

The socio-economic effects of digital technologies on Australian academics and farmers

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[This publication is linked to Chapter 4]

ABSTRACT

This thesis investigated the social and economic effects of digital technologies, and in particular information and communication technologies (ICTs), on the Australian academics and farmers in the context of an ongoing emphasis by the Australian government on the digital economy.

I am motivated to conduct the research because politicians and scholars feel that the digital economy is a way ahead for improving the living standards of general Australians. Although a substantial research initiative has already been undertaken by previous researchers to examine the benefits of modern ICTs (information and communication technologies) in society, the extent of benefits (or problems) associated with the expansion of digital infrastructure facilities are yet to be estimated for at least two sectors of the economy – higher education and agriculture. In the given context of the Australian Government’s policy on the digital future, this thesis aims to study the effects of digital technologies, particularly ICTs, on academics and farmers in Australia. The direction of effects encompasses social and economic aspects only.

I used three types of theories: affordance theory; Ajzen and Fishbein’s (1980) theory of reasoned action; and the theory of (research) production function. With regard to research methodology, I used qualitative, quantitative and a combination of both (i.e. mixed) research approaches. The data used in this study was drawn from two sources: – (i) a primary source and (ii) a secondary source. The source of the primary data was academic teaching staff members of the University of Southern Queensland, and the source of secondary data was the Australian Department of Agriculture

The thematic analysis showed that, because of the use of eLearning environments, the teaching academics at USQ perceived that their workload had increased. This was labelled as “perceived increased workloads” in this study. From this study, three broad themes emerged. These themes were classified as temporal, pedagogical and technical limitations, and were attributed to the “perceived workloads?” of the academics. This was the theoretical knowledge contribution of this thesis.

Using factor analysis , I found evidence of both positive and negative attitudes of university academic staff members to ICTs.

Next, using Ajzen and Fishbein's (1980; 2005) theory of reasoned action, a and cross-tabulation analysis, I found that the native-English language status of the academic had a statistically significant association with the variation of attitudes to ICTs. My non-parametric regression analysis also confirmed a statistically significant relationship between the language status of the teaching academics and the variations on their attitudes to ICTs.

Further, Using primary survey data and regression analysis, I found a statistically significant relationship between the teaching academics' use of the Internet per week and their research performances. Finally, using secondary data, the theory of production of microeconomics and regression analysis, I found the relationship between Australian farmers' expenditure for telephone facilities (a variable of CTs) and their agricultural revenue. In this study, I found a statistically significant positive relationship between the farmers' agricultural revenue and the farmers' expenditure on their uses of telephones.

The contributions of this research to existing knowledge are as follows. From the teaching academics' perspective, the affordances of an eLearning environment encompass pedagogical, temporal and technological limitations that contributed to the teaching academics' "*perceived workloads?*". Secondly, the empirical research supports Ajzen and Fishbein's (1980) theory regarding the relationship between the native language status of the academics, which is a social-demographic factor, and their attitudes to using ICTs. Thirdly, the empirical research supports the idea that the Internet is an important physical factor of the research production function. The contribution of the Internet is obvious because it represents a form of digital infrastructure facility. In the future, research should model a research (or knowledge) production function that incorporates the digital capital in the production function; otherwise, the study may generate biased results because of the endogeneity problem. Fourthly, and finally, I have found that telecommunication is an important physical factor of agricultural production, which means that, similarly to manufacturing and service sectors, the agricultural sector can reap benefits from the use of digital technologies, which has been so far largely unreported in the literature

The implications of digital futures lie in a number of government initiatives directed at the university and agricultural sectors of the economy. This includes

overcoming the limitations encountered by academics and expanding the national broadband network infrastructure facilities to remote Australian regions.

CERTIFICATION OF DISSERTATION

The work submitted in this thesis is original, except as acknowledged in the text.
The material herein has not been submitted, either in whole or in part, for any other
award at this or any other university except in publications.



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TABLE OF CONTENTS

1. CHAPTER ONE – INTRODUCTION, RESEARCH QUESTIONS, AND SIGNIFICANCE	1
1.1. BACKGROUND AND JUSTIFICATION	1
1.2. POLICY CONTEXT	4
1.2.0. Participation in higher education	4
1.2.1. Innovation and research	6
1.2.2. Enhanced productivity of the economy	6
1.3. STATEMENT OF THE RESEARCH PROBLEM	7
1.3.0. Online teaching and workload	7
1.3.1. The Internet and research performance	8
1.3.2. ICTs and farmers’ success	10
1.4. RESEARCH OBJECTIVES AND RESEARCH QUESTIONS	11
1.5. SIGNIFICANCE OF THE RESEARCH	12
1.6. SCOPE OF THE STUDY	12
1.7. SUMMARY OF THE CHAPTER	13
2. CHAPTER TWO: LITERATURE REVIEW	15
2.1. ICT concepts	15
2.1.0. Learning management system	15
2.1.1. The Internet	16
2.1.2. Telephone facilities	16
2.2. THE ROLE OF THE ELEARNING ENVIRONMENT IN TEACHING	16
2.2.0. Advantages	18
2.2.1. Disadvantages	19
2.3. THE ROLE OF THE INTERNET IN ACADEMIC RESEARCH	20
2.3.1. Electronic communication	20
2.3.2. Electronic discussion groups	20
2.3.3. The Internet as an information resource	21
2.3.4. The Internet as a resource for research publications	22
2.4. THE ROLE OF THE TELEPHONE IN AGRICULTURE	22
2.5. SUMMARY OF THE CHAPTER	23
3. CHAPTER THREE: CONCEPTUAL FRAMEWORK	25
3.0. AFFORDANCE AND CAPABILITY THEORIES	25
3.1. AJZEN AND FISHBEIN’S (1980) THEORY	26
3.2. THE DETERMINANTS OF ACADEMICS’ ATTITUDES TO THE LMS	28
3.2.0. Attitudes to an eLearning environment	28
3.0.3. Knowledge gaps	33
3.3. THE THEORY OF THE RESEARCH PRODUCTION FUNCTION	35
3.3.0. The determinants of academic research outputs	36
3.3.0.1. Institutional characteristics	36
3.3.0.2. The effects of research collaboration and social capital	37
3.3.0.3. Individual characteristics	39
3.3.0.4. Research grants and management	42

3.3.0.5. The Internet and research performance	43
3.3.0.6. Knowledge gaps	43
3.4. NEO CLASSICAL GROWTH THEORY	44
3.4.0. The determinants of the agricultural production functions	48
3.4.0.1. South Asian evidence of the determinants	48
3.4.0.2. African evidence of the determinants	49
3.4.0.3. Chinese evidence of the determinants	50
3.4.0.4. Cross-country evidence of the determinants	51
3.4.0.5. Knowledge gaps	51
3.5. SUMMARY OF THE CHAPTER	52
4. CHAPTER FOUR: THE RESEARCH DESIGN AND METHODS.....	53
4.1. DATA TYPES AND SOURCES	53
4.2. DATA COLLECTION	54
4.2.0. Qualitative data collection	54
4.2.1. Quantitative data collection	56
4.1.2. Quantitative data collection from secondary source	59
4.1.3. Reducing nonresponse bias	60
4.3. RESEARCH APPROACHES	61
4.3.0. Mixed approach for RQ 1	62
4.3.1. The quantitative approach for RQ2-RQ4	63
4.4. AN OVERVIEW OF DATA ANALYSIS METHODS	64
4.5. ETHICAL ISSUES	70
4.6. SUMMARY OF THE CHAPTER	71
5. CHAPTER FIVE: ICTS AND ACADEMICS' ATTITUDES.....	72
5.1. QUALITATIVE ANALYSIS AND FINDINGS	72
5.1.0. Temporal limitations	72
5.1.1. Pedagogical limitations	75
5.1.2. Institutional limitations	77
5.2. QUANTITATIVE ANALYSIS AND FINDINGS	82
5.2.0. Factor analysis	82
5.2.1. Step one of factor analysis	84
5.1.2. Step two of factor analysis	89
5.3. SUMMARY OF THE CHAPTER	92
6. CHAPTER SIX: THE ACADEMICS' VARIATIONS ON ATTITUDES TO ICT 93	
6.0.VARIABLES FOR CROSSTABS AND REGRESSIONS	93
6.0.1. Attitudes to eLearning environment	93
6.0.2. Socio-demographic variables	93
6.0.2.0. Native first language status	93
6.0.2.1. Gender, academic degree and academic rank	94
6.0.2.2. Internet usage and teaching load	94
6.0. CROSS-TABULATION RESULTS	96
6.1.0. Gender	96
6.1.1. Age group	96
6.1.2. First language status	97

6.1.3. Academic qualifications	98
6.1. TEST OF INDEPENDENCE	98
6.2.0. Determinants of negative attitudes.....	98
6.2.1. Determinants of positive attitudes	100
6.2. REGRESSION RESULTS	101
6.3.0. Discussion	106
6.3.0.1. The effect of first language status	106
6.3.0.2.. The effect of academic qualifications.....	107
6.3.0.3.. The effect of Internet usage	107
6.3. SUMMARY OF THE CHAPTER	107
7. CHAPTER SEVEN: ACADEMIC RESEARCH PRODUCTION.....	108
7.0.1. R & D in Australian universities.....	108
7.1. VARIABLES FOR THE RESEARCH PRODUCTION FUNCTION	111
7.1.0. Dependent variable.....	111
7.1.2. Explanatory variables.....	115
7.1.2.0. Teaching loads.....	115
7.1.2.1. Internet use	117
7.1.2.2. Research collaboration	119
7.1.2.3. Age	120
7.1.2.4. Research grants.....	121
7.1.2.5. Academic ranks and doctoral qualifications.....	121
7.2. SIMULATION EQUATION MODEL	123
7.2.1. Identification strategy.....	127
7.2.2. Order and rank conditions	128
7.3. ESTIMATION TECHNIQUES	131
7.3.0. Testing of exclusion restriction.....	131
7.3.1. Hausman-Wu test of exogeneity.....	132
7.3.2. Breusch-Pagan (1979) test of independence.....	132
7.3.2. Estimates for endogenous variables.....	134
7.4. RESULTS	140
7.4.0. The determinants of Internet use.....	142
7.4.1. The determinants of research collaboration.....	142
7.4.2. The determinants of research production.....	142
7.4.3. Sensitivity analysis of the model	144
7.4.4. The relative importance of explanatory variables.....	144
7.5. SUMMARY OF THE CHAPTER	144
8. CHAPTER EIGHT: ICT AND AGRICULTURAL OUTPUTS.....	146
8.1. THE STATE OF AUSTRALIAN AGRICULTURAL OUTPUTS	146
8.2. METHODS OF DATA ANALYSIS	148
8.2.0.CDPF Versus CDRF	148
8.2.1.Cobb-Douglas revenue function	149
8.2.2. Parametric approach.....	150
8.2.2.0. Testing for structural break and cross-sectional dependency	152
8.2.2.1. Panel unit root test.....	152
8.2.2.2. Cointegration test	153
8.3. DESCRIPTIONS OF VARIABLES FOR THE AGRICULTURAL REVENUE FUNCTION.....	155

8.3.0. Dependent variable	155
8.3.1. Explanatory variables.....	155
8.3.1.0. CT expenditures	155
8.3.1.1. Other variables	157
8.4. THE ECONOMETRIC ESTIMATION TECHNIQUE	158
8.4.0. Preliminary data analysis	158
8.4.1. Endogeneity test of CT variables.....	160
8.4.2. Estimation strategy	160
8.5. RESULTS	160
8.5.0. Diagnostic tests.....	160
8.5.1. Error correlation models (ECMs).....	161
8.6. SUMMARY OF THE CHAPTER	167
9. CHAPTER NINE: CONCLUSIONS AND FURTHER RESEARCH.....	168
9.1. A SUMMARY OF KEY FINDINGS	168
9.1.1.RQ1: What were academics’ attitudes, based on their reported experiences?	170
9.1.2. R2Q: Was there any variation in attitudes in terms of socio-demographic factors?	171
9.1.3. RQ3: To what extent did the use of the Internet explain the variation on research performances among teaching academics?	172
9.1.4. RQ4: To what extent did the use of ICTs by farmers explain the differences in their agricultural revenue?	175
9.1. CONTRIBUTIONS TO KNOWLEDGE	176
9.1.0. Contributions to theoretical knowledge.....	177
9.1.1. Contributions to methodological knowledge.....	177
9.1.2. Contribution to empirical knowledge.....	177
9.2. POLICY IMPLICATIONS.....	179
9.4. LIMITATIONS OF THE RESEARCH	180
9.5 FURTHER RESEARCH DIRECTIONS.....	181
9.5.0. ICTs and education administrators.....	181
9.5.1. Online education and educational quality	181
9.5.2. ICTs and academic research.....	181
9.5.2. ICTs and agriculture.....	182
9.6. SUMMARY OF THE CHAPTER	182
10. REFERENCES	183
11. APPENDICES	202
12. SURVEY QUESTIONNAIRE.....	273

LIST OF TABLES

TABLE 1.1: THE LIST OF TRANSFORMING GENERAL PURPOSE TECHNOLOGIES	2
TABLE 1.2: KEY AREAS OF THE IMPACTS OF ICTS	3
TABLE 2.1: ENABLING TECHNOLOGIES	23
TABLE 4.1: AN OVERVIEW OF THE PARTICIPANTS IN THE FGD	56
TABLE 4.2: LIST OF STATEMENTS ILLUSTRATING THE PERCEIVED EFFECTS OF ICT ON ACADEMICS WORK	57
TABLE 4.3: RELIABILITY TEST OF COMPOSITE VARIABLE	59
TABLE 5.1: AVERAGE SCORES OF THE LIKERT SCALE MEASURES	84
TABLE 5.2: KMO AND BARTLETT'S (1970) TEST FOR COMPONENT 1	85
TABLE 5.3: TOTAL VARIANCE EXPLAINED FOR COMPONENT 1	86
TABLE 5.4: PARALLEL ANALYSIS	88
TABLE 5.5: PRINCIPAL COMPONENT ANALYSIS	89
TABLE 5.6: KMO AND BARLETT'S (1970) TEST FOR COMPONENT 2	90
TABLE 5.7: TOTAL VARIANCE EXPLAINED FOR COMPONENT 2	90
TABLE 5.8: COMPONENT MATRIX ^A	91
TABLE 6.1: DEPENDENT ORDINAL VARIABLE RELATED TO ATTITUDE TO E ^L ARNING ENVIRONMENT	93
TABLE 6.2: STATUS OF FIRST LANGUAGE	94
TABLE 6.3: INDEPENDENT ORDINAL VARIABLE (GENDER)	94
TABLE 6.4: INDEPENDENT ORDINAL VARIABLE (HIGHEST ACADEMIC DEGREE)	94
TABLE 6.5: INDEPENDENT ORDINAL VARIABLE (ACADEMIC RANK)	94
TABLE 6.6: OTHER INDEPENDENT CONTINUOUS VARIABLES	95
TABLE 6.7: CROSS-TABULATION OF GENDER AND ACADEMIC WORKLOAD	96
TABLE 6.8: CROSS-TABULATION OF AGE GROUP AND ACADEMIC WORKLOAD	97
TABLE 6.9: CROSS-TABULATION OF FIRST LANGUAGE AND ACADEMIC WORKLOAD	97
TABLE 6.10: CROSS-TABULATION OF ACADEMIC QUALIFICATIONS AND ACADEMIC WORKLOAD	98
TABLE 6.11: TEST OF INDEPENDENCE BY GENDER	99
TABLE 6.12: TEST OF INDEPENDENCE BY FIRST LANGUAGE	99
TABLE 6.13: TEST OF INDEPENDENCE BY ACADEMIC QUALIFICATION	100
TABLE 6.14: TEST OF INDEPENDENCE BY GENDER	101
TABLE 6.15: TEST OF INDEPENDENCE BY ETHNICITY	101
TABLE 6.16: TEST OF INDEPENDENCE BY ACADEMIC QUALIFICATION	101
TABLE 6.17: ORDERED PROBIT REGRESSION RESULTS (MLE ESTIMATION)	104
TABLE 6.18: PREDICTED PROBABILITY OF ORDERED PROBIT OUTCOMES	105
TABLE 6.19: MARGINAL EFFECTS OF FIRST SETS OF OUTCOMES	106
TABLE 6.20: MARGINAL EFFECTS OF SECOND SETS OF OUTCOMES	106
TABLE 7.1: THE GROWTH OF RESOURCE ALLOCATION FOR RESEARCH AND DEVELOPMENT	109
TABLE 7.2: THE FREQUENCY DISTRIBUTION OF RESEARCH PRODUCTIONS (WEIGHTED AVERAGE)	114
TABLE 7.3: AVERAGE TEACHING IN 2011-2012	116
TABLE 7.4: THE AVAILABILITY OF COMPUTERS	117
TABLE 7.5: THE AVAILABILITY OF THE INTERNET AT RESIDENCE	117

TABLE 7.6: THE USE OF INTERNET PER DAY (IN HOURS)	118
TABLE 7.7: SUMMARY STATISTICS	118
TABLE 7.8: RESEARCH COLLABORATION BY GENDER	120
TABLE 7.9: DISTRIBUTION OF ACADEMIC BY AGE GROUP	121
TABLE 7.10: SUMMARY STATISTICS OF RESEARCH GRANTS	121
TABLE 7.11: SUMMARY STATISTICS OF FIRST LANGUAGE, QUALIFICATIONS AND ACADEMIC RANK	122
TABLE 7.12: CONSTRUCTS OF THE RESEARCH PRODUCTION FUNCTION	123
TABLE 7.13: IDENTIFICATIONS OF THE SIMULTANEOUS EQUATIONS MODEL	128
TABLE 7.14: RANK CONDITION TEST	129
TABLE 7.15: EXCLUSION RESTRICTION TEST	131
TABLE 7.16: ENDOGENEITY TEST RESULTS	132
TABLE 7.17: BREUSCH-PAGAN (1979) TEST OF INDEPENDENCE	133
TABLE 7.18: TEST OF HETEROSKEDASTICITY	133
TABLE 7.19: ANDERSON-DARLING (1954) TEST	134
TABLE 7.20: 2SLS AND 3SLS ESTIMATES OF THE MODEL	136
TABLE 7.21: DIFFERENCES BETWEEN 2SLS AND 3SLS ESTIMATES	138
TABLE 7.22: HAUSMAN (1978) TEST RESULTS	139
TABLE 7.23: 3SLS ESTIMATION OF SIMULTANEOUS MODELS	141
TABLE 8.1: DISTRIBUTION OF AGRICULTURAL RESOURCES BY AUSTRALIAN STATES, 2011-12	146
TABLE 8.2: DESCRIPTIVE STATISTICS OF THE AGRICULTURAL REVENUE FUNCTION	157
TABLE 8.3: CORRELATION BETWEEN CT EXPENDITURE AND AGRICULTURAL REVENUE	160
TABLE 8.4: PANEL UNIT ROOT TESTS	161
TABLE 8.5: ECM-BASED PANEL CO-INTEGRATION TEST	162
TABLE 8.6: PMG AND AMG ESTIMATION RESULTS	165
TABLE 8.7: POOLED MEAN GROUP ESTIMATION	166
TABLE 8.8: COMPARATIVE ANALYSIS OF THE ELASTICITY OF ICTS	166

LIST OF FIGURES

FIGURE 1.1: PERCENTAGE OF AUSTRALIAN UNIVERSITY STUDENTS STUDYING OFF-CAMPUS	5
FIGURE 1.2: RESEARCH AND DEVELOPMENT EXPENDITURES (PER CENT OF GDP) IN 2014	6
FIGURE 1.3: INTERNET PENETRATION RATES OF INTERNET GLOBALLY, 2014	8
FIGURE 1.4: AGRICULTURE AND LAND USE TREND IN AUSTRALIA BETWEEN 1992 AND 2012	11
FIGURE 2.1: eLEARNING ENVIRONMENT-1 AT THE USQ.	17
FIGURE 2.2: eLEARNING ENVIRONMENT-2 AT THE USQ.	17
FIGURE 2.3: KEY FEATURES OF LEARNING MANAGEMENT SYSTEM IN HIGHER EDUCATION	18
FIGURE 2.4: AN IMAGE OF E-DISCUSSION GROUPS.	21
FIGURE 2.5: THE CONCEPTUAL FRAMEWORK	24
FIGURE 3.1: THEORETICAL FRAMEWORK ABOUT THE EFFECTS OF ICT ON TEACHERS	34
FIGURE 3.2: A CONCEPTUAL FRAMEWORK ABOUT THE MECHANISM OF PRODUCTION	35
FIGURE 3.3: BASIC RELATIONSHIP BETWEEN COLLABORATION AND PRODUCTIVITY	38
FIGURE 3.4: BASIC ANALYTICAL MODEL	39
FIGURE 3.5: GRAPHICAL PRESENTATION OF THE ROLE OF ICT IN PRODUCTION	45
FIGURE 3.6: GRAPHICAL PRESENTATION OF THE RELATIONSHIP BETWEEN ICT AND PRODUCTIVITY	47
FIGURE 4.1: AN OVERVIEW OF MIXED APPROACH	62
FIGURE 4.2: AN OVERVIEW OF THE DATA ANALYSIS APPROACHES	64
FIGURE 5.1: A FRAMEWORK OF INTERACTION BETWEEN THE ACADEMICS AND eLEARNING ENVIRONMENT	80
FIGURE 5.2: AN OVERVIEW OF AN EXPLORATORY FACTOR ANALYSIS	83
FIGURE 5.3: SCREE PLOT	87
FIGURE 6.1: WEEKLY USAGE OF THE INTERNET (BY FACULTIES) FOR WORK-RELATED PURPOSE	95
FIGURE 6.2: THE RANGE OF PREDICTED PROBABILITIES OF SIX OUTCOMES	105
FIGURE 7.1: RESEARCH PUBLICATION OUTPUT, 1992-2011	110
FIGURE 7.2: RESEARCH TRAINING POLICY OF THE AUSTRALIAN GOVERNMENT	111
FIGURE 7.3: NUMBER OF RESEARCH OUTPUTS IN USQ ePRINTS, 2001 - 2013	112
FIGURE 7.4: THE FREQUENCY DISTRIBUTION OF RESEARCH PRODUCTIONS (WEIGHTED AVERAGE)	113
FIGURE 7.5: KERNEL DENSITY DISTRIBUTION OF THE RESEARCH PRODUCTIONS (IN LOG)	114
FIGURE 7.6: DISTRIBUTION OF AVERAGE TEACHING LOADS	116
FIGURE 7.7: HISTOGRAM OF INTERNET USAGE (HOURS)	118
FIGURE 7.8: WEIGHTED REGRESSION LINE	119
FIGURE 8.1: SHARE OF GROSS VALUE OF AUSTRALIA'S AGRICULTURAL PRODUCTION	148
FIGURE 8.2: AVERAGE AGRICULTURAL REVENUE IN AUSTRALIA, 1990-2012	155
FIGURE 8.3 FIXED, MOBILE TELEPHONE AND FIXED-BROADBAND SUBSCRIPTION IN AUSTRALIA	156
FIGURE 8.4: PLOT OF GROWTH OF AGRICULTURAL REVENUE AND CT EXPENDITURES	159
FIGURE 8.5: SCATTER PLOTS OF AGRICULTURAL REVENUE AND CT EXPENDITURE	159
FIGURE 9.1: A THEORETICAL FRAMEWORK ABOUT ACADEMICS' PERCEPTIONS	170
FIGURE 9.2: AN OVERVIEW OF THE KEY FINDINGS OF THIS DOCTORAL RESEARCH	176

1. CHAPTER ONE – INTRODUCTION, RESEARCH QUESTIONS, AND SIGNIFICANCE

1.1. Background and justification

Digital technologies have affected every sector of the economy and many aspects of the social and economic lives of human beings (Kirkwood, 2006) – education, health, governance, poverty reduction, communication and service delivery, regional and urban development, innovation and organisation (Hanna, 2011). Today no facet of human activity has remained unaffected by the various components of information and communication technologies (ICTs). They encompass the economy, education, governance, and the labour market i.e. every aspect of a society. Acknowledging the significance of ICTs, the Australian Governments, both current and the previous, have aimed to develop a digital economy by 2020 (Department of Broadband Communication and the Digital Economy, 2011). To this end, the Government has selected eight areas of focus:

- Expanded online education
- Australian business and non-profit organisations' online participation
- Australian households' online participation
- Smart management of infrastructure and environment
- Improved health care and aged care
- Improved teleworking
- Improved government's service delivery
- Increased engagement in regional Australia

Broadly, multifaceted ICTs have three components. These components are: (i) the appropriateness of information; (ii) communication; and (iii) supporting technologies (Figueres & Eugelink, 2014). In general, by accessing the required information people make informed decisions about their activities, and people also become enablers by joining each other, sharing ideas and co-operating with one another whenever it becomes necessary (Figueres & Eugelink, 2014). The idea of contemporary globalisation is also linked to the idea of the information society, which is based on information technology (IT) (Alampay, 2006). In this process of increasing globalisation and technological development, the world economy has become more integrated than ever before. However, I have been studying various phases of the development of ICTs which is going through revolutionary changes too. In addition, a paradigm shift is underway to deliver cloud-computing, thus providing computing power that will have a profound impact on investment in ICTs and the diffusion of technology (Hanna, 2011). ICT areas that are experiencing change today include mobile devices, wireless communications, open source software and low cost access devices (Hanna, 2011). The tremendous growths in the development of mobile technology have created opportunities for delivering services to geographically remote areas.

Development practitioners express the view that the main contribution of ICTs to economic and social development is their contribution as a General Purpose Technology (GPT) (Basu & Fernald, 2007; Majumdar, 2008; Majumdar, Carare, & Chang, 2010). Lipsey, Carlaw, and Bekar (2005) have defined GPT as a “generic product”. It has much potential and scope for development and eventually comes to be widely used. ICTs have many uses and have many Hicksian and technological complementarities (Lipsey, Carlaw, & Bekar, 2005). The Hicksian complementarity and substitutability in production theory refers to the signs of responses in quantity in response to the changes in price of one input (Lipsey, Carlaw, & Bekar, 2005). For example, because of technological change the cost of an input, say ‘x’, declines. This will cause substitution among some inputs, which in turn will change the demand for some inputs that are complementary to the input ‘x’.

The history of GPT from 10,000 BC to AD 1450 shows that 24 transforming GPTs have emerged in Western society (Lipsey, Carlaw, & Bekar, 2005). The list of transforming general purpose technologies are presented in Table 1.1.

Table 1.1: The list of transforming general purpose technologies

No	General purpose technology	Date
1	Plant domestication	9000-8000 BC
2	Animal domestication	8500-7500 BC
3	Ore smelting	8000-7000 BC
4	Wheel	4000-3000 BC
5	Writing	3400-3200 BC
6	Bronze	2800 BC
7	Iron	1200 BC
8	Waterwheel	Early medieval period
9	Sailing ship	15 th Century
10	Printing	16 th Century
11	Steam engine	Late 18 th and early 19 th Centuries
12	Factory system	Late 18 th and early 19 th Centuries
13	Railway	Mid-19 th Century
14	Iron steamship	Mid-19 th Century
15	Internal combustion engine	Late 19 th Century
16	Electricity	Late 19 th Century
17	Motor powered vehicle	20 th Century
18	Aeroplane	20 th Century
19	Mass production system (factory)	20 th Century
20	Computer	20 th Century
21	Lean production	20 th Century
22	Internet	20 th Century
23	Biotechnology	20 th Century
24	Nanotechnology	Early 21 st Century

Source: Lipsey, Crawl and Bekar (2005, p.132)

Electric power and ICTs are regarded as the most typical GPTs of modern history (Jovanovic & Rouaaeau, 2005), and ICTs in particular are the GPT of the

contemporary age (Hanna, 2011). My observation is that mobile telecommunication is one area that has affected the current society enormously. State-of-the art mobile technologies like iPads and iPhones enable instant communication among users anywhere and at any time. This has resulted in the rapid transfer of information and services over distant lands, without geographical barriers. This is a new way to connect, share and innovate using state-of-the art technology.

The uptake of ICTs is not new in the Australian economy. The Australian Government Productivity Commission (2004) has reported that since the 1990s the rapid uptake of ICTs has been taking place among Australian firms spread across different sectors of the economy (Australian Government Productivity Commission, 2004). The investment in information technology increased by 10 per cent in 2000/01 compared to the investment of 8 per cent in 1989/90. The key areas of effects where ICTs had significant impacts and the nature of those impacts are as follows (Table 1.2):-

Table 1.2: Key areas of the impacts of ICTs

Nature of impacts	Areas
Enhanced human capital	Labour
Outsourcing	Outsourcing of some facilities
Production	Major change of production process
Distribution process	Change of distribution process
Management practice	Timely and accurate management

Source: Australian Government Productivity Commission, 2004, p.4

In the development of regional and rural Australia in terms of social and economic development, ICTs are identified as a key enabler of such development (Kehal & Singh, 2005). Therefore, it is worthwhile to examine the exact nature of the effects of one or two areas in the context of regional Australia.

This study highlights the effects of ICTs on human factors (otherwise called “labour”) in two sectors of the Australian regional and national economy: education and agriculture. The justifications of focusing on two sectors are as follows. In early 2012, the Australian Government declared Collaborative Research Network (CRN) grants for selected Australian universities to develop the research capacities of specific regional universities working in collaboration with metropolitan universities. One successful CRN grant recipient was the University of Southern Queensland (USQ). Under the auspices of USQ, the Australian Digital Futures Institute initiated a project under the broad research theme entitled “*Enhanced practice through connectivity to digital technologies and information*” that aimed at identifying the effects of the use of ICTs on the agriculture and education sectors in Australia. This doctoral research is a research outcome of that project.

Secondly, this research focuses on labour following seminal work by Baumol and Bowen (1966), who explained that education is a labour-intensive industry. This means that, unlike other firms in the manufacturing industry, an educational institution in a higher education industry is unlikely to replace teaching or non-teaching staff members (who are a university's labour force) with capital (i.e., ICTs in this study). Therefore, the impact on labour is a worthy study in relation to the education sector.

Thirdly, although the agriculture sector is not labour-intensive in the same way as education, the main mechanism through which ICTs make an impact on agriculture is the deepening availability of ICT capital (Australian Government Productivity Commission, 2004). There are voluminous research studies that have highlighted the effects of the deepening effects of ICT on the manufacturing and service sectors, but the agricultural sector has remained an under-researched sector.

1.2. Policy context

1.2.0. Participation in higher education

One of the foci of the Australian Government's digital economy is participation in online education. The previous Australian Labour Government has promulgated its Digital Future Vision 2020, including tertiary higher education. The vision is to expand online education opportunity by the year 2020 (Department of Broadband Communications and the Digital Economy, 2011). The policy goal is still valid today. The goal is: *"By 2020, Australian schools, TAFEs, universities and higher education institutions will have the connectivity to develop and collaborate on innovative and flexible educational services and resources to extend online learning resources"* (p. 5)

Universal participation in higher education is a major policy objective of the current Australian government. The main policy tool in this regard has been the uncapping of the student places in higher education so that the demand for and the supply of higher education are responsive and competitive (Centre for the Study of Higher Education, 2013). As a result, the growth of Australian university student enrolments between the years 2009 and 2012 has increased from 9 to 15 per cent (Centre for the Study of Higher Education, 2013).

During the 1980s and the 1990s, the expansion of higher education opportunities within the universities altered the internal management patterns of universities globally, including in Australia. A dominant pattern has emerged that is called the corporation and enterprise model (Ramsden, 2006). Previous models included Collegium and Bureaucracy (McNay, 1995, as cited in Ramsden, 2006), which have now become obsolete. University governance is a potential concern because the goal of education institutions is to manage resources, including human resources, in a productive and efficient manner in order to achieve their objectives, in a similar way to a natural corporate enterprise (Arabac, 2010). Consequently, university governance has changed from a self-governance model to a business corporate model.

Australian universities have been structured as companies under the State or Commonwealth law (Harman & Treadgold, 2007). University governance now looks for a return on the investment in education. Some universities look for surplus. Once upon a time, the investment was a social responsibility free from any predetermined economic objectives. Academics around the world are under pressure to perform to the best of their abilities with fewer resources - more students to teach, more research publications to produce and community services to provide “Academics feel less in charge of their own destinies” (Ramsden, 2006, p. 351). It has also been argued that, in the British and in Australian universities, the academic ability of students has declined owing to the increasing demand for academics’ time and energy (Ramsden, 2006). As a result, a corporate-like organisational climate framing the academics’ work and identities has started to emerge as a concern for academics and university leaders.

In Australia, in 2012, 81 per cent of total student enrolments of university students were studying internally (on-campus), 12 per cent were studying externally and the remaining 7 per cent were studying internally and externally through multimodal programs by the year 2010 (Austrian Bureau of Statistics, 2012) and 9 per cent students were enrolled for blended learning (Norton, 2014). By the year 2013, student participation in higher education had increased to 40 per cent (Australian Bureau of Statistics, 2013), overall, the enrolment for online and distance education has never fallen below 5 per cent of total enrolments (Norton, 2012). Figure 1.1 presents the proportion of students studying off-campus during the period 1950-2010.

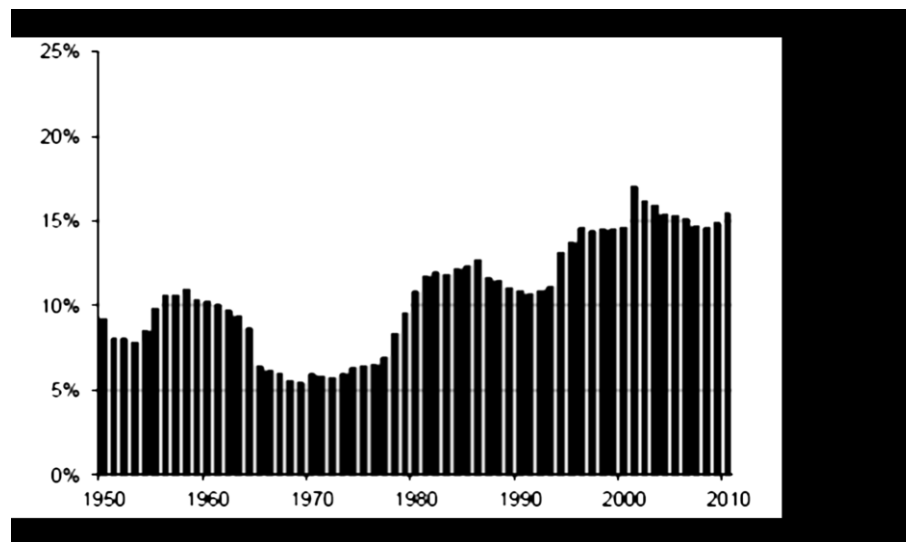


Figure 1.1: Percentage of Australian university students studying off-campus

Source: Norton (2012 p. 24)

The figure highlights that since 1970 the proportion of online and distance Australian university students enrolled for online and distance education increased steadily, albeit with dips between 1990 and 2000, and 2009 and 2010. This was due to the decreasing international student enrolments in Australian off-campus university courses (Norton, 2012). On the other hand, the rapid overall growth of off-campus higher education was due to the improved educational technologies such as the Internet, through which students have been enabled to access their desired academic

lessons while avoiding delays. Technological innovations made the off-campus study mode attractive to potential students; consequently, students with substantial work and family responsibilities became interested in university degrees, and so the overall demand for off-campus higher education increased (Norton, 2012). In order to sustain this demand, universities have been installing state-of-the-art technological devices and software.

1.2.1. Innovation and research

The Australian government’s policy is to encourage innovation, and to fund research and provide incentives for enterprises (Liberal Party of Australia, 2013). The current Australian Commonwealth Coalition government has planned an expenditure of 8.8 billion Australian dollars annually on academic research, including other scientific, private incentive and medical research. However, many politicians and academics have expressed concern that the Australian Government has reduced funding for research significantly. For instance, Greens deputy leader Adam Bandt has said “the Federal Government has cut spending on science, research, and innovation to an historic low” (ABC, 2014).

The Australian Bureau of Statistics (ABS) (2012) defines research and development (R & D) as “creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications” (ABS a, 2012.). R & D play a very important role in economic development in Australia (Abbott & Doucouliagos, 2004). In 2008-09, the Australian government spent 0.53 per cent of the (national) per capital Gross Domestic Product (GDP) on R & D; and the share of R & D has been increasing continuously (Australian Bureau of Statistics, 2008). However, in the global context, Figure 1.2 shows that Australia spent less than the USA, Japan, Germany, Finland and the Republic of Korea on R & D in the year 2014.

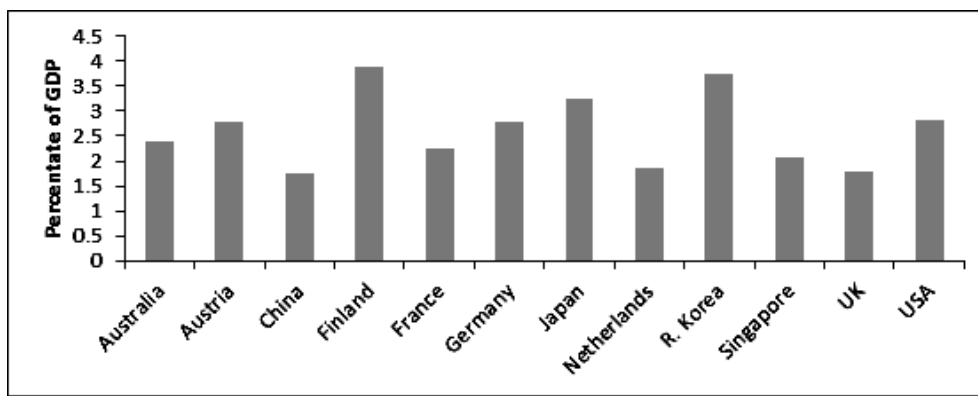


Figure 1.2: Research and development expenditures (per cent of GDP) in 2014

Source: Author’s calculation based on UNSECO data: Science, Technology and Innovation. Accessed on 20/6/2014

1.2.2. Enhanced productivity of the economy

Enhancing productivity of the economy through better and more efficient use of ICTs is a policy measure of the Australian Government (Australian Government

Productivity Commission, 2004). This provides evidence that the use of advanced technologies is among the most important factors, along with other factors, influencing the productivity of different industries (Liberal Party of Australia, 2013). With this end in view, the previous Australian Government has been expanding the National Broadband Network (NBN) infrastructure facilities connecting every house and school to Broadband Internet facilities. The current Australian Government has continued the policy but with a different political commitment. However, public investment in ICTs rose by 13 per cent in 2011-12 compared to the year 2008-09; and 68 per cent of expenditure in 2011-12 was business usual expenditure (ABS, 2012).

1.3. Statement of the research problem

1.3.0. Online teaching and workload

The Organisation for Economic Co-operation and Development (OECD) has written a book entitled “eLearning in Tertiary Education” (OECD, 2005) that has illustrated practices and issues at institutional levels in 13 OECD member countries. The book defines the use of ICTs as being to enhance and/or support learning in higher education, which refers to both wholly online provision and campus-based or other distance provision of education service delivery (p. 11). The book states that different kinds of online education services delivery are available:

- Trivial online presence
- Web supplemented
- Web dependent
- Mixed mode
- Fully online

Furthermore, several studies have used ICTs to support teaching and learning in ways referred to as e-learning, online learning or mobile learning. Hence the concepts of eLearning and online learning are used interchangeably in many studies (Martínez-Caro, 2011), including the OECD’s official documents. For instance, the OECD defines online teaching as including fully online, mixed online and trivial online presence, as per the OECD definition (OECD, 2005, p. 21). Nowadays, along with various types of state-of-the art information and telecommunication devices/tools (such as iPads, iPods, computer servers, laptop computers, tablet PCs, pocket phones, smart phones, portable media players, digital media receivers and services such as broadband Internet and WiMAX) that are used in education, institutional sponsored software is in use. This has generated a new term, “m-learning”.

Online education has enabled students living in remote and isolated locations to access education. However, such access requires a functional Internet connection, a computer (either desktop or laptop) and a valid email address. The importance of the Internet is substantial. The Internet has transformed the delivery of education services globally. The delivery of such education is known as online, distributed or eLearning in the literature.

Teachers and students have been using these diverse types of devices and services for learning, including institution-sponsored software and social software such as Facebook, Skype, Twitter, and You Tube, (Murphy et al. 2013). As a result,

unlike traditional teaching-learning processes, where communication and interaction between teachers and students take place face-to-face inside a classroom, online teaching-learning processes engage teachers and students in a communication network that works anywhere and at any time (Murphy et al., 2013).

In the past couple of years, some studies have explored barriers or challenges faced by academics when teaching students online. These studies have predominantly reflected academics' perceptions in the USA and some in Malaysia (Berge, 1998; Bolliger & Wasilik, 2009; Churchill, Fox, & King, 2012; Jamian, Jalil, & Krauss, 2011). To the best of my knowledge, any comprehensive study is currently unavailable in Australia. This PhD study provides such a comprehensive study by exploring university academics' actual perceptions of the use of ICTs in teaching students online and is intended to enrich the existing body of literature. It also helps to generalise the effects of ICTs on teaching staff members who are striving to teach students in a technology-driven new environment.

1.3.1. The Internet and research performance

The Internet can be seen as a leveraging tool. The growth of broadband Internet powered by high speed bandwidth over the last couple of decades has increased the potential of the growth of R & D globally, including in Australia. Internet penetration rates around the world have increased from 22.1 per cent in 2009 to 39.7 per cent in 2013 (Internet World Stats, 2014). However, the distribution of these penetration rates varies geographically. In December 2013, North America, Europe, and Australia had the highest penetration rates, although Asia and Latin America have been rapidly increasing in recent years (Figure 1.3). These developments have changed the ways in which we communicate, collect and disseminate information, run businesses, shop for goods and services, conduct teaching and learning, and manage our personal matters.

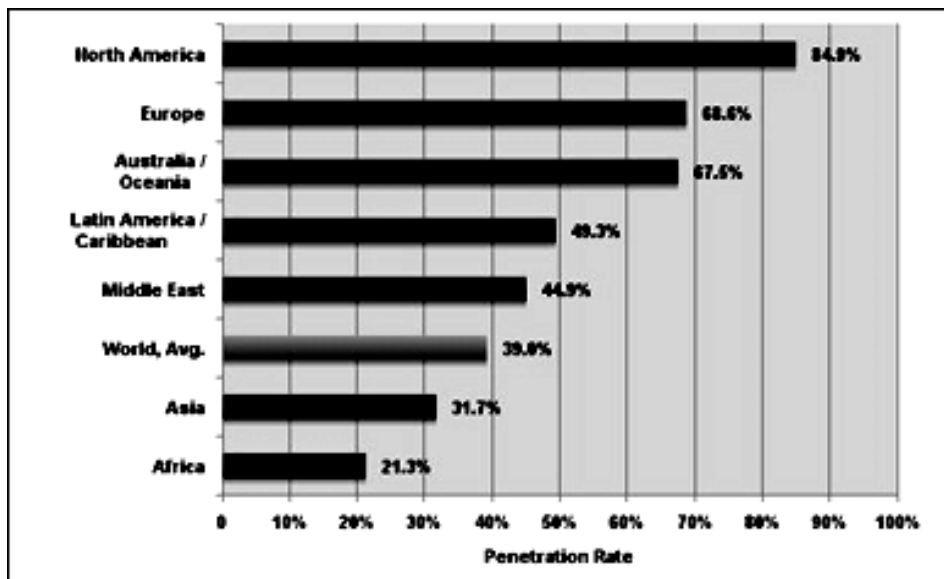


Figure 1.3: Internet penetration rates of internet globally, 2014

Source: Internet World Stats. <http://www.internetworldstats.com/stats.htm>

In Nobel Laureate Amartya Sen's capability theory, "technology is the means to reach the ends" (Coeckelbergh, 2010, p. 84). Furthermore, access to the Internet creates economic opportunities and participation (United Nation Development Programme, 2001). Therefore, there has been increasing interest among researchers and public policy makers in the likely effects of new information and communication infrastructure facilities. A recent Australian Bureau of Statistics (2011) report shows that 93 per cent of Australian households with children under 15 had Internet access in 2010-2011, and that 77 per cent of Australian households used the Internet in 2010-11 compared to 59 per cent in 2005-06 (Australian Bureau of Statistics, 2011). The Australian government is contemplating the benefits from the NBN facilities in terms of increasing online learning opportunities (Department of Broadband Communications and the Digital Economy, 2011). Accordingly, it is also timely to analyse assumed and asserted benefits in relation to academic research. The new connections through the Internet have substantially increased the number of possible technological combinations the greater the numbers, the greater the new ideas that can ultimately lead to growth in research.

Many academics use the Internet for academic purposes (Allen, Burk, & Davis, 2006). The academic uses of the Internet can contribute to scholarly activities through diverse mechanisms. These mechanisms are information resources, electronic discussions, accessing online databases, libraries, and electronic journals and newsletters (Allen, Burk, & Davis, 2006). Nowadays almost all organizations maintain their scholarly resources on their websites. The uses of commercial Internet resources vary widely. Literature shows five broad categories of use – general information gathering, background, context study, analysing data collected from a website, and website study (Allen et al., 2006).

Access to the Internet has become an essential ingredient in improving the research efforts of academics and their intellectual development in the global village of knowledge management. It was reported that 95.6 per cent of Australian academics had access to a computer and the Internet at their work, which is considered one of the most important resources of scholarly activities (Applebee, Clayton, Pascoe, & Bruce, 2000). [ENREF 3](#) A very recent phenomenon is the tremendous growth of online journals or electronic journals. In earlier days, many studies investigated the use of the Internet in educational settings among academics. Anderson and Harris (1997) reported that in Texas (USA) the use of the Internet for professional development was 45 per cent, while the use of the Internet for instructional purposes was less than 16 per cent. At the same time, in another study in two Singaporean universities, Palvia, Tung, Ee and Li (1995) found that academic staff members from the science disciplines were using the Internet. The frequency of use of electronic mail for academic and research purposes was ranked top, followed by the UseNet Newsgroup. Uddin (2003) in a study in a Bangladeshi university (Rajshahi University) found that, although 80 per cent of faculty members were using email, 56 per cent of academics were downloading files or journals. More specifically, regarding publication information seeking activities, the study found that on average 68.81 per cent of academics expressed a positive attitude to using the Internet for publication-related information. Crooks et al. (2003) also found evidence of favourable attitudes towards using web-based resources. Moreover, through high-speed Internet, researchers can access vast stores of resources simply by exploring the Internet (Butler, 1997).

1.3.2. ICTs and farmers' success

The Food and Agriculture Organization (2013) reports that globally approximately 870 million people suffer from hunger and poverty despite the production of sufficient amounts of food, which might be related to the increasing demand being generated by the world's growing population. Thus, because large numbers of people are starving, food security is a global challenge (Stoutjesdijk, 2013). Food insecurity arises when people do not have adequate access to food; therefore, increasing food production by around 70 per cent is a significant priority (FAO, 2009).

Agriculture is an important sector of the Australian economy. In 2012 the contribution of the agricultural sector to the national gross domestic product (GDP) was approximately 3 per cent (National Farmers Federation, 2012). There were approximately 134,000 farm businesses and ninety per cent of them were owned by families in 2012 (National Farmers Federation, 2012).

The broadacre sector of Australian agriculture consists of five industries: wheat and other crops, mixed livestock-crops, sheep, beef, and the sheep-beef industry (DAFF 2012). The contribution of these industries is the largest one because it generates over 85 per cent of the country's gross agricultural output (Khan, Salim, & Bloach, 2014). Based on the market value of total output, wheat is regarded as the bumper crop in broadacre agriculture (Khan, Salim, & Bloach, 2014). It exports earning account for a larger share of total exports (food items only) than any other broadacre crop such as barley, sorghum, rice, cotton, canola, oats, lupins, and sugarcane (ABARES, 2013).

Australia has seven major states: New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania and Northern Territory. Tasmania is the smallest state in Australia in terms of geographical area, and Western Australia is the largest. The unequal distribution of agricultural land and cultivated land generates interstate differences in agricultural production capability. For example, in the state of Victoria, the actual use of agricultural land was relatively very high (16.53 per cent) in 2011-12.

Although Australia has high levels of food security, it is argued that Australian farmers need to maintain a profitable and competitive farming system in order to ensure a sustainable food production system (Have & Stoutjesdijk, 2011). Therefore, the main challenge in Australian agriculture is sustainable and profitable production in the face of natural disasters, adverse weather conditions, and sudden and unexpected climatic events.

Australia is a country endowed with vast natural resources. Land is one of the God gifted resources, along with minerals. Although agriculture remains a dominant form of land use in Australia, between the years 1992/1993 and 2010/2011, the total area of agriculture in Australia decreased over time at a modest rate (Mewett et al., 2013) (Figure 1.4). It is evident from the graph that the largest decrease occurred between 2005 and 2012. The driving force behind the decline included economic, environmental, and social forces (Mewett et al., 2013).

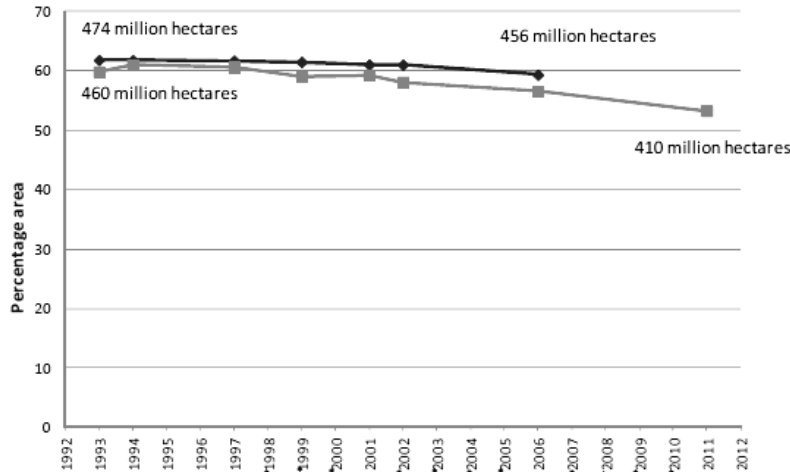


Figure 1.4: Agriculture and land use trend in Australia between 1992 and 2012

Source: Mewett et al. (2013, p. 11).

However, Stienen, Bruinsma and Neuman (2007) asserted that ICTs play an important role in overcoming the challenges of the dwindling natural resources that are essential for agriculture. For instance, these challenges include shortages of land and water, decreasing soil fertility, the effects of weather and the rapid decline of land fertility associated with rapid urbanization processes. They added that the World Summit on the Information Society (WSIS) between the years 2003 and 2005 has recognized the role of ICTs. ICTs are defined technologies that facilitate communication, processing, storage, retrieval and transmission of information by electronic means (Ajani & Agwu, 2012). It is believed that, with regard to under-performing farming communities, the interventions through ICTs can make a difference (Figueres & Eugelink, 2014). Literature has provided evidence with regard to the applications of ICTs in the manufacturing and service sectors (Cardona, Kretschmer, & Strobel, 2013); however, it is not yet known what the evidence is with regard to the agricultural sector.

1.4. Research objectives and research questions

The main goal of this research work is to assess the effects (i.e., the influences) of the uses of ICTs on teachers and farmers in Australia. Specifically, this PhD research has two research objectives:

- (i) Understanding the effects of ICTs on academics who were engaged in teaching and research (otherwise called “teaching-only academics”)
- (ii) Understanding the effects of ICTs on farmers who were engaged in broadacre agriculture.

In order to fulfil the research objectives, I frame our research questions as follows. The first two questions will develop theory and the following three research questions will test the theory or in other words will test hypotheses.

- (i) What were academics’ attitudes, based on their reported experience, in using ICTs?

- (ii) Was there any variation in academics' attitudes in terms of their socio-demographic factors?
- (iii) To what extent does the use of ICTs explain the differences in research performances amongst academics?
- (iv) To what extent did the uses of ICTs by farmers explain the differences in their agricultural output?

1.5. Significance of the research

The main significance of this research is that the research theme is built on the previous Australian Government's aim of a digital economy – to make more effective use of ICTs in departments and agencies and, thereby, to ensure a vibrant and resilient economy. In the given context, the previous Australian government has already started installing high-speed Internet facilities in Australian businesses, homes, and schools under the National Broadband Network (NBN) infrastructure (Department of Broadband Communications and the Digital Economy, 2013). The previous government invested A\$250 million and connected 6,000 kilometers of optic fibre cable across Australia, and the new links have improved broadband and mobile telephony services across regional Australia (Department of Broadband Communications and the Digital Economy, 2013 p. 11), where the agricultural firms have been operating. In the given context it is imperative to know about the likely benefits that this investment will generate for the national economy and for the agricultural economy in particular. More specifically, in the context of the use of ICTs in teaching and learning processes, a challenging working environment has emerged in universities. On the one hand, education policy makers and entrepreneurs are expanding online education opportunities; on the other hand, academics are feeling the pressure of increasing work pressures. As a result, it has become imperative to understand academics' practical experiences of using ICT in teaching students online (Xu & Meyer, 2007). The reason for this is that academic (teaching) staff members play the main role in teaching and the non-teaching staff members play the main role in supporting the teaching staff members and students. These two distinct groups are not substitutable for each other in a university. Unless satisfactory working conditions are created for the teaching staff members, students' learning outcomes may be affected adversely (Bolliger & Wasilik, 2009); consequently, the expansion of online education opportunities may be problematic. An expected outcome from this research is to generate insights about the positive and negative effects of using ICTs on Australian university teachers and farmers. Based on those insights, the effects on the Australian public policy makers will be success in designing public policy interventions required to achieve the targets of the digital economy by 2020.

1.6. Scope of the study

This study focuses on the socio-economic effect of the use of the information and communication technologies (ICTs) on two sectors of Australia: agriculture and education sectors. I have selected the two sectors because of the research theme of the Australian Digital Futures Institute (ADFI) of University of Southern Queensland, the main sponsor of this thesis. With regard to the education sector, this study focuses on the social effect of ICT in a university – University of Southern Queensland, Australia. And with regard to agriculture, this study focuses on the economic effect in Australian broadacre agriculture.

ICT is a combination of information technologies (ITs) and communication technologies (CTs). Further ICT has software and hardware components. This study examines the social effects of the use of social software, including LMS by the USQ academics who are engaged in online teaching and learning only. Blended learning remains outside the scope of this study. Further, this study examines the effect of the use Internet by the USQ academics on research productivity. Regarding the effect of the use internet in broadacre agriculture, this study examines the effect on the Australian farmers' revenue earning. The diversified capacity of internet remain outside the scope of the study. Furthermore, the use of diversified equipment and tools for using social software, including LMS and/or internet remain outside the scope of the study.

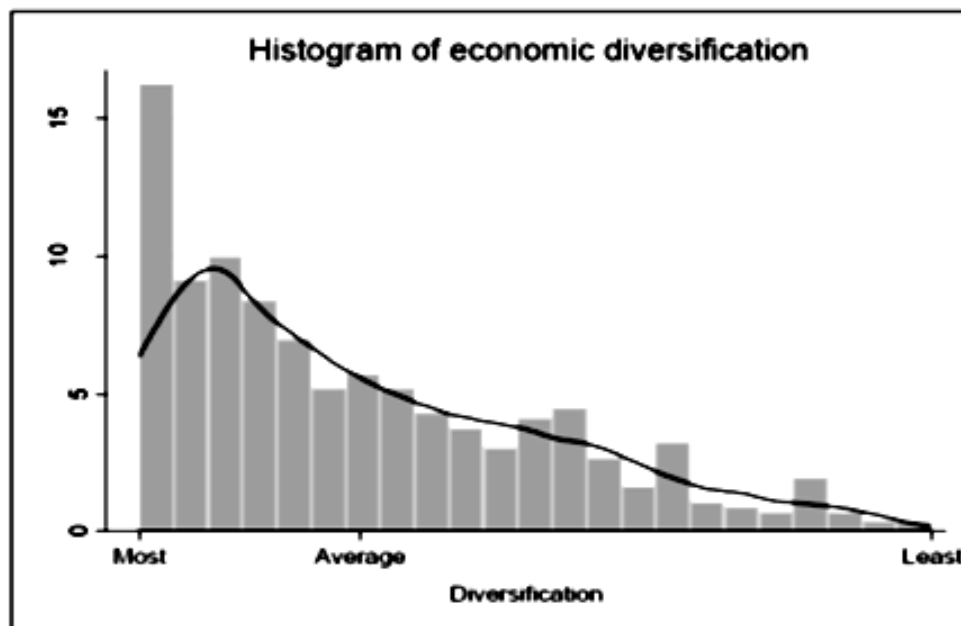


Figure 1.5: Distribution of diversification across LGAs

Source: Regional Australia Institute (n.d. p.4)

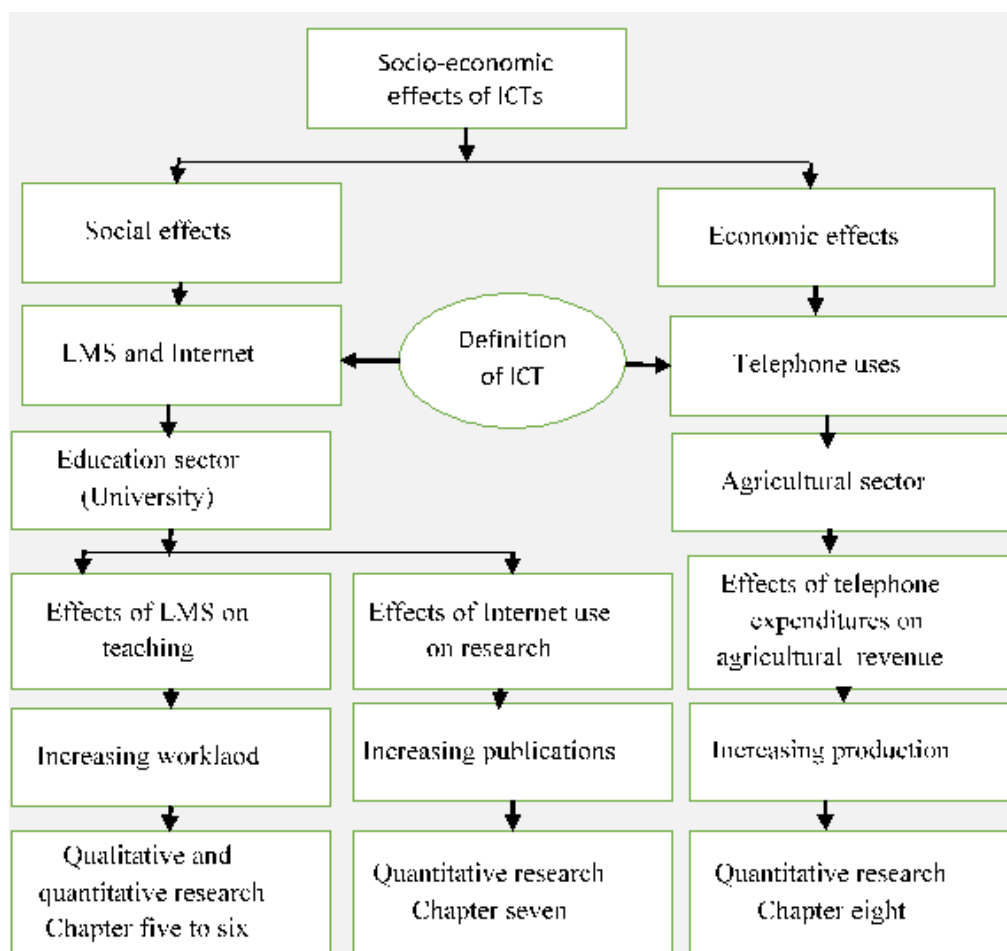
1.7. Summary of the Chapter

Politicians and scholars feel that the digital economy is a way ahead for improving the living standards of general Australians. Although a substantial research initiative has already been undertaken by previous researchers to examine the benefits of modern ICTs (information and communication technologies) in society, the extent of benefits (or problems) associated with the expansion of digital infrastructure facilities are yet to be estimated for at least two sectors of the economy – higher education and agriculture. In the given context of the Australian Government's policy on the digital future, this doctoral thesis aims to study the effects of digital technologies, particularly ICTs, on academics and farmers in Australia. The direction of effects encompasses social and economic aspects only. The Collaborative Research Network Project of the Australian Government has funded the project under the management of the Australian Digital Future Institute (ADFI) of USQ.

In order to fulfil the research objectives, this research has framed five research questions. The answers to the five research questions will make both a theoretical and empirical contribution to the existing body of knowledge related the effects of digital technologies. Figure 4 presents the organisation of the analysis chapters of the thesis. In the diagram, the flow of the study’s components is presented. At the top of the figure lies the main theme of the thesis: the socio-economic effects of ICTs.

This thesis has nine chapters, including this chapter, Chapter 1, as the Introduction. Chapter 2 describes the study’s literature review. Chapter 3 describes the conceptual framework based on the role of ICTs in university teaching and research, and agricultural farming. Chapter 4 is about the study’s research design, including data collection, data analysis and research ethics. Chapter 5, Chapter 6, Chapter 7 and Chapter 8 present the analysis and findings of the research. The thesis ends with the conclusions, limitations and recommendations outlined in Chapter 9.

Figure 1.6: Organization of the analysis of the thesis



2. CHAPTER TWO: LITERATURE REVIEW

2.1. ICT concepts

Broadly, ICT has two components - information technology (IT) and communication technology (CT). IT covers all forms of computers and network communications and CT covers all sorts of telecommunications facilities and software. This doctoral research is concerned with various components of CTs. In terms of the context of communication, this research has defined CT in the following ways:

- Learning management system (LMS), including social software;
- Internet, including web surfing, emailing and similar other online-based activities; and
- Telecommunication facilities.

The justification for the definition is that it fulfils the research objective and is based on availability of data. I have also followed examples from other studies. In the past, researchers have defined ICTs in different ways in their studies because of various research objectives. For instance, Jamin, Jalil, and Krauss (2011) have defined ICT in terms of two objects - tools and applications - to study the effect of ICTs in Malaysian universities. Meyer (2012) has defined ICT in terms of applications only, which cover a variety of web-based approaches - online discussions, group projects, and the university's learning management system.

2.1.0. Learning management system

To examine the effects on teachers engaged in online and blended teaching I have defined ICTs in terms of software – Learning Management System (LMS). LMS refers to a group of software applications designed to provide a range of administrative and pedagogical services related to formal education settings (OECD 2005). Other terms are used to describe the systems: virtual learning environments, and course management systems. The institution-listed learning management system differs from country to country and institution to institution. A portal refers to a single gateway to a range of academic and administrative information/services, typically with a single sign-on. Common functionality includes searching the course catalogue, course registration, access to assessment results, library access and course syllabus. My observation is that the most commonly used software in Australian universities is Study Desk, including Moodle.

Apart from institutional software, Social Software like Facebook, Twitter, Skype, and You Tube are used. This software is used in teaching and learning unofficially in the sense that the institution does not sponsor it, but the software is free of charge. In this thesis, I define ICT narrowly to include ICT applications only. These applications encompasses both official and non-official teaching and learning management software, such as Moodle, email, and blogs, that are used by the university's faculties mandatorily. These components are generic and will be available in all types of education institutions engaged in distance education. At the foundation of the system lie the sources of knowledge, next comes the design aspect, and then comes the delivery of the knowledge. The LMS is a state-of-the-art delivery system in the twenty-first century.

2.1.1. The Internet

Internet is the most useful component of ICT used in academic settings. People use e-mail (electronic mail) for communication, which is powered by the Internet service. The first step to access to an e-mail system is creating an email account. Perhaps it the single most used Internet service. A university without Internet facilities is no longer in existence nowadays. The most significant advantage of the use of the Internet is that it considerably reduces communication difficulties for academics working at geographical isolated universities (Applebee et al., 2000).

2.1.2. Telephone facilities

In regards to the study of the effects of ICTs on farmers in agriculture, I have defined CT in terms of the access to telephone facilities by the farmers. The justification of making this choice is the availability of data. I preferred Internet facilities used by farmers, but I did not use any data on Internet facilities. Additionally, I have focused on information about telephone facilities. The telephone includes both mobile phones and land lines. The International Telecommunication Union (ITU) recommended three indicators to measure the index of ICT in a country (International Telecommunication Union, 2011). These indicators were subscriptions for mobile phone, fixed-telephone, and Internet per 1000 inhabitants. These indicators measured 'the access to ICT' in a country. In this thesis, I was concerned with the use of ICT rather than the concept of 'the access to ICT'. Therefore, I preferred to use expenditure data on telephones, including mobile phones. The measure was a proxy variable for the main variable CT. As some Australian farmers are located in very remote areas, presumably the majority of those farmers have access to mobile phones. Today, the mobile phone comes with state-of-the-art Internet facilities. As a result, by accessing the information about phones, I can also assess the importance of the Internet as a communication technology indirectly.

2.2. The role of the eLearning environment in teaching

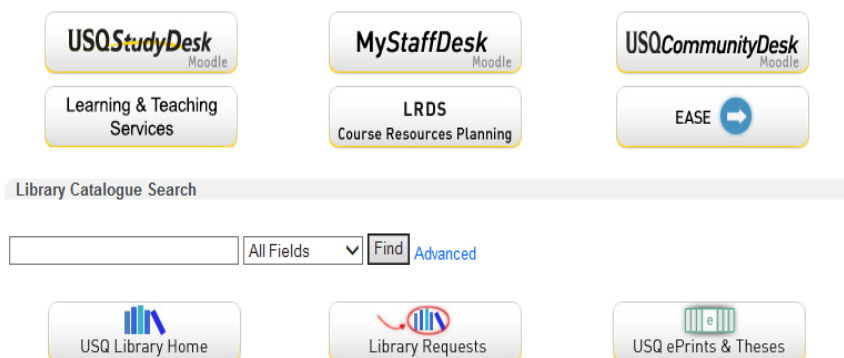
In higher education, the integration of ICT as a conversion factor in reform agendas has been noticeable around the world for a long time. The UN International Covenant on Economic, Social and Cultural Rights of 1966 declared, in Article 13, 2(c) that "higher education shall be made equally accessible to all, on the basis of capacity, by every appropriate means, and in particular by the progressive introduction of free education" (Office of the High Commission of the Human Rights, n.d.). The main contribution of ICT in higher education is to the massification of higher education around the world, and higher education is currently going through a period of transformations (Iniesta-Bonillo, Sánchez-Fernández, & Schlesinger, 2013). In the OECD member countries, campus-based student enrolments are decreasing gradually while online student enrolments are increasing (OECD, 2012). The main social force is widening access to, or participation in, higher education and higher education completion rates (Bolliger & Wasilik, 2009). However, economic and social forces are interlinked with each other. ICT driven eLearning is believed to be able to contribute by increasing access to education in society by overcoming the space constraint associated with traditional F2F education (Castillo-Merino & Sjöberg, 2008). As a result, enrolments to degree programs in higher education have increased among the groups of people who could otherwise not enrol into the program.

The most conventional ways of learning take place in a closed learning environment, typically in a classroom located in a location where an instructor deliver lectures to the students face-to-face (Castillo-Merino & Sjöberg, 2008). The progression of content within the course itself usually defines the pace of teaching and learning. In general this conventional form of learning depends on self-study. On the other hand, open learning is a common term used to describe a variety of educational opportunities that reflect an emphasis on student-centered learning rather than instructor-centered learning.

The role of ICT in higher education encompasses multiple components that make up teaching, learning, communication, design, and management. Each component is a subsystem. One such sub-system is made up of learning management systems (LMSs) that are used widely in “technology-supported education” (Sampson & Zervas, 2013, p. 163). The systems are used in many Australian universities too including at the University of Southern Queensland. A typical image of an LMS is provided in Figures 2.1 and 2.2.



Figure 2.1: eLearning environment-1 at the USQ.



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Figure 2.2: eLearning environment-2 at the USQ.

Source: adapted from the USQ website

The key differences between distance education (or online education) and F2F education is that in the former case, interaction in a course is conducted by an instructor but the course is often designed by design and content experts (Moore and Kearsley, 1996). On the basis of the design and content, the instructor interacts with the students. The interactions among instructors and students are based on issues and questions determined by the course designers. The interactions are conducted by means of the LMS, including teleconferencing or video conferencing technologies. Moore and Kearsley (1996) have stated about a traditional distance education model that “In a total system approach, the course design team sets assignments based on the content of each unit of a course, and the assignments are undertaken by individual students who send them to their personal tutors by mail. The tutor reads, comments and returns the assignment by mail” (p.11). Nowadays, because of the availability of Web 2.0 technology, the postal mail is replaced by electronic mail; and the LMS manages student submissions of assignments. Consequently, the pace of interactions between the instructors and students has become faster.

2.2.0. Advantages

The LMS has several advantages and disadvantages. The advantages of the LMS are that it includes standard communication tools, such as email and bulletin boards, which can assist teaching institutions to centralise all teaching and learning efforts, providing competency in management and standard reporting (Barron & Rickelman, 2002). The LMS can manage all sorts of modes of teaching and learning: face-to-face, and online. This enables higher education institutions to offer an optimal composition of training methods too (Barron & Rickelman, 2002). This allows the students to register for courses online, arrange for course materials, and assign resources. Using the LMS, tutors are able to organise their course syllabus, upload and share course materials, including uploading and downloading assignments and examination papers. Moreover, the LMS offers very effective ways for communication and consultation between the tutors and their students (Demetrios & Panagiotis, 2012). The key features of the LMS are as follows:

Features	Students	Tutors	Administrators	Educational Organization
Upload and share course materials		√	√	
Access and download lecture notes and course supportive material	√			
Participation to online synchronous and/or asynchronous activities	√	√		
Create online assessments		√		
Participation to on-line quizzes/surveys	√			
Access to online grade book	√	√	√	
Gather and review assignments		√		
Create and manage course syllabus		√		√
Students and Academic Personnel management and administration			√	√
Courses management and administration			√	√
Students' progress tracking	√	√	√	√
Summative students' statistics			√	√

Figure 2.3: Key features of learning management system in higher education

Source: Demetrios and Panagiotis, (2012, p. 165).

Barron and Rickelman (2002) have asserted that another advantage of the LMS includes competency management. Built-in-gap analyses are deployed to identify the gaps between the students' competency and skill levels. The LMS enables instructors to perform assessments, approve teaching plans, and monitor statuses all within a Web environment. Furthermore, with LMSs, students' progress and test results are tracked and reported automatically. The LMS puts an integrated system of teaching efforts in place where redundancies are minimised (Barron & Rickelman, 2002).

2.2.1. Disadvantages

Barron and Rickelman (2002) have also asserted some disadvantages of the LMS including financial and temporal. The LMS system requires a huge amount of expense and time to install and to be operationalised. Moreover, because of the integrated system, the existing courses and databases are required to be replaced which necessitates a major commitment of time and energy. In this study, I explore the relationship between the inputs and intermediaries, i.e. the LMS, rather than the outputs. The intermediaries contribute to the final teaching output i.e. graduates. This is a relationship between humans and the LMS, as an object, in the aforementioned relationships.

The introduction of the eLearning environment has made a transition from traditional class-room-based teaching to technology-based teaching possible, and the transition has generated several changes, including changes in learning environments. Teachers' traditional role in the classroom has changed (Prestridge, 2012). The ever-increasing uses of various technologies have changed the traditional nature of work of a teacher. The most notable change is in teaching method. The implementation of an eLearning environment in the classroom has increased co-operative learning and student- centered discussion. Each teacher has needed to develop additional work skills, which is attributed to the use of ICT in his/her work place and/ or beyond his/her work place. The list of ICT-related work includes learning new software applications and effective communication techniques with students in diverse learning spaces, specifically preparing digital content for teaching students online, F2F and/or both. Further to this, there is daily communication with the students by email. As noted above, the extended ICT-related work has created a requirement for new types of ICT skills for teachers as it is very different from teaching students online or F2F.

The usefulness of the LMS can be seen as a product of a whole learning process rather than in isolation from the learning context (Day & Lloyd, 2007). The perception of academics and the university's arrangements for teaching are two essential elements of learning contexts. In a constructivist learning context, the role of academics is to create supportive learning environments so that the learners can use features in line with their abilities to achieve learning outcomes (Kennewell, 2001). The desired learning environment can be created by academics if they are comfortable with the technology, i.e. the LMS, because academics' perceptions about the LMS might affect the action of integrating the LMS into an eLearning environment. It is very important to assess the existing academics' perceptions of (over-)workload to determine the barriers to successful transformation of inputs into outputs.

In case of the LMS, wherein the user is a teaching academic closely linked to the system, in which they are required to execute their teaching responsibilities. The LMS user's opinion of herself or himself is supposed to be affected by the affordances of the system – the LMS, which includes the content of the system, physical appearance of the system, and physical effort required to handle the system.

2.3. The role of the Internet in academic research

2.3.1. Electronic communication

In Australia, the majority universities are operating through different campuses. Therefore, communication between the campuses is essential, and in such a situation, the role of the Internet is obvious. By virtue of the Internet, one can send and receive mail at any time. The system enhances frequency of communication too. Further, one the greatest virtue of electronic communication is attaching files. For instance, a file might be any document –newsletter, conference announcement, examination paper etc. There is little argument about the general benefits of Internet. Applebee et al. (2000) reported that, given the Australian experience of multi-campus institutions, e-mail was an obvious alternative for internal communication among colleagues and students.

My observation is that a university academic may use e-mail to generate and foster research collaboration - a powerful factor for research productivity (Kartz & Martin, 1997). The extent of collaboration may vary from general advice and insights to active participation, and from substantial to negligible. Recognising the importance of research collaboration, the Department of Education of the Australian government set up a Collaborative Research Network (CRN) program in 2012-13 to develop the research capacity of smaller, less research-intensive and regional universities (Department of Education, n.d.).

2.3.2. Electronic discussion groups

Electronic discussion (or e-discussion) also provides new informal communication channels for many groups. They come together through mailing lists, list servers, or electronic conferences. A person or a group interested in offering a particular discussion forum initiates the discussion. Participants who have email accounts can participate through a networked computer hosted by the forum initiator. Many discussion groups are in existence on various subjects and in several locations on the USQ intranet. For instance, USQ has an ePortfolio system where one can join groups one is interested in. An image of the available groups is presented in Figure 2.4.

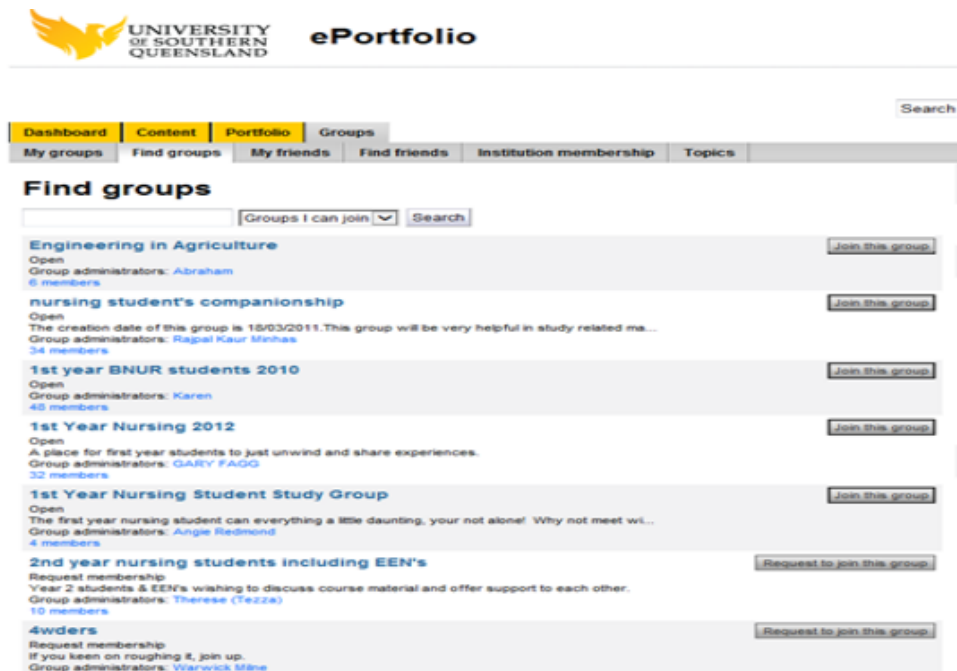


Figure 2.4: An image of e-discussion groups.

Source: Adapted from the USQ website: www.usq.edu.au

A number of assumptions made about e-discussion. E-mail and e-discussion depend on reviewability and reversibility (Williams & Murphy, 2002). Both have different kinds of constraints that incur different costs and therefore require different strategies to cope with them. Further, compared to email, e-discussion accommodates the schedules and preferences of students and instructors, as the technology allows access at a time of the user's choice (Williams & Murphy, 2002).

2.3.3. The Internet as an information resource

Besides the facility of enhanced communication among people, the Internet has already emerged as an information resource. The Internet is playing the role of a data warehouse and is used as a guide to locate information material. It affords users access to library catalogues from any place and at any time. The ability to access information databases across Australia and the world is invaluable nowadays (Bruce, 1994). USQ subscribes to databases such as Science Direct and JSTOR annually and spends a large amount of resources on them. Currently a huge amount of information is available on the Internet. Steadily, access to commercial research databases such as bibliographic databases, that were formerly only available on CD-ROM, is increasing. Numbers of electronic journals are increasing continuously as well. Nowadays, a researcher can search any bibliographic database and journal through various search engines and catalogues which are available on the World Wide Web.

.Furthermore, researchers are increasingly using the Internet to enable direct access to primary sources of information. As a result, printed newspapers, journals, and magazines are becoming obsolete and electronic newspapers, journals, manuscripts and other texts and images are emerging. New technological devices facilitate data collection too. Nowadays, researchers resort to online survey tools, such as Qualtrics and Survey Monkey, for data collection.

2.3.4. The Internet as a resource for research publications

Publishing research is time consuming work (Johnes, 2003). Johnes asserted that a successful research publication record often involves many unsuccessful attempts, and the unsuccessful efforts take a substantial amount of time, which in turn has cost implications. To publish a research article in an academic journal requires many months of vigorous effort (Johnes 2003). In the given context, rapid technological progress has altered the ways journals articles, book chapters, and books are published. Since 1987 publication companies have been going online and have been moving from paperback copies to electronic copies (Butler, 1997), which is very fast, reliable and to some extent free of charge. The author bears the cost of publication occasionally. It is argued that a significant advantage of e-journals is the short production time of the journal (Butler 1997). Sometimes, electronic journal publishers can produce articles within two days of the approval of the manuscript. Thus, it has become the most important component of the academic research world as an outlet of research.

2.4. The role of the telephone in agriculture

Nobel laureate economist Joseph Stiglitz (2000) in a seminal work first reiterated the role of information in economics in the twentieth century, when he argued that information economics has a direct and indirect effect on economics today. Since then, many economists consider that knowledge acquired through accessing information shared by various agents is the most important success factor, given other factors of production such as land, labour, capital and organisational arrangement stays at the status quo level. Therefore, the main role of ICT in production is indirect here, through the farmers' access to information.

Stoutjesdijk and Have (2013) in an ABARES technical report expresses the opinion that new enabling technologies, built on existing ones, will contribute to comparatively efficient farming practice, and to approaches to ensure profitable and productive agriculture.

In the report, they further evaluate three types of enabling technologies with reference to agriculture – information and communication technologies, biotechnology, and nanotechnology. A 2011 World Bank Report (2011) classifies enabling technologies as yield technologies (improved seed and crops) through biotechnology and information and communication technologies. Table 2.1 outlines the role of enabling technology in farmer yield and sustainable food production, based on a report by Stoutjesdijk and Have (2013).

Table 2.1: Enabling technologies

Enabling technology	Increase potential yield or water limited potential yield	Increase farmer yield	Address sustainability
Information and communications	No	Precision agriculture and new crop management tools	Yes
Biotechnology	Plant breeding	Plant breeding for tolerance against stress, pests and diseases	Yes
Nanotechnology	No	Improved pest control, remediation	Yes

2.5. Summary of the Chapter

In this Chapter, I have developed the main conceptual framework. I have defined ICT in terms of CTs. The definitions of CT with relation to the studies are following:

- Learning management system (LMS);
- Internet, including web surfing, emailing and similar other online-based activities; and
- Telecommunication facilities.

The LMS of a university consists of many online platforms – for example Study desk, eportal, virtual classroom, electronic management of assignments, and video conferencing. Here, the LMS is conceptualised as physical capital or communication infrastructure. The infrastructure plays the role of medium of interaction between students and teachers. Hence, the effect of LMSs on the academics is better termed as mediated effect.

Internet and telephone are also parts of physical capital or communication infrastructure. Academics and farmers use the Internet and telephone to access to the hosts of information resources and thereby, expedite both research publication and agricultural production. This implies that because of depending of capital per academic and per farmer productivity increases. The effects of ICTs infrastructure on labour have been well-established in literature already (Brynjolfsson & Hitt, 2000). Thus, I present a conceptual framework used in this study in the following Figure 2.5.

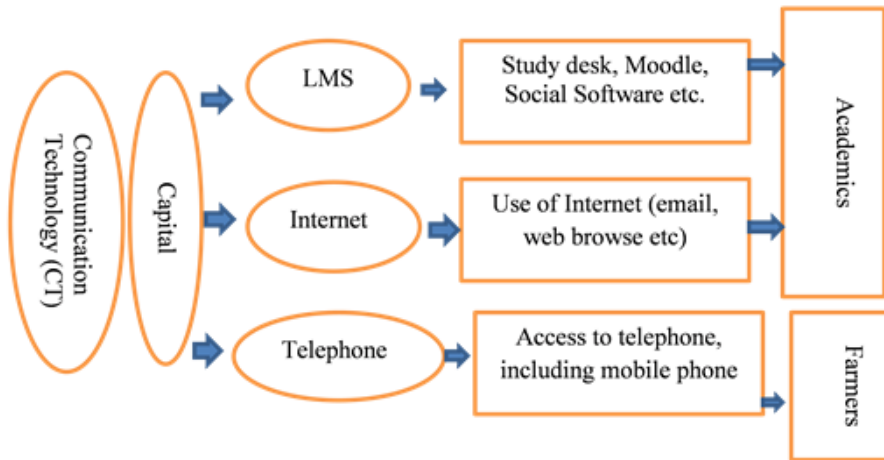


Figure 2.5: The conceptual framework

3. CHAPTER THREE: CONCEPTUAL FRAMEWORK

3.0. Affordance and capability theories

In an educational institution, humans are divided into three groups: students, teaching and non-teaching staff members. Irrespective of the groups, the interaction between human and ICTs in a natural setting is best studied by Gibson's affordance theory, which states a relationship between animals and objects (Jamian et al., 2011). In Gibson's terms:

“Something that refers to both the environment and the animal in a way that no existing term does. It implies the complement of the animal and the environment” (Hammond, 2010, p. 127).

Norman (1988), first, adopted affordance as a specific human factor in relation to the interaction between human and machine (King, 1999). According to Norman's term

“affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used” (1998, p. 9).

The term affordance refers to “the design of technological devices that influence users and those connected to them” (Norman, 1998, p. 88). Affordances arise because of the real physical and symbolic properties of computer hardware and software. General physical properties of ICT are tangible properties and the perceptions of the users are symbolic properties. The relationship between affordances and symbolic properties is implicit and can be considered with regards to positive or negative affordances (Conole & Martine, 2004). In other words, affordances of any object can be either good or bad depending upon the type and the composition of materials that impact on the human (Gibson 1979, cited in Jamian, Jalil, & Krauss 2011), especially the object that touches the human and is subjected to the human touch. Here there is a “psychology of materials” (King 1999, p. 96).

More recently Bower (2008) has distinguished the differences between Gibson's and Norman's theoretical foundations stating that Gibson's idea of affordances refers to perceived utility (perceived benefit), while Norman's idea refers to usability. Explaining the term 'usability', Bowen further adds that usability represents the functionality that an object provides to a user and the actual use of functionality by the users in order to achieve certain tasks (Huijuan, Chu, & Wenxia, 2013). Thus, Norman emphasises objective-based activities that are achievable by ICT.

More recently, a capability approach has emerged as a promising approach to frame the outcomes of human development (Andersson et al., 2012). Capability theory is associated with the work of Nobel-prize winning economist Amartya Sen and philosopher Martha Nussbaum (Johnstone, 2007). The theory was created in the discipline of welfare economics, criticising the old theory of utility or satisfaction that focuses on individual access to goods and services. Sen's argument

is that a better life is the ultimate goal of the development of a country. A better life depends on people's freedom of choice and ultimately, in access to information technologies to enhance this freedom (Qureshi, 2011). Therefore, the issue of access to information technologies and their use is a good way of applying of Sen's capability approach (Alampay, 2006).

The capability approach postulates that the differences in an individual's capability and choice play a significant role in how people evaluate the use of goods, and in Sen's terms, different people have individual ways of transforming the same combination of goods and services into opportunities (Alampay, 2006). Age, gender, income, level of education and skills in ICT are among the factors cited as having an influence the use of ICTs (World Bank, 1998). From the capability theorist's perspective 'utility' and 'access to resources' are necessary for human welfare, but in a partial way or instrumental way, rather than constitutively. It is argued that access to wellbeing is a matter here (Johnstone, 2007). According to the theory, human well-being is determined by freedom of choice (or functionalities). Freedom of choice can be positive (for example, receiving education, achieving good health, earning a living) and/or negative (intimidation, threat, violence). The positive freedom of choice enhances quality of life or individual wellbeing; while the negative freedom of choice reduces it. In a recent statement, Sen (2010) has taken up positive freedom of choice, discussing the application of mobile telephony in human life and its contribution to human capability. In Sen's terms when mobile telephony is used to call someone, it enhances functionalities of both the caller and the recipient positively (Coeckelbergh, 2010). On the other hand, if someone were intimidated via mobile telephony the recipient's freedom of choice would be adversely affected. In the two instances, though the means are the same, the functions are different. The relationship between means and functions depends upon the conversion factors (Robyns 2005) which differ between people.

People differ from each other in terms of socio-demographic characteristics. These characteristics constitute the conversion factors. It is argued in literature that the factors that are often cited as having an influence on ICT use are: gender, age, income, education level, and skills (International Telecommunication Union, 2011; World Bank, 1998). Therefore, the analytical framework of the capability approach provides for a very abstract relationship between these variables and related ICT uses. With regard to the interaction between a human and ICT, both the affordance and capability theories have the following similarities: Firstly, both theories focus on the application of ICT. In affordance theory, the theorists have used the term 'usability', and in capability theory, the theorists have used the term 'capability'. Secondly, affordance theory is only concerned with the environment created for human and ICT interaction, whereas Sen's theory is concerned with the impact on humans, because of the interaction between ICT and human. Finally, both theories focus on differential socio-economic factors that serve as determinants of ICT and human interaction.

3.1. Ajzen and Fishbein's (1980) theory

There are two theories that together might be used as an underlying theory to determinants of attitudes towards technology in the literature. One is Ajzen and

Fishben's theory of reasoned action (TRA) (Ajzen & Fishbein, 1980) and the other one is Roger's diffusion theory (Roger's, 1995). Both theories are concerned with attitude(s) of users to technology.

The concept of attitude has played a significant role in the history of psychology. The first psychologist Herbert Spencer argued that "in arriving at correct judgements on disputed questions, much depends upon the attitude of mind [..]" (Ajzen & Fishben, p. 13). Later, the definition of attitude was developed by scholars following a different direction. By 1901 scholars defined attitude as "readiness for attention or action of a definite sort" (Baldwin 1901 cited in Ajzen & Fishbein, 1980, p. 13). The breakthrough in attitude research came in 1929 when L. L. Thurstone, a psychologist, introduced psychometric methods to measure attitude where a person's position with respect to attitude is obtained by a score (Ajzen & Fishbein, 1980).

Ajzen and Fishbein (1980) have defined 'attitude' toward any concept by "a person's general feeling" of favourableness or unfavourableness for that concept. They further suggested that to assess a person's attitude toward a behaviour Thurstone's scaling method could be applied where the respondents are asked to respond to a statement. Like all standard scaling methods, these measures of attitude result in a single score which "represents a person's overall feeling of favourableness or unfavourableness to the behaviour in question" (Ajzen & Fishbein 1980, p. 13). There are two elements of attitude – intention and subjective norms. Some scholars state that "attitudes (and subjective social norms) are a function of beliefs, including the behavioural and normative beliefs directly linking to a person's intentions to perform a defined behaviour" (Chen & Chen, 2006, p. 686). In sum, Ajzen and Fishbein's theory suggest that a person's attitude influence his/her intention, which in turn influence his/her behaviour and preference to technology, which is eLearning environment in our study. However, belief toward an object is not constant; it changes over different point of time. Therefore, in order to understand the attitude of a person toward an object, it is essential to understand the belief of the person toward the object.

There are two concepts of belief – salient belief and normative belief - salient belief represents a common belief held by the population toward an object and a subjective belief involves an individual's belief. Belief influences attitude and subjective norms; these two components influence intention and intention influences behaviour (Ajzen & Fishbein, 1980). According to the theory of reasoned action, the results of changes in beliefs ultimately influence changes in behaviour. Ajzen and Fishbein (1980) asserted that some external factors also influence a person's attitude toward an object indirectly. The relationship between external factors and behaviour is mediated in a numbers of ways. One way is salient belief. For example, a better educated person holds a negative attitude toward smoking compared with a lower educated person. The difference in salient belief between better educated and a lower educated person affects attitudes toward smoking. There are a number of external factors that can influence a person's attitude toward objects, which are: age, gender, ethnicity, socioeconomic status, education, nationality, religious affiliation, personality, mood, emotion, general attitudes and values, intelligence, group membership, past experience, exposure to information, social support, coping skills, and so forth (Ajzen & Fishbein, 1980).

Roger's technology diffusion theory (Rogers, 1995) draws attention to people's attitudes too. Human will prefer technology that is easy to operate, irrespective of its assistive or non-assistive nature of the technology (King,1999). Preferences may vary from person to person based on the increasing effectiveness, efficiency and convenience of the device or tool. The user's comfort with a device or system and the satisfaction with a type of work may also influence preferences.

According to Roger's theory, "the innovation-decision process is the process through which an individual (or other decision-making unit) passes

- from first knowledge of an innovation,
- to forming an attitude toward the innovation,
- to a decision to adopt or reject,
- to implementation of the new idea, and
- to confirmation of this decision" (Rogers, 1995, p. 161).

The current research is concerned with the second stage of Roger's diffusion theory, the attitude towards the technology, in other words faculty attitude towards the application of ICT in teaching. However, Roger's diffusion theory does not elaborate how the attitude is mediated by the various attributes of users, such as users' 'attitude' in various contexts.

In sum, the role of ICTs in teaching depends upon the affordances of ICTs. The affordance of ICTs depends upon the teachers' attitudes and the attitudes of teachers are influenced by socio-demographic characteristics. Therefore, the effect of ICTs on teachers is a mediating effect.

3.2. The determinants of academics' attitudes to the LMS

3.2.0. Attitudes to an eLearning environment

The studies on the effect of ICT on students' performance in higher education have received considerable attention (see Yousseff & Dahmani, 2008). With reference to the studies on effects on teaching staff, recent literature suggests that the excessive work pressure (or in other words 'over-workload') of the teaching staff has been a major issue (Winter, Taylor, & Sarros, 2000). Whilst many claims and suggestions are made about the potential use of these technologies for educational purposes, studies suggest that teachers who are engaged in online teaching within a given eLearning environment experience extra work pressure (otherwise, called over-workload in this paper) (Bolliger & Wasilik, 2009). Such labelling is a demonstration of negative (demotivating) attitudes towards an eLearning environment. Literature suggests that the issue arises for two reasons. First, the eLearning environment has made a transition in the higher education delivery process. The traditional classroom-based delivery (otherwise called teaching) has been replaced by technology-based online teaching (Lin, Huang, & Chen, 2014; Prestridge, 2012), and co-operative learning and student-centred discussion has emerged in online teaching (Bolliger & Wasilik, 2009) . The new phenomenon has generated several changes in teaching methods. The traditional nature of the work of a teacher or academics has also been replaced. Due to the changing nature of work (here I mean teaching modalities such as web-based learning, flexible delivery and research responsibilities) academics'

common attitude to the eLearning environment has changes too.

Secondly extended ICT-related work has started demanding additional time (from the academics) to develop new types of skills required for handling ICT-related work . It has become compulsory for them to engage with ICT-related training, workshops and activities that involve learning skills related to computing, software application, and communication. An effective communication with students frequently in diverse learning spaces has become an inevitable work (Hew & Cheung, 2012). Furthermore, academics are required to prepare digital contents for online student and online teaching platforms. Overall, the teaching academics have become busier with their work than before.

Whilst education managers and entrepreneurs are expanding higher education opportunities online, academics are becoming less enthusiastic about participating in the adoption of online instruction as a mode of education delivery (Chen & Chen, 2006) due to the likelihood of the pressure of working extra hours. As a result, a contested working environment is emerging in higher education institutions, particularly in the universities. Since academic satisfaction is highly correlated with, students' learning outcome (Hartman, Dziuban, & Moskal, 2000) it has become an imperative for education managers to maintain academic satisfaction at the highest level.

From academic perspectives some studies have discussed theoretically both positive and negative affordances of ICT within the framework of working relationships between technology and human resources, based on diverse and multiple perceptions of eLearning environments (e.g. Bower, 2001; Churchill et al., 2012; Jamian et al., 2011). The central point of these studies is that ICT has both positive and negative affordances in relation to their usage in higher educational institutions. Labelling the eLearning environments negatively is a sign of negative affordance. For example, regarding the usage of ICT (specifically, the Internet) Heijstra and Rafnsdottir (2010) have written:

“The amount of emails Sigurour¹ receives and sends seems to be the norm rather than the exception. Other academics spoke of receiving about 70 emails a day, approximately 80 mails after the weekend, and hundreds of emails after three to four days. Hildar², an elderly female academic, simply states that emails are killing” (p.161).

Drawing on Gibson's affordance theory, Hammond (2010) has argued that affordances of ICT are always relative to some desirable goals or strategies regarding teaching and learning. Kay, Wagoner, and Ferguson (2006) have examined the affordances of computers for the students studying in K-12 and undergraduate class in the United Kingdom. The research has found evidence that computer affordance of computers between the two cohorts of students differed from one another. Kay et al. (2006) observed that from two different perspectives, two different types of attitudes towards computers caused a significant difference between the group's approach to computers and their usage. McLoughlin and Lee (2007) have examined three types of affordances with regard to the use of Web 2.0 and social software in tertiary teaching and learning: pedagogical, social, and

¹ It is a name of a participant of his/her study.

² Another participant's name.

technological. Their study concluded that the positive affordances of social software are sharing, communication, and information discovery.

Contrary to McLoughlin and Lee (2007) other studies have shown the negative affordances of Facebook in teaching and learning online. For instance, some studies (Karpinski, Kirschner, Ozer, Mellott, & Ochwo, 2013; Kirschner & Karpinski, 2010; Paul, Baker, & Cochran, 2012) have shown a substantial statistically significant negative relation between the use of social network sites (SNS) (per minute/per day) and cumulative grade point averages (CGPA) in the USA and in European countries during the periods of study. These studies used a quantitative research methodology. The research by Karpinski et al (2013) was based on quantitative survey data collected from the undergraduates and graduate students across the USA and Europe. The research by Paul et al. (2012) was based on the survey data collected from business students in a large state university in USA. The research by Kirschner and Karpinski (2010) was based on data collected from undergraduate and graduate college students of a large Midwestern university in the USA. In sum, in the USA, the affordance of social software is found to be negative.

Jamian et al. (2011) have analysed the working environment in a Malaysian public university where various types of ICT are used in teaching. The researchers divided the ICT-enabled environments into two types: ICT application-related and ICT tools-related. The research was carried out among the selected lecturers who were teaching within a blended learning environment. Based on qualitative research methodology (semi-structured interviews and focus group discussions), the study found evidence of both positive and negative (hidden) affordances of ICT in teaching students online. The most notable negative affordance was technical difficulties associated with the learning management system (LMS). Though Jamina et al.'s (2011) study did not identify types of barriers. In another recent study, Lin et al. (2014) explored barriers to adaptation of ICT in teaching in the USA. Based on a mixed research method, they found that technical difficulties were the most important barrier to adopt ICT for teaching Chinese language in the classroom in the USA.

Other studies have also highlighted the negative affordances of ICT. For instance, Kirschner and Karpinski (2010) have investigated the factors responsible for negative impacts of the use of Facebook on students' academic results. The findings showed that the use of Facebook increased students' mistakes while processing information circulated by fellow students on Facebook, which is a negative affordance of social software.

These findings suggest that the applications of ICT differ from one perspective to another. This differential application is known as '*affordances*' in the literature (McLoughlin & Lee 2007, p. 666). Therefore, the nature of affordance may depend upon the socioeconomic and demographic characteristics of users and perspective of their use of the object. For example, to an undergraduate the affordances of computers are learning and communication tools, by contrast, to a K-12 student the affordance of a computer may be online or off-line gaming tools. Furthermore,

“Faculty members think of technology as technology. Students think of technology as environment. Faculty uses technology as tools for presenting content. Students use technology as tools for exploring, communicating, and socialising” (Hartman, Dziuban, & Brophy-Ellison, 2007, p. 66)

Winter and Sarorros (2002) in their study have suggested two types of working climate in Australian universities: positive (motivating) and negative (demotivating) organisational climates. Based on data collected from a national survey in 1998, their study has provided evidence that over-workload has been responsible for a negative work environments for academics. By contrast, McMurray and Scott (2013) have examined the determinants of organisational climate for academia in Australian universities, analysing primary data drawn from 145 academics employed in a single university in Australia. Their study has provided evidence that organisational support, fairness, trust, innovation and recognition influence the organisational climate, but academic workload is a personal issue rather than an organisational issue. Despite this apparent contradiction about the status of workload – either an organisational issue or personal issue - it is certain that workload is an issue. Therefore, this study explores how the use of ICT affects the workload of an academic in a university in the given context of interaction between ICT and academics in a university setting.

In general, the use of ICT in education has made some academics stressed (Bower, 2001). Because of the stressful working conditions, we believe that academics’ teaching and research productivity are hampered and thereby students’ academic performances are adversely affected because academics’ satisfaction and students’ learning outcomes are highly correlated (Hartman et al., 2000). The stress arises from the use of frequent communication and collaboration, which is one of main affordances of ICT (Conole & Dyke, 2004). Therefore, academics may require additional time to teach students online.

Other studies have also examined the organisational climates in universities (Bower, 2001; Churchill et al., 2012; Gaver, 1991; Huijuan et al., 2013; Idris & Wang, 2009; Jamian et al., 2011; Kay et al., 2006; McLoughlin & Lee, 2007). These studies have discussed both positive and negative relationships between ICTs and humans based on diverse and multiple perceptions about the use of ICT in the teaching and learning process.

In a qualitative research study, Meyer (2012) examined the influence of the use of ICT on teaching and research productivity in an American university. The study concluded that online teaching increases academics’ workloads and thereby increases teaching productivity. From an institutional point of view this suggests positive affordances of ICT, while from the faculty’s point of view it suggests negative affordances of ICT.

A body of studies documented the effect of the use of technology on faculty workload in the USA (Betts, 1998; Hartman et al., 2000; Rockwell, Schauer, Fritz, & Marx, 1999), Australia (Reushele & McDonald, 2000; Samarawickrema & Stacey, 2007), and Iceland (Heijsra & Rafnsdottir, 2010). In the American context, a study has claimed that

“Many faculty members report that they are devoting more time to their work and that their work time is spread over a larger

portion of the day because they can communicate with students via e-mail or through a course management system” (Hartman, Dziuban & Brophy-Ellison 2007, p. 66)

In Australia Reushle and McDonald (2000) have documented their evaluation of an online education project implemented at USQ. The evaluation concluded that teaching students online had a significant effect on the academic staff’s workload. Because the academic staff members were managing a large section of diverse students engaged in diversified modes of education, the teachers’ teaching and non-teaching related functions had increased substantially.

Samarawickrema and Stacey (2007) have provided evidence that is inconsistent with the findings of Reushle and McDonald (2000). They (Samarawickrema & Stacey, 2007) have investigated the factors that enabled and impeded the adaptation of a web-based LMS in an Australian university (Monash University of Australia). The evidence suggested that web-based teaching significantly impacted on teachers’ working time, and served to impede developing learning resources for web environments, maintaining communication through email, course preparation, moderation, and resource collection. In another study in Iceland, Heijstra & Rafnsdottir (2010) analysed the effects of the use of the Internet and other ICT technologies on their work and family life. Their research showed evidence that while a variety of email communication between the teachers and students had improved interaction between them; it had also substantially increased teachers’ workloads. Thus, the negative affordances for the use of ICT in teaching students online are increased workload for the teachers. The workload issue has also been measured and explored analysing academics’ perceptions towards workload.

Some studies speculated that a number of issues, including an academic members’ socioeconomic, demographic, and professional factors, can influence that faculty’s perception about workload (Xu, 2007). Xu and Meyer (2007) have examined the factors related to the use of technology in teaching in the USA. As a dependent variable, the researchers used two measures, Web use and e-mail, to analyse the use of ICT. They also divided the independent variables into six blocks: institutional, demographic, professional and teaching, research and service productivity. Hierarchical multiple regression analysis was applied to analyse the data. The research findings suggested that age and Internet access were important factors related to faculty use of technology. The research further suggests that faculty with higher teaching loads were using both email and the Web relatively more; on the other hand, faculty with higher research productivity were using email relatively more often than websites. Meyer and Xu (2007) further investigated the issue within the framework of Bayesian Networking Model and Bayesian Statistics. The study found evidence that the faculty’s highest degree and teaching/research field also influenced the use of technology.

Mahdizadeh, Biemans, & Mulder (2008) have examined the factors that determine the use of an eLearning environment by university academics in The Netherlands. The study used quantitative data drawn from Wageningen University. Based on factor analysis, the study suggested that faculty time was an influential factor in terms of teachers’ opinions about eLearning environments. Their study provided an indication that an academic’s teaching load is a determinant of faculty

perception about the working environment and the workload issue. In a very recent study Stendal, Munkvold, Molka-Danielsen, and Balandin (2013) have discussed the social affordance of ICT for people with a lifelong disability. Their research indicated that the virtual world might help disabled people to participate in education and be included in society. Using qualitative methods the results indicated that people with a lifelong disability perceive that they can reach a larger and more diverse network through participation in a virtual world

3.0.3. Knowledge gaps

Thus, the negative affordances for the use of ICT in teaching students online are increased workload for the teachers. The workload issue has also been measured and explored analysing academics' perceptions towards workload.

In the given context of a changing organisational model and the increasing use of ICT (or the affordances of ICT) within universities, the academics' attitudes of working conditions have not been explored in depth in Australia. I address this issue in this study, based on an in-depth field survey about the university's academic (teaching) staff's perceptions of the over-workload issue. From this survey, a theory is developed and then compared with previous studies. The theory will be used full to design a quantitative study in the future. A conceptual framework based on previous studies is presented in Figure 3.1. The figure demonstrates that previous studies presented three types of short-comings with regards to the interaction between the students and academic (teaching) staff online. They are: pedagogical, technical, and institutional. Over-workload is an institutional factor that works as a de-motivating factor for the academics' involvement in online teaching. In the remaining part of the thesis, I use this framework to explore the issue in an Australian university.

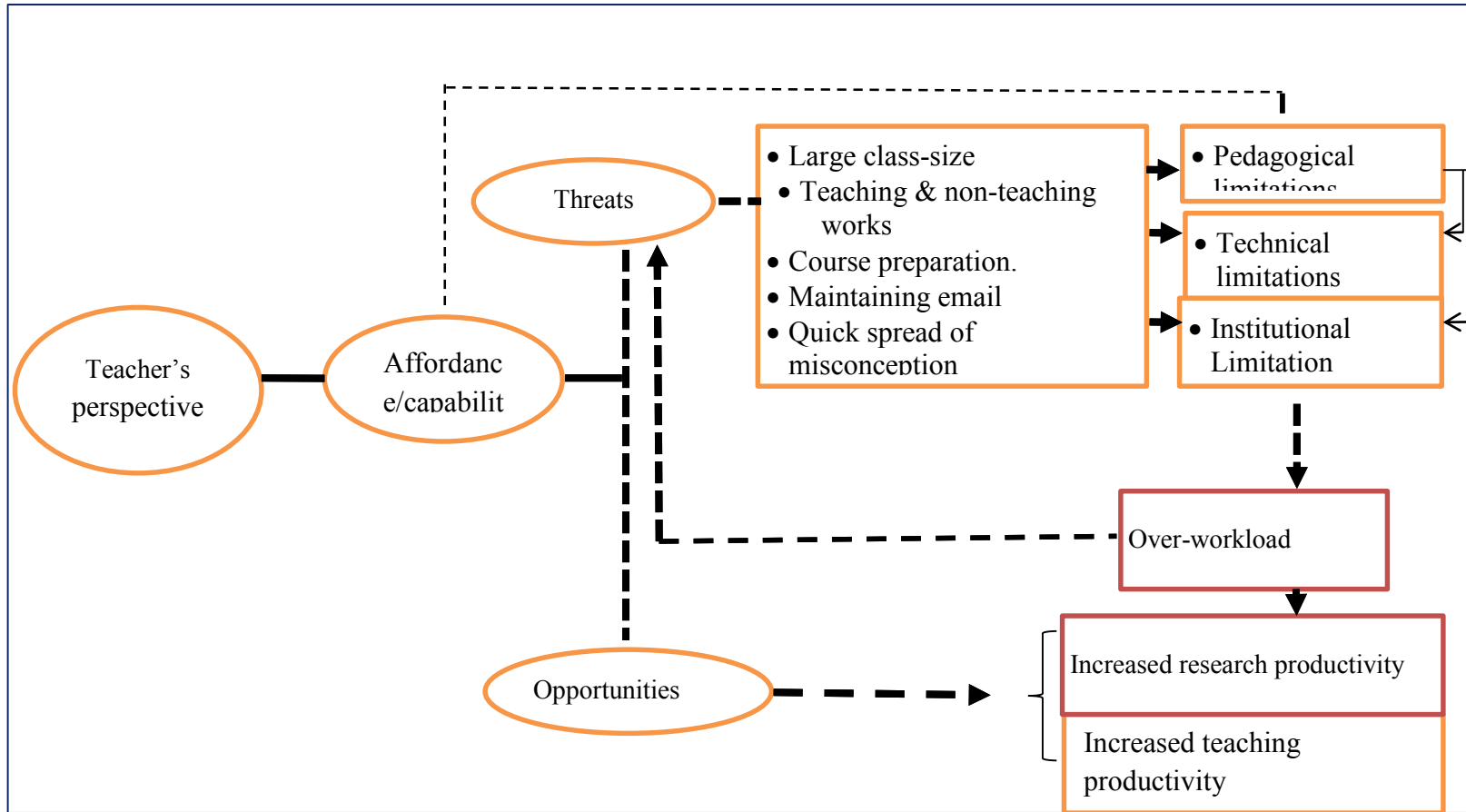


Figure 3.1: Theoretical framework about the effects of ICT on teachers

3.3. The Theory of the research production function

The terms ‘university’ and ‘higher education’ are synonymous; but university is a particular type of higher education enterprise that provides higher education. A university plays the role of a multi-product enterprise that typically produces three types of outputs: teaching output, research output, and consultancy services (Cohn & Cooper, 2004). The multi-output concept of the university is based on four concepts (Patrics & Charles, 2003) – (i) a university as a producer of qualified manpower; (ii) a university as a training ground for a research careers; (iii) a university as a provider of public services; and (iv) a university as a means of extending life chances. However, the teaching outputs are not homogenous. Here the inputs are enrolled students and the outputs are graduate students. Literature shows that undergraduate and postgraduate students provide two broad types of teaching outputs (Mamun, 2012; Mamun, 2011; Cohn, 2004). The concept of a multiproduct enterprise is based on an input-output model of microeconomics. To produce the teaching output, teaching academics play an important role.

The underlying theory of this study is the education production function. In other words, the identification of the determinants of university research output is based on the education production functions, and consists of an input and output analysis (Cohn & Geske, 1992; Hanushek, 1986). Analogous to the production function, researchers have developed the education production function to investigate the relationship between various factors used in educational activities and outputs derived from the use of factors widely (please see for details, Abbott & Doucouliagos, 2004; Cohn & Cooper, 2007).

In the literature of education economics, teaching academics, non-teaching academics, and other infrastructure factors are considered as conversion factors. These conversion factors convert inputs into outputs. The mechanism of conversion is presented in Figure 3.2.

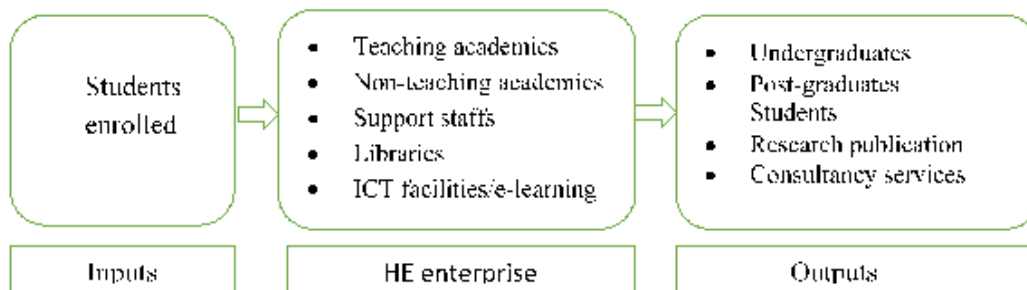


Figure 3.2: A conceptual framework about the mechanism of production

Education production function examines the relationship among different inputs into the outcomes of the educational process; the process relies on quantitative investigations relying on econometric methods (Hanushek, 1986). In higher education institutions, particularly universities, the education outcomes are very different from the

education outcome in schools, because in universities, education outputs are homogeneous. Therefore, universities are referred to as multiple-product firms (Cohn, Rhine, & Santos, 1989; Mamun, 2012). On the other hand, in schools the outputs are considered as heterogeneous. Research is one of the multiple outputs in a university (others include undergraduate students, graduate students, and public service) in a university (Cohn, Rhine, & Santos, 1989). The theoretical exposition is that research output, which is linked to various inputs, including personal and institutional including academics, general staff, research income, and student enrolment.

Another potentially relevant theory is Schumpeter's hypothesis of a link between research and development and firm size (Abbott & Doucouliagos, 2004). The theoretical exposition is that research and development (R & D) is uncertain. Therefore, this is linked to the possibility of risk and uncertainty that can be better handled by larger universities compared to smaller ones. Furthermore, larger universities tend to have better research facilities. As a result, a large sized university is more capable of attracting research funding compared with a smaller university. In the past, Abbott and Doucouliagos, (2004) have combined the education production function and Schumpeter's hypothesis to study research productivity in the Australian university. In this case, as the study is limited to a single small sized university, the theoretical foundation is limited to the production function only.

3.3.0. The determinants of academic research outputs

3.3.0.1. Institutional characteristics

Dundar and Lewis (1998) empirically examined research productivity and institutional factors at the departmental level at research universities (doctoral level) in the USA. The study used cross-section data collected from the National Research Council in 1993 and standard linear regression model to examine is a relationship between research productivity and its determinants. Individual, institutional, and departmental attributes were included in the model as explanatory variables and peer-reviewed journal articles were used as dependent variables. The research evidence suggested that academic research productivity was closely associated with faculty size – large faculties produced more research output compared with small faculties because “large departments may simply become more powerful than the college or university and receive more facilitating resources for research activities” (p. 612). Further, in terms of shared value and knowledge among the faculties, large faculties are in a better position compared with the small faculties.

Meyer (2012) examined the influence of online teaching on faculty research productivity in nine different states in the USA in the context of increasing online teaching. The study collected data from three sources: in-depth interviews, a web-based blog, and researcher notes. The study used a qualitative research approach. A mixed reaction emerged from the study about the influence of online teaching on faculty productivity. The study was in agreement and in disagreement with Xu and Meyer (2007) who found that ‘research productivity showed a positive relationship with email use and

a negative relation with the web being used in teaching. Outside the USA, Iqbal and Mahmood (2011) reached similar research findings (Iqbal & Mahmood, 2011).

Iqbal and Mahmood (2011) investigated the causes of low research productivity empirically at the university level in Pakistan. The study used cross-section data collected by a stratified random sampling method and applied a bivariate cross-tabulation analysis to achieve the objective of the paper. Furthermore, the study used demographic characteristics and institutional characteristics as control variables and found evidence that faculty-teaching loads were a barrier for research productivity in the university.

3.3.0.2.. The effects of research collaboration and social capital

Katz and Martin (1997) have defined 'research collaboration' as the working together of researchers to achieve the common goal of producing new scientific knowledge. Although research collaboration is not recognised as social capital directly in literature, I argue that research collaboration is a kind of social capital. OECD definition of social capital is “networks together with shared norms, values and understandings that facilitate co-operation within or among groups” (Keeley, 2007, p.103). Research collaboration is a network among researchers who work collectively to reach a goal.

In this age of digital technology, the role of social capital is discussed increasingly in the literature. With relation to research productivity, two recent studies have highlighted social capital undertaking two kinds of measurement of social capital. Salaran (2010) examined the effect of social capital on research productivity in Australia universities measuring social capital of the academics in Likert scale. The study has measured social interactions of respondents. For example, the time spent in social meeting, gathering, communication etc. For this study, an online survey was used to collect data from five universities in Victoria, Australia. Quantitative research techniques such as correlation study and regression analysis were applied to achieve the goals of the study. The research found a positive correlation and relationship between social interactions and research productivity.

Abramo et al. (2008) examined a correlation (not any causal relation) between research collaboration with domestic and international organisations and faculty research productivity in 78 Italian universities. The study used survey data collected from 78 Italian universities and a cross-tabulation method to analyse the correlation among the covariates. The research found that extramural research collaboration is subject / discipline-specific and a high correlation exists with research publications in international journals. Basic science researchers have more foreign collaboration compared to other categories of researchers. Further, regarding the impact of research collaboration on research productivity, Abramo et al. (2008) asserted that ICT removes transportation costs and some of the barriers of research collaboration and thereby affects research productivity positively.

In a very early stage, Lee and Bozeman (2005) added research collaboration to the conceptual framework and examined the relationship between research collaboration

and publication productivity in the USA. The study used survey data collected at three stages and a Two-Stage Ordinary Least Square (2SLS) regression analysis to achieve the research goal. The study asserted that “[...]If productivity inversely influences collaboration or if collaboration is correlated with the error term of productivity, the OLS is not appropriate and perhaps yields an inconsistent result’ (p.687-688). The research found the evidence of no significant effects of research collaboration on research productivity. The conceptual framework used by the research is presented in Figure 3.3.

Basic relationship between collaboration and productivity

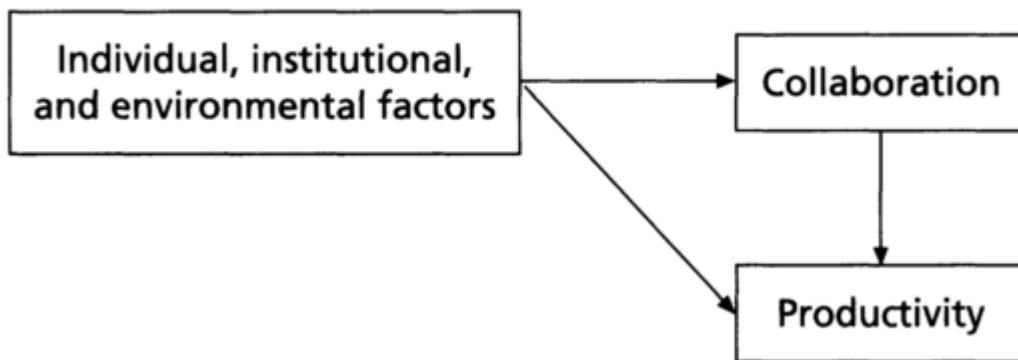


Figure 3.3: Basic relationship between collaboration and productivity

Source: Lee and Bozeman (2005, p. 673)

The endogeneity concept of research collaboration used by Lee and Bozeman (2005) is very realistic because of other studies have also discussed the factors influencing research collaboration before Lee and Bozeman’s study (Katz & Martin, 1997). These factors are: rise of scientific research cost; fall of travel cost; increasing need for specialisation, and requirement for a team approach to deal with complex research. Therefore, there is sufficient reason to believe that research collaboration is an endogenous variable.

In contrary, Chantes (2012) found the positive effects of collaborative research projects between university and industry with regard to research productivity in Thailand. The research findings of Less and Bozeman (2005) and Chantes (2012) were in agreement with Pravdic and Oluic-Vukovic (1986). Pravdic and Oluic-Vukovic (1986) found evidence that the nature of effect on research productivity depends on the type of research collaboration or links and the frequency of collaboration among the same authors. The study measured scientific output and collaboration performed on two scales: (1) an individual scale, for members of a study model, and (2) a group scale, for three samples varying in the level of productivity. Moreover, the study concluded that collaboration with high-productive research increased research productivity and collaboration with low-productive research decreased research productivity.

In another study, Teodorescu (2000) examined the influence of social capital on research productivity, incorporating the concept of membership of professional bodies or societies as social capital. This was a cross-country quantitative study. The data were collected from Australia, Brazil, Chile, Hong Kong, Israel, Japan, Korea, Mexico, the United Kingdom and the United States. In this study, a linear regression analysis was carried out for each of the ten countries. The research concluded that the causal relation between inputs and outputs are country-specific, however the commonalities in the findings included a positive relationship between the membership of a professional body and research productivity. The basic analytical model used by the researcher is presented in Figure 3.4.

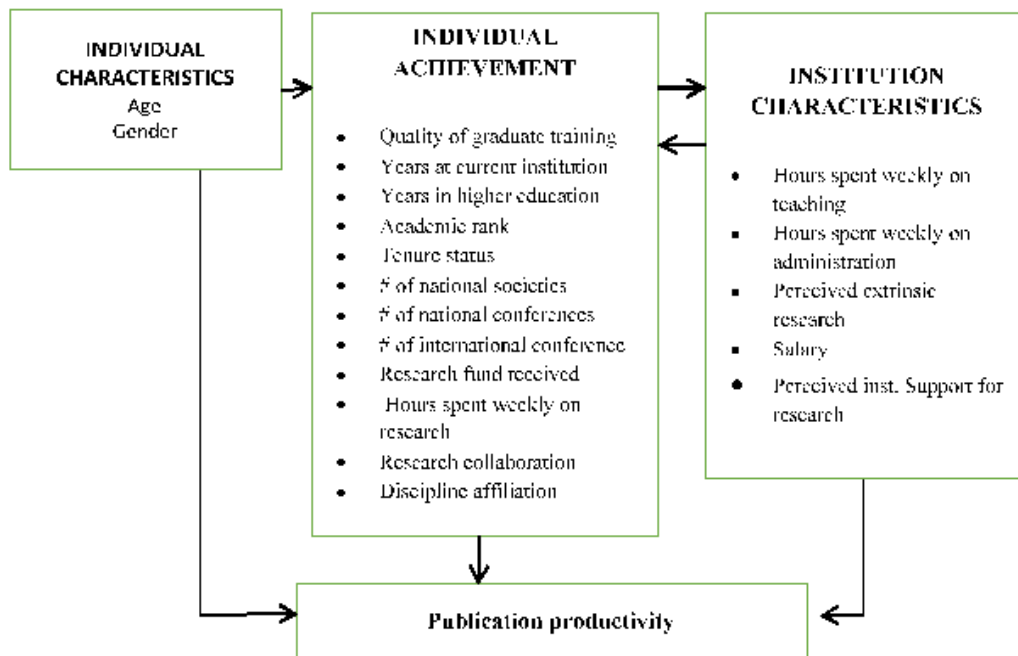


Figure 3.4: Basic analytical model
Source: Teodorescu (2000, p. 2007)

3.3.0.3. Individual characteristics

The influence of individual characteristics on research productivity has been researched widely; for example, researcher’s attitude – perceptions of the nature of the environment (Ramsden, 1994) ethnicity (Mamiseishvili & Rosser, 2010; Webber, 2011); gender (Padilla-Gonzalez et al. 2011; Jung, 2012; Bently 2011); academic rank (Maishra & Smyth 2013; Lissoni et al. 2011); research experience (Jung, 2012; Fukuzawa 2014).

3.3.0.3.1. Ethnicity

Mamiseishvili and Rosser (2010) examined the differences in research productivity between international and U.S. citizen faculty members’ productivity in the USA. The study used data from the National Centre for Educational Statistics: *The 2004 National*

Survey of Postsecondary Faculty and Structural Equation Modelling (SEM). In order to explore the relationships, gender, ethnicity, tenure status, and academic rank were used as explanatory variables. The research found that research productivity of international faculty members was greater than their peers who were US-born faculty.

Webber (2011) examined a similar issue - the role of international faculty in research productivity in the USA. The study used data from the same source as Mamiseishvili and Rosser (2010). However, unlike Mamiseishvili and Rosser (2010), Webber (2011) used a Two-Stage Hierarchical Generalized Linear Model. The study found that overall international faculty produced more scholarly works compared to their US-born peers.

3.3.0.3.2. Gender

The influence of gender on research productivity is mixed in the literature. Padilla-Gonzalez, Metcalfe, Galaz-Fontes, Fisher, and Snee (2011) examined the effects of gender gaps on research productivity in USA, Canada, and Mexico. The study collected data at the institutional level from different countries and then used the multiple regression analysis to achieve the goal of the paper. The study found contrasting research results in the different countries. For example, while in the USA there was no effect of the gender gap on research productivity, in Canada and Mexico there was a positive effect of the gender gap on research productivity. Compared with Canada, the effect was more profound in Mexico.

In another study in Australia Bently (2011) examined the effect of gender differences on research productivity empirically in Australian universities. The study used data for the periods 1991-93 and 2005-07, and linear regression analysis. The explanatory variables used in the study were: age, marital status, number of children in home, child and elderly care, highest academic degree, academic rank, research collaboration, international conference participation, research funding, collegial support for research and finally institutional facilities, such as computer, library and office facilities. The study did not find gender gap to be a statistically significant predictor; however, it found that academic rank, doctorate qualifications, research time, and international research collaboration were the strongest positive impact factors associated with publication productivity. In another study in Hong Kong Jung (2012) also examined the research productivity of academics empirically. The researcher used cross-section data collected from “the Changing Academic Profession” (CAP) project which was conducted in 2007.

Further, the study used descriptive analysis and standard regression analysis to achieve the goal of the paper. The research evidence was that the gender gap and numbers of years of experience had a positive influence on research productivity. Other important factors were workload, differences in research styles and institutional characteristics.

In another study in Hong Kong (in the years 1990-1995), Ho (1998) investigated the publication output (all sorts of publications such as articles, conference papers, book

chapters, magazine articles) in six selected Hong Kong universities. The study used Analysis of Variance (ANOVA) to explore bi-variate relationships among the following factors: university reputation, faculty rank, gender, workload³, research style, and institutional characteristics. The research found evidence of the following statistically significant factors: university reputation, academic rank, and year. These studies considered academic rank as exogenous, in contrast to some other studies that considered academic rank as endogenous.

Lissoni (2011) examined the relationship between academic promotion and scientific publication controlling socio-demographic variables. The study used data from Italian and French universities in the academic year 2004-2005 and used a Tobit model to design the empirical relationship between control and dependent variables. Furthermore, the study used lagged of the dependent variable to control the unobserved heterogeneity issue in the model. The research found that size and international nature of collaboration projects, and previous research productivity, have a significant impact on research productivity. Furthermore, gender has a differential impact on research productivity in Italy and France.

3.3.0.3.3. Academic rank & research experience

Considering the endogeneity issue of the variable- academic rank, Mishra and Smyth (2013) examined the causal link between research productivity and academic seniority in terms of academic rank in Australian law schools within the universities empirically. The data was collected by the researchers directly from the staff profile; hence, the data were self-reported data. They used Lewbel's (2012) approach of a two stage least square estimation technique, and generalised methods of moments to control the endogeneity problem in their study. The research evidence showed that endogeneity caused misleading conclusions about the effect of academic seniority on research productivity in the past. While endogeneity was controlled, academic rank had no impact on research productivity.

Ramsden (1994) investigated academics' research productivity in Australia based on cross-sectional survey data on full-time staff working in 18 Australian higher education institutions. The study measured research indexes based on journal articles, book chapters, books, and conference proceedings in the last five years. On the other hand, the study did not use any socio-demographic control variables, but rather calculated a research activity index based on self-reported data. In order to collect the self-reported data, the study asked the respondents a number of questions. For each affirmative reply to a question, the respondents received one point, while for any others they received zero. Bivariate analysis showed that interest in research, involvement in research activity, and seniority of academic rank had a strong correlation with research productivity. However, the study did not present any causality.

³ The workload was measured by time spent on teaching, research, and percentage of instruction time spent on doctoral students.

Other studies have extended Dundar and Lewis's model in various ways. For example Salaran (2010) and Teodorescu (2000) have added social capital in the analytical framework. In a cross-country study, Teodorescu (2000) examined the factors influencing research productivity empirically. The researcher used three sets of variables in their model: descriptive, achievement, and institutional. The research found that faculty research productivity differs remarkably across nations. The membership of professional societies, attendance of professional conferences, and research grants were statistically significant predictors of research productivity.

In a very recent study, Fukuzawa (2014) examined the relationship between research performance and individual researchers' characteristics within the life science and medical science disciplines in 39 universities in Japan. The research found that a researcher's previous research experience had a statistically positive relationship with their research productivity.

3.3.0.4. Research grants and management

There are debates in the literature as to whether the research grants (or income) constitute inputs or outputs (Johnes & Johnes, 1993; Koshal & Koshal, 1999). Koshal and Kohal (1991) argued the case for inputs, while Johnes and Johnes (1993) argued that research grants were not only used for research assistance, which is an output, but also for other facilities that were inputs into the research production function. The implication of the foregone assertion is that if research grants are input, this should be placed on the right-hand side of a production function.

In a qualitative study carried out at the University of New England Wood (1990) found that research output was influenced by many factors, including research grants. However, the study did not show any causality in the relationship. In a cross-country study Teodorescu (2000) has argued for the importance of research grants or special funding support for research in Australia, Hong Kong, Israel, Japan, Korea, UK and the USA. Based on panel data for the periods 1995-2000, Abbott and Doucouliagos (2004) examined the determinants of research productivity in Australia. The study used the education production function and Schumpeter's hypothesis. The main explanatory variables used in the study were: research income, all kinds of staff and number of students enrolled. The research evidence was that research income, academic staff and postgraduates affected research output positively. The main theoretical exposition is that academics search recognition by publication in scholarly journals, which enhances possibilities for access to research grants, which then has a positive effect on these research grants.

The role of university managerial practice is highlighted by the study of Edgar and Geare (2011) and Beerkens (2013). Edgar and Geare (2011) examined the research productivity in universities in New Zealand by examining features of managerial practice and culture within university departments. Qualitative and quantitative data are drawn from three New Zealand universities. The study adopted a research methodology of comparative analysis. The findings of the study showed that departmental autonomy and

egalitarianism, along with a strong cultural ethos supporting achievement and individualism, contribute to research performance at the departmental level.

Beerkens (2013) also focused on research management practice to examine the research productivity at Australian universities based on panel data (a panel of 36 universities for 13-years). Similar to past studies, the study used a research management index as the main predictor in the model. Moreover, the study used the number of research publications in Thomson Reuters Web of Science Indices as research output. The output was measured at the aggregate level without correcting for co-authored papers. In order to check the robustness of the results, the researcher used total weighted publications and amount of competitive grants as two measures of research outputs. The research showed that the research management at the university level is statistically significant for research productivity.

3.3.0.5. The Internet and research performance

I conducted an extensive survey about the role of ICT and found the existence of one study (Xu & Meyer, 2007). Xu and Meyer (2007) examined faculty teaching and productivity by based on the status of the use of information technology (IT) and communication technology (CT) in the USA. The study concluded that productive faculty use technology to make them more productive and “faculty productivities in research, teaching, and service explained a significant proportion of variance in technology” (1999, p. 49). Further, “research productivity showed a negative correlation with web use in teaching” (p. 49). However, it is unknown to date how the use of Internet affects the research productivity of academics, and what the key factors are that drive research productivity at an Australian university. I found that Vakkari (2008) explored the influence of the use of electronic information resources on academic scholars' opinions of work in connection to their publication productivity at all universities in Finland. The data consisted of a nationwide Web-based survey of the end-users of *FinELib* - the Finnish Electronic Library. The researcher differentiated the influences into two dimensions: improved accessibility and literature availability. The study concluded that improved access was positively associated with the number of international publications. The study concluded that investment in an academic digital library was beneficial to researchers.

3.3.0.6. Knowledge gaps

The foregone literature review is summarised in Appendix Table 3 (please see the Annexure A3) in a matrix format to provide a total overview of the literature reviewed. From the review, various features of the determinants of faculty research productivity have emerged. First, quantitative research methodology was used in all cases to assess research output by means of one common measure – publication in peer-reviewed journals, and books. Secondly, cross-sectional data at the individual level were used. Thirdly, a single equation model was used in all cases. Fourthly, the direction of the

relationship was inconclusive. The research gaps that emerged from the previous studies are as follows.

First, research collaboration is recognised as an important determinant, which is considered as exogenous in previous studies. Secondly, my assertion is that research collaboration is a choice variable. If a researcher does not believe in collaborative research, he/she may decide not to join in with any collaborative work. Further, individual success in research might generate scope for research collaboration. This implies that research collaboration is supposed to be endogenous, which has been disregarded in the past. Thirdly, qualitative analysis is totally missing. I would assert that a quantitative analysis of the qualitative dataset can give us useful insights into the determinants of research productivity. Finally, at this age of technology, while enough technology-driven research tools are available in higher education institutions, particularly universities, the influence of technology on research productivity is yet to be explored.

Teaching, research, administration, and management are main roles and responsibilities of academics. In all these areas of responsibility the Internet holds great potential in increasing their productivities (Hinson, 2006). Many studies have investigated the determinants of research productivity, in the USA (Jordan, 2013; Hooper, 2002; Xu, 2007) and Australia (e.g. Abbott & Doucouliagos, 2004; Bently, 2011; Salaran, 2010). The studies included various factors as explanatory variables and discussed the contributions of institutional and personal attributes to faculty research productivity. However, the effect of ubiquitous information and communication technology, particularly the Internet, is an under-researched area.

3.4. Neo classical growth theory

Neoclassical growth theory postulates that capital is a part and parcel of an overall production process. In this process, capital is divided into ICT-capital and non-ICT capital (Shahiduzzaman & Alam, 2014). Non-ICT capital constitutes tangible physical facilities, including all sorts of communication but excluding telecommunication facilities. On the other hand, ICT capital constitutes IT facilities, including telecommunication facilities. Here the roles of ICT and non-ICT capital in the total production process are similar. As information is costly (Stiglitz, 2000), a well-developed ICT infrastructure contributes to the efficient use of input in the production process and thereby to the total output. Furthermore, well-developed information technology infrastructure makes possible substitution between ICT capital and non-capital that can ensure further movement along the production function, raising the total level of output without affecting the production possibility frontier. The theoretical concept is illustrated graphically in Figure 3.5.

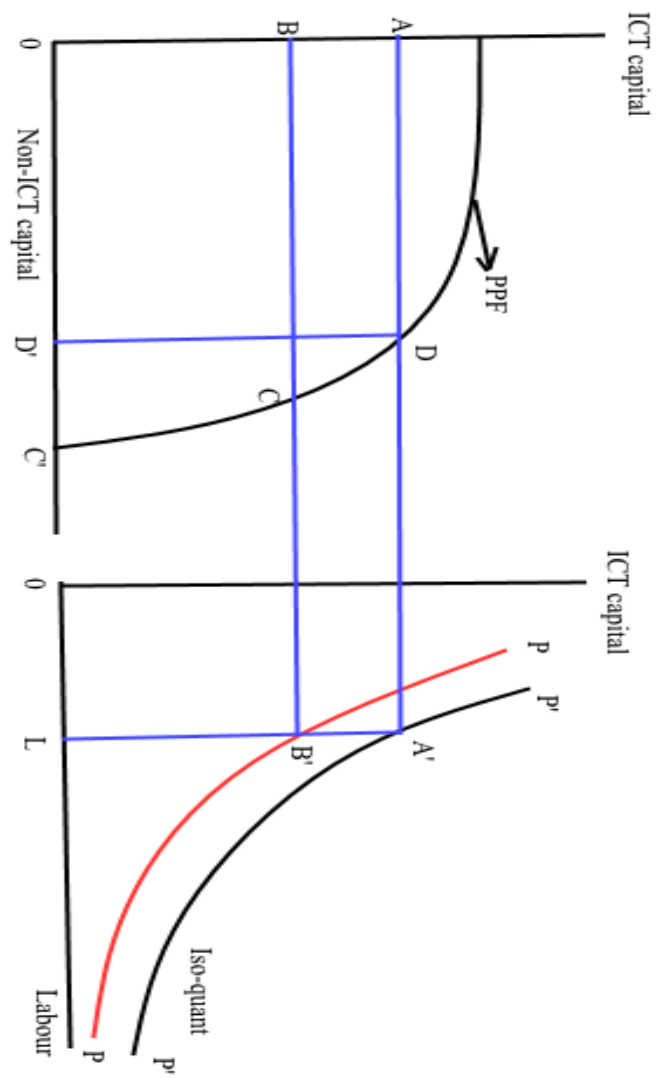


Figure 3.5: Graphical presentation of the role of ICT in production

Source: Author's development

The left hand-side graph of Figure 3.5 shows the Production Possibility Frontier (PPF) and the right-hand graph presents the production function. The X-axis and Y-axis of the left-hand side graph present Non-ICT capital and ICT capital used respectively. I have assumed with the combination of ICT-capital and non-ICT capital that a country (for example, Australia) can produce at point C provided that full production capacity is utilized. Now I presume a situation where, ICT capital facilities are enhanced in the country. Thereafter, the former use of OC' amount of non-ICT is reduced and replaced by OD' amount of non-ICT capital and the country now produces at D on the PPF, given that other conditions remain unchanged.

At point C, the country combines OL amount of labour to produce at point B' on the PP iso-quant curve, which represents the production function. At point D, with the same amount of labour OL the country combines more ICT-capital replacing non-ICT capital. This means that per head of labour ICT-capital increases. Consequently, the country moves to the higher level of iso-quant curve $P'P'$ at point A' . Such movements on higher iso-quant (i.e. from lower iso-quant to higher iso-quant) indicate the increase in total output (Samuelson & Nordhaus, 2009). This is also known as increased labour productivity in literature. The main reason for increased labour productivity is increased intensity of ICT-capital per head of labour (Shahiduzzaman & Alam, 2014).

At the Australian farm level, innovation is the main driver of productivity growth as farmers reduce production costs by applying technologies and management techniques efficiently (Gray & Sheng, 2014). The efficient use of technology enables farmers to reduce cost of production and thereafter to achieve productivity growth through saving costs associated with cost of inputs. On the other hand, farmers can achieve efficient management through expanding farm size and thereby exploiting the scope of economies of scale if there any (Sheng, Davidson, & Fuglie, 2014). Furthermore, socio-demographic characteristics of farmers and farm managers are also important determinants of productivity growth (Emily et al. 2014). These characteristics include the innovative capacity of farmers, farming experience, level of education and training, financial status, and attitude toward risk taking which is interlinked with farm-level profit maximisation objectives

There are two sets of agricultural technologies (The World Bank, 2011): (i) agricultural yield technology and (ii) information and communication technology, and the links between them. The link between agricultural yield technologies and ICTs is that when farmers use (yield enhancing) technologies such as organic fertiliser instead of chemical fertilizer, but are not aware of how much to apply, access to ICTs (radio/mobile phone/Internet) provide farmers with information as to the appropriateness of the use technologies. The resulting optimal use of inputs should cause efficient or effective output per unit of labour and capital – that is multi-factor productivity is raised (Australian Government Productivity Commission, 2004). Other broad applications of ICT in agriculture are pest and weather information management (The World Bank, 2011). For instance, the government or other related agencies may alert farmers through SMSs via mobile phones.

The application of information and communication technologies include farm-gate sales and marketing and better communication within farming operations and with regional peers and production knowledge transfer (World Bank, 2011). The World Bank report (2011) describes the difference between the two types of technologies and their relationship with productivity (Figure 3.6). The figure shows that ICT work as a medium or instrument to receive information about the effective use of yield technology. More specifically,

“ICT can be used to monitor pest thresholds in integrated pest management, provide relevant and timely information and agricultural services, map agro-biodiversity in multiple-cropping systems, forecast disasters, and predict yields. Crop losses diminish as farmers receive relevant and timely information on pests and climate warning through SMS technology” (World Bank, 2011, p. 88).

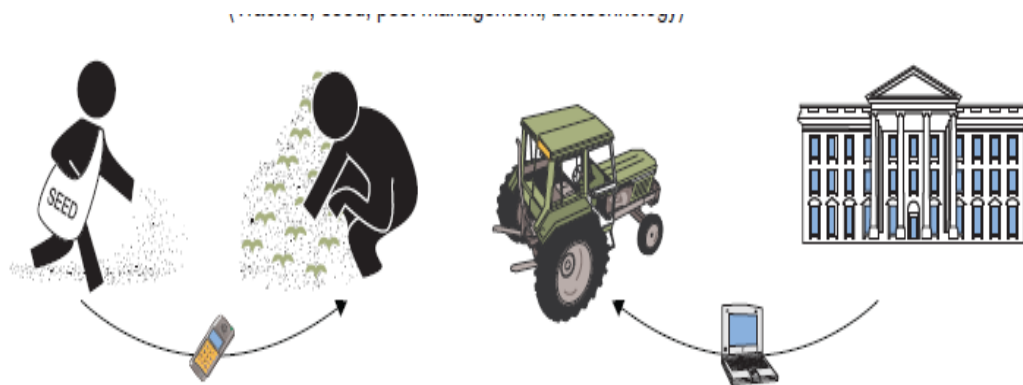


Figure 3.6: Graphical presentation of the relationship between ICT and productivity

Source: World Bank (2011, p. 88).

ICT enables farmers individually or as an organisation to gain more regular and timely access to information about various situations, including weather conditions, water conditions, soil quality, pesticide management and seed technology (Bank, 2011; Figueres, 2014; Richardson, 2000). The improved production techniques enable the producer to generate higher amounts of agricultural output in terms of per-unit inputs, which is known as productivity in the economics literature. The ultimate benefit of the efficient use of ICT is enhanced income for farmers. Further, it is asserted that ICT use improves farmers’ business management skills in terms of calculation and planting (Figueres & Eugelink, 2014). ICT enables farmers to access product price in the market, which then strengthens the bargaining power of farmers as individuals or as part of enterprises such as cooperatives, unions and federations. The combined use of internet, mobile phone, and computer makes things happen.

Each country has its own economic and technological strengths. Being a developed country, Australian farming is supposed to be different from developing countries. Various uses of information technologies are observed in Australian agriculture. They include:

- Crop modelling applying the Agricultural Production Systems Simulator (APSIM)
- Precision agriculture

Precision agriculture is used predominantly in broadacre cropping in Australia (Stoutjesdijk & Have, 2013). Precision agriculture is an ongoing process that uses information technology, guidance systems, variable rate application and zone management. Further, with reference to Australian agriculture, Australian farmers see the benefit of access to mobile telephony, email and SMS services too (Stoutjesdijk & Have, 2013). For instance, Australian farmers send their clients SMSs with advice about plating, fertilizer, and alternative pesticides. According to Stienen et al. (2007) the potential contributions of ICT to agriculture include:

- Increasing production
- Improving market access
- Capacity building and empowerment
- In the context of policy initiative, it has become imperative to understand the influence of the expansion of ICT infrastructure on various sectors of the economy.

In the context of policy initiative, it has become imperative to understand the influence of the expansion of ICT infrastructure on various sectors of the economy. The mechanisms through which the interventions generate benefits are as follows:

- Farmers become producers
- Farmers become better decision makers with regards to making products

3.4.0. The determinants of the agricultural production functions

Rolf, Gregor, and Menzies (2003) have research into the farmers in the Central Queensland region of Australia to explore the perceived benefits from the use of computers and the Internet. The study has used retrospective data and quantitative research methodology such as regression analysis. The research evidence suggests that farmers' perceptions have been that computer and internet services have been useful for gains in agricultural output. What looks obvious in hindsight might not be obvious at the time. Empirical research evidence in the Australian context has been absent until now. However, my search shows that previous studies have been carried out in South Asian agriculture, African agriculture, and Chinese agriculture. The majority of studies are micro-level studies (Muto, 2008; Aker, 2010; Mittal et al., 2010; Zanello, 2012; Dey et al., 2013) and very few are macro-level studies (Lio & Liu, 2006; Rashid & Elder, 2009). Furthermore, all studies are quantitative except one by Mittal et al. (2010).

3.4.0.1. South Asian evidence of the determinants

In the South Asian context Dey et al. (2013) investigated farmers' information needs to reduce production costs and thereby improve a farm's income in Bangladesh. The

evidence shows that the expansion of mobile coverage has increased the flow of agricultural market information among farmers, which has also assisted farmers in managing crop farming and product marketing. Moreover, the access to mobile phones has improved information asymmetry among farming communities and thereby contributed toward the reduction in production costs.

I have accessed a considerable body of literature that has been carried out in India too. Ali and Kumar (2011) analysed the role of information delivered through ICT in enhancing decision-making capabilities of Indian farmers empirically. The Indian Tobacco Company (ITC) initiated a research project known as the *e-Choupal* initiative, a special initiative to serve farmers through mobile telephony. Their findings were then compared with the non-users, and the *e-Choupal* initiative users showed significantly better decision-making aptitudes. The research provides evidence of substantial impacts on the farmers' decisions on planning, farming, and post-harvest product marketing.

In another study, Mittal et al. (2010) reported on the effects of the ownership of mobile phones on small and large farmers, brokers, and fishermen in the Indian state of Uttar Pradesh. In Uttar Pradesh they used mobile phones to receive information and to communicate with each other for information regarding marketing, weather, and fishing zones. Access to mobile telephony saved the users travel costs, gave them weather information and market information, and thereby contributed to agricultural productivity.

3.4.0.2. African evidence of the determinants

In the West African context, in a very recent study, Aker and Fafchamps (2013) investigated the effects of access to mobile phones on agricultural product prices. The study compared two situations: a situation where the farmer had no access to a mobile phone and a situation where the farmer did have access to a mobile phone. Access to a mobile phone reduced the spatial distribution of agricultural product prices by 6 per cent, but did not ensure higher agricultural product prices in the market.

In an earlier study, Muto (2008) investigated the effects of the ownership of mobile telephones on banana sales in Uganda. The study used panel data covering the period 2003 – 2005. The expansion of mobile phone coverage increased banana sales by 19 per cent for the farmers who were living far away from the district headquarters. In another study, Aker (2010) investigated the relation between mobile telecommunication infrastructure and performance in the agricultural market in Niger. The study used panel data too. Mobile phone coverage has reduced market price dispersion by 10 per cent across various product markets. Thus, both studies found positive effects of the access to mobile telephony on farmer's participation in product marketing.

Underpinning a slightly different conceptual foundation, Zanello (2012) examined the effects of the use of ICTs on farmers' participation in product marketing in Ghana, taking into account the usage of mobile phones. The study examined the effects of mobile phone usage on farmers' participation in the market. Solving the endogeneity problem, the study found a statistically significant positive influence of mobile phone usage on

farmers' participation in the market. A distinct finding of the study was that "the ownership of the mobile phones and radio is not a significant factor...the actual use of ICT tools rather than ownership is relevant for market participation" (2012, p. 710).

Information and Communication Technology for Development (ICT4D), a corporation located in Canada, has implemented several development programs aimed at improving access to mobile telephony in developing countries. A program experience, implemented in Senegal, showed that the ownership of mobile telephones has increased farmers' profit by 15 per cent (Rashid & Elder, 2009).

3.4.0.3. Chinese evidence of the determinants

The role of technological progress in Chinese agriculture has been highlighted in a number of studies (Liu & Wang, 2005; Jin, Huang, & Rozelle, 2010). Liu and Wang (2005) investigated the role of technological progress in Chinese agriculture in the 1990s. They used panel data and a Cobb-Douglas production function. The empirical evidence was that the effects of technological progress (captured by a time variable) on Chinese agriculture was positive during the 1990s. Later Liu et al. (2005), Jin, Huang & Rozell (2010) reassessed the issue. They used panel data for 28 provinces, covering the years 1991–1999. The research evidence was that the technological progress (represented by mechanisation level and irrigation scale) was responsible for 39 per cent of the total productivity growth during the period 1991–1999.

Fan & Pardey (1997) analysed agricultural productivity by using a dataset regarding eight regions of the PRC. The researchers used both conventional and quasi-translog Cobb-Douglas production functions in their study. Their study showed that 45.2 per cent of the total agricultural growth was linked to conventional inputs, and 22.2 per cent of the growth was linked to research expenditures.

Chen et al. (2008) have analysed productivity growth in China again. They used panel data regarding 29 Chinese provinces. They used the Malmquist productivity index and Data Envelopment Analysis (DEA) estimation techniques. The research evidence was that the technical progress was the major source of agriculture productivity for the period of study. In this study, the effect of research and development expenditure on agricultural productivity was positive too. After Chen et al. (2008), Jin, Huang, & Rozelle (2010) empirically researched the cross-province differences in investment in R & D by the government and its effects on agricultural productivity. R & D expenditures had a large effect on technological development that ultimately affected agricultural productivity.

Chen et al. (2008) have provided empirical evidence in support of the theory that level of education relates to the level of productive capacity on the part of a worker. The researchers examined the role of farmers' education on the technical efficiency of Chinese agriculture. Farmers' levels of education enable farmers to select better factors of production and thereby allocate them efficiently (Pudasaini, 1983). A better-educated farmer is capable of using resources for agricultural output better than his counterpart whose education level is comparatively low.

3.4.0.4. Cross-country evidence of the determinants

Analysing panel data covering the period 1995–2000 on eighty one countries, Lio and Liu (2006) found evidence that the new ICT has a significantly positive impact on agricultural productivity. The evidence suggested that the adoption of modern industrial inputs in agricultural production relies on information and communication infrastructure. Moreover, the empirical evidence from this study also suggested that new ICT could be a factor for the divergence between countries in terms of overall agricultural productivity.

3.4.0.5. Knowledge gaps

A good body of literature has examined the causal links between access to information and communication technologies (ICTs) and productivity gains at the macro and sectoral levels (please see Cardona, Kretschmer, & Strobel, 2013 for details). As a result, many empirical research studies have emerged that point to the important role of ICT in productivity gains in the service and manufacturing sectors. However, the agricultural sector has been assumed to have had no gains from ICT as it is considered a primary sector of the economy (Rolf, Gregor, & Menzies, 2003). So far, except for Lio and Liu (2006), no reliable study has examined the relationships between ICT and productivity gains in agriculture. This thesis explores the role of ICT in agricultural productivity by measuring the returns from investment in telephony (a proxy measure for ICT) in Australian agriculture, and thereafter comparing the returns with that of the other non-agriculture sectors.

My study is different from previous studies in the following ways. First, the study has used the concept of the usage of telephony rather than access to telephony. Here the usage is measured in monetary term by the expenditures for telephone uses; secondly, it uses a dynamic agricultural production function to estimate the elasticity of telephony expenditure (or consumption). Here the effect is divided into the short-run and long-run effect⁴; thirdly, it compares the estimated elasticity (or return) of telephony with the estimated elasticity in the non-agriculture sectors; finally, the study uses very recent data. Previous literature has suffered from methodological issues such as endogeneity and econometric estimation techniques. O'Mahony and Vecchi (2005) focused on firm-level heterogeneity and endogeneity issues in production in order to investigate the impact of ICT on output in non-agricultural sector firms (industry-level data was used). A similar argument has been made in other literature (Kangasniemi, Mas, & Robinson, 2012). Given the context, the past studies that used a single equation model of agricultural production would provide misleading results. Hempell (2005) found that different quantitative results attributed to varying definitions of ICT stocks and differing

⁴ For general readers, short-run and long-run define two situations used in the theory of production. According to the theory of production factors of production are two types: fixed and variable inputs. In the short-run some inputs are fixed; in the long-run there is no fixe input. Therefore, short-run and long-run are temporal concepts.

quantitative methods and model specifications. The paper suggested a dynamic panel data model, and generalised methods of moments (GMM) estimation techniques as the most suitable econometric approach to investigate the causal relation between ICT stock and output at the firm-level.

I intend to overcome the gap in the literature by examining an agricultural production function of the Cobb-Douglas type and also by deploying dynamic panel data modelling to explore the causality between ICT and agricultural productivity as suggested by Hempell (2005). We also test the endogeneity nature of the main variable of interest – ICT capital stock. Thus, this study fills the knowledge gap and thereby extends the existing body of studies. In order to fulfil my research objective I correct the methodological issues and investigate the influences of telephony expenditure on farmers' revenue from agricultural activities.

3.5. Summary of the Chapter

In chapter 3 I have reviewed four theoretical concepts underpinning this doctoral research and previous research evidence on five research questions. From this analysis, I derived the research gaps in the literature. The theories were (i) Affordance theory, (ii) Ajzen and Fishbein theory, (iii) research production theory, and (iv) New classical growth theory.

The main research gaps that emerged in this study were as follows. First, the effect of the LMS on academics was limited to theoretical discussion, and empirical studies were lacking. Second, empirical studies on the research production function did not consider the Internet as a potential capital factor in the production function. Third, though many studies highlighted the effect of communication technologies on manufacturing and service sector firms, the potential effect on the agricultural sector farmers is yet to be investigated.

4. CHAPTER FOUR: THE RESEARCH DESIGN AND METHODS

4.1. Data types and sources

This doctoral research used data from two sources: – (i) a primary source and (ii) a secondary source. The source of the primary data was academic teaching staff members of the University of Southern Queensland, and the source of secondary data was the Australian Department of Agriculture. The primary data was cross-sectional and the secondary data was panel data. The panel data were gathered from five states in Australia: New South Wales, Queensland, South Australia, Victoria, and Western Australia. Because of the non-availability of data, the Australian Northern Territory, Tasmania and the Capital Territory were excluded from this study. The period of the panel data was the 13 years: from 1990 to 2012.

In Australia, there were 39 full universities, apart from Open Universities Australia, as of 2014 (Australia's Universities, 2014). The distribution of these universities was as follows: New South Wales had 10 (ten), Victoria had 8 (eight), Queensland had 8(eight), South Australia had 3(three), Western Australia has 5(five), Tasmania has 1(one), the Northern Territory had 1(one), and the Australian Capital Territory had 2(two) universities. The other higher education enterprises are colleges and other institutions, and schools authorised by the Australian Government that comply with the Australian Higher Education Qualification Framework (Department of Industry, 2012).

The University of Southern Queensland (USQ) was established in 1961 on an area of 200 acres of land located to the southwest part of the regional city, Toowoomba, Queensland. Initially, in 1967 the university was identified as being affiliated with the Queensland Institute of Technology. After the enactment of the Education Act 1971, the institution became the Darling Downs Institute of Advanced Education. By 1973, the Institute began to offer professional degree courses in engineering, education, science and business studies. In 1974 the School of Arts was formed. In 1978, the Institute established the External Studies Department. Later it became a model of external education globally. The Institute experienced unprecedented growth between 1980 and 1990. Consequently, the University College of Southern Queensland was established under the auspices of the University of Queensland. By the 1st of January 1992, the University of Southern Queensland began its journey as an independent university. In 2013, the total number of students' enrolment was 27337 and the total number of teaching academic staff members (both full-time and fractional) was around 466, while there were 1668 administrative staff members.

USQ was one of the pioneers in online education in Australia based on the state-of-the-art technology. The USQ, one of 16 regional universities, has installed

eLearning environments that include: Study Desk, ePortfolio, virtual classrooms, Presentation Capture, electronic assignment submission, plagiarism detection software, content authoring software, materials repository, video conferencing, media services, copyright services, and BYO tools. This study was carried out at the USQ, because the constraint of time and budget. Secondly, the institution has a well-recognised reputation worldwide for its off-campus mode of teaching and learning. In recognition of this reputation, USQ won a Prize of Excellence in 1999 for distance education from the Executive Committee of the International Council for Open and Distance Education, which is based in Oslo, Norway (Reushle & McDonald, 2000).

The Australian Government Department of Agriculture is an independent government department. The Australian Bureau of Agricultural and Resource Economics and Science (ABARES) is a body within the Department of Agriculture engaged in supporting the government of Australia to make evidence-based policy, to develop capacity for integrated research and advice, to promote research findings, and to manage people, systems, and processes. ABARES conducts a range of surveys each year including the Australian agriculture surveys. Their farm level survey database is known as 'AGSURF'. Its datasets are available online at <http://apps.daff.gov.au/AGSURF/>

4.2. Data collection

Two types of primary data - qualitative and quantitative data - were collected. The secondary data were quantitative data. First, I describe the primary data collection procedures.

4.2.0. Qualitative data collection

4.2.0. 1. Sampling technique

In Australian universities, academic staff members were divided into four categories: teaching only staff, research only staff; teaching and research only staff members; and academic administrative only staff members. Each category of staff is recruited on the basis of full-time or part-time employment. For primary data, I targeted all of the above categories except academic administrative staff members irrespective of their modality of employment – full-time or part-time. On that basis, I So, I used a non-probability purposeful sampling technique (Bernard & Ryan, 2010; Tashakori, 1998).

I used purposeful sampling because I was interested in selecting participants who were capable of recollecting memories and giving information. Previous studies used the sampling methodology to investigate the influence of online teaching on teaching and research productivity. An example was the study of Meyer (2012). However, that sampling method did not ensure representativeness of the population, which was proven effective in securing trust and cooperation from the participants. The participants were invited to participate in the Focus Group Discussions (FGDs) based on their personal connections with the academic staff members.

3.2.0.2. Focus group discussions (FGDs)

FGDs were considered in order to promote “self-disclosure” (Krueger & Casey, 2000, p. 7) among the participants. As I wanted to know the participants’ thoughts about and attitudes to the use of the LMS in teaching students online, self-disclosure from everyone was not desirable in all settings. For some of the participants self-disclosure was comfortable and for others it could be uncomfortable. When participants “feel comfortable and when the environment is permissive and non-judgemental” (Krueger & Casey, 2000, p. 9) they are more likely to say what they really think. FGDs are a strategy to set up a natural setting for the participants so that the environment is comfortable for ‘self-disclosure’ by the participants.

Krueger and Casey’s framework (2000) was used to frame the FGDs in some of the literature, for example in a study by Brownie and Coutts (2013). Based on prior success, I have used Krueger and Casey’s framework in my study too. I started with opening questions, then I moved to transition questions, followed by the main questions that were the focus of this study. The participants’ responses to the questions were voluntary.

I organised three focus groups taking into account the participants’ interests and availability. In order to make each FGD effective, I took charge of coordinating talk, keeping time, and co-ordinating different lines of arguments. Each FGD lasted for 60 minutes. Finally, the FGDs were audio-recorded, and I took notes. A professional organisation was hired to transcribe the audio-tapes. The statements about online teaching experience and practices in different areas of teaching were developed after the analysis of the transcripts of audio-recorded discussions and notes.

In December 2013, at USQ 466 (teaching and research) staff members were available for interviews from two faculties, the Faculty of Business, Education, Law, and Arts, and the Faculty of Health, Engineering and Science. The eligibility criteria for inclusion of the participants in this study were: (i) teachers’ active participation in online teaching, and (ii) teachers’ willingness to participate in the study. An overview of the participants is presented in Table 4.1.

Table 4.1: An overview of the participants in the FGD

Date	Venue	No.	Gender
02/12/2013	USQ	5 (Five)	Male : 5
27/11/2013	USQ	6 (six)	Male: 3 Female: 3
11/11/2013	USQ	5 (Five)	Male : 4 Female: 1

4.2.1. Quantitative data collection

4.2.1.1. Sampling technique

For quantitative primary data, I targeted USQ teaching only staff members, research only staff members and teaching and research academic only staff. To collect these data, an online survey was conducted during the period of February - March 2014. In 2013-2014, according to the USQ statistics warehouse, 466 academic (teaching and research) staff members were on USQ's payroll. Eighty-seven per cent of them were full-time, while the remaining staff members were casual and contractual. I selected all full-time and part-time USQ academic staff members except administrative staff members. Academics who were engaged in administrative roles such as the University Vice-Chancellor and President were excluded from the survey.

4.2.1.2. Data collection instrument

The data collection instrument was prepared based on past literature and expert consultation. I developed an instrument for online surveys using Qualtrics⁵. The instrument contained two types of questions – closed questions and questions measurable on a Likert scale. Socio-demographic variables were collected by the closed questions. The closed questions consisted of multiple choice type questions. The variables were socio-demographic variables and were selected based on past research.

In order to collect Likert-type data, academics were given a list of 11 (eleven) statements that measured the perceived effects of their use of ICT for teaching and research. Each statement was measured on a 6-point Likert Scale: 1=strongly agree through to 6=not applicable. In the primary survey there were 85 respondents. After data cleaning, I found that only 65 respondents' replies were valid for analysis. As the observation size was small, I collapsed the 6-point Likert scale measure into a 3-point Likert scale measure: 1=Agree, 2=Uncertain, and 3= Disagree. I collapsed 6-point scale

⁵ Qualtrics is an online data collection platform. The web address was www.qualtrics.com

to 3-point scale in the following ways: I collapsed strongly agree and agree to make agree; strongly disagree and disagree to make disagree; and finally, I collapsed “*uncertain*” and “*not applicable*” to make uncertain. To do this, I calculated an average of the items, which resulted in 1 to 5. I did it in order to make sure that the cross-tabulation was statistically meaningful. A list of statements is reproduced in Table 4.2.

Table 4.2: List of statements illustrating the perceived effects of ICT on academics work

Label	Statement
Q1	The use of study desk/moodle/email/digital course content preparation reduces time for research
Q2	The use of ICT has increased academic workloads
Q3	Email communication has increased the volume of unwanted mail from students
Q4	Owing to unwanted mail communication, the time available for research has decreased
Q5	The use of email enhances collaborative research outputs
Q6	Email communication has increased the complexity of doing teaching and research
Q7	The use of online survey tools increase research outputs (such as journal article)
Q8	The use of data analysis software makes data analysis simple
Q9	Currently ICT based online teaching is technologically driven rather than pedagogically driven
Q10	Academics’ fail to align digital tools available on study desk/moodle with their students’ pedagogical needs
Q11	The use of web-based tools has impacted on your participation in domestic and international conferences

Source: The table comes from the Appendix 6

Table 4.2 shows that some of the items present positive attitudes towards the effects of the use of ICTs on academics’ work, for instance, in the table 4.2 Label E5 - ‘The use of ICT enhances collaborative research output’ and Label E8 - ‘The use of data analysis software makes data analysis simple’. Some of the items measure negative attitude, for instance, E2- ‘Email communication has increased the volume of unwanted mail from students’. On the whole, the 11 (eleven) items measure two underlying dimensions - the *positive effects* and the *negative effects* of the use of ICTs on academics’ work.

Before finalising the survey instrument, I piloted the survey three times in order to ensure the highest quality of the instrument. I selected the participants for the pilot survey from a group of USQ academics. I ensured representation from across the disciplines: science, arts, and commerce. I received very important suggestions regarding the instrument. As per their recommendations, I corrected the required items in the instrument. I rephrased six items and I included five items in the instrument.

In order to encourage participation in the survey a web link was sent to the participants through email. Participants were not required to log into the site, as the link was enough to complete the questionnaire. Approximately 10 minutes were required to complete the survey in normal circumstances. All responses were anonymous and confidential. As an incentive, participants were able to register for the drawing of a gift by providing their contact information at the end of the survey. Approximately one and a half months were given to participate in the survey. In response to the call, I received 83 responses. The rate of participation was around 20 per cent.

Among the respondents, 55 per cent were male and 45 per cent were female faculty staff. In terms of academic rank, 6 per cent was Associate Lecturer, 45 per cent was Lecturer, 28 per cent was Senior Lecturer, 11 per cent was Associate Professor and 11 per cent was Professor.

4.2.1.3. Measures of reliability

Classical test theory requires us to evaluate the reliability of a measuring instrument (Blunch, 2008). “The reliability is an instrument that provides its ability to give identical results in repeated measurements under identical conditions” (Blunch 2008, p. 27).

The validity of a measure relies on the reliability of that measure. Hence, the validity of a composite variable is limited if we rely on a single presentation of a single questionnaire. Under the given circumstances, some checks were required. My composite variable ‘work satisfaction’, which was a composite of 11 (eleven) items in Question 24, really did represent a single entity which indicated how satisfied academics were with their work in the context of enhanced uses of ICTs.

For a measure with reliability I tested the same set of academics on different occasions, and the scores from one should be highly correlated with the scores from the other times. This is a recommended method to establish the reliability of one measure. A second method is to administer the questionnaire only once, then split to the items used to create a composite variable into two equivalent halves. I created two composite variables from these two sets of items and correlated them. The higher the correlation, the higher the reliability was. This is called split-half reliability (Blunch, 2008). The problem with the method is determining which would be the most split of the items. The solution is to use Cronbach’s Alpha, which can be thought of as the mean of all possible split-half coefficients. There is no standard guide to following the general rule. The rule of thumb is that, if the value of Cronbach’s Alpha is equal to or above 0.7, it is considered to represent acceptable reliability (Field, 2005, p. 668). Cronbach’s Alpha (Cronbach, 1951) is as follows:

$$\hat{\alpha} = \frac{N(\overline{\text{cov}})}{\sum s_{item}^2 + \sum (\text{cov})_{item}}$$

The guide line should be followed with caution because the value of Cronbach’s Alpha depends on the number of items on the scale. Cronbach’s Alpha shows that the top of the equation includes the number of items squared. Therefore, a large value of Cronbach’s

Alpha is possible if the number of items on the scale is very large, not because the scale is reliable (Field, 2005). This implies that a low number of items in the equation produce a low value of alpha, not that the scale is unreliable. From SPSS Output we find that Cronbach's Alpha is 0.69 which is not far from the acceptable value of 0.70. Hence, my composite value is acceptable in its current form.

Table 4.3: Reliability test of composite variable

Case Processing Summary			
		Number	Percentage
Cases	Valid	65	77.4
	Excluded ^a	19	22.6
	Total	84	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Numbers of items
0.686	11

4.1.2. Quantitative data collection from secondary source

The data used in this study are drawn from the website of the Department of Agriculture, Fisheries and Forestry (DAFF) of the Government of Australia. The address of the website is <http://apps.daff.gov.au/AGSURF/>. The website contains data about the Australian broadacre agriculture for each state covering the periods 1990-2012. According to this source financial data are expressed in constant terms deflated by the price level of 2012. However, as the data for certain states and territories of Australia such as Tasmania and the Northern Territory were not available, these states were excluded from the dataset. Therefore five states are included. These states were:

- New South Wales,
- Victoria,
- Queensland,
- South Australia, and
- Western Australia.

I used cross-section and time series data covering the period 1990-2012, where the total number of states were 5, i.e. $N = 5$; total years were 22 i.e. $T = 22$. The total number of observations was $(5 \times 22) = 115$.

My dataset included the following variables: agricultural revenue (Y), non-ICT capital (K), communication technology (CT) capital, expenditure for labour (L), agricultural land rent (Lr) and fertilizer (F). Y is a measurement of aggregate revenue that includes cash receipts from the sales of crops, livestock, livestock products, royalties, rebates, refunds, plant hire, contracts, share farming, insurance claims and compensation,

and government assistance payments. The variable ‘non-ICT’ capital included physical capital expenditures for machinery, equipment, fuel and irrigation facilities. The variable CT measured expenditure for farmers’ use of telecommunication, including telephone and the Internet. As this CT expenditure pattern served as an estimate of real functioning too (McGregor & Borooah, 1992), this variable represented an aggregate measure of the adoption or use of CTs.

Appropriate climatic conditions are very significant for agriculture. They influence broadacre agriculture in Australia too. I included a variable rainfall (*RF*) to capture the influence of the variable in broadacre agricultural production. The data in the variable rainfall were collected from the Australian Bureau of Meteorology. Following Khan, Salim and Bloch (2014) the period for measuring rainfall was chosen to match the growing season in each state. The remaining unobserved variables were subsumed in the error term in the production function.

4.1.3. Reducing nonresponse bias

Nonresponse bias is a critical issue in survey data study (Bethlehem, 1988; Hugo & Lacy, 2011). This happens in survey data collection when the required number of respondents that represents the population of the study does not respond during the time of survey. This causes the main problem in estimating the potential characteristics of the population of the study (Bethlehem, 1988). In my survey, I experienced a shortage of the required number of responses from the population of my study. However, this data limitation does not prevent researchers from conducting their research. Keete et al. (2006) researched the effects of variations in response rates on the variation on results with respect to population characteristics. They found statistically identical results using two survey data with two different rates of 25 per cent and 50 per cent. Horta and Lacy (2011) researched into the effects of research unit size on academics’ scientific productivity and information exchange behaviours using a survey where the response rate was 18 per cent. Visser et al. (1996) conducted research using a 20 per cent response rate and found relatively more accurate results compared to studies that used higher response rates.

However, some adjustment techniques are required to reduce the problem(s) of nonresponse bias after data collection. These techniques are weighting, imputing missing data and compiling auxiliary information (Bethlehem, 1998). Krenzke et al. (2005) suggested some pre-data collection measures too. These measures include understanding the reasons for nonresponse and motivation. In my survey data collection, I undertook both pre-survey and post-survey measures. As pre-survey measures, I requested the office of the Deputy Vice-Chancellor (Students and Communities) to communicate with the potential respondents in order to highlight the importance of the survey. Secondly, I kept the language of the survey very simple and understandable so that a potential respondent could reply to a question quickly. Thirdly, I announced a prize for participating in the survey. As a post-data collection measure, I weighted the respondents because “weighting is generally preferred” (Bethlehem, 1988, p. 252).

4.3. Research approaches

In this doctoral research, research question 1 (RQ 1) was qualitative and research question 2 (RQ 2) was quantitative in nature. While research question 3 (RQ 3) and research question 4 (RQ 4) were both quantitative in nature. In order to fulfil the objective of the research I used two types of approaches – (i) a mixed approach and (ii) a quantitative approach. The mixed methods design was used to reply to RQ1. The mixed method is a procedure for collecting and analysing both qualitative and quantitative data (Tashakori, 1998). This study used this approach because neither a qualitative, nor a quantitative research approach alone was deemed sufficient to understand the complex interactions between humans and technology. Here qualitative and quantitative data complemented each other and the mixed methodology allowed a comprehensive analysis to be conducted (Tashakori, 1998).

I have presented a sequential mixed research design in Figure 4.1. Phase 1 of the mixed approach was a qualitative study, while Phase II was a quantitative study. In Phase I, I examined the dynamics of teachers' perceptions, based on practical experience, towards the affordances of ICTs in online teaching. In Phase 2 I examined how teachers' perceptions varied with respect to socio-economic and demographic characteristics. The literature showed that four factors - timing, weight, mixing, and theorising – help to shape the procedures of a mixed method study (Creswell, 2009).

4.3.0. Mixed approach for RQ 1

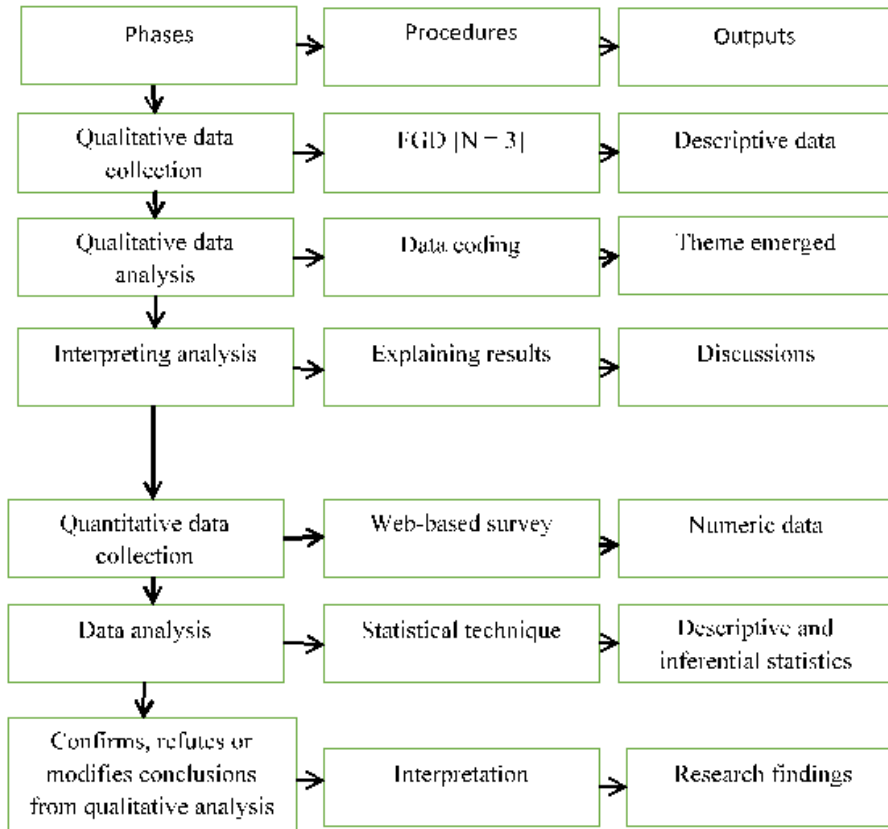


Figure 4.1: An overview of mixed approach

Using qualitative data and a qualitative research approach, the study explored attitudes based on real life experiences of using an LMS for teaching. The qualitative research approach is capable of systematically organising some parts of the human experience, but it is not concerned with the statistical interpretation of data but rather with the exploration of some common themes (Donalek & Soldwisch, 2004). The literature argue that any qualitative research design is given shape by the researcher, which then underpins the theoretical orientation (Denzin & Lincoln, 2000, as cited in Crowley-Henry, 2009). A theoretical orientation is a model used to describe the behaviour or personality of an individual. In the absence of any theoretical orientation in this study, I studied the academics’ experiences based on participant observation whereby the researcher immerses himself/herself in the customs and lives of the sample population under exploration, otherwise known as “ethnography” (Crowley-Henry, 2009, p. 35). In such a situation, no pre-developed questionnaire is administered among the participants to collect the data (Creswell, 2009). “The research process is flexible and typically evolves contextually in response to the lived realities encountered in the field setting” (Le Compte & Schensul, 1999, as cited in Creswell, 2009, p. 13). As this approach was suitable for fulfilling the objectives of this thesis, this study used the ethnographic data

collection technique. One research objective was to study the effects of ICTs on a sub-population of teaching staff of the university in a 'natural' setting. The general features of the ethnographic data collection technique are as follows:

- Researcher(s) study people's behaviour in their normal environments and not under experimental conditions
- Researcher(s) collect data from different sources by observations and through conversations
- The focus is on a group
- Researcher(s) analyse data by interpreting the meanings in talk
- Finally, researchers describe cultures (Creswell, 2009)

There are three major ethnographic methods: triangulation, participant observations and field notes (Creswell, 2009). However, ethnographic approaches are flexible but may be confusing (Crowley-Henry, 2009), which is why justification of the researcher's own individual ethnographic approach and position is useful. In this study my approach was to use field notes to record the researcher's ideas of the issues regarding the use of ICTs in teachers' academic work environments. In order to gather the notes I conducted three FGDs. The members of each FGD were academic teaching staff at USQ, Australia. FGD is a very useful ethnographic approach to provide insights into work-related perceptions about online teaching based on different opinions observed among different individuals or parties involved in the process (Stewart & Shamdasani, 1990). The aim of group discussion was to establish rapport with participants and to gather data about the working experiences of USQ teaching staff from their talk in several group meetings that took place at the USQ campus where they work.

In my qualitative study, I narrated the pre-work experiences of the teaching academics and derived the major themes. I also checked whether the major themes were consistent with the previous themes. I interpreted the data collected to build-up a theory inductively. After extensive examination of the narratives and patterns of talk, I pulled together elements from the interviews and built up a framework for further quantitative research.

4.3.1. The quantitative approach for RQ2-RQ4

A quantitative research approach explains phenomena by using numerical data collected and statistical methods (Balnaves & Caputi, 2001). Therefore, a quantitative approach inevitably requires quantitative data. As for statistical methods, written books and journal articles provide a rich collection of information, and the main question here is what kind of question a researcher is going to examine in his/her research. Two of the research objectives of this PhD research involved multiple questions have already been noted in Chapter 1. Two of the aforementioned questions required hypothesis testing. I conducted hypothesis testing using regression analysis, which is asserted to be the best suited strategy in the literature (McClave, Benson, & Sincich, 2005). The regression strategy control the confounding factors to examine the cause and effect relationship between the

variables of interest. Thus, regression analysis was used to examine the relevant research questions.

4.4. An overview of data analysis methods

I used four types of data analysis methods to achieve the objectives of this paper. These methods are

- Thematic analysis,
- Factor analysis,
- Cross-tabulations, and
- Regression analysis.

I have explained each method in detail in the chapter concerned in order to keep a flow for the reader and to allow for a smooth connection to the respective research question and answers. In the following figure 4.2 , I have presented an overview;

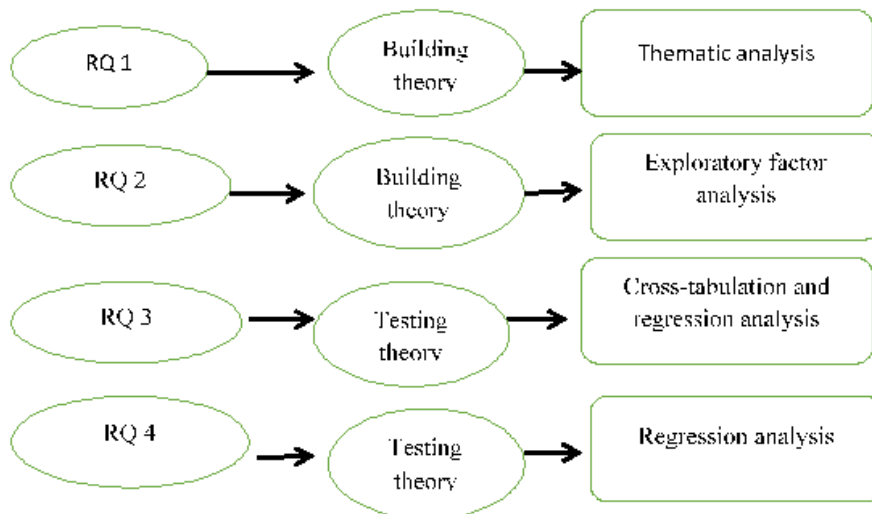


Figure 4.2: An overview of the data analysis approaches

4.4.0. Thematic analysis

In a qualitative analysis, thematic analysis is used to examine themes within the data (Daly, Kellehear & Gliksman, 1997). This technique focuses on organising and describing the data set. The function of thematic analysis is to identify thoughts and ideas expressed by the participants.

The primary process of thematic analysis is coding the raw data. During this coding of the raw data, the important facts and figures are underlined and later encoded for interpretation (Richards, 1998). For interpretation of the coded data, the calculation of frequency of a particular fact and figure is taken into account and then comparative analysis is carried out. In this regard, a graphic demonstration of the relationship between different themes is very useful. A majority of researchers interested in qualitative research use thematic analysis to capture the intrinsic meaning of the data (Guest, 2012).

A qualitative dataset entails a wide range of texts that range from a single word reply to a multiple word reply, encompassing many lines of recorded transcript (Saldana, 2009). In my study, the responses to an open-ended questions entailed talk captured in many paragraphs, which was then transcribed by a professional transcriber.

My thematic analysis is focused on the human experience of the teaching academic subjectively (Guest, 2012). In my study, I focused on the university teaching academics' perceptions, feelings, and experiences of using an eLearning environment to interact with online students. In this process, the participants discussed the experience in their own words.

In research two broad methods of reasoning are involved: inductive and deductive (Braun, & Clarke, 2006). In the inductive approach, the themes are identified based on the data collected, which is otherwise known as a data-driven process. The deductive way involves prior theory, which is other-wise known as a theory-driven process. In my study, the qualitative data analysis was deductive. This implied that the data coding activities were independent of any pre-existing hypothesis or model. It is asserted, however, that this approach of data analysis, the researcher was not free from any theoretical responsibility.

A theme is a common pattern of responses to emerge from data that is related to a research question of interest (Braun & Clarke, 2006). Generally, themes occur numerous times in the dataset; however, a higher frequency of a common response does not guarantee a theme. A detailed thematic analysis is included attached in Appendix A4. Please see Table A4.

4.4.1. Factor analysis

Factor analysis is a statistical method of analysing variability in unobserved latent variable(s) based on observed variable(s) (Harman, 1976). It looks for a joint variation on variable(s). In order to gain an insight into the latent variable(s), I observed many variables, where the variables were interrelated. Through factor analysis, the number of interrelated variables is reduced in the dataset (Harman, 1976). There are two techniques of factor analysis: exploratory factor analysis, and confirmatory factor analysis. However, there is a link between the two. Researchers use exploratory factor analysis before they move on to confirmatory factor analysis.

Exploratory factor analysis is used to explore the underlying structure of a set of observed variables (Ruscio & Roche, 2012). Based on exploratory factor analysis, a set of

scales is identified. Later, using the set of scales, a set of latent constructs is developed (Fabrigar et al., 1999). The common factor model is the underlying base of exploratory factor analysis. There are many procedures to retain the optimum number of factors, including Kaiser's eigenvalue, scree plot, very simple structure criterion, the model comparison technique, optimal coordinates, and minimum average partial (Harman, 1976).

Confirmatory factor analysis is used to test a prior hypothesis based on the measured construct, where the hypothesis is developed based on theory or past research studies (Kline, 2010). I used exploratory factor analysis because the goal of exploratory factor analysis is to identify factors (or latent constructs) based on observed data (Thompson, 2004).

4.4.2. Cross tabulation

Cross-tabulation, a statistical technique, is also referred to as contingency table or cross-tab. This parametric statistical technique measures the degree of association between two variables. It is a multivariate frequency distribution table in matrix form (Wagner, 2007).

The standard content of a contingency table consists of multiple columns. Each column refers to a certain group, or to multiple groups of a sample population. Each cell in each column contains a value measured as a percentage terms. Tests of significance are generally used to measure the degree of association between two cells in a column.

The main objective of this analysis was to study the association between dependent and explanatory variables. General wisdom was that social phenomena did not just occur without causes. Before I examined the explanatory variables or factors, I looked at the statistically significant association between dependent and independent variables. In this regard, there are a number of Chi-square based measures: Chi-square statistics, Phi-square, Contingency coefficient, and Cramer's V (Leibetrau, 1983).

Chi square test

Chi-square statistic provides a test of as to whether or not there is a statistical relationship between the variables in the cross-tabulation Table. Here the hypothesis was:

Null hypothesis: The two variables are independent.

Alternative hypothesis: The two variables are not independent.

Chi-square test statistics
$$\chi^2 = \sum \frac{[n_{ij} - E_{ij}]^2}{E_{ij}}$$

Where $E_{ij} = \frac{R_i C_j}{n}$; n_{ij} = Observed counts; and E_{ij} represents expected count. R_i is row I ; and C_j is column j . For this test the expectation was that the cell frequency must be greater than five (McClave, Benson, & Sincich, 2005)

There were a number of limitations to this test. First, it did not include the nature of relationships. Secondly, the size of the statistics did not provide a reliable guide to the

strength of the relationship between the two variables. Thirdly, when the sample sizes for two tables differed, the size of chi-square statistics was a misleading indicator of the extent of relationship between two variables. Under the given circumstance, one way to overcome the problem with the chi-square statistics was to adjust the Chi-square statistics for either the sample size or the dimension of the table (McClave, Benson, & Sincich, 2005). Phi-statistic has the advantage of this. Because of its inbuilt facilities, I did not need to give to adjustment manually.

Phi statistics

Phi test statistics are $(\phi) = \sqrt{\frac{\chi^2}{n}}$. Sometimes phi-square is used as a measure of association. For this measurement, the chi square statistics for the table are determined first, and from this it is relatively easy to determine phi statistic. One advantage of Phi statistics is that it carries out adjustment the required for the sample size or the dimension of the table.

Contingency coefficient

A slightly different measure of association is contingency coefficient which is measure by

$C = \sqrt{\frac{\chi^2}{(n + \chi^2)}}$ since $\phi^2 = \frac{\chi^2}{n}$ it is straightforward to show that $C = \sqrt{\frac{\phi^2}{(1 + \phi^2)}}$ The contingency coefficient has much the same advantages as Phi.

Cramer's V

One final chi square base measure of association is Cramer's V. This measure is defined as

$$V = \sqrt{\frac{\phi^2}{t}} = \sqrt{\frac{\chi^2}{nt}}$$

where t is the smaller of the number of rows minus one or the number of columns minus one. If r is the number of rows, and c is the number of columns, then

$$t = \min(r - 1, c - 1)$$

Cramer's V corrects for the problem that measures of association for tables of different dimensions may be difficult to compare directly by using the information concerning the dimension of the table (McClave, Benson, & Sincich, 2005). If the statistic is zero it means that there is no association between two variables. If the statistics is 1, it means there is a strong association.

I have used *Phi* and *Cramer's V* statistics for bivariate analysis because of the small sample size in my study. Furthermore, Phi is recommended for simple two

by two cell tables, Cramers V is recommended for tables with more rows and columns (McClave, Benson, & Sincich, 2005) because these measures are robust to the selection of the dimensions of the table or the sample size. This test is also used where one variable is ordinal and the other is nominal. The test result has a value between 0 and 1. To interpret the value, a value near zero means there is a very weak relationship between two variables, whereas when a value is very close to 1 it means there is a strong association between the two variables. For example

0.10= weak
 0.50 = moderate
 0.90= strong

4.4.3. Regression analysis

Regression analysis is a statistical technique used to estimate a relationship between the endogenous variable and a set of exogenous variables (Wooldridge, 2009). The main objective of this analysis is to estimate a relationship between a particular variable of interest and the endogenous variable, holding the movement of other variables constant. This kind of analysis assists the researcher(s) to establish a relationship based on observed data. The ultimate goal of this analysis is to confirm (or reject) any theory and /or hypothesis. In my research, there were three research questions that required demand confirmation (or rejection) of theory and hypothesis. Therefore, I selected regression analysis as a statistical technique of analysis.

At the beginning of the regression analysis I have conducted a statistical t-test (test of independence) to investigate the potential determinants of teacher’s attitudes as suggested by Field (2005).

To study the empirical relationship between the ordinal dependent variable(s) and a set of categorical and continuous independent variables, an ordinal regression model (ORM) and a maximum likelihood estimation (MLE) technique were selected. Previous research (Daykin & Moffatt, 2002; Maddala, 1992) used similar methods. Daykin and Moffatt (2002) clarified the consequence of applying linear regression. In ORM analysis, it was implicitly assumed that the distance between the ordered responses – *strongly agree* and *disagree* were the same. Secondly, it was implicitly assumed that between the two respondents anyone who gave the same response had exactly the same attitude. The ordered probit model overcame this problem because it estimated the parameters of the underlying distribution, rather than the response itself. The general model was

Equation (1) :
$$y_i^* = X_i' \beta + u_j$$

where $y_i^* = 1 \dots j$ unobserved the ordinal outcomes. X_i' was a vector of independent variables. β was a vector of coefficients, and u_j was a statistical error term. In an ordered probit model, a probability score was estimated as a linear function of the independent

variables and a set of cut points. The probability of observing outcome i was corresponding to the probability that the estimated linear function, plus a random error. It was within the range of cut points. It was estimated for the following outcome:

Equation (2):
$$P_r[(outcome)_j = i] = P_r(k_{i-1} < y_i^* \leq k_i)$$

Where, $y_i^* =$

$$\beta_1 x_{1j} + \beta_2 x_{2j} + \beta_3 x_{3j} + \beta_4 x_{4j} + \beta_5 x_{5j} + \beta_6 x_{6j} + \beta_7 x_{7j} + u_j$$

u_j is assumed normally distributed and k_i was threshold or cutpoints. In this case, the observed (*outcome*) was associated with the underlying latent variable y_j^* . We estimated the coefficients $\beta_{x_1}, \dots, \beta_{x_7}$ together with the cut points k_i through k_{i-1} . We assume $k_0 = -\infty$ to $-\infty$. Here the cut points were treated as a nuisance parameter (Daykin & Moffatt, 2002). The threshold k showed the range of the normal distribution associated with the specific values of the response variable. The remaining estimates $\hat{\beta}$ reported the effect of change in explanatory variables. u_i was assumed to be normally distributed in ordered probit. I estimated the parameter coefficient $\beta = \beta_1, \beta_2, \dots, \beta_k$ together with the cut points k_1, k_2, \dots, k_{k-1} . Other variable notations were:

$x_1 =$ Per centage of teaching load

$x_2 =$ Weekly Internet use in hours

$x_3 =$ Age

$x_4 =$ Dummy for native English language (1 = *English*; 0 = *Otherwise*)

$x_5 =$ Dummy for Gender (1 = male; 0 = *Otherwise*)

$x_6 =$ Dummy for academic qualification (1 = *Doctoral*; 0 = *otherwise*)

$x_7 =$ Dummy for academic rank

The estimated parameter coefficients of the ordered probit model did not have any direct interpretation. Therefore, a marginal effect – a change in the predicted distribution of the dependent variable with respect to the change in one unit of one of the covariates – was more convenient. The method of calculation was as follows.

Suppose, a model was being fitted as:

Equation (3):
$$y = \beta f(x) + u$$

The marginal effect of x on y was computed as the partial derivative of slope of the line relating to x to y , often called the marginal effect or marginal changes (Long & Freese, 2006).

Equation (4):
$$\frac{\partial y}{\partial x} = \frac{y}{\partial x} = \beta$$

However, the effect of a dummy or categorical variable could not be computed with a partial derivative because dm is a discrete variable (Long & Feese, 2006). Instead, the measurement of the discrete change in y was shown as a dummy variable, and was changing from 0 to 1, holding x constant:

Equation (5):
$$\delta y / \delta x = [\beta, f(x) + \delta(dm = 1) + u] - [\beta, f(x) + \delta(dm = 0)] + u$$

When dm changes from 0 to 1, y changes by δ units regardless of the level of x .

Equation (6)
$$\Pr(y = 1) = \frac{\exp\{\beta f(x) + \delta dm + u\}}{[1 + \exp\{\beta f(x) + \delta dm + u\}]}$$

In the given equation, x was continuous and dm was a binary variable. In this situation partial derivation was never constant throughout the curves. To estimate the basic model the use of the Ordinary Least Square (OLS) model was problematic because the assumptions of OLS were violated (Maddala, 2001), that was

$$\frac{\partial \Pr(y = 1)}{\partial x} \neq \beta; \quad \frac{\Delta \Pr(y = 1)}{\Delta dm} \neq \delta$$

This was illustrated in the triangle in the graph 18(a). In non-linear models, the effect of change in a variable relied on the values of all variables in the model

I estimated the ordered logit and ordered probit models and hereafter compared the results to check the robustness. I estimated the model by using Stata, statistical data analysis software.

4.5. Ethical issues

Research ethics is an important issue in research (Hesse-Biber & Leavy, 2006, as cited in Creswell, 2009). My primary data collection activities were subject to the approval of the USQ Office of Research. I received approval prior to my primary data collection. In my letter to the ethics officer, I stated the purpose and the research questions of my study. I also specified the sponsorship of my study in order to set up the trust and credibility of the study. I received ethics approval on 18 December, 2013. The ethics approval number was H13REA260 (please see the appendix A5).

I maintained ethical practice during the periods of data collection. At the outset of each FGD, I distributed a 'consent form', based on the USQ template, to the participants and received their consent in written format, duly signed by the participants. In the consent form, I included the following:

- Purpose of the research
- Potential benefit
- Identification of risks to the participants
- Assurance that the participants could withdraw at anytime
- Provision of names of persons to contact if questions arose
- An assurance that to analyse and interpret the data

I would give a full attention to ethical issues, including confirming the following steps:

- Anonymity of the respondents
- Privacy of the data
- Maintaining an accurate account of the data

Furthermore, in order to collect data from the primary sources, I launched an online survey, for which I received official permission from the ethics office of USQ. Next, I requested the Senior Deputy Vice-Chancellor's office for permission regarding email communication with academics. In response to my request, the Senior Deputy Vice-Chancellor office contacted the target participants via email and provided them with the background information about my study.

4.6. Summary of the Chapter

I used in this research study both primary and secondary data. The primary data were collected from the University of Southern Queensland, Australia and the secondary data were collected from the Australian Department of Agriculture. Furthermore, the primary data were of two types – qualitative and quantitative – whereas the secondary data were quantitative. The qualitative data were collected through FGDs and the primary qualitative data were collected through online surveys during the period of February – March 2014.

I used diverse research approaches to fulfil the research objectives. These approaches include the thematic analysis of qualitative data, the factor analysis and cross-tabulation of quantitative data, and the regression analysis of quantitative data. The diverse approaches were necessary to meet the needs of the types of research questions.

5. CHAPTER FIVE: ICTs AND ACADEMICS' ATTITUDES

5.1. Qualitative analysis and findings

This study used a thematic analysis of generic forms of data emerging from the FGDs and categorised them under major themes (Creswell, 2009). I applied the content of the responses to the open-ended questions and created ninety two unique codes to represent teachers' attitudes to eLearning environments. Each code was related to each theme mentioned at least once by the participants in the FGDs.

At the outset of the FGDs, the participants were asked about the experience of using ICT in teaching students online. In responses, the teaching academics talked about the use of the various elements of the LMS they used for teaching. The discussions took place in a natural setting. The participants were of the view that Study Desk was the most common LMS used widely by the academic to upload teaching materials, disperse audio and video recorded lectures and perform other online teaching related activities. In addition to Study Desk, 40 per cent of the participants confirmed that they used Moodle; 13 – 20 per cent have used email and social software such as Facebook, Twitter, Blogs and Skype for teaching. Based on the data, this information was categorised into three groups following Idris and Wang's (2009) classification strategy. Idris and Wang (2009) examined the affordances of ICT in higher education by dividing the participants into three groups pertaining to temporal, pedagogical, and technical issues.

5.1.0. Temporal limitations

In the FGD, the participants talked about the increasing volume of their workloads. Sixty per cent of participants discussed their working time and related matters including email, course preparation time, asynchronous teaching time, and the use of multiple teaching platforms (i.e. Facebook).

5.1.1. Increasing workload

Meyer (1998) defined "faculty workload as time spent on professionally appropriate activities" (p. 39). In this paper, the word 'workload' was used to mean the time spent by the academic for teaching and research following the definition of Mayer (1998). In an academic context, a faculty member referred to 'workload' as the distribution of multiple duties assigned. These duties entailed teaching, research and service related activities. At USQ, an academic (teaching) staff member was expected to work 37.5 hours per week over a 46 week period (University of Southern Queensland, 2010). These were indicative hours only, not measured in definite terms as teaching and teaching-related activities, research and service to the university community and profession (University of Queensland, 2010).

In our FGDs, 56 per cent of the participants (nine participants out of sixteen) expressed their concerns about the increasing workload (or over-workload). This occurred because of one-to-one interaction in the online teaching environment. In a F2F teaching mode, a teacher was able to handle many students' queries simultaneously. For instance, while a student asked a query everybody listened to the question and the replied given by the teacher. Such interaction remained absent in an online teaching mode. Therefore, a large class size in an online mode of teaching created many limitations for faculty members, though in the literature such a large class size was often considered an opportunity (Meyer, 2012). In one FGD, one participant claimed that

“The other thing is workload to teach online is actually more work.” (FGD 2)

“ The reason for increased workload was that in a classroom when one student asked a question, then everyone hear answer. Whereas when on study desk one person will post a question and not everyone will look at it, even though it's there, they don't look at it.”

(FGD 3)

Other notable experiences emerging from the discussions included:

“Managing time is definitely a major issue. As I said before, the online environment has a far higher workload and implications than teaching on-campus. Setting boundaries for my students so they know; don't email me after 5:00 pm Friday unless you're happy to get a response at 9:00 am Monday. This is my time. ”

(FGD 1)

Moreover, in the FGDs the participants talked about the consequences of increasing workload. One participant claimed that

“ I have people who focus on the weekend area. And I allocate extra hours for that sort of engagement, whereas others who I know in my team have young families, I say don't worry about the weekend I'll be doing it, Deb will be doing it whatever. So that sort of area I think is just something that needs to be taken account of in our teaching loads”

(FGD 2)

One participant said that “I never switch off” (FGD 3)

As a limitation, which was a bad affordance of the use of ICT in teaching students online, 'time' had already been seen as an issue in past literature (Heijstra, 2010; Reisman, 2001; Xu, 2007). In Australia, increasing workload also received attention as an issue (Beerens, 2013). Thus, my findings were very consistent with past research findings. The opinion expressed by the FGDs was that university management did not consider this as an issue; quite the contrary, “teachers are pushed on status as if their workload is diminishing” (FGD 2). According to the Union, “online

teaching is not adequately recognised” (National Tertiary Education Union, 2014, p. 7)

5.1.2. Risky interaction

During the FGDs I found that four participants out of sixteen (25 per cent) were engaged in Facebook, Wikis and Skype to interact with their online students. The participants who were active on Facebook were very critical about their experiences. They were of the view that teaching and learning on social software was very risky, because interaction among students on social software results in quick dissemination of incorrect knowledge or ideas. One participant has claimed that:

“ students learn in so many spaces, they take their learning into Facebook, Twitter and so on. And there they end up with misconceptions and misinformation put out there into the broader spaces. That sometimes it is hard to reign that back in and to reinforce the accurate message.” (FGD2).

Similarly, another participant expressed his view by opposing learning on social media like Facebook. The participant stated that

“Another thing that comes up from time to time, and I’m sure my colleagues have experienced it as well, is when the students go outside the university system to social media to discuss and work on the course. They are talking to each other and giving wrong information instead of using the platform that’s been provided for them, where they get the right answers all the time....that creates havoc in that outer environment” (FGD 1).

So, it was emerged that misconception and misinformation spread very quickly over social media. This had a negative effect on students’ learning outcomes as was found in previous empirical studies (e.g. Karpinski et al., 2013; Kirschner & Karpinski 2010; Paul et al., 2012.). In particular the findings of this study were consistent with those by Kirschner & Karpinski (2010) on this specific point - misconception spreads quickly through Facebook users. Therefore, the qualitative and quantitative research findings provided a warning for the proponents of online education with regard to the affordances of mobile technologies in terms of its unique opportunities for students to engage in teaching.

5.1.3. Increasing email

Study Desk and Moodle has an in-built e-mail facilities. When a student or a member of the teaching staff posts a message on StudyDesk or Moodle, the message is immediately communicated to the group members automatically. Such an instant messaging facility made email a useful medium of communication between students and teachers. Therefore, academic (teaching) staff were receiving emails from students at any point in time, and as soon as a student had posted any query on StudyDesk.

Therefore, the general wisdom was that if the number of students in any course was high, there was a probability that the volume of email would be high. Regarding this phenomenon, a mixed reaction was expressed by the LMS participants. Forty per cent of the participants expressed their concerns about the increasing volume of email. For instance one participant claimed that:

“ I think two years ago I had a student who was studying economics as a part of her MBA course with Business Economics. Before the start of the semester, she started sending me email and ended up with a total of 72 – 75. I responded to her all email.the Faculty of Business only allocated thirty minutes for a student consultation; but I spent 750 minutes for a student.” (FGD 1)

Another participant has added to the previous perception stating that,

“we always encourage students not to communicate through email. Put your enquiry to Study Desk so that other students will look at it. So not all students will look at email, not all people ask the questions, but when we put the answer, they look. So, if the students communicate only through emails that is time” (FGD 1)

5.1.1. Pedagogical limitations

5.1.1.0. Large class size

Large class size is a distinct characteristic of online teaching (Orellana, 2006) Because of this online education is claimed to be cost-effective in a way that is not achievable in F2F teaching. The participants in the FGD discussions identified engagement with large class size as a critical issue. According to the participants' information, at USQ, the academic (teaching) staff members handled a class size as large as seven hundred for a course in a semester. Though a large number of students in a class generated additional revenues for the university, teachers were given a disproportionate share to deliver the services, which was regarded as a “general business issue” (FGD 2). Moreover, large class sizes for online teaching affects teachers' teaching capability and thereby, adversely affected student management. Thirty five per cent of the participants expressed their concern about large class size. For example, one participant claimed

“I was trying to replicate seminar style teaching where you basically get students to research or a topic or prepare basically a report of some sort and then present that to class and one of the challenges is how do you do that in an online environment” (FGD 2)

Another participant has claimed that

“One of the problems I find is it’s very difficult to gauge where everyone is at. It’s impossible. Whereas if you have it on campus you can see who’s there and not there. And you can see who’s there and fallen asleep! I know what you mean and those sorts of things whereas online you have no idea. I can go look at logs and yes, they’ve logged in, logged out, but for a big course, you aren’t going to check every student. It’s just not possible, and are they really engaging? Not being able to see where students are at is a big issue?” (FGD 2)

Academic disciplines are different from each other, for instance engineering courses are different from economics courses. Individual courses requires different delivery technique(s). However, the commonly featured Study Desk on the LMS was not suitable for customised presentations for different courses. Hence, the FGD participants found Study Desk problematic in their existing format. The participants were of the view that the course-specific demand was rarely met in the LMS. One participant claimed that

“I do notice that students often say different subjects will have different layouts of Study Desk and I think that’s really good because that’s how we prefer to teach and we would set our classrooms up differently, but I do understand that it can get really confusing for people” (FGD 3)

About the given perspective another participant stated that

“online teaching processes involved numerical based courses and it’s hard to interact easily in an online environment with discussion forums and not all students interact” (FGD 1).

Another participant from another focus group stated,

“I would think that we need technology to do things that will work very well for my kind of course (finance). We are now being forced to record our lectures; I actually do not like something if it is forced on me....” (FGD2)

The most serious pedagogical issue identified by the FGD participants was that students often were not interacting on Study Desk or Moodle for their learning. They often left Study Desk and used Facebook or Twitter to interact with other students and teachers. Only twenty per cent of participants expressed the view that LMS was as attractive as Facebook. For instance, one participant claimed that

“Study Desk, Moodle are not as attractive as Facebook” (FGD 2).

5.1.1.1. Increasing plagiarism

Plagiarism is considered cheating in the academic world, and each university has its own policy in this regard. The participants were asked about their perception as to

whether plagiarism increased among online students, and expressed contrasting views about plagiarism. Not everybody thought that plagiarism increased. Moreover, some participants believed that due to technological developments it became easy to control the issue. One participant stated,

“We have cases where students have admitted they purchased their whole assignment. What can you do? There is no way of detecting that, at all” (FGD 1)

Another view was that

“It's easier to plagiarise. You just copy and paste. I know of some cases where people have been caught and were asked why it does” (FGD 1)

The FGD participants sometimes believed that they had to deal with a situation where students purchased assignments and copied and pasted from web sources. Though software was also available on the market to deal with the issue, teachers did not find it difficult to check each assignment using plagiarism detection software.

5.1.2. Institutional limitations

In the FGDs, forty per cent of the participants were of the opinion that the lack of technical support had a critical issue for teaching online effectively. The study classified these issues as technical and non-technical in this chapter.

5.1.2.0. Technical limitations

One major theme emerged from FGDs was technical issues involving the use of the LMS. Technology is dynamic in nature, hence new technology is continuously being replacing old. New technology involves new features, which implies that an additional new skill is required to handle the technology. Teachers, who were using a certain type (or version) of an LMS for a certain period, often experienced disruption in their work, while they came across a new system on board. Some teachers found it hard to catch up with the time to train themselves for the new arrival. One participant stated that

“I use our Study Desk and the Moodle 2 downgrade and it's been very challenging, some of the things that no longer work that you could rely on once upon a time.” (FGD 2).

Another participant stated,

“I've found that at USQ it's not necessarily the technology itself, it's what USQ opens up within that technology. So for example, there are lots of things we can do in Moodle that USQ shuts off and doesn't let us do. So it's not necessarily the tool itself and even, even things like at USQ we enable a student to have an email for life, but we don't support that for our staff members.” (FGD 2)

Another participant stated,

“So, ICT systems should work for us the way we want to deliver the product. The previous version, the upgrade version of Moodle which was 1.9 ..., if you graded someone and you didn’t really feel like giving them a grade, the new system if you go to grade someone and don’t give them a grade, and just go save and next, gives them full marks” (FGD 2).

Enriching this view further, another participant stated,

“I have spent 6 hours arguing with ICT to get this thing fixed. That is an example of ICT in general, I’m not, not having a go at them, but it’s an example of what happens. They fiddle with something, break core business has huge impact for the way we deliver things, and it’s happening everywhere.” (FGD 2).

Technological limitations arose, because of the development and implementation of technological features in isolation of human factors. The system that was easier to figure out, more obvious and more user-friendly in its function would be used frequently.

5.1.2.1. Non-technical limitations

Academics comprise ordinary human beings, and in their work, they are motivated by positive reinforcement (Bower, 2001). Academics engaged in online teaching are compensated for their work in a similar way to faculties who are engaged in face-to-face teaching. The majority of the participants were of the view that although their engagement in online teaching increased, they (academic teaching staff) were compensated proportionally compensated by fair distribution of workload. This created a frustration among faculty staff members. One participant claimed that

“you had a course that switched from on campus to external or on campus to online, do you know what they do? They would remove workload” (FGD2).

Adding similar view another participant claimed,

“When you’ve got 600 people, okay you work that out? Ah that is ½ a million dollars per semester coming in, don’t try and get me to deliver a course with \$15,000 expenditure, can’t be done. Okay if I’m bringing in ½ a million dollars, I will spend \$80,000 to \$100,000 to deliver that course, the university can have the rest. The business model and analytics are all out of whack. So those are the sort of general business issues that I think need to be resolved, and it’s not just this university, I’m saying this is a general issue.” (FGD 2)

Another participant was of the view that

“You’ve got 54 students but only 2 of them are on campus. So, we’re going to push everyone online and we’ll give you half the number of hours to deliver the course. I’m sorry it doesn’t wash” (FGD 2).

5.1.2.2. A framework of the relationships

Based on the findings of the FGDs, I developed a theoretical framework about the interaction between various elements of the LMS and online students, broadly between the applications of ICT in teaching students online. The theoretical framework is presented in Figure 5.1. The left-side shows various components of the LMS arising from the discussions. These components are Study Desk, Moodle, Email, Blogs and Facebook. In the middle of Figure 5.1, various constraints or limitations that intervene while teaching academics are interacting with students online are presented and grouped into three constraints:

- Pedagogical limitations
- Temporal limitations
- Technological limitations

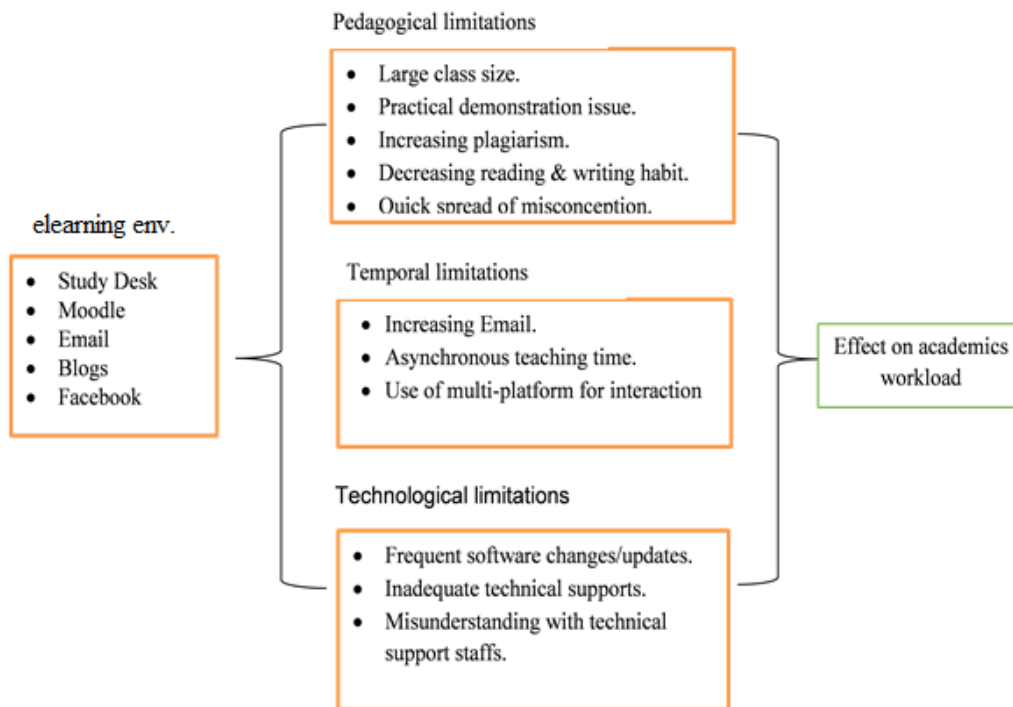


Figure 5.1: A framework of interaction between the academics and eLearning environment

A further conclusion was that the elements contributing to each constraint are diverse. The five (05) major items contributing to pedagogical limitations were:

- Large class sizes
- Issues connected to the practical demonstration of lessons
- Increasing plagiarism
- Decreasing reading and writing habits among the students
- Rapid spread of misconceptions

Because of the diversity of issues, a common approach to tackle pedagogical limitations was not deemed suitable. A priority-based approach might work better. Among the elements contributing to pedagogical constraints, large class size was the most important one identified by the academics in the FGDs. Class sizes might be as large as 800 with students dispersed around the world. Because of time differences, they were in interaction with academics in different time zones.

Though a large class-size was the strength of online education in terms of low cost of education and required physical spaces, compared to face-to-face education. It came at the cost of distressed academics who were engaged in online teaching. This cost incurred was seldom taken into account while distance education was labelled as 'low-cost' education by the government and bureaucracies. This element of pedagogical constraints (i.e. large class size) inevitably generated an increased workload for teaching academics as shown in the extreme right-hand side in Figure 5.1. The main elements of temporal constraints derived from the FGDs were as follows:

- increasing volume of email communication with students
- asynchronous teaching time
- Multi-faceted platform for interaction with students.

As the number of students (or class-size) increased, email communication with students also rose. Email communication acted as one-to-one teaching which was considered very frustrating by the academics who participated in the FGDs. This frustration arose due to the increasing over-workload, which was not recognised by academic administrators. Alternatively, the participants in the FGDs were of the opinion that education administrators regarded online teaching as low stress work.

The elements that contributed to the technological limitations included frequent changes in software to enhance or replace the existing system of online teaching arrangements. The changing phenomena often came with inadequate technical supports from the department concerned. In the context of temporal constraints, the changes demanded additional time from the academics staff members to make them accustomed to the new arrangements. The issue eroded academics' spare time and compelled them to work prolonged hours to make up the scheduled lessons or teaching programs. The academics expressed the view that the relevant ICT support units were not as fast as was anticipated owing to the administrative issues involved in this context.

So far, I considered some perceptions or attitudes to the use of the LMS in

teaching students online in the context of a university. In the following section, I discussed the ways in which academics' attitudes varied with respect to their socio-demographic characteristics. Understanding this relationship was desirable because as humans, academics differ from other factors in terms of the innate ability associated with external factors such as demographic variables (Ajzen & Fishbein, 2005). Ajzen and Fishbein's 'theory of reasoned action' (Ajzen & Fishbein, 2005) provided a theoretical underpinning to predict and understand an individual's attitudes which ultimately affect their behaviour. According to the theory of reasoned action, a person's intention is a function of two basic determinants: personal and social influence. The personal factor encompasses positive or negative evaluations of performing the behaviour, which is termed attitude towards behaviour. In the simplest terms, this means personal judgement about performing behaviour which is good or bad, people may differ in their evaluation of performance. The second determinant is termed as the subjective norm. These two issues were explored in the final part of this study.

5.2. Quantitative analysis and findings

This section provided quantitative analysis of academics' attitudes towards the influences of ICT. The main research purpose in this section was the enquiry into the components or factor structure of two types of attitudes. The objective of this analysis was to develop a theoretical model based on empirical data that can be used for further research in the future. The study findings were useful to put forward strategies for overcoming problems of teaching communities in universities.

In the previous chapter we learnt of the attitudes (or perceptions) of the teaching academics about the use of eLearning environments, including the LMS in teaching students online. Attitude is a latent variable. In order to receive information about the variable, I provided some statements reflecting both positive and negative roles of ICT in teaching and research activities of teaching academics. Eleven underlying statements contributed to the factors in our study. Some of these statements might overlap, and some of them might be redundant. There were two approaches to locating underlying dimensions of a dataset: factor analysis and principal component analysis (Field, 2005). I used factor analysis as a quantitative data analysis technique.

5.2.0. Factor analysis

Factor analysis is data reduction strategy that removes redundancy or duplication from a set of interconnected or correlated statements. Further it is useful to form a factor (latent variable) based on observed variables, which are relatively independent of one another.

Two types of factor analysis are carried out in applied research: exploratory factor analysis and confirmatory factor analysis. Confirmatory factor analysis is a special type of Structural Equation Modelling (Kaplan, 2000). Exploratory factor analysis is used to explore the dimensionality of a measurement instrument; furthermore, it places no structure on the linear relationship between the observed variables (Brown, 2001). It only specifies the latent variable numbers. On the other hand, confirmatory factor analysis is used to study the best fit of a hypothesised factor model in sample data drawn from a population. I have used exploratory factor analysis

because it fulfils the objective of this study, i.e. to explore latent variables. Rietveld and Hout (1993) presented an overview of the steps in exploratory analysis which is presented in Figure 5.2.

A correlation matrix is the starting point of a factor analysis. Here, this involved inter-correlations among the variables of the study. The variables that have high correlations might be considered for measuring one underlying variable which is called a factor. Next, come factor scores and factor loading. Factor scores are ‘the scores of a subject on a certain factor while factor loading is the correlation of the original variable with a factor’ (Rietveld & Hout, 1993, p. 292). The factor scores can be used for further analysis rather than the original data (Field, 2005). For example, they can be used for regression analysis as a predictor.

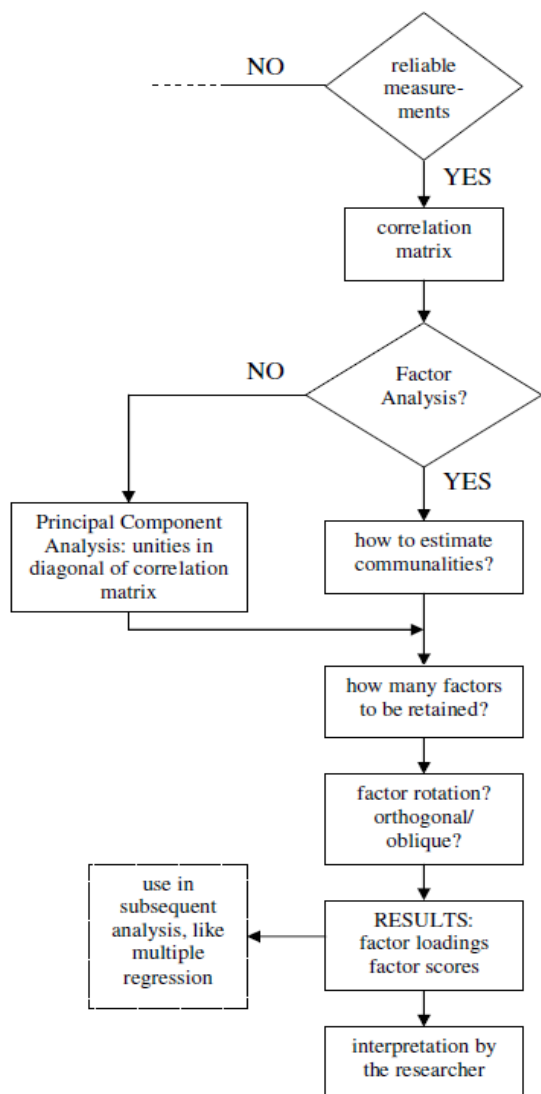


Figure 5.2: An overview of an exploratory factor analysis

Source: Rietveld and Van Hout (1993, p. 291)

5.2.1. Step one of factor analysis

In order to find out the level of agreement and disagreement, I have presented in Table 5.1 the average scores of Likert Scale measures with respect to each statement. Here a higher score indicate disagreement and a lower score meant higher agreement compared to higher scores. As we can see from the table, the overall mean was around 1.5. No statement was overriding in a significant way to depict the effect of the use of ICT on academics' work.

Table 5.1: Average scores of the Likert scale measures

Variable	Obs	Mean	Std. Dev.
Q1	67	1.7	0.79
Q2	67	1.9	0.86
Q3	67	1.7	0.81
Q4	67	1.6	0.80
Q5	67	1.7	0.96
Q6	67	1.8	0.94
Q7	67	1.6	0.68
Q8	67	1.5	0.74
Q9	67	1.9	0.77
Q10	67	1.8	0.85
Q11	67	1.7	0.81

For this analysis, the following steps were followed:

- The correlation matrix was calculated that showed that correlations were sufficient to carry out the factor analysis.
- Computation of anti-image correlation was done
- A Kaiser-Meyer-Oklin (KMO) measure of sampling adequacy was estimated. KMO value of over 0.60 was accounted for the next step analysis.
- Barlett's test statistics were calculated and found statistically significant at 5 per cent level.

5.2.1.0. Factor extraction

I used a principal factor analysis method to extract factors and the number of factors to be retained. It is typically dependent upon the researcher to determine the number of factors that is considered best in order to describe the underlying relationship in the dataset. But I had to balance two conflicting needs. The first one was to find a simple solution with as few factors as possible. The second one was to get a complete picture and to explain as much of the variance in the original data as possible. So I had to create a balance between the complete and efficient measures. Three measures helped

me to determine the efficient factors that explain the maximum variation in the data. They were the Kaiser criterion, variance explained, the Scree Plot analysis (Trehan & Paul, 2014, p. 10) and the Monte Carlo Principal Component for Parallel Analysis. In Table 5.2, 5.3 and Figure 5.3 the three measures are presented. Being consistent with the research objective a two factor structure was derived from my data set – positive and negative factors.

Table 5.2: KMO and Bartlett's (1970) test for component 1

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.643
	Approx. Chi-Square	174.706
Bartlett's Test of Sphericity	df	55
	Sig.	.000

For the KMO statistic, Kaser recommends a minimum value of 0.5 (Thompson, 2004), that a value lies between 0.5 and 0.7 presents mediocre. My Kaiser test result was 0.64 which was above 0.60. Therefore, I should be confident that my dataset was suitable for factor analysis. I also checked the diagonal of the anti-image correlation matrix (I have not presented in the thesis). I found that the values for all variables were above the bare minimum.

The Bartlett test statistic measures the null hypothesis that the original correlation matrix is an identity matrix. A test of significant informs me that the matrix was not an identity matrix. The Bartlette's test statistic was highly significant at 5 per cent level of significance, because *Sig-value* was less than 0.05

Table 5.3: Total Variance Explained for component 1

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings ^a
	Total	per cent of Variance	Cumulative per cent	Total	per cent of Variance	Cumulative per cent	Total
1	2.908	26.439	26.439	2.908	26.439	26.439	2.413
2	1.933	17.577	44.016	1.933	17.577	44.016	2.010
3	1.319	11.989	56.005	1.319	11.989	56.005	1.528
4	1.131	10.280	66.286	1.131	10.280	66.286	1.797
5	.924	8.400	74.686				
6	.735	6.679	81.365				
7	.553	5.024	86.389				
8	.520	4.728	91.117				
9	.397	3.608	94.725				
10	.340	3.088	97.813				
11	.241	2.187	100.0				

Extraction Method: Principal Component Analysis.
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

The Eigenvalues represent the total variance explained by each factor. In my case, the factor that has an eigenvalue more than one was kept for the analysis. Table 5.3 shows that four items had eigenvalue of more than one and the remaining items had eigenvalues of less than one. Factor 1 explained 26.44 per cent, while factor 2 explained 17.58 per cent. Factor 3 explained 11.99 per cent and factor four explained 10.28 per cent of the total variance. Here, the total variance was the sum of the variance of each factor. The cumulative variance of the four factors – factors 1, 2 3 and 4 explained 66 per cent of the total variation in my dataset.

The Scree plot (Figure 5.3) involved plotting each of the Eigenvalues of each of the items. Inspecting the Figure I looked for a plot from where the shape of the curve had started to change direction and become horizontal.

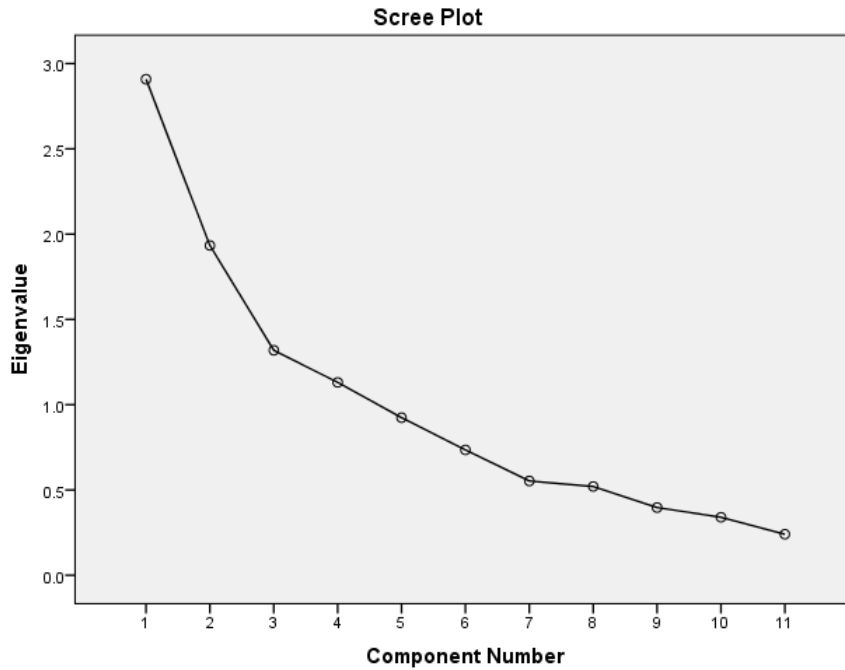


Figure 5.3: Scree plot

However, I observed that based on Eigenvalues, three components were extracted. The Scree plot presented that between component one and component two there was an elbow (or a break) that presented the change of direction of the line. Under the given circumstances I applied Parallel Analysis (Patil, Singh, Mishra, & Donovan, 2008) using the computer software Monte Carlo PCA Parallel Analysis Engine (Patil, Singh, Mishra, & Donovan, 2007). The Monte Carlo PCA Parallel Analysis engine calculates Eigenvalues from randomly generated correlation matrices. These values were compared with Eigenvalues extracted from my dataset and the factors to retain were the number of Eigenvalues that were larger than the corresponding random Eigenvalues (Horn, 1965, cited in Patil et al., 2007). Table 5.4 shows that I should retain two factors: factor 1 and factor 2. Both had Eigenvalues greater than random Eigenvalues extracted from the Parallel analysis. The remaining factors' Eigenvalues did not exceed the random Eigenvalues generated by the Parallel analysis. These were also very consistent with my research objective. The two components measured two underlying dimensions of the effects – positive and negative effects in my dataset.

Table 5.4: Parallel analysis

Eigenvalues Extracted Using Principal Components Analysis			Eigenvalues extracted from my dataset
Factor	Mean	Per centile	Initial value
1	1.720	1.925	2.908
2	1.503	1.660	1.933
3	1.330	1.426	1.319
4	1.190	1.279	1.131
5	1.076	1.152	0.924

5.2.1.1. Factor rotation and interpretation

There are two approaches for factor rotations – (i) uncorrelated and, (ii) correlated factor solutions. An uncorrelated factor rotation is easier for interpretation and reporting. However, it requires an assumption that the constructs are independent of each other. On the other hand, the correlated approach allows correlation amongst the constructs, which is difficult to interpret. Through factor rotation, I obtained factor loading. In my cases, the results were generated through an uncorrelated approach with varimax, where all factor loading greater than 0.3 was retained. The results of the principal component analysis with varimax rotation for overall sample are presented in Table 5.5. The table shows that four components were extracted from the eleven items. Furthermore, it shows eight items loaded on component 1 and six items loaded on component 2. The items have a value loading of over 0.3. There were very few items loaded on component 3 and component 4. This implied that the first two components had the best inter-relationships among the items. Now I wanted to stick to the components that had the strongest interrelationships, so that the two factor components were the most appropriate for the remaining analysis.

Table 5.5: Principal component analysis

	Component Matrix ^a			
	1	2	3	4
Q9	.721		-.426	
Q3	.705	-.489		
Q4	.696	-.333		
Q10	.694		-.520	
Q11	.567	.337		
Q7		.768		
Q8	.343	.711		
Q5		.502	.344	
Q2			.653	.314
Q6				.716
Q1	.423		.416	-.617

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

5.1.2. Step two of factor analysis

Next, I used statistical data analysis software - SPSS for two factor solutions. Similar to the Step One analysis, I repeated the KMO and Bartlett's Test (Table 5.6), total variance explained (Table 5.7) and the component matrix (Table 5.8). Kaiser and Bartlett's test statistics provided evidence that the two factor analysis was valid. The two components explained 50 per cent variation in the dataset. Six items were loaded on component 1 that measured the positive effect of the use of ICT on academics' work. Three items were loaded on component 2 that measured the negative effect of the use of ICT on academics' work. I renamed the components - component 1 and component 2 in the following ways:

- Component 1 is academic threat and
- Component 2 is academic opportunity.

Table 5.6: KMO and Barlett's (1970) test for component 2

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.607
	Approx. Chi-Square	100.656
Bartlett's Test of Sphericity	df	28
	Sig.	.000

Similar to my previous KMO statistic, my Kaiser test result was 0.61 which was above 0.60. Therefore, I should be confident that my dataset was suitable for factor analysis. I also checked the diagonal of the anti-image correlation matrix (I have not presented in the thesis). I found that the values for all variables were above the bare minimum.

Table 5.7: Total variance explained for component 2

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings ^a Total
	Total	per cent of Variance	Cumulative per cent	Total	per cent of Variance	Cumulative per cent	
1	2.22	27.83	27.83	2.23	27.83	27.83	2.23
2	1.81	22.60	50.43	1.81	22.60	50.43	1.81
3	1.09	13.68	64.11				
4	0.93	11.66	75.77				
5	0.67	8.41	84.19				
6	0.54	6.80	90.99				
7	0.42	5.30	96.29				
8	0.30	3.71	100.00				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 5.8: Component matrix^a

	Components	
	(Negative effect)	(Positive effect)
Q3-Email communication has increased the volume of unwanted mail from students	0.85	
Q4-Owing to unwanted mail communication, the time available for research has decreased	0.82	
Q9-Currently ICT based online teaching is technologically driven rather than pedagogy driven.	0.66	
Q2-The use of ICT has increased academic work- loads (both teaching and research)	0.48	
Q6-Email communication has increased the complexity of doing teaching and research.	0.38	
Q7-The use of online survey tools increase research outputs (such as journal article publication)		0.85
Q8-The use of data analysis software makes data analysis simple		0.80
Q5-The use of email enhances collaborative research outputs		0.61

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

My exploratory factor analysis derived two factors that interpreted weighted scores for two types of effects:

- positive effects
- negative effects

The above positive and negative effects were labelled in this study as:

- academic opportunity
- academic threat

Academic opportunity: Academic opportunity was the next important factor, which accounted for 22.60 per cent variance in the dataset of my study. Three statements constituted this factor and these statements provided an indication about the conducive academic work environment that entailed research work.

Academic threat: Academic threat was the most important factor of the overall dataset in my study and it alone accounted for around 28 per cent of the total variance. Five out of eleven statements were loaded significantly onto this factor. These statements were the perfect examples of the negative effects of the use of ICT on academics' work. The nature of work entailed daily communication through electronic mail. The negative effects were labelled as 'over-workload'. The attitude of the academics could be seen as a threat for the expansion of online education opportunities in the future.

5.3. Summary of the Chapter

The main contribution of the chapter was to develop a theory around the academics' attitudes to eLearning environments, including LMSs. Based on the FGD data and field note analysis; I found negative perceptions of academics to the use of eLearning environments, including LMSs for online teaching because of increasing workload. This was labelled as a 'negative attitude' in this study. The contributory factors for these increasing workloads were associated with the constraints of the eLearning environment, including the LMS. These constraints were classified as temporal limitations, pedagogical limitations, and institutional limitations.

After non-parametric quantitative analysis, such as factor analysis, among a small of USQ academics I found both positive and negative attitudes towards the use of eLearning environments: Internet in the office, email communication, online research resources for teaching, and research work.

6. CHAPTER SIX: THE ACADEMICS' VARIATIONS ON ATTITUDES TO ICT

6.0. Variables for crosstabs and regressions

6.0.1. Attitudes to eLearning environment

Table 6.1 presents three categories: *agree* (category 1), *disagree* (category 2) and *uncertain* (category 3). The Table shows that the respondents were very marginally divided between the categories- 40.30 per cent agreed, 32.84 per cent disagreed, and 26.87 per cent of participants were uncertain.

Table 6.1: Dependent ordinal variable related to attitude to eLearning environment

Dependent ordinal variables	Frequency	Per cent
<i>Agree</i> (Category 1)	27	40.30
<i>Disagree</i> (Category)	22	32.84
<i>Uncertain</i> (Category 2)	18	26.87
Total	67	100.00

6.0.2. Socio-demographic variables

The main socio-demographic variables of this study were: age, gender, status of the native language, highest academic degree achieved, and academic rank. These variables were selected based on previous studies mentioned in the literature section.

6.0.2.0. Native first language status

In the Australian universities, the role of overseas-born academics is substantial (Hugo, 2008). Foreign-born academics come from various countries. For this study, they have been divided into two groups based on their first language (or native language). Such grouping helps to broadly identify the ethnicity of the academics. In this dataset, around 73 per cent of the participants were native English language speakers and the remaining 27 per cent were non-native English language speakers (Table 6.2). Native English speaking academics come from several English speaking countries including Australia, New Zealand, UK, South Africa and the USA. Non-native English speaking academics come from Bangladesh, India, China, and Sri Lanka. Therefore, I could divide them into two groups: Asian-born academics and non-Asian born academics. According to Table 6.2, seventy-four per cent of academics who participated in the survey were native English speakers.

Table 6.2: Status of first language

1=English; 0=Otherwise	Frequency	Per cent
Others	18	26.87
English	49	73.13
Total	67	100.00

6.0.2.1. Gender, academic degree and academic rank

The other categorical socio-demographic variables were: gender, highest academic degree, and academic rank (Table 6.3, Table 6.4 and Table 6.5). The dataset shows that around 58 per cent of the participants were male and around 42 per cent were female (Table 6.3). Around 80 per cent of faculty staff had a Doctoral degree qualification and the remaining faculty had Masters and Bachelor degree qualifications (Table 6.4). Furthermore, the majority of the respondents are held the rank of Lecturer and Senior Lecturer. Table 6.5 shows that forty-five per cent of the respondents held the rank of Lecturer and 28 per cent.

Table 6.3: Independent ordinal variable (gender)

Gender(1=Male; 0=Otherwise)	Frequency	Per cent
Female	28	41.79
Male	39	58.21

Table 6.4: Independent ordinal variable (highest academic degree)

Academic qualifications (1=doctorate; 0= otherwise)	Frequency	Per cent
Otherwise	13	19.40
Doctoral degree	54	80.60

Table 6.5: Independent ordinal variable (academic rank)

Rank	Frequency	Per cent
Associate Lecturer	4	5.97
Lecturer	30	44.78
Senior lecturer	19	28.36
Associate Professor	7	10.45
Professor	7	10.45

6.0.2.2. Internet usage and teaching load

At USQ, a non-administrative full-time academic is committed to working 1725

hours per year⁶. However, by default, all academics receive 10 per cent of the total workload for service to the University and the balance is devoted to the teaching and research work load⁷. The distribution of teaching and research load differs from academic to academic based on their prior experience in research and teaching.

The use of the Internet for academic and non-academic work is inevitable. Per-week academics' usage of the Internet is an important covariate that might influence academics' attitudes to workload. I asked the participants about their usage of the Internet in their office and their home for work-related purpose⁸. The frequency of Internet usage for work-related purposes according to age group is presented in Figure 6.1. A clear pattern that emerged from the table is that the use of Internet for at least 12 hours is prevalent among all age groups. Furthermore, within the 50-64 age groups, around 60 per cent of academics use the Internet for at least 12 hours per week.

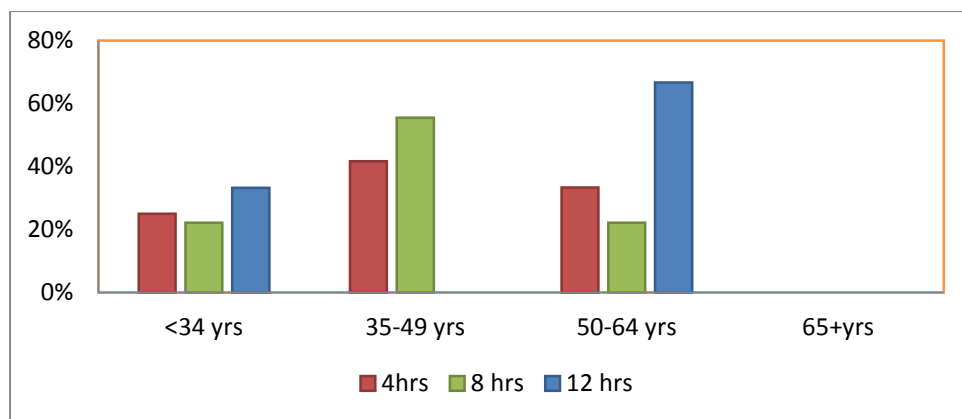


Figure 6.1: Weekly usage of the Internet (by faculties) for work-related purpose

This study required academics to report their average teaching load over the last two years. Other continuous explanatory variables were age, and weekly Internet usage. Table 6.6 presents descriptive statistics of the variables. The mean average teaching load (x_1) in the last two years (i.e. 2010-2012) of the survey (2013) was 45 per cent, the balance was for research and service. Weekly Internet usage for academic work (x_2) was 42 hours. The mean and standard deviation of this variable (x_2) showed that the distribution in the tails was low. Finally, the average age of academics (x_3) was 46 years.

Table 6.6: Other independent continuous variables

Variable notation	Description	Obs	Mean	Std. Dev	Min	Max
x_1	Average teaching	67	45.07463	28.96566	0	100

⁶ According to Work Allocation Policy and Procedures' at USQ, a standard work allocation consists of 37.5 hours per week over a period of 46 weeks. Available at <http://policy.usq.edu.au/documents.php?id=13470PL>.

⁷ This piece of data is generated from a personal interview with a faculty member through research at the University of Southern Queensland, Australia.

⁸ By work-related purpose, I meant teaching and research related works only.

	load in the last two years in percentage					
x_2	Weekly Internet use in hours	67	42.73134	22.14045	7	112
x_3	Age in years	67	46.16418	10.04173	27	72

6.0. Cross-tabulation results

For this study, I merged six categories and created three categories as follows: 1=*agree*; 2=*uncertain*; 3=*Disagree*; the merging rules were as follows. I combined *strongly agree* and *agree* to create a category *agree*; *strongly disagree* and *disagree* to create a category *disagree*; and *uncertain* and *not applicable* to create a category *uncertain*. The necessity was to enhance the frequency of cells over 5 as per requirement for chi square test (McClave et al., 2005).

6.1.0. Gender

In our survey, 50 per cent of females agreed with the statement and 28.57 per cent disagreed, while 21.43 per cent were uncertain about the statement. On the other hand, 33.33 per cent of males agreed, 35.90 per cent disagreed, and 30.77 per cent were uncertain about the statement. Overall 28.57 per cent of females and 35.9 per cent males disagreed with the statement. Compared with males, more females agreed with the statement. The measure of association between academics' perception of workload and gender was weak (Cramér's $V = 0.17$). Further Pearson's chi-square statistics was 1.92, $p=0.30$. This tells us that there was no statistically significant association between gender and differences in their attitudes. That is, both males and females were equally divided among the options: agree, disagree and uncertain (Table 6.7).

Table 6.7: Cross-tabulation of gender and academic workload

Gender; 1= Male 0= Female	Academic workload (per cent)			
	Agree	Disagree	Uncertain	Total
Male	13 (33.33)	14 (35.90)	12 (30.77)	39 (100)
Female	14 (50.00)	8 (28.57)	6 (21.43)	28 (100)
Total	27 (40.30)	22 (32.84)	18 (26.87)	67 (100)
Cramér's $V = 0.17$; $\chi^2_{(2)} = 1.92$; $p\text{-value} = 0.3$				

Figures in the parentheses show percentages

6.1.1. Age group

In the survey, academics belonging to the 35-49 years group (30 per cent) were the dominant participants. A 4×3 contingency table (Table 6.8) shows that among them around 50 per cent of respondents agreed on the statement, 30 per cent disagreed, and 20 per cent remained uncertain about the statement.

Table 6.8: Cross-tabulation of age group and academic workload

Age groups	Academic workload (per cent)			Total
	Agree	Disagree	Uncertain	
< 34	5 (41.67)	3 (25.00)	4 (33.33)	12 (100)
35-49	15 (50.00)	9 (30.00)	6 (20.00)	30 (100)
50-64	6 (27.27)	5 (35.29)	5 (36.36)	22 (100)
65- above	1 (33.33)	2 (66.67)	0.00	3 (100.00)
Total	27 (40.30)	22 (32.84)	18 (26.87)	67 (100)

Cramér's V = 0.1999; $\chi^2_{(6)} = 5.35$; p-value = 0.50

Figures in the parentheses show percentage

Further, 6.8 per cent of respondents belonged to the age group 50-64. In this age group 27.27 per cent agreed with the statement. The majority of respondents either disagreed or remained uncertain about the statement. The estimation of Cramér's V statistics for this relationship was 0.19 which is low. Further, Pearson's chi-square statistics were 5.35, $p=0.50$. This tells us that there was no statistically significant association between age and differences in the perceptions of workload. That is, the age of the academic did not influence the preference of options: agree, disagree and uncertain.

6.1.2. First language status

The association between the ethnicity status of academics and their perception about the statement is measured in the contingency Table 6.9.

Table 6.9: Cross-tabulation of first language and academic workload

Native Language 1= English; 0 = Otherwise	Academic workload (per cent)			Total
	Agree	Disagree	Uncertain	
English	23 (46.94)	17 (34.69)	9 (18.37)	49 (49)
Otherwise	4 (22.22)	5 (27.78)	9 (50.00)	18 (100)
Total	27 (40.30)	22 (32.84)	18 (26.87)	67 (100)

Cramér's V = 0.3253; $\chi^2_{(2)} = 7.09$; p-value = 0.03*

Figures in the parentheses show percentages.* means significant at 5 per cent level.

The results showed that around 47 per cent of academics whose native language was English agreed with the statement. By contrary 35 per cent of academics, disagreed, and 18.37 per cent were uncertain about the statement. On the other hand, 22.22 per cent of the academics whose native language was not English agreed on the statement against 27.78 per cent who disagreed. The estimated Cramér's V statistics were 0.33, which is reasonably high. It means that the degree of association between the academics' ethnicity and their perception of the workload is moderate.

Furthermore, Pearson's chi-square statistics were 7.09, $p=0.03$. This tells us that there was a statistically significant association between the ethnicity of academics and their different perceptions of the workload issue. The relationship is statistically

significant at 5 per cent level. The conclusion is that the ethnicity status of academic did influence the preference of options: *agree*, *disagree* and *uncertain*.

6.1.3. Academic qualifications

The study further examined the differences in opinions among academics according to their academic qualifications. Around 41 per cent of the faculty members who had doctorate degrees agreed with the statement, 33.33 per cent of the academics disagreed and around 26 per cent were uncertain about the statement (Table 6.10). The estimated Cramér's V statistics were 0.04, which is very low by any standard. The variation of opinions among the academics according to their academic qualifications was almost negligible.

Table 6.10: Cross-tabulation of academic qualifications and academic workload

Academic Qualification	Academic workload (per cent)			Total
	Agree	Disagree	Uncertain	
Doctoral Degree	22 (40.74)	18 (33.33)	14 (25.93)	54 (100)
Otherwise	5 (38.46)	4 (30.77)	4 (30.77)	13 (100)
Total	27 (40.30)	22 (32.84)	18 (26.87)	67 (100)

Cramér's V = 0.0434; $\chi^2_{(2)} = 0.13$; p-value = 0.94

Figures in the parentheses show percentages

Furthermore, Pearson's chi-square statistics were 0.13, $p=0.94$. This tells us that there was no statistically significant association between academics' attitudes and their academic qualifications.

In summary from the foregone bivariate analysis, it can be concluded that the ethnicity of the academics had a statistically significant association with the perception of academics about the workload issue. In the next section, I undertook multivariate regression analysis to explore the relationship between the ordinal outcomes and the explanatory variables.

6.1. Test of independence

6.2.0. Determinants of negative attitudes

First, I examined the variation of responses about the negative effects of ICT, which is termed as a 'threat' in this thesis. I checked the mean difference of scalars between male and female. The null hypothesis is the difference between the two groups – male and female faculty staff is equal to zero. The estimated test statistics are presented in Table 6.11 which shows that the null hypothesis of no difference between two groups

of academics was not rejected at 5 per cent. This implies that there was no difference of in responses amongst academics according to their gender

Table 6.11: Test of independence by gender

Group	Observation	Means	Std. Err.	Std. Dev.
Female	28	1.6	0.09	0.47
Male	39	1.77	0.08	0.53
Combined	67	1.72	0.06	0.51
Diff	-0.117			
diff = mean(Female) - mean(Male)			t =	-0.9285
Ho: diff = 0		degrees of freedom = 65		
Ha: diff < 0	Ha: diff != 0	Ha: diff > 0		
Pr(T < t) = 0.1783	Pr(T > t) = 0.3566	Pr(T > t) = 0.8217		

Table 6.12: Test of independence by first language

Group	Observation	Means	Std. Err.	Std. Dev.
Others	18	1.68	0.11	0.46
English	49	1.74	0.07	0.53
Combined	67	1.72	0.06	0.51
Diff	-0.06		0.14	
diff = mean(Others) - mean(English)			t =	-2.4610
Ho: diff = 0		degrees of freedom = 65		
Ha: diff < 0	Ha: diff != 0	Ha: diff > 0		
Pr(T < t) = 0.3232	Pr(T > t) = 0.0463	Pr(T > t) = 0.6768		

With regard to ethnicity, I re-examined the test of independence between the mean differences of the value of Factor 1 by ethnicity. The t-test of indolence is presented in Table 6.12. The result was that the table did not reject the null of no differences between the mean values of Factor 1 by ethnicity. This implied that there was a difference between the academics according to ethnicity when it comes to negative attitudes to the use ICTs on their works-.

Table 6.13: Test of independence by academic qualification

Group	Observation	Means	Std. Err.	Std. Dev.
Others	13	1.8	0.14	0.54
Doctorate degree	54	1.7	0.06	0.50
Combined	67	1.72	0.06	0.50
Diff	0.130	.1576562	-.1840919	.4456304
diff = mean (Otherwise) - mean(Doctoral) t = 0.8295				
Ho: diff = 0 degrees of freedom = 65				
Ha: diff < 0 Ha: diff != 0 Ha: diff > 0				
Pr(T < t) = 0.7951 Pr(T > t) = 0.4099 Pr(T > t) = 0.2049				

I further conducted a test of independency according to the academic qualifications of academics. The academics were divided into two groups: those with a PhD degree, and others. The tests are reported in Table 6.13. This table did not reject the null hypothesis of independency either.

6.2.1. Determinants of positive attitudes

The next step was to examine the variation of opinions about the positive effects of ICT, which was termed ‘opportunity’ in this thesis. I checked the mean differences of scale between males and females. The null hypothesis is that the difference between the two groups – male and female faculty - is equal to zero. The estimated test statistics are presented in Table 6.14. The table shows that the null hypothesis of no difference between the two groups of academic was not rejected at 5 per cent.

Taking into account the ethnicity of the academics, I re-examined the test of independence between the mean differences of scale among the faculties. The *t*-test of indolence is presented in Table 29. The result was that the findings did not reject the null of no differences between the mean values of factor 1 by ethnicity. This implies that there was no difference between academics according to ethnicity regarding the positive effects of the use ICT on their work.

Finally, I considered whether the differences in scale varied in terms of the academic qualifications of the academics. I divided the academics into two groups: those with a PhD degree and those without. The results are reported in Table 6.15. This table did not reject the null hypothesis of independency either.

Table 6.14: Test of independence by gender

Group	Observation	Means	Std. Err.	Std. Dev.
Female	28	1.67	0.09	0.46
Male	39	1.64	0.08	0.51
Combined	67	1.65	0.06	0.49
Diff		0.37	0.12	0.21
diff = mean(Female) - mean(Male)			t = -0.9285	
Ho: diff = 0		degrees of freedom = 65		
Ha: diff < 0	Ha: diff != 0	Ha: diff > 0		
Pr(T < t) = 0.62	Pr(T > t) = 0.76	Pr(T > t) = 0.38		

Table 6.15: Test of independence by ethnicity

Group	Observation	Means	Std. Err.	Std. Dev.
Others	18	1.53	0.10	0.43
English	49	1.70	0.07	0.50
Combined	67	1.65	0.06	0.49
Diff		-0.16	0.13	-0.43
diff = mean(Other) - mean(English)			t = -0.96	
Ho: diff = 0		degrees of freedom = 65		
Ha: diff < 0	Ha: diff != 0	Ha: diff > 0		
Pr(T < t) = 0.11	Pr(T > t) = 0.65	Pr(T > t) = 0.88		

Table 6.16: Test of independence by academic qualification

Group	Observation	Means	Std. Err.	Std. Dev.
Others	13	1.64	0.42	0.42
Doctoral	54	1.66	0.07	0.51
Combined	67	1.65	0.06	0.49
Diff		-0.019	0.15	-0.32
diff = mean(Other) - mean(English)			t = -1.21	
Ho: diff = 0		degrees of freedom = 65		
Ha: diff < 0	Ha: diff != 0	Ha: diff > 0		
Pr(T < t) = 0.45	Pr(T > t) = 0.90	Pr(T > t) = 0.55		

6.2. Regression results

Table 6.17 reports the estimated ordered probit regression results. Since there were six possible outcomes, the model contains five cut points ($k = 5$). One of the underlying assumptions is that ordered probit regression assumes the coefficients that describe the relationship between the lowest versus the higher categories of the response variables are as same as those that describe the relationship between the next lowest category and all higher categories. I needed to test the null hypothesis that there were no category-specific parameters, and hoped for a non-significant result.

The first hypothesis was tested by the likelihood ratio (LR) test, where the test statistic was $LR = -2(\text{Log}L_{\text{ordered probit}} - \text{Log}L_{\text{generalised threshold}})$, which had a chi-square distribution (Mallick & Rafi, 2009). The LR test of the ordered probit

model against the generalised ordered probit extended model was as follows: $\chi^2_{(1)}$ statistic = 0.89 (p-value = 0.34).⁹

The above likelihood was improved very little by the ordered probit model, and the LR test did not reject the ordered probit model: a $\chi^2_{(1)}$ statistic of 0.89, giving a p-value of 0.34. Therefore, I have used the ordered probit model result to interpret the findings.

The estimated log-likelihood test result of the model was -96.88. As the maximum likelihood estimation ran between 0 and 1, the log-likelihood estimation was always negative. The χ^2 statistic was 21.62 (degree of freedom is 10). It rejected the null hypothesis that all explanatory variable coefficients in the model were simultaneously equal to zero at least at the 5 per cent level ($\text{Prob} > \chi^2_{(2)} = 0.017$). This supported the overall fitness of the model. It means that at least one of the predictor's coefficients was not equal to zero. Out of 10 explanatory variables, I found that three variables were statistically significant at the 1 per cent and 5 per cent level. They were weekly Internet use (x_2), ethnicity dummy (x_4) and academic qualification dummy (x_6). It is claimed that using ML for a small sample less than 100 is risky (Long 1997) “[...] standard advice is that with samples you should accept larger p-values” (Long 1997, p.54).

Ordered logistic regression summary:

Log likelihood = - 96.89;

Number of observations = 67

LR Chi-square (10) = 21.62

Probability > Chi-square = 0.017

Pseudo R-square: 0.10

- **Log Likelihood** - Log likelihood of the fitted model is -96.88 which is in the Likelihood test as to whether all predictors' regression coefficients in the model are simultaneously zero or not.
- **Number of observations** – The number of observations in the model is 67. This number of observations may be less than the number of cases in the dataset.
- **LR chi2(10)** - Likelihood Ratio (LR) is a Chi-Square test. This test states that at least one of the predictors' regression coefficient is not equal to zero. The number in the parenthesis which is 10 (ten) here indicates the degrees of freedom of the Chi-Square distribution that is used to test the LR Chi-Square statistic. The number of predictors in the model defines the LR Chi-Square statistic. The statistic is calculated by $-2 * (L(\text{null model}) - L(\text{fitted model})) = -2 * ((-107.699963) - (-96.889727)) = 21.620$, where $L(\text{null model})$ is from the log likelihood with just the response variable in the model (Iteration 0) and $L(\text{fitted model})$ is the log likelihood from the final iteration (assuming the model converged) with all the parameters.
- **Prob > chi-square** – This states the probability of obtaining the chi-square statistic which is 21.62, if there is no effect from the explanatory variables. This p-value is compared to a specified level of significance. The level of significance is typically

⁹ Results are reported here only. Detailed calculation are available upon request.

set at 0.05 or 0.01, in some cases though it may be set at 0.10. While the number of observation is small, the significant level is to be set at 0.10.

- **Pseudo R-square** - Pseudo R-square is McFadden's pseudo R-squared. Similar to R-square in the ordinary least square estimator, logistic regression does not have any R-square value. Similar to R-square it has Pseudo R-square value. A wide variety of pseudo R-squared statistics are given in regression analysis, which can result in contradictory inference from the estimation.
- **Coefficients** – The coefficients of Table 31 shows change in the outcome variable to one unit change in predictor of other variables if other elements in the model are held constant. Regression coefficient indicates the extend of the changes. Furthermore, the sign of the coefficient gives the direction of changes.
- **Cut points** – Cut point in ordered logit or probit models behave like a constant in the ordinary regression analysis. The number of cut points depends upon the number of ordered outcomes. In this case, there were six outcomes; hence, five cut points are displayed in the regression table.

Results in Table 6.17 indicate that for a larger p -value the number of statistically significant variables remained unchanged. The coefficients of the variables have positive and negative signs. The positive sign means that the respondent is more likely to be in the higher category and the negative sign means that the respondent is more likely to be in the lower category. Finally, I turn to the cut point estimates. These are estimated intercepts of the predicted non-linear probability model. Based on Table 6.17, I calculated predicted probability of each outcome, and the results are reported in Table 6.18. A total of the predicted probability of the six outcomes was equal to one. The predicted probability of the outcome 1 (*strongly agree*) was very high compared with the predicted probability of the outcome 2 (*disagree*) and outcome 3 (*strongly disagree*).

Table 6.17: Ordered probit regression results (MLE estimation)

Dependent Ordinal outcomes	Coef.	Std. Err.	z-stat.	P> z
x_1	0.007	0.009	(0.80)	0.425
x_2	0.025	0.012	(2.08)**	0.038
x_3	0.011	0.025	(0.46)	0.643
x_4				
English	-2.04	0.642	(3.18)*	0.001
x_5				
Male	-0.27	0.533	(0.51)	0.610
x_6				
Doctoral degree	-1.332	0.638	(2.12)**	0.034
x_7				
Associate professor	-0.35	1.287	(0.27)	0.784
Professor	0.484	1.266	(0.38)	0.702
Senior lecturer	-0.36	1.078	(0.34)	0.735
Lecturer	0.046	0.997	(0.05)	0.963
/cut1	-2.36	1.62		-5.541
/cut2	-0.99	1.60		-4.136
/cut3	-0.91	1.60		-4.052
/cut4	-0.43	1.59		-3.557
/cut5	0.49	1.59		-2.623
Log-likelihood	=	- 96.88		
Prob > $\chi^2_{(2)}$	=	0.017		
LR chi2(10)	=	21.62		
Obs		67		

N.B. *, ** and *** mean level of significance at 1 per cent, 5 per cent and 10 per cent respectively.

Table 6.18: Predicted probability of ordered probit outcomes

Outcomes	Mean probability	Std. Dev.	Min	Max
<i>Strongly agree</i>	0.24	0.164	0.015	0.592
<i>agree</i>	0.25	0.083	0.041	0.328
<i>Uncertain</i>	0.02	0.003	0.004	0.020
<i>Disagree</i>	0.08	0.022	0.034	0.119
<i>Strongly disagree</i>	0.16	0.055	0.053	0.228
<i>Not applicable</i>	0.25	0.192	0.038	0.789

An easy way to investigate the range of the predictions is with Dotplot which is presented in Figure 6.2. The predicted probabilities for the last outcome tend to be evenly distributed, with most predictions for the outcome 3 *uncertain* falling very close to zero. In very rare cases the probability of outcome 1 i.e. *strongly agree* is greater than 0.5.

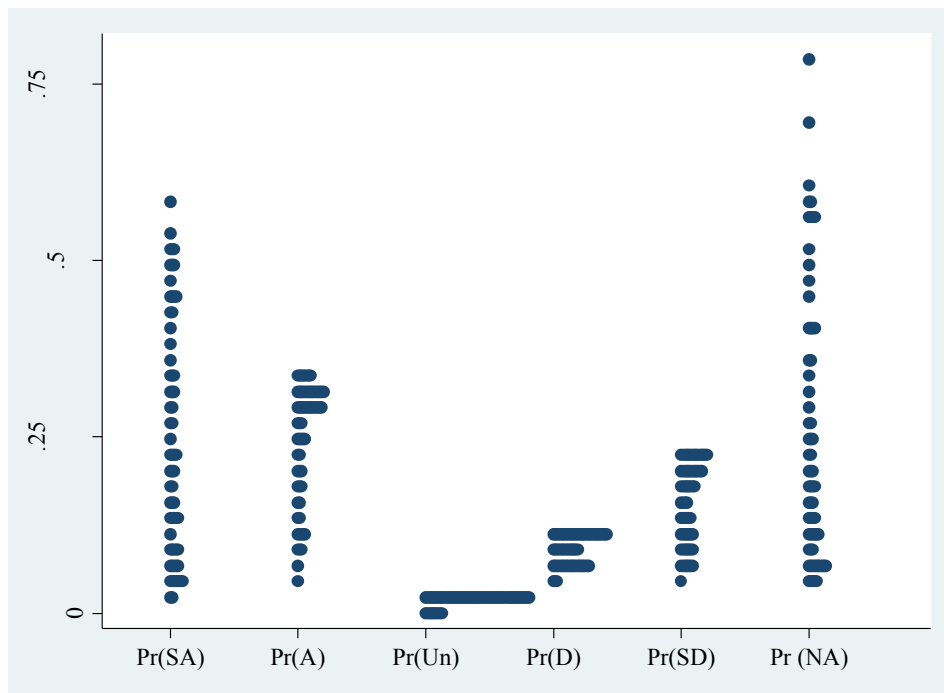


Figure 6.2: The range of predicted probabilities of six outcomes

To explore the substantial findings, I computed predictions in terms of using the formula given in Equation (6) at specific, substantively information values. To calculate the average marginal effects or the predicted probability of six outcomes, I took into account continuous variables, including weekly Internet use (x_2) at mean and ethnicity dummy (x_4) and academic qualification dummy (x_6) equal to one. The results are reported in Table 6.19 and Table 6.20. I did not consider gender differences and differences in academic rank here, because these variables were found to be statistically insignificant in the regression table. The estimated

predicted probability of six outcomes for the respondent, who is a native English speaker (*i. e.* $x_4 = 1$), holds a PhD degree (*i. e.* $x_6 = 1$) and uses the Internet at mean (*i. e.* $x_2 = mean$), is presented in Table 9. Further, the estimated predicted probability of six outcomes for the respondent, who is not a native English speaker (*i. e.* $x_4 = 0$), holds a PhD degree (*i. e.* $x_6 = 1$) and uses the Internet at mean (*i. e.* $x_2 = mean$), is presented in Table 33

Table 6.19: Marginal effects of first sets of outcomes

variables	Outcome	Outcome	Outcome	Outcome	Outcome	Outcome
	1 (Z-stat)	2 (Z-stat)	3 (Z-stat)	4 (Z-stat)	5 (Z-stat)	6 (Z-stat)
x_2	-0.0 (2.27)**	0.00 (0.18)	0.00 (0.90)	0.00 (1.75)	0.00 (2.01)**	0.00 (1.76)
x_4	0.43 (2.89)*	- 0.01 (0.18)	- 0.00 (0.89)	-0.07 (1.67)	- 0.14 (2.42)**	-0.20 (3.49)*
x_6	0.22 (2.51)**	0.07 (1.24)	- 0.00 (0.32)	-0.02 (1.16)	-0.08 (2.10)**	-0.19 (1.77)

Table 6.20: Marginal effects of second sets of outcomes

	Outcome	Outcome	Outcome	Outcome	Outcome	Outcome
	1 (Z-Stat)	2 (Z-Stat)	3 (Z-Stat)	4 (Z-Stat)	5 (Z-Stat)	6 (Z-Stat)
x_2	-0.00 (1.36)**	-0.00 (0.19)	-0.00 (0.93)	0.05 (1.66)	0.04 (0.56)	0.00 (2.36)**
x_4	0.13 (3.43)*	0.20 (3.27)*	0.01 (0.91)	0.07 (1.34)	0.07 (0.63)	-0.46 (2.96)*
x_6	0.04 (1.64)***	-0.00 (1.98)**	0.00 (0.93)	-0.00 (1.74)	-0.00 (1.47)	-0.28 (2.37)**

N.B. * means level of significant at 1 per cent level ; ** means level of significance at 5 per cent level.;

6.3.0. Discussion

6.3.0.1. The effect of first language status

The predicted probability is that if the academics are native English speakers (*i. e.* $x_4 = 1$), they are more likely to be in the first category by 43 per cent if other things remain the same. This means because of change of ethnicity status from 0 (*i. e.* $x_4 = 0$) to 1 (*i. e.* $x_4 = 1$), holding other elements remain constant, an academic is more likely to be in the first outcome by 43 per cent (*i. e.* *strongly agree*) provided that he/she has a doctoral qualification. On the other hand, an academic is less likely to be in the second outcome by 1 per cent (*i. e.* *agree*). An academic is less likely to be in the third outcome is absolutely none (*i. e.* *uncertain*). An academic is less likely to be in the fourth outcome by 7 per cent (*i. e.* *disagree*). An academic is less likely to be in fifth outcome by 14 per cent (*i. e.* *strongly disagree*), and less likely to be in the sixth outcome by 20 per cent (*i. e.* *not applicable*). This implies that the predicted probability that an academic is likely to tick *strongly agree* on the statement is comparatively high.

If the academic is Asian-born, the expectancy is that the respondent is 13 per cent more likely to be in the first outcome (*strongly agree*), 20 per cent more likely to be in the second outcome (*agree*) and 46 per cent less likely to be in the sixth outcome (*not applicable*) provided that they have a doctoral qualification. This result may be true for other non-English speaking background academics.

6.3.0.2.. The effect of academic qualifications

Regarding the marginal effects of a PhD degree, Table 9 and Table 10 indicate the predicted probability of outcome 1 (*strongly agree*) for non-Asian born academics as being higher by $(0.22-0.04 = 0.18)$ 18 per cent compared with Asian-born academics. The predicted probability of the remaining outcome is negligible.

6.3.0.3.. The effect of Internet usage

With regard to the marginal effects of weekly Internet use (x_2), Table 9 and Table 10 show that the predicted probability of outcome 1 through to outcome 6 for non-Asian born academics is the same as for Asian-born academics; and in all cases the extent of the effect is negligible. The result that academics' ethnicity (measured by the status of the native language) is significant is not significantly different from the conventional findings of previous research studies.

6.3. Summary of the Chapter

In this chapter by both nonparametric and parametric analysis, I have tried to test the relationship between varied attitudes of the academics to ICT grounded Ajzen and Fishbein theory of reasoned action. Both nonparametric and parametric analysis confirmed that the socio-demographic factor(s) (e.g. in this study, native language status, academic qualification) were correlated with the varied attitudes to ICT. The predicted probability of changing attitudes is that if the academics are native English speakers they are more likely to express negative attitudes to ICT because of the consequence of increasing workload.

7. CHAPTER SEVEN: ACADEMIC RESEARCH PRODUCTION

7.0.1. R & D in Australian universities

Research and development is an important area of public and private investment in many countries, including Australia, because of their direct and indirect effects overall economy. In Australia the Research and Development, Industry Commission Report (1994) showed that R & D had a positive impact on all sectors of the economy (Borland et al., 2000). For example, one per cent increase in R & D stock increased agricultural productivity by 0.1 per cent. In the USA Jaffe (1989) found a significant effect of university research on corporate patents, particularly in the areas of drugs and medical technology, and engineering. In addition, university research had an indirect effect on local innovation.

Developed and developing country experiences showed that research and development (R & D) were carried out by three types of organisations- universities, public research organisations and private research organisations. In developed countries, R & D were predominantly conducted by universities, while by contrast in developing countries, R & D were predominantly the responsibility of public research organisations, rather than by universities. One potential reason for the differential natures of R & D in developed and the developing countries was that universities in developed countries were predominantly research institutions whereas universities in developing countries were predominantly teaching institutions.

As in other developed countries in Australia, universities play a vital role in R & D. Broadly four types of research activities occur in universities: pure basic research, strategic basic research, applied research, and experimental development (ABS 2014). Between the years 2008 and 2012, a structural change took place in research activities. With the progress of time, the proportion of pure basic research decreased, while applied research increased (ABS 2014). Applied research gained momentum and reached 45 per cent of total activities from 30 per cent in the year 1992. On the other hand, strategic and experimental research remained stable (ABS 2014). Two types of resources were devoted to R & D in Australian Higher Education: education expenditure on R & D and human resources devoted to R & D. In Table 7.1, I present the growth of R & D during the period 2002-2012.

Table 7.1: The growth of resource allocation for research and development

Items	Unit	2002	2004	2006	2008	2010	2012
Expenditure on R&D	Per cent	Base	26	25	26	19	18
Human resources devoted to R&D	Per cent	Base	11	7	5	12	8

Author's calculation based on ABS data Cat No. 8111.0. "Research and Experimental Development, Higher Education Organisations, Australia, 2012"

Table 7.1 shows that in the last few years, expenditure on R & D decreased alongside the human resources devoted to R & D. There are two main sources of research funds: general university funding and Australian government competitive research grants (ABS, 2014). Since 2010, R & D funds from the two major sources have started to decline. Donations, bequests, and foundations funding declined by 12 per cent and non-commonwealth Australian competitive research grants declined by 12 per cent, while on the other hand human resources devoted to R & D increased by 7 per cent between 2010 and 2012 (ABS, 2014).

With regard to the objectives of research, the ABS data showed that medical and health science research, engineering science, and studies in human society made up 52 per cent of the total higher education research in 2012 and attracted 34 per cent of the total research and development expenditures (ABS, 2014).

The Australian Department of Education provides yearly data about the research performances of Australian government and non-government universities. The Australian government measures the research performances in four categories: books, book chapters, full-written conference papers and journal articles. Based on Department of Education data, I presented the research publications for the universities (those who were members of the Universities Australia only) the periods 1992-2011 in Figure 7.1. The Figure 7.1 shows a clear time series pattern of increasing research publications during the periods of the study. Compared to book and book publications, the publication of journal articles experienced a spectacular growth. From 1995, the increasing trend of journal articles was very rapid clearly indicating the increasing efforts of researchers and academics in this field.

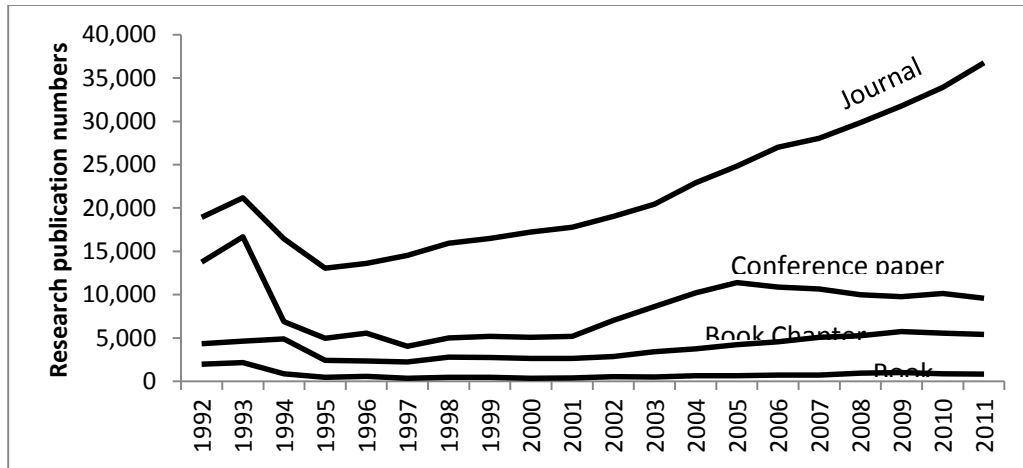


Figure 7.1: Research publication output, 1992-2011

Source: Author's presentation based on Australian Department of Education data. Available at <http://docs.education.gov.au/node/34561>

At universities, academic research is carried out by two cohorts of researchers. They are full-time academics staff members and full-time and /or part-time doctoral research students. Currently Australian government policy on research training is characterised by two initiatives: developing research capacity in the Australian workforce, and shifting government regulations on university management (Palmer, 2013). In order to strengthen the research capacity of the workforce one identified strategy was to identify “physical and human resources that support research” (ibid, p. 86). In line with the objectives, the Australian government undertook the initiative to review the research and training scheme (RTS), Australian Postgraduate Award (APA), and International Postgraduate Research Scholarship. The chronological development of Australian government policy is presented in Figure 7.2

Year	Title	Description
2013	<i>Draft Standards for Research Training</i> ²³¹	A discussion paper on proposed threshold standards for research training.
2011	<i>Defining Quality for Research Training in Australia</i> ²³²	Consultation paper for the first stage of a review of the Research Training Scheme.
2011	<i>Research skills for an innovative future</i> ²³³	Outcome document from the Research Workforce Strategy development process.
2011	<i>Examining the Full Cost of Research Training</i> ²³⁴	Report commissioned by DIISR to examine the full cost of research training in Australian universities.
2010	<i>Meeting Australia's Research Workforce Needs</i> ²³⁵	Consultation paper to inform the development of the Research Workforce Strategy.
2010	<i>Australia's International Research Collaboration</i> ²³⁶	Report of the House of Reps. Standing Committee on Industry Science and Innovation Inquiry into Australia's international research engagement.
2010	<i>IPRS Program Evaluation</i> ²³⁷	Program evaluation for the International Postgraduate Research Scholarships scheme (IPRS).
2009	<i>Powering Ideas</i> ²³⁸	Responded directly to <i>Venturous Australia</i> and indirectly to a range of reports including <i>Building Australia's Research Capacity</i> .
2009	<i>Response to Committee report: Building Australia's Research Capacity</i> ²³⁹	The Australian Government's formal response to <i>Building Australia's Research Capacity</i> , indicating mixed support for the recommendations made.
2008	<i>Building Australia's Research Capacity</i> ²⁴⁰	The House of Representatives Inquiry into Research Training and Research Workforce Issues in Australian Universities was the first comprehensive review of research training since the inception of the RTS.
2008	<i>Venturous Australia</i> ²⁴¹	The final report of the Review of the National Innovation System included recommendations regarding The Australian Postgraduate Award scheme, but did not address the RTS in detail.
1999	<i>New knowledge, New Opportunities; Knowledge & Innovation</i> ²⁴²	Detailed discussion paper and policy statement on research and research training, circulated as green & white papers. Led to the 2002 implementation of the RTS.
1998	<i>Learning for Life</i> ²⁴³	Final report of the Review of Higher Education Financing & Policy. Described the initial outline for the RTS, later developed through the green & white papers.

Figure 7.2: Research training policy of the Australian government

Source: Palmer (2013, p.87)

7.1. Variables for the research production function

7.1.0. Dependent variable

Research production (I used the words 'production' and 'output' interchangeably in this study) in universities was diverse and included journal articles, book chapter, books, and conference papers, patents, art works, public lectures and so on (Carrington, Coelli, & Rao, 2005), because of this diversity, measuring a common research output that combined different research output was problematic. Research quantum and the weighted composite index were two measures used in the past to measure performance in universities in Australia (Carrington, Coelli & Rao 2005). Carrington et al. (2005) used a 'weighted

publications' index that included books, book chapters, journal articles, and conference papers. The publication index method was based on publication counts without paying any attention to the impact factor of the journal that was published the papers. Impact factor wa a measure of quality publications nowadays, but to rank journals, “judgment is still required to assign weight” (Carrington et al., 2005, p. 151). Nevertheless, the preferred measure of research for academic exercises in the past involved weighted publications.

Following the past study, I decided to use a weighted composite index, including books, book chapters, journal articles, and conference papers. Unlike the past studies, to give weight, I used Commonwealth Scholarship Guidelines Research (available at <http://www.comlaw.gov.au/Details/F2012L02535/Download>), which provided some guidance about the weighted calculation of the research performance of an applicant for a scholarship. Following the Commonwealth guidelines, I assigned weight one for a journal article, one for a conference paper and five for a book/book chapter and thereafter I calculated the weighted average of research output. If the value was less than one but greater than zero, a default of one was given. Moreover, any fractional value was converted to a round number. For example, 1.2, and 1.5 were converted to 2 and 3 respectively. However, the rounding was required for 3 percent of the data.

The research outputs at the USQ examined in terms of publications deposited in USQ's electronic depository account (<https://eprints.usq.edu.au>) by researchers. Figure 7.3 presents the time series pattern on the number of publications reported between the year 2001 and 2013.

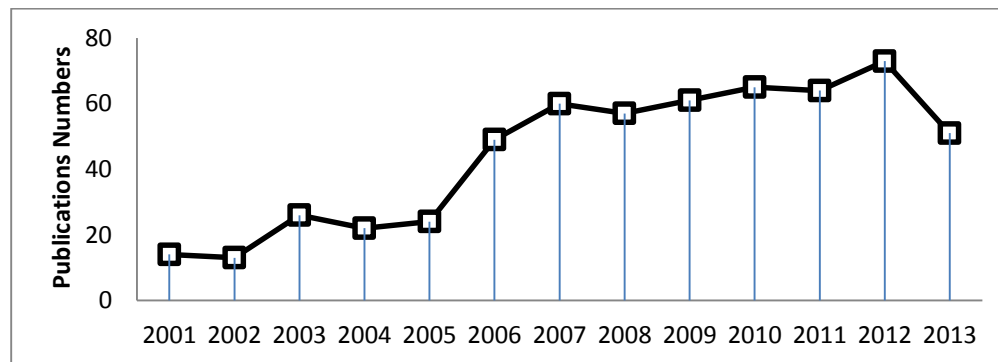


Figure 7.3: Number of research outputs in USQ ePrints, 2001 - 2013

Source: https://eprints.usq.edu.au/view/centre/cesrc.html#group_2013

There was evidence that between 2001 and 2013 research outputs showed an increasing trend. In 2001, the number of total research outputs was around 10 and the numbers increased to over 70 in 2012, but in 2013 the number decreased to 50. The sudden decline might have been attributed to the changing pattern of research funding within the university and outside the university at the national level. With this background in mind, this study assessed the determinants of research performance at USQ . Borland et al. (2000) summarised of the return to investment in university research based on previous literature. The evidence suggested that

- university research makes an important contribution to innovation in industry;
- industrial R & D as well as university R & D is largely conducted by university graduates
- university academics have a strong incentive to make their findings public, therefore the spillover benefits from R & D are thought to be especially important

I calculated research output for the period 2012-2013 (January-December). This was self-reported data. The self-reported data created the problem of bias in applied research which was already debated in the literature (Donaldson & Grant-Vallone, 2002), because “research participants want to respond in a way that makes them look as good as possible” (Donaldson & Grant-Vallone 2002, p.247). In our study however, the respondents were not reporting to any perceived value, rather they depended on the actual performance(s). Hence, self-reporting bias was been perceived as a problem in this study. The collection of data online did have scope to explain in detail what exactly was wanted from the question. The research depended absolutely on the understanding of the respondent in this case.

A frequency distribution of the dependent variable is presented in Figure 7.4. The Figure shows that there is tail in the distribution which indicates that the majority of academics have weighted an average number of less than 2.5 in the dataset.

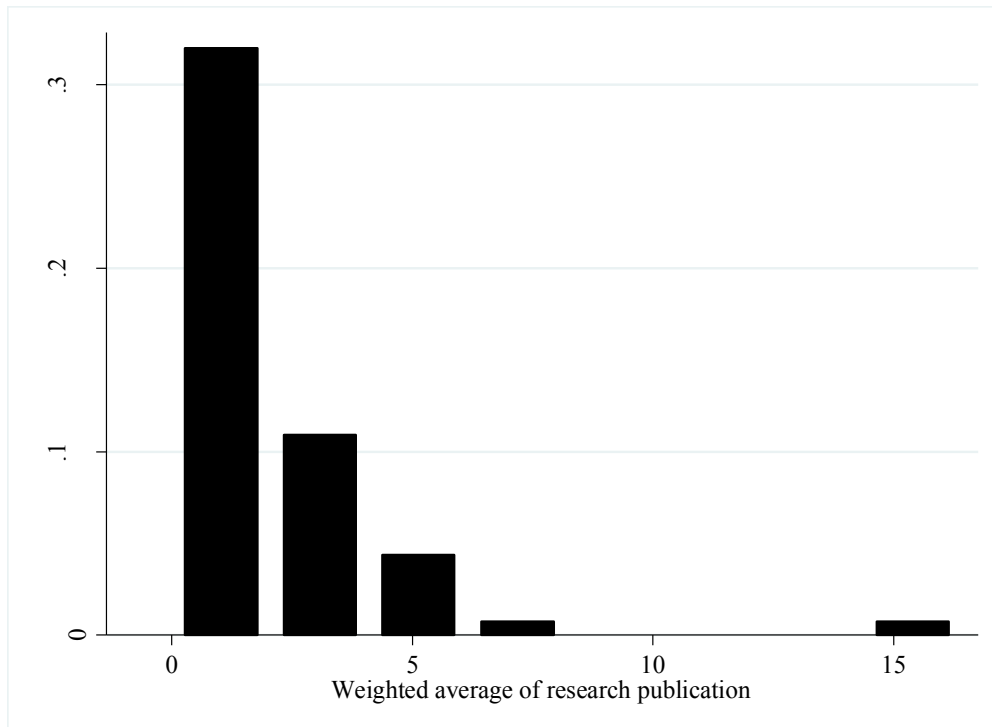


Figure 7.4: The frequency distribution of research productions (weighted average)

According to Table 7.2, thirty-two per cent of academics' have an average (weighted) research output around one, while 55 per cent have an average (weighted) research output within the range of 1.1 to 5.0. A small proportion has an average of over 5.0.

Table 7.2: The frequency distribution of research productions (weighted average)

Weighted average research production	Percentage
0 to 1.0	34.32
1.1 to 2.0	29.85
2.1 to 5.0	25.37
5.1 to 8.0	7.49
8.1 and above	2.98

Source: Author's calculation

As the data was skewed to the left, I normalised the data by taking a natural logarithm of the data. After logarithmic transformation, the distribution of the research output was shown in Figure 7.5. The figure shows that after logarithmic transformation, normality is achieved in the dataset.

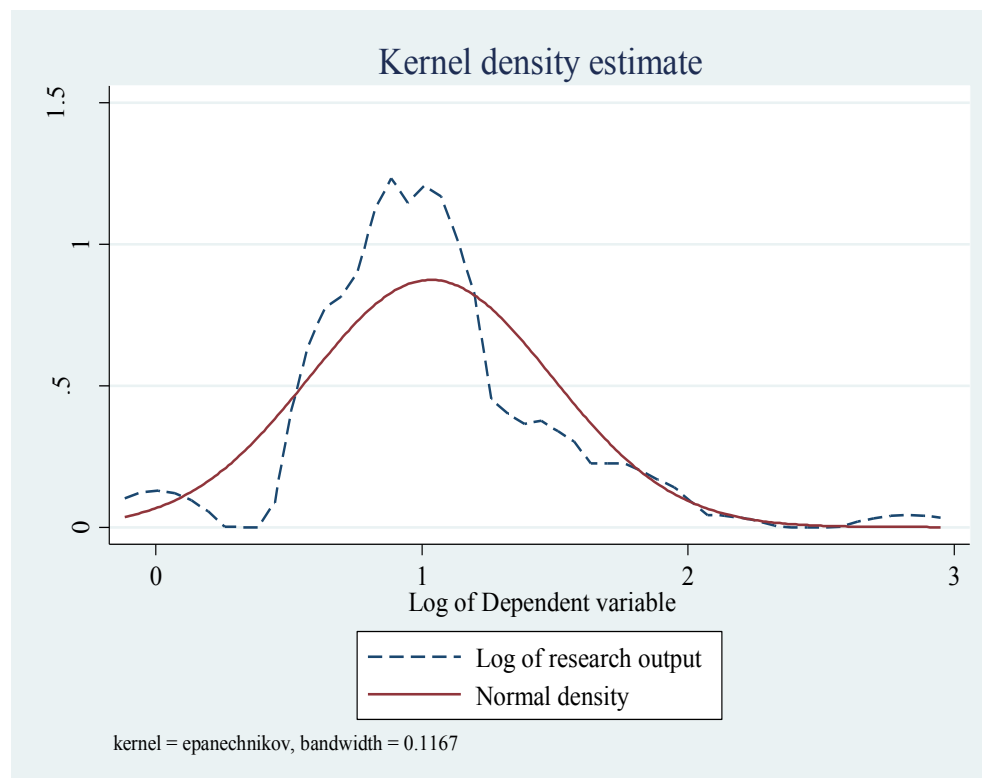


Figure 7.5: Kernel density distribution of the research productions (in log)

7.1.2. Explanatory variables

7.12.0. Teaching loads

Meyer (1998) used three types of measures to estimate faculty activities. They were the total number of hours worked per week and the total number of hours spent per week for teaching. Teaching and research are inter-related responsibilities of academics (Moses, 1990). The relationship between the research output and explanatory variables was examined in previous studies – Meyer (2012) in the USA, Iqbal and Mahmood (2011) in Pakistan, and Jung (2012) in Hong Kong. This study used the term ‘workload for teaching’ to measure the teaching activities of academics, because the working time might had three components in the context of the academic environment, which were:

- (i) time for teaching,
- (ii) time for research, and
- (iii) time for administrative work.

On the other hand, Fairweather (2002) defined total faculty productivity in terms of time for teaching and research. I asked the academics to provide information about their average teaching load for the period 2011-2012. Table 7.3 presents the average teaching load for 2011-2012. The table shows that only three per cent of academics had a full-time teaching load (91-100 per cent of the total workload).

Table 7.3: Average teaching in 2011-2012

Teaching load (per cent)	Frequency	Cumulative frequency
0-10	14	14
11-20	05	19
21-30	03	22
31-40	06	28
41-50	10	38
51-60	5	43
61-70	12	55
71-80	11	66
81-90	01	67
91-100	01	68

In order to understand the distribution of the teaching load by gender, I have presented separate data for both male and female in Figure 7.6.

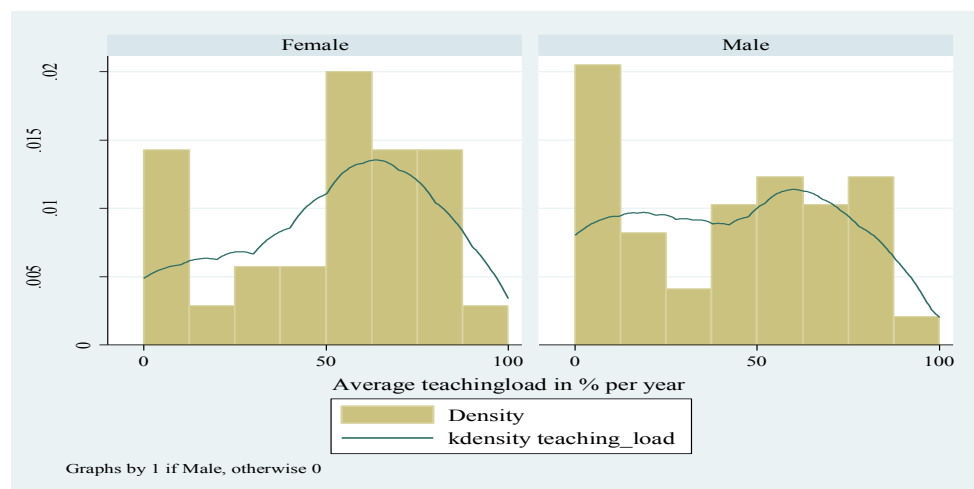


Figure 7.6: Distribution of average teaching loads

In this dataset, the average teaching load for females was 50 per cent and for male 41.53 per- cent. This implies that female academics had more workload compared to their male counterparts. At this stage, I examined the statistical significance of the mean difference between male and female academics by applying an independent t-test. The test statistics was 1.18 (degrees of freedom = 65). The test result did not reject the null of no difference between the average teaching load for male and female.

7.1.2.1. Internet use

Academics' use of Internet for academic work was an important variable of this study. I asked the academics to provide information about their use of the Internet per week for academic work during and outside office hours. Along with the question, it was important to gain information about access to information and communication devices and services in the office. Table 7.4, Table 7.5, and Table 7.6 present data on access to ICT devices, services and time on the Internet for academic staff.

Table 7.4: The availability of computers

Availability	Responses	Percentage
Desktop	56	80
Laptop	55	79
Tablet	45	64
Smartphone	30	43
Others	06	9

Table 36 shows that around 80 per cent of academics replied that they used desktop and laptop computers in the office and at home. Around 64 per cent of academics replied that they used a tablet. Regarding access to Internet services, only eight per cent had access to the National Broadband Network (NBN) service at their residence (Table 39). The data provided evidence that the expansion of NBN was yet to be realised, and that large area in regional Australia had no NBN facilities.

Table 7.5: The availability of the Internet at residence

Availability	Response	Percentage
Broadband with ADSL	35	51
Wireless broadband	32	47
National Broadband Network	8	12
Other (please specify) Wi-Fi/ None	3	4

Table 7.6: The use of Internet per day (in hours)

Use of Internet	Frequency	Percentage
1 – 15 hours	9	13.43
16 – 30 hours	17	25.37
31 – 45 hours	12	17.91
46 hours & above	29	43.28

Regarding the use of the Internet by academics at work and at home for academic work information indicated that 43 per cent of academics were using the Internet for 46 hours per week and above while 15 per cent were using it between 16 hours and 30 hours. Female academics were using the Internet for 46.75 hours per week on average; male academics were using it for 39.85 hours per week on average. At this point, I carried out an independent t-test to find out whether there was any significant difference between male and female academics regarding the use of the Internet. The estimated t-test value is 1.26 (degrees of freedom = 65). This test result did not reject the null hypothesis that the difference between male and female academics was equal to zero. A summary statistics is presented in Table 7.7. The table shows a high standard deviation in the data. By gender, the pattern of use is presented in a histogram (Figure 7.7).

Table 7.7: Summary statistics

Variable	Unit	Mean	Std. Dev.	Min	Max
Internet use	Weekly hours	42.73	22.14	7	112

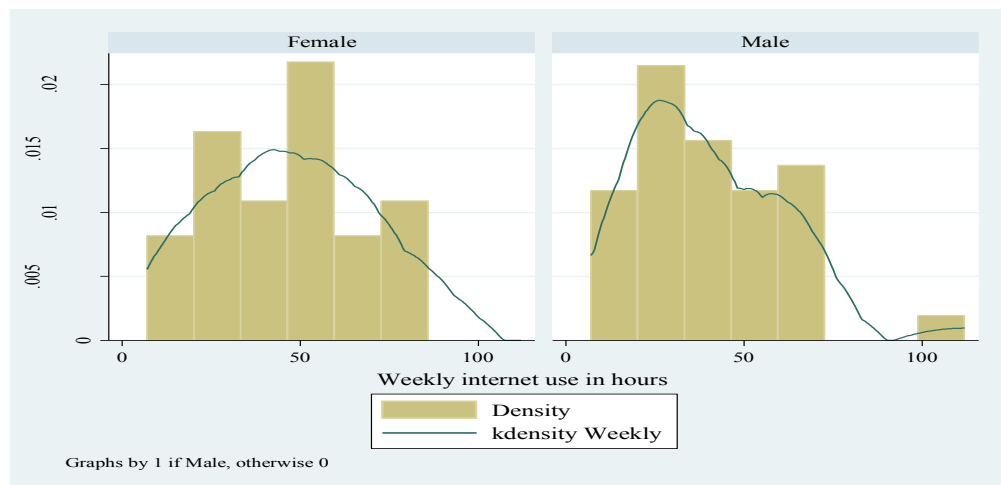


Figure 7.7: Histogram of Internet usage (hours)

The histogram (Fig 29) shows that the mean use of the Internet between male and female academics varies. The mean use of the Internet by males and female was 47 hours and 40 hours per week. To determine whether the mean differences between male and female academics were statistically significant I conducted a test of independence, where the null hypothesis is that there is no difference between males and females. The estimated t-statistic was 1.26 (df=65). Both one-sided and two-sided t-test results did not reject the null hypothesis that the mean differences between males and females were equal to zero.

At this point of analysis, I used locally a weighted scatterplot smoothing (LOWESS) curve, a non-parametric regression (local mean smoothing), to discover the actual functional relationship between the main explanatory variable of interest (the log of the use of the Internet per week) and the dependent variable (the log of research output). Figure 7.8 reports on the LOWESS curve. The LOWESS curve showed a linear increasing relationship between the two series of data, and by weighted regression line. In the remaining parts of this Chapter, I examined the degree of the relationships controlling other control variables.

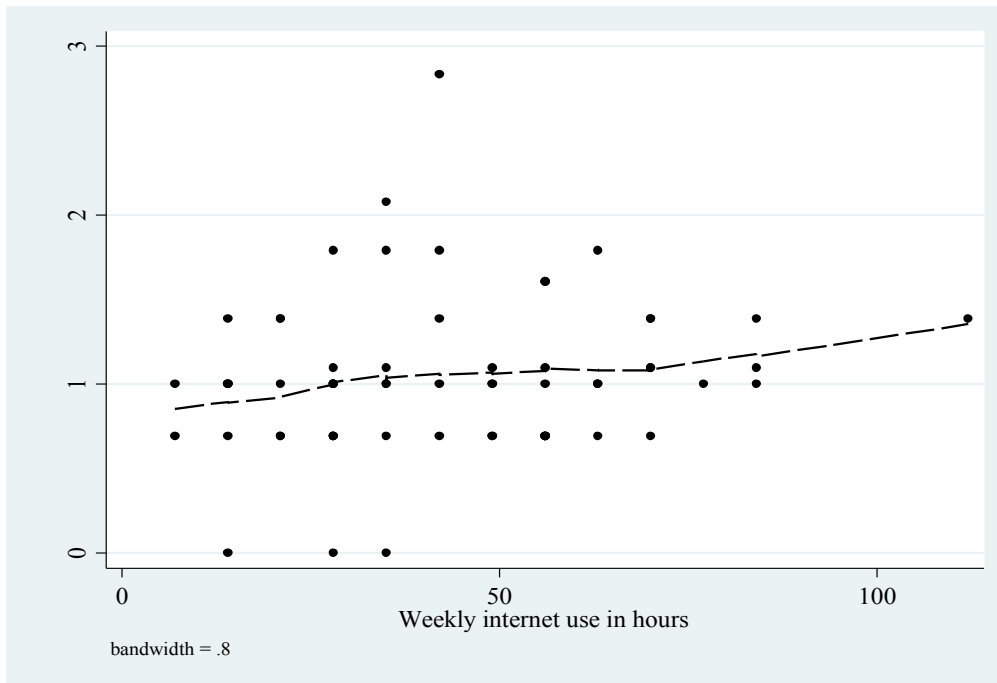


Figure 7.8: Weighted regression line

7.1.2.2. Research collaboration

The *Oxford Dictionary* suggests that collaboration means the working together of individuals to achieve a common goal. Underpinning this definition, literature defines research collaboration as working together among researchers to achieve a common goal (Katz & Martin, 1997). The literature further suggested some criteria to separate collaborative researchers from ordinary researchers, which were:

- those who contribute to a designated research project collectively
- those whose names or posts appear in the research output
- those responsible for the main element of the research

Because of the influence of international research collaboration or extramural research collaboration on research output (Lee, 2005; Abramo, 2008; Bently, 2011; Lissoni, 2011) research collaboration was selected as a construct of the production model of this study. Despite differential methodological approaches, the studies found a positive influence of international or extramural research collaboration on research output. Therefore, research collaboration was an important variable of interest in this study. Academics was asked whether they were engaged in external collaborative research (outside their own university). Around 26 per cent of academics replied in the negative (Table 7.8). The difference between males and the females seemed negligible. Independent t-test confirmed that the difference between male and female academics was insignificant (t-test value = 0.08; p-value = 0.47). Though difference in gender was not regarded as statistically significant in Bently’s (2001) study, the variable was regarded as statistically significant in other studies, for instance, Lissoni et al. (2011).

Table 7.8: Research collaboration by gender

Sex	Yes (per cent)	No (per cent)
Male	89.0	11.0
Female	85.0	15.0

7.1.2.3. Age

Over (1982) included the age variable to study the influence of the age of academics on research output in British universities. In recent literature (Fukuzawa, 2014; Jung, 2012) the variable was also included. A linear age term was expected to contribute to research output. A summary of statistics is presented in Table 7.9. The table shows that the majority of academics were within the age group 35-49 years (45 per cent); 33 per cent of the academics were within the age group 50-64 years and a proportion was within the age group of less than 34 .

Table 7.9: Distribution of academic by age group

Age group	Freq.	Per cent	Cum
Less than 34	12	17.91	17.91
35-49	30	44.78	62.69
50-64	22	32.84	95.52
Above 65	3	4.48	100.00

7.1.2.4. Research grants

The research grant was an important control variable of this study because of its influence on research productivity in the past (e.g. Abbott & Doucouliagos, 2004). Academics were asked to give us information about the amount of research grant monies they received during the periods 2012-2013. The summary statistics of the variable are presented in Table 7.10. The Table shows that 45 per cent of academics did not secure any research grant monies. Among the grant recipients, the male academic received an average of AU\$239,000 and female academics received an average of AU\$89,000. The independent t-test showed that the mean difference between males and females is not statistically significant (t -value -1.15; degrees of freedom = 35).

Table 7.10: Summary statistics of research grants

Variable	Unit (K)	Mean	Std. Dev.	Min	Max
Research grant	1000	102.2985	300.5395	0	1740

7.1.2.5. Academic ranks and doctoral qualifications

Some studies highlighted academic rank and doctoral qualification as important determinants in Australian universities (Bently, 2011). The role of academic qualification was found positive. Following Bently (2011), this study also included the variable: academic rank, academic qualification. Furthermore, the role of the ethnicity of academics in research performance was highlighted in many research studies, some of them were very recent studies (e.g. Webb, 2012; Edgar & Geare, 2011). Ethnicity entered into the production system as an individual socio-demographic factor. Webb (2012) classified ethnicity as US-born academics and as foreign-born academics, while Edgar and Geare (2011) classified ethnicity by European New Zealander, European New Zealand Maori, Asian and other origins (p.782). This study classified ethnicity by the native language status of academics - native English speaker and non-native native English speaker. If the first language was English, it implied that academics were Australia-born or European English-speaking country-born academics. Otherwise, the academic was born in non-English-speaking countries. The dataset of this doctoral research showed that the Asian-born academics come from Bangladesh, India, Sri Lanka, and China. Summary statistics of the categorical variables – ethnicity, academic qualifications, and academic ranks are presented in Table 7.11.

Table 7.11: Summary statistics of first language, qualifications and academic rank

	Freq.	Per cent
<i>Native first language</i>		
Others	18	26.87
English	49	73.13
<i>Academic qualifications</i>		
Bachelor degree	3	4.48
Master's degree	10	14.93
PhD degree	54	80.60
<i>Ranks</i>		
Associate lecturer	4	5.97
Lecturer	30	44.78
Senior Lecturer	19	28.36
Associate professor	7	10.45
Professor	7	10.45

Finally, a list of constructs of the production function used in this study are present in the Table 7.12.

Table 7.12: Constructs of the research production function

Model construct		Expected sign	Sources
Dependent variable	Number of peer and non-peer reviewed articles, book reviews, book chapters, or other creative works in the past 02 years	n.a.	Beerkens (2013); Weber (2011); Mamiseishvili and Rosser (2010)
	Age	-ve	(Lissoni, 2011)
Independent variables	Gender	+ ve	Padilla-Gonzalez et al. (2011); (Lissoni, 2011)
	Ethnicity	+ve	Weber (2011)
	Rank		Bently (2011)
	Qualification	+ve	Bently (2011)
	Average teaching load in the last two years	-ve	Jung (2012); Iqbal and Mahmood (2011)
	Research grant	+ve	Abbott and Doucouliagos (2004); Lee and Bozeman (2005)
	Extramural Research collaboration	+ve	Abramo et al. (2008); Lee and Bozeman (2005)
	Weekly use of Internet for academic work (hours)	+ve	Our's hypothesis

7.2. Simulation equation model

In the given context, this study employed a simultaneous equation model to provide an unbiased estimate as recommended by econometricians (Cameron & Trivedi, 2005; Greene, 2012). In this study, the simultaneous equation model consisted of three functions- research production, Internet use, and research collaboration. Each function was linked to theory and evidence from past research which was discussed in the

following sections. Based on past studies, evidence and the theory of education production function, the research production is specified as follows:

Equation (7)

$$y_i = \alpha_0 A_i + \alpha_1 G_i + \alpha_2 I_i + \alpha_3 T_i + \alpha_4 Q_i + \alpha_5 C_i + \varepsilon_1$$

Equation (7) described as a research production function, where the right-hand side variable y_i is individual research output measured by the number of publications. The right-hand side variables of Equation (1) were A_i = age of academic, G_i = research grants, I_i = average weekly Internet use by an academic, T_i = teaching loads of an academic, Q_i = academic qualification of an academic, C_i = participation in collaborative research work, and ε_1 was the error term. The research output of an academic is specified as

Equation (8)

$$I_i = \beta_0 A_i + \beta_1 y_i + \beta_2 W_i + \beta_3 Q_i + \varepsilon_2$$

Equation (8) described the determinants of the use of the Internet by academics. In Equation (8), I incorporated two variables that differ from the variables in Equation (1). These two variables were W_i = dummy variable for gender of an academic (0 = male; 1 = female), and ε_2 which is the error term for Equation (8). The theoretical choice to underpin the model depends upon the context of Internet use. For example, at the household level, the Internet was deemed consumption goods, and at the institutional level, the Internet was deemed investment goods. At the individual level, the International Telecommunication Union (ITU) report 2011 asserted that education, income, gender, age, and location played an important role in increasing use of the Internet at the individual level. Seyal, Rahman, and Rahim (2002) found that perceived usefulness and perceived easiness were two determinants of the use of the Internet by academics in Brunei Darussalam. In this study, in the institutional setting, academics' accessed to the Internet was free of cost. This perspective made the uses of the Internet independent of the cost of Internet and location of use(s). In the given context, this study selected academic qualification, gender, age, and perceived benefit as potential drivers for the use of the Internet. As the perceived benefits of the Internet use were unobservable, research output (or publications) was applied as a proxy variable to measure academics' benefits from the use of the Internet.

Equation (9)

$$C_i = \gamma_0 y_i + \gamma_1 R_i + \gamma_2 N_i + \varepsilon_3$$

Equation (9) described the determinants of collaborative research work in this study. Here the determinants were R_i = rank or position of an academic, N_i = native language status of an academic, and ε_3 = error term.

The contribution of research collaboration to research production was well-established in the literature, (for example, Abramo, D'Angelo & Di Costa, 2008; Bently, 2011; Lee & Bozeman, 2005; Lissoni et al. 2011). In spite of differential methodological approaches, previous studies considered the positive influence of international or extramural research collaboration on research output. Based on prior evidence, I developed a research collaboration model.

Collaboration or connectivity was a form of social capital (Keeley, 2007). In the area of research, any collaboration between a group of researchers constitutes research collaboration, which was a form of social capital. The Internet facilitates communication with colleagues' worldwide (Organ & McGurk, 1996). Collaboration in research allowed more than one person to work together on a research project and thereby contributed successfully to research output. Nonetheless, there were five categories of research collaboration concentrated along a trajectory of increasing faculty risk and decreasing stability. Interaction was costly, and increasing time was needed for research output (Rambur, 2009). The five categories were: (i) parallel facility sharing; (ii) data sharing; (iii) bridging peers; (iv) diverse scientific language and cultures; (v) collaboration with human subjects.¹⁰ Each category had a different interface for delivery. The greater the dimension the more the interaction cost was. Therefore, research collaboration varied dramatically in terms of the dimensions of interaction that needed a negotiation and accommodation.

Hence, an investment in capital presupposed an expectation about return. As a return of investment, an academic desired success in his/her academic career. Therefore, collaboration in research was a matter of individual choice. It was influenced by unobserved factors. These factors were (i) level of funding; (ii) the desire of researchers to increase their scientific popularity; (iii) demand for the rationalisation of scientific work force (iv) requirements for more complex instrumentation; (v) specialisation in science; (vi) the need to work in close proximity with others in order to benefit from their skills and tacit knowledge (Katz & Martin, 1997). Therefore, research collaboration was not an exogenous factor to individuals' research activity over their working life. Further, an individual's preference for collaboration might have been influenced by the success or failure of successful research output. It was unlikely all collaboration leads to a successful research output. Failure in successful research publication might negatively influence the likelihood of participation in future research collaboration. The theoretical discussions about the status of an academic in research collaboration affected research output although the direction of effect could only be determined empirically. The potential reverse effect of research collaboration on research output would cause a simultaneity bias to the effect of research collaboration if it was treated as exogenous in the (research) production function. The probability of participation was a latent variable (statistics). The

¹⁰ For a detailed discussion, please see Rambur (2009), pp. 85-95.

measure of the variable was completed, based on self-reported data rather than any observed data. In social science research, self-reported data also suffer from measurement error as for example in self-reported health data (Bound, 1991). Because of the measurement errors, collaborative research would be regarded as an endogenous variable in single-equation modelling (Greene, 2000). It was necessary to allow for correction between research collaboration and research output equations in order to obtain unbiased estimates of the coefficients of interest. Therefore testing of interdependency between the two equations was crucial in this study. One equation was concerned with the determinants of research output, and the other one was concerned with the probability of participation in collaborative research.

Thus, equations (7)-(9) constituted a simultaneous equation system. In this system of equations $y_i, I_i,$ and C_i were endogenous variables. Consequently, a test of exogeneity hypothesis was required to understand the endogeneity hypothesis of the two variables: Internet use (I_i) and research collaboration (C_i). In Equation (7), (8) and (9), α_0 to $\alpha_5,$ β_0 to β_3 and γ_0 to γ_3 were coefficients to be estimated where the coefficient of α_2 was required. The variable coefficients explained intermediate or proximate cause of the Internet (I) on research output (y). The reduced form of the coefficients provided us equilibrium impact.

In order to impose the normality condition of the dataset this study took the natural log of the selected dataset of the variables where there was a substantial skewed distribution. However, in order to avoid a drop of any observation with zero such as research output, zero was transformed to one before taking the natural logarithm and taking the natural log of one afterward as suggested by Wooldrige (2000) for a log-linear model. Thus, the system of simultaneous equations was consisted of log-linear equations as follows:

Equation
(10)

$$\ln(y)_i = \alpha_0 A_i + \alpha_1 \ln(G)_i + \alpha_2 \ln(I)_i + \alpha_3 \ln(T)_i + \alpha_4 Q_i + \alpha_5 C_i + \varepsilon_1$$

$$\ln(I)_i = \beta_0 A_i + \beta_1 \ln(y)_i + \beta_2 W_i + \beta_3 Q_i + \varepsilon_2$$

$$C_i = \gamma_0 \ln(y)_i + \gamma_1 R_i + \gamma_2 N_i + \varepsilon_3$$

In order to estimate Equation (10) two types of estimators were considered in such a situation: two-stage estimator (2SLS) and three-stage estimator (3SLS) (Belsley, 1988; Wooldridge, 2002; Gujrati, 2003). The literature argued that the former was cheaper computationally and the latter was efficient asymptotically (Belsley, 1998). It was suggested that if 3SLS and 2SLS estimates were significantly different from each other, then one should consider 2SLS (Belsley, 1998, p.282). A similar suggestion was made

by others (Wooldridge 2002; Gujarati 2003), because the presence of simultaneity 2SLS would give consistent and efficient results if all equations were correctly specified. Under such a circumstance, the Hausman test was suggested to test the difference in coefficients between two estimators (Spencer & Berk, 1981).

7.2.1. Identification strategy

Two alternative specifications were available for a simultaneous equation model: reduced form and structural form. The former was comprised of M-reduced form equations and some assumptions about the distribution of the error terms in the reduced form equations. Furthermore, it did not serve the purpose of interpretation of the results. By contrast, the structural equation comprised M-equations and assumptions about the error terms in the equations. In contrast to the reduced form equation model, the structural-equation model provided economic reasoning to the estimates. The structural model was used in this study.

Two alternative approaches could be used to estimate a simultaneous equation model. In a simultaneous equation model, one can estimate the parameters of a single equation taking into account information provided by other equations in the system (Gujarati, 2003). This involves the estimation of one or more equations separately. On the other hand, system estimation involves the estimation of two equations jointly. This study used a system of estimation because of it had comparative advantage over a single equation estimation. The main advantage was that the system equation used more information that produced precise estimates of the parameter coefficients.

The definitions for all variables and the equation (either Equation 7 or Equation 8) in which they were included are presented in Table 7.13. Estimations as to whether the identification conditions for simultaneous equation were satisfied meant that a different set of independent variables was included in Equation (7) and Equation (8).

Table 7.13: Identifications of the simultaneous equations model

Endogenous variables	
Research output	Log of average research output
Collaborative research	Self-assessed participation in collaborative research. 1=Yes; 0 = No
Ln(Internet)	Log of weekly Internet use (hours)
<i>Common variables in Eq (7)- (9)</i>	
Age	Age (continuous variable)
Ln (<i>grant</i>)	Log of research grant (A\$)
Academic qualification	1=PhD degree holder; 0=Otherwise.
<i>Additional variable appeared in Eq (7)</i>	
Ln (Teaching)	Log of teachingload (per cent)
<i>Additional variable appeared in Eq (8)</i>	
Sex	Dummy. 1= Male; 0 = Female
<i>Additional variable appeared in Eq (9)</i>	
Rank	Dummy. 0= Associate lecturer; 1=lecturer; 2 = Sr. lecturer; 3=Associate professor; 4=Professor
Native language	Dummy; 1= English; 0=otherwise

7.2.2. Order and rank conditions

Identifying an equation in a system of equations was a crucial issue. If each equation in the system of equations was not satisfied, the estimated parameters in the simultaneous equations model were meaningless. In this regard, satisfaction of order conditions was necessary and the satisfaction of rank conditions was mandatory. If the rank condition was satisfied, the equation was identified (Baum, Schaffer, & Stillman, 2007; Wooldgridge, 2009).

Say, the number of endogenous variables in our systems of equations was G and the number of variables that were missing from the equation under consideration is M . The order condition stated that:

- (a) If $M < G - 1$ the equation was under identified;
- (b) If $M = G - 1$ the equation was exactly identified; and
- (c) If $M > G - 1$ the equation was over identified.

This meant that if these conditions did not hold, then the equation was not identified. If these conditions did hold then it was required to check rank conditions to be certain about the status of each equation in the system. I checked as to whether the order and rank conditions were satisfied for each equation mentioned in the system of Equations 10. Results are reported in table 7.41. Here three endogenous variables are available - $\ln(\text{researchoutput})$, $\ln(\text{Internet})$ and Collaboration , so $G = 3$ and $(G - 1) = 2$. In the first equation of research collaboration, the number of excluded variables is three so $M = 3$. So, the first equation is over identified because of $M > G - 1$. For the second equation, $M = 4$, so the second equation is over identified because of $M > G - 1$. For the third equation (collaboration equation), $M = 5$, so the third equation is over identified

because of $M > G - 1$. Now I need to proceed to check the rank conditions from the Table 7.41

Table 7.14: Rank condition test

Endogenous coefficient matrix							
	$\ln(\text{researchoutput})$	$\ln(\text{Internet})$	<i>Collaboraton</i>				
$\ln(\text{researchoutput})$	-1						
$\ln(\text{Internet})$	0.5	-1					
<i>Collaboraton</i>	0.5	0					
Exogenous coefficients matrix							
	Age	Ln (res. Output)	Ln (teaching)	Qualifications	Gender	Rank	Language
$\ln(\text{researchoutput})$	0.5	0.5	0.5	0.5	0	0	0
$\ln(\text{Internet})$	0.5	0	0	0.5	0.5	0	0
<i>Collaboraton</i>	0	0	0	0	0	0.5	0.5

I checked the rank condition using a *checkreg3* command in statistical data analysis software Stata version 13 (Baum, 2007). An image from the Stata output was produced in the following. The system of checking rank condition manually was as follows:

- (a) delete the row of the equation under examination
- (b) write out the remaining elements of each column for which there is a zero in the equation under examinations; and
- (c) next I consider the resulting array.
- (d) If there are $(G - 1) = 2$ rows and columns which are not all zeros, then the equation is identified.

My test results confirmed that all three equations in the Equation (10) were satisfied. Upon identification, I preceded further to estimate the parameter coefficients of the variables of interest.

Image1: An image from the Stat output command - *checkreg3*

```

Endogenous coefficients matrix
      lnresearchoutput      lnweekly      Collaq10_1
lnresearchoutput      -1
      lnweekly          .5      -1
      Collaq10_1        .5          0      -1

Exogenous coefficients matrix
      age lnresearch lnresearch lnresearch lnresearch lnresearch lnresearch lnresearch
lnresearchoutput      .5      .5      .5      .5      .5      .5      .5
      lnweekly          .5          0          0          0          0          0
      Collaq10_1        0          0          0          0          0          0          .5

Eq 1 is identified
Eq 2 is identified
Eq 3 is identified

System is identified

```

7.3. Estimation techniques

7.3.0. Testing of exclusion restriction

Before estimating a structural equation, it is necessary to determine whether the equations are identified. If the equation is not identified, then it is meaningless to estimate coefficients. In a system of two equations when both equations are linear, some identification strategy is required. In such a case, equation-specific variables are used to facilitate model identification (Wooldrige, 2002). For example, age and log of teaching load were two excluded instruments in endogenous collaborative research equations. This means that exclusion restrictions were imposed on the model. The argument for exclusion was that academics were appointed for three kinds of work: teaching, research, and public service. Therefore, the interrelationship between the three kinds of work was expected. While in the recruitment process academics' age was an indifferent factor, it had a bearing on any of the three kinds of work due to some unobservable factors. One such factor was health status. On the other hand, it was assumed that academics' teaching and their age were independent of their choice for collaboration in research. Since there was no theoretical and empirical evidence in support of this argument, evidence for exclusion restriction becomes mandatory. I had provided a statistical test as evidence for exclusion restriction.

Two general rules can be applied to check if model restriction is achieved; these are rank condition and ordered condition. The former is very difficult to apply and the latter is a necessary but not sufficient condition for identification. Literature said that exclusion restrictions were identifying restrictions that could also tested by an over-identification test (Wooldrige, 2002). "The frequently employed tests are over-identification tests" (Cai 2010, p. 83). I have deployed Hansen-Sargan's over-identification test statistics. This test was employed to assess the validity of instrumental variables, which was included in one equation, but not in another. I deployed this method to test the exclusion restriction in this study, where the "test statistic is distributed Chi-square with $(G*L - K)$ degrees of freedom¹¹" (Davidson & Mackinnon 1993 cited in Cai, 2010, p. 83). The procedure took proper account of linear constraints on the parameter vector imposed during estimation. The test (Table 7.15) results confirmed that exclusion restrictions were valid in our study. The test results were as follows.

Table 7.15: Exclusion restriction test

Number of equations	3
Total number of exogenous variables in system	9
Number of estimated coefficients	14
Hansen-Sargan's over identification statistics	$\chi^2_{(4)} = 2.48; \text{Prob} > \chi^2 = 0.65$

¹¹. Where G is the number of simultaneous equations; and K = total number of endogeneous and exogenous variables excluded in the equation checked for identification.

N.B. null hypothesis is exclusion restriction is valid.

One strong assumption of an education production function was that all right-hand side variables were exogenous and the left-hand variables were endogeneous. In this study I relaxed this strong assumption and assume that some of the right-hand side variables were endogenous. The study asserted that the use of the Internet by academics was endogenous because of the influences of unobserved and observed exogenous variables on other variables such as the motivation of the users, age, and education. Further research collaboration (right-hand side variable) was an endogenous variable because of its relation with individual research output (left-hand side variable), a phenomenon known as a simultaneity problem in econometrics. The presumption about the simultaneous relationship between research output and research collaboration was rooted in the observation that participation in collaborative research was a matter of personal choice for a researcher. Furthermore, those who had a high research credentials or who were senior academics were comparatively more successful in managing research collaboration compared with those who had low research credentials or who were junior academics.

7.3.1. Hausman-Wu test of exogeneity

I conducted a Hausman-Wu exogeneity hypothesis for two endogenous variables separately: the Internet use variable, and participation in collaborative research. Here the dependent variable (research output) was a continuous variable. The null hypothesis was: both Internet and participation in collaborative research are exogenous. The test results are presented in Table 7.16

Table 7.16: Endogeneity test results

Variables	Durbin (score)	Wu-Hausman
Internet	$\chi^2_{(1)} = 4.21; p = 0.04$	$F(1,63) = 4.22; p = 0.04$
Collaborative research	$\chi^2_{(1)} = 13.86; p = 0.00$	$F(1,63) = 16.44; p = 0.00$

The statistics are significant at a 5 per cent level implying that Internet use should be considered an endogenous variable in the research production function.

7.3.2. Breusch-Pagan (1979) test of independence

I estimated a correlation matrix of the residuals, to check whether there was any correlation between the residual of the two systems of Equations (7) - (9), Next, I carried out a Breusch-Pagan test of independence. Here the null hypothesis was Equations (7) - Equations (9) were dependent. The null hypothesis was that the correlation of the system of equations was zero. The null was rejected because of $\chi^2_{(3)} = 9.8$ and p-value = 0.02. The correlation matrix was provided below and the test statics are shown in Table 7.17:

Covariance matrix of error term:

$$\begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} \end{bmatrix} = \begin{bmatrix} 0.14 & -0.11 & -0.003 \\ -0.11 & 0.76 & 0.02 \\ -0.03 & 0.02 & 0.36 \end{bmatrix}$$

Table 7.17: Breusch-Pagan (1979) test of independence

	ε_1	(Equ 7)	ε_2	(Equ 8)	ε_3 (Equ 9)	Breusch-Pagan test
ε_1	(Equ 7)	1.00	-			$\chi^2_{(3)} = 9.8$
ε_2	(Equ 8)	-0.35	1.00			$p - value = 0.02$
ε_2	(Equ 9)	-0.05	0.15		1.00	

The test results did not reject the null hypothesis of dependency (the alternative hypothesis was independency). This implied that the error terms of two equations in the system of equation were correlated. Table 7.17 shows that the (X_{1i}) and (ε_{1i}) are negatively correlated, because the source of the bias is the simultaneous determination of Y_{1i} and X_{1i} , with the bias being referred to as simultaneity bias (or joint determination) in the literature (Wooldridge, 2009). Further, I tested the heteroskedasticity of the data used in this study, and found the presence of heteroskedasticity. The test results are shown in Table 7.18.

Table 7.18: Test of heteroskedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance; Variables: fitted values of $Ln(research)$

$$\chi^2_{(1)} = 2.15; \text{Prob} > \chi^2 = 0.00$$

I took a natural logarithm of the variables concerns to overcome the problem of heteroskedasticity in the dataset. This strategy was suggested in an econometrics text book (Wooldridge, 2009). After taking a natural logarithm of the variables – research grant, transformation of the continuous variable, I conducted an Anderson-Darling (1954) normality test (z-test). The null hypothesis of normality was not rejected at the 5 per cent level. The test results are reported in Table 7.19.

Table 7.19: Anderson-Darling (1954) test

OLS Non Normality Anderson-Darling Test

Ho: Normality - Ha: Non Normality

- Anderson-Darling Z Test = 1.0312 P > z(2.320) = 0.9898

7.3.2. Estimates for endogenous variables

As there was a simultaneous relationship between the dependent and explanatory variables, the ordinary least square (OLS) estimators were not only biased here, they also produces inconsistent results. Two types of estimators were considered in such a situation: two-stage estimator (2SLS) and three-stage estimator (3SLS) (Belsley 1988; Wooldgride, 2002; Gujrati 2003).

2SLS is a special type of instrumental variable (IV) estimator which involves two successive applications of the ordinary least square estimator. However, 2SLS can generate inefficient estimates of the coefficients because of the contemporaneous correlation between the disturbance terms of these equations. This is due to the fact that unobserved factors may influence the disturbance term of one equation may influence also affect the disturbance term of other equations. In such a situation, the 3SLS estimator can produce efficient estimates of the coefficients.

3SLS is a system estimator that uses an instrumental variable (IV) technique to obtain efficient estimates. It uses a generalised least square (GLS) to consider the correlation structure of the disturbance terms, and thereby uses more information than a single equation estimator does, therefore, 3SLS is considered more efficient than 2SLS.

The literature argued that the former one was cheaper computationally, and the latter one was efficient asymptotically (Belsley, 1988). Baltagi (2002) suggested that if 3SLS and 2SLS estimates were significantly different, then one should consider 2SLS (p.282). A similar suggestion was made by others (Wooldridge 2002, p. 222; Gujrati 2003, p.753), because in the presence of simultaneity 2SLS would give consistent and efficient results if all equations were correctly specified. Under such circumstances, the Hausman test (1978) was suggested to test the difference in coefficients between the two estimators (Spencer & Berk, 1981). If the null hypothesis of difference was not rejected (accepted) I preferred to use 3SLS as an alternative to 2SLS. Furthermore, if the equation Eq (1) and Eq (2) were over-identified it would be more efficient to estimate by 3SLS (Wooldridge 2002, p. 224). Stata statistical software[®] was used to estimate the simultaneous equation model.

Furthermore the presence of heteroskedasticity was a crucial issue that makes a conventional IV estimator inefficient and a generalised method of moments estimator was more efficient (Greene, 2002). The heteroskedasticity was checked to consider GMM as a potential estimator too.

The estimated coefficients derived under the 2SLS and 3SLS are presented in Table 7.20. The differences in coefficients between the two estimators are presented in Table 7.21, and the Hausman test results are presented in Table 7.22. Table 7.22 shows that the Chi-square statistics are $\chi^2_{(16)} = 5.52$. This result indicates that the t-statistics are below the critical value of 26.29 at the 5 per cent level of significance. So the null was not rejected and the 3SLS might be an appropriate estimator in this study.

Table 7.20: 2SLS and 3SLS estimates of the model

	2SLS	3SLS
<i>Ln</i> (research – output)	-0.002	-0.002
	(0.34)	(0.38)
<i>Ln</i> (<i>grant</i>)	0.042	0.040
	(3.85)**	(4.30)**
<i>Ln</i> (Internet)	0.182	0.172
	(2.19)*	(2.39)*
Rank	0.000	0.000
0=Asso. Lecturer		
1= Lecturer	0.452	0.229
	(0.80)	(0.47)
2= Sr. Lecturer	1.436	1.289
	(1.87)	(1.92)
3=Asso. Prof.	1.001	0.792
	(0.73)	(0.66)
4=Professor	2.376	2.074
Rank× <i>Ln</i> (Internet) (base)	(1.99)*	(1.99)*
Lecturer× <i>Ln</i> (Internet)	0.000	0.000
	-0.112	-0.110
Sr. lecturer × <i>Ln</i> (Internet)	(0.75)	(0.85)
	-0.371	-0.389
Associate Prof	(1.77)	(2.13)*
× <i>Ln</i> (Internet)		
	-0.272	-0.276
Professor × <i>Ln</i> (Internet)	(0.73)	(0.85)
	-0.630	-0.608
Rank× <i>Ln</i> (Internet) (base)	(2.00)*	(2.22)*
<i>Ln</i> (Teaching)	0.014	0.014
	(0.38)	(0.43)
Native language	0.000	0.000
0=Otherwise		
1= Native	-0.181	-0.224
	(1.28)	(1.82)
Qualification (0=Otherwise)	0.000	0.000
1= Doctorate	-0.141	-0.137
	(1.18)	(1.33)
Gender 0=Female	0.000	0.000
1=Male	0.314	0.305
	(2.17)*	(2.44)*
Collaboration (0= No)	0.000	0.000
1=Yes	0.105	0.413
	(0.39)	(1.80)

Collaboration	Ln (research output)	0.094 (0.83)	0.099 (0.96)
	Native language (0=Others)	0.000	0.000
	1=English	0.156 (2.64)**	0.157 (2.89)**
	Ln(Internet)	0.016 (0.46)	0.016 (0.47)
	Rank	0.000	0.000
	0=Asso. Lecturer		
	1= Lecturer	0.677 (2.99)**	0.673 (3.26)**
	2=Sr. Lecturer	0.337 (0.89)	0.331 (0.96)
	3=Asso. Prof.	0.583 (0.81)	0.575 (0.88)
	4=Professor	0.748 (1.27)	0.739 (1.37)
	Rank×Ln(Internet) (base)	0.000	0.000
	Lecturer×Ln(Internet)	0.005 (0.07)	0.005 (0.09)
	Sr. lecturer ×Ln(Internet)	0.092 (0.91)	0.093 (1.00)
	Associate Prof ×Ln(Internet)	0.038 (0.20)	0.039 (0.22)
	Professor ×Ln(Internet)	-0.010 (0.07)	-0.009 (0.06)
	<i>N</i>	67	67

N..B. *means $p < 0.05$; **means $p < 0.01$

Table 7.21: Differences between 2SLS and 3SLS estimates

--- Coefficients-----

	(b)	(B)	(b-B)	Sqrt (diag(V_b- V_B))
	2SLS	3SLS	Difference	Std.Err.
age	-.0018397	-.0017831	-.0000566	.0027535
Ln (<i>grant</i>)	.0415379	.0402605	.0012775	.0053429
Ln(Internet)	.1821235	.1717085	.0104149	.0415904
Rank				
1= Lecturer	.4520473	.2290118	.2230355	.2834383
2=Sr. Lecturer	1.436244 1	.289226	.1470179	.3796294
3=Asso. Prof.	1.000847	.7915505	.2092962	.6744847
4=Professor	2.376204	2.073743	.3024615	.5890726
Rank×Ln(Internet)				
Lecturer ×Ln(Internet)	-.1118877	-.1101108	-.0017769	.0738185
Sr. lecturer ×Ln(Internet)	-.371399	-.3887216	.0173225	.1028701
Associate Prof ×Ln(Internet)	-.2723346	-.2762076	.003873	.181616
Professor ×Ln(Internet)	-.6297412	-.6076745	-.0220667	.1546339
Ln (Teaching)	.0139533	.0135242	.0004291	.0188088
1= Native	-.1806591	-.2238381	.043179	.0703569
1=Male	-.1413866	-.1370383	-.0043483	.0609817
1= Doctorate	.3144733	.3048017	.0096716	.0734258
Collaboration	.1053943	.4126826	-.3072883	.1365482

b = consistent under Ho and Ha;

B = inconsistent under Ha, efficient under Ho.

Table 7.22: Hausman (1978) test results

b	= consistent under Ho and Ha; obtained from reg3
B	= inconsistent under Ha, efficient under Ho; obtained from reg3
Test:	Ho: difference in coefficients not systematic
	$x^2_{(16)} = (b-B)'[(V_b-V_B)^{-1}](b-B)$
	= 5.52
	Prob>chi2 = 0.9925

7.4. Results

I estimated five models with 3SLS estimators. The results are reported in Table 7.23. At the very beginning of the analysis, I looked at the results of Research Equation, Internet use Equation and Research Collaboration Equation simultaneously. I found that the estimated coefficient on log of Internet use in Research Equation (0.16) and the estimated coefficient on log of research output in the Internet use Equation (2.15) were joint statistically significant at 5 per cent level because of high z-values, which were 2.12 and 4.00 respectively. Moreover, the Research Collaboration Equation, the estimated coefficient of the log of research output, was 0.17 and it was statistically significant at 10 level. The above joint significances of the variables research output, Internet use, and research collaboration implies that these three variables are endogenous variables. These three variables influence each other in the systems of equations.

Since the small sample size used in this study was small, I simulated the model by applying bootstrapping for 200 times in order to test the hypothesis. The bootstrap is a modified type of Monte Carlo simulation and was also used by the researcher to test the hypothesis (Cameron & Trivedi, 2005). I selected 200 times as a standard rule of thumb, as proposed by Efron and Tibsharani (1993, p. 52). The estimated bootstrap standard error and the associated p-values are reported in Table 7.23. The advantage of the bootstrapping method was it checked the robustness of the estimated coefficients subject to the small sample size.

Table 7.23: 3SLS estimation of simultaneous models

		-Sensitivity analysis -			
		3SLS	Bootstrap	Without Age	Standard Coefficients
1st					
Equation	Ln(Internet)	0.164 (2.12)*	0.16 (2.26)*	0.149 (2.25)*	0.13
	age	-0.002 (0.38)	-0.001 (0.35)	- ()	0.00
	Ln (grant)	0.033 (3.39)**	0.033 (3.79)**	0.033 (3.44)**	0.40
	Ln (teaching)	0.003 (0.09)	0.003 (0.11)	0.001 (0.02)	0.05
	Qualification (0=Otherwise)				
	Doctorate	0.295 (2.27)*	0.30 (2.57)*	0.289 (2.27)*	0.29
	Collaboration (0= No)				
	Yes	0.096 (0.50)	0.096 (0.61)	0.082 (0.44)	0.10
	R-square	0.88	0.85	0.89	0.89
2nd					
Equation	Ln (res. output)	2.147 (4.00)**	2.15 (4.15)**	2.147 (4.00)**	0.55
	age	0.034 (3.60)**	0.034 (3.61)**	0.034 (3.60)**	0.84
	Male	0.008 (0.03)	0.008 (0.03)	0.008 (0.03)	0.09
	Qualification (0=Otherwise)				
	Doctorate	-0.341 (0.78)	-0.34 (1.00)	-0.341 (0.78)	0.25
	R-square	0.91	0.90	0.90	0.89
3rd					
Equation	Ln (res. output)	0.17 (1.59)***	0.17 (1.26)	0.166 (1.59)	0.56
	Rank				
	0=Asso. Lecturer				
	Lecturer	0.681 (5.95)**	0.68 (3.74)**	0.681 (5.95)**	1.88
	Sr. Lecturer	0.659 (5.01)**	0.66 (3.24)**	0.659 (5.01)**	1.89
	Asso. Prof.	0.699 (4.78)**	0.70 (3.82)**	0.699 (4.78)**	1.21
	Professor	0.680 (4.36)**	0.68 (3.36)**	0.680 (4.36)**	1.22
	Native language				
	0=Otherwise				
	Native language status	0.157 (2.93)**	0.15 (1.79)	0.157 (2.93)**	0.45
	R-square	0.96	0.96	0.95	0.92
	N	67	67	67	

N.B. * means $p < 0.05$; ** means $p < 0.01$; *** means $p < 0.10$; Values in the parenthesis show z-values.

7.4.0. The determinants of Internet use

Table 7.23, presents the determinants of the use of the Internet by academics. Age was a statistical predictor for Internet use. The positive sign of the coefficient on the age variable indicated that an increase in average age meant an increase of the Internet use for academic work. Furthermore, the coefficient on log of research output was 2.147, which was statistically significant at 5 per cent. The positive sign of the coefficient also meant that an increase in research output increased the use of the Internet among academics. Differences in gender and academic qualifications were found as statistically insignificant determinants because of low coefficients and z-value.

7.4.1. The determinants of research collaboration

The R-square value of the research collaboration equation in Table 7.23 was 0.96. It meant that the research collaboration model was a good-fit. In this model, the academic rank and native language status of the academics were two statistically significant predictors of participation in collaborative research. The coefficients on the rank dummy showed that coefficients on all ranks were between 0.66 and 0.70. The sign of the coefficients was positive. The results implied that participation among the academics holding the post of Academics was significantly higher compared to the academics holding the rank of Lecturer, Senior Lecturer, and Professor (here, the base was Associate Lecturer).

The estimated coefficient on the native language status of the academics was 0.15, statistically significant at the 5 per cent level. This result implied that compared with the foreign-born academics in this dataset who reportedly came from Asian countries, the probability of participation in collaborative research was significantly higher (because the outcome of research collaboration is a dichotomous variable). However statistically insignificant coefficients on research output implied that research output did not influence the probability of academics' participation in collaborative research. The model had two statistically significant variables – log of grants and academic qualification dummy (doctoral degree holder =1 or otherwise).

7.4.2. The determinants of research production

The research output equation in Table 7.23 presents the determinants of research output in a simultaneous equation system. In this case, the R-square value was 0.88. Out of the five explanatory variables I found three variables statistically significant at the 5 per cent level. These variables were the log of research grant (*Lngrant*), log of weekly Internet use (*LnInternet*), and academic qualification dummy (*Qualification*; 1 = *Phd*; 0 = *otherwise*). In the following sub-sections I presented the effects of the explanatory variables on research output.

7.4.2.0. The effect of Internet use on research production

Table 7.23 further indicates that the effect of the log of weekly use of the Internet on research output is positive. The size of the effect, which was an estimated elasticity, was 0.16. The variable was statistically significant at 1 per cent level. The finding implied that a one per cent increase in the use of Internet for academic work would

result in a 0.16 per cent increase in research publications. Alternatively, we could conclude that Internet was a significant input in the research production function. The effect came into existence through various channels, for example the increasing use of data on the Internet.

7.4.2.1. The effect of research grant on research production

The variable research grant was in natural logarithm form, so the coefficient of research grant measured elasticity of research grant too. The estimated coefficient on log of the research grant was 0.033 and it was statistically significant at the 5 per cent level. The variable had a positive sign. This implied that research grant was an important determinant that influenced research output positively. A one per cent increase in research grant would cause a 0.33 per cent increase in research publications. This study's finding was consistent with previous research findings by Abbott and Doucouliagos (2004) and Bently (2011). These studies found a positive effect of the log of research grant on research output too.

7.4.2.2. The effect of teaching load on research collaboration

The estimated coefficient on the log of teaching load was 0.003. The variable was statistically insignificant at the 5 per cent level. The positive measure indicated that the elasticity of the teaching load was insignificantly positive. The finding was in contrast to previous findings by Jung (2012) and Iqbal and Mahmood (2011), who found a negative influence of teaching load on research output in Hong Kong and Pakistan. My finding implied that the teaching load was an integrated part of overall academic responsibilities of an academic at USQ, however, it does not hamper research work. This finding was unexpected. My expectation was that the sign of the coefficient should be negative.

7.4.2.2. The effects of research collaboration on research production

The estimated effect of research collaboration measured by the coefficient on research collaboration (which was a dummy variable) was 0.10. The variable was statistically insignificant because of a low z-value which was 0.88. My study's finding was in contrast to previous findings by Abramo et al. (2008) and Bently (2011). Bently (2011) found that international research collaboration has a statistically significant effect on research output in Australian universities. The difference in findings might be owing to the differences in economic modelling of the research production function used in my study and in Bently's study – a standard linear regression model.

7.4.2.3. The effect of age and academic qualification on research production

The estimated coefficient on age of the academics was -0.002 and a z-value of 0.38. The value of the coefficient was very small and negative in my study. The sign of the coefficient implied that with the increase of the average age of academics, research publications would decrease. This finding was very consistent with previous findings by Lissoni et al. (2011) in an Italian context. But unlike Lissoni et al. (2011), I found an insignificant effect on research output.

The estimated coefficient on the academic dummy variable (1=doctorate degree) was 0.29. The coefficient was statistically significant at the 5 per cent level. The positive sign of the coefficient implied that compared to non-doctorate degree

holder academics, doctorate degree holder academics would have a higher impact on research output. This result was expected because doctoral level study included research training. Through this training, academics gained more experience in research compared with their peers who did not have doctoral training. This finding was consistent with Bently's (2011) study that found a positive influence of doctoral study on research output in Australia.

7.4.3. Sensitivity analysis of the model

I conducted sensitivity analysis of the estimates. This was an important part of applied research work. I analysed the sensitivity of the system of equations with respect to the exclusion of variables and variations in small sample size. I simulated the model by applying bootstrapping 200 times in order to test the hypothesis that the coefficients of the variables measured would change had the small size increase (i.e. from 67 to 200 approximately). The bootstrap was a slightly different type of Monte Carlo simulation and used by the researcher to test the hypothesis (Cameron & Trivedi, 2005). Two hundred times was selected as a standard rule of thumb proposed by Efron and Tibsharani (1993, p. 52). The estimated bootstrap standard error and the associated p-values are reported in Table 7.23 (middle columns).

The estimated bootstrapped coefficients showed that the coefficients of the variables would not change significantly, including the sign of the coefficients compared to previous studies. Therefore, I concluded that my estimated results were robust with respect to the small size.

Next, I dropped the age variable from the research production equation and re-estimated the model; the estimated results are reported in the second last column in Table 7.23. The estimated results did not change, compared to the first study results reported in column 1 in Table 7.23. Therefore, I concluded that my findings are robust to the variables selection.

7.4.4. The relative importance of explanatory variables

Measurement of standardised coefficients is a statistical tool to measure the relative importance of variables in a regression analysis. In order to measure the relative importance of variables in the system of simultaneous equations I presented the standardised coefficients of the full-model in the last column in Table 7.23 (last column). The results showed that in Research Output Equation, a research grant was the most important determinant because of a high standardised coefficient 0.40. In the Internet Use Equation, the average age of the academic was the most important determinant; and finally, in the Research Collaboration Equation, academic rank – lecturer rank of the academic - was the most important determinant. In the system of Research Output Equation, research grant was the most important determinant, followed by PhD degree of the academic, and the use of Internet for academic uses.

7.5. Summary of the Chapter

In the past, research studies contended that there was a positive correlation between research publications and other explanatory variables, including participation in research collaboration. Recently, a compelling argument in the literature was developed for the existence of a two ways relationship between research collaborations and research publications. Thus, the incidence of participation was

collaborative research results in increasing research publications, while the incidence of increasing publications results was increasing participation in research collaborations. The motivating fact was success in a research career that in turn results in increasing research collaborations. My study extended the argument with further evidence that in the age of digital technology, the use of the Internet had an influence on research output. The other way around research output had an influence on the use of the Internet. In a nutshell, there was an existence of a bi-directional relationship between the use of the Internet and research output.

Although I found a huge volume of literature on research productivity in universities, none of them examined the possibility of a joint determination empirically. This was the first research work that provided evidence in the context of an Australian university. In the simultaneous equation framework, my empirical study suggested that research collaborations and research publications were indeed jointly determined and both significantly and positively affect each other. Therefore, the previous single equation study would produce biased results. This meant that in the single-equation model, the effect of research collaboration on research publications might have been overestimated or underestimated.

8. CHAPTER EIGHT: ICT AND AGRICULTURAL OUTPUTS

8.1. The state of Australian agricultural outputs

Australia has six major states and two territories. New South Wales (NSW), Victoria (VIC), Queensland (QLD), South Australia (SA), Western Australia (WA), Tasmania, Australian Capital Territory, and Northern Territory. Amongst the states, Tasmania is the smallest state in Australia in terms of geographical area, and Western Australia is the largest. The unequal distribution of agricultural land and cultivated land generates interstate differences in agricultural production capability. For example, in the state of Victoria, the actual use of agricultural land was relatively very high (16.53 per cent) during 2011-12. I present an overview of available resources in the six Australian states and the Northern Territory Table 8.1. The resources included the total agricultural land, total cultivated land, and total agricultural business units.

Agriculture makes up a small but an important part of Australia's economy. Compared with the 1980s, in 2011-2012 the real value of agricultural production increased by 114 per cent i.e. nearly \$30 billion in 2011-12 from around \$14 billion at the start of the 1980s. The sector contributed to export revenue around five times of its share of gross domestic product in 2011-12 (GDP)(Gray & Sheng, 2014). Further, the sector was the largest employer in Australia compared with the manufacturing industries, whereby farm exports made up over 10 per cent of all goods and services traded in 2011-12 (Gray & Sheng, 2014).

The National Farmers' Federation (NFF) report stated that the gross value of Australian farm production in 2009-10 was \$48.7 billion. This sector employed 307,000 people, approximately 17.2 per cent of the total labour force in 2012 (National Farmers Federation, 2012). In the same year, the farm sector's contributions were more than 60 per cent of Australia's total exports earnings. The broadacre sector of Australian agriculture had five industries. The industries included wheat and other crops, mixed livestock-crops, sheep, beef, and the sheep-beef industry (Department of Agriculture, Fisheries and Forestry, 2012). The contribution of these industries was the largest one because it generated over 85 per cent of the country's gross agricultural output in 2012 (Khan & Salim, 2013). Wheat was the bumper crop in broadacre agriculture because of the market value of the total output, and the income from wheat exports account for a larger share of total exports (food items only) than any other broadacre crop in 2012 (Gray & Sheng, 2014). Other large exportable crop items included barley, sorghum, rice, cotton, canola, oats, lupins, and sugarcane. Table 8.1 presents an overview of the total agricultural land, total cultivated land and total agricultural business units in the six Australian states and the Northern Territories.

Table 8.1: Distribution of agricultural resources by Australian states, 2011-12

States	Total agricultural Land (million hect)	Total agricultural business units	Total cultivated agricultural land (million hect)	Actual use of agricultural land (in per cent)
New South Wales	60.6	44 000	4.20	6.93
Northern Territory	55.1	500	N.A.	N.A.
Queensland	137.0	28 200	1.80	1.31
South Australia	49.7	13 900	2.40	4.82
Victoria	12.7	32 500	2.10	16.53
Western Australia	88.4	12 500	5.20	5.88
Tasmania	1.7	4100	0.087	5.11

Note: N.A. = 'Not available'. Data are sourced from the website of the Australian Bureau of Statistics 2011-2012.

Hooper, Martin, Love, and Fisher (2002) suggested that farm size was an important contributing factor to inter-farm differences in agricultural income (total revenue minus total costs) in 2000-2001. They also suggested that large agricultural farms that were engaged in cropping were able to take advantage of the use of technologies. However, Sheng, Davidson and Fuglie (2014) noted that larger farms achieved higher productivity by not increasing their scale, but by changing production technology. Here the '*productivity*' was defined as rate of total output (or return) with respect to the use of a particular input with other things remaining the same in the Australian agriculture sector, including factors beyond the control of the farmers such as seasonal variation (Australian Government Productivity Commission, 2004). This kind of concept of productivity was known as '*partial productivity*' in economics.

Many factors influence productivity capacity of a firm or business. During the period 1974/75 – 2003/04 multifactor productivity (which is conceptually different from partial productivity) growth was 2.8 per cent which was stronger than other sectors of the economy. Labour productivity growth was 3.3 per cent and capital productivity growth was 2.7 per cent (Australian Government Productivity Commission, 2004). In recent decades, although growth in agricultural output has increased significantly without using increasing amounts of inputs, recently it was slowing down (Nossel & Goody, 2009). However, it remained “stronger relative to other sectors of the economy” (National Farmers' Federation, 2012, p. 15).

Many farm-specific characteristics affect productivity in agriculture. One of them was farmers' managerial abilities and new technologies usage (Nossal & Goody, 2009; National Farmers' Federation, 2012). Farmers could enhance farm management skills, particularly in terms of decisions regarding resource allocation, scale and scope of production, and production marketing, by taking advantage of new technologies or information (Nossal & Goody, 2009). New technologies and farm management enabled the Australian agriculture sector to remain ahead of international competitors

through efficiency gains (National Farmers' Federation, 2012). The precise nature of the mapping from ICTs to agricultural outputs was the subject matter of the next section.

The Australian agricultural sector comprises a range of industries with broadacre agriculture having a comparative advantage because of the abundance of land (Gray & Sheng, 2014). According to Gray and Sheng (2014) broadacre farms contributed 54 per cent of the gross value of agricultural production and made up around 53 per cent of agricultural businesses. Furthermore, high value horticultural industries contributed significantly to the gross value of agricultural production in 2011–12 (see Figure 8.1).

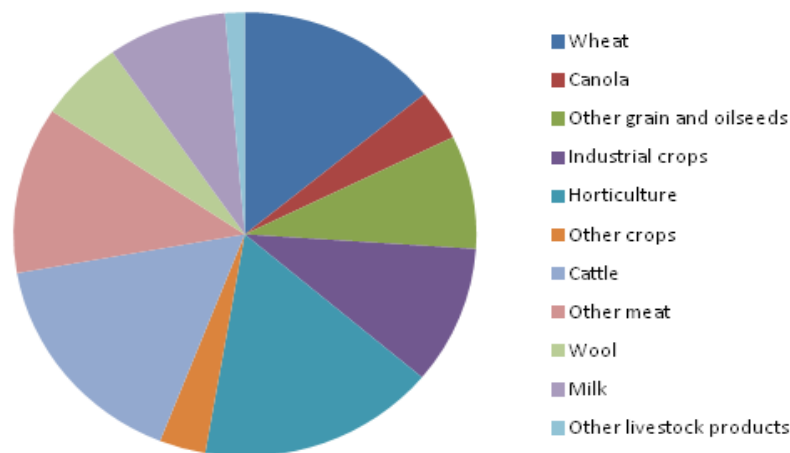


Figure 8.1: Share of gross value of Australia's agricultural production

Source: Gray, Oss-Emer and Sheng (2014, p. 6),

8.2. Methods of data analysis

In the past, researchers used parametric and non-parametric approaches to assess the effects of ICT on productivity in the manufacturing and service sectors: the growth accounting techniques; productivity estimation techniques and the Ganger causality test technique (Cardona, Kretschmer, & Strobel, 2013). In my study I used a parametric approach. I used the Cobb-Douglas aggregate production function that avoids imposing a theoretically based relationship between inputs and outputs. The estimated output elasticity with respect to input(s) are derived directly without assuming any behavioural conditions (profit maximisation/cost minimisation/output maximisation) for producers and factor markets (Cardona, Kretschmer, & Strobel, 2013). Previous studies used a similar approach. Examples include Röller and Waverman (2001), Ghosh and Prasad (2012), and Brynjolfsson and Hitt (2000). The main advantage of a parametric approach like production function was that I estimated the factor substitutability for the factors of production - physical capital versus ICT capital or other factor(s) of production.

8.2.0.CDPF Versus CDRF

Cobb Douglas Production Function (CDPF) and Cobb-Douglas Revenue Function (CDRF) are two forms of production function used in microeconomics and applied research. The main differences between these two forms of production functions lies

in the left-hand side variable of the production function. In CDPF the left-hand side variable is captured by physical quantity or volume of total output. In CDRF, the left-hand side variable is expressed in total revenue, which conceptually is equal to total quantity of output multiplied by the market price of each unit of output. In the latter case, the left-hand variable – total revenue is derived by multiplying total physical agricultural output by the market price of the agricultural product.

In my study I used a Cobb-Douglas revenue function or CDRF. The reasons for selecting CDRF instead CDPF were as follows. Agricultural outputs were not homogeneous products. This implied that barley, cotton, lupins, sugarcane, or wheat were not the same outputs. Therefore, to measure agricultural output doing a summation of total physical quantities of those outputs was problematic. An alternative solution to the problem was to convert the physical quantity of each agricultural output into market value of the output by multiplying the market price of the output by the total quantity of the output. Then, by doing a summation of market value of each output we derived a total agricultural revenue (or income). Furthermore, revenue function did not significantly affect the estimated elasticities of interest in the production function (Mairesse, 2005). The literature suggested that in absence of price information the revenues function was suitable for analysing productivity for firms that are engaged in the production of heterogeneous products (Kato, 2012). Following the previous study by Kato (2012) I used deflated agricultural revenue to measure agricultural output. The justification was that the use of a revenue-based measure of output would cause product heterogeneity was a minor issue which was not discernible in my study. Barkley and Barkley (2013) noted that “the majority agricultural products are homogeneous products across all producers” (p, 275). It is observable that in the crop industry irrespective of country, hundreds of crop producers produce a crop (say wheat) and sell crop to the sellers in a perfectly very competitive market. The characteristics of competitive market were as follows. The price of the crop is given in the market and a crop producer is unable to influence the price given in the market; the distribution of the crop producers are dispersed widely around the country; similarly, buyers are dispersed widely around the country. The most significant characteristic is that a crop (say wheat) is a homogeneous product. In other words, product differentiation is not possible. Thus, I assumed safely that by using the revenue function I would overcome the problem of heterogeneity if there was any.

8.2.1. Cobb-Douglas revenue function

In the Cobb-Douglas revenue function, the variable capital entered into the production function by two mechanisms - ICT-capital and physical capital. Here physical capital was non-ICT capital. It was noted that ICTs had two components – CTs and ITs. The CTs capital included expenditures for CTs. The non-ICTs capital included agricultural machinery, equipment, irrigation facilities in agriculture and energy. Similar approach was used by researchers in the past (e.g. Cardona et al. 2013). An aggregate production function was of the following form:

$$\text{Equation (11): } \quad [Y = AK_t^\alpha L_t^\beta T_t^{1-(\alpha+\beta)}]$$

Where:

$$\alpha + \beta + \{1 - (\alpha + \beta)\} = 1; \alpha, \beta < 1$$

where Y_t is per state agricultural revenue at year t ; K_t is non-ICT physical capital including irrigation facilities at year t ; L_t is labour expenditure at year t and T_t is here in fact CT that is non-physical capital expenditures at year t .

The relationships between the CT expenditure and agricultural revenue followed a mechanism. Farmers' expenditures on CTs such as land phones, mobile telephones and the Internet determined the intensity of the use of communication technologies and digital connectivity in relation to the local and global knowledge hub. Because of the connectivity farmers were capable of handling the use of existing knowledge and improved technology (World Bank, 2011). The improved application of agricultural knowledges and technologies increased agricultural output. The increased agricultural output helped to generate increased revenue in the product market provided that other determinants remain the same.

I used log-log form of revenue function, because of natural logarithm transformations of the data, the outliers in the data were linearised and estimation of elasticity was convenient. This was a very common strategy used in empirical research as suggested by Wooldridge (2002) too. As I used mobile and land-fixed telephone expenditure by the agricultural firms as a proxy for variable CT, I rewrote Equation (11) in the following way:

$$\text{Equation (12):} \quad \log Y_t = \theta + \theta_1 \log K_t + \theta_2 \log L_t + \theta_3 \log CT_t + \mu_t$$

where θ_1 , θ_2 and θ_3 measure elasticities of capital, labour and CT expenditure. In agriculture weather condition was an important determinant in Australia. Past research showed that weather conditions significantly affected Australian agriculture, particularly the broadacre agriculture (Salim & Islam, 2010). In order to capture the influence of seasonal weather conditions on Australia's agricultural productivity I augmented Equation (12) by adding a rainfall (RF) variable. Further, I added land rental (Lr) expenditure as an additional control variable in Equation (13) to capture the use of agricultural land in the production process. The justification of including land in agricultural production was obvious.

$$\text{Equation (13):} \quad \log y_t = \theta + \theta_1 \log K_t + \theta_2 \log L_t + \theta_3 \log CT_t + \theta_4 \log RF_t + \theta_5 \log Lr_t + \theta_6 \log F_t + u_t$$

As cross-section dimensions of the dataset had 5 states, the appropriate expression of Equation (14) was:

$$\text{Equation (14):} \quad \log y_{it} = \theta + \theta_1 \log K_{it} + \theta_2 \log L_{it} + \theta_3 \log CT_{it} + \theta_4 \log RF_{it} + \theta_5 \log Lr_{it} + \theta_6 \log F_t + u_t$$

Here the number of groups $i = 5$ states and $t = 1 \dots 23$ years.

8.2.2. Parametric approach

In my study, it was already mentioned that there were five states. Each state was different from other in Australia. Since Australia is a continent where the states are very diversified in terms of distribution of land, weather conditions and people. Because of this panel heterogeneity was an important assumption here. Such heterogeneity arises particularly in cross-country analysis (Pesaran Shin & Smith, 1999). This study presumed that a region-specific or time-specific effect was in existence in such a situation. If region-specific heterogeneity was not captured by the explanatory variables in the model, it might lead to parameter heterogeneity in the specified model. In such cases, Pesaran, Shin, and Smith (1999) suggested two different estimators in order to resolve the bias due to heterogeneous slope in dynamic panels. These were Pooled Mean Group (PMG) and Mean Group (MG) estimators.

One advantage of using the PMG was that the application of PMG allowed for the short-term effect of inputs, but constrains the long-term effect to be equal. I addressed the problem of non-stationarity too because in absence of non-stationary data the regression would generate spuriously significant estimates in the absence of an actual relationship between the dependent and independent variables (Kangasniemi, Mas, & Robinson, 2012). Several studies used the techniques in various settings. For example, Kangasniemi, Mas, and Robinson (2012) used PMG to estimate the parameter coefficients in their studies where they investigated IT expenditure and firm-level productivity issue, and migration and national level productivity issue respectively. The advantage of the PMG technique was that it would estimate model coefficients efficiently even in the presence of endogeneity (Kangasniemi, Mas, & Robinson, 2012). The PMG approach was modelled as an autoregressive distributed lag (ARDL) model. The ARDL (p, q_1, q_2, \dots, q_k) dynamic panel model was specified as follows:

$$\text{Equation (15)} \quad y_{it} = \sum_1^p \lambda_{ij} y_{i,t-j} + \sum_{j=0}^q \delta_{ij} \mathbf{X}'_{i,t-j} + \mu_i + \varepsilon_{it}$$

where the number of cross-section units $i = 1, 2, \dots, N$; the number of period $t = 1, 2, \dots, T$. \mathbf{X}_{it} is a $k \times 1$ vector of explanatory variables; δ_{ij} is the $k \times 1$ coefficient vector; λ_{ij} are scalars and μ_i is the cross-section specific effect. For convenience, Equation (15) was parameterized as follows:

$$\text{Equation (16)} \quad \Delta y_{it} = \phi_i (y_{i,t-1} - \theta_i' \mathbf{X}_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}^* \Delta \mathbf{X}_{i,t-j} + \mu_i + \varepsilon_{it}$$

where, $\phi_i = -(1 - \sum_{j=1}^p \lambda_{ij})$, $\theta_i = \left(\frac{\sum_{j=0}^q \delta_{ij}}{1 - \sum_{k=1}^p \lambda_{ik}} \right)$; $\lambda_{ij}^* = -\sum_{m=j+1}^p \lambda_{i,m}$, $j = 1, 2, \dots, p-1$, and

$$\delta_{ij}^* = -\sum_{m=j+1}^q \delta_{i,m}, \quad j = 1, 2, \dots, q-1.$$

The parameter ϕ_i is the error-correction speed of adjustment term. Rejection of the null of $\phi = 0$ is the evidence of long-run equilibrium relationship, that is, the variables are co-integrated. In this case, the parameter value is expected to be significantly negative. The vector θ contains the long-run relationship among the variables. Equation (6) can be expressed in terms of our model in Equation (4) as follows:

Equation (17)
$$\Delta \ln y_{it} = \phi_i (\ln y_{i,t-1} - \theta_i' \mathbf{X}_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta \ln y_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}^{*/} \Delta \mathbf{X}_{i,t-j} + \mu_i + \varepsilon_{it}$$

where \mathbf{X} is the vector of $\log K$, $\log L$, $\log CT$, $\log F$, $\log Lr$, and $\log RF$.

One potential problem with the PMG estimator was that it had inability to deal with cross-sectional dependence. As five states of Australia were the cross-section units in this study, it was very likely that cross-sectional dependence would be an issue in the estimation process.

8.2.2.0. Testing for structural break and cross-sectional dependency

I started my analysis with a test for a structural break in the dataset by Chow test, which was written by Shehata (2012) for statistical data analysis software Stata (Shehata, 2012).¹² Next, I proceeded to test for cross-sectional dependence in my model. These tests are Persan's (2004) test, Friedman's test (1937) and Fees' test (1995) (Pesaran, Shin, & Smith, 1999). For a dynamic panel model Persan's test is valid under the fixed effects and the random effects model (De Hoyos & Sarafidis, 2006). I used Stata to carry out the test. This test was based on the following statistics

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N \widehat{\rho}_{ij} \right), \text{ where } \widehat{\rho}_{ij} \text{ was the sample estimate of the pairwise}$$

correlation of the residuals:
$$\widehat{\rho}_{ij} = \widehat{\rho}_{ji} = \frac{\sum_{t=1}^T \hat{u}_{it} \hat{u}_{jt}}{\left(\sum_{t=1}^T \hat{u}_{it}^2 \right)^{1/2} \left(\sum_{t=1}^T \hat{u}_{jt}^2 \right)^{1/2}}$$

8.2.2.1. Panel unit root test

To examine whether all variables were integrated with the same order, a number of panel data unit root tests was available. The most widely available tests were Levin and Lin's, Fisher's, Im-Pesaran-Shin's (here after called IPS), and Maddala and Wu's test. Maddala and Wu's test statistic was the first generation tests and ignored cross-sectional dependency. It "arises from unobserved common factors, externalities, regional and macroeconomic linkage, and unaccounted residual interdependence" (Bangake & Eggoh, 2012, p. 10).

The second generation test by Pesaran (2007) represented a Cross-sectional Augmented IPS (CIPS) tests. This test allowed for cross-sectional dependence attributed to unobserved common factors allowed for heterogeneity in the autoregressive coefficient of the Dickey-Fuller regression in the data. The new Correlated Augmented Dickey-Fuller (CADF) model was

Equation (18)
$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \gamma_i t + \sum_{j=1}^p d_{it} \Delta y_{i,t-j} + \delta_i \bar{y}_t + e_{it}$$

¹²-*chowreg*- command in Stata 13 version is available to carry out Chow Test.

where, \bar{Y}_t denotes vectors of cross-sectional average of dependent variable. To test the null hypothesis against the alternative hypotheses Pesaran (2007) proposed the cross-sectional dependence IPS (CIPS) statistics as the simple average of the t-statistics from the ordinary least square (OLS) estimates of

$$CIPS = \frac{1}{N} \sum_{i=1}^n \tilde{t}_i;$$

where \tilde{t}_i is an ordinary least square (OLS)-based *t*-statistic of β_i . In my study, I used Maddala and Wu's (1999) tests and Pesaran's (2007) panel unit root test. The most recent study by Mohammadi and Parvaresh (2014) used panel unit root tests to conduct a similar study too.

8.2.2.2. Cointegration test

Since my dataset had a time and panel dimensions, the use of panel co-integration techniques to test for the presence of long-run relationships among the integrated variables was much needed. By accounting for both a time and cross-sectional dimensions, test power could be increased (Westerlund, 2007). The earlier residual based co-integrated test as suggested by Engle and Granger (1987), had a shortcoming of a common factor restriction that caused a significant loss of power for residual-based co-integration tests (Persyn & Westerlund, 2008). Instead of residual dynamics, Westerlund (2007) developed four new panel co-integration tests that did not impose any common factor restriction. Furthermore, it was a more general test of panel co-integration than Perdroni's (1999) co-integration test, because Westlund allowed for the possibility of a multiple structural break. Since in my dataset there could be a multiple structural breaks in the dependent and the explanatory variables, I tested the influence of telephone expenditures on agricultural revenues at the macro level. The postulated relationship between the dependent variable and telephone consumption expenditure allowed for a linear trend based on the following model:

Equation (19):

$$[\ln(Y) = \eta_0 + \eta_1 t + \eta_3 \ln(tele)_{it} + e_{it}]$$

I employed an additional cointegration test introduced by Westerlund (2007) which was robust when there was cross-sectional dependence. The cointegrated test was required to examine any long-run relationship in the series of the data. In this cointegration test, four test statistics were proposed. Two tests were designed to test the alternative hypothesis that the panel was cointegrated as a whole. While the other two were designed to test the alternative hypothesis that variables in at least one cross-section unit were cointegrated. The former two statistics were referred to as *group statistics*, while the latter two were referred to as *panel statistics*. The data generating process in this test was assumed to be as follows:

Equation (20): $y_{it} = \phi_1 + \phi_2 t + z_{it}$

Equation (21): $x_{it} = x_{it-1} + v_{it}$

where t and i represent time and space dimensions of data, respectively. In this formulation, the vector x_{it} is modelled as a pure random walk and y_{it} is modelled as the sum of the deterministic term $\phi_{1i} + \phi_{2i}t$ and a stochastic term z_{it} . This term is modelled as follows:

$$\text{Equation (22) :} \quad \alpha_i(L)\Delta z_{it} = \alpha_i(z_{it-1} - \beta_i'x_{it-1}) + \gamma_i(L)'v_{it} + e_{it}$$

$$\text{where, } \alpha_i(L) = 1 - \sum_{j=1}^{P_i} \alpha_{ij}L^j \text{ and } \gamma_i(L)' = \sum_{j=0}^{P_i} \gamma_{ij}L^j$$

Now substituting Equation (20) into Equation (22) gives the following error correction model for y_{it} :

$$\text{Equation (23):} \quad \alpha_i(L)\Delta y_{it} = \delta_{1i} + \delta_{2i}t + \alpha_i(y_{it-1} - \beta_i'x_{it-1}) + \gamma_i(L)'v_{it} + e_{it}$$

$$\text{where, } \delta_{1i} = \alpha_i(1)\phi_{2i} - \alpha_i\phi_{1i} + \alpha_i\phi_{2i} \text{ and } \delta_{2i} = -\alpha_i\phi_{2i}$$

In Equation (23) above, the vector β_i defined a long run equilibrium or cointegrating relationship between the variables x and y . However, in the short run there might be disequilibrium, which was corrected by a proportion $-2 < \alpha_i \leq 0$ each period. Here, α_i was called an error correction parameter. If $\alpha_i < 0$, then there was error correction and the variables were co-integrated and if $\alpha_i = 0$, then there was no error correction and the variables were not co-integrated. The test statistics were given by the following¹³

Group test statistics

$$G_\tau = \frac{1}{N} \sum_{i=1}^N \frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)}$$

$$G_\alpha = \frac{1}{N} \sum_{i=1}^N \frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)}$$

Panel statistics:

$$P_\tau = \frac{\hat{\alpha}}{SE(\hat{\alpha})}$$

$$P_\alpha = T\hat{\alpha}$$

8.3. Descriptions of variables for the agricultural revenue function

¹³ For derivation of these statistics, please see Westerlund (2007).

8.3.0. Dependent variable

In my study total cash receipts was a dependent variable. The variable was denoted by Y . The unit of measurement is the Australian dollar. The measurement of aggregate revenue included cash receipts by farmers from their sales of products. These products included crops, livestock, and livestock product. Further included were royalties, rebates, refunds, plant hire, contracts, share farming, insurance claims and compensation, and government assistance payments. The variable was deflated by the price in the survey year 2012. This variable was readily available from the source. Figure 8.2 presents inter-state differences in per farm total cash receipts from broadacre agriculture (here after called agricultural revenue) for the years 2000-2012.

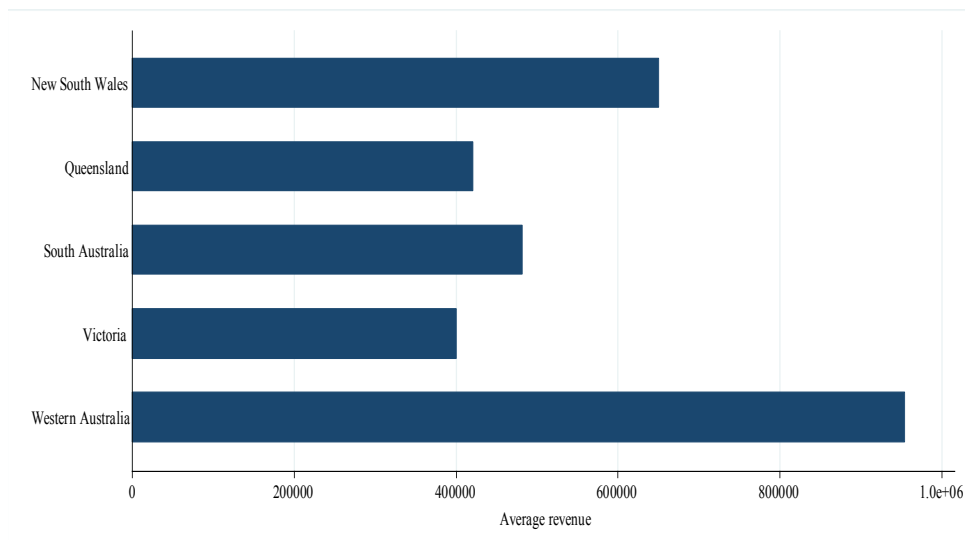


Figure 8.2: Average agricultural revenue in Australia, 1990-2012

Source: Ministry of Agriculture. Available at <http://apps.daff.gov.au/AGSURF/>

The Figure 8.2 shows that Western Australian agricultural farms were receiving more revenue compared with their counterpart agricultural farms in the other states. This indicated that the distributions of revenue within agriculture were far from uniform. Physical and economic characteristics which were presented in Table 8.1 along with climate, soil type, water drainage patterns, and access to services and facilities contributed collectively to the variation in agricultural output and thereafter, agricultural revenue within and among the states if other things remain same in a given state.

8.3.1. Explanatory variables

8.3.1.0. CT expenditures

The main explanatory variable of interest in this study was CT usage. The variable CT measured expenditure for farmers' use of telecommunication including, telephone and internet. The International Telecommunication Union (ITU) recommended three indicators to measure the index of ICT in a country (International Telecommunication Union, 2011). These indicators were subscriptions for mobile phone, fixed-telephone, and Internet per 1000 inhabitants. These indicators measured 'the access to ICT' in a country. In this thesis, I was concerned with the use of ICT rather than the concept of

‘the access to ICT’. Therefore, I preferred to use expenditure data on telephones, including mobile phones. The measure was a proxy variable for the main variable CT. I was unable to include expenditures for Internet services directly here due to non-availability of data. However, the variable expenditure for telephone was a good proxy for the use of Internet because of high correlation between the two types of communication services – the use of telephone and the use of internet. I clarified the matter in Figure 8.3. Figure 8.3 presents subscribers for telephone and broadband Internet per 1000 inhabitants during the years 2000-2012. The Figure showed that since 2000 mobile and broadband (fixed) Internet subscribers were increasing. The estimated correlation coefficient between mobile phone and fixed (wired) broadband Internet was 0.95. The degree of correlation coefficient shows mobile phone subscriptions were a good proxy for Internet subscriptions. Furthermore, the given relationship showed the dependency on mobile devices for Internet services.

The variable expenditure for telephone represented an aggregate measure of the adoption or use of CTs. The reasons for selecting the variable were as follows. There were two perspectives with regard to using CTs devices and services. One was an institutional perspective and the other one was a household perspective. From an institutional perspective, the expenditure on CTs was an investment goods. On the other hand, in the household perspective, the expenditure for CTs was a consumption goods because CT devices and services such as telephone, internet were sold in the marketplace and income was an important determinant of ICT adoption (Billon, Marco, & Lera-Lopez, 2009). From this perspective, telephone and Internet consumption also reflected the behavior of ICT adoption (Zhang, 2013). In welfare economics expenditure patterns also served as an estimate of real functioning (McGregor & Borooah, 1992). Therefore, CT expenditure patterns also served as an estimate of real functioning (McGregor & Borooah, 1992). I selected total expenditure for telephony (in Australian dollars) denoted by *tele*.

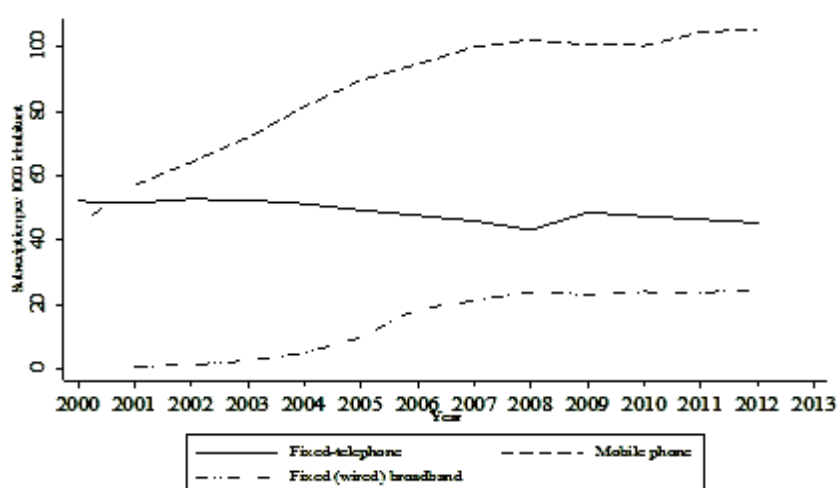


Figure 8.3 Fixed, mobile telephone and fixed-broadband subscription in Australia

Source of data:

International Telecommunication Union (ITU) *Time Series by Country*, available at <http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>. World Bank: World Development Indicators <http://data.worldbank.org/data-catalog/world-development-indicators>

8.3.1.1. Other variables

The Food and Agricultural Organisation (FAO) identified agricultural land, labour and machinery as key inputs in any agricultural production system (Food and Agriculture Organization, 2013). Following FAO's suggestion, the study selected total expenditures for agricultural labour, agricultural land, fertilizer and irrigation facilities as explanatory variables. The unit of measurement for all variables was the Australian dollar. These data were deflated by the survey year price level already (which was 2012). These variables were readily available in the dataset.

I measured the variable 'non-ICT' capital by farmers' expenditures for physical capitals (K), including agricultural machinery, equipment, energy and irrigation facilities. It was mentioned before that I included rainfall (RF) in the production function. The remaining unobserved variables were subsumed in the error term e_{it} in the production function.

Table 8.2 presents descriptive statistics of the dependent and independent variables used in the study. The table showed that the actual use of inputs differ substantially among the states over the years.

Table 8.2: Descriptive statistics of the agricultural revenue function

<i>Variable</i>	<i>Descriptions</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
<i>New South Wales (NSW)</i>					
<i>logY</i>	Log of cash receipt	5.801319	0.1001782	5.557905	6.0000
<i>logL</i>	Log of wages paid for labour	4.281244	0.1729887	3.916507	4.643275
<i>logF</i>	Log of expenditure for fertiliser	4.707243	0.1979886	4.150664	5.015737
<i>logLr</i>	Log of rental for land	3.591061	0.3121491	2.933993	4.183384
<i>logK</i>	Log of payment for capital	4.053803	0.1727587	3.693639	4.329459
<i>logCT</i>	Log of CT expenditure	3.537241	0.0837634	3.358506	3.676968
<i>logRF</i>	Log of rainfall	6.259914	0.2248682	5.74342	6.703311
<i>Victoria (VIC)</i>					
<i>logY</i>	Log of cash receipts	5.582023	0.1467801	5.159681	5.783906
<i>logL</i>	Log of wages paid for labour	3.747203	0.2269411	3.186391	4.089764
<i>logF</i>	Log of expenditure for fertiliser	4.540071	0.2122594	3.922725	4.833962
<i>logLr</i>	Log of rental for land	3.756998	0.2360898	3.292034	4.188056
<i>logK</i>	Log of payment for capital	3.549046	0.2374538	3.037426	3.994229
<i>logCT</i>	Log of CT expenditure	3.332385	0.143505	3.003461	3.537567
<i>logRF</i>	Log of rainfall	6.180541	0.2100015	5.678054	6.528031
<i>Queensland (QLD)</i>					
<i>logY</i>	Log of cash receipts	5.601046	0.1390799	5.390721	5.886043
<i>logL</i>	Log of wages paid for labour	4.052674	0.2307113	3.59384	4.511349

$logF$	Log of expenditure for fertiliser	4.511349	0.1703692	4.118562	4.713087
$logLr$	Log of rental for land	3.372212	0.3656596	2.49693	3.999783
$logK$	Log of payment for capital	2.58422	0.5457705	1.724276	3.801129
$logCT$	Log of CT expenditure	3.415377	0.1085776	3.21906	3.581722
$logRF$	Log of rainfall	6.441659	0.251216	5.951111	7.036236
<i>South Australia (SA)</i>					
$logY$	Log of cash receipts	5.669169	0.1119478	5.394758	5.900694
$logL$	Log of wages paid for labour	3.843503	0.2380351	3.228657	4.208334
$logF$	Log of expenditure for fertiliser	4.674449	0.1618723	4.357725	4.947042
$logLr$	Log of rental for land	4.947042	0.520899	2.012837	4.425192
$logK$	Log of payment for capital	3.135285	0.204999	2.620136	3.410102
$logCT$	Log of CT expenditure	3.395455	0.0809251	3.195623	3.525304
$logRF$	Log of rainfall	5.032306	0.3500868	4.295924	5.63529
<i>Western Australia (WA)</i>					
$logY$	Log of cash receipts	5.961265	0.127284	5.731713	6.20412
$logL$	Log of wages paid for labour	4.358448	0.1619438	4.003848	4.694166
$logF$	Log of expenditure for fertiliser	5.119009	0.1888813	4.737678	5.455761
$logLr$	Log of rental for land	3.937058	0.3894449	3.263873	4.670228
$logK$	Log of payment for capital	2.854626	0.4148652	1.857332	3.332438
$logCT$	Log of CT expenditure	3.656619	0.1138707	3.391817	3.850891
$logRF$	Log of rainfall	5.29788	0.3293319	4.487962	5.768946

8.4. The Econometric estimation technique

8.4.0. Preliminary data analysis

Figure 8.4 presented a two way relationship between the growth of agricultural revenue and telephone usage for the years 2000-2012. It was observable that both series follow each other closely, except two breaks in the years 1996, 2003, and 2008. Growth in telephone expenditure exceeded the growth in agricultural revenue at different points in different years, for instance 1994-1995, 1997-1999, and 2003. In the remaining years, growth in agricultural revenue outpaced growth in telephony expenditure. There were droughts in Australian agriculture during periods 1982-83, 1994-95, and 2002-2003 (ABS, 2005..)

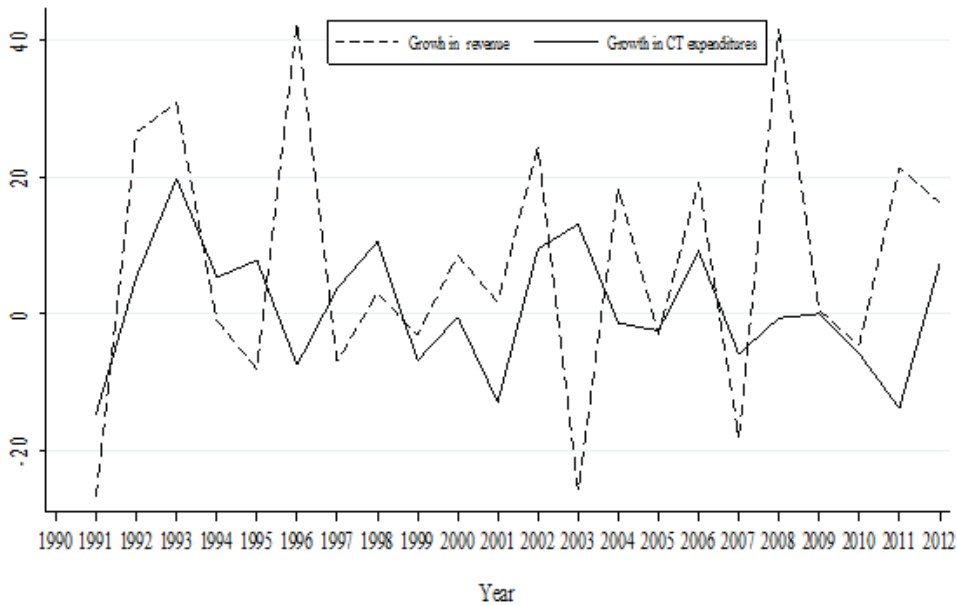


Figure 8.4: Plot of growth of agricultural revenue and CT expenditures

Source: Department of Agriculture, Fisheries and Forestry (DAFF) of the Government of Australia: <http://apps.daff.gov.au/AGSURF/>.

I further used a Locally Weighted Scatter Plot Smoothing (LOWESS) curve. LOWESS is a non-parametric regression (local mean smoothing), and was used to discover the actual functional relationship between the dependent variable and explanatory variable (CT expenditure). The advantage of using LOWESS curve was that we did not impose any functional relationship. The LOWESS curve was presented in Figure 8.5. The LOWESS curve showed a linear increasing relationship between the two categories of variables. In the remaining parts of this thesis, the degree of their relationships would be explored controlling other explanatory variables.

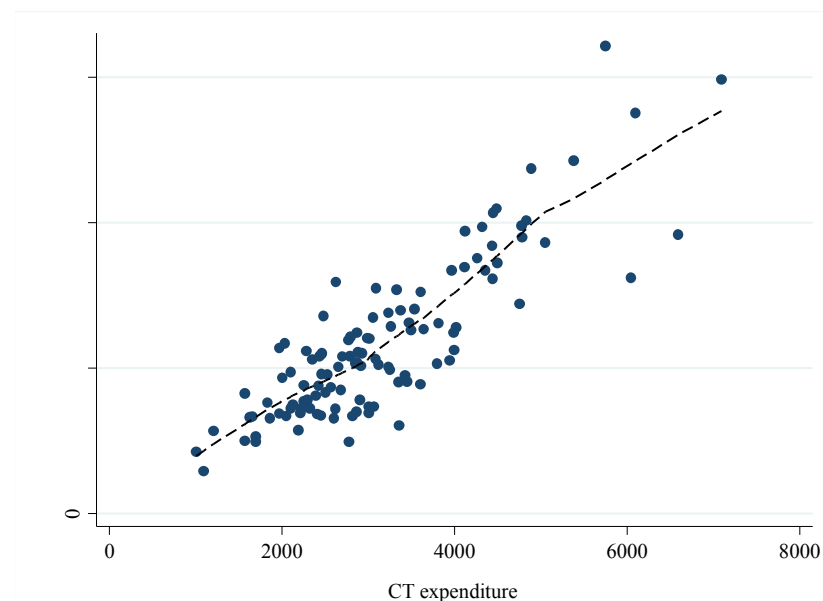


Figure 8.5: Scatter plots of agricultural revenue and CT expenditure

Next I conducted a simple correlation analysis. Table 8.3 presented the results of correlation analysis. The correlation between the CT expenditures and agricultural revenue are confirmed by the results of the Table 8.3 in five Australian states. The correlation coefficients are statistically significant at 5 per cent level.

Table 8.3: Correlation between CT expenditure and agricultural revenue

NSW	VIC	QLD	SA	WA
0.61	0.48	0.65	0.54	0.78
(0.00)	(0.02)	(0.00)	(0.00)	(0.00)

Note: Figures in the parentheses are p values

The table shows that the actual use of inputs differed substantially among the states over the years.

8.4.1. Endogeneity test of CT variables

Endogeneity is a crucial issue in the empirical research literature. In a production function study, the issue arises due to simultaneity between the right-hand and left-hand side variables. Such association might arise due to persistent productivity shocks and inputs may be dependent on past shocks (Kangasniemi, Mas, & Robinson, 2012). Generally, endogeneity problems are resolved through the use of instrumental variables, which is related to the variable of interest but unrelated to the productivity shocks. In the presence of such endogeneity in the production function, ARDL model can produce consistent estimates as long as lag order is appropriate (Pesaran, Shin, & Smith, 1999). Thus, the endogeneity problem is resolved in my study.

8.4.2. Estimation strategy

Panel heterogeneity was an assumption in my study. Such panels arose particularly in cross-country analysis (Pesaran, Shine, & Smith, 1999). I presumed that a regional-specific or time-specific effect was in existence in Australia due to heterogeneity among the states. If it was not captured by the explanatory variables in the model, it would lead to parameter heterogeneity in the model specified. Under the given conditions, I assumed panel heterogeneity in our study. In such cases, Pesaran, Shin and Smith (1999) suggested two different estimators in order to resolve the bias due to heterogeneous slope in dynamic panels. They were Pooled Mean Group (PMG) and Mean Group (MG) estimators.

8.5. Results

8.5.0. Diagnostic tests

I started by presenting a Chow test regression result where the null hypothesis was no structural changes. The estimated result was 7.4936 ($p - value = 0.00$). Therefore, the null hypothesis was rejected at a 5 per cent level of significance. The test result supported that a structural break was present in my dataset.

The most commonly estimated models for panel data was Fixed- and Random-effect model. Applying these models without controlling for diagnostic tests such as

cross-sectional dependence, heteroskedasticity, and serial correlation would cause biased estimates. The Pesaran's CD test was used to check for cross-sectional dependence, where the null hypothesis was cross-sectional independency. The table in Appendix Table A2 presented the estimated test results. For a fixed-effects model, the test results did reject the null hypothesis of cross-sectional independence; no homoscedasticity; and no first order auto correlation (otherwise known as serial correlation) in the error terms at 5 per cent level of significance. These results strongly indicated the presence of common factors affecting cross-sectional units. The results of the diagnostic tests were useful to select an appropriate econometric estimation technique for estimating the short-run and long-run relationships between the dependent and independent variables.

8.5.1. Error correlation models (ECMs)

8.5.1.0. Unit root and cointegration tests

Before applying a unit root test I examined if there was any cross-sectional dependence by using Pesaran's (2004) CSD test. The results (Table A1 in Appendix) indicated that the null hypothesis of cross-sectional independence was rejected at 1 per cent significance level for all variables except the non-ICT capital variable, for which the null was rejected at 10 per cent level. I, therefore, needed to take corrective measures to account for cross-sectional dependence in applying the PMG estimator.

I used the first generation Maddala and Wu's (1999) tests and the second generation Pesaran's (2007) test to examine the time series properties of the dependent and explanatory variables. The null hypothesis was $I(1)$. Table 8.4 reports unit roots tests results. The choice of lag lengths was based on the Akaike Information Criteria (AIC). The test results showed that Pesaran's test rejected the null of unit root for three variables ($\log Y$, $\log Lr$ and $\log CT$) at level, whereas Maddala and Wu's test rejected the null of unit root for five variables ($\log Y$, $\log L$, $\log F$, $\log Lr$, and $\log CT$). Maddala and Wu's (1999) test procedure was not robust enough to detect unit roots when common factors influenced the underlying process of the test (Mohammadi & Parvaresh, 2014). Overall finding of unit root test results indicated that most of the variables are $I(1)$ when cross-sectional dependence was taken into account.

Table 8.4: Panel unit root tests

Variables	Test statistic at level		Test statistic at first difference	
	Pesaran test	Maddala & Wu test	Pesaran test	Maddala & Wu test
$\log Y$	-2.992 (0.05)**	26.447 (0.00)*	-3.804 (0.00)*	64.701 (0.00)*
$\log CT$	-3.557 (0.00)*	23.049 (0.01)*	-3.776 (0.00)*	77.836 (0.00)*
$\log L$	-2.070 (0.72)	21.940 (0.015)**	-4.634 (0.00)*	67.165 (0.00)*

$\log F$	-2.681 (0.19)	26.848 (0.00)*	-3.695 (0.00)*	61.531 (0.00)*
$\log Lr$	-3.989 (0.00)*	22.346 (0.01)**	-4.569 (0.00)*	94.264 (0.00)*
$\log K$	0.708 (0.76) ¹⁴	13.321 (0.206)	-3.658 (0.00)*	53.204 (0.00)*
$\log RF$	-1.565 (0.96)	4.503 (0.92)	-4.065 (0.00)*	116.850 (0.00)*

Note: *t*-statistics is with time trend. * And ** indicate 1 per cent and 5 per cent level of significance respectively.

Next, I examined the possibility of Westerlund's co-integration test between the CT expenditure and agricultural revenue. The null hypothesis was no cointegration. For each series, I selected an optimal lag and lead lengths, while the Barlett kernel window was set to 3 according to the formula of $4(T/100)^{2/9}$. The results are presented in table 8.5.

Table 8.5: ECM-based panel co-integration test

Statistic	Value	Z-value	<i>p</i> -value	Bootstrap <i>p</i> -value
G_t	-2.504	-3.284	0.001	0.010
G_α	-10.200	-3.146	0.001	0.010
P_t	-5.772	-3.967	0.000	0.000
P_α	-10.157	-7.052	0.000	0.000

Note: Dependent variable = Y ; Null hypothesis of the test: No cointegration

Table 8.5 presented that the test statistics of G_t and G_α . The test statistics rejected the null hypothesis at 5 per cent level. This gave an evidence of co-integration of at least one of the cross-sectional units. The test statistics of P_t and P_α rejected the the null hypothesis at 5 per cent too. This gave an evidence of co-integration of the panel as a whole. The co-integration test statistics provided the evidence of a long-run equilibrium relationship between the dependent and independent variable. Had no error correction hypothesis rejecte rejected, it would be practically importance to see the speed of adjustment in the short run. This could be done by calculating the value of α_i - the error correction parameter. The estimated value of this error correction parameter was found from Equation (13). The estimated value of P_α was -10.157 and the time period T was 23, therefore, the value of α was $\hat{\alpha} = \frac{P_\alpha}{T} = \frac{-10.157}{23} = -0.442$, that is, the speed of adjustment of short-term departure towards the long run equilibrium was 0.442 per year. This meant that 44.2 per cent of the deviation from the long-run relation between CT expenditure and agricultural revenue was adjusted

¹⁴ This series is unbalanced; therefore instead of *t*-statistic standardised *z* statistic is reported.

each year, that is, it takes slightly more than 2 (two) years to restore the equilibrium relation.

Next, I estimated the model specified in Equation (14) using PMG proposed by Pesaran (1999). To account for cross-section dependence, variables were transformed by time, demeaning the data, in which case a panel model took the following form:

Equation (24):

$$(y_{it} - \bar{y}_t) = (\alpha_i - \bar{\alpha}) + \beta'(\mathbf{x}_{it} - \bar{\mathbf{x}}_t) + (\mu_{it} - \bar{\mu}_t)$$

Equation (25):

$$(\mu_{it} - \bar{\mu}_t) = (\phi_i - \bar{\phi})f_t + (\varepsilon_{it} - \bar{\varepsilon}_t)$$

$$\text{where, } \bar{y}_t = \frac{1}{N} \sum_i^N y_{it} \text{ and so on.}$$

The error structure was given by $\mu_{it} = \phi_i f_t + \varepsilon_{it}$; where f_t represented the unobserved factor that generated cross-sectional dependence, and ϕ_i is factor loading. In this transformation, disturbances were expressed in terms of deviations from time-specific averages and therefore essentially removed the mean impact of f_t . In addition to PMG, I also estimated the model using the Augmented Mean Group (AMG) technique. The AMG technique was proposed by Bond and Eberhardt (2009) and Eberhardt and Teal (2010). Both AMG and Common Correlated Estimator (CCE) of Pesaran (2006) account for cross-section dependence; however, unlike CCE, AMG provided an estimate of common dynamic process that gave rise to cross-sectional dependence. The empirical model considered in AMG is as follows:

Equation (26):

$$y_{it} = \beta_i' x_{it} + u_{it}$$

where x_{it} was a vector of observable independent variables, which was modelled as linear functions of unobserved common factors (f_t) and state-specific factor loadings (g_t) as follows:

Equation (27):

$$x_{mit} = \pi_{mi} + \delta_{mt}' \mathbf{g}_{mt} + \rho_{1mi} f_{1mt} + \dots + \rho_{nmi} f_{nmt} + u_{mit}$$

where $m = 1, \dots, k$; $\mathbf{f}_{.mt} \subset \mathbf{f}_t$; $\mathbf{f}_t = \varphi' \mathbf{f}_{t-1} + \epsilon_t$ and $\mathbf{g}_t = \kappa' \mathbf{g}_{t-1} + \epsilon_t$

The error term u_{it} in Equation (15a) was composed of group-specific fixed effects (α_i) and a set of common factors (f_t) with country specific factor loadings (λ_i) as follows:

Equation (28):

$$u_{it} = \alpha_i + \lambda_i' \mathbf{f}_t + \varepsilon_{it}$$

To obtain the AMG estimator, estimation was done in two stages. In the first stage the model (15a) was estimated by OLS in first difference with T–1 year dummies as follows:

Equation (29):

$$\Delta y_{it} = b' \Delta x_{it} + \sum_{t=2}^T c_t \Delta D_t + e_{it}$$

In the second stage the estimated coefficient of year dummy (\hat{c}_t) was included in each of the N state regressions. These individual state regressions may include linear time trend to "capture omitted idiosyncratic processes which evolve in a linear fashion over time" (Eberhardt & Bond, 2009, p.3) as follows:

Equation (30):

$$y_{it} = a_i + \mathbf{b}_i' \mathbf{x}_{it} + \eta_i t + d_i \hat{c}_t + e_{it}$$

Following Pesaran and Smith's (1995) Mean Group (MG) approach, the AMG estimates were derived as averages of the individual state estimates as follows:

$$\hat{\mathbf{b}}_{AMG} = N^{-1} \sum_{i=1}^N \hat{\mathbf{b}}_i$$

8.5.1.1. Long-run effects of CT on agricultural revenue

Table 8.6 presented PMG (with time de-meaned variables) and AMG estimation results. The results revealed that standard errors of AMG (both with and without trend) estimators are smaller than that of the PMG estimator. I also examined residuals from the estimators. I examined whether there is an autocorrelation and the residuals are normality distributed. I applied Wooldridge (2002) test for first order autocorrelation in panel data. The test statistics are presented in Table A2 in Appendix A. The statistics indicated that the null hypothesis of 'no first-order autocorrelation' was not rejected at 5 per cent level. This indicated that the residuals were free from autocorrelation. However, residuals from the PMG estimation failed to pass the normality assumption. In Figure A1 in Appendix A, a normal distribution was superimposed on the kernel density of the residuals. Kernel density graphs of the residuals from AMG (with and without trend) almost coincide with the normal distribution, which indicated that residual normality could not be rejected; however, the kernel density graph of the PMG residuals was quite different from the normal distribution graph. This indicated that PMG residuals are not normally distributed. From the viewpoint of estimates precision and residual normality, one, therefore, should rely on AMG estimators. Another advantage of the AMG estimator was that it provided the numerical value of common dynamic process, which was, in the present case, around 0.90 and highly significant.

Table 8.6: PMG and AMG estimation results

	PMG	AMG (with trend)	AMG (without trend)
$\log CT$	0.24* (0.12)	0.21*** (0.07)	0.20** (0.08)
$\log L$	-0.03 (0.06)	0.04 (0.06)	0.02 (0.07)
$\log F$	0.64*** (0.08)	0.57*** (0.05)	0.54*** (0.06)
$\log Lr$	0.04 (0.04)	0.07*** (0.02)	0.07*** (0.02)
$\log K$	-0.03 (0.02)	0.01 (0.02)	0.01 (0.03)
$\log RF$	0.18* (0.11)	0.07** (0.04)	0.07* (0.04)
<i>Error correction term</i>	-0.76*** (0.11)	—	—
<i>Trend</i>	—	-0.00 (0.00)	—
<i>Constant</i>	—	1.83*** (0.22)	2.09*** (0.33)
<i>Common dynamic process</i>	—	0.89*** (0.23)	0.90*** (0.23)

Note: Figures in parentheses are standard errors. ***, ** and * indicate 1 per cent, 5 per cent and 10 per cent level of significance

Further, Table 8.6 demonstrated evidence that all three coefficients on CT expenditure were significant at 5 per cent level. These values were 0.24, 0.21, and 0.20. These values were very close to each other. The PMG coefficient was slightly higher than the AMG coefficients; however, AMG coefficients were more precise than that of the PMG for the reason mentioned above. This meant that a 10 per cent increase in CT expenditure in the long-run would cause agricultural revenue to increase by around 2 per cent.

The rainfall variable was found to have a significant impact on revenue in the long run. This implies that a 10 per cent increase in rainfall would increase agricultural revenue by more than 0.70 per cent (AMG) and 1.78 per cent (PMG) in the long run. In all three estimations, fertiliser had the largest impact on revenue in the long run. Among other variables, the land rental coefficient in AMG estimation was found to have a significant impact on revenue in the long run. The error correction term in the PMG estimation was highly significant and had a negative sign as expected, which further confirmed Westerlund (2007) results above, namely that the variables were cointegrated in the long run.

8.5.1.2. Short-run effects of CT on agricultural revenue

One limitation of the AMG estimator was that it provided only long-run coefficients; however, I could get an idea of short-run impacts of the variables on revenue from the PMG estimation results. PMG also gave state-wise values of short-run coefficients. Table 8.7 reported these short-run coefficients.

Table 8.7: Pooled Mean Group estimation

Regressors	Avg. coeff.	NSW	VIC	QLD	SA	WA
(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta \log CT$	-0.04 (0.06)	0.07 (0.15)	-0.15 (0.27)	0.11 (0.17)	-0.20 (0.14)	-0.03 (0.19)
$\Delta \log L$	0.09*** (0.02)	0.04 (0.07)	0.05 (0.07)	0.13* (0.08)	0.15*** (0.04)	0.06 (0.13)
$\Delta \log F$	0.06 (0.08)	0.16 (0.11)	-0.06 (0.22)	0.04 (0.15)	0.33*** (0.10)	-0.15 (0.18)
$\Delta \log Lr$	0.02 (0.02)	-0.01 (0.04)	0.08 (0.05)	0.04 (0.03)	-0.02 (0.02)	-0.00 (0.06)
$\Delta \log K$	0.04*** (0.01)	0.06 (0.05)	0.05 (0.06)	0.03 (0.02)	0.08** (0.03)	0.00 (0.03)
$\Delta \log RF$	-0.04 (0.07)	-0.23* (0.13)	0.00 (0.19)	0.13 (0.12)	0.05 (0.07)	-0.17 (0.12)
<i>constant</i>	-0.00 (0.02)	0.03 (0.02)	-0.04 (0.03)	0.02 (0.02)	0.01 (0.02)	-0.04 (0.04)

Note: Figures in parentheses are standard errors. ***, ** and * indicate 1 per cent, 5 per cent and 10 per cent level of significance

Short-run coefficients from PMG estimation reported in Table 8.7 (column 1) made it clear that CT had no significant impact in the short-run. Among other variables only payment to labour, non-ICT capital had significant (at 1 per cent level) positive impact on revenue. State-specific short-run results (column 2 through 7) provided more or less similar results. In none of the cases CT was found to had significant influence in the short run. These findings were not unexpected, because CT caused changes in the structure of an economy and its benefit was realised in the long run. New technology was not adopted immediately and it took time for the agent to adopt it (Christiansen, 2008). It difused slowly throughout the economy (David, 1990; Hall, 2004)

8.5.1.2. Comparison of other studies

Now I presented the effects of the use of, and the access to, ICTs on agricultural and non-agricultural sectors in the USA, the European Union, and Australia in Table 8.8. The table showed that the effects of the investment in ICT in different sectors of the economy varied across the studies. Overall, the effect of ICTs was positive in both non-agriculture and agriculture sectors. Furthermore, compared with the effects in the non-agriculture sector, the effects in the agriculture sector was substantial. Such differential findings was due to the differential econometric model and estimation techniques used in the previous studies. However, the comparative studies provided us with a general understanding about the prevailing potentiality of ICTs in agriculture.

Table 8.8: Comparative analysis of the elasticity of ICTs

Study area/ sector of study	Study regions	Data year	Authors/Studies	Elasticity	Year of publications
Manufacturing industry	World Wide	1973- 2004	Achary and Basu (2010)	0.031	2010*

Service sector firms	European Union	2000-2008	Mahr and Krestschmer (2010)	0.13	2010*
Service sector firms	European Union	1995-2003	Bloom et al. (2010)	0.015	2010*
Service sector firms	USA	1987-2006	Tamber and Hitt (2011)	0.04	2011*
Agriculture	World Wide	1995-2000	Lio and Liu (2006)	0.21	2006
Agriculture	Australian states	1990-2013	Our study	0.25	N/A

*Note: Compiled from Cardona, Krestschmer, & Strobe. 2013 et al. (2013, p. 118)

8.6. Summary of the Chapter

This chapter examined the relationship between CT (communication technology), particularly telephone use, and farmers' agricultural revenue earning in Australia. Using a parametric approach, this chapter found a statistically significant positive relationship between the use of telephones and agricultural revenue earning in the long-run among Australian farmers; but the relationship was positive and statistically insignificant in the short-run. Following comparative studies, this chapter concluded that the agricultural sector could reap benefit from the use of information and communication technology. However, like the manufacturing and service sectors, the benefit of the use of ICT in agriculture would be spontaneous. This was exactly the phenomenon of input and output in agricultural production. A further finding was that communication technology was a capital input in the agricultural production function in Australia.

9. CHAPTER NINE: CONCLUSIONS AND FURTHER RESEARCH

9.1. A summary of key findings

This thesis was an outcome of a Collaborative Research Network (CRN) Project of the Australian Government and was supported by the Australian Digital Futures Institute at USQ. In close alignment with the CRN project, this doctoral research project has examined the effects of digital technologies on two sectors of the Australian economy: – universities and agriculture. As the definition of ICT is very broad, this thesis has defined ICT in three realms, subject to the research need, evidence from previous literature, and the availability of data. The definition of ICTs encompasses eLearning environments, the Internet, and telecommunication facilities.

According to my observation, the most widely used software in Australian universities for teaching and learning is Moodle, including differently named variations of Study Desk. Apart from Moodle, limited free social software is used, which can be found free on the web. The most widely used social software includes Facebook, Twitter, Skype, and You Tube. These types of software are not permitted officially in many institutions. Despite that restriction, the wide use of social software platforms indicates their popularity. The application of an eLearning environment encompasses both official and non-official teaching and learning management software. These components are generic and are available in all types of education institutions engaged in distance education.

Secondly, with regard to the effects of ICTs on academics' research and teaching, this study has defined ICTs in terms of the use of the Internet for teaching and research. The use of internet-based correspondence is embedded in the LMS. For instance, when a student posts a query on the Study Desk, it is immediately sent to a course lecturer or a tutor by email. On the other hand, the main application of the Internet for academic research is found in the use of online resources.

Thirdly, with regard to the effects of ICTs on farmers, this study has defined ICTs in terms of telecommunication facilities available to farmers in the farming context throughout Australia. As telecommunication requires an infrastructure, based on the previous literature review, the availability of infrastructure facilities is measured by the access to the telephone (both mobile and land lines).

My literature review has found that the attitudes of teaching academics to eLearning environments were labelled as (over)work load in the literature already. However, the discussion has been limited to a theoretical exposition only. In the given context of changing organisational models and the increasing use of ICTs (or the affordances of ICTs) within universities, the academics' attitudes towards working conditions were not explored in depth in Australia. I have addressed this issue in this study, based on an in-depth field survey about university academics' or (teaching) staff members' perceptions about the (over-)workload issue. From this survey, I developed a theory and compared that with previous studies. The theory will be used to design a quantitative study in the future.

Further, the study has extended the theoretical knowledge by exploring the contribution of the factors attributed to academics' attitudes to the (over-) work load issue. I claim that this study is the first ever empirical study that investigates academics' attitudes towards (over-)work load within the context of eLearning environments in Australia from the perspective of academics'. A salient feature of this research is that I have used current primary data and an inferential quantitative research method to provide evidence about the differences in attitudes towards (over-)work load amongst academics.

With regard to the research production function, my literature review has identified the determinants of academics' research performances. These determinants include academic staff members' personal socio-demographic characteristics, research grants, research collaboration status, teaching load status, academic rank, research experience, membership of professional organisations, academic qualifications, and research management. In the past, the model of the research production function did not consider the Internet as a factor of production.

In terms of research methodology, firstly a quantitative research methodology was used in all cases measuring research output by one common measure – publication in peer-reviewed journals, and research books. Secondly, cross-sectional data at the individual level were used. Thirdly, a single equation model was used in all cases. Fourthly, the direction of the relationship was inconclusive. From a methodological point of view, the research gaps that emerged were as follows. First, research collaboration is recognised as an important determinant, which has been considered as exogenous in the past studies. The exogeneity hypothesis has been nullified in this thesis because of the assertion that research collaboration is a choice variable. If a researcher does not believe in collaborative research, he/she may decide not to join any collaborative work. In addition to that, individual success in research might generate scope for research collaboration. This implies that research collaboration is supposed to be endogenous.

With regard to the agricultural production function, previous studies have examined the relationship between access to (ICTs) and gains in productivity in manufacturing and service sector firms. As a result, many empirical research studies have pointed to the important role of ICTs in productivity gains. However, the agricultural sector has remained out side of purview of these studies, which might be due to the assumption that there is no gain from ICTs as it is considered for agriculture - a primary sector of the economy. Futher research gaps that emerged were related to methodologies used in past studies. In the given context of conceptual and methodological gaps, this thesis has examined the causal relationship between farmers' access to telecommunication and their gains in agricultural revenue earning. In the agricultural study, I overcame the gap in the literature by examining an agricultural production function of the Cobb-Douglas type and by deploying dynamic panel data modelling to explore the causality between ICTs and agricultural productivity. In addition, I tested the endogeneity nature of the main variable of interest – ICTs capital stock. Thus, this study fills a knowledge gap and thereby extends the existing body of studies. In order to fulfil my research objectives, I have

corrected the methodological issues and investigated the influences of telephony expenditure on farmers' revenue from agricultural activities.

In the context of the above concepts and knowledge gaps, this thesis has used both primary and secondary data. The research approaches encompass both mixed methods and quantitative studies. For data analysis, this thesis has used thematic analysis, factor analysis and regression analysis. Thematic analysis was used for the qualitative research, and factor analysis and regression analysis have been used for the quantitative research.

9.1.1.RQ1: What were academics' attitudes, based on their reported experiences?

Based on the findings of the focus group discussions, I developed a theoretical framework about the interactions between academics and online students; more specifically, this framework relied on data from the teachers' perspectives about the application of various elements of eLearning environments in teaching students online. The theoretical framework is presented in Figure 9.1.

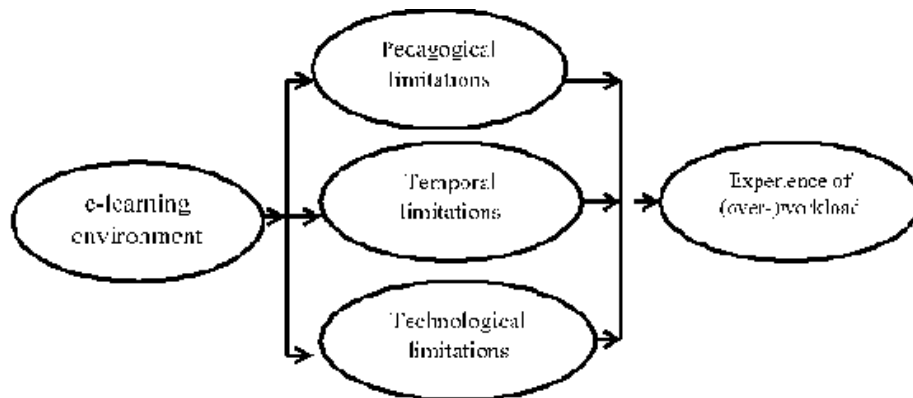


Figure 9.1: A theoretical framework about academics' perceptions

On the left-hand side of Figure 9.1, I have presented various components of the eLearning environment with regard to participants' perceptions of the eLearning environment that I identified in the FGDs. These components were Study Desk, Moodle, Email, Blogs, and Facebook. In the middle area of Figure 9.1, I have presented various constraints or limitations that intervened while teaching academics interacted with students online. I grouped them into the following three constraints:

- Pedagogical limitations
- Temporal limitations
- Technological limitations

Because of the above three limitations, the teaching academics' perception was that their workload had increased. In this thesis, the enhancement of work was termed as (over-)workload. This finding was consistent with previous studies. One of the significant findings was three identified constraints that contributed to (over-)workload. These constraints were negative affordances of the eLearning environment

(or more broadly of ICTs) with relation to the use of ICT in teaching from academics' perspectives. This finding was in contrast to the positive affordances of ICTs from students' point of view, which favoured "anywhere any time" type of learning. But this learning comes at a cost of extra work experienced by academics.

The main significance of identifying the limitations in this study was that efforts would be needed by concerned authorities to overcome the limitations, and thereby, to make the eLearning environment more teacher friendly.

9.1.2. R2Q: Was there any variation in attitudes in terms of socio-demographic factors?

For this part of the research, I provided 11 (eleven) statements highlighting both the positive and the negative attitudes of academics. Based on the replies, I developed six categories of outcomes as per recommendation by the experts in the USQ – *strongly agree*, *agree*, *uncertain*, *disagree*, *strongly disagree*, and *not applicable*. Using factor analysis, this study found two types of evidence, which were classified as positive attitudes and negative attitudes towards the use of eLearning environments, including the Internet and websites for teaching and doing research. The negative attitudes pertained to the teaching workload, and the positive attitudes pertained to research performance. However, there were variations on attitudes amongst university academics.

Based on Ajzen and Fishbein's theory (1980; 2005) of reasoned action and on non-parametric data analysis (i.e. cross-tabulation, t-test), I examined the correlation between the variations in attitudes and socio-demographic factors. The cross-tabulation results showed that a single demographic factor of academics – the main language of communication (or native language status) explained the variation significantly. However, since the correlation did not ensure a relationship, I extended the empirical analysis to the parametric regression analysis – an ordered probit regression analysis technique. The reason for selecting regression analysis was to understand the relationship between the variables of interest and their effects.

The regression analysis also found that the native language status of the academic, their the highest academics qualification, and their weekly Internet use were statistically significant causal factors that influenced their academics' attitudes towards the use of ICTs for teaching and research work. The predicted probability of effects was as follows. Given that academics had a doctoral degree, and that a change of ethnicity status of the academics moved from 0 (non-native English speaker) to 1 (native English speaker), this increased the predicted probability of outcome 1 (i.e., *agree*) by $(0.43-0.13) = 0.20$ or 20 per cent. This calculation was made by subtracting the predicted probability of outcome 1 (*strongly agree*) from the predicted probability of outcome 1 (*strongly agree*) in Table 6.17. Moreover, there was a difference in the marginal effect of having a doctoral degree on the predicted outcome between Asian-born academics and native English speaker academics. For native English speaker academics, the predicted effect was higher by $(0.22-0.04) = 0.18$ or 18 per cent higher. Furthermore, the *p*-value showed that the marginal effect was statistically significant at the 5 per cent level.

The variables relating to native language status of the academic, highest academic qualification, and weekly Internet use were socio-demographic variables. The evidence of relationship confirmed Ajzen and Fishbein's (1980; 2005) theory of reasoned action, which is that the socio-demographic variables influences attitude, empirically in an Australian context. This research finding is consistent with the previous findings of Ahadiat (2005) in the context of the USA. Ahadiat (2005) determined what factor influenced accounting university teachers' decisions to use technology in their classes. In that study, a survey was used to measure attitudes towards technology among accounting educators. That study found the existence of significant differences in academics' attitudes to technology. Furthermore, the study found evidence of academics' ethnicity (their ethnicity was measured by African American, Caucasian American, Hispanic, Middle Eastern, Asia Pacific Islander, and other) along with other socio-demographic variables, as a determinant of the variation of academics' attitude to the use of ICT in teaching and learning in the USA.

A possible explanation for such a finding is that in my dataset the participants who had a status of non-native English speaker came from a small number of Asian countries such as Bangladesh, India, Srilanka, Nepal, China and Japan. On the other hand, in my dataset, the participants who had a status of native English speaker came from a small number of European countries, the USA, and New Zealand or they were Australian- born. Being immigrants, the non-native English speakers were less likely to express their negative attitudes towards the eLearning environment. This might be attributed to the fact that the Asian-born academics migrate to Australia or the USA (or to other developed countries) fostering high hopes and expectations about their careers and future prospects. They often desire to consolidate their employment and position in a foreign land. Such expectations might outweigh their frustration, if there is any, about the working conditions. Therefore, they are apparently ready to work extra hours whenever this is required without expressing dissatisfaction. This implies that the academics whose first language is not English are less likely to complain than their Anglo-Australian counterparts. However, as this study was carried out in a single regional university and the sample size was not large, generalisation from this result is not suitable. Further research is recommended on a large scale, including all universities of Australia.

9.1.3. RQ3: To what extent did the use of the Internet explain the variation on research performances among teaching academics?

This study examined the enabling role of the Internet in academic research at USQ. Unlike previous studies, where single-equation models of the determinants of (academic) research production have been used, I modelled and estimated a simultaneous equations model of a research production function.

The main finding of my study was that the elasticity of the weekly use (in hours) of the Internet by teaching academics for their academic research output was statistically significant and positive. The estimated elasticity of weekly Internet use was 0.16. In my econometric model, this right-hand side variable and the left-hand side dependent variable (i.e. research output) were in a natural logarithm. According to the rule of econometrics, the relationship between the left-hand side and right-hand variable can be interpreted in a percentage. The interpretation of the above finding was that a 1 per cent increase in weekly use of Internet (in hours) will cause a 0.16 per cent increase in research publications - publications in peer-reviewed journal

articles, conference proceedings, book chapters and books. Although the size of the effect is not sizeable, this finding supports my expectation that the Internet use is a statistically significant input in the research production function. In the past, any empirical evidence was missing. The research contribution of this thesis is that it provides evidence in support of my expectation.

The use of the Internet can influence research productivity through multiple mechanisms. For example, the use of various online-based data collection platforms like Qualtrics or Survey Monkey might make the researcher's data collection work more easily and faster than traditional data collection method(s). This happens because accessing the Internet at home and in the office might make the researcher capable of (i) accessing research databases and communicating with research collaborators anywhere, any time; (ii) attending conferences at home and abroad without being physically present at the conference venue; and (iii) submitting research papers online for publication in online journals. One type of scholarly resource on the Internet is electronic journals, which have reduced the lead time to research publication. Moreover, in the traditional way of data collection, research needed a substantial number of both human and non-human resources. Internet-based data collections save resources. These identified research gaps can be used as future research directions.

Furthermore, I found a statistically insignificant positive effect of research collaborations on research production. The coefficient on the research collaboration (a binary variable) was 0.17. This finding was in contrast to previous findings by Lee and Bozeman (2005), Abramo et al. (2008), and Bently (2011), which found statistically significant positive effects of research collaborations on research production in the USA, Italy and Australia. These differences in findings between my study and the studies mentioned above can be attributed to the modelling of the research production function. The previous studies used a single-equation model, whereas I used a simultaneous equation model. The differences in findings implied that treating research collaborations as an exogenous variable might have led to an overestimation of the effect of research collaborations on research output in previous studies.

Other notable findings of this study were as follows. This study found that research grants and doctoral degree qualifications (a binary variable) of academics were two important determinants of the research production function. This finding was as per my expectation and similar to the previous research findings of Abbot and Doucouliagos (2004), Lee and Bozeman (2000) and Bently (2011), who found a statistically significant positive relationship between the research grants and doctoral qualifications of academics, and research production. The coefficient on the log of research grants was 0.03 and the coefficient on doctoral qualifications was 0.29.

However, care needs to be taken when interpreting the results of this study. First, research and teaching are two outputs of academics in Australian universities; other outputs are community and professional service and consultancy (Dundar & Lewis, 1998). As inputs are not divisible between the research and teaching outputs, the measurement of research output is not without difficulties. Some scholars think that "evaluating research performance is an inexact science" (Dundar & Lewis, 1998, pp. 625-626). The research productivity of an academic may vary with different measures of research productivity.

Further, this study has not considered the quality of research publications. As publications in Excellence in Research in Australian-ranked journals and journals with high impact factors are considered quality research, this might be used as a

quality indication in future research. Finally, the innate ability of researchers was overlooked in this study owing to the nature of the data, which were cross-sectional data. Panel data and panel data econometric modelling can handle this issue efficiently, which might provide scope for further research in the future.

9.1.4. RQ4: To what extent did the use of ICTs by farmers explain the differences in their agricultural revenue?

I have examined the role of uses of communication technologies (CTs), a component of total ICTs, in Australian farmers' agricultural revenue in the short-run and the long-run during the period 1990-2013. This research used telephones expenditure, both mobile and land phone lines, as a measure of the use of CTs by farmers. Because of the lack of data, I was not able to use any variable regarding the farmers' expenditure on the Internet. However, I strongly believe that the absence of that variable did not make my study less effective or weak, because, nowadays, people acquire mobile phone connections that have an integrated Internet facility. People use the Internet on their mobile phones anywhere and at any time. The nature of the data was time series and cross-sectional data or panel data. The data were drawn from the Australian Department of Agriculture website.

One distinct methodological aspect of this study was that I modelled a dynamic relationship to study the relationship between the inputs and the outputs in agriculture as opposed to the static production function used in previous studies (Aker 2010; Ali 2012; Ali & Kumar 2011; Lio & Liu, 2006). The study overcame the methodological problem of endogenous bias owing to simultaneity. Applying a basic econometric model, the study used the Error Correlation Model. Pool Mean Group (PMG) and Mean Group (MG) estimators were deployed to estimate the parameters of interest.

The empirical findings from the research were as follows: (i) both the short-run and the long-run income elasticity of telephony were positive; and (ii) the estimated long-run elasticity was higher than the estimated short-run effect. In Australian agriculture, the estimated long-run elasticity was 0.25 and the short-run elasticity was 0.12. The interpretations of the results included that a 10 per cent increase in telephone expenditure enhanced agriculture revenue by 1.2 per cent in the short-run and 2.5 per cent in the long-run. Therefore, the estimated results confirmed that the expenditure on CTs as capital on agricultural productivity gains, which was similar to the gains found in the manufacturing and service sectors in relation to the use of ICTs.

The importance of this finding is that agriculture farmers, who are generally located in the geographically remote areas, are capable of reaping the benefit of increasing revenue from increasing use of telephone facilities. Therefore, future public policy initiatives directed towards increasing telecommunication infrastructure facilities should not be limited to cities and manufacturing hubs, but should be equally expanded to remote and regional areas where agricultural firms and farmers are located.

Moreover, the comparative analysis provided evidence that the gains in Australian agriculture from the use of CTs were relatively higher than the gains in the service and manufacturing firms (or industries) from the use of ICTs. This result further confirmed that the performance of ICTs in different sectors of the economy varies substantially. However, my study did examine what factor(s) contributed to the inter-sectoral difference in gains from the use of CT or ICT as a whole. Finally, this research used aggregate data. In order to generate an insight into the farmer-specific

effects of the actual use of ICTs, data at the individual level would be required. These might be an avenue for further research.

The empirical findings have several policy implications. If other things remain the same in Australia, the ongoing National Broadband Network expansion to the regional areas will bring about benefits for farming communities in terms of increasing connectivity. Like their counterparts in developing countries, Australian farmers will be increasingly connected digitally to the local and global knowledge hub, which will make these (farmers) capable of handling all sorts of information in relation to production technology and production marketing. Thus, Australian farmers' average earnings are expected to rise substantially. However, the impact of CTs requires a 'critical mass' before it is felt (Röller & Waverman, 2001); therefore, achievement of a critical mass in regional areas should be a policy priority of the government of Australia. Furthermore, an effective regional-specific public policy intervention entailing skill development (for example, training) is required for farmers so that they can acquire required skills in using ICTs in regional areas along with the diffusion of National Broadband Network facilities. I have presented a summary of the key findings in Figure 9.2.

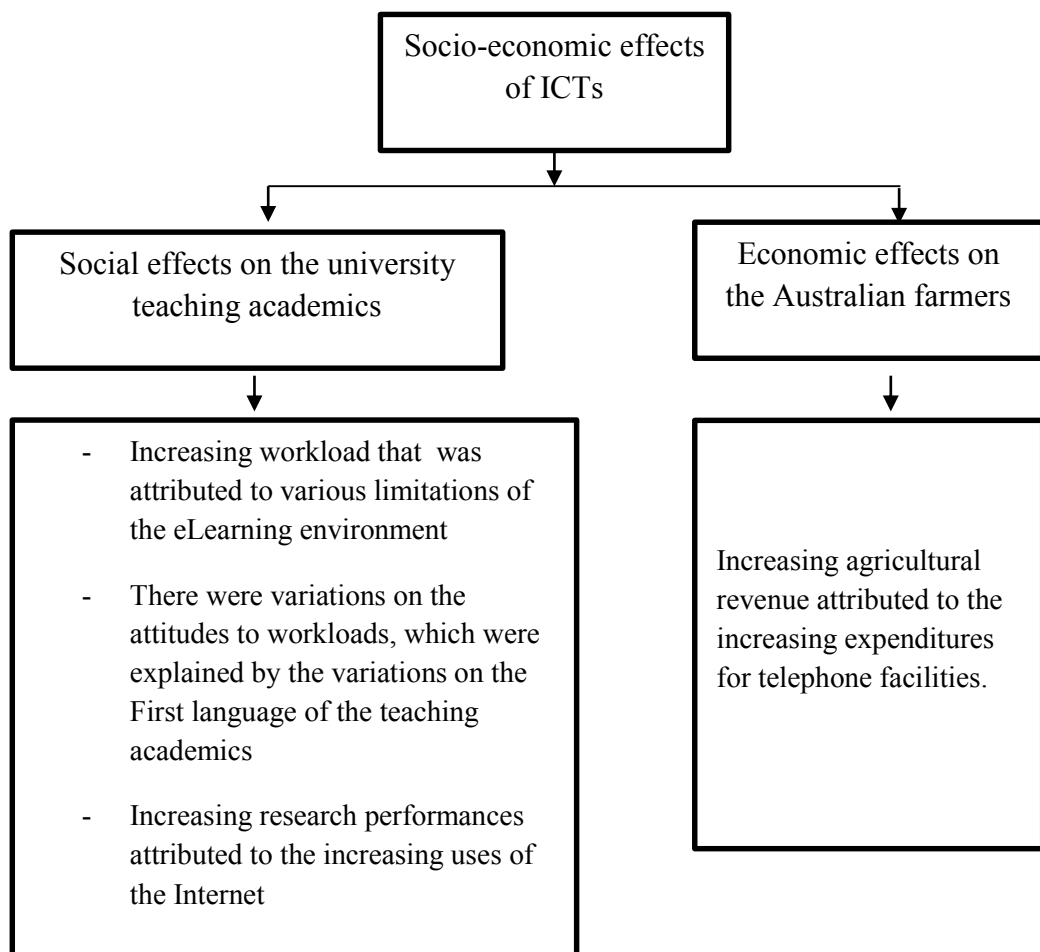


Figure 9.2: An overview of the key findings of this research

9.1. Contributions to knowledge

The contributions to the existing body of knowledge are presented in the following sub-section 9.2.0 through Sub-section 9.2.2.

9.1.0. Contributions to theoretical knowledge

Theoretically, the effects of eLearning environments (or more broadly ICTs) depend upon the affordances of technology, and those affordances of technology depend upon the attitudes of teaching academics, which in turn depend upon the socio-demographic features of academics. My research contribution is that, in the participating Australian university, the reported affordances of ICTs for (teaching) academics were different from the affordances of ICTs to students. The interactions between students and academics were mediated by the perceived affordances of ICT that are characterised by three kinds of limitations: - pedagogical limitations; temporal limitations; and technological limitations. Because of these limitations, academics perceived increasing workloads. However, there were variations on academics' attitudes to ICTs and the socio-demographic factor explains these variations in attitudes to ICTs. Ajzen and Fishbein's theory postulates that there is a correlation between the socio-demographic characteristics and attitudes. My study empirically confirmed this theory by providing statistically significant evidence of the three variables - native language status of academics, academic qualifications, and time spent on the Internet - that explained the variations in attitudes on ICTs.

9.1.1. Contributions to methodological knowledge

In terms of methodology, two contributions were made by this thesis. Firstly, so far in the literature, the knowledge (or research) production function has had the shape of a single equation model where any component of ICTs was not a variable (or input). This research made a methodological contribution by providing evidence that, firstly, the knowledge production function (or research production function) should have the shape of simultaneous equations (i.e. more than one equation).

Secondly, in agricultural sector, to study the agricultural production function researchers used static form of Cobb-Douglas production function. In this study, I provided evidence of the dynamic Cobb-Douglas agricultural revenue production function arguing that unlike the manufacturing and service sector, in agriculture the production process is dynamic in nature.

9.1.2. Contribution to empirical knowledge

In chapter 6, chapter 7 and chapter 8 this study made empirical contributions. The attitudes of academics' to ICTs were divided into positive and negative and first language status of the academics (which was a measure of ethnicity in this study) was a determinant of the variation of attitudes to ICTs.

Secondly, in the knowledge production function, the time spent by the academics on Internet for academic work was an important determinant or factor of production of knowledge, which was overlooked by researchers in the past to conceptualise knowledge production function.

Thirdly, so far to the agricultural production function, the contribution of ICT as capital was overlooked. In the production, the use of capital was a combination of physical and ICT-capital. In this study, I provided the evidence that a part from

physical capital, the contributions of ICTs as capital to farmers' revenue in agriculture was statistically significant and positive in Australia. Furthermore, this study provided evidence that the positive contribution of information and communication was not limited to the manufacturing and service sectors only, as was found by previous research. My study extended previous studies and added that, ICTs was an important factor of production in the production process in Australian agriculture.

9.2. Policy implications

Online and face-to-face (F2F) teaching will have to be given more weight in terms of the allocation of workloads to academics. As understood by academics, the prevailing notion of online teaching – i.e. online teaching means low-workload will have to be abandoned. For online teaching, there should be a limit to the number of students to be enrolled in an individual course based upon consultation with the course tutor. There should be some clear guidelines regarding the interactions by email between students and teachers, so that the teachers' personal lives are not interrupted.

Funding higher education in Australia is a longstanding problem (Palmer, 2013). The Australian government funded higher education almost fully prior to the 1980s, and after 1989 with the introduction of the Higher Education Contribution Scheme (HECS) the funding policy of the Australian government began to change. The previous Australian government introduced the Gonski reform bill: a funding plan for primary and secondary schools, which the current sitting government has put under scrutiny. Last year (2014), the Australian Federal Government delivered its 2014-2015 year budget giving policy directives towards deregulated tuition fees for the public universities from 2015, which means that A\$ 1.1 billion will potentially be withdrawn from higher education. This withdrawal would have a significant impact on public universities' research funding too. In the context of decreasing available funds for research, increased productivity as a strategy to respond to declining government funding has already been debated in the literature (Gates & Stone, 1997, as cited in Salaran, 2010). Had research funding unchanged, the increasing engagement of academics with online resources might have contributed to increasing research outputs.

My contribution to this debate has been an examination of the contributions of potential contributors to research productivity. I have identified two statistically significant contributors: research funding and Internet use. State-of-the-art Internet-based resource facilities should be expanded. This expansion can be achieved by subscribing to new online resources such as electronic journals, data collection software, and data warehouses. However, simply buying services from increasing numbers of databases will not bring benefits unless the facilities are utilised fully. With this end in view, special training programs to enhance the capacity of the academics may be contemplated. There may be some academics who are not well-informed of the vast resources available on the Internet. In this context, training and development programs for academics will enhance their digital literacy on the one hand, and their resource utilisation capacity on the other.

If this opportunity is expanded among academics, it will generate benefits for academic institutions and for academics equally. This expansion can be made in two directions. Firstly, the physical capacity of the Internet bandwidth can be expanded by being connected to state-of-the-art Internet facilities and to resource hubs such as databases. The National Broadband Network facilities are an initiative of the previous and current Australian Governments that is intended to connect digitally every household and person working or living at home, at school and in universities. In the regional areas, the expansion is yet to be fully realised. The research findings of this study suggest that the sooner that these facilities reach the regional areas the better for regional universities and the regional economies. The potential benefits from the use of the Internet might come through increasing use of research facilities being made

accessible online, and through extramural research collaborations in Australia and abroad. Broadband infrastructure facilities featuring high-speed Internet should be expanded rapidly to rural Australia for two justifications. First, high-speed Internet will increase farmers' productivity. Secondly, it will reduce costs for the Internet for those farmers who are using Internet on mobile phones. If the cost of the Internet is reduced, farmers' payments for telecommunications will decrease, and agricultural revenue thereby will increase.

With regard to Australian agriculture, the empirical findings have a number of policy implications. If other factors remain the same, the ongoing National Broadband Network expansion to the regional areas will bring about benefits for the farming communities in terms of increasing connectivity. However, the impact of communication technology requires a 'critical mass' before it is felt (Röller & Waverman, 2001); therefore, the achievement of a critical mass in the regional areas should be the policy priority of the government of Australia. Further, an effective regional-specific public policy intervention entailing skill development (for example, training) is required for farmers so that they can acquire the required skills in using ICTs in regional areas along with the diffusion of NBN facilities.

9.4. Limitations of the research

Research time, resources, and logistics are important limiting factors of this research. As CRN Project 5 has funded this research under a partial scholarship plan, the research idea has always been influenced by the overall research theme of the CRN Project 5. The research theme of CRN Project 5 has been changed during the period of the implementation of the project, and consequently some time and resources lapsed to cope with the changes required for the research theme as well.

Secondly, primary data collection was the prime challenge of this research project because of factors that went beyond the control of the researcher. One challenge that I experienced regarding primary data collection from USQ was reluctant participants. I tried my utmost to ensure participation as per the requirements of sample size. While I have ultimately achieved the required sample size sufficient for my study, it falls short somewhat of my initial expectation. While the inclusion of more participants would have yielded a greater diversity of responses, the number of participants in the study was sufficient to yield in-depth and meaningful data that enabled the study's research questions to be addressed. The study included a number of self-reported data that did not afford independent verification by the researcher. At the same time, the focus groups provided a framework for informal checking of one another's responses to the developing conversations, and individual participants had no perceived benefit to be gained from exaggerating their responses to the survey questionnaires.

Thirdly, the definitions of ICTs are vast and highly diversified. In this research, I examined the effects of ICTs on the Australian higher education sector by defining ICTs narrowly and focusing on a single component of those ICTs: the learning management system (LMS). On the other hand, when I examined the effects of ICTs on academic research at a single Australian university, I defined ICTs as the Internet. Finally, when I examined the effects on the Australian agricultural sector, I defined ICTs very broadly by analysing total farmers' expenditures on telephone services. Therefore, a number of clearly circumscribed definitions of ICTs were used in this study.

Fourthly, Australia is a vast country divided into six states and two territories. Each state is diversified in terms of socio-economic and demographic characteristics, which are inevitably observable in overall competitiveness and diversification indices. An undated report published by the Regional Australia Institute disclosed the competitiveness of Australia's 560 Local Government Areas (LGAs) and 55 Regional Development Australia (RDA) regions that showed that the distribution of economic diversification is skewed to the right, which means that a large proportion of LGAs are relatively diverse (Figure 1.5) (Regional Australia Institute, n.d.). Regional competitiveness, regional infrastructure, technological readiness, innovation and human capital contribute to economic diversification across all LGAs. Therefore, the effects of ICT infrastructure might not be identical across every sector and every regional and local government area. Thus, pre-existing diversification restricts the potential generalisation of this study.

Fifthly, I conducted this research into the effect of digital technologies based on primary data collected from USQ. Therefore, any generalisation of the findings of this study is not suitable.

9.5 Further research directions

9.5.0. ICTs and education administrators

It was already stated in Chapter 2 that education administrators represents a group of human factors working in the university sector of education. Like the other groups of human factors, these group administrators are interacting with various components of ICTs. So far, research into the effects of ICTs on this group of administrators is missing from the literature. One potential reason might be a lack of interest among researchers, but this area of research can be examined by researchers in the future.

9.5.1. Online education and educational quality

Proponents of online (or blended or distance) education are always arguing for the expansion of educational opportunities as a benefit of online education world-wide. However, many studies have argued that the massification of higher education potentially comes at the cost of low quality of education and of further aggregating educational inequality (Li, Zhou, & Fan, 2014; Walters, 2000). Li, Zhou and Fan (2014) in their recent study of the effects of distance higher education on the state of educational inequality in China showed that distance education has increased educational inequality, if the quality of education is taken into account during the analysis. In the Australian universities, a study similar to Li, Zhou, and Fan's (2014) would be very useful to gain an insight into the effects of the expansion of online education on educational opportunity in terms of the quality of education.

9.5.2. ICTs and academic research

Research is an intellectual exercise that requires education and training. The innate ability of the trainee might have a potential influence on that person's research productivity. However, innate ability is an unobservable characteristic (Shields & Shields, 2009; Vandenberghe, 1999). Previous research failed to consider the influences of the 'innate ability' of each researcher on research outputs. In order to control for the ability bias, a panel dataset would be useful (Green, 2003) in such research.

9.5.2. ICTs and agriculture

The major weakness of the previous studies has been that these studies have assumed a static input and output relationship in agriculture, but crop and livestock production processes are not static or spontaneous owing to their biological lags that generate time lags in the input-output relationship. Not only the agricultural production process but also agricultural marketing is dynamic (Liu, Keyzer, Boon, & Zikhali, 2012). Owing to existing dynamic agricultural production processes, a dynamic agricultural input and output model is an appropriate model. Secondly, very recent studies have criticised previous research findings and have argued that access to ICTs does not necessarily guarantee the actual usage of the ICTs (Coeckelbergh, 2011; Gutierrez & Gambo, 2010; James, 2008). For example, James (2008) argued that "the access to the ICT is a potential concept, and whether this potential is converted to the actual use is the real issue" (p.57). Therefore it has become imperative to take into account this argument as a conceptual tool in a future study.

9.6. Summary of the Chapter

Regarding the social and economic effects of digital technologies on academics and farmers, I have learned the following. First, the potential effects on academics are mixed – a combination of increasing workloads and research publications. Consequently, academics have become busier academically than they were before. Secondly, the potential effects on farmers is positive –increasing revenue earnings with increasing use of CTs.

As to the contribution to an existing body of knowledge, this thesis contributed theoretically by building a theory on the interactions between academics and students online, and testing three pre-existing theories empirically – Ajzen and Fishbein's (2005) theory of reasoned action, the theory of research production function and the theory of agricultural production function. Additionally, I developed two new models. One model was used to study the research performances of academics in an Australian university and the other model was used to study the agricultural revenue function.

The potential shortcoming of this research is that I have conducted the study on a limited scale in terms of data. Therefore, I was not able to provide evidence of social and economic effects in a much bigger context. Despite that, I conclude that there are differential effects of digital technologies on at least two sectors of the Australian economy – agriculture and education.

10. References

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11. APPENDICES

Table A1: Cross-section dependence test

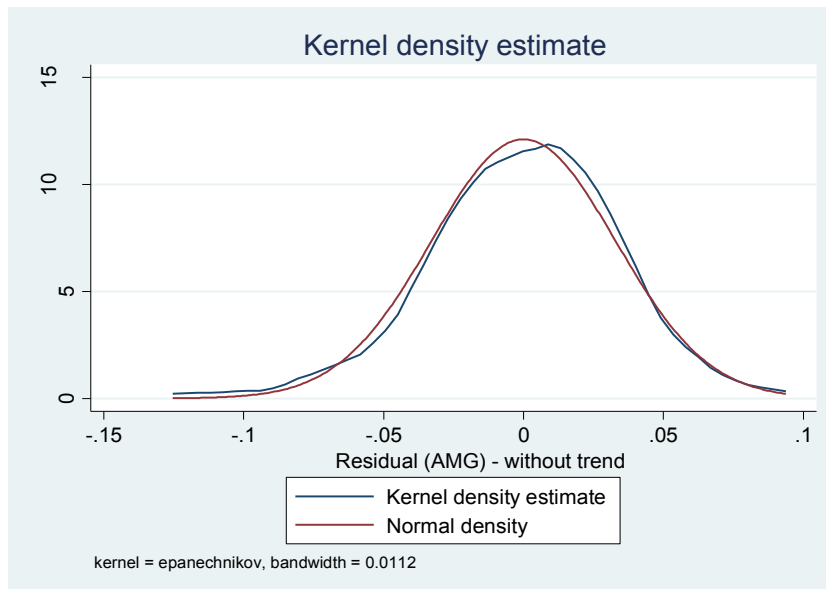
Variables	CSD test stats (<i>p</i> value)	Correlation
$\log Y$	8.31 (0.000)	0.548
$\log CT$	10.24 (0.000)	0.675
$\log L$	6.91 (0.000)	0.456
$\log Lr$	9.75 (0.000)	0.643
$\log I$	1.78 (0.075)	0.210
$\log F$	10.41 (0.000)	0.686
$\log RF$	9.22 (0.000)	0.621

Table A2: Wooldridge test for autocorrelation

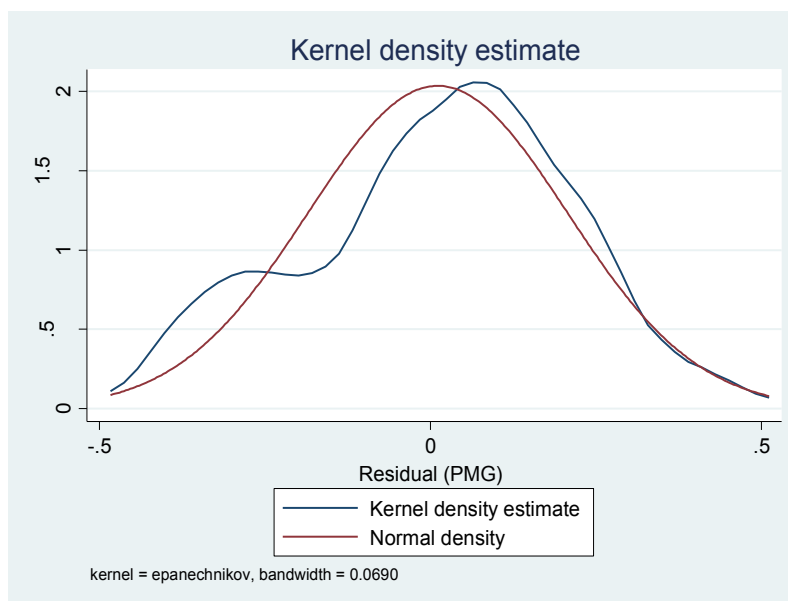
	AMG (with trend)	AMG (witout trend)	PMG
Test statistic	0.211	0.293	0.420
(<i>p</i> value)	(0.6699)	(0.61730)	(0.5522)

Null hypothesis: no first-order autocorrelation

Figure A1: Kernel density estimates of residual normality



Without trend (AMG)



PMG

Table A3: Matrix of literature on research production study

Literature	Country	Research output measures	Level of analysis and data	Data analysis methods	Findings: Correlates and Determinants (+ve/-ve)
Ramsden (1994)	Australia	Research output index	Individual cross-section	Bivariate	Research interest, involvement in research activities, and academic seniority (+ve)
Dundar and Lewis (1998)	USA	Number of articles in peer-reviewed journals	Individual. Cross-section	Standard multiple linear regression	Departmental culture such as shared attitudes (+ve). Faculty size (large or small) (+ve)
Ho (1998)	Hong Kong	Weighting and counting publication outputs.	Institutional level cross-sectional.	Analysis of variance (ANOVA)	University reputation (+ve) Academic rank (+ve). Experience (+ve)
Teodorescu (2000)	Australia, Brazil, Chile, Hong Kong, Israel, Japan, South Korea, Mexico, the United Kingdom, and the United States	Number of journal articles in the last three years periods.	Individual. Cross-country	Standard linear regression for each of the 10 countries	Membership of professional society. Attendance of conference and receipts of research grants (+ve)
Abbott and Doucouliagos (2004)	Australia	Weighted average of research	Institutional level panel data.	Dynamic panel data regression.	Research grant (+ve)

		publications	35 government universities, 5-year long time scale.		
Lee and Bozeman (2005)	USA	Number of journal paper publications in peer-reviewed journals	Survey data at the university level	2SLS test of hypothesis	Research grants (+ve), Citizenships (+ve), and Collaborative strategy (+ve)
Abramo et al. (2008)	Italy	Scientific publication (number) in international journal	Survey data among 78 Italian universities. Individual level	Crosstabulation analysis	Extramural Research collaboration (+ve)
Mamiseishvili and Rosser (2010)	USA	Survey data among 78 Italian universities Individual level	Crosstabulation analysis	Structural equation modelling.	International faculty (+ve)
Salaran (2010)	Australia	Productivity index	Cross-sectional data at the individual level from five Australian universities	Correlation Linear regression	Social interaction (+ve)
Bently (2011)	Australia	Weighted sum of self-reported publications during the three-year period prior to the survey years.	Individual level cross-sectional survey data.	Standard linear regression analysis	Gender (none) Academic rank (+ve). Doctorate degree (+ve). Research fund (+ve). International research Collaboration (+ve).
Lissoni(2011)	French and Italy	Number of articles in journals	Cross-sectional data	Generalised Tobit Model	Size and nature of international

		with impact factors			collaboration (+ve). Age (-ve). Gender has differential impacts. Females publish less than male.
Literature	Country	Research output measures	Level of analysis and data	Econometric methods	Determinants (+ve/-ve)
Weber (2011)	USA	Number of peer and non-peer reviewed articles, book chapters and other creative works in the past two years.	Individual cross-section data.	Two-level hierarchical generalized multiple regression (Poisson regression model)	Foreign-born faculty (+ve)
Padilla-Gonzalez et al. (2011)	USA Canada Mexico	Number of published chapters in academic books in the last two years	Institutional-level cross-sectional data	Standard multiple regression	Gender gap in USA (none) Canada (+ve), Mexico (+ve)

Iqbal and Mahmood (2011)	Pakistan	Number of research papers in the past two years in peer-reviewed journals	Individual. cross-section	Cross-tabulation	Faculty teaching load (-ve)
Jung (2012)	Hong Kong	Number of journal articles, book chapters and edited books in three years	Individual. cross-section	Standard multiple regression	Gender (+ve). Teaching experience (Years) (+ve). Time on teaching (-ve). Time on research (+ve).
Meyer (2012)	USA	Not found	Individual	Qualitative study - Interviews	Mixed reaction to the influence of online teaching on research productivity
Beerkens (2013)	Australia	(i) Number of articles (ii) Amount research grants. (iii) Weighted number of publications	Institutional level panel data. 36 universities, 13-years long.	Panel data regression.	Research management (+ve)

Literature	Country	Research output measures	Level of analysis and data	Econometric methods	Determinants (+ve/-ve)
Mishra and Smyth (2013)	Australia	Publications in law journals	Individual level cross-sectional	Instrumental variable approach Lewbel (2012) identification strategy	Academic rank has no effect.
Fukuzawa (2014)	Japan	Number of research publications	Cross-sectional data, 39 universities in Japan	Tobit regression	Previous research experiences (+ve)

Table A4: Thematic analysis

Experiences	Focus Group 1				Focus Group 2						Focus Group 3					No of coded ref.
	P1	P2	P3	P4	P1	P2	P3	P4	P5	P6	P1	P2	P3	P4	P5	
Use Study Desk,	x	x	x	x	x	x	x	x	x	x	x	x	x	x	X	15 (100per cent)
Use Email, Moodle			x		x		x			x		x		x		06 (40per cent)
Use social media like Facebook , Blog								x					x			02 (13per cent)
StudyDesk unattractive					x							x			x	03 (20per cent)
Increase workload/work intensification/ work without limit	x	x	x	x		x			x	x		x	x			09 (60per cent)
Online student warrant more time	x	x														02 (13per cent)
Lack of synchronous working time										x					x	03 (20per cent)

Student purchase their assignment				x												01 (7per cent)
Different course have different approach of teaching delivery						x				x						02 (13per cent)
Seminar style teaching approach is used in online environment			x				x							x		03 (20per cent)
No difference between Online and Offline							x			x						02 (13per cent)
Online students are not homogenous in terms of their orientation to online pedagogy								x								01 (7per cent)
Practical problem of engineering students								x								01 (7per cent)

Lack of readiness									x					x		02 (13per cent)
Presentation of materials to students in an organised way is difficult		x			x				x							03 (20per cent)
Who should be the focus of the changes to educational technology - students or teachers			x						x							02 (13per cent)
Large class size /so many of them/difficult to engage online in terms of pedagogy	x	x	x			x				x	x		x	x		08 (53per cent)
Online student seek personal advice		x										x				02 (13per cent)
Online student do better than face-to-face students	x	x	x												x	04 (27per cent)

Low level of training on ICT related teaching tools.						x						x		x		03 (13per cent)
Students reading habit is declining													x			01 (7per cent)
Engaging students in social software is problematic					x		x			x	x			x	X	06 (40per cent)
Student learns in so many spaces such as Facebook, Moddle, study desk				x								x				02 (3per cent)
The whole university LMS is not attractive		x					x							x		03 20per cent)
Organizing teaching material well ahead of semester		x			x				x					x		04 (27per cent)
Lack of technical support	x			x		x				x	x		x			06 (40per cent)

Inadequate software								x					x		x		03 (20per cent)
Restrict relationship with student					x												01 (7per cent)

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OFFICE OF RESEARCH

Human Research Ethics Committee
PHONE +61 7 4631 2690 | FAX +61 7 4631 5555
EMAIL ethics@usq.edu.au



18 December 2013

Mr Md Shamsul Mamun

Dear Md Shamsul

The USQ Human Research Ethics Committee has recently reviewed your responses to the conditions placed upon the ethical approval for the project outlined below. Your proposal is now deemed to meet the requirements of the *National Statement on Ethical Conduct in Human Research (2007)* and full ethical approval has been granted.

Approval No.	H13REA260
Project Title	The impacts of the use of ICT s on teaching and learning in the Australian Universities
Approval date	18 December 2013
Expiry date	18 December 2016
HREC Decision	Approved

The standard conditions of this approval are:

- (a) conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the HREC
- (b) advise (email: ethics@usq.edu.au) immediately of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project
- (c) make submission for approval of amendments to the approved project before implementing such changes
- (d) provide a 'progress report' for every year of approval
- (e) provide a 'final report' when the project is complete
- (f) advise in writing if the project has been discontinued.

For (c) to (e) forms are available on the USQ ethics website:
<http://www.usq.edu.au/research/ethicsbio/human>

Please note that failure to comply with the conditions of approval and the *National*

Statement (2007) may result in withdrawal of approval for the project.

You may now commence your project. I wish you all the best for the conduct of the project.



Annmaree Jackson
Ethics Committee Support Officer

Copies to: sakmamun@iubat.edu

Appendix 6

Default Question Block

Dear USQ teaching staff member

I would like to invite you to participate in a short survey to identify the impact of the use of the information and communication devices and services on your academic research achievements. This survey is an integral part of my PhD research entitled 'The impact of the use of ICT on teaching and learning in Australian universities'.

Please would you be willing to spend 20 to 30 minutes completing this questionnaire? **As a thank you for your time if you complete the questionnaire I will be entering you into a draw to win a iPhone.** The data collected by this survey will be analysed and results will be published in my PhD dissertation and associated journal articles. All responses are anonymous. Participation in the survey is voluntary. Any information collected from you in this survey will be kept confidential. If you do not wish to take part in the survey you are not obliged to do so. Your decision not to take part in the survey will not affect your relationship with the University of Southern Queensland. My principal supervisor is Professor Patrick Danaher, Associate Dean (Research and Research Training) and Dr. Mafiz Rahman, Senior Lecturer from the Faculty of Business, Education, Law & Arts.

Should you have any queries regarding this research, please contact me using the contact details provided below:

M S Arifeen Khan Mamun
School of Commerce
Faculty of Business, Education, Law & Arts
Phone: (07) 4631 5345
Email: msarifeenkhan.mamun@usq.edu.au

If you have any ethical concerns with how the research is being conducted or any query about your rights as a participant please feel free to contact the University of Southern Queensland Ethics Officer on the following details.

Ethics and Research Integrity Officer
Office of Research and Higher Degrees
University of Southern Queensland
West Street, Toowoomba 4350
Ph: +61 7 4631 2690.
Email: ethics@usq.edu.au
HREC Approval Number: H13REA260

By selecting the 'Yes, I agree to participate' option below you indicate that, having read the information provided above, you consent to participating in the online survey.

Yes, I agree to participate

No, I do not wish to participate

What is your age ?

What is your designation ?

Associate lecturer

- Lecturer
- Senior lecturer
- Associate professor
- Professor

What is your gender ?

- Male
- Female

Which of the following describes your current status?

- Australia citizen
- Permanent resident
- Temporary resident

What is your first language?

- English
- Other (please specify)

What is the highest academic degree you have achieved?

- Doctoral
- Masters
- Bachelor / other postgraduate
- Other post-graduate

What is your major discipline of teaching and research ?

- Basic science (such as Agriculture, Mathematics, Physics, Chemistry, Statistics)
- Engineering
- Arts (such as Literature, Drama, Anthropology)
- Business (such as Accounting, Economics, Management)
- Education
- ICT
- Law
- Linguistics
- Psychology

- Non-teaching staff member
- Social Science (such as Anthropology, Sociology)
- Other (please specify)

Over the past 2 years which of the following research methods had you used most frequently for your research publication purposes. [If it is not possible to choose only one method, you may choose more than one]

-
- Action research / participatory action research
 - Design-based research
 - Applied research
 - Basic research
 - Qualitative research
 - Quantitative research
 - Mixed method

What was your average teaching load in the past two years (in %)? [Please enter numerical value in percentage e.g. 10]

In the last 2 years had you collaborated with other researchers for research purpose(s)?

-
- Yes
 - No

What type(s) of device(s) do you use in your work ? [Here the term 'use' mean 'actual use but not 'access to']
 [Choose more than one if it is applicable]

-
- Desktop
 - Laptop
 - Tablet
 - Smartphone
 - Other (please provide further detail)

What is your view regarding your preference for laptop as a device?

	1 - Not very important	2 - Not important	3 - Neither unimportant nor important	4 - Important	5 - Very important
Price of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Availability of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Requirement of the nature of activities/job responsibilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Preference for the device [e.g. for easy to handle]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What is your view regarding your preference for smartphone?

	1 - Not very important	2 - Not important	3 - Neither unimportant nor important	4 - Important	5 - Very important
Price of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Availability of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Requirement of the nature of activities/job responsibilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Preference for the device [e.g. for easy to handle]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What is your view regarding your preference for tablet PC?

	1 - Not very important	2 - Not important	3 - Neither unimportant nor important	4 - Important	5 - Very important
Price of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Availability of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Requirement of the nature of activities/job responsibilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Preference for the device [e.g. for easy to handle]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality of the device	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What type(s) of Internet connection(s) you are using in your residence?

Dial up
 Broadband with ADSL
 Wireless broadband
 National Broadband Network
 Other (please specify)

How important are each of the following reasons to you when you chose your internet service?

	1 - Not very important	2 - Not important	3 - Neither unimportant nor important	4 - Important	5 - Very important
Price of the service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Availability of the service
Requirement of the nature of the activities/job responsibilities
Preference for the service [e.g. for easy to handle]
Internet speed

How many hours per day (average) did you spend on the Internet in the last two years ?

How much did you spend [% of household expenditures] for Internet services including telephone in the last two years ?

How many peer reviewed journal articles had you published in the last two years?

How many peer reviewed book/ book chapter(s) had you published in the last two years?

How many peer reviewed conference proceedings had you published in the last two years ?

Please write down the total amount of research funding received for your research in the last two years [Please enter approximate value, otherwise enter 'zero']

Which of the following sources have you used to collect research data in the past two years? (You may select more than one)

-
- Field survey
 - Online survey
 - CD-ROM from the source [e.g. Australian Bureau of Statistics, World Bank]
 - Internet (e.g. online databases, other secondary data)
 - Interviews/Focus groups (telephonic, Skype or face-to-face)

Observations

Other (please specify):

To what extent do you agree or disagree with each of the following statements about the use of ICT for academic research.

	Strongly agree	Agree	Uncertain	Disagree	Strongly Disagree	Not applicable
The use of studydesk/moodle/email/digital course content preparation reduces time for research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of ICT has increased academic work loads (both teaching and research)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Email communication has increased the volume of unwanted mail from students	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Owing to unwanted mail communication, the time available for research has decreased	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of email enhances collaborative research outputs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Email communication has increased the complexity of doing teaching and research.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of online survey tools increase research outputs (such as journal article publication)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of data analysis software makes data analysis simple	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Currently ICT based online teaching is technologically driven rather than pedagogy driven.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Academic fail to align digital tools available on study desk/moodle with their students' pedagogical needs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The use of web-based tools has impacted on your participation in domestic and international conferences	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Finally, please feel free to write any additional comments here that will help me to understand your perceptions and experiences of the impact of education technology (e.g. ICT) on your teaching and research.

Thank you for participating in this research study. If you have any questions you are welcome to contact me on the following contact details:

M S Arifeen Khan (Mamun)
 School of Commerce Faculty of Business, Education & Arts
 Phone: (07) 4631 5345
 Email: msarifeenkhan.mamun@usq.edu.au

If you would like to be entered into the prize draw to win iPhone please select YES below to provide us with your contact details. If you do not wish to provide your contact details and be entered into the prize draw please select NO to close the survey.

- No
 Yes

To enter into the prize draw please enter your name and email address into the field below. The information will be kept confidential and will only be used to contact you if you win the prize:

Name

Email address