



Research Paper

Business Innovation and the Use of Information and Communications Technology – An Update

New
Issue

Research Paper

Business Innovation and the Use of Information and Communications Technology – An Update

Liza Tiy, Oliver Berry and David Taylor

Innovation and Technology Statistics Branch

AUSTRALIAN BUREAU OF STATISTICS

EMBARGO: 11.30 AM (CANBERRA TIME) FRI 10 MAY 2013

ABS Catalogue no. 1351.0.55.042

© Commonwealth of Australia 2013

This work is copyright. Apart from any use as permitted under the *Copyright Act 1968*, no part may be reproduced by any process without prior written permission from the Commonwealth. Requests and inquiries concerning reproduction and rights in this publication should be addressed to The Manager, Intermediary Management, Australian Bureau of Statistics, Locked Bag 10, Belconnen ACT 2616, by telephone (02) 6252 6998, fax (02) 6252 7102, or email <intermediary.management@abs.gov.au>.

Views expressed in this paper are those of the author(s), and do not necessarily represent those of the Australian Bureau of Statistics. Where quoted, they should be attributed clearly to the author(s).

Produced by the Australian Bureau of Statistics

INQUIRIES

The ABS welcomes comments on the research presented in this paper. For further information, please contact Mr David Taylor, Innovation and Technology Statistics Branch, on Perth (08) 9360 5275 or email <innovation.technology@abs.gov.au>.

CONTENTS

ABSTRACT	1
1. BACKGROUND AND INTRODUCTION	2
2. DATA	4
3. METHODOLOGY	5
4. RESULTS	6
4.1 Cross tabulation analysis	6
4.2 Correlation analysis	8
4.3 Regression analysis	9
4.4 Marginal effects	12
4.5 ICT and innovation novelty	14
5. CONCLUSION	15
ACKNOWLEDGEMENTS	15
REFERENCES	16
APPENDIXES	
A. VARIABLE LISTS	17
B. SAMPLE DISTRIBUTIONS	19
C. CORRELATION ANALYSIS	21
D. REGRESSION RESULTS USING ICT VARIABLES INDIVIDUALLY	22
E. REGRESSION RESULTS WITH ALTERNATIVE DEPENDENT VARIABLES	23
F. MARGINAL EFFECTS	25
G. COMPARABLE ICT INTENSITY INDEX FOR 2007–08 AND 2008–09	26
H. ICT INTENSITY AND DEGREE OF INNOVATION NOVELTY	28

BUSINESS INNOVATION AND THE USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY – AN UPDATE

Liza Tiy, Oliver Berry and David Taylor
Innovation and Technology Statistics Branch

ABSTRACT

In 2011, the ABS released a research paper – *Business Innovation and the Use of Information and Communications Technology* by Jessica Todhunter and Ruel Abello – investigating the relationship between Information and Communication Technology (ICT) use by businesses and innovation activity. This paper replicates that study using more recent firm level data from the ABS Business Longitudinal Database (BLD) and the Business Characteristics Survey (BCS).

A similar approach to the 2011 study was used to summarise the diverse types of ICT usage (broadband internet connection, business web presence, use of e-commerce) into a single ordered categorical variable, to determine a measure of a firm's intensity of ICT use. This ICT intensity 'index' reflects the business' highest degree of ICT sophistication and is used in the analysis to determine its relationship to innovation. The results of this analysis again show businesses which use ICT more intensely are more likely to undertake: innovation of all types, more types of innovation, more novel innovations; and are more likely to develop their innovations in-house.

1. BACKGROUND AND INTRODUCTION

As business innovation is regarded as a key determinant of individual business success and national economic growth, understanding the factors that enable innovation is of interest to businesses and policy makers alike. In 2011, the ABS released a research paper – *Business Innovation and the Use of Information and Communications Technology* by Jessica Todhunter and Ruel Abello – investigating the relationship between Information Communication Technology (ICT) use by businesses and innovation activity. In that paper Todhunter and Abello developed a novel way to measure ICT use by creating an ordered, categorical variable for ICT intensity which could be used for modelling purposes. This paper draws largely on the methods developed by Todhunter and Abello, and replicates their study with more recent data from the 2007–08 and 2008–09 Business Longitudinal Database (BLD) and Business Characteristics Survey (BCS). While the methodology used is largely the same, the reader is advised against drawing comparisons between the figures presented in the two papers. This is because the data used for analysis in each paper are from different samples which are not directly comparable as results have not been weighted and therefore only represent the sample from which the data have been taken.

The two studies differ in the following respects:

- The market share variable could not be used in the latest regression model as it was not collected in the more recent surveys.
- A new variable measuring degree of competition has been added to the regression model replacing the market share variable.
- The age of the business variable has not been used in the regression to be consistent with more recent studies using the BLD data.
- The ICT intensity index used for the main regression analysis has been adjusted as the “uses IT to a high extent” information was not collected in the more recent surveys.
- A sensitivity analysis using alternative ICT intensity indexes has not been undertaken this time as the more detailed ICT questions were not collected from all units in our sample for 2007–08.

For the purposes of this paper, innovation is considered in the broader sense of being ‘innovation-active’ because the focus of this paper is on innovation *effort*. As two years of comparable data are used, our analysis is potentially restricted if we focus only on those businesses which successfully developed and implemented an innovation, which may take many years to complete.

Four types of qualitative measures of business innovation, as defined by the Organisation for Economic Co-operation and Development (OECD) Guidelines for Collecting and Interpreting Innovation data, are considered:

- A *product* innovation is the introduction of a good or service that is significantly improved with respect to its characteristics or intended uses and includes significant improvements in technical specifications, components and materials, incorporated software and user friendliness or other functional characteristics.
- A *process* innovation is a new or significantly improved production or delivery method, including significant changes in techniques, equipment and/or software.
- An *organisational* or *managerial* innovation is the implementation of a new or significantly improved method of the firm's business practices, workplace organisation or external relations.
- A *marketing* innovation is the implementation of a new or significantly improved marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. The *marketing method* must not have been previously used by the firm and must be part of a new *marketing concept or strategy* representing a significant departure from the firm's existing methods.

ICT is considered a valuable source of business innovation as it makes it possible to achieve efficiency gains that provide an opportunity for innovation. It can be considered as a platform upon which further productivity enhancing changes can be based. It also enables closer links between businesses, their suppliers, customers, competitors and collaborative partners allowing the business to be more responsive to innovation opportunities. This paper combines broadband internet connection, business web presence, use of e-commerce into an ICT intensity index to develop a convenient and meaningful measure of ICT sophistication.

The previous paper outlined business size, market structure (degree of competition in the market), networks and collaboration, foreign ownership and export activity as other factors associated with innovation. Again in this study, these factors show an association with innovation with the exception of foreign ownership. However, conflicting theories of foreign ownership may explore the reasons for this. There is some suggestion that foreign ownership implies greater financial resources and greater access to knowledge and technology and therefore has a positive impact. Alternatively it is considered that Australian domestic businesses may be merely adopting innovations that have already been developed elsewhere in the company and thus cannot be classified as innovations.

2. DATA

The data sources for this analysis are the ABS Business Longitudinal Database (BLD) and the Business Characteristics Survey (BCS). The BCS is an annual ABS survey containing a consistent set of core questions on ICT, innovation and other business characteristics to allow for longitudinal analysis.¹ The BLD combines data from the ABS Business Characteristics Survey (BCS) and financial data sourced from other government agencies.² For this study, the data set comprised of the responses from firms with reliable responses in both 2007–08 and 2008–09, resulting in a sample of 8350 firms.

Much of the data comes from subjective responses from the survey respondents and this should be taken into account when considering the results.

1 For more information on the BCS see *Selected Characteristics of Australian Business, 2008-09* (ABS,2010).

2 For more information on the BLD, see *Technical Manual: Business Longitudinal Database, CURF, Australia, 2004-05 to 2009-10* (ABS,2011).

3. METHODOLOGY

Three forms of analysis are used on the data, cross-tabulation, correlation and regression. The cross tabulation studies show the distribution of innovative versus non-innovative businesses by selected variables. The correlation analysis shows the degree of association between the various ICT variables and the innovation variable. The regression analysis shows the association between ICT use and innovation activity while controlling for the effects of a range of other business characteristics. Probit based models are used for the regression due to the categorical nature of the dependant variables. A binary probit model was used for the variables with a binary outcome and an ordered probit model was used for the non-binary outcome variables.

For the cross tabulation and main regression analysis the innovation variable is defined as:

“Businesses which undertook any type of innovative activity, be it product, process, organisational / managerial or marketing innovation, which was either implemented, ongoing or abandoned in 2008–09.”

For analysis involving other innovation variables, the reader is directed to Appendix A for descriptions of the variables.

As in previous studies, feedback is expected between business innovation and ICT use. To try to control for this, data from two years is analysed where ICT usage in year one (2007–08) was modelled against the innovation activity in year two (2008–09).

One of the potential problems in this type of analysis is multicollinearity. This occurs when many closely related independent variables are included in a model and can lead to biased estimates. In this analysis it was expected that the ICT variables would be closely related. This was confirmed when correlation analysis was performed which showed that the ICT variables are all highly correlated. This was also evident when a series of probit regression models were run using the ICT variables individually (see Appendix D). To overcome this issue, an ordered categorical variable for ICT intensity was created. Hereafter referred to as the ICT intensity index.

The ICT intensity index used is the same as the comparable ICT index that Todhunter and Abello created in their original study. Further information on the ICT intensity index can be found in the regression analysis section.

4. RESULTS

4.1 Cross tabulation analysis

The following section contains the results of the cross tabulation analysis between various ICT variables and whether the business was innovative or non-innovative.

The results highlight the difference in the proportion of businesses innovating in 2008–09, according to their use of ICT in the previous year. They can be used to give an idea of the impact these variables have on innovation. The reader is reminded that the proportions presented are unweighted and only represent the sample of businesses used for analysis.

Computer use can be viewed as a basic indicator of ICT use. Table 4.1 shows, businesses which used a computer in 2007–08 were more likely to undertake some type of innovative activity in 2008–09 (51%), when compared to businesses which did not use a computer in 2007–08 (16%).

4.1 Comparison of innovative activity in 2008–09 and computer use in 2007–08

	<i>Computer use in 2007–08</i>					
	<i>No</i>		<i>Yes</i>		<i>Total</i>	
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
Undertook any type of innovative activity in 2008–09						
No	779	84%	3,630	49%	4,409	53%
Yes	149	16%	3,792	51%	3,941	47%
Total	928	100%	7,422	100%	8,350	100%

Table 4.2 shows businesses with an internet connection were more likely to have been innovators in 2008–09 when compared to businesses that did not have an internet connection. Furthermore, businesses with a broadband internet connection in 2007–08 can be seen to have a higher proportion of innovators in 2008–09 (52%) than businesses with dial up (40%).

4.2 Comparison of innovative activity in 2008–09 and internet connection in 2007–08

	<i>Main type of internet connection in 2007–08</i>							
	<i>Dial up</i>		<i>Broadband</i>		<i>No internet</i>		<i>Total</i>	
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
Undertook any type of innovative activity in 2008–09								
No	311	60%	3,244	48%	854	83%	4,409	53%
Yes	208	40%	3,563	52%	170	17%	3,941	47%
Total	519	100%	6,807	100%	1,024	100%	8,350	100%

For the following tables, web presence includes businesses which have their own website, home page or have a presence on another entity's website, but excludes online listings or directories.

Table 4.3 shows amongst businesses which had a web presence in 2007–08, 63% undertook innovative activity in 2008–09. Compared to businesses without a web presence in 2007–08, where only 35% undertook innovative activity in 2008–09.

4.3 Comparison of innovative activity in 2008–09 and web presence in 2007–08 (for businesses using the internet in 2007–08)

	<i>Had web presence in 2007–08</i>							
	<i>No</i>		<i>Yes</i>		<i>Missing</i>		<i>Total</i>	
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
Undertook any type of innovative activity in 2008–09								
No	1,976	65%	1,577	36%	2	100%	3,555	48%
Yes	1,072	35%	2,699	63%	0	0%	3,771	52%
Total	3,048	100%	4,276	100%	2	100%	7,326	100%

Tables 4.4 and 4.5 show that businesses using e-commerce in 2007–08 were more likely to go on to undertake innovative activity in 2008–09 compared to businesses which did not use e-commerce. Amongst businesses that placed orders via the internet in 2007–08, 61% undertook innovative activity, compared to businesses that did not place orders where only 40% undertook innovative activity. Similarly amongst businesses which received orders via the internet in 2007–08, 61% undertook innovative activity the following year, compared to businesses that did not receive orders, where 47% undertook innovative activity.

4.4 Comparison of innovative activity in 2008–09 and whether the business placed orders via the internet in 2007–08 (for businesses using the internet in 2007–08)

	<i>Placed orders via the internet in 2007–08</i>							
	<i>No</i>		<i>Yes</i>		<i>Missing</i>		<i>Total</i>	
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No</i>	<i>%</i>	<i>No.</i>	<i>%</i>
Undertook any type of innovative activity in 2008–09								
No	1,937	60%	1,597	39%	21	40%	3,555	48%
Yes	1,289	40%	2,451	61%	31	60%	3,771	52%
Total	3,226	100%	4,048	100%	52	100%	7,326	100%

4.5 Comparison of innovative activity in 2008–09 and whether the business received orders via the internet in 2007–08 (for businesses using the internet in 2007–08)

	<i>Received orders via the internet in 2007–08</i>							
	<i>No</i>		<i>Yes</i>		<i>Missing</i>		<i>Total</i>	
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
Undertook any type of innovative activity in 2008–09								
No	2,659	53%	894	39%	2	100%	3,555	48%
Yes	2,369	47%	1,402	61%	0	0%	3,771	52%
Total	5,028	100%	2,296	100%	2	100%	7,326	100%

4.2 Correlation analysis

Polychoric or tetrachoric correlation coefficients are used to measure the degree of association between the ordered categorical variables and range between –1 and 1. Larger positive values represent stronger positive association, whereas larger negative values represent stronger negative association between the variables.

The results of the correlation analysis between the individual ICT variables and innovation variables are presented in table 4.6. There appears to be a positive relationship between ICT use and business innovation. Other correlation analysis was also undertaken on implemented only innovation and is presented in Appendix C.

4.6 Correlation analysis for individual ICT variables (2007–08) and innovation (2008–09)

	<i>Any type (anyinnact09)</i>	<i>Product (gsinnact09)</i>	<i>Process (opinnact09)</i>	<i>Organisation (ominnact09)</i>	<i>Marketing (mainnact09)</i>
Computer use	0.48	0.39	0.43	0.52	0.45
Type of Internet	0.42	0.34	0.37	0.45	0.36
Web presence	0.49	0.40	0.45	0.48	0.42
Places orders via the internet	0.40	0.32	0.34	0.35	0.32
Receives orders via the internet	0.28	0.30	0.21	0.18	0.33

4.3 Regression analysis

The dependant variable used in the regression analysis relates to whether or not a business undertook innovative activity in 2008–09. The independent variables used are ICT use, employment size, industry division, export activity, degree of competition, degree of foreign ownership and cooperative joint R&D arrangements.

ICT intensity index

The use of an ICT intensity index to represent ICT use was developed by Todhunter and Abello (2011). Details of the specific ICT intensity variable are presented in table 4.7. As in Todhunter and Abello, the categories are mutually exclusive, with businesses classified according to the highest level of ICT use.

4.7 ICT intensity index – based on ICT use in 2007–08

<i>Values</i>	<i>ICT intensity</i>	<i>Description</i>	<i>Frequency</i>	<i>Percentage</i>
1	Most	Business has broadband connection, web presence, places orders via the internet and receives orders via the internet or web in 2007–08	1,294	15.5%
2	High	Business has broadband connection, web presence and places orders via the internet, but does not receive orders via the internet or web in 2007–08	1,576	18.9%
3	Moderate	Business has broadband connection and web presence but does not place or receive orders via the internet or web in 2007–08	1,277	15.3%
4	Low	Business has broadband connection, but has no web presence in 2007–08	2,660	31.8%
5	Least	Business does not use broadband connection in 2007–08	1,543	18.5%

Regression results

Table 4.8 shows the regression results from a number of models testing for the relationship between innovation and the ICT intensity index as well as other independent variables.

The regression results in table 4.8 show that ICT intensity has significant and positive coefficients, which increase with each intensity level. This suggests that businesses which used more complex ICT are more likely to undertake innovative activity. The results also show that the ICT intensity index is robust as it continues to be significant with each increase to the model complexity. This further highlights that the impact of ICT use is strongly related to the likelihood that a business will undertake innovative activity.

The results also show that the larger the business (as proxied by the number of employees within the business), the more likely it is to undertake innovative activity.

The coefficients for the competition variable are also positive and increasing with each degree of competition. This implies that the degree of competition the business experienced in 2008–09 is positively linked with the business' likelihood of undertaking innovative activity in 2008–09; with businesses who experienced a strong degree of competition being significantly more likely to innovate.

Businesses that had a collaborative joint research and development arrangement in 2008–09 were also more likely to undertake innovation than businesses that did not have an arrangement. Similarly, exporting businesses are more likely to undertake innovative activity.

Model V was also tested using different dependant variables and the results are shown in Appendix E. In that analysis we consider the probability of a business undertaking a specific type of innovation (for example product innovation). The results show that ICT intensity is still robust and is positively associated with the likelihood to undertake any of the following types of innovation: product, process, organisational, marketing. This relationship also held true for implemented only innovations (as can also be seen in Appendix E).

The following notes may assist in the interpretation of the regression results. Within each variable group (e.g. industry, business size) a reference category is selected. The reference or base case has an implicit coefficient of zero. Businesses from other categories are compared with businesses from the reference category to establish which businesses are more (or less) likely to innovate. For example, Manufacturing is the reference category for Industry division. Thus, businesses from an industry with a statistically significant positive (/negative) coefficient are considered more (/less) likely to innovate than Manufacturing firms.

4.8 Regression results for any innovative activity in 2008–09 using ICT intensity index

	<i>Model I</i>	<i>Model II</i>	<i>Model III</i>	<i>Model IV</i>	<i>Model V</i>
Intercept	-0.2582 ***	-0.3235 ***	-0.6203 ***	-0.6192 ***	-0.6695 ***
ICT intensity					
Most intense	0.9228 ***	0.8730 ***	0.8362 ***	0.8357 ***	0.8260 ***
High	0.6654 ***	0.6383 ***	0.6083 ***	0.6080 ***	0.5863 ***
Moderate	0.5049 ***	0.4805 ***	0.4470 ***	0.4481 ***	0.4472 ***
Low	0.2062 ***	0.2027 ***	0.2002 ***	0.1998 ***	0.2040 ***
Least intense					
Number of employees					
Non-employing	-0.6823 ***	-0.6760 ***	-0.6125 ***	-0.6109 ***	-0.6080 ***
1–4 employees	-0.3217 ***	-0.3172 ***	-0.3029 ***	-0.3035 ***	-0.2985 ***
5–19 employees					
20–199 employees	0.1831 ***	0.1618 ***	0.1546 ***	0.1562 ***	0.1516 ***
200+ employees	0.2510 ***	0.1864 ***	0.1788 ***	0.1952 ***	0.1535 ***
Industry division					
Agriculture, forestry and fishing	-0.1323 **	-0.0852	-0.0470	-0.0487	-0.0615
Manufacturing					
Mining	-0.2956 ***	-0.2763 ***	-0.2266 ***	-0.2242 ***	-0.2781 ***
Electricity, water, gas and waste services	-0.2924 **	-0.1896	-0.0987	-0.1059	-0.1832
Construction	-0.3304 ***	-0.2546 ***	-0.2511 ***	-0.2523 ***	-0.2393 ***
Wholesale	-0.1098 *	-0.0976	-0.1221 *	-0.1174 *	-0.0965
Retail trade	-0.1323 *	-0.0567	-0.0876	-0.0912	-0.0581
Accommodation and food services	-0.3067 ***	-0.2097 ***	-0.2171 ***	-0.2187 ***	-0.2034 ***
Transport, postal and warehousing	-0.2392 ***	-0.1638 **	-0.1282 *	-0.1288 *	-0.1041
Information, media & telecommunications	-0.0094	0.0294	0.0445	0.0472	0.0513
Financial and insurance services	-0.0267	0.0514	0.0473	0.0472	0.0616
Rental, hiring and real estate services	-0.1047	-0.0218	-0.0141	-0.0147	-0.0022
Professional, scientific & technical services	-0.1323 *	-0.1011	-0.0734	-0.0741	-0.0686
Administrative and support services	-0.5086 ***	-0.4218 ***	-0.4132 ***	-0.4164 ***	-0.3839 ***
Health care and social assistance	-0.2181 **	-0.0849	-0.0210	-0.0356	-0.0661
Arts and recreation services	-0.1806 **	-0.1197	-0.0943	-0.0981	-0.0986
Other services	-0.1015	-0.0269	-0.0290	-0.0310	-0.0134
Export activity					
Non-exporter in 2008–09					
Exporter in 2008–09		0.2852 ***	0.2713 ***	0.2800 ***	0.2400 ***
Competition					
No competition					
Minimal competition			0.1853 ***	0.1857 ***	0.2034 ***
Moderate competition			0.2968 ***	0.2976 ***	0.3180 ***
Strong competition			0.4247 ***	0.4258 ***	0.4499 ***
Foreign ownership					
Foreign ownership 0%–50% in 2008–09					
Foreign ownership >50% in 2008–09				-0.0665	-0.0657
R&D arrangements					
No joint R&D (collaborative arrangements) in 2008–09					
Joint R&D (collaborative arrangements) in 2008–09					0.6339 ***

*** denotes $\text{Pr}>\text{ChiSq} < 0.01$; ** denotes $\text{Pr}>\text{ChiSq} < 0.05$; * denotes $\text{Pr}>\text{ChiSq} < 0.10$.

4.4 Marginal effects

The figures below present the estimated probability that a business engages in some type of innovative activity in 2008–09. The estimated probabilities in figure 4.9 are based on a hypothetical business with the following characteristics: Manufacturing industry, non-exporter, no competition, less than 50% foreign ownership and no collaborative R&D arrangements. Figure 4.9 shows that if this hypothetical business was in the 5–19 employee business size and had moderate ICT intensity (i.e. a broadband connection and a web presence) it would be approximately eight percentage points more likely to innovate than an identical business with low ICT intensity (broadband connection only).

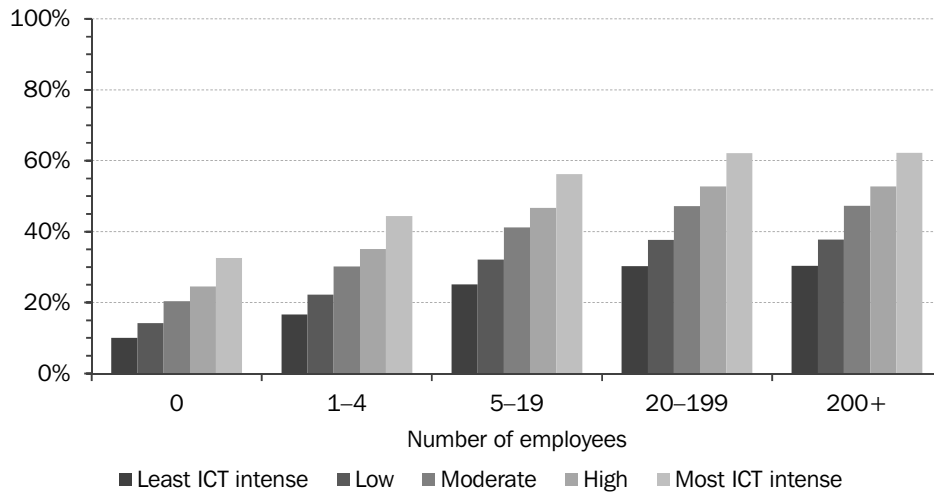
Figure 4.9 shows that in relation to business size, larger businesses are the most likely to undertake innovative activity.

Figures 4.10 and 4.11 show the impact export activity and collaborative R&D arrangements have on our hypothetical business' likelihood to undertake innovative activity. Across all business sizes and ICT intensities, on average those businesses which have export activity are nine percentage points more likely to innovate than non-exporting businesses. If the business also has a collaborative R&D arrangement they are on average a further 23 percentage points more likely to innovate.

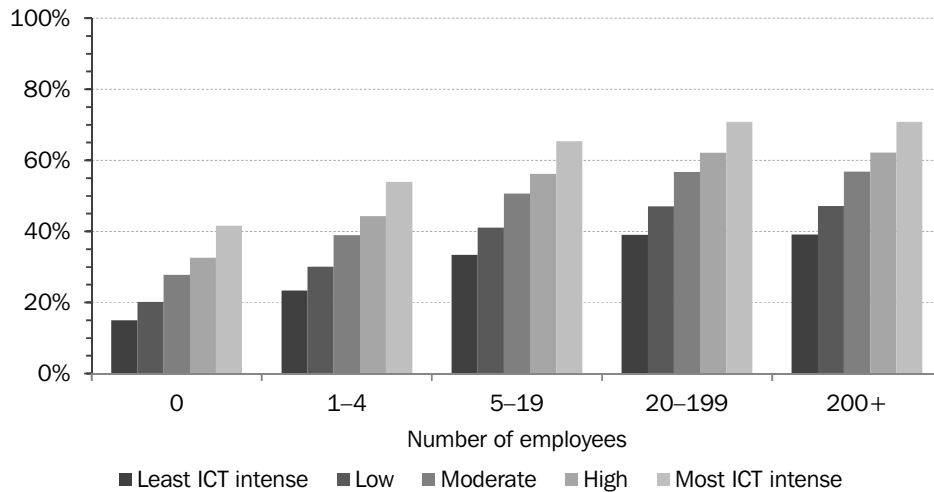
The estimated probabilities for the hypothetical case are also presented in Appendix F.

The estimated probabilities in figure 4.12 are based on businesses in different industries with the following characteristics: 5–19 employee size, non-exporter, no competition, less than 50% foreign ownership and no collaborative R&D arrangements. Figure 4.12 shows that across the selected industries, businesses with higher ICT intensity are more likely to innovate than those with low ICT intensity.

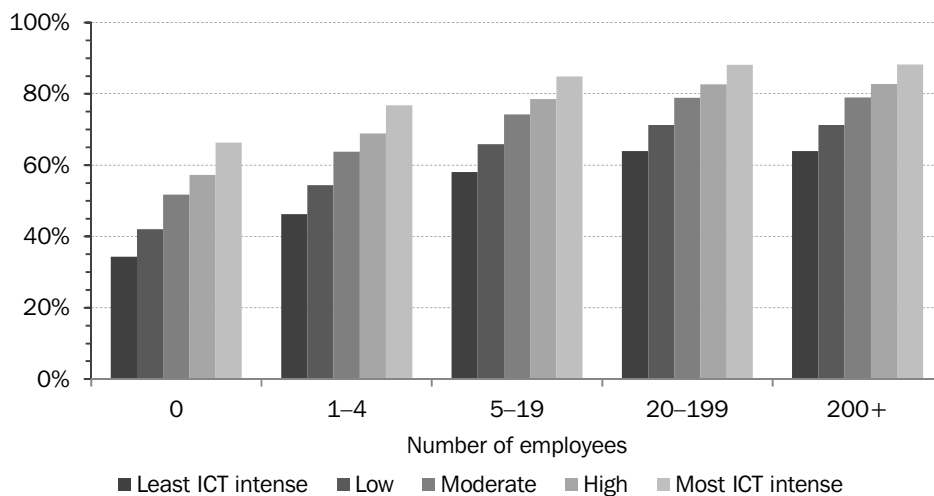
4.9 Estimated probability of engaging in innovative activity in 2008–09



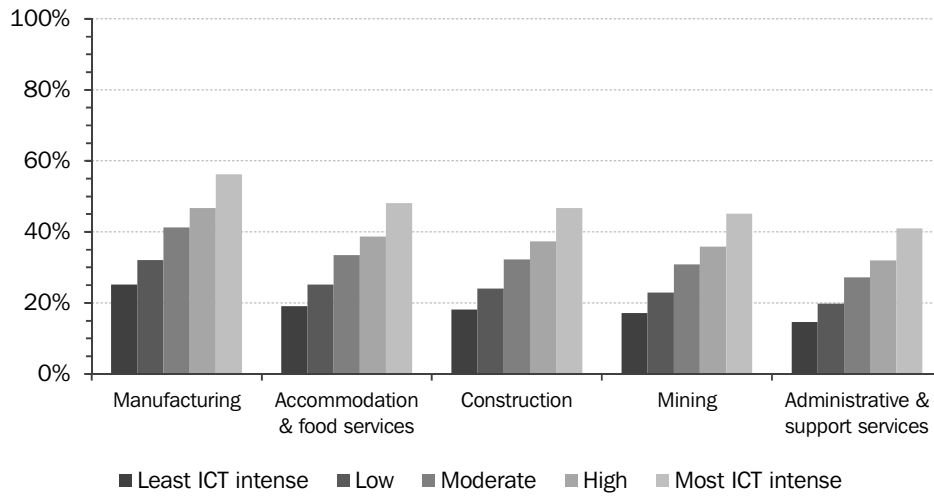
4.10 Estimated probability of engaging in innovative activity in 2008–09, Exporting business



4.11 Estimated probability of engaging in innovative activity in 2008–09, Exporting business with collaborative R&D arrangement



4.12 Estimated probability of engaging in innovative activity in 2008–09, for different industries



4.5 ICT and innovation novelty

The effect of ICT intensity on the sophistication of business innovative activity was also modelled. This involved creating three ordered categorical dependent variables, namely Novelty, Who developed and Number of innovations. Descriptions, frequency counts and the regression analyses of these variables can be found in Appendix H. The results show that ICT intensity is positively and significantly linked with the degree of novelty of an innovation, who developed the innovation and the number of innovations. Businesses with more intense ICT use are more likely to produce novel innovations, to develop innovations internally and develop more types of innovations.

5. CONCLUSION

This paper uses the ABS Business Longitudinal Database and Business Characteristics Survey to investigate the relationship between ICT use and business innovation. An ICT index (as developed by Todhunter and Abello) is used to measure a business' degree of ICT sophistication.

The cross tabulation, correlation and regression analysis show there is a strong relationship between ICT intensity and the likelihood that a business will undertake innovative activity. Furthermore, businesses that use more sophisticated forms of ICT are significantly more likely to innovate, produce a higher number of innovations, produce more novel innovations and develop their innovations internally.

Other variables from the model that were found to be significant were business size, competition, export status and cooperative arrangements for joint R&D.

ACKNOWLEDGEMENTS

The authors are grateful for the helpful comments and suggestions made during the analysis and drafting by Mr Patrick Stakelum from the Department of Broadband Communications and the Digital Economy (DBCDE), Mr Peter Rossiter (ABS) and Mr Franklin Soriano (ABS). Any remaining errors and omission are the responsibility of the authors.

REFERENCES

- Australian Bureau of Statistics (2010) *Selected Characteristics of Australian Business, 2008–09*, cat. no. 8167.0, ABS, Canberra.
- (2011) *Technical Manual: Business Longitudinal Database, CURF, Australia, 2004–05 to 2009–10*, cat. no. 8168.0.55.002, ABS, Canberra.
- Todhunter, J. and Abello, R. (2011) “Business Innovation and the Use of Information and Communications Technology”, *Methodology Research Papers*, cat. no. 1351.0.55.033, ABS, Canberra.

APPENDIXES

A. VARIABLE LISTS

A.1 Innovation variables

<i>Variable</i>	<i>Description</i>	<i>Values</i>	<i>Sample</i>
anyinnact09	Any type of innovation activity (Product, Process, Organisational/Managerial or Marketing) which was implemented, ongoing or abandoned in 2008–09	(1,0)	All businesses
gsinnact09	Product (Good and/or Service) innovation which was implemented, ongoing or abandoned in 2008–09	(1,0)	
opinact079	Operational Process innovation which was implemented, ongoing or abandoned in 2008–09	(1,0)	
ominact09	Organisational or Managerial innovation which was implemented, ongoing or abandoned in 2008–09	(1,0)	
mainact09	Marketing innovation which was implemented, ongoing or abandoned in 2008–09	(1,0)	
anyinn09	Any type of innovation (Product, Process, Organisational/Managerial or Marketing) which was implemented in 2008–09	(1,0)	
gsinn09	Product (Good and/or Service) innovation which was implemented in 2008–09	(1,0)	
opin09	Operational Process innovation which was implemented in 2008–09	(1,0)	
omin09	Organisational/Managerial innovation which was implemented in 2008–09	(1,0)	
main09	Marketing innovation which was implemented in 2008–09	(1,0)	
anynovel09	Any type of innovation (Product, Process, Organisational/Managerial or Marketing) which was implemented in 2008–09, classified by the highest degree of novelty of any type of innovation	0 = No implemented innovation 1 = Innovation was new to the business only 2 = Innovation was new to the industry only 3 = Innovation was new to Australia; 4 = Innovation was new to the world 5 = Business implemented innovation, but missing information on degree of novelty	Businesses which reported implementing an innovation.
anydevelop09	Any type of innovation (Product, Process, Organisational/Managerial or Marketing) which was implemented in 2008–09, classified by who developed the innovation	0 = No implemented innovation 1 = Innovation was developed exclusively by other business(es) or institution(s) 2 = Innovation was developed by this business, in cooperation with other business(es) or institution(s) 3 = Innovation was developed by this business or a related company only 4 = Business implemented innovation but missing information on 'who developed' the innovation	Businesses which reported implementing an innovation.

A.2 Information and communications technology (ICT) variables

<i>Variable</i>	<i>Description</i>	<i>Values</i>	<i>Sample</i>
comptr	Business used a computer in 2007–08	(1,0)	All businesses
webpres08	Business had a web presence in 2007–08	(1,0)	Businesses with an internet connection.
intercon08 intercon09	Type of internet connection in 2007–08 and 2008–09 respectively.	0 = No internet 1 = Dial-up connection 2 = Broadband connection	All businesses
plorder08 plorder09	Business placed orders via the internet or web in 2007–08 and 2008–09 respectively	(1,0)	All businesses with an internet connection
record08 record09	Business received orders via the internet or web in 2007–08 and 2008–09 respectively	(1,0)	All businesses with an internet connection

A.3 Other business demographic variables

<i>Variable</i>	<i>Description</i>	<i>Values</i>	<i>Sample</i>
d_export	Business received any income from exporting in 2008–09	(1,0)	All businesses
competition09	Degree of competition the business experienced in 2008–09	1 = Captive market/ No effective competition 2= Minimal 3=Moderate 4=Strong	
for_ownership09	Degree of foreign ownership in 2008–09	1= greater than 50% foreign ownership 2= 0 to 50% foreign ownership	
coopjres	Business had a collaborative arrangement for joint research and development in 2008–09	(1,0)	

B. SAMPLE DISTRIBUTIONS

B.1 Employment size

<i>Employment size</i>	<i>Frequency</i>	<i>Percent</i>	<i>Cumulative frequency</i>	<i>Cumulative percent</i>
Non-employed	421	5.0%	421	5.0%
1–4 employees	3,120	37.4%	3,541	42.4%
5–19 employees	1,806	21.6%	5,347	64.0%
20–199 employees	1,245	14.9%	6,592	78.9%
200+ employees	1,758	21.0%	8,350	100.0%

B.2 Industry division

<i>Industry Division (ANZSIC 2006)</i>	<i>Frequency</i>	<i>Percent</i>	<i>Cumulative frequency</i>	<i>Cumulative percent</i>
Agriculture, forestry and fishing*	1,320	15.8%	1,320	15.8%
Mining	306	3.8%	1,626	19.5%
Manufacturing*	1,277	15.7%	2,903	34.8%
Electricity, water, gas and waste services	108	1.3%	3,011	36.1%
Construction	492	6.0%	3,503	42.0%
Wholesale*	732	9.0%	4,235	50.7%
Retail trade	454	5.6%	4,689	56.2%
Accommodation and food services	438	5.4%	5,127	61.4%
Transport, postal and warehousing	542	6.6%	5,669	67.9%
Information, media and telecommunications	258	3.2%	5,927	71.0%
Financial and insurance services	181	2.2%	6,108	73.1%
Rental, hiring and real estate services	223	2.7%	6,331	75.8%
Professional, scientific and technical services	460	5.6%	6,791	81.3%
Administrative and support services	382	4.7%	7,173	85.9%
Health care and social assistance	298	3.7%	7,471	89.5%
Arts and recreation services	289	3.6%	7,760	92.9%
Other services	387	4.8%	8,147	97.6%
Missing	203	2.4%	8,350	100.0%

* Includes additional food industry sample that was introduced to three relevant industry divisions for panels one to three of the BLD.

B.3 Proportion* of businesses innovating

<i>Type of innovation</i>	<i>2007–08</i>		<i>2008–09</i>	
	<i>Number</i>	<i>Percentage</i>	<i>Number</i>	<i>Percentage</i>
Implemented Innovations				
Any type	3,817	45.7%	3,472	41.6%
Product	1,966	23.5%	1,714	20.5%
Operational process	2,209	26.5%	2,051	24.6%
Organisational/Managerial	2,061	24.7%	2,008	24.0%
Marketing	1,385	16.6%	1,426	17.1%
Implemented, ongoing or abandoned				
Any type	4,330	51.9%	3,941	47.2%
Product	2,047	28.8%	2,144	25.7%
Operational process	2,691	32.2%	2,458	29.4%
Organisational/Managerial	2,363	28.3%	2,220	26.6%
Marketing	1,886	22.6%	1,830	21.9%

* As a proportion of total businesses in the sample.

C. CORRELATION ANALYSIS

C.1 Correlation analysis for individual ICT variables (2007–08) and implemented (only) innovation (2008–09)

	<i>Any type anyinn09</i>	<i>Product gsinn09</i>	<i>Process opinn09</i>	<i>Organisation omin09</i>	<i>Marketing mainnt09</i>
Computer use	0.46	0.35	0.42	0.50	0.43
Type of internet	0.41	0.31	0.37	0.45	0.36
Web presence	0.48	0.43	0.38	0.46	0.42
Places orders via the internet	0.38	0.29	0.32	0.33	0.32
Receives orders via the internet	0.26	0.27	0.20	0.17	0.32

D. REGRESSION RESULTS USING ICT VARIABLES INDIVIDUALLY

D.1 Regression results – Any innovative activity in 2008–09 (implemented, ongoing, or abandoned), using separate ICT variables

	<i>Model I</i>	<i>Model II</i>	<i>Model III</i>	<i>Model IV</i>
Intercept	-0.4489 ***	-0.1320 ***	-0.2553 ***	-0.2908 ***
Number of employees				
Non-employing	-0.6715 ***	-0.7234 ***	-0.6816 ***	-0.6728 ***
1–4 employees	-0.3738 ***	-0.3345 ***	-0.3117 ***	-0.3111 ***
5–19 employees				
20–199 employees	0.2651 ***	0.1879 ***	0.1789 ***	0.1879 ***
200+ employees	0.4692 ***	0.2414 ***	0.2173 ***	0.2502 ***
Industry division				
Agriculture, forestry and fishing	-0.2506 ***	-0.1496 ***	-0.1401 **	-0.1148 **
<i>Manufacturing</i>				
Mining	-0.3731 ***	-0.3493 ***	-0.3588 ***	-0.3219 ***
Electricity, water, gas and waste services	-0.3482 ***	-0.2810 **	-0.2887 **	-0.2611 *
Construction	-0.3794 ***	-0.3143 ***	-0.2996 ***	-0.2768 ***
Wholesale	-0.0929	-0.0830	-0.0925	-0.0982
Retail trade	-0.1199 *	-0.1147	-0.1293 *	-0.1263 *
Accommodation and food services	-0.2910 ***	-0.3168 ***	-0.3144 ***	-0.3049 ***
Transport, postal and warehousing	-0.2613 ***	-0.2303 ***	-0.2324 ***	-0.2244 ***
Information, media and telecommunications	0.1108	0.0543	-0.0037	-0.0027
Financial and insurance services	-0.0380	-0.0110	-0.0326	-0.0060
Rental, hiring and real estate services	-0.0410	-0.0988	-0.1293	-0.0950
Professional, scientific and technical services	-0.0979	-0.1071	-0.1666 **	-0.1368 *
Administrative and support services	-0.5381 ***	-0.5015 ***	-0.5099 ***	-0.4859 ***
Health care and social assistance	-0.2926 ***	-0.2664 ***	-0.2945 ***	-0.2460 ***
Arts and recreation services	-0.1205	-0.1518 *	-0.1851 **	-0.1761 **
Other services	-0.1396 *	-0.1236	-0.1284 *	-0.1046
Internet				
No internet				
Dial-up	0.6240 ***			
Broadband	0.6584 ***			
Web presence				
No				
Yes		0.5659 ***	0.4625 ***	0.4283 ***
Place orders				
No				
Yes			0.3676 ***	0.3223 ***
Received orders				
No				
Yes				0.1851 ***

*** denotes $\text{Pr} > \text{ChiSq} < 0.01$; ** denotes $\text{Pr} > \text{ChiSq} < 0.05$; * denotes $\text{Pr} > \text{ChiSq} < 0.10$.

E. REGRESSION RESULTS WITH ALTERNATIVE DEPENDENT VARIABLES

E.1 Regression results – Individual types of innovative activity in 2008–09 (implemented, ongoing or abandoned)

	<i>Any type</i>	<i>Product</i>	<i>Operational process</i>	<i>Organisational</i>	<i>Marketing</i>
Intercept	-0.6695 ***	-1.1137 ***	-1.0530 ***	-1.3122 ***	-1.5328 ***
ICT intensity					
Most intense	0.8260 ***	0.6567 ***	0.6297 ***	0.7395 ***	0.8856 ***
High	0.5863 ***	0.3825 ***	0.4429 ***	0.6470 ***	0.5750 ***
Moderate	0.4472 ***	0.3567 ***	0.3574 ***	0.5370 ***	0.5427 ***
Low	0.2040 ***	0.1500 ***	0.1701 ***	0.3078 ***	0.1879 ***
<i>Least intense</i>					
Number of employees					
Non-employing	-0.6080 ***	-0.4256 ***	-0.4936 ***	-0.6117 ***	-0.4119 ***
1–4 employees	-0.2985 ***	-0.1097 **	-0.3100 ***	-0.4040 ***	-0.2384 ***
5–19 employees					
20–199 employees	0.1516 ***	0.0426	0.2264 ***	0.2121 ***	-0.0296
200+ employees	0.1535 ***	0.0054	0.3891 ***	0.2158 ***	-0.2599 ***
Industry division					
Agriculture, forestry and fishing	-0.0615	-0.4628 ***	0.0329	0.0737	-0.1241 *
<i>Manufacturing</i>					
Mining	-0.2781 ***	-0.6985 ***	-0.3217 ***	-0.1185	-0.3644 ***
Electricity, water, gas and waste services	-0.1832	-0.5716 ***	-0.1321	0.1180	-0.4596 ***
Construction	-0.2393 ***	-0.4603 ***	-0.3341 ***	0.1030	-0.3057 ***
Wholesale	-0.0965	-0.0721	-0.1200 *	-0.0040	-0.0494
Retail trade	-0.0581	-0.0930	-0.2190 ***	0.0195	0.0715
Accommodation and food services	-0.2034 ***	-0.1717 **	-0.4383 ***	0.0023	0.0401
Transport, postal and warehousing	-0.1041	-0.2481 ***	-0.0717	0.0386	-0.1096
Information, media and telecommunications	0.0513	0.1696 *	-0.2251 **	0.0031	0.1085
Financial and insurance services	0.0616	-0.0184	0.0661	0.2175 **	0.1602
Rental, hiring and real estate services	-0.0022	-0.3795 ***	-0.2232 **	0.1436	0.0427
Professional, scientific and technical services	-0.0686	-0.2055 ***	-0.1928 **	0.2058 ***	-0.0336
Administrative and support services	-0.3839 ***	-0.3599 ***	-0.3900 ***	-0.0528	-0.2349 **
Health care and social assistance	-0.0661	-0.2318 **	-0.1654 *	0.2793 ***	-0.0988
Arts and recreation services	-0.0986	-0.3153 ***	-0.3956 ***	-0.0201	0.1786 *
Other services	-0.0134	-0.1341	-0.2189 **	0.0929	0.1353
Export activity					
<i>Non-exporter in 2008–09</i>					
Exporter in 2008–09	0.2400 ***	0.3139 ***	0.1377 ***	0.1432 ***	0.1368 ***
Competition					
<i>No competition</i>					
Minimal competition	0.2034 ***	0.2225 ***	0.1662 **	0.0497	0.1871 **
Moderate competition	0.3180 ***	0.3286 ***	0.2745 ***	0.1774 ***	0.4611 ***
Strong competition	0.4499 ***	0.4046 ***	0.3767 ***	0.2608 ***	0.6373 ***
Foreign ownership					
<i>Foreign ownership 0%–50% in 2008–09</i>					
Foreign ownership >50% in 2008–09	-0.0657	-0.0484	-0.0381	-0.0232	-0.0951
R&D arrangements					
<i>No joint R&D (collaborative arrange.) in 2008–09</i>					
Joint R&D (collaborative arrange.) in 2008–09	0.6339 ***	0.5525 ***	0.5140 ***	0.4286 ***	0.4269 ***

*** denotes $\text{Pr} > \text{ChiSq} < 0.01$; ** denotes $\text{Pr} > \text{ChiSq} < 0.05$; * denotes $\text{Pr} > \text{ChiSq} < 0.10$.

E.2 Individual types of innovative activity implemented in 2008–09

	<i>Any type</i>	<i>Product</i>	<i>Operational process</i>	<i>Organisational</i>	<i>Marketing</i>
Intercept	-0.7720 ***	-1.2612 ***	-1.1387 ***	-1.3827 ***	-1.6915 ***
ICT intensity					
Most intense	0.7976 ***	0.5720 ***	0.6016 ***	0.6898 ***	0.8670 ***
High	0.5320 ***	0.3031 ***	0.4027 ***	0.5948 ***	0.5192 ***
Moderate	0.4408 ***	0.2819 ***	0.3273 ***	0.5407 ***	0.5001 ***
Low	0.2007 ***	0.1052 *	0.1734 ***	0.3295 ***	0.1866 ***
<i>Least intense</i>					
Number of employees					
Non-employing	-0.6266 ***	-0.4613 ***	-0.5708 ***	-0.6311 ***	-0.4591 ***
1–4 employees	-0.3190 ***	-0.1507 ***	-0.3375 ***	-0.4166 ***	-0.2628 ***
5–19 employees					
20–199 employees	0.1813 ***	0.0579	0.2308 ***	0.2070 ***	-0.0064
200+ employees	0.1653 ***	0.0253	0.3520 ***	0.2442 ***	-0.1234 **
Industry division					
Agriculture, forestry and fishing	-0.1053 *	-0.4390 ***	-0.0377	0.0421	-0.1427 *
<i>Manufacturing</i>					
Mining	-0.2987 ***	-0.6346 ***	-0.3256 ***	-0.1621	-0.3808 ***
Electricity, water, gas and waste services	-0.2961 **	-0.5590 ***	-0.3550 **	0.0683	-0.5583 ***
Construction	-0.1936 ***	-0.4498 ***	-0.3613 ***	0.1036	-0.3013 ***
Wholesale	-0.0619	-0.0327	-0.1308 **	0.0440	-0.0156
Retail Trade	0.0020	0.0360	-0.2004 **	0.0478	0.0939
Accommodation and food services	-0.1720 **	-0.1359	-0.4224 ***	-0.0068	0.0655
Transport, postal and warehousing	-0.0768	-0.1965 **	-0.1192	0.0360	-0.1309
Information, media and telecommunications	0.0149	0.1806 *	-0.1370	0.0431	0.0445
Financial and insurance services	0.0516	0.0824	-0.0160	0.2015 *	0.2045 *
Rental, hiring and real estate services	0.0119	-0.3974 ***	-0.2257 **	0.1348	0.0859
Professional, scientific and technical services	-0.0523	-0.1307 *	-0.2265 ***	0.2447 ***	-0.0619
Administrative and support services	-0.2812 ***	-0.2788 ***	-0.3263 ***	-0.0220	-0.2564 ***
Health care and social assistance	-0.0043	-0.1505	-0.2054 **	0.2894 ***	-0.1173
Arts and recreation services	-0.0759	-0.2741 ***	-0.4821 ***	0.0068	0.2142 **
Other services	0.0022	-0.0809	-0.2654 ***	0.1172	0.1516 *
Export activity					
<i>Non-exporter in 2008–09</i>					
Exporter in 2008–09	0.1916 ***	0.2718 ***	0.1251 ***	0.1478 ***	0.1516 ***
Competition					
<i>No competition</i>					
Minimal competition	0.1908 ***	0.2710 ***	0.1997 ***	0.0341	0.1495 *
Moderate competition	0.2868 ***	0.3247 ***	0.2504 ***	0.1807 ***	0.4382 ***
Strong competition	0.3557 ***	0.3762 ***	0.3261 ***	0.2396 ***	0.5715 ***
Foreign ownership					
<i>Foreign ownership 0%–50% in 2008–09</i>					
Foreign ownership >50% in 2008–09	-0.0214	0.0133	0.0143	-0.0382	-0.1250 *
R&D arrangements					
<i>No joint R&D (collaborative arrange.) in 2008–09</i>					
Joint R&D (collaborative arrange.) in 2008–09	0.5602 ***	0.4980 ***	0.4972 ***	0.3856 ***	0.3937 ***

*** denotes $\text{Pr} > \text{ChiSq} < 0.01$; ** denotes $\text{Pr} > \text{ChiSq} < 0.05$; * denotes $\text{Pr} > \text{ChiSq} < 0.10$.

F. MARGINAL EFFECTS

The estimated probability that a business engages in some type of innovative activity in 2008–09 based on a hypothetical business with the following characteristics:

BASE: Manufacturing industry, non-exporter, no competition, less than 50% foreign ownership and no collaborative R&D arrangements.

EXPORTER: Manufacturing industry, exporter, no competition, less than 50% foreign ownership and no collaborative R&D arrangements.

EXPORTER AND R&D: Manufacturing industry, exporter, no competition, less than 50% foreign ownership and has collaborative R&D arrangements.

F.1 Estimated probability of engaging in innovative activity in 2008–09

	<i>Business size (number of employees)</i>				
	0	1 to 4	5 to 19	20 to 199	200 or more
	BASE				
ICT intensity					
Least	10%	17%	25%	30%	30%
Low	14%	22%	32%	38%	38%
Moderate	20%	30%	41%	47%	47%
High	24%	35%	47%	53%	53%
Most	33%	44%	56%	62%	62%
	EXPORTER				
ICT intensity					
Least	15%	23%	33%	39%	39%
Low	20%	30%	41%	47%	47%
Moderate	28%	39%	51%	57%	57%
High	33%	44%	56%	62%	62%
Most	42%	54%	65%	71%	71%
	EXPORTER AND R&D				
ICT intensity					
Least	34%	46%	58%	64%	64%
Low	42%	54%	66%	71%	71%
Moderate	52%	64%	74%	79%	79%
High	57%	69%	79%	83%	83%
Most	66%	77%	85%	88%	88%

G. COMPARABLE ICT INTENSITY INDEX FOR 2007–08 AND 2008–09

G.1 Frequency of ICT intensity variables from 2007–08 and 2008–09

Values	ICT intensity	Description	2007–08		2008–09	
			No.	%	No.	%
1	Most	Business has broadband connection, web presence, places orders via the internet or web and receives orders via the internet or web in 2007–08	1,294	15.5%	1,729	20.7%
2	High	Business has broadband connection, web presence and places orders via the internet or web, but does not receive orders via the internet or web in 2007–08	1,576	18.9%	1,478	17.7%
3	Moderate	Business has broadband connection and web presence but does not place or receive orders via the internet or web in 2007–08	1,277	15.3%	1,199	14.3%
4	Low	Business has broadband connection, but has no web presence in 2007–08	2,660	31.8%	2,953	35.4%
5	Least	Business does not use broadband connection in 2007–08	1,543	18.5%	991	11.9%

G.2 Cross-tabulation of ICT intensity in 2007–08 by ICT intensity in 2008–09

ICT intensity in 2007–08	ICT intensity in 2008–09					Total
	1	2	3	4	5	
1	1,025 59.3%	93 6.3%	134 11.2%	36 1.2%	6 0.6%	1,294 15.5%
2	337 19.5%	974 65.9%	203 16.9%	55 1.9%	7 0.7%	1,576 18.9%
3	216 12.5%	289 19.6%	685 57.1%	72 2.4%	15 1.5%	1,277 15.3%
4	92 5.3%	102 6.9%	103 8.6%	2,292 77.6%	71 7.2%	2,660 31.9%
5	59 3.4%	20 1.4%	74 6.2%	498 16.9%	892 90.0%	1,543 18.5%
Total	1,729 20.7%	1,478 17.7%	1,199 14.4%	2,953 35.4%	991 11.9%	8,350 100.0%

G.3 Regression results – Any innovative activity in 2008–09, using ICT index on comparable data from 2007–08 and 2008–09

	2007–08	2008–09
Intercept	–0.6695 ***	–0.8733 ***
ICT intensity		
Most intense	0.8260 ***	1.1022 ***
High	0.5863 ***	0.8844 ***
Moderate	0.4472 ***	0.6193 ***
Low	0.2040 ***	0.3516 ***
Least intense		
Number of employees		
Non-employing	–0.6080 ***	–0.5357 ***
1–4 employees	–0.2985 ***	–0.2534 ***
5–19 employees		
20–199 employees	0.1516 ***	0.1448 ***
200+ employees	0.1535 ***	0.1335 **
Industry division		
Agriculture, forestry and fishing	–0.0615	–0.0187
Manufacturing		
Mining	–0.2781 ***	–0.2897 ***
Electricity, water, gas and waste services	–0.1832	–0.2018
Construction	–0.2393 ***	–0.2524 ***
Wholesale	–0.0965	–0.1106 *
Retail trade	–0.0581	–0.0572
Accommodation and food services	–0.2034 ***	–0.2064 ***
Transport, postal and warehousing	–0.1041	–0.1014
Information, media and telecommunications	0.0513	0.0360
Financial and insurance services	0.0616	0.0642
Rental, hiring and real estate services	–0.0022	–0.0392
Professional, scientific and technical services	–0.0686	–0.1061
Administrative and support services	–0.3839 ***	–0.3980 ***
Health care and social assistance	–0.0661	–0.0819
Arts and recreation services	–0.0986	–0.1497 *
Other services	–0.0134	0.0069
Export activity		
Non-exporter in 2008–09		
Exporter in 2008–09	0.2400 ***	0.2076 ***
Competition		
No competition		
Minimal competition	0.2034 ***	0.1722 ***
Moderate competition	0.3180 ***	0.2801 ***
Strong competition	0.4499 ***	0.4105 ***
Foreign ownership		
Foreign ownership 0%–50% in 2008–09		
Foreign ownership >50% in 2008–09	–0.0657	–0.0719
R&D arrangements		
No joint R&D (collaborative arrangements) in 2008–09		
Joint R&D (collaborative arrangements) in 2008–09	0.6339 ***	0.6145 ***

*** denotes $\text{Pr} > \text{ChiSq} < 0.01$; ** denotes $\text{Pr} > \text{ChiSq} < 0.05$; * denotes $\text{Pr} > \text{ChiSq} < 0.10$.

H. ICT INTENSITY AND DEGREE OF INNOVATION NOVELTY

H.1 Frequency counts for dependent variable = Implemented innovations in 2008–09, by degree of novelty (anynovel09)

<i>Value</i>	<i>Description</i>	<i>Frequency</i>	<i>Percent</i>
0	No implemented innovation	4,878	58.4%
1	Implemented an innovation which was, at best, new to the business	1,575	18.9%
2	Implemented an innovation which was, at best, new to the industry	137	1.6%
3	Implemented an innovation which was, at best, new to Australia	151	1.8%
4	Implemented an innovation which was, at best, new to the world	95	1.1%
5	Missing – Business implemented an innovation, but did not provide information on the degree of novelty *	1,514	18.1%

* These businesses are excluded from the innovation novelty models.

H.2 Frequency counts for dependent variable = Implemented innovations in 2008–09, according to who developed (anydevelop09)

<i>Value</i>	<i>Description</i>	<i>Frequency</i>	<i>Percent</i>
0	No implemented innovation	4,878	58.4%
1	Implemented an innovation which was developed exclusively by other business(es) or institution(s)	114	1.4%
2	Implemented an innovation which was developed by the business, in co-operation with other business(es) or institution(s)	264	3.2%
3	Implemented an innovation which was developed exclusively internally (by the business or a related company)	1,641	19.6%
5	Missing – Business implemented an innovation, but did not provide information on the degree of novelty *	1,453	17.4%

* These businesses are excluded from the innovation novelty models.

H.3 Frequency counts for dependent variable = Number of types of innovative activity in 2008–09 (mult_inn09)

<i>Value</i>	<i>Description</i>	<i>Frequency</i>	<i>Percent</i>
0	No innovative activity of any type	4,409	52.8%
1	Business engaged in a <i>single</i> type of innovative activity (Product, Process, Organisational or Managerial) which was either, implemented, ongoing or abandoned.	1,396	16.7%
2	Business engaged in <i>two</i> types of innovative activity (Product, Process, Organisational or Managerial) which was either, implemented, ongoing or abandoned.	1,072	12.8%
3	Business engaged in <i>three</i> types of innovative activity (Product, Process, Organisational or Managerial) which was either, implemented, ongoing or abandoned.	780	9.3%
4	Business engaged in <i>four</i> types of innovative activity (Product, Process, Organisational or Managerial) which was either, implemented, ongoing or abandoned.	693	8.3%

H.4 Ordered Probit regression results – Implemented innovations in 2008–09, according to degree of novelty

Intercept	
Innovation new to the business	-1.1657 ***
Innovation new to the industry	-2.4743 ***
Innovation new to Australia	-2.7229 ***
Innovation new to the world	-3.1924 ***
ICT intensity	
Most intense	0.8943 ***
High	0.7297 ***
Moderate	0.6354 ***
Low	0.2444 ***
<i>Least intense</i>	
Number of employees	
Non-employing	-0.9646 ***
1–4 employees	-0.4543 ***
5–19 employees	
20–199 employees	0.1667 ***
200+ employees	0.3282 ***
Industry division	
Agriculture, forestry and fishing	-4.9437
<i>Manufacturing</i>	
Mining	-0.3118 ***
Electricity, water, gas and waste services	-0.1438
Construction	-0.1474 *
Wholesale	-0.0060
Retail trade	0.0237
Accommodation and food services	-0.2796 ***
Transport, postal and warehousing	-0.1458 *
Information, media and telecommunications	-0.0016
Financial and insurance services	0.1667
Rental, hiring and real estate services	0.0006
Professional, scientific and technical services	-0.0444
Administrative and support services	-0.3176 ***
Health care and social assistance	-0.0429
Arts and recreation services	-0.1085
Other services	-0.0414
Export activity	
<i>Non-exporter in 2008–09</i>	
Exporter in 2008–09	0.2077 ***
Competition	
<i>No competition</i>	
Minimal competition	0.1696 **
Moderate competition	0.1868 ***
Strong competition	0.2583 ***
Foreign ownership	
<i>Foreign ownership 0%–50% in 2008–09</i>	
Foreign ownership >50% in 2008–09	0.0828
R&D arrangements	
<i>No joint R&D (collaborative arrangements) in 2008–09</i>	
Joint R&D (collaborative arrangements) in 2008–09	0.5022 ***

*** denotes $\text{Pr} > \text{ChiSq} < 0.01$; ** denotes $\text{Pr} > \text{ChiSq} < 0.05$; * denotes $\text{Pr} > \text{ChiSq} < 0.10$.

H.5 Ordered probit regression results – Implemented innovations in 2008–09, according to who developed the innovation

Intercept		
Internally	-1.4557	***
In co-operation	-1.2937	***
Externally	-1.2247	***
ICT intensity		
Most intense	0.9096	***
High	0.7184	***
Moderate	0.6390	***
Low	0.2972	***
<i>Least intense</i>		
Number of employees		
Non-employing	-0.9878	***
1–4 employees	-0.4985	***
5–19 employees		
20–199 employees	0.1971	***
200+ employees	0.3888	***
Industry division		
Agriculture, forestry and fishing	-4.9398	
<i>Manufacturing</i>		
Mining	-0.3280	***
Electricity, water, gas and waste services	-0.1041	
Construction	-0.1294	
Wholesale	-0.0334	
Retail trade	0.0269	
Accommodation and food services	-0.2690	***
Transport, postal and warehousing	-0.0870	
Information, media and telecommunications	-0.0234	
Financial and insurance services	0.3172	***
Rental, hiring and real estate services	0.0251	
Professional, scientific and technical services	-0.0236	
Administrative and support services	-0.2529	***
Health care and social assistance	0.0905	
Arts and recreation services	-0.0912	
Other services	0.0443	
Export activity		
<i>Non-exporter in 2008–09</i>		
Exporter in 2008–09	0.2008	***
Competition		
<i>No competition</i>		
Minimal competition	0.1736	**
Moderate competition	0.2279	***
Strong competition	0.3011	***
Foreign ownership		
<i>Foreign ownership 0%–50% in 2008–09</i>		
Foreign ownership >50% in 2008–09	0.0470	
R&D arrangements		
<i>No joint R&D (collaborative arrangements) in 2008–09</i>		
Joint R&D (collaborative arrangements) in 2008–09	0.4605	***

*** denotes $\text{Pr} > \text{ChiSq} < 0.01$; ** denotes $\text{Pr} > \text{ChiSq} < 0.05$; * denotes $\text{Pr} > \text{ChiSq} < 0.10$.

H.6 Ordered Probit regression results – Number of types of innovative activity in 2008–09

Intercept	
1 type of innovation	-0.6534 ***
2 types of innovation	-1.1666 ***
3 types of innovation	-1.6592 ***
4 types of innovation	-2.1810 ***
ICT intensity	
Most intense	0.8250 ***
High	0.5741 ***
Moderate	0.4919 ***
Low	0.2185 ***
<i>Least intense</i>	
Number of employees	
Non-employing	-0.5748 ***
1–4 employees	-0.2996 ***
5–19 employees	
20–199 employees	0.1410 ***
200+ employees	0.1229 ***
Industry division	
Agriculture, forestry and fishing	-0.1117 **
<i>Manufacturing</i>	
Mining	-0.3829 ***
Electricity, water, gas and waste services	-0.2346 **
Construction	-0.2731 ***
Wholesale	-0.0752
Retail trade	-0.0657
Accommodation and food services	-0.1647 **
Transport, postal and warehousing	-0.1174 *
Information, media and telecommunications	0.0256
Financial and insurance services	0.0940
Rental, hiring and real estate services	-0.1016
Professional, scientific and technical services	-0.0688
Administrative and support services	-0.3210 ***
Health care and social assistance	-0.0592
Arts and recreation services	-0.1400 *
Other services	-0.0358
Export activity	
<i>Non-exporter in 2008–09</i>	
Exporter in 2008–09	0.2054 ***
Competition	
<i>No competition</i>	
Minimal competition	0.1832 ***
Moderate competition	0.3328 ***
Strong competition	0.4582 ***
Foreign ownership	
<i>Foreign ownership 0%–50% in 2008–09</i>	
Foreign ownership >50% in 2008–09	-0.0531
R&D arrangements	
<i>No joint R&D (collaborative arrangements) in 2008–09</i>	
Joint R&D (collaborative arrangements) in 2008–09	0.5450 ***

*** denotes $\text{Pr} > \text{ChiSq} < 0.01$; ** denotes $\text{Pr} > \text{ChiSq} < 0.05$; * denotes $\text{Pr} > \text{ChiSq} < 0.10$.

FOR MORE INFORMATION . . .

<i>INTERNET</i>	www.abs.gov.au The ABS website is the best place for data from our publications and information about the ABS.
<i>LIBRARY</i>	A range of ABS publications are available from public and tertiary libraries Australia wide. Contact your nearest library to determine whether it has the ABS statistics you require, or visit our website for a list of libraries.

INFORMATION AND REFERRAL SERVICE

Our consultants can help you access the full range of information published by the ABS that is available free of charge from our website, or purchase a hard copy publication. Information tailored to your needs can also be requested as a 'user pays' service. Specialists are on hand to help you with analytical or methodological advice.

<i>PHONE</i>	1300 135 070
<i>EMAIL</i>	client.services@abs.gov.au
<i>FAX</i>	1300 135 211
<i>POST</i>	Client Services, ABS, GPO Box 796, Sydney NSW 2001

FREE ACCESS TO STATISTICS

All statistics on the ABS website can be downloaded free of charge.

<i>WEB ADDRESS</i>	www.abs.gov.au
--------------------	----------------