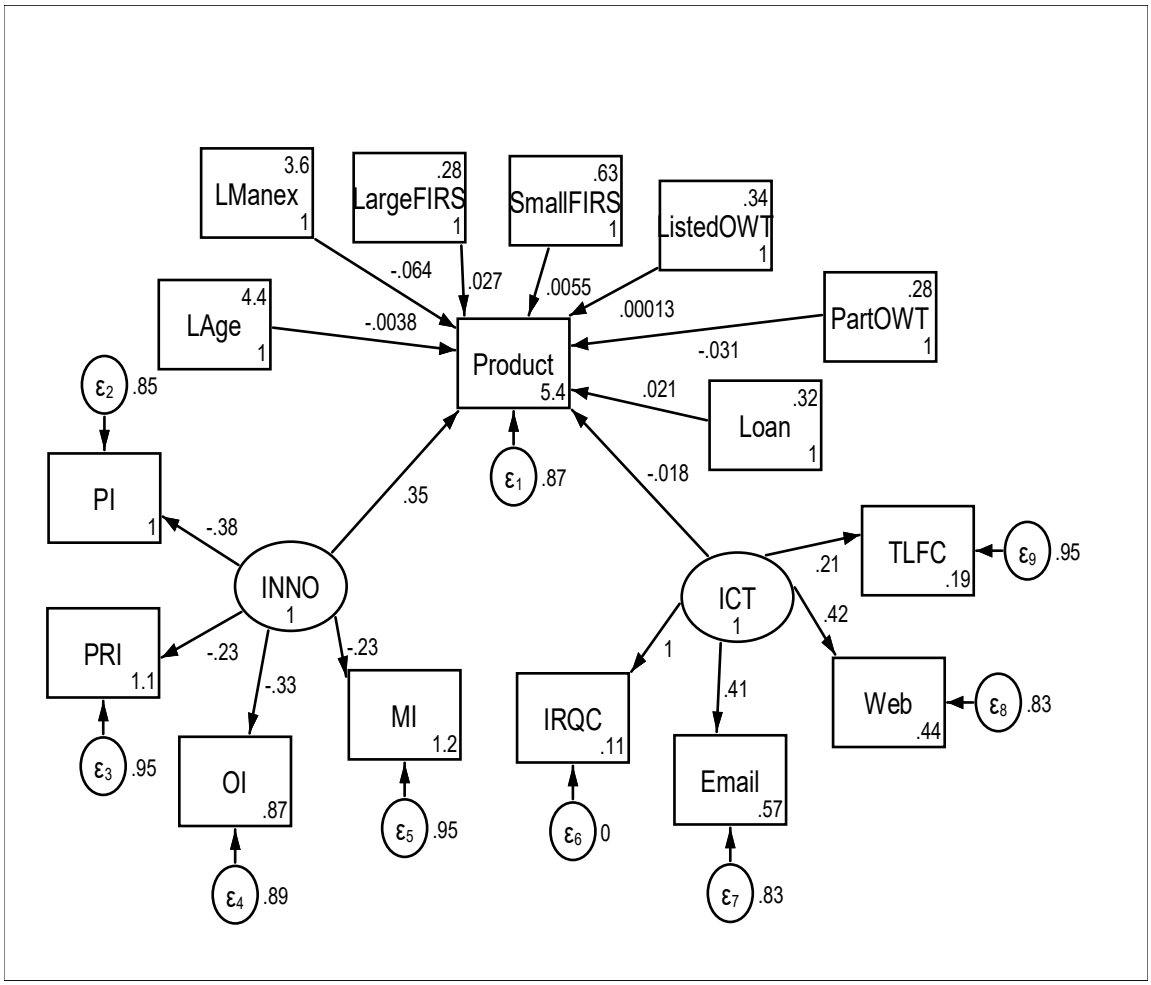
[33] Bentler-Raykov squared multiple correlation coefficient

This study proceed to estimate the SEM model using the aggregate firms' data. Looking at the path coefficients of the SEM model in Figure 4.1, it is found that the standardised coefficients of the direct structural paths for the effect of innovation and ICT in productivity (Product) shows a mixed sign. Innovation is positively related to productivity, while ICT deterred it. Thus, only innovation plays a positive role for increasing productivity of firms in Nigeria.

The results further showed that firm age has a negative impact on productivity of enterprise firms in Nigeria. The observed negative effect of firm age could mean that, firms delay their productive strategy after observing their productivity sales in the markets.

In line with expectation, loan access (LOAN) is found to be positively impacting on productivity. This result is similar to that obtained by Babatunde, (2017), Bellone et al., (2010), and Chaney, (2005) where it was reported that firms access to finance help them to meet additional investment required to expand production.

Figure. 4.1. Standardised Estimated Coefficients and Path Analysis for the role of Innovation and ICT in Productivity (All firms)



Source: Author Estimation from STATA 15.

4.3.2 The Role of Innovation and ICT in Exporting of Firms (All firms)

The structural effect of innovation and ICT in exporting of Nigerian enterprise firms is depicted in Figure 4.2, while Table 4.7 evidenced good fits from the output estimation of the model. Specifically, the model shows an RMSEA value of 0.067, as well as TLI and CD values of 0.913 and 0.953 respectively which are indicative of a good fit in our data.

Table 4.6: Fit indices for the Structural Model of Exporting-productivity in Nigeria

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	152.323 (26)		
p	0.000	< 0.05	Good Fit
RMSEA	0.067	<= 0.06	Good Fit
CD	0.953	>= 0.50	Good Fit
TLI	0.913	< = 0.9	Good Fit
CFI	0.937	< = 0.9	Good Fit
SRMR	0.070	<= 0.95	Good Fit

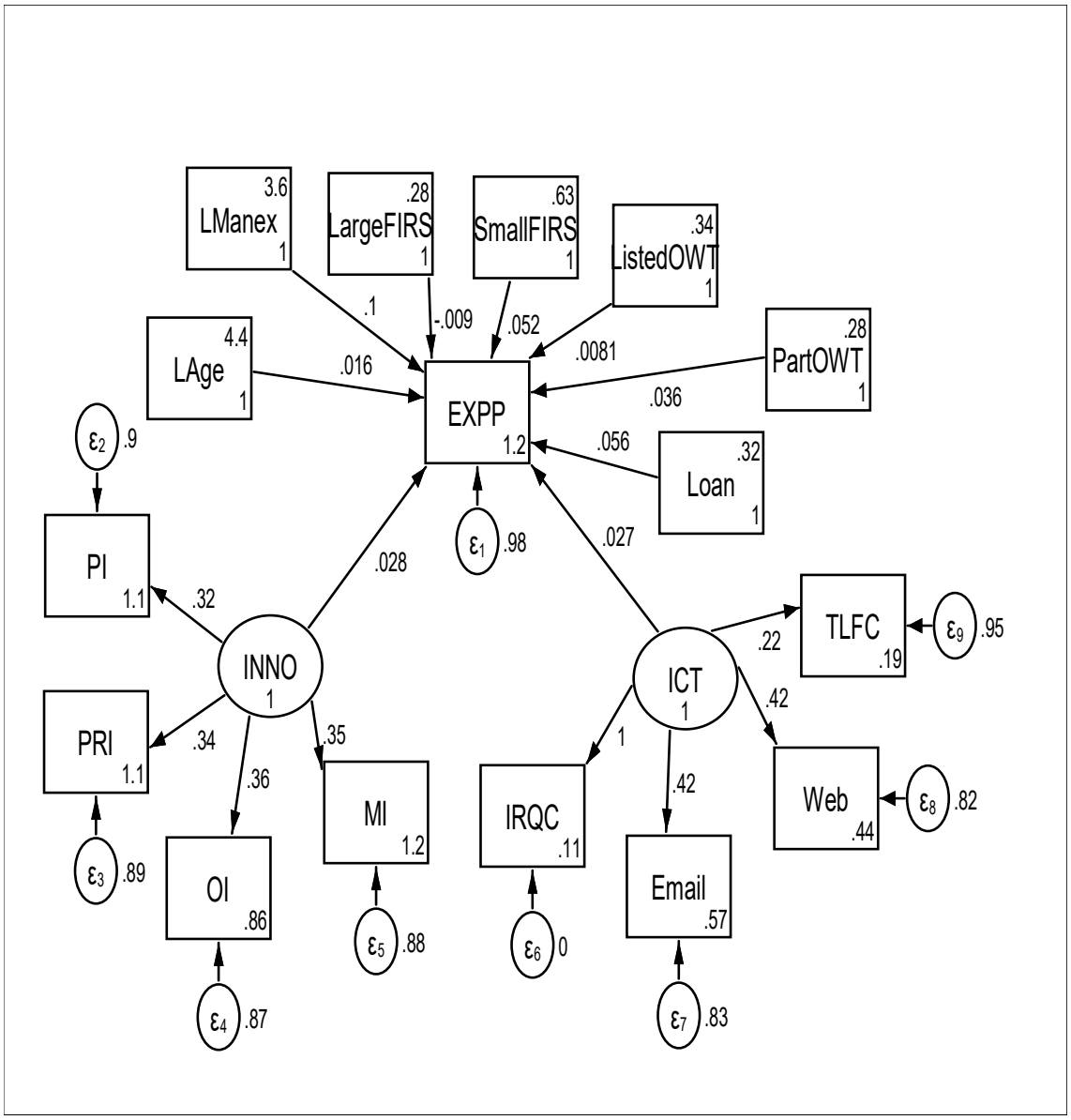
Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

The direct effect of innovation and ICT in exporting is positive and statistically significant. This result can be interpreted to mean that entrepreneur involvement in process, product, marketing and organisational innovations improve exporting by raising the quality of goods and services and reducing the costs of business transaction at the international market. Similarly, use of ICT such as website and email help firms to improve product ordering and products delivery. This observed result is similar to the work of Cuevas-Vargas, et al., (2016); Leon et al., (2016); Cassiman and Golovko (2007) and Chudnovsky, Lopez, and Pupato (2006) where it was established that innovation substantially impact on the performance of businesses.

Further, firm age and access to loan had positive impact on exporting. The observed results on loan access negate the findings of Fowowe, (2017, where it was reported that there is a negative relationship between loan access and firm performance.

Small firm size relative to medium size firm has a positive impact on exporting, while partnership form of ownership relative to sole proprietorship also exhibited a positive (3.6) influence on exporting.

Figure. 4.2. Standardised Estimated Coefficients and Path Analysis for the role of Innovation and ICT in Exporting (All firms)



Source: Author Estimation from STATA 15.

4.3.3 Link between Exporting and Productivity among all Firms

In the model establishing the link between exporting and productivity of firms, the standard goodness of fit shows a stable model with an RMSEA value of 0.003, TLI (0.499) and CD value of 0.708 are indicative of a good fit in our data (Table 4.8).

Table 4.7: Fit indices for the Structural Model of Exporting-productivity in Nigeria

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)[34]	159.315 (27)		
p	0.000	< 0.05	Good Fit
RMSEA	0.003	<= 0.06	Good Fit
CD	0.708	>= 0.50	Good Fit
TLI	0.499	< = 0.8	Good Fit
CFI	0.624	< = 0.8	Good Fit
SRMR	0.053	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

[34] Bentler-Raykov squared multiple correlation coefficient

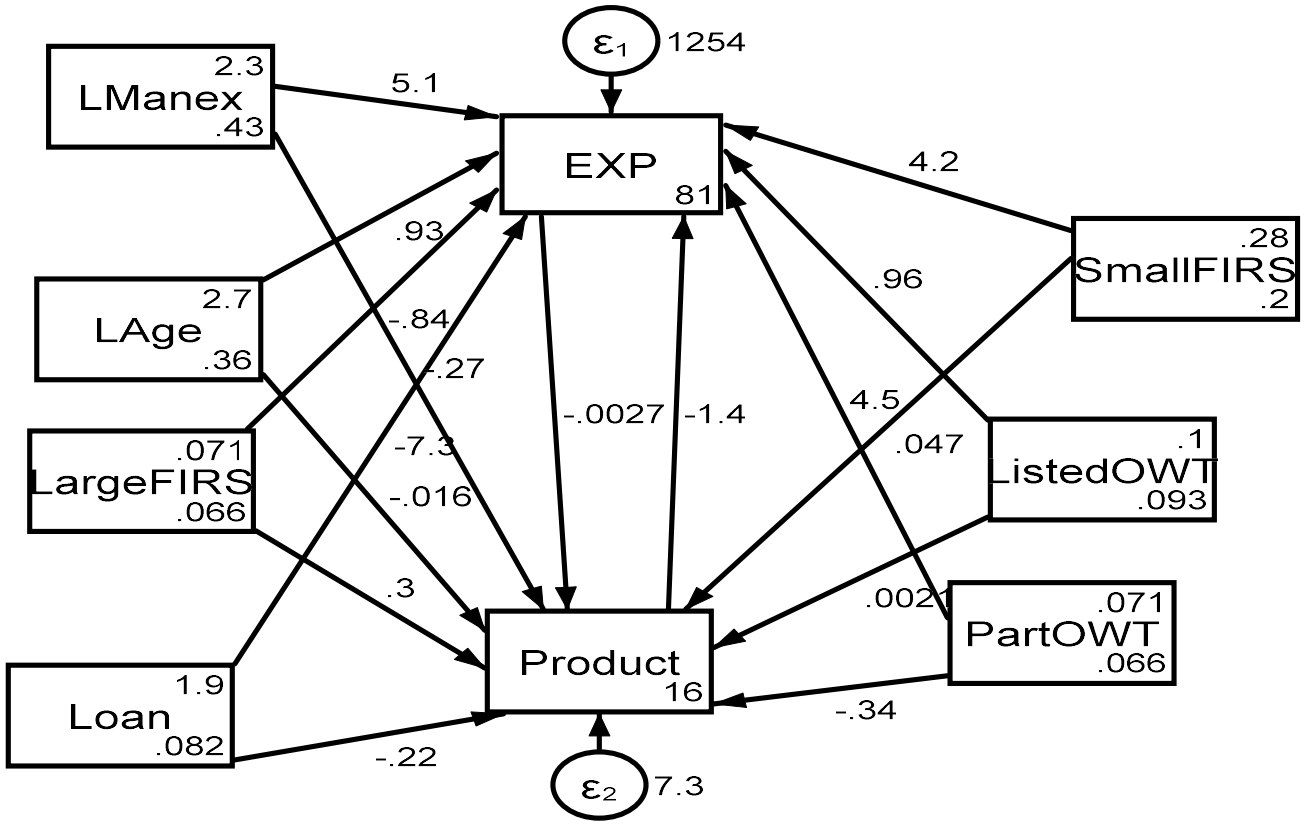
Figure 4.3 shows the path diagram for exporting-productivity link. It is found that the standardised coefficients of the direct structural paths are mostly not in line with expectations in terms of sign and significance. For instance, the direct effect of exporting (EXPP) on productivity (Product) had a negative impact. Intuitively, Nigerian enterprise firms that enter into exporting and continue to export experience decline in their productivity and hence results do not support learning-by-exporting hypothesis. A plausible reasons for this could be as a result poor learning ability, low competiveness and reduced technology adoption among the enterprise firms.

On the other hand, productivity had significant negative direct effect on exporting (1.4). This implies that increases in productivity of firms, leads to a reduction in exporting of up to 14 per cent. This results also negate the self-selection hypothesis, which could also be as a result of low product quality. Therefore, both learning by exporting and self-selection hypothesis does not hold among Nigerian enterprise firms (at the aggregate). This is because of the negative association and due to several government incentives in place for assisting firms exporting performance. This finding is consistent with the findings of Sharma and Mishra, (2015) and Mez-Castillejo *et al.,* (2010), where they obtained a negative relationship between trade and productivity for Indian and Spain manufacturing firms respectively.

However, the direct effects of firm age (AGE), Manager experience (MANEX), Small firm Size, Listed (ListOWT) and Partnership form of Ownership (PartOWT) have a positive effect on exporting of enterprise firms. Thus, as firms' age and manager experiences improved among enterprise firms, exporting of firms also improved, whereas they both reduce the productivity of firms.

The negative effect of firm age and manager experience on productivity could better be explain in that new firms develop responsive strategy only after observing their productivity in the industry.

Figure 4.3: Standardised Estimated Coefficients and path analysis for Exporting-Productivity Link (All Firms)



Source: Author estimation from STATA 15

Thus, productivity decreased with age and thus, provide room for learning effect. Additionally, the results could also mean that the enterprise firms have taken quality of product for granted as they gain experience in the market overtime. This result is similar to that of Alvarez and Lopez (2005), Taymaz (2002) and Power (1998). Further, Smaller firm (0.525) relative to medium size firm, List ownership (0.008) and Partnership (0.032) relative to Sole Proprietorship is positively related to exporting decision of enterprise firms in Nigeria. Contrarily to expectation, loan access (LOAN) is found to be negatively related with both exporting decision and productivity of firms. A negative coefficient of the variable implies that enterprise firms faced constraint in terms of loan access and thus, resort to obstruct productivity and exporting. This is similar to results in (Fowowe, 2017; Ayyagari, Demirguc-Kunt, and Maksimovic, 2008 and Dinh, Mavridis and Nguyen, 2012).

4.3.4 Mediating Role of Innovation and ICT in the Link between Exporting and Productivity

This section deals with the third objective of the study after the establishment of exporting-productivity link by focusing on the mediating role of innovation and ICT in the relationship between exporting-productivity links. Table 4.9 present the goodness fit index. The RMSEA (0.000), TLI (0.238) and CFI (0.059) showed evidence for a better fit in our model. Also, the standardised root mean squared residual (SRMR) value of 0.169 is less than the critical value of 0.950 and thus, further confirmed the robustness of the fit model. Given better fitness of the model, the path model was estimated via SEM and now with the interaction of a mediator (Figure 4.4).

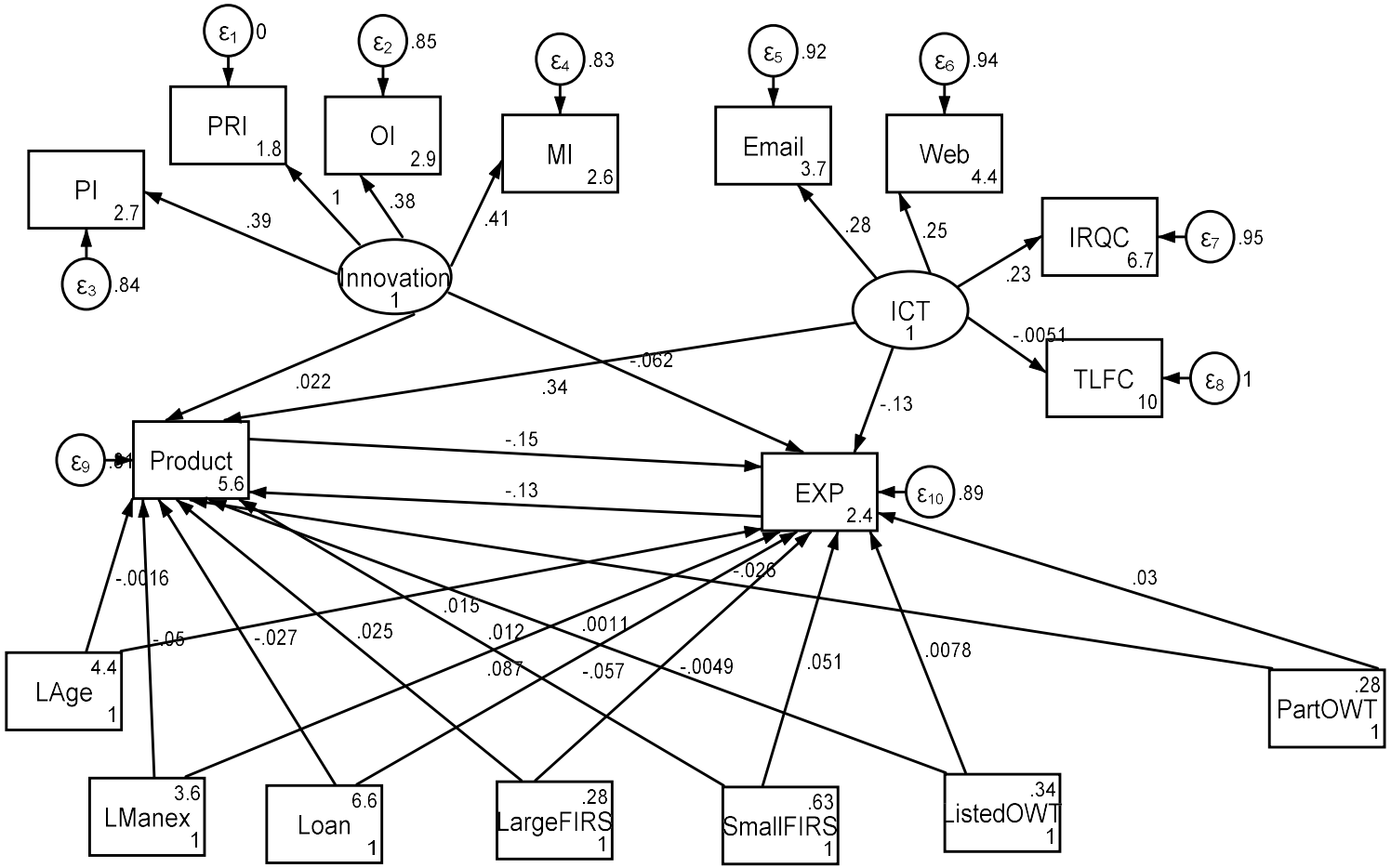
Table 4.8: Fit indices for the Structural Model on the mediating role of innovation and ICT usage in the link between Exporting-productivity (All Firms)

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	2442.030 (115)		
p	0.000	< 0.05	Good Fit
RMSEA	0.000	<= 0.06	Good Fit
CD	1.000	>= 0.50	Good Fit
TLI	0.238	< = 0.8	Good Fit
CFI	0.059	< = 0.8	Good Fit
SRMR	0.169	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

As previously estimated and reported in Figure 4.3, the direct effect of exporting on productivity (Product) and productivity on exporting is negative, however, the mediating role of innovation and ICT reduced the effect to 13 and 15 per cent for exporting-productivity and productivity-exporting relationship respectively. Further, the indirect mediating effect of innovation (INNO) on productivity (Product) via exporting (EXPP) is positive and stood at (-0.062)*(-0.13) = 0.00806 ≈ 0.81 per cent. Similarly, the indirect mediating effect of innovation (INNO) on exporting (EXP) via productivity (product) is negative at (0.022)*(-0.15) = - 3.3 per cent. Also, the indirect mediating effect of ICT on productivity (Product) via exporting (EXPP) is positive with a coefficient value of (-0.13)*(-0.13) = 0.0169 ≈ 0.02 per cent. Likewise, the indirect mediating effect of ICT on exporting (EXP) via productivity (product) is also positive (-0.062)*(-0.15) = 0.093 ≈ 0.01 per cent. In summary, the overall results showed a negative relationship between exporting-productivity link, however, the presence of innovation (0.81) and ICT (0.02) help firms offset the negative link between exporting-productivity relationships among firms. Although, there is need for enterprise firms to further improve on their involvement in innovation and use of ICT, as both has a role to play in offsetting the negative link between exporting-productivity of firms in Nigeria.

Figure 4.4: Standardised Estimated Coefficients and path analysis for Exporting-Productivity Link (All Firms)



Source: Author estimation from STATA 15

In the result on Figure 4.4, other firm's characteristics, firm age (0.05), manager experience (0.01), Loan access (0.01) and partnership (0.03) and listed (0.01) ownership forms of business relative to sole-proprietorship are positive determinants factors influencing exporting, while manger experience (0.05) and large firms (0.3) and small firms (0.05) size relative to medium firms size are positive factors influencing productivity of firms in Nigeria.

4.4 The Role of Innovation and ICT in Productivity of Manufacturing Firms

For manufacturing operating firms, the analysis on the role of innovation and ICT on productivity showed that our model has an RMSEA value of 0.065, TLI (0.914) and CD value of 0.950. All these indicator shows a better fit for our model (Table 4.6).

Table 4.9: Fit indices for the Structural Model of Productivity of Manufacturing Firms

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	84.477 (26)		
p	0.000	< 0.05	Good Fit
RMSEA	0.065	<= 0.06	Good Fit
CD	0.950	>= 0.50	Good Fit
TLI	0.914	< = 0.9	Good Fit
CFI	0.938	< = 0.9	In decision
SRMR	0.068	<= 0.95	Good Fit

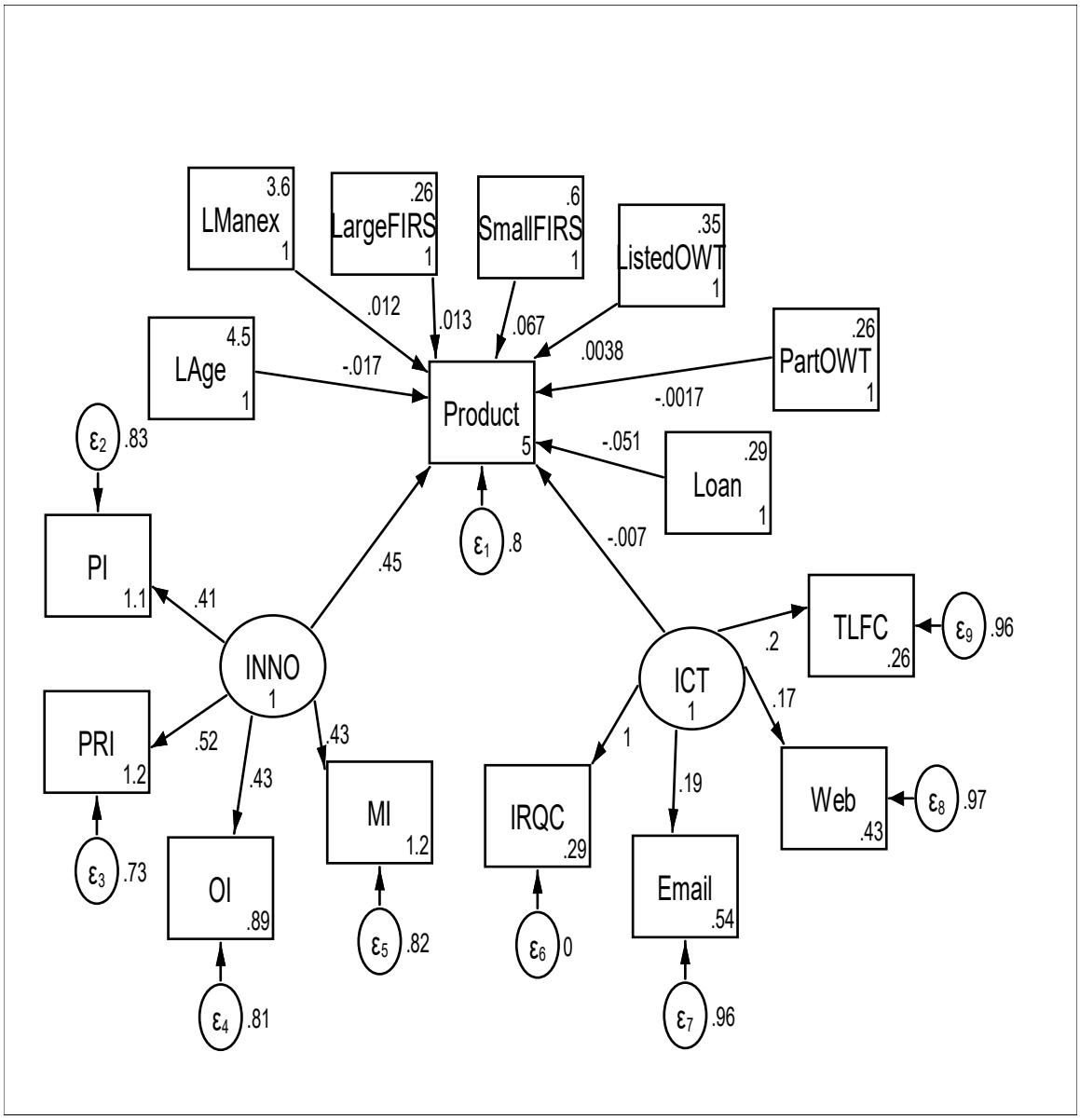
Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

At the manufacturing level, the path diagram coefficients from the SEM models in Figure 4.5 evidenced a positive driving structural impact between innovation and productivity, while ICT showed a negative impact on productivity of manufacturing firms. The result showed different effects for measures of innovation with process innovation (0.52) having more positive impact on productivity than organisational (0.43), marketing (0.43) and process innovation (0.41).

The results further showed that firm age had negative impact on productivity. The observed negative effect of firm age could mean that, firms delay their productive strategy after observing their sales in the markets.

In line with expectation, manager experience and firms' size (both large and small firms' size relative to medium firm) are positively impacting on productivity.

Figure 4.5. Standardised Estimated Coefficients and Path Analysis for the role of Innovation and ICT in Productivity of Manufacturing Firms



Source: Author Estimation from STATA 15.

4.4.1 The Role of Innovation and ICT in Exporting of Manufacturing Firms

The structural effect of innovation and ICT on exporting status of Nigerian manufacturing enterprise firms is depicted in Figure 4.6, while Table 4.11 evidenced good fits from the output estimation of the model. Specifically, the model shows an RMSEA value of 0.068 which is expected to be less than 0.06, TLI (0.913) and CD value of 0.953 value which is expected to be less than or equal to the critical value of 0.9. The estimated critical values depicts an exact model fit in our analysis.

Table 4.10: Fit indices for the Structural Model of Exporting of Manufacturing Firms

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	89.544 (26)		
p	0.000	< 0.05	Good Fit
RMSEA	0.068	<= 0.06	Exact Fit
CD	0.950	>= 0.50	Good Fit
TLI	0.904	< = 0.9	Exact Fit
CFI	0.934	< = 0.9	Exact Fit
SRMR	0.070	<= 0.95	Good Fit

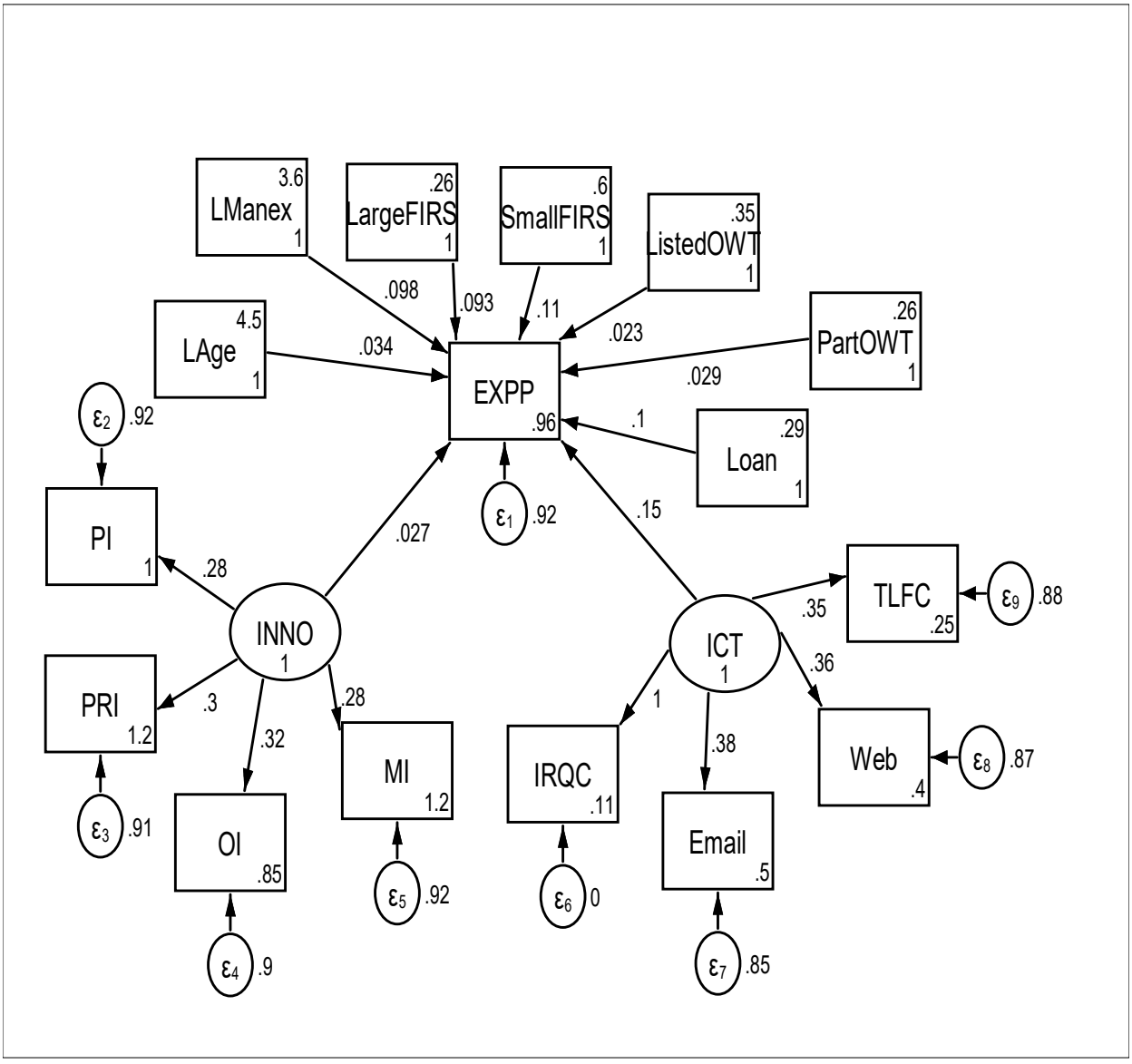
Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

The direct impact of innovation and ICT on exporting is positive and statistically significant at one per cent level. This implies that a unit increase in innovation and ICT would improve Nigerian manufacturing firms exporting activities by about 2.7 per cent and 15 per cent respectively.

The result showed different positive impact for measures of innovation and ICT on exporting. For innovation measures, organisational innovation (0.32) exhibit more impact on productivity, followed by process innovation (0.30), while both product (0.28) and marketing innovation (0.28) have similar impact on productivity of manufacturing firms. For the measures of ICT, email (0.38), web ownership (0.36) and technology licensed by foreign company (0.35) firms are positive impact determinants for productivity of manufacturing firms in Nigeria.

The above discussed results can be interpreted to mean that manufacturing firms' establishment of web presence and use of email that is coupled with organisational, process, product and marketing innovations will improve their exporting by encouraging their product ordering and products delivery at the global market. This observed result is similar to the work of Cuevas-Vargas, et al., (2016); Leon et al., (2016); Cassiman and Golovko (2007) and Chudnovsky, Lopez, and Pupato (2006) where it was established that innovation and the use of ICT substantially impact on the performance of businesses.

Figure 4.6: Standardised Estimated Coefficients and Path Analysis for the role of Innovation and ICT in Exporting of Manufacturing Firms



Source: Author Estimation from STATA 15.

4.4.2 The Link between Exporting and Productivity among Manufacturing Firms

This section considered only manufacturing enterprise firms in Nigeria. The measurement model assessment depicted a good model using the model fitness criterion for valuation based on the criteria presented in column 3 of Table 4.11, recommended in the SEM literature to determine the fit of structural path estimates. Given that as it is, the path coefficients of the SEM models in Figure 4.7, established that the standardised coefficients of the direct structural paths of the nexus between exporting and productivity are mostly in line with expectations in terms of sign, although they are not significant. The direct effect of exporting (EXPP) on productivity (Product) show a negative and insignificant impact of about one (1) per cent. This is similar with the results observed when dealing with aggregate firms. This implies that productivity improvement does not influence firms' decision to exporting. Thus, learning-by-exporting hypothesis does not hold among manufacturing enterprise firms, thus, further confirmed that Nigerian firms are less competitive (Adewuyi, et al., 2014).

Further, the direct effect of productivity on exporting also exhibit a negative impact of about three (3) per cent. This implies that a unit increase in productivity would lead firms to record less exporting activities. This results also negate the self-selection hypothesis among the manufacturing firms. Therefore, both learning by exporting and self-selection hypothesis does not hold among manufacturing enterprise firms in Nigeria. This findings followed same direction with the work of Sharma and Mishra, (2015) and Mez-Castillejo et al., (2010) where they also observed a weaker interlink between trade and productivity for Indian and Spain manufacturing firms respectively.

Table 4.11: Fit indices for the Structural Model of Exporting-productivity in Nigeria (Manufacturing Firms)

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)[35]	238.873(36)		
p	0.000	< 0.05	Good Fit
RMSEA	0.132	<= 0.06	Good Fit
CD	-0.463	>= 0.50	Good Fit
TLI	-0.639	< = 0.8	Good Fit
CFI	0.089	< = 0.8	Good Fit
SRMR	0.091	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

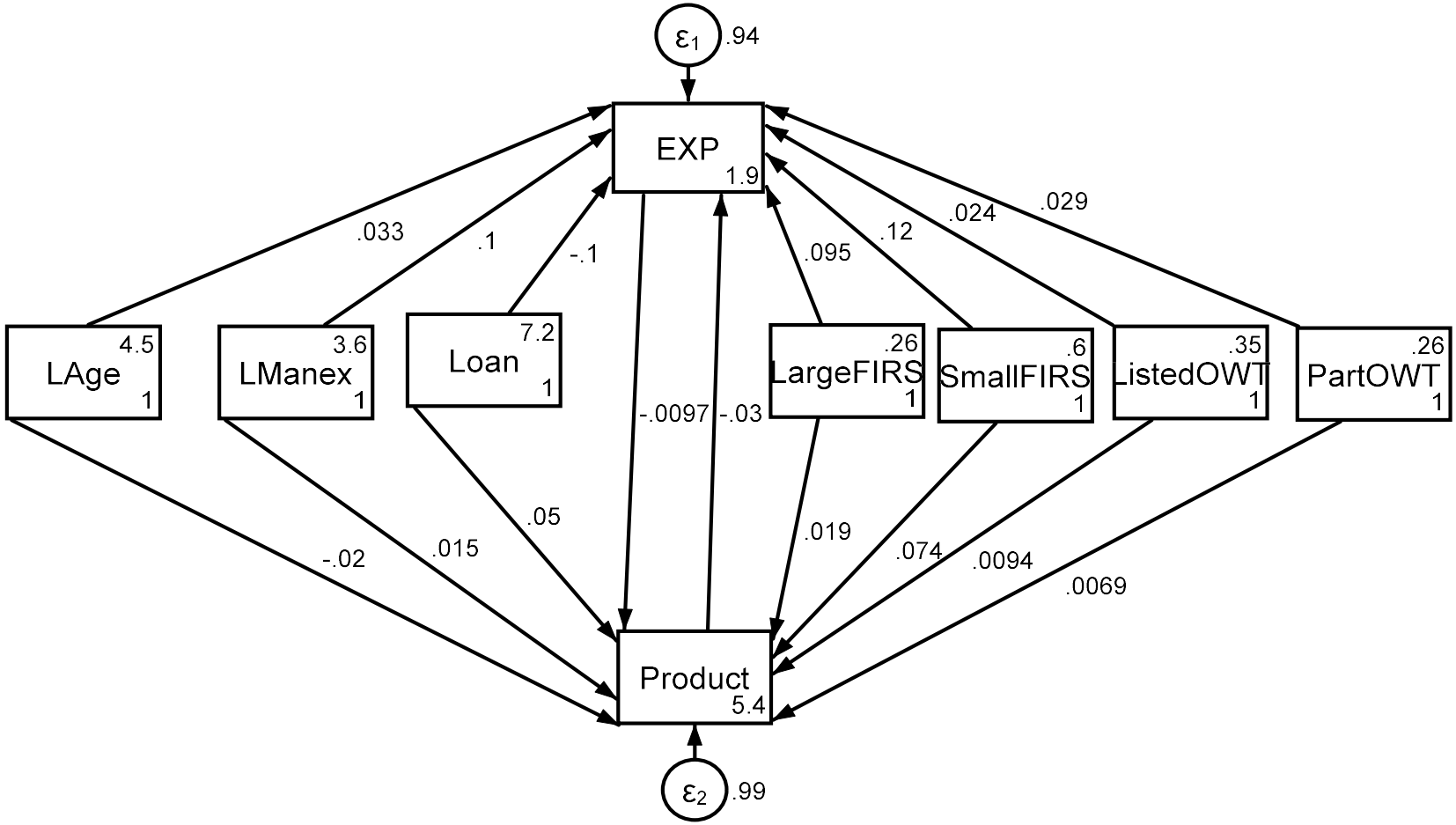
The direct effects of manager experience (MANEX), firm size (either large or small) and ownership form (either listed or partnership form of manufacture enterprise) showed

[35] Bentler-Raykov squared multiple correlation coefficient

positive effect on exporting and productivity of manufacturing enterprise firms. Therefore, manager experiences, firm size and ownership types are the factors aiding manufacturing firms' productivity and exporting in Nigeria. Firm age (AGE) exhibit a mixed result with both exporting and productivity of the manufacturing firms. The negative effect of firm age on productivity explained that new firms developed coupling tactic after they close monitor their productivity. Moreover, the positive effect of firm age (AGE) on exporting is weak – showing that a year increase in firm age will lead to about 3 per cent up ward shift in firm exporting (EXP).

Similar to the aggregate results, manufacturing loan access (LOAN) is also negatively related with both propensity to export and productivity of firms. This further confirmed that manufacturing enterprise firms have less access to loan or finances, which again appears to hinder firms' exporting as firms will not be able to afford both sunk and variables cost of entry into the exports market.

Figure 4.7: Standardised Estimated Coefficients and path analysis for Exporting-Productivity Link (Manufacturing Firms)



Source: Author estimation from STATA 15.

4.4.3 Mediating role of innovation and ICT in the link between Exporting and Productivity (Manufacturing Firms)

Table 4.12 and Figure 4.8 present the estimated goodness fit index and path diagram of the standardised SEM coefficients. The RMSEA (0.072), TLI (0.726) and CFI (0.788) showed evidence for a better fit. Also, the standardised root mean squared residual (SRMR) value of 0.077 is less than the critical value of 0.950 and thus, further established the strength of the model. Figure 4.8 present the SEM path for the mediating role of innovation and ICT in the exporting-productivity link among manufacturing firms.

Although, the exporting-productivity links is still negative, however, the mediating role of innovation and ICT is shown by the indirect path between innovation and ICT and exporting-productivity. For instance, the indirect effect of innovation (INNO) on Productivity (product) can be calculated by going through the exporting (INNO → EXPP → Product) paths.

Thus, the indirect mediating effect of innovation on productivity via exporting is negative (-0.022)*(0.036) = 0.0008 (0.08 per cent), while the indirect impact of INNO → Product → EXPP is negative at 0.002 = (0.039)*(0.050). Although, the impact is still negative, however, the role of innovation has helped these manufacturing firms to offset some of the negative impact – as reduced from 0.009 (0.9%) to 0.001 (0.1%) and 0.03 (3%) to 0.002 (0.2%). Thus, a role is observed for innovation in exporting-productivity link among Nigerian Manufacturing firms.

Similarly, the indirect mediating effect of ICT → Product → EXPP is negative at 0.001 = (0.031)*(-0.022), while the indirect impact of ICT → EXPP → Product is also negative at 0.001 = (0.14)*(-0.05). Although, the impact is still negative, however, the role of ICT is also observed for manufacturing firms – as reduced from 0.009 (0.9%) to 0.001 (0.01%) and 0.03 (3%) to 0.001 (0.1%). Thus, we can also conclude a role for ICT in exporting-productivity link among Nigerian Manufacturing firms.

Table 4.12: Fit indices for the Structural Model of the role of innovation and ICT usage in the link between Exporting-productivity (Manufacturing Firms)

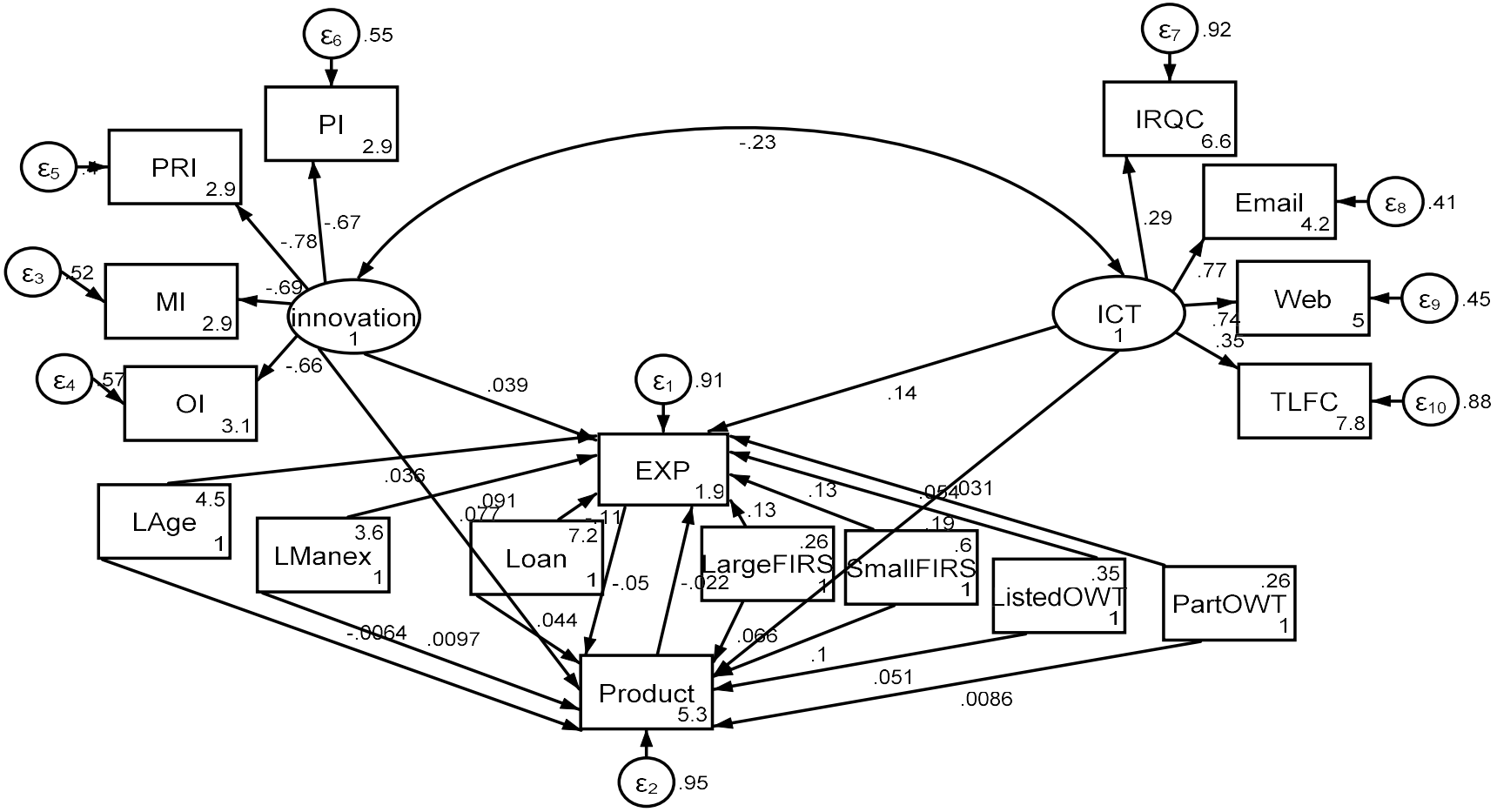
Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	333.502 (89)		
p	0.000	< 0.05	Good Fit
RMSEA	0.072	<= 0.06	Good Fit
CD	0.953	>= 0.50	Good Fit
TLI	0.726	< = 0.8	Good Fit
CFI	0.788	< = 0.8	Good Fit
SRMR	0.077	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

The observed results is similar to other studies like Greenhalgh et al. (1994) for UK firms; Roper and Love (2002) for UK and Germany manufacturing firms; Chudnovsky, et al., (2006) for Argentina manufacturing; Cassiman and Golovko (2007) for Spanish manufacturing firms; Commander, et al., (2011) for Brazil and India firms; Ceccobelli and Mancuso, (2012) for 14 OECD; Marzábal et al., (2016) for Galicia (Spain) firms and Leon et al., (2016) for companies in Basque country - where they individually established using different country sample size to obtained a positive relationship between the probability of exporting and innovation (product and process innovations). According to these studies firm innovation status is imperative of the positive exporting-productivity association among manufacturing firms.

This study also include other firm's characteristic such as age, size, loan access and manager experience (Figure 4.8). In the result, firm age, size, ownership and manager experience are determinants factors influencing the link between exporting-productivity links in Nigeria. The observed results in this study is similar to that of Babatunde, (2017) where it was established that firm age, labour productivity, access to loan and infrastructure are robust determinants of export propensity in Nigeria.

Figure 4.8: Standardised Estimated Coefficients and path analysis for the role of Innovation and ICT in Exporting-Productivity Link (Manufacturing Firms)



Source: Author estimation from STATA 15.

4.5 The Role of Innovation and ICT in Productivity of Services' Firms

This section of the study focuses on the influence of innovation and use of ICT on productivity of the services operating enterprise firms in Nigeria. After the structural estimation of the model, a RMSEA value of 0.059, TLI (0.933) and CD value of 0.955 are obtained and tabulated in Table 4.13. The overall fit indices showed that are model is of good fit and thus, the study proceed to interpret the derived estimated coefficients.

Table 4.13: Fit indices for the Structural Model of Productivity among Services Firms

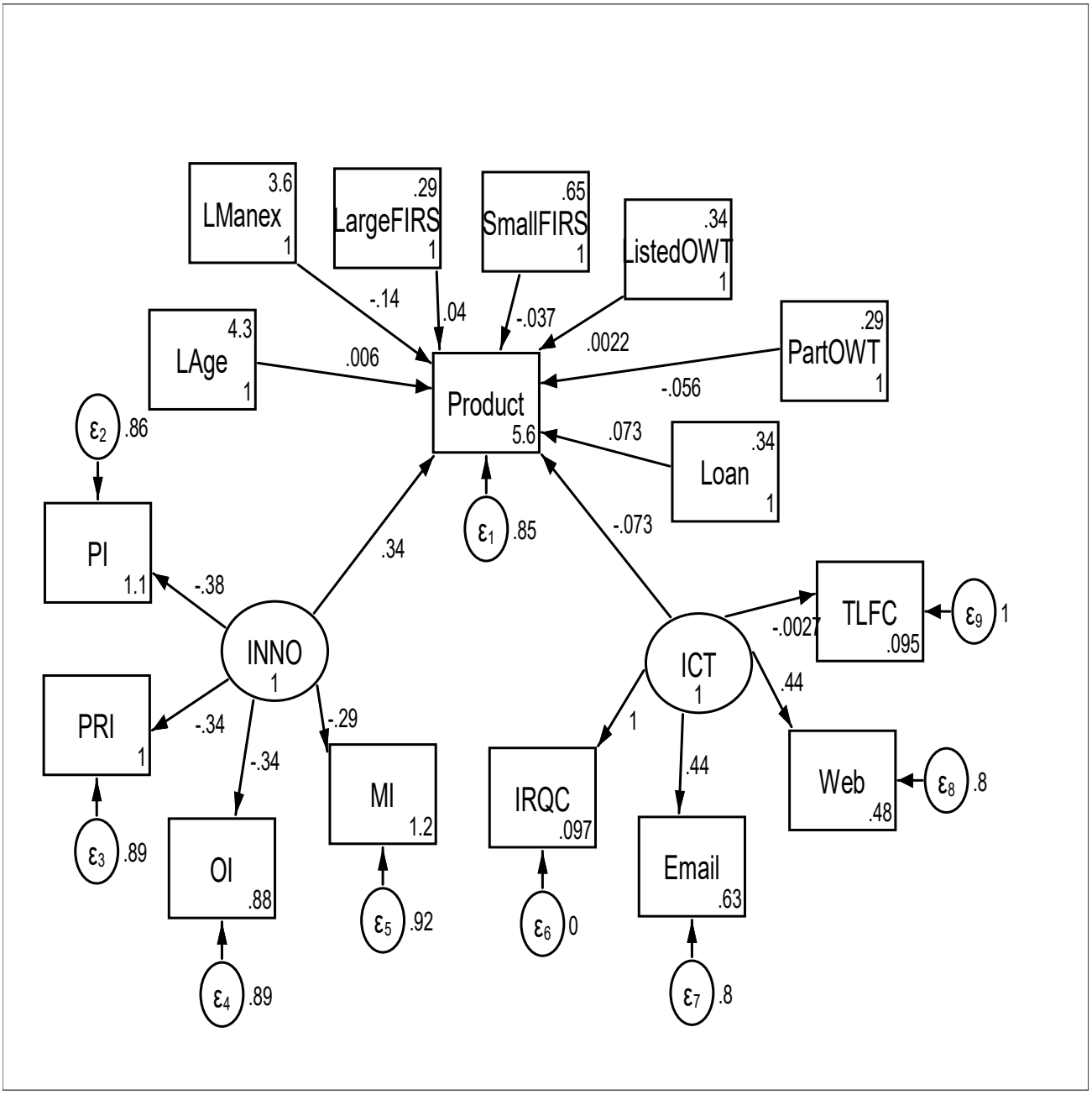
Index	Value	Criteria	Decision
Model $\chi 2$ (DF)[36]	76.765 (26)		
p	0.000	< 0.05	Good Fit
RMSEA	0.059	<= 0.06	Good Fit
CD	0.955	>= 0.50	Good Fit
TLI	0.933	< = 0.9	Good Fit
CFI	0.951	< = 0.9	Good Fit
SRMR	0.070	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

[36] Bentler-Raykov squared multiple correlation coefficient

The path coefficients of the SEM models in Figure 4.9 showed that the standardised coefficients of the direct structural path for innovation has a positive and significant relationship with productivity of the services enterprise firms in Nigeria, while ICT exhibit a negative impact. Precisely, the direct effect of innovation on productivity implies that increases in innovation activities of the service's firms would improve their productivity by about 34 per cent, while the use of ICT would decrease it by about 7.3 per cent. The observed result in this study is similar to that of other studies like Castiglione and Infante, (2014); Kusumaningtyas and Suwarto, (2015); Cuevas-Vargas, et al., (2016); Leon et al., (2016); Edquist and Henrekson, (2017b); Commander, et al., (2011) and Strobel, (2016) where they all observed a positive relationship between innovation and business performance in different countries. The observed negative result could mean that, an adoption or introduction of ICT can imply employee lay-off and few or even negative gains in productivity. This detected result is in line with the findings of Bresnahan et al. (2001) – where it was argued that, in the short run, the introduction of ICT may lead to employee lay-off, while in the medium to long-run, the successful adoption of ICT requires a re-shaping of internal workplace organisation and high skills to generate increase in productivity.

Figure 4.9: Standardised Estimated Coefficients and Path Analysis for the role of Innovation and ICT in Productivity of Services' Firms



Source: Author Estimation from STATA 15.

4.5.1 The Role of Innovation and ICT in Exporting of Services' Firms

The structural effect of innovation and ICT on exporting of Nigerian services enterprise firms is depicted in Figure 4.10, while Table 4.14 evidenced good fits from the output estimation of the model. Specifically, the model shows an RMSEA value of 0.060, TLI (0.931) and CD value of 0.950 that shows a good fit, since the estimated value gauge with the critical conditions.

Table 4.14: Fit indices for the Structural Model of Exporting-productivity in Nigeria

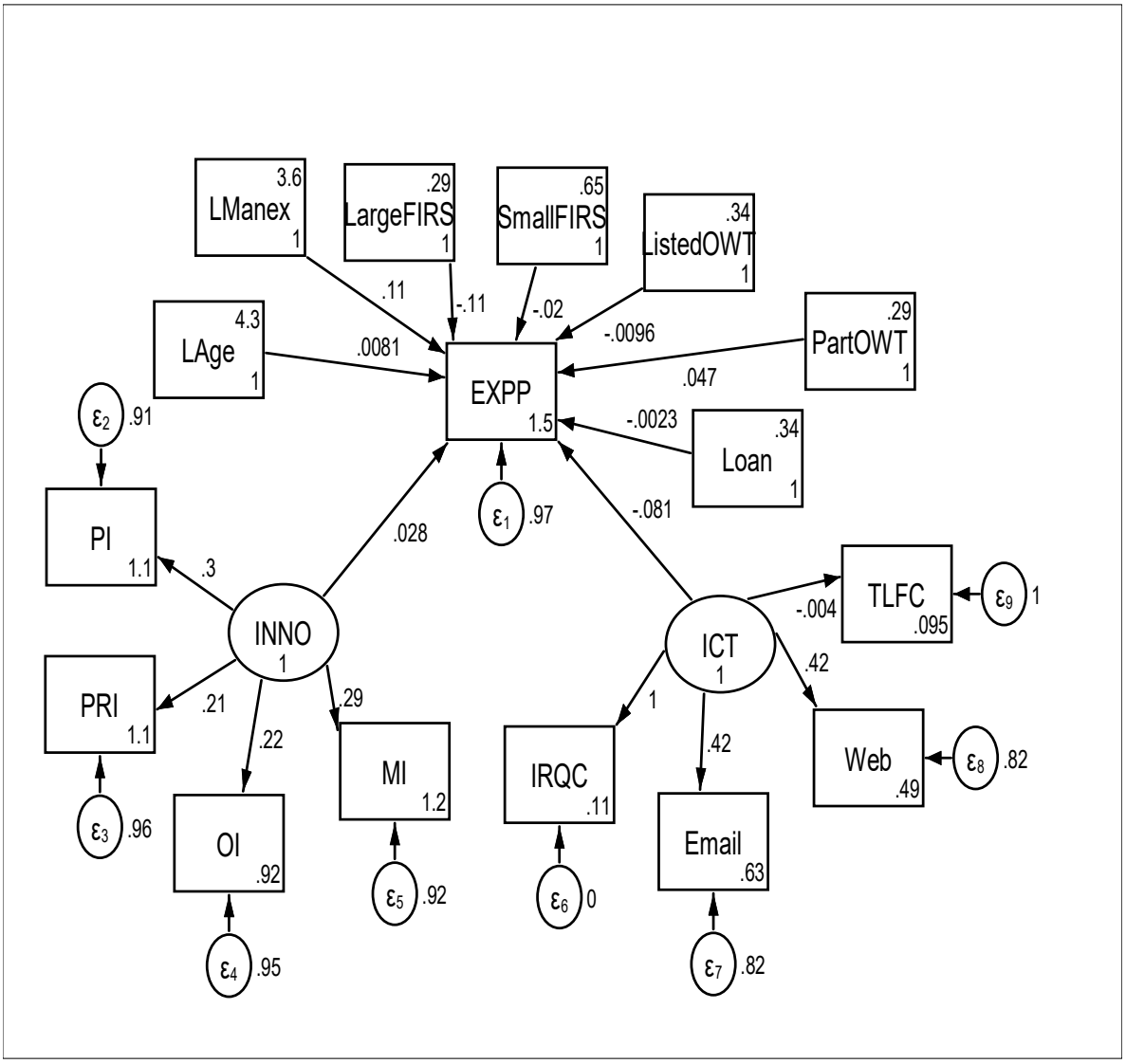
Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	78.465 (26)		
p	0.000	< 0.05	Good Fit
RMSEA	0.060	<= 0.06	Good Fit
CD	0.956	>= 0.50	Good Fit
TLI	0.931	< = 0.9	Good Fit
CFI	0.950	< = 0.9	Good Fit
SRMR	0.071	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

The direct effect of innovation on exporting (EXP) is positive. This implies that a unit increase in innovation activities such as process, product, marketing and organisational innovation among services enterprise firms would leads to about 2.8 per cent increase in services firms exporting. The observed result is similar to that of Dohse and Niebuhr, (2018); Azar, G., and Ciabuschi, F. (2017); Rodil, and Sánchez, (2016) and Tuhin, (2016) where new evidences supporting the existence of a positive relationship between innovation and exporting is observed. The study of Dohse and Niebuhr, (2018) advised that variety of innovation and marketing innovation are critical factors explaining firms' involvement in exporting.

Contrary to the above, result showed a negative impact between ICT and exporting of services firms. Thus, a unit increase in ICT would lead to about 8.1 per cent decrease in the level of services exporting firms. This result implies that entrepreneur establishment of web presence, technology licensed, quality certification and use of email decrease their exporting. The result here is not in line with the work of Cuevas-Vargas, et al., (2016) and Leon et al., (2016) where evidences support the existence of a positive relationship between firms' use of ICT and exporting. The result in this study should interpreted to mean that, in order to have substantive exporting improvements, it is not sufficient to use new ICT technologies as substitutes for the old ones (for instance sending an e-mail as opposed to postal mail), but it is necessary to change the organization of the whole productive process, taking advantage of the opportunities created by the new technologies.

Fig. 4.10. Standardised Estimated Coefficients and Path Analysis for the role of Innovation and ICT in Exporting of the services' firms



Source: Author Estimation from STATA 15.

4.5.2 The Link between Exporting and Productivity among Service Firms

As presented in Table 4.15, we detected a good fit in our model and thus proceed to estimates results in Figure 4.11. The path coefficients results evidence that both direct link between productivity and exporting are negative and insignificant, while firms age is positively related to both exports propensity and productivity of the service firm. Thus, increases in exports propensity of firms and productivity or sales would leads to less productivity and exports propensity of about 15 per cent and 7 per cent among Nigerian services enterprise firms. This results also follow the direction for both aggregate firms and manufacturing firms' analysis, where self-selection and learning by exporting hypotheses does not hold among firms. Thus, the submission that Nigerian enterprise firms is less competitive in international market is observed. This finding follows that of Sharma and Mishra, (2015) and Mez-Castillejo *et al.,* (2010).

However, the direct effects of manager experience on exporting status and productivity exhibit an inconsistence relationship (Figure 4.11). Manager experience aid exporting performance of services firms but it reduces their productivity level. This results is supported by Arrow, (1962) proposition that firms that continue to exporting, experience decline in productivity over time. According to him, the decline in productivity is explained if exporting firms experience a surge in productivity just before entry, in which case they might be expected to grow less slowly in subsequent periods.

Table 4.15: Fit indices for the Structural Model of Exporting-productivity among Service Firms

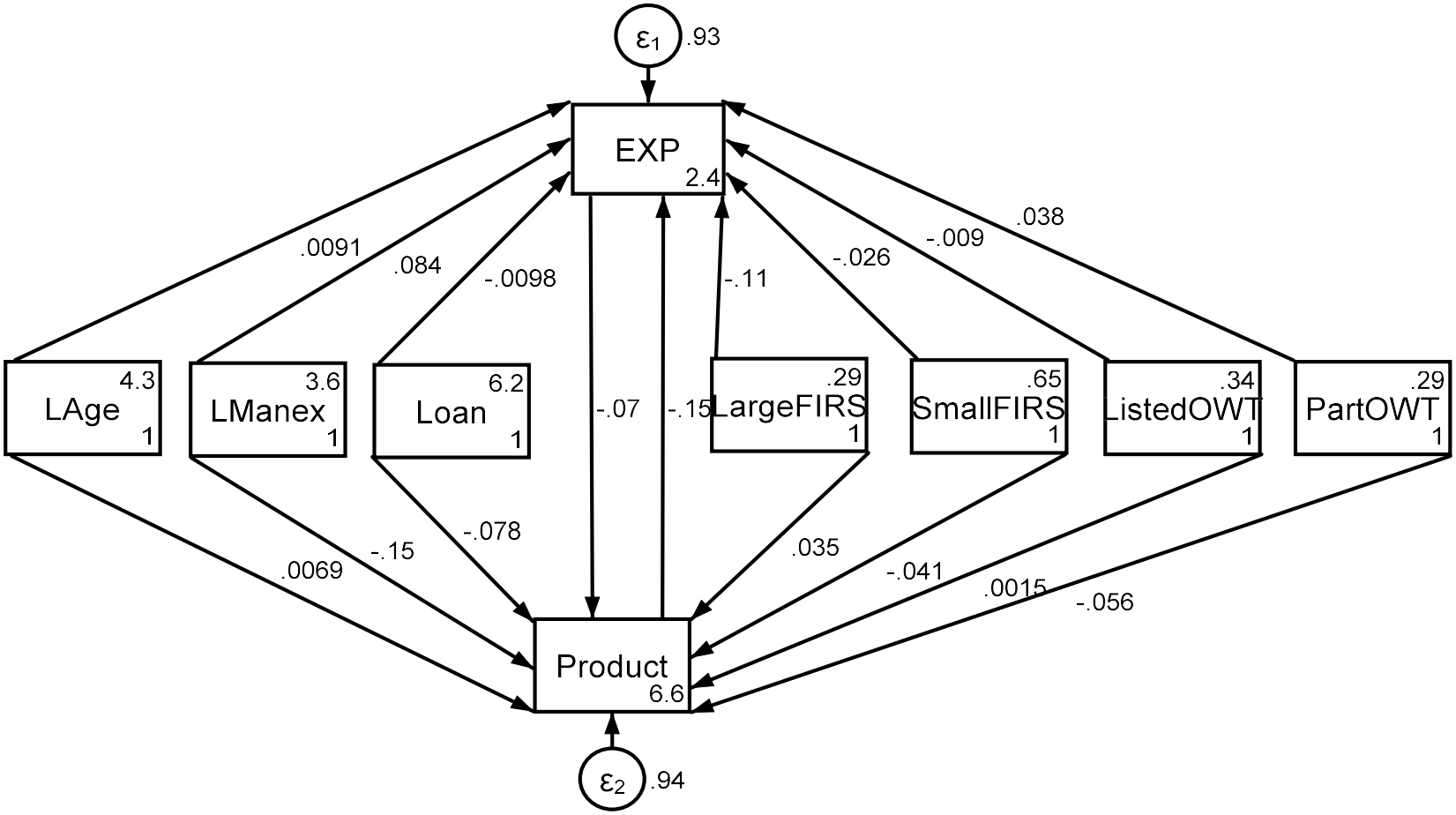
Index	Value	Criteria	Decision
Model $\chi 2$ (DF)[37]	63.427(15)		
P	0.000	< 0.05	Good Fit
RMSEA	0.001	<= 0.06	Good Fit
CD	0.074	>= 0.50	Good Fit
TLI	-0.639	< = 0.8	Good Fit
CFI	0.451	< = 0.8	Good Fit
SRMR	0.009	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. **Note**: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

[37] Bentler-Raykov squared multiple correlation coefficient

In the result, negative effect was also observed for loan access, which is contrarily to expectation. Loan access is found to be negatively related to both exporting status and productivity of firms (Figure 4.11). The result implies that services enterprise firms faced constraint in terms of loan access and thus, resort to decreasing productivity and exporting activities. These results are similar to other studies (Fowowe, 2017; Ayyagari, Demirguc-Kunt, and Maksimovic, 2008 and Dinh, Mavridis and Nguyen, 2012) that show that inadequate financing is a serious constraint that African firms face, and which adversely affects their performance. Hence, the results suggest the need for policy intervention to strengthen financial access through the financial market and other financial institutions to promote export and productivity activities.

Figure 4.11: Standardised Estimated Coefficients and path analysis for Exporting-Productivity Link (Service Firms)



Source: Author estimation from STATA 15.

4.5.3 Mediating role of innovation and ICT in the Link between Exporting and Productivity (Service Firms)

Premised on the estimated fit model in Table 4.16, the model goodness of fit indicators are good and show adequate indication to report and interpret the model estimates.

Figure 4.12 shows the SEM path for the mediating role of innovation and ICT in exporting-productivity link among service sector firms. Although, the exporting-productivity link is still negative, however, the self-selection hypothesis is confirmed with a positive link between productivity and exporting of service firms. Thus, increase in service firm productivity would lead to about 9.9 per cent increase in exporting, while a similar increase in exporting would dampen productivity by about 3.2 per cent. Further, the mediating role of innovation and ICT is witnessed by observing the indirect path between innovation and ICT and exporting-productivity. The indirect mediating effect of innovation on productivity via exporting is negative (-0.09)*(0.099) = 0.009 per cent, while the indirect impact of INNO → EXPP → Product is also negative at 0.002 = (0.075)*(-0.032). Although, the impact is still negative, however, the role of innovation has helped these service firms to offset some of the negative impact – as reduced from 0.07 (7%) to 0.009 (1%) and 0.15 (15%) to 0.002 (0.2%). Thus, we can conclude a role for innovation in exporting-productivity link among Nigerian service firms.

Similarly, the indirect mediating effect of ICT → Product → EXPP is positive at 0.005 = (0.052)*(0.099), while the indirect impact of ICT → EXPP → Product is negative at 0.004 = (0.13)*(-0.032). Although, the impact is still negative, however, the role of ICT is also observed for Service firms – as reduced from 0.07 (7%) to 0.005 (0.5%) and 0.15 (15%) to 0.004 (0.4%). Thus, we can also conclude a role for ICT in exporting-productivity link among Nigerian service firms.

The result is consistent with other studies like Jorgenson, et al., (2011); Adeoti, (2011); Ceccobelli, et al., (2012); Díaz-Chao, et al., (2015) and Marzábal et al., (2016) who noted that innovation and use of ICT are important determinant factors in explaining the positive link between exporting-productivity association among firms.

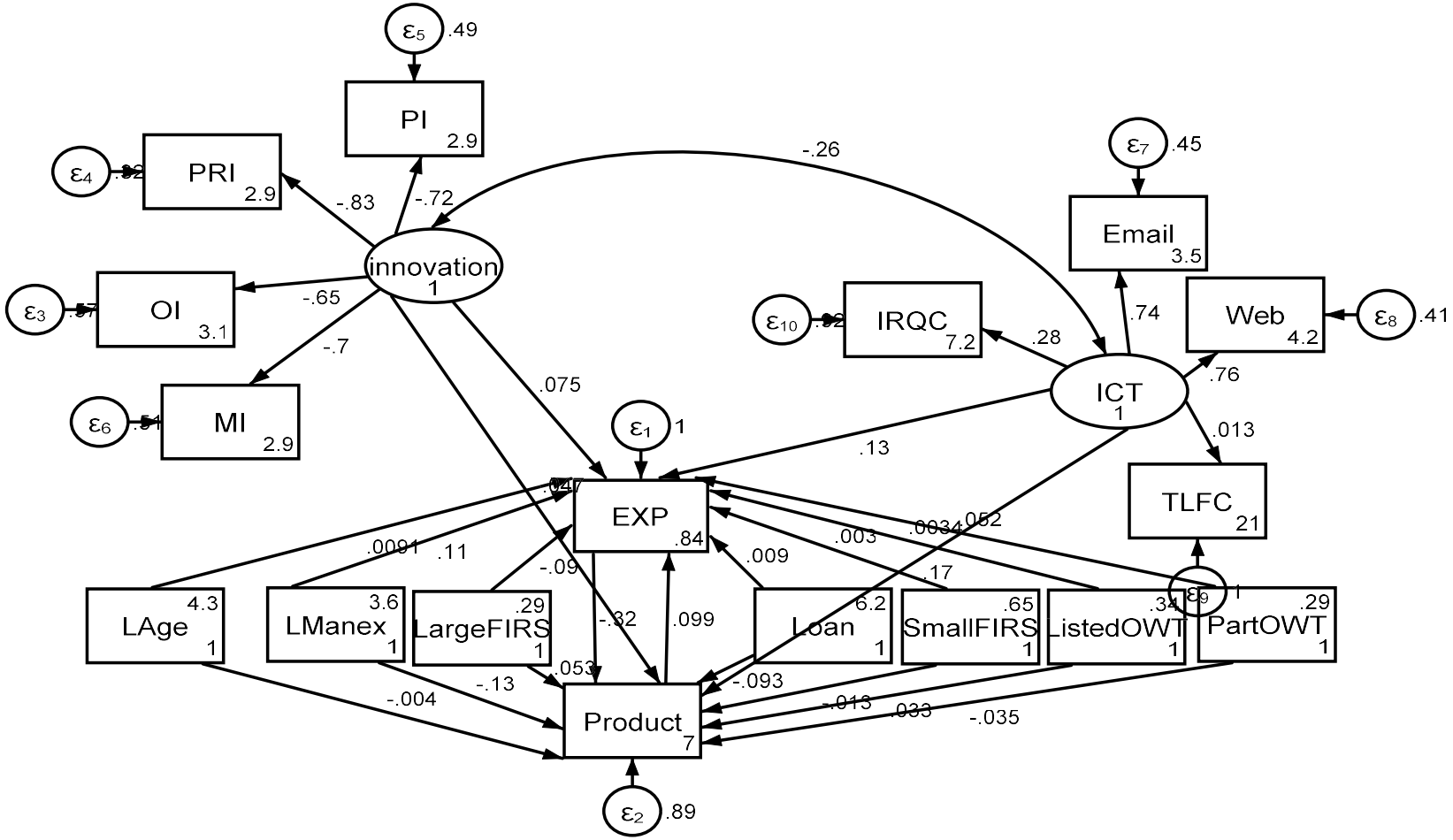
Table 4.16: Fit indices for the Structural Model of the role of innovation and ICT usage in the link between Exporting-productivity (Service Firms)

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	1352.225 (115)		
P	0.000	< 0.05	Good Fit
RMSEA	0.031	<= 0.06	Good Fit
CD	0.724	>= 0.50	Good Fit
TLI	0.193	< = 0.8	Good Fit
CFI	0.788	< = 0.8	Good Fit
SRMR	0.164	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. Note: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

For other control determinants, firm age, manager experience and financial loan access are also positively related to productivity of services enterprise firms. This suggest that a one percent increases in firm age, manager experience and access to finances would lead to about 0.9, 11 and 0.9 per cent improvement in productivity among services enterprise firms in Nigeria. This result coincide with that of Chaney, (2005) and Bellone et al., (2010), where it was reported that firms access to finance help to meet additional investment requirement and positively affects firms' productivity.

Figure 4.12: Standardised Estimated Coefficients and path analysis for the role of Innovation and ICT in Exporting-Productivity Link (Service Firms)



Source: Author estimation from STATA 15.

4.6 The Role of Innovation and ICT in Productivity of Exporting Firms

This section of the study focuses on the influence of innovation and use of ICT on productivity of exporting enterprise firms in Nigeria. After the structural estimation of the model, a RMSEA value of 0.062, TLI (0.916) and CD value of 1.000 are obtained and tabulated in Table 4.17. The overall fit indices showed that the model is good and thus, the study proceed to interpret the derived estimated coefficients.

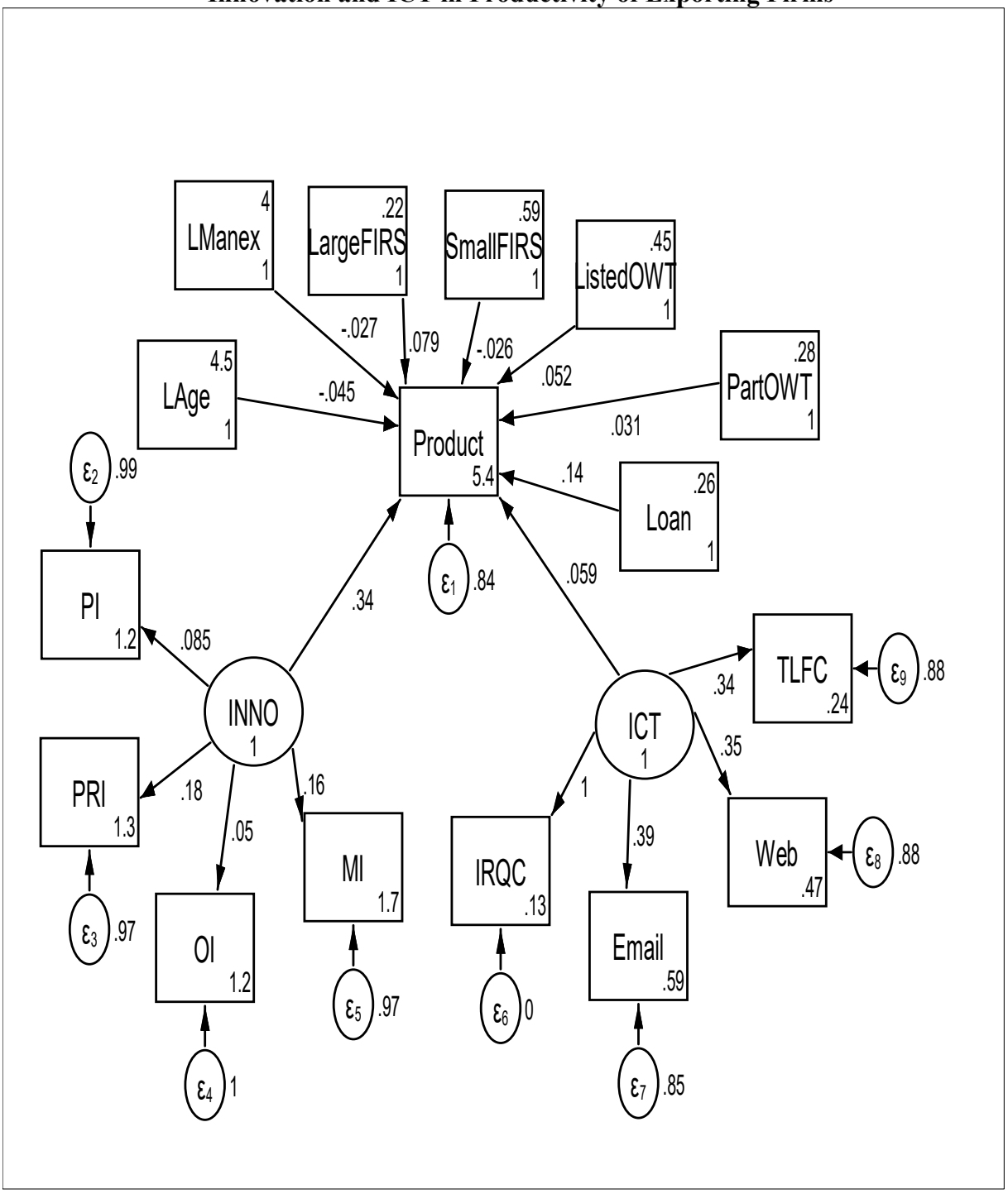
Table 4.17: Fit indices for the Structural Model of Productivity among Exporting Firms

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	50.944 (26)		
p	0.000	< 0.05	Good Fit
RMSEA	0.062	<= 0.06	Good Fit
CD	1.000	>= 0.50	Good Fit
TLI	0.916	< = 0.9	Good Fit
CFI	0.939	< = 0.9	Good Fit
SRMR	0.067	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. Note: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

Figure 4.13 depicted the structural path coefficients of the SEM model. The result showed that the direct structural paths for innovation and ICT has positive impact on productivity. Indeed, innovation improve productivity of exporting firms by about 34 per cent, while the use of ICT improves it by about 5.9 per cent. Thus, exporting firms' involvement in innovation (marketing, product, process and organisational) play more influencing role on productivity than their use of ICT. This observed results is akin with the study of Strobel, (2016); Cuevas-Vargas, et al., (2016); Leon et al., (2016); Kusumaningtyas and Suwarto, (2015) and Castiglione and Infante, (2014) where they all observed a positive relationship between innovation, ICT and business performance in different countries.

Figure 4.13: Standardised Estimated Coefficients and Path Analysis for the role of Innovation and ICT in Productivity of Exporting Firms



Source: Author Estimation from STATA 15.

4.6.1 The Role of Innovation and ICT in Exporting (Exporting' Firms)

The structural effect of innovation and ICT on exporting of exporting firms is depicted in Figure 4.13, while Table 4.18 evidenced good fits from the output estimation of the model. Specifically, the model shows an RMSEA value of 0.060, TLI (0.931) and CD value of 0.950 that shows a good fit, since the estimated value gauge with the critical conditions.

Table 4.18: Fit indices for the Structural Model of Exporting-productivity in Nigeria

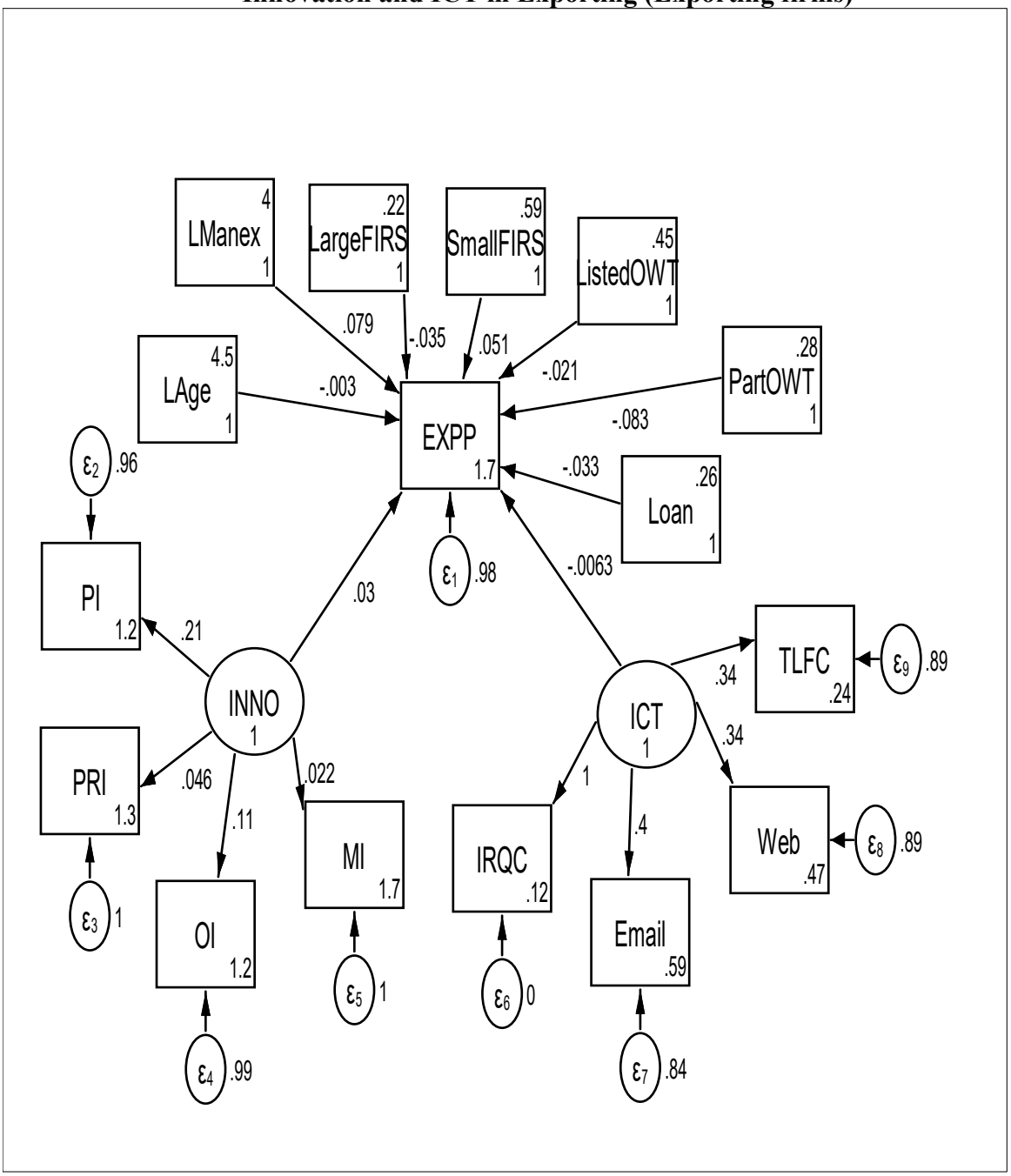
Index	Value	Criteria	Decision
Model χ2 (DF)	78.465 (26)		
p	0.000	< 0.05	Good Fit
RMSEA	0.060	<= 0.06	Good Fit
CD	0.956	>= 0.50	Good Fit
TLI	0.931	< = 0.9	Good Fit
CFI	0.950	< = 0.9	Good Fit
SRMR	0.071	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. Note: χ2 (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

The direct effect of innovation on exporting is positive, while the impact of ICT on exporting is negative. This implies that a unit increase in innovation activities (process, product, marketing and organisational) among services firms would lead to about 3 per cent increase in exporting, while a similar increase in ICT will reduce exporting by less than 1 per cent. The observed result is similar to that of Dohse and Niebuhr, (2018); Azar, G., and Ciabuschi, F. (2017); Rodil, and Sánchez, (2016) and Tuhin, (2016) where new evidences support the existence of a positive relationship between innovation and exporting are noted.

Result on firm age and loan access exhibit a negative relationship and thus, a year increase in firm age would lead to about 0.3 per cent decrease in exporting. Further, manager experience showed a positive determinant influence on exporting.

Figure 4.14: Standardised Estimated Coefficients and Path Analysis for the role of Innovation and ICT in Exporting (Exporting firms)



Source: Author Estimation from STATA 15.

4.6.2 The Link between Exporting and Productivity among Exporting Firms

Contrary to other observed results and in line with expectation, the structural path coefficients results showed a positive link between productivity and exports propensity of enterprise firms, though not significant. This implies that an increase of one (1) per cent in productivity performance of exporting firms lead to about nine (9) per cent increase in exports propensity. This result need not be taken seriously as the coefficient is not significant and thus we cannot conclude for observing the self-selection hypothesis among exporting firms in Nigeria. The result also evidence that Large firm relative to Medium scale firms, Partnership and listed owned firms relative to sole proprietorship and access to finance has a positive influence on propensity of exports of exporting firms in Nigeria.

Moreover, the link between exports propensity and productivity is negative, while firms age, access to finance and manager experience has positive influence on propensity to exports of exporting firms in Nigeria. Thus, the Nigerian exporting enterprise firms are not competitive in international market is also observed for exporting firms. Although, the chi-square probability test and the Coefficient of determination (CD) are not of good fit as presented in Table 4.19, the study still proceed given that other measures of fitness of the model performed better.

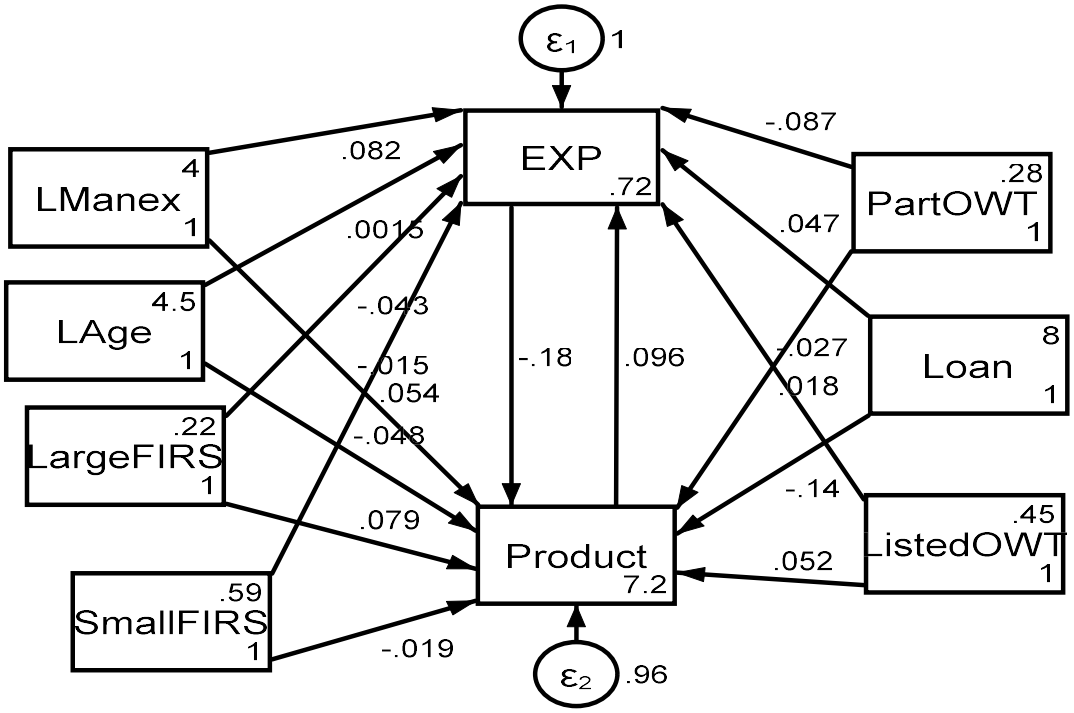
Table 4.19: Fit indices for the Structural Model of Exporting-productivity among Exporting Firms

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	17.482(15)		
p	0.291	< 0.05	Good Fit
RMSEA	0.004	<= 0.06	Good Fit
CD	0.024	>= 0.50	Good Fit
TLI	0.336	< = 0.9	Good Fit
CFI	1.000	< = 0.9	Good Fit
SRMR	0.001	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. Note: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

Similarly, the result on Figure 4.15 showed that access to finance is the main key influencing factor that determine the exports propensity and productivity of the exporting firms in Nigeria. This result is better linked to the government incentives provided to these firms to aid their participation in international market. It should be noted that Nigerian exporters within the export processing zone are entitled to several exports incentives to include exemption from all taxes, levies, duties and foreign exchange regulations within the zone, hundred per cent ownership and easy repatriation of foreign exchange investment proceeds - profits and dividends. This results point to the impact of government policies like Export Expansion Grant Fund, Export Development Fund, Export Adjustment Scheme Fund, Manufacture-In-Bond Scheme, Pioneer Status - Export Incentive and Export Processing Zones Incentives that are offered to encourage exporting among Nigerian exporting firms. This observed finding is similar with that of Kumarasamy and Singh (2018); Chor and Manova, (2012) and Amiti and Weinstein, (2011) where they noted that improvements in access to finance enable firms that are operating away from capital or major cities to enter export markets easily and thus, assist them to pay for both sunk and variable costs of entry into the exporting market.

Figure 4.15: Standardised Estimated Coefficients and path analysis for Exporting-Productivity Link (Exporting Firms)



Source: Author estimation from STATA 15.

4.6.3 Mediating role of innovation and ICT in Exporting- Productivity Link of Exporting Firms

Figure 4.16 shows the SEM path for the mediating role of innovation and ICT in exporting-productivity link among exporting firms. The direct effect of exporting on productivity has a negative relationship as obtained in Figure 4.15. Although, only the self-selection (productivity-exporting link) is still negative after the introduction of innovation and ICT, however, the mediating role of innovation and ICT is witnessed. For instance, the indirect mediating effect of innovation on productivity via exporting is positive at 0.002 per cent = (-0.002)*(-0.096), while the indirect impact of INNO → Product → EXPP is also positive at 0.3 per cent = (0.056)*(0.005). The impact has changed in sign and magnitude, thus, innovation play a role in mediating the link between exporting and productivity.

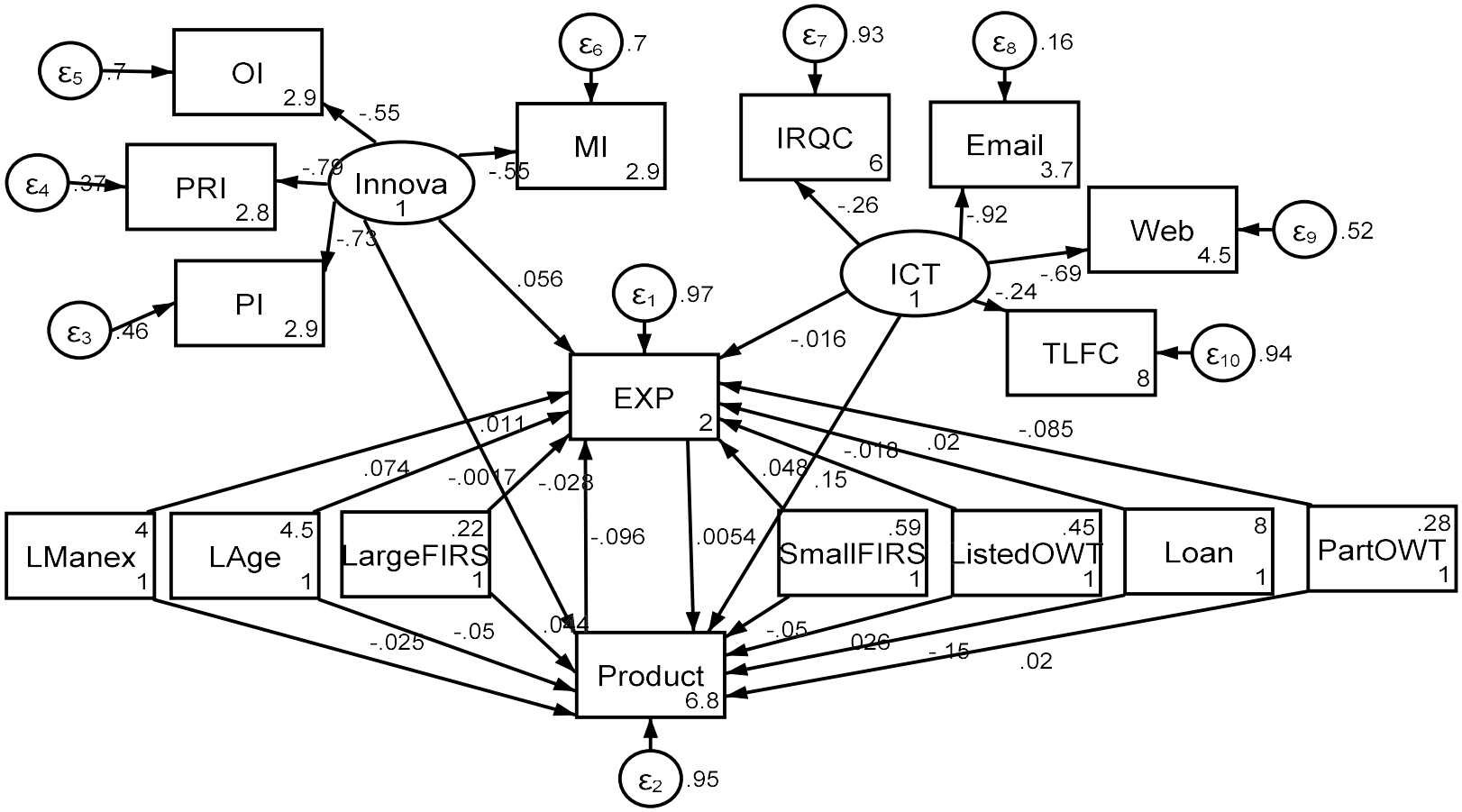
Similarly, the indirect mediating effect of ICT → Product → EXPP is negative at 0.014 = (0.15)*(-0.096), while the indirect impact of ICT → EXPP → Product is also negative at 8.64x10-4 = (-0.016)*(0.005). Although, the impact is still negative, however, the role of ICT is also observed for exporting firms – as reduced from 0.03 (3%) to 0.001 (1.4%) and 0.006 (0.6%) to 8.64x10-4 (0.08%). Thus, we can also conclude a role for ICT in exporting-productivity link among Nigerian exporting firms. This research result is reliable and its follow that of Jorgenson, et al., (2011); Adeoti, (2011); Ceccobelli, et al., (2012); Díaz-Chao, et al., (2015) and Marzábal et al., (2016) who renowned the importance of innovation and use of ICT in exporting-productivity link among firms.

Table 4.20: Fit indices for the Structural Model of the role of innovation and ICT usage in the link between Exporting-productivity (Exporting Firms)

Index	Value	Criteria	Decision
Model $\chi 2$ (DF)	460.773 (45)		
p	0.000	< 0.05	Good Fit
RMSEA	0.031	<= 0.06	Good Fit
CD	1.000	>= 0.50	Good Fit
TLI	0.193	< = 0.8	Good Fit
CFI	1.000	< = 0.8	Good Fit
SRMR	0.069	<= 0.95	Good Fit

Source: Author's Compilation from STATA 15. Note: $\chi 2$ (DF) = Chi-Square (Degree of Freedom); P = Probability value; RMSEA = Root mean squared error of approximation; CD = Coefficient of determination; TLI = Tucker-Lewis index; CFI = Comparative fit index; and SRMR = Standardised root mean squared residual.

Figure 4.16: Standardised Estimated Coefficients and path analysis for the mediating role of Innovation and ICT in Exporting-Productivity Link (Exporting Firms)



Source: Author estimation from STATA 15.

4.7 Mediating Effect of Innovation and ICT in Exporting - Productivity link of Firms

This section of the thesis exploit the link between exporting-productivity relationships, by re-grouping (see page 97) firms into the following.

- **a)** Firms using ICT only
- **b)** Firms without ICT
- **c)** Firms with innovation only
- **d)** Firms without innovation
- **e)** Firms with both ICT and Innovation
- **f)** Firms without both ICT and Innovation

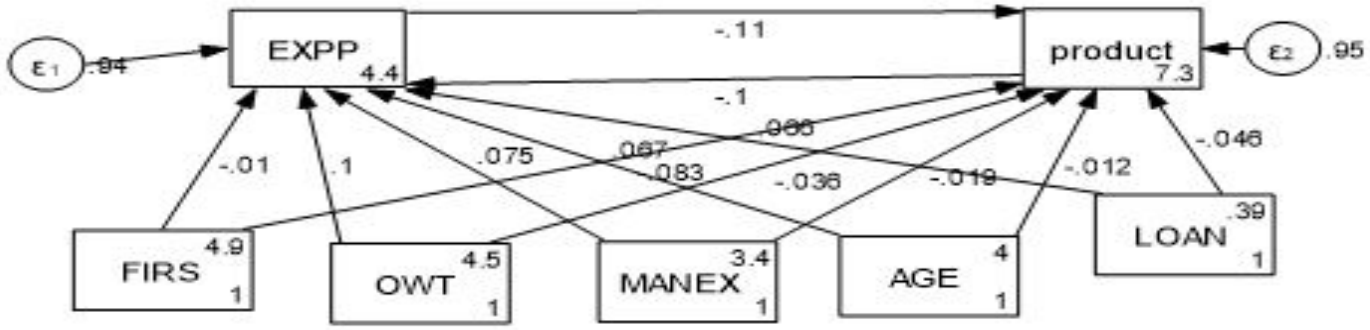
For the grouping – The researcher employed at least two major measures of ICT (Email and Website ownership) and two major measures of innovation (product and Process innovation). Therefore, any firms that indicated both measures are declared to be an ICT compliance and or innovating firms respectively.

4.7.1 Mediating Effect of ICT on Exporting-Productivity link of Firms

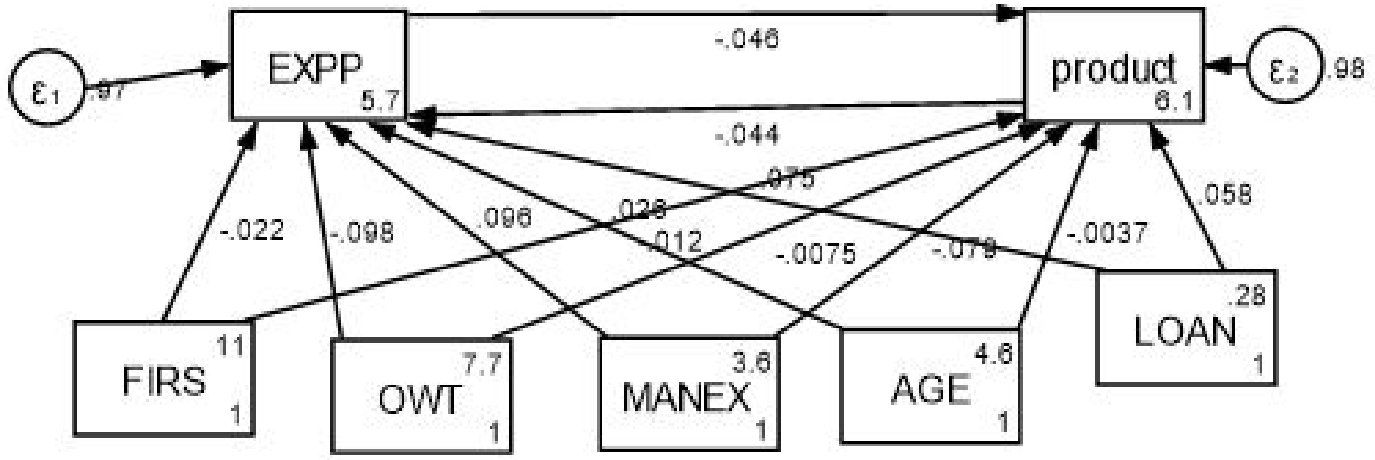
For the analysis and results, Figure 4.17 showed a consistent negative nexus for exporting-productivity link (EXPP → Product (0.11 and 0.046) and Product → EXPP (0.10 and 0.044)) for both firms using ICT and those without ICT (Panel A and Panel B in Figure 4.17 on page 174). For firms using ICT, the main determinants of exporting are ownership (0.10), manager experience (0.075), age of firms (0.067) and loan access (.066), while the productivity determinant is firm size (0.075). On the other hand, manager experience (0.096), firm age (0.012) and loan access (0.075) are the main determinants of exporting, while firm size (0.028), ownership (0.012) and loan access (0.058) are the determinants of productivity for firms without ICT (Panel B).

From the results, it can be concluded that the uses of ICT do not mediate exporting-Productivity link of Firms in Nigeria, as the coefficient of estimate improved from a negative value of 0.046 for EXPP → Product and 0.044 for Product → EXPP link to

negative 0.11 for EXPP → Product and 0.10 for Product → EXPP among firms without ICT and those with ICT.



Panel A: Firms using ICT ONLY



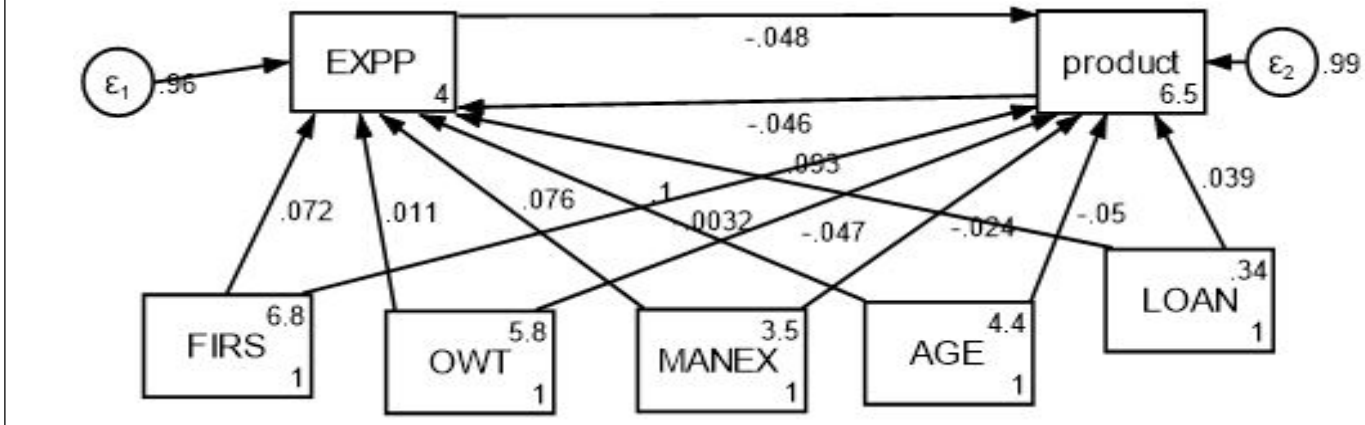
Panel B: Firms without ICT

Figure 4.17: Standardised Estimated Coefficients and Path analysis for the mediating role of ICT on Exporting-Productivity Link

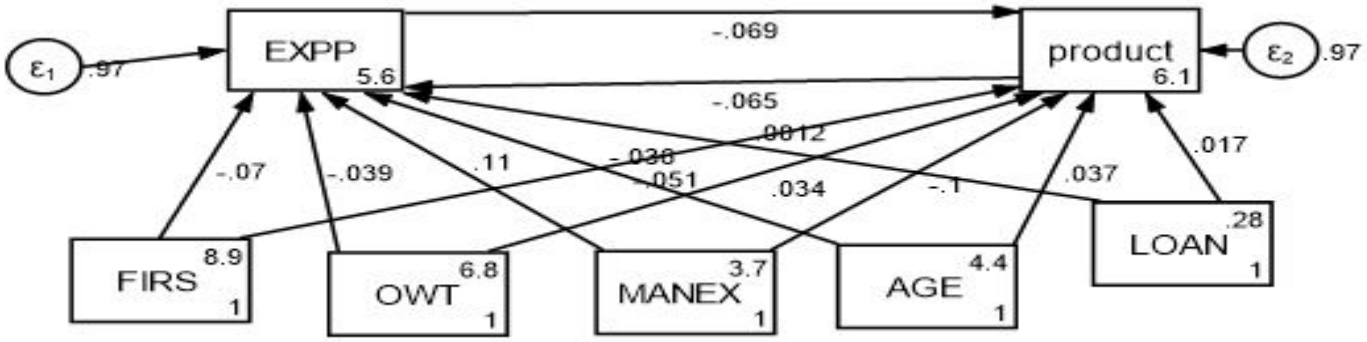
Source: Author estimation from STATA 15.

4.7.2 Mediating Effect of Innovation on Exporting - Productivity link of Firms

On the mediating effect of innovation on exporting-productivity link, the analysis and observed coefficients are presented in a path diagram in Figure 4.18. The result further showed a negative nexus for exporting-productivity link (EXPP → Product (0.048 and 0.069) and Product → EXPP (0.046 and 0.065)) for both firms undertaking Innovation and those without Innovation (Panel A and Panel B in Figure 4.18 on page 176). From the results, it can be concluded that innovation help mediate the exporting-productivity link of Firms in Nigeria, as the coefficient of estimate reduced from a negative value of 0.069 for EXPP → Product and 0.065 for Product → EXPP link to 0.048 and 0.046respectively among firms without Innovation and those with Innovation.



Panel A: Firms using Innovation



Panel B: Firms without Innovation

Figure 4.18: Standardised Estimated Coefficients and Path analysis for the mediating role of Innovation on Exporting-Productivity Link

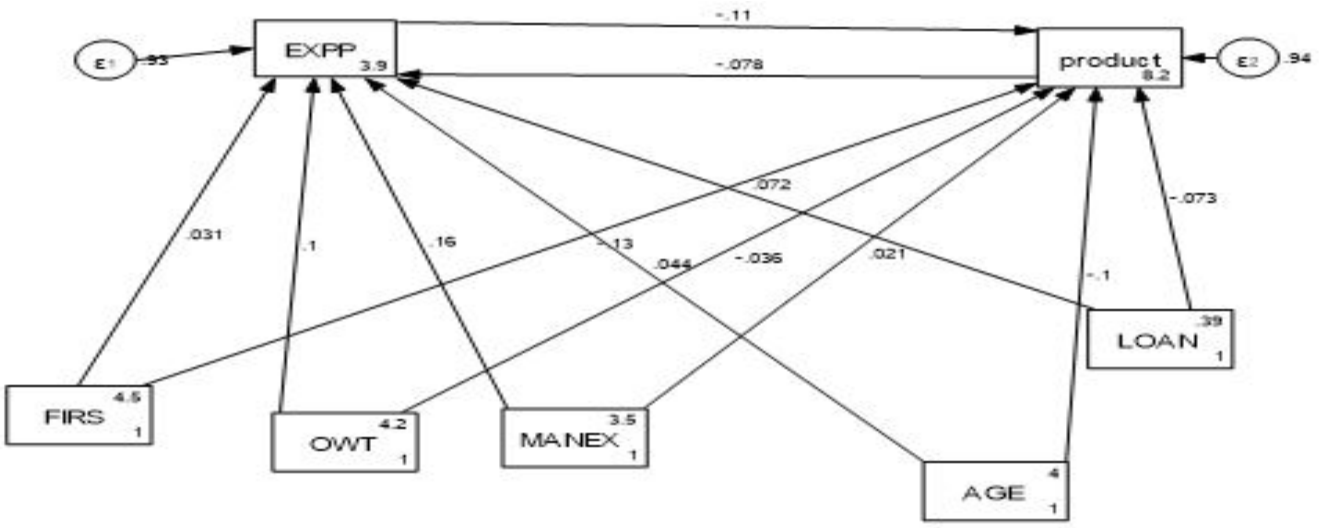
Source: Author estimation from STATA 15.

4.7.3 Mediating Effect of Both ICT and Innovation on Exporting-Productivity link of Firms

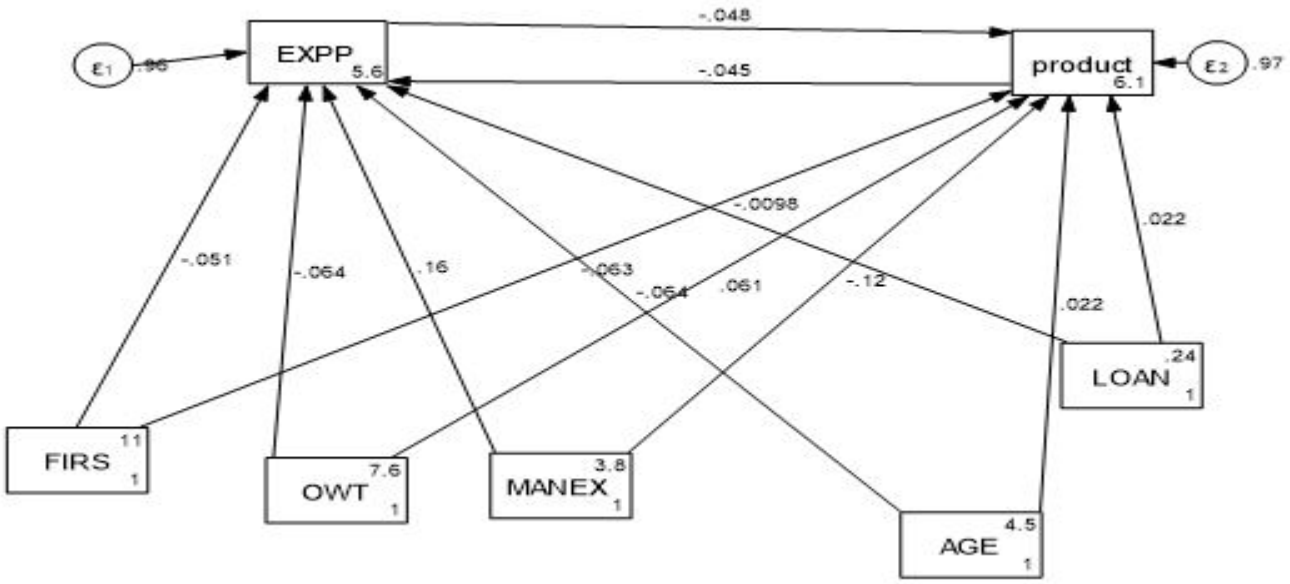
This sub-section is interested in the join mediating effect of ICT and innovation on exporting-productivity link. The analysis and observed coefficients are presented in a path diagram in Figure 4.19. The joint mediating effect ICT and innovation on exporting-productivity link (EXPP → Product (0.11 and 0.048) and Product → EXPP (0.078 and 0.045)) is found to be negative among firms (Panel A and Panel B in Figure 4.19 on page 178).

From the results presented in figure 4.19, it can be concluded that both ICT and innovation jointly do not help mediate the exporting-productivity link of Firms in Nigeria, as the coefficient of estimate increase from a negative value of 0.11 for EXPP → Product and 0.078 for Product → EXPP link to 0.048 and 0.045 respectively among firms with both ICT and Innovation and those with ICT and Innovation.

In panel A (Firms using both ICT and innovation), the main determinants of exporting are firm size (0.031), ownership (0.10), manager experience (0.16), and loan access (0.10), while the productivity determinant are Firm size (0.072), ownership type (0.044), and manager experience (0.021).



Panel A: Firms using both ICT and Innovation



Panel B: Firms without both ICT and Innovation

Figure 4.19: Standardised Estimated Coefficients and Path analysis for the mediating role of Both ICT and Innovation on Exporting-Productivity Link

Source: Author estimation from STATA 15.

4.8 What holds in Nigeria for the Role of Innovation and ICT in Exporting-Productivity Link?

The summary of results for the relationship under study is presented in Table 4.21 following each of the objectives analysed in the study. The first and second objectives, which has to do with the role of innovation and ICT on productivity and exporting is summarised in Table 4.21, while the third objective that underscore the mediating role of innovation and ICT in exporting-productivity link is summarised in the Table second part.

At the aggregate level, empirical results confirmed that innovation is positively related to productivity (35%), while ICT deterred it (1.8%). Also, firm age (-0.3%) negatively impact productivity, while loan access (2.1%) improve productivity. Further, innovation (2.8%) and ICT (2.7%) positively impact exporting, while firm age, access to loan and Small firm size (3.6%) relative to medium size firm are positive determinants of exporting among all firms. From the estimate, there is absence of learning by exporting and self-selection hypothesis among enterprise firms at the aggregate. The overall results showed a negative exporting-productivity links, however, the presence of innovation (8.1%) and ICT (2.0%) help firms offset the negative exporting-productivity links among firms.

For manufacturing firms, estimates show a positive impact of innovation on productivity (45.0%), while ICT showed a negative impact on productivity (1.0%), while innovation (2.7%) and ICT (15%) have a positive influence on exporting. Also at the manufacturing level, estimate support the absence of learning by exporting and self-selection hypothesis, while the role of innovation and ICT help in offsetting some of the negative impact – as reduced from 0.9% to 0.1% , 1% and from 3% to 0.2%, 0.1% for innovation and ICT respectively.

At the service firms' level also, estimates show a positive impact of innovation on productivity (34.0%) and exporting (2.8%), while ICT showed a negative impact on productivity (7.3%) and exporting (8.1%), while self-selection and learning by exporting hypotheses does not hold among firms. Innovation and ICT play a role by offsetting the negative link between exporting-productivity and thus, reduced from 7% to 1% and 0.5% and from 15% to 0.2% and 0.4% for innovation and ICT respectively, while firm age (9%), manager experience (11%) and financial loan access (0.9%) are the other positively determinants factor for productivity and exporting of services firms in Nigeria.

Table 4.21: Summary of Results

Sector	Role of innovation and ICT on Productivity		Role of innovation and ICT on Exporting	
	Innovation	**ICT**	**Innovation**	**ICT**
Aggregate Firms	+	-	+	+
Manufacturing Firms	+	-	+	+
Services Firms	+	-	+	-
Exporting Firms	+	+	+	-

The role of Innovation and ICT on the link between Exporting - Productivity of Nigerian Enterprise Firms

Sector	Learning by exporting Exporting ⟶ Productivity	Self-selection Productivity ⟶ Exporting	Mediating Role of Innovation and ICT
Aggregate Firms	-	-	YES
Other Determinants	Firm Age, Firm Size, Ownership Types and Manager experience		
Manufacturing Firms	-	-	YES
Other Determinants	Firm Size, Ownership Types and Manager experience		
Services Firms	_	_	YES
Other Determinants	Small firms (5 – 19) relative to medium (20 – 99) and Listed Firms relative to sole proprietorship		
Exporting Firms	_	+	YES
Other Determinants	Manager experience, loan access and Listed Firms relative to sole proprietorship		

Source: Author's compilation, 2019

For exporting firms, estimates showed positive impact of innovation (34.0%) and ICT (5.9%) on productivity (34.0%) and innovation (3.0%) is positively related to exporting, ICT (1.0%) showed a negative impact, while self-selection and learning by exporting hypotheses does not also hold among exporting firms. Innovation and ICT play a role by

offsetting the negative link between exporting-productivity, with a positive link established at 0.2% and 0.3%, while the effect is reduced from 3% to 1.4% and from 0.6% to 0.08% for ICT. The main observed determinants factors for exporting-productivity links are firm age (7.4%), manager experience (1.1%) and financial loan access (2.0%) for productivity and exporting of services firms in Nigeria.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

This chapter presents the summary, conclusion and recommendation to the study. Finally, areas of possible future research and the study limitations are discussed.

5.1 Summary of Findings

The main objective of this study is to examine the role of innovation and ICT in exporting-productivity link among Nigerian firms. The specific objectives includes: the impact of innovation and ICT on productivity and exporting of firms at aggregate and sectoral levels, while also analysing the mediating effect of innovation and ICT in exporting-productivity relationship at aggregate and sectoral levels. In order to achieve these specific objectives, this study provides an extension of the new-new trade theory by incorporating innovation and ICT usage variables in the free-market entry model. This study employed structural equation model (SEM) to investigate the link between exporting and productivity, while emphasizing the role of innovation and ICT.

This study checks the characteristics of the data set employing exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) with almost all our measures of innovation and ICT having strong association with their underlying latent construct. Similarly and following the usual approach of measurement model assessment, this study used some index criteria to evaluate the goodness of fit including Root mean square error of approximation (RMSEA), Coefficient of determination (CD), Tucker-Lewis index (TLI), Comparative fit index (CFI) and Standardised root mean squared residual (SRMR). The results at four level of analyses (aggregate, manufacturing, services and exporting firms) evidenced good model fits.

At the aggregate level, empirical results confirmed that innovation is positively related to productivity (35%), while ICT deterred it (1.8%). Also, firm age (-0.3%) negatively impact productivity, while loan access (2.1%) improve productivity. Further, innovation (2.8%) and ICT (2.7%) positively impact exporting, while firm age, access to loan and Small firm size (3.6%) relative to medium size are positive determinants of exporting among all firms. From the estimate, there is absence of learning by exporting and self-selection hypothesis among enterprise firms at the aggregate. The overall results showed a

negative exporting-productivity links, however, the presence of innovation (8.1%) and ICT (2.0%) help firms to offset the negative exporting-productivity links.

For manufacturing firms, estimates showed positive impact of innovation on productivity (45.0%), while ICT (1.0%) showed a negative impact on productivity and innovation (2.7%) and ICT (15%) have positive influence on exporting. Also, estimate support the absence of learning by exporting and self-selection hypothesis, while the role of innovation and ICT help in offsetting some of the negative impact – as reduced from 0.9% to 0.1% and 1% for innovation and from 3% to 0.2% and 0.1% for ICT respectively.

At the service firms' level, estimates showed positive impact of innovation on productivity (34.0%) and exporting (2.8%), while ICT showed a negative impact on productivity (7.3%) and exporting (8.1%). The self-selection and learning by exporting hypotheses does not hold among service firms. Similarly, innovation and ICT reduced the negative exporting-productivity links from 7% to 1% and 0.5% for innovation and from 15% to 0.2% and 0.4% for ICT respectively, while firm age (9%), manager experience (11%) and financial loan access (0.9%) are the other positively determinants factors for productivity and exporting of services firms in Nigeria.

For exporting firms, estimates showed positive impact of innovation (34.0%) and ICT (5.9%) on productivity (34.0%), innovation (3.0%) is positively related to exporting, ICT (1.0%) showed a negative impact, while self-selection and learning by exporting hypotheses does not also hold among exporting firms. Innovation and ICT play a role by offsetting the initial negative exporting-productivity link, with a positive link established at 0.2% and 0.3%, while the effect is reduced from 3% to 1.4% and from 0.6% to 0.08% for ICT. The main observed determinants factors for exporting-productivity links are firm age (7.4%), manager experience (1.1%) and financial loan access (2.0%) for productivity and exporting of services firms in Nigeria.

5.2 Policy Recommendation

Following the findings from this study, the subsequent recommendations are advice;

i. As determined, a negative relationship exist between exporting – productivity and or productivity - exporting among Nigerian enterprise firms. Therefore, there is

need to further promote export promotion policy toward stimulating exports in Nigeria. The current export incentives (Development Fund and Export Expansion Grant) should be extended to cover enterprise firms. Further, policies that increase labour productivity (through investment in capital, physical and/or human) and profitability of firms should be encouraged.

ii. It was also observed that negative relationship exist between loan access and exporting - productivity link in Nigeria. Therefore, it is important for Nigerian government to formulate policies that will compel commercial banks to relax their restrictive regulations and operations which discourage borrowing and offer less credit facilities for enterprise firms. The government should re-introduce and enforce the mandatory minimum credit allocation by banks to enterprise firms in the Annual Monetary Policy Circular and Guidelines. This in particular, will help Nigerian firm's self-select and learn-by-exporting; as both are not mutually exclusive possibilities. Therefore, high-productivity firms will be able to afford the sunk and variable costs of entry to export markets and, in principle; they will continue to improve their productivity as a result of their exposure to exporting.

iii. Also, the result established that innovation and ICT usage matters for both exporting and productivity. Thus, there is need for more supports for policy intervention in terms of subsidies to encourage firms to innovate and engage in the use of ICT. There is need for firms to do more in terms of innovation and use of ICT.

iv. Further, more resources should be allocated to funding and support internal firm innovation and use of ICT instead of promoting external innovation and ICT comprehensive policy.

v. Policy should be expanded to cover sector innovation policies, while efforts should also be directed to linking industrial trade and innovation (technology) policies.

vi. Lastly, corporate managers should act as a matter of need by engage in training and re-training staffs and managers in order to improve on their experiences, so as to promote productivity and hence exporting decisions of firms.

5.3 Conclusion

This study was set out to examine the role of innovation and ICT in exporting-productivity link of firms in Nigeria. It utilizes the technique of cross-sectional survey analysis to assess both the structural impact of innovation and ICT on productivity and exporting of Nigerian enterprise firms. The study employed a unique 2014 enterprise firm level survey that features innovation and ICT characteristics of enterprise firms across the country. Therefore, this study concluded that both learning by exporting and self-selection hypotheses does not hold in Nigeria. Also for the entire model, it was discovered that innovation and ICT plays a very important role in increasing productivity and exporting status of enterprise firms in Nigeria.

5.4 Study Limitations

5.4.1 Limitations of the Study

Similar studies that have been done identified problem such as variables restrictions on analysis and unavailability of registered firms' data as the main significant challenges faced. Conversely, the availability of the enterprise survey data provided us with information on exporting, productivity innovation and ICT level of firms in Nigeria.

5.4.2 Limitations to the Study

In the course of carrying out this research work, some challenges were encountered. The first problem encountered has to do with the dataset used which does not contains information on firms market access, internet broadband subscription, mobile phone, board size, number of auditors and independence of directors - which prevents us from investigating how these indicators would help moderate the relationship under study. Also, was the problem of finances, which limit the researcher from undertaking personal survey to further buttress the findings of this study. However, all these hindrances did not in any way affect the validity of the study for the purpose for which it was carried out.

5.5 Advise for Further Research

In view of the limitation of this study, further research is still needed to ascertain whether or not the findings of this study can be generalized to other countries (especially within West African Countries) or whether the findings are only peculiar to Nigeria. Future

research should consider other variables like firms corporate governance, institutions and geographical locations as well. This study examine the link between exporting and productivity, while also investigating the mediating role of innovation and ICT in Nigeria. While this approach is useful, a single-country study is nevertheless limited by its scope compared with comparative international analysis. Thus, further research should be extended to multiple-country/global studies that will include other identified variables.

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Appendix 1: Computed Productivity index of firms

S/N	idstd	Sector	Firm Size	TFP
1	586989	Services	Medium	0.171
2	586990	Services	Small	0.246
3	586991	Manufacturing	Small	0.121
4	586992	Manufacturing	Small	0.245
5	586993	Manufacturing	Small	1.689
6	587006	Services	Small	0.285
7	587007	Services	Medium	0.145
8	587015	Manufacturing	Small	0.183
9	587018	Services	Small	0.188
10	587019	Services	Medium	0.219
11	587023	Manufacturing	Small	0.192
12	587028	Services	Small	0.163
13	587029	Manufacturing	Medium	0.259
14	587032	Services	Medium	0.208
15	587034	Manufacturing	Small	0.364
16	587036	Services	Medium	1.862
17	587037	Manufacturing	Small	0.073

18	587045	Manufacturing	Small	0.265
19	587048	Manufacturing	Small	0.223
20	587049	Services	Small	0.132
21	587050	Manufacturing	Small	0.275
22	587052	Services	Medium	0.09
23	587054	Services	Small	0.169
24	587056	Services	Small	0.179
25	587058	Services	Medium	0.264
26	587059	Services	Small	0.11
27	587064	Services	Large	0.049
28	587065	Manufacturing	Small	0.245
29	587066	Manufacturing	Small	0.292
30	587068	Services	Small	0.124
31	587069	Manufacturing	Small	0.262
32	587078	Services	Large	1.72
33	587082	Manufacturing	Medium	0.103
34	587085	Services	Small	0.149
35	587089	Manufacturing	Small	1.732
36	587091	Services	Medium	0.202
37	587098	Manufacturing	Small	0.289
38	587101	Manufacturing	Small	0.258
39	587103	Manufacturing	Medium	0.202
40	587111	Services	Small	0.282
41	587116	Services	Medium	0.199
42	587118	Services	Small	0.186
43	587121	Services	Medium	0.27
44	587125	Services	Small	0.203
45	587127	Services	Large	0.314
46	587129	Manufacturing	Medium	0.133
47	587130	Manufacturing	Small	0.098
48	587132	Manufacturing	Small	1.683
49	587133	Services	Small	0.147
50	587134	Services	Large	0.237
51	587145	Services	Medium	0.147
52	587146	Manufacturing	Medium	1.687
53	587147	Manufacturing	Medium	1.672
54	587149	Services	Medium	0.144
55	587150	Manufacturing	Small	1.654
56	587151	Services	Medium	0.254
57	587162	Services	Small	1.922

58	587166	Manufacturing	Small	0.16
59	587168	Manufacturing	Small	0.165
60	587172	Services	Small	0.121
61	587174	Manufacturing	Medium	1.716
62	587176	Services	Large	0.241
63	587182	Manufacturing	Small	0.246
64	587184	Services	Medium	0.197
65	587186	Services	Medium	0.204
66	587187	Manufacturing	Medium	0.184
67	587189	Services	Medium	0.221
68	587192	Services	Small	0.202
69	587193	Services	Small	0.207
70	587196	Services	Medium	0.33
71	587197	Services	Large	0.098
72	587198	Manufacturing	Small	0.229
73	587200	Services	Medium	0.225
74	587206	Manufacturing	Small	0.091
75	587208	Services	Small	0.188
76	587214	Services	Small	0.202
77	587215	Manufacturing	Small	0.183
78	587221	Manufacturing	Small	0.143
79	587222	Services	Large	0.274
80	587224	Services	Small	0.214
81	587225	Manufacturing	Small	0.201
82	587229	Manufacturing	Small	0.196
83	587232	Manufacturing	Small	0.191
84	587234	Services	Small	0.194
85	587239	Services	Small	0.219
86	587240	Manufacturing	Medium	0.216
87	587242	Services	Small	1.819
88	587249	Services	Medium	0.23
89	587250	Manufacturing	Large	0.295
90	587253	Manufacturing	Small	0.222
91	587259	Services	Small	0.231
92	587260	Manufacturing	Small	0.278
93	587263	Services	Medium	0.18
94	587264	Services	Large	0.199
95	587266	Manufacturing	Small	0.212
96	587267	Manufacturing	Medium	0.214
97	587270	Manufacturing	Small	0.218

98	587271	Services	Small	0.191
99	587276	Services	Small	0.222
100	587284	Manufacturing	Small	0.226
101	587285	Manufacturing	Large	0.174
102	587288	Services	Medium	0.184
103	587295	Services	Medium	0.262
104	587297	Services	Small	0.268
105	587299	Manufacturing	Small	0.255
106	587301	Manufacturing	Small	0.243
107	587306	Services	Small	0.309
108	587308	Services	Large	0.136
109	587312	Services	Small	0.208
110	587316	Manufacturing	Large	0.222
111	587319	Manufacturing	Small	0.14
112	587320	Manufacturing	Small	0.328
113	587321	Services	Small	0.268
114	587324	Manufacturing	Medium	0.283
115	587325	Manufacturing	Medium	0.289
116	587326	Manufacturing	Small	0.241
117	587330	Manufacturing	Small	0.262
118	587343	Manufacturing	Small	0.263
119	587345	Services	Medium	0.334
120	587348	Services	Large	0.285
121	587350	Manufacturing	Medium	0.213
122	587351	Manufacturing	Small	0.252
123	587357	Manufacturing	Medium	0.289
124	587358	Manufacturing	Medium	0.274
125	587359	Services	Small	0.236
126	587361	Services	Medium	0.282
127	587369	Manufacturing	Small	0.323
128	587372	Manufacturing	Small	0.149
129	587374	Manufacturing	Small	0.289
130	587376	Manufacturing	Small	0.415
131	587377	Manufacturing	Small	0.38
132	587382	Manufacturing	Small	0.393
133	587390	Manufacturing	Small	0.308
134	587393	Manufacturing	Small	0.287
135	587396	Services	Small	0.136
136	587402	Manufacturing	Small	0.237
137	587403	Manufacturing	Small	0.251

138	587406	Manufacturing	Medium	0.211
139	587409	Services	Large	0.331
140	587415	Services	Small	0.36
141	587418	Manufacturing	Medium	0.128
142	587422	Services	Small	0.106
143	587423	Manufacturing	Small	0.209
144	587424	Manufacturing	Small	0.217
145	587425	Manufacturing	Medium	0.247
146	587426	Manufacturing	Medium	0.313
147	587430	Manufacturing	Small	0.172
148	587437	Manufacturing	Small	0.18
149	587438	Manufacturing	Small	0.293
150	587440	Manufacturing	Small	0.221
151	587441	Services	Large	0.116
152	587442	Services	Small	0.151
153	587443	Manufacturing	Small	0.129
154	587445	Services	Small	0.168
155	587449	Manufacturing	Medium	0.127
156	587450	Services	Small	0.233
157	587451	Manufacturing	Small	0.249
158	587453	Services	Small	0.212
159	587454	Services	Medium	0.311
160	587455	Services	Medium	0.187
161	587456	Services	Small	1.768
162	587458	Manufacturing	Small	0.151
163	587460	Manufacturing	Small	1.732
164	587462	Services	Medium	0.277
165	587465	Manufacturing	Small	1.793
166	587467	Manufacturing	Small	1.62
167	587471	Manufacturing	Medium	1.853
168	587472	Services	Large	0.289
169	587484	Services	Medium	0.217
170	587485	Services	Small	0.275
171	587486	Services	Small	0.163
172	587487	Services	Large	0.135
173	587489	Services	Medium	0.174
174	587493	Services	Medium	0.186
175	587494	Services	Large	0.143
176	587496	Services	Small	0.178
177	587497	Services	Large	0.221

178	587499	Services	Small	0.075
179	587502	Manufacturing	Large	0.201
180	587503	Manufacturing	Large	0.227
181	587504	Manufacturing	Large	0.226
182	587506	Services	Medium	0.183
183	587511	Services	Large	1.739
184	587516	Services	Large	0.295
185	587520	Services	Small	0.212
186	587527	Manufacturing	Small	0.141
187	587528	Services	Small	0.251
188	587531	Manufacturing	Small	0.434
189	587539	Manufacturing	Small	0.364
190	587547	Services	Small	1.779
191	587549	Manufacturing	Small	0.343
192	587550	Services	Medium	0.258
193	587555	Manufacturing	Medium	0.243
194	587556	Services	Medium	0.324
195	587565	Services	Medium	0.359
196	587569	Manufacturing	Small	0.374
197	587572	Services	Medium	0.358
198	587573	Manufacturing	Small	0.293
199	587575	Manufacturing	Small	0.294
200	587576	Manufacturing	Small	0.296
201	587577	Services	Small	0.298
202	587579	Services	Small	0.325
203	587582	Manufacturing	Large	0.324
204	587583	Manufacturing	Small	0.184
205	587584	Services	Medium	0.392
206	587585	Services	Medium	0.031
207	587586	Services	Medium	0.28
208	587588	Manufacturing	Small	0.227
209	587589	Manufacturing	Small	0.232
210	587592	Manufacturing	Small	0.289
211	587598	Manufacturing	Large	0.284
212	587599	Manufacturing	Small	0.267
213	587600	Services	Small	0.432
214	587604	Services	Small	0.284
215	587607	Manufacturing	Medium	0.248
216	587608	Manufacturing	Large	0.249
217	587610	Manufacturing	Small	0.184

218	587612	Services	Small	0.223
219	587613	Manufacturing	Medium	0.162
220	587614	Manufacturing	Small	0.211
221	587617	Services	Medium	0.136
222	587619	Manufacturing	Small	0.188
223	587623	Services	Medium	0.243
224	587624	Manufacturing	Medium	0.166
225	587625	Manufacturing	Small	0.176
226	587626	Services	Medium	0.266
227	587630	Manufacturing	Small	0.277
228	587633	Manufacturing	Large	0.224
229	587634	Services	Medium	0.272
230	587636	Manufacturing	Small	0.274
231	587640	Services	Small	1.656
232	587641	Manufacturing	Small	0.148
233	587644	Services	Small	0.289
234	587648	Manufacturing	Small	0.231
235	587650	Services	Small	0.258
236	587652	Manufacturing	Small	0.255
237	587658	Manufacturing	Small	0.299
238	587659	Manufacturing	Small	0.275
239	587660	Manufacturing	Small	0.414
240	587661	Services	Large	0.266
241	587664	Manufacturing	Small	0.213
242	587665	Manufacturing	Medium	0.241
243	587668	Manufacturing	Medium	0.375
244	587672	Manufacturing	Small	0.31
245	587673	Manufacturing	Medium	0.27
246	587677	Manufacturing	Medium	0.464
247	587683	Manufacturing	Medium	0.29
248	587684	Manufacturing	Small	0.199
249	587688	Services	Small	0.251
250	587689	Services	Medium	0.123
251	587691	Manufacturing	Small	0.166
252	587692	Manufacturing	Small	0.21
253	587696	Manufacturing	Large	0.251
254	587697	Manufacturing	Medium	0.307
255	587699	Manufacturing	Small	0.238
256	587701	Services	Medium	0.206
257	587704	Manufacturing	Small	1.779

258	587707	Manufacturing	Medium	1.838
259	587708	Services	Small	0.216
260	587713	Services	Small	1.725
261	587718	Services	Medium	0.278
262	587726	Services	Small	0.275
263	587730	Services	Small	0.304
264	587731	Services	Medium	0.312
265	587734	Manufacturing	Small	0.192
266	587735	Manufacturing	Medium	1.772
267	587736	Manufacturing	Small	0.098
268	587743	Manufacturing	Small	0.264
269	587745	Services	Medium	0.235
270	587746	Services	Medium	0.231
271	587750	Services	Small	0.14
272	587751	Manufacturing	Small	0.204
273	587752	Services	Medium	1.802
274	587753	Services	Medium	1.85
275	587759	Services	Medium	1.937
276	587760	Manufacturing	Medium	0.133
277	587761	Manufacturing	Small	1.682
278	587769	Manufacturing	Small	0.316
279	587772	Services	Small	0.149
280	587773	Services	Medium	0.122
281	587785	Services	Small	0.184
282	587788	Manufacturing	Small	0.293
283	587790	Manufacturing	Small	0.227
284	587795	Services	Small	1.676
285	587796	Services	Small	0.238
286	587799	Manufacturing	Small	0.283
287	587800	Manufacturing	Small	0.106
288	587803	Manufacturing	Small	0.239
289	587804	Manufacturing	Small	0.224
290	587805	Services	Small	1.643
291	587806	Services	Large	0.242
292	587807	Manufacturing	Small	0.166
293	587809	Services	Small	0.13
294	587810	Manufacturing	Small	0.263
295	587811	Services	Small	0.273
296	587812	Services	Medium	0.281
297	587813	Manufacturing	Small	0.245

298	587814	Manufacturing	Small	0.384
299	587816	Services	Small	0.218
300	587817	Manufacturing	Medium	0.387
301	587818	Manufacturing	Small	0.362
302	587819	Services	Small	0.129
303	587822	Manufacturing	Medium	0.418
304	587823	Services	Medium	0.321
305	587824	Manufacturing	Medium	0.187
306	587825	Manufacturing	Small	0.265
307	587826	Manufacturing	Small	1.647
308	587829	Manufacturing	Small	0.285
309	587835	Services	Small	1.641
310	587838	Services	Medium	0.163
311	587840	Services	Medium	0.229
312	587843	Manufacturing	Small	0.222
313	587844	Services	Medium	0.339
314	587845	Manufacturing	Medium	0.242
315	587847	Services	Medium	0.167
316	587856	Manufacturing	Large	0.113
317	587868	Manufacturing	Small	0.193
318	587869	Manufacturing	Small	0.259
319	587872	Manufacturing	Small	0.214
320	587873	Services	Small	0.222
321	587875	Manufacturing	Small	0.311
322	587877	Services	Small	0.246
323	587879	Services	Small	0.068
324	587881	Manufacturing	Small	0.203
325	587882	Manufacturing	Small	0.185
326	587883	Manufacturing	Small	0.267
327	587884	Manufacturing	Small	0.273
328	587885	Manufacturing	Small	0.28
329	587888	Manufacturing	Small	0.283
330	587889	Manufacturing	Small	0.174
331	587893	Services	Small	0.257
332	587894	Services	Small	1.632
333	587895	Services	Small	0.21
334	587896	Manufacturing	Small	0.397
335	587898	Manufacturing	Small	0.247
336	587899	Manufacturing	Small	0.194
337	587901	Manufacturing	Small	0.218

338	587902	Manufacturing	Medium	1.773
339	587903	Services	Small	0.164
340	587905	Services	Small	0.19
341	587907	Services	Medium	0.255
342	587909	Manufacturing	Medium	0.257
343	587912	Services	Large	0.224
344	587913	Manufacturing	Large	0.223
345	587916	Manufacturing	Small	0.216
346	587925	Manufacturing	Large	1.834
347	587926	Services	Large	0.218
348	587930	Services	Small	0.235
349	587931	Services	Medium	0.268
350	587936	Manufacturing	Medium	0.255
351	587937	Manufacturing	Small	0.271
352	587939	Manufacturing	Small	0.245
353	587941	Manufacturing	Small	0.133
354	587946	Manufacturing	Small	0.2
355	587948	Services	Small	0.229
356	587950	Services	Small	0.159
357	587951	Services	Small	0.232
358	587953	Manufacturing	Small	1.794
359	587954	Services	Small	0.18
360	587955	Manufacturing	Small	0.173
361	587957	Manufacturing	Small	1.719
362	587963	Services	Small	0.205
363	587964	Services	Small	0.144
364	587965	Services	Small	0.285
365	587966	Services	Small	0.148
366	587971	Manufacturing	Small	0.186
367	587972	Services	Small	0.205
368	587973	Services	Small	0.233
369	587974	Services	Small	0.186
370	587977	Manufacturing	Small	0.237
371	587980	Manufacturing	Small	0.141
372	587983	Manufacturing	Small	0.205
373	587984	Manufacturing	Small	0.204
374	587985	Manufacturing	Small	0.138
375	587986	Manufacturing	Small	0.178
376	587987	Manufacturing	Small	0.15
377	587992	Manufacturing	Small	0.175

378	587993	Manufacturing	Small	0.21
379	587995	Services	Small	0.175
380	587999	Manufacturing	Small	0.266
381	588006	Manufacturing	Small	0.238
382	588007	Services	Small	0.201
383	588008	Manufacturing	Small	0.181
384	588009	Manufacturing	Small	0.175
385	588010	Manufacturing	Small	0.256
386	588011	Manufacturing	Medium	0.192
387	588013	Manufacturing	Medium	0.219
388	588014	Manufacturing	Small	0.245
389	588018	Manufacturing	Small	0.147
390	588021	Manufacturing	Small	0.104
391	588023	Manufacturing	Small	0.2
392	588024	Manufacturing	Small	0.19
393	588027	Services	Medium	0.124
394	588029	Manufacturing	Small	0.225
395	588031	Manufacturing	Small	0.135
396	588035	Manufacturing	Small	0.187
397	588037	Manufacturing	Small	0.142
398	588038	Manufacturing	Small	0.169
399	588041	Manufacturing	Small	0.214
400	588043	Services	Small	0.17
401	588044	Services	Small	0.156
402	588045	Services	Small	0.171
403	588053	Services	Small	0.206
404	588058	Services	Small	0.23
405	588067	Manufacturing	Small	0.257
406	588068	Manufacturing	Small	0.291
407	588073	Services	Small	0.13
408	588074	Services	Small	0.237
409	588075	Services	Small	0.154
410	588076	Services	Small	0.159
411	588077	Services	Small	0.205
412	588085	Manufacturing	Small	0.225
413	588086	Manufacturing	Small	0.205
414	588090	Manufacturing	Medium	0.173
415	588091	Manufacturing	Small	0.19
416	588093	Manufacturing	Medium	0.148
417	588094	Manufacturing	Small	0.363

418	588097	Services	Small	1.696
419	588098	Services	Small	0.156
420	588103	Manufacturing	Small	1.615
421	588104	Manufacturing	Small	0.209
422	588108	Manufacturing	Medium	0.246
423	588110	Services	Small	0.139
424	588111	Services	Small	0.297
425	588112	Services	Small	0.173
426	588113	Services	Small	0.223
427	588115	Services	Small	0.216
428	588117	Manufacturing	Small	0.222
429	588118	Manufacturing	Small	0.236
430	588121	Manufacturing	Small	0.226
431	588130	Services	Medium	0.181
432	588131	Services	Small	0.176
433	588132	Manufacturing	Small	0.203
434	588133	Manufacturing	Small	1.694
435	588134	Manufacturing	Small	0.1
436	588135	Manufacturing	Small	0.1
437	588136	Services	Small	0.126
438	588143	Services	Small	0.107
439	588146	Manufacturing	Medium	0.247
440	588148	Manufacturing	Small	0.238
441	588150	Services	Small	1.806
442	588152	Services	Small	0.234
443	588153	Services	Small	0.197
444	588155	Services	Small	0.221
445	588156	Services	Small	1.729
446	588158	Services	Small	0.247
447	588159	Manufacturing	Small	0.176
448	588160	Manufacturing	Small	0.21
449	588162	Manufacturing	Small	0.231
450	588163	Manufacturing	Small	1.801
451	588164	Manufacturing	Medium	0.211
452	588165	Manufacturing	Small	0.26
453	588166	Manufacturing	Medium	0.233
454	588167	Manufacturing	Medium	0.208
455	588169	Manufacturing	Medium	0.258
456	588170	Manufacturing	Medium	0.242
457	588171	Manufacturing	Small	0.207

458	588172	Manufacturing	Small	0.214
459	588173	Manufacturing	Small	0.266
460	588174	Manufacturing	Small	0.214
461	588175	Manufacturing	Small	0.353
462	588176	Manufacturing	Small	0.238
463	588177	Manufacturing	Small	0.232
464	588178	Manufacturing	Small	1.846
465	588179	Manufacturing	Small	0.1
466	588180	Services	Medium	0.233
467	588181	Services	Small	0.227
468	588182	Services	Small	1.687
469	588183	Services	Medium	1.676
470	588189	Manufacturing	Small	1.701
471	588190	Manufacturing	Small	1.702
472	588191	Manufacturing	Small	0.225
473	588194	Services	Small	0.277
474	588196	Manufacturing	Small	0.232
475	588207	Manufacturing	Small	1.626
476	588221	Manufacturing	Small	0.249
477	588223	Manufacturing	Medium	0.18
478	588224	Manufacturing	Small	0.257
479	588225	Manufacturing	Small	0.163
480	588230	Services	Small	0.25
481	588233	Manufacturing	Small	1.751
482	588235	Services	Medium	1.65
483	588242	Services	Small	0.168
484	588244	Services	Small	0.156
485	588248	Manufacturing	Medium	0.135
486	588250	Services	Small	0.14
487	588252	Manufacturing	Medium	0.246
488	588253	Manufacturing	Medium	1.628
489	588254	Manufacturing	Small	1.733
490	588255	Manufacturing	Small	0.186
491	588257	Manufacturing	Medium	0.154
492	588259	Manufacturing	Small	1.632
493	588261	Manufacturing	Small	1.653
494	588263	Services	Small	0.263
495	588266	Manufacturing	Small	1.646
496	588268	Services	Small	0.172
497	588269	Services	Small	0.281

498	588270	Services	Small	0.055
499	588271	Services	Small	1.757
500	588272	Services	Small	1.999
501	588278	Manufacturing	Small	1.791
502	588283	Services	Small	0.165
503	588288	Manufacturing	Small	0.136
504	588292	Manufacturing	Small	0.256
505	588293	Manufacturing	Small	0.251
506	588296	Services	Small	0.236
507	588297	Services	Small	0.298
508	588301	Services	Small	0.137
509	588302	Manufacturing	Small	0.24
510	588308	Manufacturing	Small	0.244
511	588311	Services	Medium	0.246
512	588313	Manufacturing	Small	0.274
513	588314	Services	Medium	0.265
514	588315	Services	Small	0.099
515	588316	Manufacturing	Medium	0.152
516	588317	Manufacturing	Small	0.247
517	588318	Manufacturing	Small	0.376
518	588319	Manufacturing	Large	0.327
519	588320	Manufacturing	Small	1.76
520	588321	Manufacturing	Small	1.668
521	588325	Manufacturing	Small	0.324
522	588326	Services	Medium	0.272
523	588341	Manufacturing	Small	0.252
524	588342	Services	Small	0.177
525	588350	Services	Small	0.216
526	588351	Services	Small	0.211
527	588353	Manufacturing	Small	0.273
528	588354	Services	Medium	0.185
529	588359	Services	Small	0.153
530	588360	Manufacturing	Small	0.28
531	588361	Manufacturing	Small	0.226
532	588362	Services	Large	0.136
533	588363	Services	Small	0.206
534	588364	Manufacturing	Small	0.185
535	588365	Manufacturing	Small	1.872
536	588373	Manufacturing	Small	0.251
537	588374	Manufacturing	Small	0.253

538	588375	Manufacturing	Small	0.31
539	588377	Manufacturing	Medium	1.756
540	588378	Manufacturing	Medium	0.176
541	588379	Manufacturing	Small	0.199
542	588380	Manufacturing	Small	0.263
543	588381	Manufacturing	Small	0.261
544	588382	Manufacturing	Small	0.276
545	588383	Manufacturing	Small	0.187
546	588385	Manufacturing	Small	0.268
547	588386	Manufacturing	Small	1.74
548	588387	Services	Small	0.236
549	588389	Services	Small	0.182
550	588397	Manufacturing	Small	0.112
551	588398	Manufacturing	Small	0.254
552	588399	Manufacturing	Small	0.229
553	588401	Services	Small	0.272
554	588403	Services	Small	0.278
555	588404	Manufacturing	Small	0.2
556	588405	Manufacturing	Small	0.242
557	588409	Services	Medium	0.201
558	588410	Services	Medium	0.122
559	588411	Manufacturing	Small	0.234
560	588412	Manufacturing	Small	0.379
561	588414	Manufacturing	Small	0.275
562	588417	Services	Medium	1.594
563	588419	Services	Small	0.278
564	588422	Manufacturing	Medium	0.248
565	588423	Manufacturing	Medium	1.6
566	588424	Manufacturing	Medium	0.321
567	588433	Manufacturing	Medium	0.202
568	588434	Manufacturing	Medium	0.202
569	588435	Manufacturing	Small	0.086
570	588436	Manufacturing	Medium	0.242
571	588437	Manufacturing	Small	0.316
572	588438	Manufacturing	Small	1.692
573	588440	Services	Small	0.391
574	588442	Services	Small	0.316
575	588443	Manufacturing	Small	0.166
576	588462	Manufacturing	Medium	0.294
577	588464	Manufacturing	Medium	0.17

578	588470	Services	Medium	0.25
579	588471	Services	Medium	0.198
580	588481	Services	Small	1.603
581	588486	Manufacturing	Small	0.187
582	588488	Services	Medium	0.186
583	588490	Manufacturing	Small	0.156
584	588491	Manufacturing	Small	1.706
585	588494	Manufacturing	Small	0.264
586	588495	Manufacturing	Medium	0.171
587	588496	Services	Medium	0.329
588	588500	Manufacturing	Medium	0.207
589	588501	Manufacturing	Small	0.187
590	588503	Manufacturing	Small	0.321
591	588504	Services	Small	0.351
592	588506	Services	Small	0.311
593	588516	Manufacturing	Small	1.614
594	588520	Manufacturing	Medium	1.567
595	588524	Manufacturing	Medium	0.274
596	588525	Manufacturing	Small	0.242
597	588526	Manufacturing	Medium	0.365
598	588529	Manufacturing	Small	0.194
599	588540	Manufacturing	Medium	0.092
600	588550	Services	Medium	0.189
601	588553	Manufacturing	Small	1.827
602	588554	Manufacturing	Small	0.2
603	588562	Manufacturing	Medium	1.627
604	588565	Services	Small	0.259
605	588567	Services	Small	0.351
606	588570	Services	Medium	0.324
607	588571	Manufacturing	Medium	0.35
608	588572	Manufacturing	Small	0.295
609	588573	Manufacturing	Small	0.195
610	588578	Services	Medium	0.156
611	588581	Services	Small	0.2
612	588583	Services	Small	0.347
613	588585	Manufacturing	Small	0.226
614	588586	Services	Small	0.247
615	588596	Manufacturing	Small	0.258
616	588597	Services	Small	1.542
617	588600	Manufacturing	Small	0.196

618	588602	Manufacturing	Medium	0.199
619	588607	Manufacturing	Small	0.196
620	588609	Services	Medium	0.241
621	588610	Services	Medium	0.232
622	588611	Services	Small	0.246
623	588612	Services	Small	0.127
624	588613	Manufacturing	Small	0.217
625	588614	Manufacturing	Small	0.164
626	588621	Manufacturing	Medium	0.295
627	588622	Services	Small	0.251
628	588626	Manufacturing	Small	0.288
629	588629	Manufacturing	Medium	0.234
630	588635	Manufacturing	Medium	0.185
631	588642	Manufacturing	Small	0.298
632	588643	Services	Small	0.145
633	588644	Manufacturing	Medium	0.275
634	588647	Manufacturing	Small	0.173
635	588648	Services	Small	0.2
636	588652	Manufacturing	Small	0.166
637	588654	Manufacturing	Medium	0.227
638	588655	Services	Medium	0.236
639	588659	Services	Small	1.8
640	588660	Manufacturing	Medium	0.292
641	588664	Services	Small	0.211
642	588665	Services	Medium	0.235
643	588666	Manufacturing	Medium	0.219
644	588668	Manufacturing	Small	0.162
645	588671	Services	Medium	0.205
646	588672	Manufacturing	Small	0.228
647	588674	Manufacturing	Large	0.244
648	588677	Manufacturing	Medium	0.097
649	588685	Manufacturing	Medium	0.187
650	588688	Services	Medium	0.153
651	588692	Manufacturing	Medium	0.18
652	588693	Manufacturing	Medium	0.253
653	588695	Manufacturing	Small	0.134
654	588698	Services	Medium	0.213
655	588700	Services	Medium	1.691
656	588701	Services	Medium	0.191
657	588702	Services	Medium	1.718

658	588708	Manufacturing	Medium	0.275
659	588709	Services	Medium	0.275
660	588712	Manufacturing	Medium	0.19
661	588713	Manufacturing	Medium	0.118
662	588715	Services	Medium	0.206
663	588722	Manufacturing	Medium	0.182
664	588723	Services	Medium	0.234
665	588726	Manufacturing	Medium	0.255
666	588732	Manufacturing	Small	0.184
667	588733	Services	Medium	0.245
668	588738	Services	Medium	0.247
669	588739	Manufacturing	Medium	0.181
670	588746	Services	Small	0.251
671	588748	Services	Small	0.198
672	588751	Manufacturing	Large	0.179
673	588753	Services	Medium	0.354
674	588754	Services	Medium	0.257
675	588755	Manufacturing	Medium	0.164
676	588756	Manufacturing	Medium	0.334
677	588757	Services	Medium	0.291
678	588759	Services	Large	0.245
679	588760	Services	Large	1.692
680	588761	Services	Small	0.227
681	588762	Services	Large	0.286
682	588764	Manufacturing	Medium	1.648
683	588765	Services	Medium	0.135
684	588766	Services	Medium	0.197
685	588767	Manufacturing	Medium	0.06
686	588770	Services	Large	1.828
687	588775	Manufacturing	Large	0.187
688	588777	Services	Large	0.071
689	588780	Manufacturing	Small	0.27
690	588786	Manufacturing	Medium	0.21
691	588788	Services	Large	0.327
692	588789	Services	Large	0.4
693	588791	Services	Large	0.238
694	588795	Services	Large	0.218
695	588797	Services	Medium	1.634
696	588801	Manufacturing	Small	0.32
697	588808	Manufacturing	Large	0.255

698	588810	Services	Medium	0.259
699	588811	Services	Small	0.281
700	588815	Services	Large	0.339
701	588819	Services	Large	0.218
702	588823	Manufacturing	Large	0.273
703	588824	Manufacturing	Small	0.147
704	588826	Manufacturing	Large	0.137
705	588828	Services	Large	1.543
706	588833	Manufacturing	Large	0.387
707	588834	Services	Large	0.368
708	588839	Manufacturing	Large	0.327
709	588840	Manufacturing	Large	0.293
710	588843	Services	Medium	0.278
711	588845	Manufacturing	Large	0.217
712	588846	Services	Medium	0.33
713	588848	Manufacturing	Medium	0.176
714	588851	Services	Large	0.322
715	588853	Manufacturing	Small	0.395
716	588857	Services	Large	1.825
717	588860	Manufacturing	Small	0.184
718	588863	Services	Small	0.262
719	588864	Services	Large	0.289
720	588866	Manufacturing	Large	0.334
721	588870	Manufacturing	Small	0.264
722	588872	Manufacturing	Small	0.274
723	588875	Manufacturing	Medium	0.283
724	588878	Manufacturing	Small	0.24
725	588879	Manufacturing	Small	0.21
726	588880	Manufacturing	Large	1.943
727	588881	Manufacturing	Small	0.26
728	588887	Manufacturing	Small	0.388
729	588890	Manufacturing	Medium	0.318
730	588895	Manufacturing	Medium	0.311
731	588896	Manufacturing	Small	0.062
732	588897	Manufacturing	Small	0.302
733	588899	Manufacturing	Small	0.137
734	588900	Manufacturing	Small	1.816
735	588901	Manufacturing	Medium	0.298
736	588902	Manufacturing	Small	0.228
737	588903	Manufacturing	Small	0.247

738	588904	Manufacturing	Medium	0.269
739	588905	Manufacturing	Medium	0.3
740	588908	Manufacturing	Medium	0.251
741	588910	Manufacturing	Medium	0.161
742	588913	Manufacturing	Small	0.194
743	588914	Manufacturing	Medium	1.652
744	588917	Manufacturing	Small	0.236
745	588921	Manufacturing	Medium	0.216
746	588924	Manufacturing	Medium	0.254
747	588925	Manufacturing	Small	0.246
748	588926	Manufacturing	Small	0.299
749	588927	Manufacturing	Small	0.283
750	588932	Manufacturing	Small	0.296
751	588935	Manufacturing	Small	0.316
752	588937	Manufacturing	Small	0.276
753	588938	Manufacturing	Small	0.339
754	588944	Manufacturing	Small	1.585
755	588945	Manufacturing	Medium	1.633
756	588950	Manufacturing	Small	0.243
757	588961	Manufacturing	Small	0.278
758	588963	Manufacturing	Small	1.796
759	588964	Manufacturing	Small	0.246
760	588965	Manufacturing	Medium	0.157
761	588966	Manufacturing	Small	0.26
762	588968	Manufacturing	Small	0.168
763	588969	Manufacturing	Medium	0.148
764	588971	Manufacturing	Small	0.161
765	588972	Manufacturing	Small	0.276
766	588974	Manufacturing	Small	0.193
767	588977	Manufacturing	Medium	0.214
768	588978	Manufacturing	Small	1.577
769	588980	Manufacturing	Small	0.229
770	588982	Manufacturing	Medium	0.214
771	588984	Manufacturing	Small	0.24
772	588989	Manufacturing	Medium	0.213
773	588996	Manufacturing	Small	0.233
774	588998	Manufacturing	Medium	0.23
775	588999	Manufacturing	Medium	1.743
776	589000	Manufacturing	Small	0.1
777	589002	Manufacturing	Medium	0.167

778	589005	Manufacturing	Small	1.858
779	589007	Manufacturing	Small	0.321
780	589009	Manufacturing	Large	0.236
781	589014	Manufacturing	Small	0.155
782	589016	Manufacturing	Large	0.22
783	589017	Manufacturing	Small	1.972
784	589018	Manufacturing	Small	0.204
785	589020	Services	Small	0.148
786	589021	Services	Medium	0.231
787	589024	Services	Small	0.308
788	589025	Services	Small	0.167
789	589027	Services	Small	0.252
790	589028	Services	Small	0.176
791	589033	Services	Small	0.157
792	589035	Services	Small	0.128
793	589047	Services	Small	0.154
794	589049	Services	Small	0.339
795	589052	Services	Small	0.19
796	589054	Services	Small	0.182
797	589055	Services	Medium	0.224
798	589056	Services	Small	0.188
799	589057	Services	Small	0.23
800	589060	Services	Small	0.235
801	589065	Services	Medium	0.242
802	589067	Services	Small	0.28
803	589069	Services	Small	0.244
804	589070	Services	Medium	0.226
805	589071	Services	Small	0.182
806	589072	Services	Small	0.29
807	589075	Services	Small	0.196
808	589076	Services	Small	0.23
809	589078	Services	Small	0.25
810	589079	Services	Small	0.169
811	589081	Services	Small	0.238
812	589082	Services	Small	0.183
813	589084	Services	Small	0.248
814	589085	Services	Small	0.25
815	589086	Services	Small	0.244
816	589087	Services	Small	0.163
817	589088	Services	Medium	0.232

818	589089	Services	Small	0.279
819	589090	Services	Medium	0.234
820	589092	Services	Medium	0.152
821	589093	Services	Small	0.224
822	589094	Services	Small	0.152
823	589095	Services	Medium	0.263
824	589096	Services	Small	0.327
825	589097	Services	Small	0.188
826	589098	Services	Medium	0.182
827	589099	Services	Small	0.17
828	589100	Services	Small	0.246
829	589101	Services	Small	0.099
830	589102	Services	Small	0.225
831	589103	Services	Medium	0.257
832	589104	Services	Medium	0.135
833	589105	Services	Small	0.141
834	589108	Services	Small	0.105
835	589109	Services	Small	0.211
836	589110	Services	Small	0.146
837	589111	Services	Small	0.238
838	589112	Services	Small	0.176
839	589113	Services	Small	0.253
840	589114	Services	Medium	0.194
841	589115	Services	Small	0.236
842	589116	Services	Small	0.241
843	589117	Services	Small	1.662
844	589118	Services	Small	0.172
845	589119	Services	Small	0.204
846	589120	Services	Small	0.237
847	589123	Services	Small	0.236
848	589124	Services	Small	0.16
849	589125	Services	Small	0.278
850	589126	Services	Small	0.191
851	589127	Services	Small	0.181
852	589128	Services	Small	0.196
853	589129	Services	Medium	1.889
854	589130	Services	Small	0.163
855	589131	Services	Medium	0.222
856	589134	Services	Small	0.141
857	589140	Services	Small	0.228

858	589143	Services	Small	0.116
859	589144	Services	Small	0.191
860	589146	Services	Small	0.137
861	589147	Services	Small	0.195
862	589148	Services	Medium	0.294
863	589149	Services	Small	0.22
864	589152	Services	Medium	0.309
865	589155	Services	Medium	0.216
866	589157	Services	Small	0.167
867	589161	Services	Small	0.241
868	589165	Services	Small	2.115
869	589168	Services	Small	0.317
870	589169	Services	Small	0.134
871	589172	Services	Medium	0.206
872	589175	Services	Small	0.224
873	589176	Services	Small	0.273
874	589181	Services	Small	0.251
875	589182	Services	Medium	0.302
876	589183	Services	Medium	0.187
877	589184	Services	Medium	0.207
878	589186	Services	Small	0.226
879	589187	Services	Small	1.81
880	589188	Services	Small	0.216
881	589189	Services	Medium	0.161
882	589190	Services	Medium	0.245
883	589192	Services	Large	0.152
884	589193	Services	Small	0.24
885	589196	Services	Medium	0.16
886	589198	Services	Small	0.343
887	589199	Services	Medium	0.206
888	589200	Services	Small	0.272
889	589201	Services	Small	0.097
890	589202	Services	Small	0.106
891	589203	Services	Small	0.154
892	589204	Services	Medium	0.188
893	589205	Services	Small	0.155
894	589206	Services	Small	0.23
895	589207	Services	Small	0.259
896	589208	Services	Small	1.714
897	589209	Services	Medium	0.118

898	589210	Services	Large	0.173
899	589211	Services	Medium	0.155
900	589213	Services	Large	0.12
901	589215	Services	Small	0.197
902	589221	Services	Small	0.194
903	589224	Services	Small	0.185
904	589231	Services	Small	0.215
905	589232	Services	Small	0.231
906	589235	Services	Small	0.206
907	589237	Services	Small	0.195
908	589240	Services	Small	0.166
909	589241	Services	Small	0.242
910	589244	Services	Small	0.226
911	589248	Services	Small	0.219
912	589250	Services	Small	0.181
913	589252	Services	Small	0.283
914	589255	Services	Small	0.078
915	589260	Manufacturing	Medium	0.224
916	589263	Services	Small	0.221
917	589265	Services	Small	0.321
918	589268	Services	Small	0.366
919	589272	Services	Small	0.339
920	589275	Services	Small	0.262
921	589276	Services	Small	0.214
922	589277	Services	Small	0.241
923	589278	Manufacturing	Small	1.674
924	589280	Services	Small	0.197
925	589281	Services	Small	2.027
926	589282	Services	Small	0.246
927	589285	Services	Small	0.134
928	589286	Services	Small	0.185
929	589287	Services	Small	0.18
930	589288	Manufacturing	Small	0.135
931	589290	Manufacturing	Small	0.196
932	589291	Services	Small	0.178
933	589292	Services	Small	0.092
934	589293	Services	Small	0.214
935	589294	Services	Small	1.731
936	589296	Services	Small	0.117
937	589297	Services	Small	0.153

938	589298	Services	Small	0.146
939	589299	Services	Small	0.096
940	589300	Services	Small	0.16
941	589301	Services	Small	0.285
942	589302	Services	Small	1.733
943	589303	Services	Small	0.204
944	589305	Services	Small	0.162
945	589306	Services	Small	0.24
946	589307	Services	Small	0.257
947	589310	Services	Small	0.179
948	589311	Services	Small	0.186
949	589314	Manufacturing	Small	0.19
950	589316	Manufacturing	Medium	0.229
951	589317	Services	Small	0.185
952	589318	Services	Small	0.23
953	589322	Manufacturing	Small	0.17
954	589327	Manufacturing	Medium	0.12
955	589328	Manufacturing	Small	0.126
956	589329	Manufacturing	Small	0.253
957	589330	Manufacturing	Small	0.214
958	589331	Manufacturing	Small	0.169
959	589334	Manufacturing	Small	0.199
960	589335	Manufacturing	Medium	1.736
961	589337	Manufacturing	Small	0.192
962	589338	Manufacturing	Medium	0.217
963	589339	Manufacturing	Medium	0.205
964	589341	Manufacturing	Medium	0.242
965	589342	Manufacturing	Medium	0.169
966	589344	Manufacturing	Large	0.193
967	589347	Manufacturing	Medium	0.175
968	589353	Manufacturing	Medium	0.134
969	589354	Manufacturing	Small	0.113
970	589356	Manufacturing	Small	0.128
971	589357	Manufacturing	Medium	0.223
972	589361	Manufacturing	Medium	0.234
973	589362	Manufacturing	Small	0.199
974	589363	Manufacturing	Small	0.127
975	589364	Manufacturing	Small	0.134
976	589366	Manufacturing	Small	0.207
977	589368	Manufacturing	Small	0.136

978	589372	Manufacturing	Medium	0.103
979	589373	Manufacturing	Medium	0.14
980	589376	Manufacturing	Small	0.205
981	589378	Manufacturing	Medium	0.082
982	589381	Manufacturing	Large	0.139
983	589384	Manufacturing	Medium	0.026
984	589385	Manufacturing	Large	0.141
985	589387	Manufacturing	Medium	1.796
986	589388	Manufacturing	Small	1.763
987	589389	Manufacturing	Small	0.055
988	589394	Manufacturing	Small	0.233
989	589395	Manufacturing	Medium	1.658
990	589397	Manufacturing	Medium	0.136
991	589398	Manufacturing	Small	1.702
992	589399	Manufacturing	Medium	0.552
993	589400	Manufacturing	Small	1.582
994	589403	Manufacturing	Small	0.19
995	589404	Manufacturing	Large	0.262
996	589441	Manufacturing	Large	1.62
997	589448	Manufacturing	Small	0.171
998	589449	Manufacturing	Small	1.479
999	589451	Manufacturing	Small	0.163
1000	589453	Manufacturing	Small	0.211
1001	589459	Services	Small	0.248
1002	589460	Services	Small	0.169
1003	589461	Services	Small	1.525
1004	589463	Services	Medium	0.181
1005	589464	Services	Small	0.122
1006	589465	Services	Medium	0.152
1007	589466	Services	Medium	1.597
1008	589469	Services	Small	0.137
1009	589471	Services	Medium	0.218
1010	589474	Services	Medium	0.061
1011	589483	Services	Small	0.2
1012	589486	Services	Small	0.171
1013	589488	Services	Small	0.188
1014	589489	Services	Small	0.119
1015	589490	Services	Medium	0.273
1016	589491	Services	Medium	0.153
1017	589492	Services	Small	0.261

1018	589494	Services	Small	0.12
1019	589495	Services	Small	0.138
1020	589496	Services	Small	0.165
1021	589497	Services	Medium	0.223
1022	589498	Services	Medium	0.241
1023	589502	Services	Medium	0.152
1024	589503	Services	Medium	0.118
1025	589506	Services	Small	0.17
1026	589510	Services	Medium	0.122
1027	589513	Services	Medium	0.061
1028	589514	Services	Medium	0.227
1029	589515	Services	Medium	0.274
1030	589517	Services	Small	0.279
1031	589518	Services	Medium	0.247
1032	589519	Services	Small	0.229
1033	589520	Services	Medium	0.249
1034	589521	Services	Medium	0.248
1035	589522	Services	Small	1.55
1036	589523	Services	Medium	0.173
1037	589524	Services	Small	0.283
1038	589525	Services	Small	0.249
1039	589526	Services	Medium	0.137
1040	589527	Services	Medium	0.07
1041	589530	Services	Medium	0.091
1042	589533	Services	Medium	0.166
1043	589536	Services	Medium	0.105
1044	589539	Services	Large	0.138
1045	589541	Services	Medium	0.18
1046	589542	Services	Small	0.048
1047	589543	Services	Small	0.177
1048	589545	Services	Small	0.178
1049	589551	Services	Small	0.059
1050	589554	Services	Small	1.831
1051	589555	Services	Medium	0.119
1052	589557	Services	Medium	0.057
1053	589562	Services	Medium	0.739
1054	589563	Services	Small	0.273
1055	589566	Services	Small	0.042
1056	589567	Services	Small	0.204
1057	589569	Services	Large	0.246

1058	589570	Services	Medium	0.226
1059	589571	Services	Small	0.193
1060	589572	Services	Small	0.252
1061	589574	Services	Small	0.128
1062	589577	Services	Small	0.178
1063	589578	Services	Small	0.239
1064	589579	Services	Medium	0.178
1065	589580	Services	Medium	0.254
1066	589584	Services	Medium	0.239
1067	589588	Services	Medium	0.187
1068	589590	Services	Small	0.204
1069	589595	Services	Medium	0.212
1070	589597	Services	Medium	0.174
1071	589600	Services	Small	0.148
1072	589602	Services	Small	0.19
1073	589603	Services	Small	0.22
1074	589604	Services	Medium	0.239
1075	589606	Services	Small	0.041
1076	589607	Services	Small	0.277
1077	589608	Manufacturing	Small	0.256
1078	589609	Services	Small	0.186
1079	589610	Services	Small	0.274
1080	589611	Services	Small	0.27
1081	589612	Services	Small	0.226
1082	589613	Services	Small	0.183
1083	589617	Services	Small	0.251
1084	589619	Services	Small	0.2
1085	589620	Services	Small	0.159
1086	589621	Services	Small	0.235
1087	589624	Services	Small	0.23
1088	589626	Services	Small	0.342
1089	589627	Services	Medium	0.429
1090	589634	Manufacturing	Small	0.15
1091	589654	Manufacturing	Medium	0.175
1092	589661	Services	Small	0.208

Source: Author's computation from STATA 15