



Research Paper

Experimental Estimates of a Multi-Year Innovation Rate, Australia

**Exploring methodological differences
in innovation surveys used in
Australia and Europe**

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
BCS	Business Characteristics Survey
CIS	Community Innovation Survey
ISIC	International Standard Industrial Classification
MYIR	Multi-Year Innovation Rate
NSO	National Statistical Office
OECD	Organisation for Economic Co-operation and Development
SISCA	Standard Institutional Sector Classification of Australia

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EXECUTIVE SUMMARY

The Organisation for Economic Co-operation and Development (OECD) publishes innovation indicators for a number of member countries on a biennial basis, offering opportunity to compare rates of innovation across nations. In the 2015 Innovation Indicators publication, Australia had the 5th highest proportion of innovation-active businesses of the countries included (OECD, 2015). However, there are some methodological differences (including survey scope, design and reference period) that obfuscate direct comparison of results between some countries.

This research paper outlines key differences in survey scope and methodology between Australia's Business Characteristics Survey (BCS) and Europe's Community Innovation Survey (CIS) to enhance understanding of how Australian innovation rates compare internationally.

An experimental methodology has been developed by the Australian Bureau of Statistics (ABS) that uses BCS innovation data collected for a single reference year to estimate of the proportion of Australian businesses that were innovation-active over a three year reference period. This is referred to as the Multi-Year Innovation Rate (MYIR). The MYIR methodology is then applied to a sample scoped to match business industry and employment classifications used by the CIS. Applying this experimental methodology aligns the BCS survey methodology as closely as possible to the survey methodology used in the CIS, although some remaining differences are not controlled for.

The experimental estimates presented in this paper indicate that the proportion of innovation-active businesses in Australia is greater when both industry and employment scope and reference periods are aligned with those used by the CIS. These results indicate that the ranking of 5th highest proportion of innovation-active businesses of the countries included in the OECD's 2015 Innovation Indicators publication would be higher when these methodological differences are addressed using the experimental methods.

Despite a level of uncertainty in the experimental estimates due to unaddressed methodological differences and provider recall, this research adds to the body of knowledge related to innovation survey methodologies and their impacts on estimates of business innovation. The methodology in this paper enhances our understanding of how Australian innovation rates compare internationally, without making changes to the current innovation survey methodology used.

1. INTRODUCTION

1.1 PURPOSE OF THIS PAPER

This research paper provides an overview of some of the key differences in survey scope and methodology between Australia's Business Characteristics Survey (BCS) and Europe's Community Innovation Survey (CIS). It also presents an experimental methodology developed to produce estimates of business innovation in Australia that are aligned as closely as possible to the scope and reference periods that are used in the CIS. This adds to the body of knowledge related to innovation survey methodologies and their impacts on estimates of business innovation. It also better equips researchers in understanding how Australian business innovation rates compare internationally.

The structure of the paper is as follows. Section 2 provides an overview of the key differences between the survey methodologies used in Australia and Europe. The experimental methodology developed by the Australian Bureau of Statistics (ABS) to align survey scope and reference periods, and resulting estimates, are explained in detail in Sections 3, 4 and 5. These results are then examined, with consideration of some of the limitations and differences that still remain in drawing comparisons between Australian and international estimates.

1.2 BACKGROUND

Innovation contributes to economic growth and productivity. As such, supporting innovative activity in Australian business is a policy priority for the Australian Government. Indicators of innovation in Australian businesses are important to researchers and policy makers in building an understanding of the drivers and impacts of innovation and understanding how Australian rates of innovation compare internationally.

The Organisation for Economic Co-operation and Development (OECD) leads the development of international guidelines for the collection and use of data on innovation activities in industry. These are set out in *The Oslo Manual, Guidelines for Collecting and Interpreting Innovation Data* (OECD 2005).

The ABS, drawing on the concepts and practises from the Oslo Manual, measures the innovation practices of Australian businesses using the BCS. Key indicators published by the ABS include measures of business innovation, types of innovation and status of innovation, which are published on an annual basis in *Selected Characteristics of Australian Businesses* (cat. no. 8167.0), with more detailed information published every two years in *Innovation in Australian Business* (cat. no. 8158.0).

The OECD publishes innovation indicators for a number of member countries on a biennial basis (Table 1.1), offering opportunity to compare rates of innovation across nations. Estimates from the countries included in this publication are produced using definitions presented in the Oslo Manual, but there are differences in survey methodology between countries that can obfuscate the direct comparison of results.

EXPERIMENTAL ESTIMATES OF A MULTI-YEAR INNOVATION RATE, AUSTRALIA

1.1 TOTAL PROPORTION OF INNOVATIVE ENTERPRISES IN SELECTED OECD COUNTRIES (including enterprises with abandoned/suspended or on-going innovation activities), with survey vehicle and reference period information, by country

Country	Survey vehicle	Reference years	Length of reference period	Total proportion of innovative enterprises
			(Years)	%
Switzerland	2011 Survey on Innovation Activities in the Swiss economy	2010-12	3	79.6
Brazil	Technological Innovation Survey (PINTEC 2011)	2009-11	3	73.1
Germany	Community Innovation Survey 2012	2010-12	3	66.9
Luxembourg	Community Innovation Survey 2012	2010-12	3	66.1
Australia (a)	Business Characteristics Survey (BCS)	2012-13 (financial year)	1	64.1
India	Indian National Innovation Survey	2010-11	2	63.7
Ireland	Community Innovation Survey 2012	2010-12	3	58.7
Italy	Community Innovation Survey 2012	2010-12	3	56.1
Sweden	Community Innovation Survey 2012	2010-12	3	55.9
Belgium	Community Innovation Survey 2012	2010-12	3	55.6
Portugal	Community Innovation Survey 2012	2010-12	3	54.6
Austria	Community Innovation Survey 2012	2010-12	3	54.4
France	Community Innovation Survey 2012	2010-12	3	53.4
Finland	Community Innovation Survey 2012	2010-12	3	52.6
Greece	Community Innovation Survey 2012	2010-12	3	52.3
Denmark	Community Innovation Survey 2012	2010-12	3	51.4
Netherlands	Community Innovation Survey 2012	2010-12	3	51.4
Israel	The Israel Innovation Survey, 2010-12	2010-12	3	49.0
Turkey	Community Innovation Survey 2012	2010-12	3	48.5
Japan	Japanese National Innovation Survey 2012 (J-NIS 2012)	2009-11 (financial years)	3	47.9
Estonia	Community Innovation Survey 2012	2010-12	3	47.6
Slovenia	Community Innovation Survey 2012	2010-12	3	46.5
Norway	Community Innovation Survey 2012	2010-12	3	44.7
Czech Republic	Community Innovation Survey 2012	2010-12	3	43.9
Slovakia	Community Innovation Survey 2012	2010-12	3	34.0
Spain	Community Innovation Survey 2012	2010-12	3	33.6
Hungary	Community Innovation Survey 2012	2010-12	3	32.5
Korea (South)	Korean Innovation Survey	2011-13	3	31.1
Latvia	Community Innovation Survey 2012	2010-12	3	30.4
United Kingdom	Community Innovation Survey 2012	2010-12	3	25.6
Chile	8th Innovation Survey, Year 2011	2009-10	2	23.7
Poland	Community Innovation Survey 2012	2010-12	3	23.0
Russia	Russian Innovation Survey	2011-13	2	10.3

Source: OECD (2015)

(a) BCS estimates published by the OECD in Innovation Indicators 2015 are scoped to match the Community Innovation Survey 2012. Employment size and industry classification scope differs to estimates published in Cat. No. 8167.0

Increased awareness of the dissimilarities across survey methodologies would assist researchers in understanding variations in innovation estimates between countries. However, determining all differences in survey methodology between Australia and all of the countries included in the OECD publication would be a difficult task. Since the CIS is the most widely used, unpacking the differences between the BCS and CIS and aligning their survey methodologies as close as possible may offer the best opportunity to understand how these differences impact innovation estimates. This will better equip researchers in understanding how Australian results compare with the majority of European nations.

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2. METHODOLOGICAL DIFFERENCES BETWEEN THE BCS AND CIS

As outlined, the ABS produces measures of the innovative activity of Australian businesses using BCS. Estimates on innovation practices of businesses in the 28 countries which are members of the EU are produced using the CIS. Both surveys use the statistical concepts and underlying methodology defined by *The Oslo Manual, Guidelines for Collecting and Interpreting Innovation Data* (OECD 2005). Although the concepts measured are comparable, as outlined in Section 1, there are some methodological differences that obfuscate direct comparison of results from the two surveys.

The key differences in survey methodology between the CIS and BCS are summarised in Table 2.1.

2.1 SUMMARY OF DIFFERENCES IN SURVEY METHODOLOGIES USED BY THE BUSINESS CHARACTERISTICS SURVEY (BCS) 2014-15 AND THE COMMUNITY INNOVATION SURVEY (CIS) 2012

	<i>Business Characteristics Survey (BCS)</i>	<i>Community Innovation Survey (CIS)</i>
<i>Reference period</i>	One year reference period. Businesses report activity that occurred in a single financial year (e.g. the 2014-15 results cover a period from 1 July 2014 to 30 June 2015)	Three year reference period. Businesses report activity that occurred over a three calendar year period (e.g. the 2015 results cover a period from 1 January 2012 to 31 December 2014)
<i>Scope and coverage</i>	Target population includes all business entities in the Australian economy except for SISCA 3000 General Government and SISCA 6000 Rest of the World in the following employment and industry classifications. <i>Employment classifications in scope:</i> Business entities with employment greater than zero (i.e. employing business) <i>Industry classifications in scope:</i> Businesses classified in the following ANZSIC Divisions: A Agriculture, Forestry and Fishing B Mining C Manufacturing D Electricity, Gas, Water and Waste Services E Construction F Wholesale Trade G Retail Trade H Accommodation and Food Services I Transport, Postal and Warehousing J Information Media and Telecommunications K Financial and Insurance Services (Except Groups 624 Financial Asset Investing; and 633 Superannuation Funds) L Rental, Hiring and Real Estate Services M Professional, Scientific and Technical Services N Administrative and Support Services Q Health Care and Social Assistance R Arts and Recreation Services S Other Services (Except Groups 954 Religious Services and 955 Civic, Professional and Other Interest Group Services; and Subdivision 96 Private Households Employing Staff)	Target population is also limited to non-government enterprises, and includes all businesses within the relevant country's economy, in the following employment and industry classifications. <i>Employment classification in scopes:</i> Businesses with 10 or more employees. <i>Industry classifications in scope:</i> Businesses classified in the following ISIC industries: B Mining and Quarrying C Manufacturing D Electricity, Gas, Steam and Air Conditioning Supply E Water Supply; Sewerage, Waste Management and Remediation Activities G46 Wholesale Trade, Except of Motor Vehicles and Motorcycles H Transportation and Storage J Information and Communication K Financial and Insurance Activities M71 Architectural and Engineering Activities; Technical Testing and Analysis M72 Scientific Research and Development M73 Advertising and Market Research
<i>Frequency</i>	Annual	Biennial
<i>Sample size and criterion to enumerate</i>	Collection of data included in the 2014-15 cycle was undertaken based on a random sample of approximately 6,870 businesses. The sample is stratified by industry and an employment-based size indicator High employing businesses or those with unique characteristics may be completely enumerated in the BCS.	Sample rates used by each country in the 2012 CIS are provided in Appendix A. Most countries carry out a stratified sample survey in order to collect the data. A limited number of countries use a census or a mix of census and sample survey. Appendix B provides the criterion to enumerate, by country.
<i>Response rates</i>	Due to the survey being compulsory for all business entities, response rates are high (94% in 2014-15).	Response rates vary from country to country. In the 2012 CIS, the weighted unit response rate ranged from 100%, down to 42%. See Appendix C for response rates by country.
<i>Collection method</i>	Along with business innovation data, the BCS collects information on a number of other topics including collaborative arrangements, geographic markets in which businesses sold goods or services, government	The CIS is a standalone innovation collection i.e. aside from some basic demographic information; only questions relating to innovation are asked.

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procurement, business finance sought, reasons for seeking debt or equity finance, government financial assistance, changes to business performance and activity, barriers to innovative activity, skills used in undertaking core business activities and skills shortage or deficiency in undertaking core business activities.

Participants complete either an online form (from 2013-14 onwards) or mail-out questionnaire.

Data are mainly collected via online or mail surveys. A few countries choose also other collection methods such as face to face interviews.

Participation requirements

Participation is compulsory for all selected business entities.

Participation varies from country to country. In some countries is on a voluntary basis – some countries have compulsory reporting for larger businesses, some are conducted on a 100% voluntary basis. See Appendix C.

Sources: ABS (2016); Eurostat (2012 and 2014)

2.1 IMPACTS ON INNOVATION ESTIMATES

2.1.1 Scope and coverage

The estimates that the ABS provides to the OECD for their Innovation Indicators publication already take into account differences in industry and employment size scope and coverage. This is done by reducing the sample scope used to produce estimates to only include businesses with 10 employees or more that are in the selected industries covered by the CIS. The estimate provided in Table 1.1 reflects this, and so the impacts of these scope differences can be quantified. The estimated proportion of innovation-active businesses when CIS scope is applied is higher compared to the estimates published in ABS Cat. No. 8166.0 using the full BCS scope (64.1%, compared to 42.2% in 2012-13).

Employment classification

The CIS follows the Oslo Manual's minimum recommendation of including businesses with 10 or more employees in the survey scope. The BCS on the other hand includes all employing businesses (i.e. businesses with greater than zero employees). Small businesses play an important role in the Australian economy, with businesses with 0 to 9 employees making up approximately 18% of businesses in scope for the BCS (2014-15). Therefore measuring innovative activity in these businesses offers a more complete picture of innovation activity in Australia.

Historical results from the BCS have shown that the propensity for businesses to undertake innovative activity is related to the size of the businesses. That is, small businesses are less likely to introduce innovation than large businesses. It is therefore expected that exclusion of the smallest businesses from the estimates of innovative activity in Australian business results in a higher proportion of innovation-active businesses in revised estimates.

Industry classification

In addition, the CIS includes a narrower industry scope compared to the BCS. The industry divisions it does include have some of the highest Business Expenditure on Research and Development in Australia; Manufacturing, Professional, Scientific and Technical Services, Financial and Insurance Services and Mining (ABS 2015), and include the five most knowledge-intensive industries identified by the Department of Industry, Innovation and Science; Mining, Manufacturing, Information, Media and Telecommunications, Financial and Insurance Services, Professional, Scientific and Technical Services (Department of Industry, Innovation and Science 2016). Given this, it is reasonable that when the BCS scope is narrowed to only include businesses operating in industries included in the CIS scope, the proportion of innovation-active businesses is again higher.

2.1.2 Reference period

Both the BCS and the CIS follow the Oslo Manual recommendation that “the observation period for innovation surveys should not exceed three years”. The CIS uses the maximum three year reference period, with data collected biennially. The BCS is conducted on an annual basis and the reference period is limited to a single financial year. In the development of the BCS questionnaire, cognitive testing concluded that a single year reference period would make the reporting and validation of innovation data much easier for survey respondents. It also allows innovation indicators to be published more frequently.

The length of time that the survey reference period covers will have a direct impact on the proportion of innovation-active businesses. That is, the longer reference period will increase the likelihood that a business innovated.

2.1.3 Other differences

The agency in charge of commissioning, design, field work, data processing and estimation of the CIS is in most countries the National Statistical Office (NSO). Survey sample size, accepted response rates and participation requirements are determined by the NSO in each country as they are the best placed to determine the most-fit-for-purpose statistical methodology. Thus they differ across participant countries.

The impacts that these other differences such as the frequency of collection, sample size, response rates, and the collection instrument would have on innovation estimates would be difficult to measure and cannot be controlled for. There is no reason to believe that these other methodological differences would significantly hamper the comparison of results between surveys, but the true impacts are not known.

2.2 ALIGNING BCS AND CIS METHODOLOGY

The differences in reference period and industry and employment size scope and coverage form the basis of the methodology presented in this paper.

Other differences, such as the frequency, collection methods, sample size and participation, as outlined, cannot be controlled for in the experimental methodology and this should be considered when drawing comparisons.

To better facilitate a comparison between CIS and BCS collections, the ABS has developed an experimental methodology that:

1. Uses BCS data collected for a single financial year reference period to create an Australian estimate of the proportion of businesses that were innovation-active over a three year reference period; and
2. Applies this to a sample of businesses that correspond with the industry and employment size scope and coverage used by the CIS.

The expected result is that once this methodology is applied, the proportion of innovation-active businesses in Australia will be higher compared to the proportion published by the ABS using BCS scope and a single year reference period.

3. CREATING AN AUSTRALIAN MULTI-YEAR INNOVATION RATE

As outlined, an experimental methodology has been developed that uses BCS innovation data collected for a single reference year to produce Australian estimates of the proportion of businesses that were innovation-active over a three year reference period. This is referred to throughout this paper as the Multi-Year Innovation Rate (MYIR).

3.1 DEFINITION

For the purposes of this paper, the MYIR is defined as the proportion of businesses that had undertaken any innovative activity (i.e. innovation-active business) during a given three year reference period including: introduction of any type of innovation; and/or the development or introduction either still in progress or abandoned.

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Taking the number of businesses in the population that were active at the end of a given reference financial year (t), the MYIR is calculated as the proportion of these businesses that innovated at least once in either that financial year (t), or the preceding two financial years (t-1 or t-2).

$$MYIR = \frac{\text{Number of active businesses which innovated at least once in the three year reference period}}{\text{Number of active businesses at the end of the three year reference period}} \times 100$$

For example, the MYIR for 2014-15 reference period would be calculated as the number of active businesses in the population in the financial year 2014-15 that innovated at least once in any of the financial years 2014-15, 2013-14 or 2012-13, as a proportion of all active businesses in the population at the end of 2014-15.

3.2 METHODOLOGY

In calculating the MYIR, the total weighted BCS sample for a given reference year represents the number of active businesses at the end of the relevant three year reference period.

Establishing which of the businesses innovated at least once in the three year time period is more complex. As with most ABS business surveys, the sample is selected on a rotating basis from within each (industry and employment size) stratum, this is done to minimise the respondent load placed on businesses. As a result, not all of businesses in the BCS sample are surveyed in three consecutive years, and those that are includes a disproportionate number are large complex firms which are not representative of the full business population. Therefore, deriving a MYIR for a given three-year period by simply pooling the survey data across the three years is not feasible.

3.2.1 Determining the three year innovation status of sampled businesses

All live responding businesses in the BCS sample at the end of the three year reference period are categorised as either having been selected in the sample in the previous two years, or as having no available data for one or more year.

Businesses which were selected in all three reference years can contribute directly to the MYIR estimate as their innovation status for the three year period is known. That is, if they reported that they were innovation-active in one or more of the reference years, they are considered to be innovation-active in the MYIR. Otherwise, if they reported no innovation activity in any of the three years, they are considered non-innovation active in the MYIR.

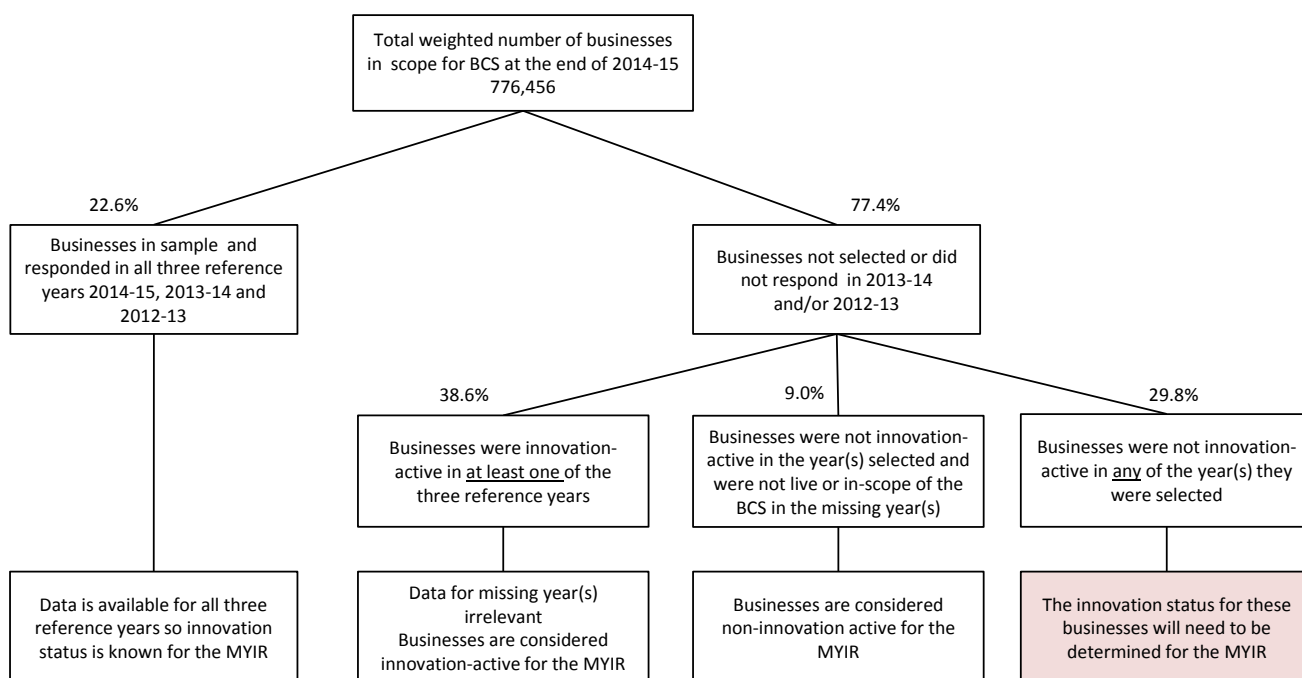
For businesses that were not selected in the sample for all three of the reference years or did not respond in at least one year, an innovation status is determined as follows:

- i) If the business was innovation active in at least one of the three reference years it was selected, the business is automatically considered to be **innovation-active** for the MYIR
- ii) If the business was not innovation-active in any of the years selected and were not live or in-scope of the BCS in the missing year(s) the business is considered to be **non-innovation active** for the MYIR
- iii) If the business was not innovation-active in any of the years selected but was live and in scope of the BCS, the **innovation status for the missing year(s) is unknown** and needs to be determined for the MYIR

To provide an example, Figure 3.1 shows the process used to determine a three year innovation status for businesses selected in the 2012-13 to 2014-15 MYIR reference period.

EXPERIMENTAL ESTIMATES OF A MULTI-YEAR INNOVATION RATE, AUSTRALIA

3.1 BCS WEIGHTED SAMPLE BREAKDOWN FOR CALCULATION OF THE MYIR, Determining the innovation-active status of businesses, 2012-13 to 2014-15



There were 776,456 (weighted) live responding businesses in the 2014-15 BCS sample. Of these businesses, 23% were also selected in the 2013-14 and 2012-13 samples so their innovation status for the entire three year MYIR reference period is known. That is, if they innovated in one or more of these years they are considered innovation-active for the MYIR, and likewise, if they did not innovate in any of the three years, they are considered non-innovation active for the MYIR.

The remaining 77% were not selected or did not respond in all three reference years and so data is not available for the full period. However, 39% of businesses were innovation-active in at least one of the three reference years so their innovation status in the missing year(s) is irrelevant and they can automatically be considered innovation-active for the MYIR. In addition, 9% of businesses were not innovation-active in the year(s) they were selected, but not live or in scope of the BCS in the missing year(s). These businesses can automatically be considered non-innovation active for the MYIR. The remaining 30% of businesses were not selected or did not respond in all three years and were not innovation-active in any of the year(s) they did respond, so the innovation status of these businesses for the MYIR needs to be determined.

The weighted proportion of businesses that fall into this category ranges from 27% to 34% across all years that a MYIR estimate has been produced (that is, 2009-10 to 2014-15).

3.2.2 Firm-Level Modelling approach

The ABS has developed an experimental methodology, called Firm-Level Modelling, to estimate the innovation status of the businesses for which a three year innovation status is not known.

This method calculates the probability that a business was innovation-active in the three year reference period based on the innovation-active status of businesses with similar characteristics (e.g. industry and employment size) and similar reporting patterns over the three year period.

A pattern of reporting is derived for each business in the MYIR sample by combining their reporting behaviour across the three reference years, where the first status refers to the most recent reference year (t), the second refers to the previous reference year (t-1) and the third refers to two years prior to the reference year (t-2).

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The reporting behaviour of each business in all three of the years for a particular reference period is defined as:

Y = Business was innovation-active in the reference year,

N = Business was not innovation-active in the reference year, and

M = Business was not selected in the sample in the reference year or did not respond; innovation-active status is not known.

For example, for a business which reported no innovative activity in year t, but reported innovative activity in both t-1 and t-2, their pattern of reporting would be NYY.

There are 18 possible patterns of reporting across three years, but it is only those businesses which were not selected in the BCS or did not respond for least one of the three reference years (i.e. pattern contains an M), and not innovation-active in the year(s) it was selected (i.e. pattern does not contain a Y) that require an innovation status to be imputed using the Firm-Level Modelling approach. That is, businesses with a reporting pattern of NNM, NMN and NMM.

In the case of businesses for which an innovation-status needs to be determined (patterns NNM, NMN and NMM), the probability that a business was innovation-active at least once in the three year period is calculated using responses from businesses that have no missing values (i.e. responded in all reference three years). These probabilities are calculated and applied at the industry and employment size level.

For example, for a business with a reporting pattern NNM in the Manufacturing industry, with 5-19 persons employed, the probability that this pattern was actually NNY is estimated as the weighted number of businesses in the same industry and employment size category that had a reporting pattern NNY, as a proportion of businesses in the same classification that either had a reporting pattern NNY or NNN. In other words, the probability that the M in the reporting pattern was actually a Y is calculated.

Note that an assumption is made that the businesses that were in the sample for all three reference years can inform rates of innovation for businesses in the same industry and employment size category that were not in sample or did not respond.

The probability of observing an innovation (that is, the M in the reporting pattern changing to a Y) is thus calculated at the industry and employment size level, as follows:

$$\text{For businesses with pattern NNM: } P(NNY) = \frac{NNY}{NNY+NNN}$$

$$\text{For businesses with pattern NMN: } P(NYN) = \frac{NYN}{NYN+NNN}$$

$$\text{For businesses with pattern NMM: } P(NNY \text{ or } NYN \text{ or } NYY) = \frac{NNY+NYN+NYY}{NNY+NYN+NYY+NNN}$$

where NNY = Weighted number of businesses in the stratum with reporting pattern NNY,

NYN = Weighted number of businesses in the stratum with reporting pattern NYN,

NYY = Weighted number of businesses in the stratum with reporting pattern NYY, and

NNN = Weighted number of businesses in the stratum with reporting pattern NNN.

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MYIR estimates are then calculated by multiplying the reported or modelled probability by the survey weight and aggregating to the required level. That is:

$$MYIR = \sum_{i=1}^n w_i x_i$$

where w_i = weight of business i ,

x_i = 0, if business i was selected in the sample in all three reference years but did not report innovating in any of these years,

0, if business i was not selected in the sample in all three reference years, it did not report innovating in any of the years it was selected, and it was not live or in-scope of the BCS in the missing year(s),

1, if the business reported innovating in one or more of the three reference years, regardless of which year(s) it was selected in the sample, and

P , the modelled probability, if the business did not report innovating in any of the years it was selected in the sample, but was live and in-scope of the BCS in the missing year(s).

3.3 RESPONDENT RECALL

The difference in length of reference period has an additional factor that may influence results. The ability for survey respondents to recall innovation activity over a three year period compared to a single year may bias results produced using the MYIR methodology. Respondent recall was a consideration in the development of the BCS questionnaire, with respondent feedback suggesting that the shorter one year reference period, compared to a three year period, would allow for easier reporting, validation and comparison to previous data.

A brief investigation was conducted using data collected for a two-year reference period by the ABS in the Innovation Survey 2005. Results of this investigation are presented in Appendix D. While the results were not conclusive, they could indicate that it is conceivable that providers may be less likely to recall information about innovations when reporting for a longer reference period. Thus, estimates produced using the experimental MYIR methodology that are based on three years of data collected using a single-year reference period data may have a positive bias compared to estimates produced using a three-year reference period. This is important to consider when analysing results.

3.4 EXPERIMENTAL AUSTRALIAN MYIR ESTIMATES – BCS SCOPE

Using the Firm-Level Modelling approach, experimental Australian MYIR estimates at the employment size and total levels were first produced using the standard BCS employment size and industry scope for six reference periods; 2007-08 to 2009-10 through to 2012-13 to 2014-15. Table 3.2 shows experimental estimates for businesses with any innovative activity over the six three-year reference periods.

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3.2 BCS SCOPED MULTI-YEAR INNOVATION RATE, Estimated proportions of businesses with any innovative activity (innovation-active businesses), by employment size for reference periods 2007-08 to 2009-10 through to 2012-13 to 2014-15

	2007-08 to 2009-10 %	2008-09 to 2010-11 %	2009-10 to 2011-12 %	2010-11 to 2012-13 %	2011-12 to 2013-14 %	2012-13 to 2014-15 %
Multi-Year Innovation Rate (a)						
Employment size						
0-4 persons	47.8	46.2	52.4	49.2	54.2	53.7
5-19 persons	70.4	68.6	71.0	69.0	77.3	71.1
20-199 persons	78.3	81.6	85.0	81.6	80.1	81.8
200 or more persons	84.7	85.2	87.6	87.7	88.5	88.9
Total	57.5	56.1	60.7	58.1	63.4	61.5
	2009-10 %	2010-11 %	2011-12 %	2012-13 %	2013-14 %	2014-15 %
Single-year innovation rate (b)	43.8	39.1	46.6	42.2	48.3	45.0

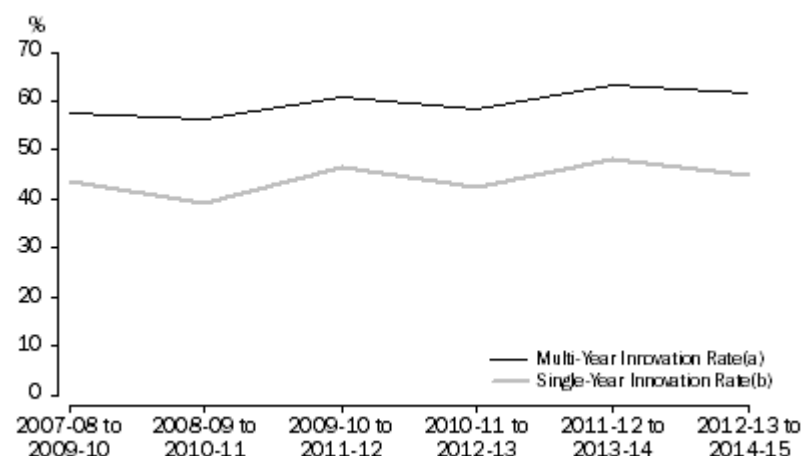
(a) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in the three year reference period

(b) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in one year reference period (Source: ABS Cat. No. 8166.0)

3.5 COMPARISON OF MYIR TO SINGLE YEAR BCS ESTIMATES

To assess the reliability of the experimental MYIR estimates produced by the Firm-Level Modelling approach, results were compared with single-year estimates published in Cat. No. 8166.0. This is shown in Figure 3.3. As expected, the MYIR is consistently higher than the single year rate and follows approximately the same pattern over time.

3.3 MULTI-YEAR AND SINGLE-YEAR INNOVATION RATES (BCS SCOPE), Proportions of businesses with innovative activity (innovation-active businesses), 2007-08 to 2009-10 through to 2012-13 to 2014-15



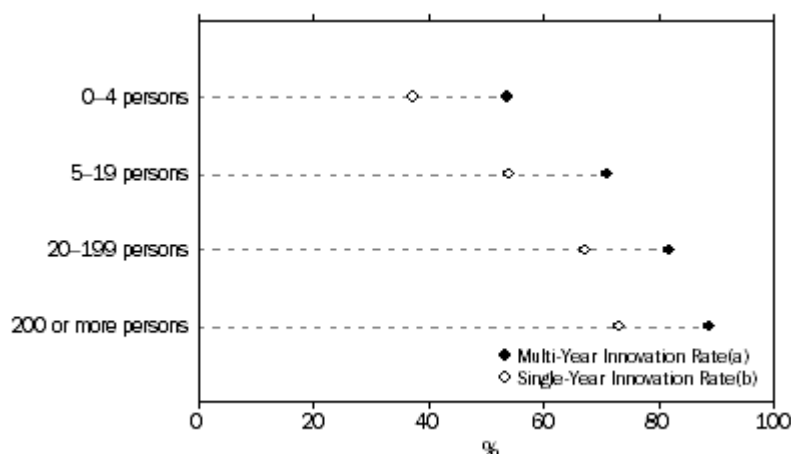
(a) Estimated proportion of inn businesses with any innovative activity (innovation-active businesses) in the three year reference period

(b) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in one year reference period - corresponds to the most recent year in the 3 year reference period as per Table 3.2 (Source: ABS Cat. No. 8166.0)

Further analysis shows that, at the employment size level, the 2012-13 to 2014-15 MYIR and the 2014-15 single-year innovation rates follow a consistent pattern across all employment size groups, with smaller businesses reporting lower rates of innovation than larger businesses, as shown in Figure 3.4. Similar patterns were seen for other reference periods.

EXPERIMENTAL ESTIMATES OF A MULTI-YEAR INNOVATION RATE, AUSTRALIA

3.4 MULTI-YEAR AND SINGLE-YEAR INNOVATION RATES (BCS SCOPE), Proportion of businesses with any innovative activity (innovation-active businesses), by employment size, for 2012-13 to 2014-15 reference period



(a) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in the three year reference period 2012-13 to 2014-15

(b) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in one year reference period 2014-15

(Source: ABS Cat. No. 8166.0)

To provide an indication of the sampling error associated with the experimental estimates produced, standard errors have been calculated for the MYIR (see Appendix F). The largest standard error for any BCS scoped MYIR estimate was 2.1 percentage points.

3.6 LEVEL OF IMPUTATION

As outlined in Section 3.2, businesses are generally selected for the BCS for a maximum of three years, with rotation effects controlled for through a rotating sample methodology. Smaller businesses are generally selected for the BCS from sampled strata, so the proportions of businesses requiring imputation were greater for smaller employment size classifications. Conversely, high employing businesses or those with unique characteristics may be completely enumerated in the BCS, reducing the requirement to impute innovation statuses. A summary of imputation by employment size range is provided in Table 3.5.

3.5 LEVEL OF IMPUTATION APPLIED TO BCS SAMPLE, weighted proportion of businesses that required innovation status to be imputed 2007-08 to 2009-10 through to 2012-13 to 2014-15

	2007-08 to 2009-10 %	2008-09 to 2010-11 %	2009-10 to 2011-12 %	2010-11 to 2012-13 %	2011-12 to 2013-14 %	2012-13 to 2014-15 %
Employment size						
0-4 persons	32.8	33.0	37.4	36.6	29.4	32.9
5-19 persons	24.1	24.3	28.9	29.1	23.6	25.8
20-199 persons	20.8	19.7	23.2	22.9	18.8	22.7
200 or more persons	4.5	7.7	8.9	8.6	6.6	9.5
Total	29.0	29.2	33.6	33.0	26.7	29.8

4. SCOPING THE BCS SAMPLE TO MATCH THE CIS

As outlined, the CIS scope is narrower both in the employment size and industry classification of businesses compared to the BCS scope. A methodology to align to the scope of the BCS with that of the CIS is already applied to single reference year innovation to provide estimates to the OECD for its Innovation Indicators publication (as provided in Table 1.1).

An explanation of how the CIS employment size and industry scope is applied to the BCS sample is provided below.

4.1 EMPLOYMENT SIZE SCOPE

Businesses reporting less than 10 employees at the end of the reference period are removed from the sample when aligning the BCS with the CIS.

The BCS sample is stratified by industry and an employment-based size indicator that does not concord with the CIS scope. When businesses with fewer than 10 employees are removed from the scope of the estimates, the original weights of the remaining units are retained.

4.2 INDUSTRY/SECTOR SCOPE

4.2.1 Sector scope

The BCS scope includes all employing business entities in the Australian economy except for the following sectors:

SISCA 3000 General Government

SISCA 6000 Rest of the World

The CIS also only includes non-government entities that are based in the surveying country.

4.2.2 Industry scope

The broad industries that are in and out of scope for the BCS and the CIS are presented in Table 4.1. The CIS uses the *International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4* to classify businesses. The ABS uses the *Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) (cat. no. 1292.0)* to classify businesses in the Australian population.

A concordance between the ANZSIC and ISIC is available in *Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 - Correspondence Tables, 2008 (cat. no. 1292.0.55.001)*, and this concordance is used to identify which ANZSIC classes are included when calculating a MYIR that is comparable to the CIS.

Appendix E provides full details on how the concordance between ANZSIC and ISIC was implemented and the specific ANZSIC classes that were determined to be in scope for the CIS. For the most part, businesses that are excluded from the BCS scope are also excluded from the CIS scope, with the exception of Groups 624 Financial Asset Investing and 633 Superannuation Funds. Since no data were collected from businesses in these groups, they cannot be included in the CIS scoped MYIR estimates.

EXPERIMENTAL ESTIMATES OF A MULTI-YEAR INNOVATION RATE, AUSTRALIA

4.1 BCS AND CIS SCOPE CLASSIFICATIONS INCLUDED, BY INDUSTRY (a)

	BCS Scope Classifications (b)	CIS Scope Classifications (c)
Agriculture, Forestry and Fishing	ANZSIC06 Div A - Agriculture, Forestry and Fishing	NOT INCLUDED
Mining	ANZSIC06 Div B - Mining	ISIC Rev. 4 Div B - Mining and Quarrying
Manufacturing	ANZSIC06 Div C - Manufacturing	ISIC Rev. 4 Div C - Manufacturing
Electricity, Gas, Water and Waste Services	ANZSIC06 Div D - Electricity, Gas, Water and Waste Services	ISIC Rev. 4 Div D - Electricity, Gas, Steam and Air Conditioning Supply ISIC Rev. 4 Div E - Water Supply; Sewerage, Waste Management and Remediation Activities
Construction	ANZSIC06 Div E - Construction	NOT INCLUDED
Wholesale Trade	ANZSIC06 Div F - Wholesale Trade	ISIC Rev. 4 G46 - Wholesale Trade, Except for Motor Vehicles and Motorcycles
Retail Trade	ANZSIC06 Div G - Retail Trade	NOT INCLUDED
Accommodation and Food Services	ANZSIC06 Div H - Accommodation and Food Services	NOT INCLUDED
Transport, Postal and Warehousing	ANZSIC06 Div I - Transport, Postal and Warehousing	ISIC Rev. 4 Div H - Transportation and Storage
Information Media and Telecommunications	ANZSIC06 Div J - Information Media and Telecommunications	ISIC Rev. 4 Div J - Information and Communication
Financial and Insurance Services	ANZSIC06 Div K - Financial and Insurance Services EXCLUDING Group 624 Financial Asset Investing; and Group 633 Superannuation Funds	ISIC Rev. 4 Div K - Financial and Insurance Activities
Rental, Hiring and Real Estate Services	ANZSIC06 Div L - Rental, Hiring and Real Estate Services	NOT INCLUDED
Professional, Scientific and Technical Services	ANZSIC06 Div M - Professional, Scientific and Technical Services	ISIC Rev. 4 M71 - Architectural and Engineering Activities; Technical Testing and Analysis ISIC Rev. 4 M72 - Scientific Research and Development ISIC Rev. 4 M73 - Advertising and Market Research
Administrative and Support Services	ANZSIC06 Div N - Administrative and Support Services	NOT INCLUDED
Public Administration and Safety	NOT INCLUDED	NOT INCLUDED
Education and Training	NOT INCLUDED	NOT INCLUDED
Health Care and Social Assistance	ANZSIC06 Div Q - Health Care and Social Assistance	NOT INCLUDED
Arts and Recreation Services	ANZSIC06 Div R - Arts and Recreation Services	NOT INCLUDED
Other Services	ANZSIC06 Div S - Other Services EXCLUDING Group 954 Religious Services; Group 955 Civic, Professional and Other Interest Group Services; and Subdivision 96 Private Households Employing Staff	NOT INCLUDED

(a) Broader industry categories are based on ANZSIC 2006 industry divisions.

(b) BCS uses ANZSIC 2006 to classify businesses to industry

(c) CIS uses ISIC Rev. 4 to classify businesses to industry. These may not necessarily concord directly to ANZSIC 2006 Industry Divisions

EXPERIMENTAL ESTIMATES OF A MULTI-YEAR INNOVATION RATE, AUSTRALIA

4.3 SAMPLE LEFT IN SCOPE

Once the employment size and industry scope described above is applied to the BCS sample, the weighted proportion of businesses left in the CIS scope ranges from 5% to 6% in each reference period (Table 4.2).

4.2 WEIGHTED NUMBER OF BUSINESSES IN MYIR SAMPLE, BCS AND CIS SCOPE, for reference periods 2007-08 to 2009-10 through to 2012-13 to 2014-15

	2007-08 to 2009-10	2008-09 to 2010-11	2009-10 to 2011-12	2010-11 to 2012-13	2011-12 to 2013-14	2012-13 to 2014-15
BCS Scope	775,955	763,899	776,361	770,486	756,848	776,456
CIS Scope	43,167	42,274	42,211	40,435	41,457	39,705
<i>Resulting proportion of businesses in CIS scope</i>	6%	6%	5%	5%	5%	5%

5. CIS-SCOPED EXPERIMENTAL AUSTRALIAN MYIR

Table 5.1 presents the experimental estimates produced when the MYIR methodology is applied to the CIS scoped sample.

Note that in producing the estimates presented in this section, the sample was first scoped to match CIS before the probabilities described in Section 3.2.2 were calculated and applied.

5.1 CIS-SCOPED MULTI-YEAR INNOVATION RATE, Proportion of businesses that were innovation-active, by employment size, for reference periods 2007-08 to 2009-10 through to 2012-13 to 2014-15

	2007-08 to 2009-10 %	2008-09 to 2010-11 %	2009-10 to 2011-12 %	2010-11 to 2012-13 %	2011-12 to 2013-14 %	2012-13 to 2014-15 %
Multi-Year Innovation Rate (a) – CIS Scope (b)						
Employment size						
10–19 persons	77.1	80.2	77.7	76.3	89.9	82.6
20–199 persons	85.2	84.9	90.9	85.8	78.0	72.9
200 or more persons	86.7	86.1	91.0	90.0	89.7	88.6
Total	81.1	82.3	84.0	81.1	84.5	78.7
Multi-Year Innovation Rate (a) – BCS Scope (c)						
Total	57.5	56.1	60.7	58.1	63.4	61.5

(a) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in the three year reference period

(b) See Section 4 for full details of CIS industry and employment classifications and how they are applied to BCS sample

(c) See Section 4 for full details of BCS industry and employment classifications

Given that applying the CIS scope to single-year BCS estimates results in a higher proportion of innovation-active businesses, the above estimates align with expectations that this would also occur with the MYIR estimates.

5.1 LEVEL OF IMPUTATION

The proportions of businesses in the CIS scoped sample that had an innovation status imputed for the MYIR was lower compared to the full BCS sample (Table 5.2). This reflects the differences in the characteristics of the sample.

EXPERIMENTAL ESTIMATES OF A MULTI-YEAR INNOVATION RATE, AUSTRALIA

5.2 LEVEL OF IMPUTATION APPLIED TO CIS SCOPED SAMPLE, weighted proportion of businesses that required innovation status to be imputed 2007-08 to 2009-10 through to 2012-13 to 2014-15

	2007-08 to 2009-10 %	2008-09 to 2010-11 %	2009-10 to 2011-12 %	2010-11 to 2012-13 %	2011-12 to 2013-14 %	2012-13 to 2014-15 %
Employment size						
10–19 persons	20.2	14.3	24.1	24.1	19.2	21.7
20–199 persons	14.4	16.9	19.8	20.7	17.5	21.9
200 or more persons	4.3	6.1	4.1	3.6	4.1	3.3
Total	17.0	15.0	21.4	21.7	17.8	21.1

6. UNDERSTANDING THE RESULTS

The experimental MYIR methodology described approximates the scope and reference period used by the CIS. However, the ability to draw direct comparisons between the estimates is still limited by the remaining differences in collection methodology (including survey frequency, collection and sampling methods and level of survey participation) and potential bias that the issue of provider recall may be having. Despite this, the experimental estimates provide information about the possible contribution of scope and reference period to the difference in estimates of innovative activity from the BCS versus those from the CIS.

A breakdown of the impacts of applying the Firm-Level modelling methodology to model a longer reference period and CIS scope to the BCS estimates of innovation-active businesses in Australia is presented in Table 6.1.

6.1 COMPARING ESTIMATED PROPORTION OF INNOVATION-ACTIVE BUSINESSES USING DIFFERING SCOPE AND REFERENCE PERIOD LENGTHS, 2007-08 to 2009-10 through to 2012-13 to 2014-15

	Length of reference period	
	1 year (a) %	3 years (b) %
	2009-10	2007-08 to 2009-10
BCS Scope (c)	43.8	57.5
CIS Scope (d)	65.1	81.1
	2010-11	2008-09 to 2010-11
BCS Scope (c)	39.1	56.1
CIS Scope (d)	67.2	82.3
	2011-12	2009-10 to 2011-12
BCS Scope (c)	46.6	60.7
CIS Scope (d)	69.3	84.0
	2012-13	2010-11 to 2012-13
BCS Scope (c)	42.2	58.1
CIS Scope (d)	65.4	81.1
	2013-14	2011-12 to 2013-14
BCS Scope (c)	48.3	63.4
CIS Scope (d)	70.3	84.5
	2014-15	2012-13 to 2014-15
BCS Scope (c)	45.0	61.5
CIS Scope (d)	66.3	78.7

(a) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in one year reference period (Source: ABS Cat. No. 8166.0)

(b) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in the three year reference period

(c) See Section 4 for full details of CIS industry and employment classifications and how they are applied to BCS sample

(d) See Section 4 for full details of BCS industry and employment classifications

EXPERIMENTAL ESTIMATES OF A MULTI-YEAR INNOVATION RATE, AUSTRALIA

Expectations that a longer reference period and narrowing of the scope would result in a higher proportion of innovation active businesses were met. Interestingly though, it is narrowing the BCS sample scope to the employment size and industry classifications included in the CIS that has a greater positive impact on the proportion of innovation-active businesses. Further analysis performed showed that the biggest driver of this difference was the exclusion of businesses with 0 to 9 employees from the scope, rather than the narrower industry classification scope.

The difference in reference period also has a positive impact as expected, but the impact is less pronounced. Further analysis shows that the weighted proportion of businesses that were not innovation active in year t (i.e. would not be innovation active for single reference year estimates) but were deemed innovation-active in the three-year reference period ranged from 24% and 30% between reference periods (Table 6.2).

6.2 WEIGHTED PROPORTION OF BUSINESSES THAT WERE NON-INNOVATION ACTIVE IN SINGLE-YEAR REFERENCE PERIOD, BUT WERE INNOVATION-ACTIVE IN 3-YEAR REFERENCE PERIOD (MYIR), 2007-08 to 2009-10 through to 2012-13 to 2014-15

	2007-08 to 2009-10 %	2008-09 to 2010-11 %	2009-10 to 2011-12 %	2010-11 to 2012-13 %	2011-12 to 2013-14 %	2012-13 to 2014-15 %
BCS Scope (a)	24.3	28.0	26.5	27.5	29.2	29.9

(a) See Section 4 for full details of BCS industry and employment classifications

6.1 ADDITIONAL FACTORS TO CONSIDER

As well as the methodology differences highlighted in Section 3, there are some additional factors that need to be considered when understanding these results.

6.1.2 Respondent recall

As identified in Section 3.3 and Appendix D, respondent recall may have an influence on the experimental MYIR estimates. A shorter reference period (as used in the BCS) is likely to lead to a greater level of recall which could positively bias the proportions of innovation-active businesses. It is important to consider this source of non-sampling error when making comparisons between estimates from the two surveys.

6.1.2 Lag in reference periods

The CIS collects innovative activity over a three calendar year period, for example, the latest CIS estimates available relate to innovative activity that took place during the period 2012-2014 (i.e. 1 January 2012 to 31 December 2014). On the other hand, Australian BCS data provides innovative activity for a single financial year, e.g. the latest data available is for the financial year 2014-15 (i.e. 1 July 2014 to 31 June 2015). The experimental methodology takes into account the differences between calendar and financial years, but will approximate the same reference period. For example to approximate the 2012-2014 CIS, BCS data for 2012-13, 2013-14 and 2014-15 can be combined, resulting in data from 1 July 2012 to 30 June 2015 instead of from 1 January 2012 to 31 December 2014, thus a six month reference period lag will remain.

6.1.3 Data quality

The BCS sample is not designed to support the CIS scope, and when it is reduced to match the CIS the resulting sample is much smaller and only represents a small proportion of the Australian economy. This means that the probabilities estimated in the production of the MYIR are calculated using a much smaller sample of businesses. For additional information on the quality of estimates produced in this paper, standard errors for the MYIR estimates using both BCS and CIS scope are provided in Appendix F.

7. CONCLUSION

Comparing Australian innovation rates internationally is complicated by a number of differences in survey methodologies used across countries. This paper has provided an overview of some of the key differences between Australia's BCS and Europe's CIS and presented a methodology that aligns the survey methodologies as closely as possible.

The estimates that the ABS provides to the OECD for the Innovation Indicators publication already have the CIS industry and employment size scope and coverage applied (Table 1.1), so it was already understood that the impact of reducing the BCS scope to match the CIS results in a higher proportion of innovation-active businesses. Differences in length of reference period on the other hand have not been well understood until now. It was assumed that increasing the reference period would result in higher estimated proportions of innovation-active businesses but the full impact was unknown.

The experimental MYIR methodology described in this paper approximates the CIS scope and reference period, aligning the survey methodologies for both surveys as closely as possible. Resulting estimates show that by modelling single-year BCS data to produce estimates of the proportion of innovation-active businesses over a three year reference period, and applying CIS industry and employment scope results in a higher proportion of innovation-active businesses. However, estimates show that applying CIS industry and employment scope to the BCS estimates has a greater impact on increasing the proportion of innovation-active businesses than the extension in reference period. The exclusion of businesses with 0 to 9 persons employed, in particular, has the largest impact on estimates.

Referring back to the results presented in Table 1.1 (Single-year BCS estimates with CIS scope applied to the sample, as reported to the OECD), the analysis in this paper and the experimental estimates produced indicate that when differences in reference period are addressed, the proportion of innovation-active businesses in Australia is higher than the estimate in the OECD's innovation indicators publication. However, with other survey methodology differences still not addressed and the issue of provider recall providing uncertainty, the question of exactly how many more business would indicate they were innovation-active if given a longer reference period is still not certain.

Despite the uncertainty in the experimental estimates, this research adds to the body of knowledge related to innovation survey methodologies and their impacts on estimates of business innovation. For the purpose of providing researchers and policy makers with indicators that offer a complete picture of innovation in Australian businesses, the BCS is successful in capturing all business activity in the economy, which is diverse in industry and businesses size. In addition, for consistency, ease of reporting for respondents and to allow the availability of timely indicators, a one year reference period remains appropriate. The methodology in this paper enhances our understanding of how Australian innovation rates compare internationally, without making changes to the current innovation survey methodology used.

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EXPERIMENTAL ESTIMATES OF AN AUSTRALIAN MULTI-YEAR INNOVATION RATE

APPENDIX A: COMMUNITY INNOVATION SURVEY SAMPLE RATES

A.1 TARGET POPULATION, SAMPLE SIZE, SAMPLED AND ENUMERATED UNITS AND OVERALL SAMPLE RATE, by country – Community Innovation Survey 2012

Country	Target Population	Sample	In case of combination sample/census:		Overall sample rate
	No.	No.	Sampled units	Enumerated units	%
Belgium	n/a	n/a	n/a	n/a	n/a
Bulgaria			Census		
Czech Republic	22,253	5,449	3,554	1,895	27.0
Denmark	17,231	4,909	4,415	494	26.0
Germany	165,704	22,951	19,715	3,236	13.9
Estonia	n/a	n/a	n/a	n/a	64.4 (sampled and enumerated units incl.)
Ireland	6,964	4,650	n/a	n/a	67.0
Greece	14,987	4,212	3,998	214	28.1
Spain	76,338	27,279	15,072	12,207	35.7
France	71,015	22,296	19,249	3,049	31.4
Croatia	11,148	4,305	n/a	n/a	38.6
Italy	114,517	20,246	17,910	2,336	17.7
Cyprus	1,588	1,205	286	919	n/a
Latvia	n/a	n/a	n/a	n/a	32.0
Lithuania	9,243	2,289	n/a	n/a	24.8
Luxembourg	1,618	881	389	492	54.2
Hungary	15,163	6,032	4,398	1,634	39.8
Malta			Census		
Netherlands	25,242	6,234	n/a	n/a	25.0
Austria	16,451	5,624	4,848	776	34.0
Poland	n/a	n/a	n/a	n/a	n/a
Portugal	21,724	8,963	8,514	449	41.0
Romania	-	-	5,829	3,290	31.0
Slovenia	4,249	2,500	1,516	984	46.4 (only for small enterprises)
Slovakia	7,202	2,313	1,944	369	n/a
Finland	8,700	3,585	3,154	431	38.1 (for enterprises <250 employees)
Sweden	17,876	6,192	5,381	811	35.0
United Kingdom	28,365	14,487	-	-	51.0
Norway	8,948	4,185	2,013	2,172	47.0
Serbia	-	+/-2000	-	811	23.0
Turkey	94,721	10,980	8,774	2,206	12.0

Source: Eurostat (2012)

EXPERIMENTAL ESTIMATES OF AN AUSTRALIAN MULTI-YEAR INNOVATION RATE

APPENDIX B: COMMUNITY INNOVATION SURVEY CRITERION TO ENUMERATE

B.1 TYPES OF DATA COLLECTION AND CRITERIA APPLIED IN CASE OF COMBINATION OF SAMPLE AND CENSUS, by country – Community Innovation Survey 2012

<i>Country</i>	<i>Status of data collection</i>	<i>Sample/census</i>	<i>Criterion to enumerate the enterprises</i>
Belgium	n/a	n/a	n/a
Bulgaria	Mandatory	Census	
Czech Republic	Mandatory	Combination sample/census	Expected CVs
Denmark	Mandatory	Combination sample/census	Size class (>100); previous reporting of R&D expenditures greater than a certain threshold; R&D service industry; belong to the "Advanced Technology Group"
Germany	Voluntary	Combination sample/census	Size class (500+)
Estonia	Mandatory	Combination sample/census	
Ireland	Mandatory	Combination sample/census	Size class (50+)
Greece	Mandatory	Combination sample/census	Size class and R&D performers
Spain	Mandatory	Combination sample/census	Size class (200+) and R&D performers
France	Mandatory	Combination sample/census	Size class (250+)
Croatia	Mandatory	Combination sample/census	Size class
Italy	Mandatory	Combination sample/census	Size class (250+)
Cyprus	Mandatory	Combination sample/census	Size class (20+)
Latvia	Mandatory	Combination sample/census	Size class (250+)
Lithuania	Mandatory	Sample	
Luxembourg	Mandatory	Combination sample/census	Size class
Hungary	Mandatory	Combination sample/census	Size class (100+)
Malta	Mandatory	Census	
Netherlands	Mandatory	Combination sample/census	
Austria	Voluntary	Combination sample/census	Size class (250+)
Poland	n/a	n/a	n/a
Portugal	Mandatory	Combination sample/census	Size class
Romania	Mandatory	Combination sample/census	Size class (100+)
Slovenia	Mandatory	Combination sample/census	Size class (50+)
Slovakia	Mandatory	Combination sample/census	Size class (250+)
Finland	Mandatory	Combination sample/census	Size class (250+)
Sweden	Mandatory	Combination sample/census	NACE 72 and size class
United Kingdom	Voluntary	Combination sample/census	Size class (250+) except for G46 and K64 ; SMEs in D35.1/2 (electric power generation) and E36 (water collection, tmt and supply)
Norway	Mandatory	Combination sample/census	NACE, size class and R&D performers: (NACE 72, all) ; (F,G,H, 100+) ; (remaining industries,50+) + R&D performers
Serbia	Mandatory	Combination sample/census	
Turkey	Mandatory	Combination sample/census	Size class

Source: Eurostat (2012)

EXPERIMENTAL ESTIMATES OF AN AUSTRALIAN MULTI-YEAR INNOVATION RATE

APPENDIX C: COMMUNITY INNOVATION SURVEY RESPONSE RATES

C.1 NON-WEIGHTED AND WEIGHTED UNIT NON-RESPONSE RATE BY NACE CATEGORIES AND FOR ENTERPRISES WITH 10 OR MORE EMPLOYEES, by country – Community Innovation Survey 2012

	Core NACE (B-C-D-E-46-H-J-K-71-72-73)		Core industry (B-C-D-E excluding construction)		Core Services (46-H-J-K-71-72-73)	
	Un-weighted unit non-response rate	Weighted unit non-response rate	Un-weighted unit non-response rate	Weighted unit non-response rate	Un-weighted unit non-response rate	Weighted unit non-response rate
Belgium	n/a	n/a	n/a	n/a	n/a	n/a
Bulgaria	0.6	0.6	0.9	0.9	0.3	0.3
Czech Republic	12.2	14.2	12.0	13.2	12.6	15.5
Denmark	4.0	5.0	4.0	4.0	5.0	5.0
Germany	76.4	n/a	75.6	n/a	77.9	n/a
Estonia	22.2	25.0	21.6	23.9	23.2	26.0
Ireland	n/a	n/a	n/a	n/a	n/a	n/a
Greece	51.1	55.5	47.9	52.6	54.7	58.1
Spain	6.8	9.6	6.3	8.7	7.6	10.4
France	19.8	22.1	18.9	20.9	20.9	23.1
Croatia	24.3	27.3	24.4	29.1	24.1	25.1
Italy	40.6	41.8	45.2	44.0	36.0	37.4
Cyprus	0	0	0	0	0	0
Latvia	5.8	5.4	5.7	4.9	6.0	5.8
Lithuania	0.9	0.9	0.8	1.2	0.9	0.8
Luxembourg	8.8	n/a	9.6	n/a	8.5	n/a
Hungary	9.1	11.9	7.6	10.9	11.5	12.9
Malta	0.2	n/a	0.2	n/a	0.2	n/a
Netherlands	30.0	27.0	26.0	26.0	32.0	28.0
Austria	46.4	47.9	47.0	49.1	45.9	46.9
Poland	n/a	n/a	n/a	n/a	n/a	n/a
Portugal	14.5	17.2	14.1	17.4	15.1	17.0
Romania	9.2	0	7.4	0	11.9	0
Slovenia	20.7	11.5	21.1	11.7	20.3	11.0
Slovakia	18.0	21.6	14.7	19.2	21.1	24.7
Finland	25.7	27.0	24.7	26.0	26.7	27.8
Sweden	14.1	15.8	14.4	17.0	13.8	15.1
United Kingdom	49.2	n/a	48.3	n/a	49.8	n/a
Norway	3.6	n/a	3.8	n/a	3.4	n/a
Serbia	22.6	29.1	25.3	32.8	19.1	24.4
Turkey	4.1	4.9	3.8	5.6	4.5	4.1

Source: Eurostat (2012)

APPENDIX D: INVESTIGATING PROVIDER RECALL ISSUES

Prior to the development of the BCS, stand-alone Innovation Surveys were conducted by the ABS in 2005 and 2003. The 2005 innovation survey used a two year reference period, asking businesses to report on any innovation activity in the 2004 and 2005 calendar years. Specifically, after establishing that the business had introduced any new goods, services or processes in the two-year reference period, Question 9 on the survey asked businesses to “Please indicate which calendar year(s) these new goods, services or processes were introduced or implemented”. Response options were given as (a) In calendar year 2004 and (b) In calendar year 2005 for each type of innovation. Because respondents were asked to indicate in which calendar year(s) of the two year reference period they introduced each type of innovation, this information could be useful in understanding how the issue of provider recall may impact on innovation estimates.

As Table D.1 shows, of the businesses that indicated they had introduced an innovation in the two-year reference period, the estimated proportion of businesses that had introduced innovation in the 2004 calendar year was lower for each type of innovation, compared to the 2005 calendar year. Overall, 83.5% of the businesses that introduced innovation indicated that innovation was introduced in the 2005 calendar year, compared to 51.6% in the 2004 calendar year.

D.1 BUSINESSES THAT INTRODUCED INNOVATION IN EACH YEAR AS A PROPORTION OF BUSINESSES THAT INNOVATED IN TWO-YEAR REFERENCE PERIOD

	<i>Introduced in 2004</i>	<i>Introduced in 2005</i>
	%	%
Type(s) of innovation (a):		
Goods and/or services	50.98	76.13
Operational processes	45.62	77.75
Organisational/managerial processes	39.83	80.33
Any of the above innovations introduced	51.59	83.45

(a) Marketing methods was not included in the Innovation Survey 2005 and this are not included in ‘Any of the above innovations’

A further breakdown of this information in Table D.2 shows that the estimated proportion of innovating businesses introduced innovation in the 2004 calendar year only was lower for all types of innovation compared to those that introduced innovation in the 2005 calendar year only.

D.2 BUSINESSES THAT INTRODUCED INNOVATION IN EACH OR BOTH YEAR(S) AS A PROPORTION OF BUSINESSES THAT INNOVATED IN TWO-YEAR REFERENCE PERIOD

	<i>Introduced in 2004 only</i>	<i>Introduced in 2005 only</i>	<i>Introduced in both 2004 and 2005</i>
	%	%	%
Type(s) of innovation (a):			
Goods and/or services	23.87	49.02	27.11
Operational processes	22.25	54.38	23.37
Organisational/managerial processes	19.67	60.17	20.16
Any of the above innovations introduced	16.55	48.41	35.04

(a) Marketing methods was not included in the Innovation Survey 2005 and this are not included in ‘Any of the above innovations’

It is important to understand that some businesses responding to the 2005 Innovation Survey may not have been alive in 2004. It would therefore be expected that fewer of the businesses would have existed in 2004 and therefore been unable to introduce any innovation, however, of the businesses that responded to the survey, it was found that 92% were alive at some point in 2004.

Without further information it is not possible to definitively conclude that difference in proportions of businesses indicating that they introduced innovation in 2004 compared to 2005 is due to provider recall. Estimates produced using single-year BCS data shows that the estimated proportion of Innovation-active businesses does fluctuate up and down slightly each year and this may account for some of this difference. However, given the size of the difference, it is conceivable that the issue of provider recall could also be playing a part.

Note: Compared to BCS, the 2005 Innovation Survey scope excluded businesses with fewer than 5 employees and all businesses classified to the Agriculture Forestry and Fishing industry so comparison with the BCS estimates is be advisable.

APPENDIX E: CONVERTING THE COMMUNITY INNOVATION SURVEY SCOPE TO ANZSIC CODES

The CIS uses the *International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4* to classify businesses. The ABS uses the *Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) (cat. no. 1292.0)* to classify businesses in the Australian population.

A concordance between the ANZSIC and ISIC is available in *Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 - Correspondence Tables, 2008 (cat. no. 1292.0.55.001)* and this is used to determine which ANZSIC classes should be included when scoping the BCS to match the CIS.

In order to perform this concordance, the following is determined:

1. Which ISIC codes are in scope for the CIS
2. Which ANZSIC classes concord to the ISIC codes that are in scope

In some cases, ANZSIC classes do not concord directly to a single ISIC code - that is, the ANZSIC class concords to multiple ISICs. Where this occurs, if at least half of the corresponding ISIC codes are in CIS scope, then the ANZSIC code is included.

For example, the ANZSIC code 1120 Seafood Processing has a part concordance to three different ISIC codes (0311, 1020 and 1075), as shown below. Since ISIC 0311 Marine fishing is out of scope of the CIS, but ISIC 1020 Processing and preserving of fish, crustaceans and molluscs and ISIC 1075 Manufacture of prepared meals and dishes are both included in the scope of the CIS, the ANZSIC code 1120 is included when scoping the BCS to CIS.

E.1 SAMPLE ANZSIC CODE WHICH HAS PART CONCORDANCE TO MULTIPLE ISIC CODES

ISIC	Label	ANZSIC	Label
0311	Marine fishing (EXCLUDED FROM CIS SCOPE)	0411	Rock Lobster and Crab Potting
		0412	Prawn Fishing
		0413	Line Fishing
		0414	Fish Trawling, Seining and Netting
		0419p	Other Fishing
		0529p	Other Agriculture and Fishing Support Services
		1120p	Seafood Processing
1020	Processing and preserving of fish, crustaceans and molluscs (INCLUDED IN CIS SCOPE)	1120p	Seafood Processing
1075	Manufacture of prepared meals and dishes (INCLUDED IN CIS SCOPE)	1111p	Meat Processing
		1112p	Poultry Processing
		1113p	Cured Meat and Smallgoods Manufacturing
		1120p	Seafood Processing
		1140p	Fruit and Vegetable Processing
		1161p	Grain Mill Product Manufacturing
		1199p	Other Food Product Manufacturing n.e.c.

There were 6 ANZSIC classes which had part concordance to multiple ISICs and were included when scoping the BCS to CIS, and 12 ANZSIC codes which were excluded as a result of this rule (Table E2 and E3).

EXPERIMENTAL ESTIMATES OF AN AUSTRALIAN MULTI-YEAR INNOVATION RATE

E.2 ANZSIC CODES WHICH CONCORD TO MULTIPLE ISIC CODES BUT WERE INCLUDED WHEN SCOPING BCS TO CIS

ANZSIC	Label
1120	Seafood Processing
1492	Wooden Structural Fitting and Component Manufacturing
1913	Polymer Foam Product Manufacturing
5101	Postal Services
5292	Freight Forwarding Services
5921	Data Processing and Web Hosting Services
6924	Other Specialised Design Services
6950	Market Research and Statistical Services
6999	Other Professional, Scientific and Technical Services n.e.c.
7713	Fire Protection and Other Emergency Services
9422	Electronic (except Domestic Appliance) and Precision Equipment Repair and Maintenance
9429	Other Machinery and Equipment Repair and Maintenance
9499	Other Repair and Maintenance n.e.c.
9533	Parking Services

E.3 ANZSIC CODES WHICH CONCORD TO MULTIPLE ISIC CODES AND HAVE BEEN EXCLUDED WHEN SCOPING BCS TO CIS

ANZSIC	Label
3109	Other Heavy and Civil Engineering Construction
3232	Electrical Services
3239	Other Building Installation Services
3299	Other Construction Services n.e.c.
3505	Motor Vehicle Dismantling and Used Parts Wholesaling
3800	Commission-Based Wholesaling
4273	Antique and Used Goods Retailing
6923	Engineering Design and Engineering Consulting Services
6962	Management Advice and Related Consulting Services
7712	Investigation and Security Services
7720	Regulatory Services
9419	Other Automotive Repair and Maintenance

There are ANZSIC codes which are excluded, by definition, from the BCS scope, but are included (as ISICs) in the CIS scope. It is not possible to make adjustments for industry classes that are not included in the BCS and as such this difference in scope should be taken into account when making comparisons between the two sets of estimates.

E.4 ANZSIC CLASSES THAT CONCORD TO ISIC CODES IN CIS SCOPE BUT EXCLUDED FROM THE BCS SCOPE

Classes out of scope for BCS		ISICs these classes concord to	
ANZSIC	Label	ISIC	Label
6240	Financial asset investing	6240	Activities of holding companies
		6430	Trusts, funds and similar financial entities
		6499	Other financial service activities, except insurance and pension funding activities, n.e.c.
6330	Superannuation funds	6530	Pension funding

The full list of ANZSIC classes which have been included when scoping the BCS to CIS scope available on request.

EXPERIMENTAL ESTIMATES OF AN AUSTRALIAN MULTI-YEAR INNOVATION RATE

APPENDIX F: STANDARD ERRORS

The difference between estimates obtained from a sample of businesses and the estimates that would have been produced if information had been obtained from all businesses is called sampling error. The expected magnitude of the sampling error associated with any estimate can be estimated from the sample results. One measure of sampling error is given by the Standard Error (SE), which indicates the degree to which an estimate may vary from the value that would have been obtained from a full enumeration (the 'true' figure). There are about two chances in three that a sample estimate differs from the true value by less than one standard error, and about 19 chances in 20 that the difference will be less than two standard errors.

For example, the proportion of businesses with any innovative activity (innovation-active businesses) calculated using the MYIR methodology for 2014-15 is 61.5%. The standard error of this estimate is 0.8pp (percentage points). Hence, there would be approximately two chances in three that a full enumeration would have given a figure in the range of 60.6% to 62.3%, and 19 chances in 20 that it would be in the range of 59.8% and 63.1%.

F.1 STANDARD ERRORS FOR BCS SCOPE MULTI-YEAR INNOVATION RATE, Proportion of businesses with any innovative activity (innovation-active business), by employment size, 2007-08 to 2009-10 through to 2012-13 to 2014-15, values are given in percentage points

	2007-08 to 2009-10	2008-09 to 2010-11	2009-10 to 2011-12	2010-11 to 2012-13	2011-12 to 2013-14	2012-13 to 2014-15
Multi-Year Innovation Rate (a)						
Employment size						
0-4 persons	1.3	1.1	1.2	1.2	1.1	1.2
5-19 persons	1.3	1.2	1.5	1.5	1.4	1.4
20-199 persons	2.1	1.4	1.7	1.9	2.0	1.9
200 or more persons	1.7	1.6	1.3	1.2	1.7	1.1
Total	0.9	0.8	0.9	0.9	0.8	0.8

(a) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in the three year reference period

F.2 STANDARD ERRORS FOR CIS SCOPE MULTI-YEAR INNOVATION RATE, Proportion of businesses with any innovative activity (innovation-active business), by employment size, 2007-08 to 2009-10 through to 2012-13 to 2014-15, values are given in percentage points

	2007-08 to 2009-10 %	2008-09 to 2010-11 %	2009-10 to 2011-12 %	2010-11 to 2012-13 %	2011-12 to 2013-14 %	2012-13 to 2014-15 %
Multi-Year Innovation Rate (a)						
Employment size						
10-19 persons	3.0	2.6	4.3	4.2	2.6	3.6
20-199 persons	3.0	1.9	3.2	2.9	3.4	3.4
200 or more persons	2.1	1.9	1.0	1.1	1.5	1.0
Total	2.1	1.6	2.7	2.4	2.2	2.5

(a) Estimated proportion of businesses with any innovative activity (innovation-active businesses) in the three year reference period

GLOSSARY

Innovation

An innovation is the introduction of a new or significantly improved good or service; operational process; organisational/managerial process; or marketing method.

Innovative activity

Innovative activity includes any work that was intended to, or did, result in the introduction of an innovation.

Measures of business innovation

Two measures of business innovation are considered in this paper:

- *Innovating businesses* - businesses that introduced any type of innovation during the reference period.
- *Innovation-active businesses* - businesses that had undertaken any innovative activity during the reference period including: introduction of any type of innovation; and/or the development or introduction either still in progress or abandoned.

Non innovation-active businesses

Businesses that, during the reference period, did not undertake any innovative activity.

Status of innovation

Three statuses of innovation are considered in this paper:

- *Introduced* - the business successfully introduced an innovation during the reference period (although the innovation does not need to have been commercially successful).
- *Still in development* - the business was in the process of developing or introducing an innovation during the reference period but work on the innovation was still in progress at the end of the period.
- *Abandoned* - the business abandoned the development and/or introduction of an innovation during the reference period (i.e. work on the innovation ceased without full introduction occurring).

Types of innovation

Four types of innovation are considered in this paper:

- *Goods or services* - Any good or service or combination of these which is new to a business (or significantly improved). Its characteristics or intended uses differ significantly from those previously produced/offered.
- *Operational processes* - New or significantly improved methods of producing or delivering goods or services of a business (including significant change in techniques, equipment and/or software).
- *Organisational/managerial processes* - New or significantly improved strategies, structures or routines of a business which aim to improve performance.
- *Marketing methods* - New or significantly improved design, packaging or sales methods aimed to increase the appeal of goods or services of a business or to enter new markets.

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