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Patterns of Innovation in Australian Businesses 2003

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Patterns of Innovation in Australian Businesses

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CONTENTS

FIGURES

TABLES

PREFACE

The release of the results from the 2003 Innovation Survey in February 2005 (*Innovation in Australian Business*, *2003* ABS cat. no. 8158.0) represents a significant step forward in understanding the types of innovation undertaken by Australian businesses, and the drivers and barriers to such innovation. The richness of this dataset and its relevance to public policy formulation and evaluation is widely recognised.

To maximise the usefulness of these data to the Australian community, the Australian Statistician decided in May 2005 to enter into an analytical collaboration arrangement with the Department of Industry, Tourism and Resources (DITR). Such collaborations are authorised under statistics legislation where the work is directly assisting the Statistician with his statistical functions.

This report covers some preliminary findings of the analytical collaboration between the ABS and DITR.

This paper has been prepared by Ester Basri with data and statistical assistance from Umme Salma and Hsien Toh (Department of Industry Tourism and Resources). Glyn Prichard (Australian Bureau of Statistics) provided technical support and helpful comments.

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LIST OF ABBREVIATIONS

ABBREVIATIONS

ABN	Australian Business Number
ABS	Australian Bureau of Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
BLD	Business Longitudinal Database
CIS	Community Innovation Survey
DITR	Australian Government Department of Industry, Tourism and Resources
ICT	information and communication technology
OECD	Organisation for Economic Co-operation and Development
R&D	research and development
RSE	relative standard error
TAU	Type of activity unit
USA	United States of America

MAIN FEATURES

This paper represents the first consolidated analysis of innovation across Australian businesses as part of a collaboration between DITR and ABS. The research is based on micro-level data from the ABS *Innovation in Australian Business 2003* survey, which covers businesses with 5 or more employees in most industries.

The survey provides detailed information on innovation in Australian businesses. The aim of this study is to provide a broad overview of the main patterns of innovation in Australian businesses, the general characteristics of innovators and an analysis of expenditure on innovation. It shows that:

- **Innovation is occurring across the economy.** 35% of Australian businesses undertook one or more forms of innovation activity (introduced new goods and/or services, operational and/or organisational/managerial processes). These types of innovation are not confined to particular sectors in the economy as it is wide in scope. Industries that may be regarded as less likely to innovate, such as Electricity, gas and water supply, have very similar proportions of innovating businesses to those in Communication services, which are frequently regarded as the cutting edge of modern innovation.
- **Innovation in goods and/or services is lower than both operational process innovation and organisational/managerial innovation in most industries.**
- **Only 9% of goods or service innovators are engaged in 'new to the world' activities.** For most goods or service innovating businesses the highest degree of novelty is 'new to the business' (56%). Very few businesses are introducing 'new to the world' operational processes (3%), and 75% of these innovators are focusing on 'new to the business' activities. This strong emphasis on 'new to the business' innovation occurs in nearly every industry across the economy. Australia is not unique in this respect as this strong emphasis on 'new to the business' innovation appears to be a general characteristic of innovation at the global level. It should be noted that 'new to the business' product and process innovation are forms of diffusion that have powerful economic impacts over the long term.
- **More than half (53%) of goods or service innovating businesses generate less than 10% of their turnover from new goods or services, while just 10% generate more than 50% of their turnover from new innovations.** This result is found in most industries as the majority of goods or service innovating businesses report that less than 10% of their turnover is attributed to new goods or services. Thus, although innovation activity is widely spread across industry, a major proportion of turnover attributed to new goods or services is highly concentrated in relatively few businesses.

- **The proportion of businesses innovating increases with employment size from 28% in businesses with '5–9' employees to over 60% in businesses with '250 plus' employees.**
- **The differences between business size categories and innovation novelty is less clear.** The proportion of 'new to the business' goods or service innovation ranged from 37% to 63% but this does not follow any particular pattern. The result for 'new to Australia' goods or service innovation also varied. While businesses with '250 plus' employees reported more new to Australia innovations than those in the '5–9', '10–19', '20–49' and '50–99' employee size categories, the '100 to 249' group is nine percentage points higher than the '250 plus' category. The proportion of 'new to the world' goods and service innovation is roughly similar across each business size category. The majority of operational process innovation is 'new to the business' (59% to 84%), but the results do not follow any particular pattern across the business size categories.
- **Foreign ownership appears to be associated with a higher rate of innovation.** In terms of innovation novelty, businesses with more than 50% foreign ownership have more than double the proportion of 'new to the world' goods or services than the other categories. The variation between ownership categories is less marked for operational process novelty. The noteworthy difference is in the 'new to Australia' group where businesses with 10% or more foreign ownership report a higher degree of process innovation. While this pattern may be partly explained by the sectoral distribution of foreign owned businesses, it still suggests that these businesses are at the forefront of adopting and implementing new process technologies in Australia.
- **The relationship between the age of the business and innovation activity appears to be unclear.** Although there is some variation across the categories used in the analysis, the degree of innovation novelty does not suggest any particular association.
- **Innovation expenditure is not primarily based on R&D as it involves high levels of non-R&D expenditure.** Non-R&D expenditure on innovation represents 69% of innovators' expenditure on innovation. Overall, innovating businesses expenditure on R&D represented 0.7% ($5800.6m) of total business expenditure whereas non-R&D innovation expenditures represented 1.7% ($13,123.4m). Only 31% of innovating businesses report R&D expenditure. These results demonstrate that innovation inputs are much broader than R&D.
- **Not all types of innovation require the same commitment of financial resources.** Although the proportion of businesses reporting operational and organisational/management process innovation is higher than goods or service innovation (23%, 21% and 17% respectively), these process innovations do not require substantial expenditure in comparison with goods or service innovation.

- **The relationship between business size and expenditure on innovation and R&D is not straightforward.** While a greater proportion of large businesses innovate compared with small businesses the expenditure ratio (measured as the ratio of innovation and R&D expenditure to total business expenditure) does not follow this pattern. Small businesses with 5 to 9 employees have an innovation and R&D expenditure ratio that is similar to large businesses with 250 or more employees, but these results do not take into account the uneven distribution of expenditure within firm size categories.
- **There is wide variation between the proportion of businesses innovating and the intensity of expenditure reported across industry.** This suggests that in some industries the nature or extent of the innovation they are undertaking requires relatively less financial investment.
- **Expenditure on R&D and goods or service innovation by innovators varied markedly across industries.** As a proportion of total business expenditure R&D expenditure ranged between 0.08% (Retail trade) and 1.9% (Property and business services). For goods or service innovation the expenditure range was between 0.2% (Retail trade and Electricity, gas and water supply) and 3.1% (Wholesale trade). The variation between industries' expenditure on operational and organisational/managerial innovations was not as marked. For operational processes expenditure was between 0.1% and 0.9% whereas for organisational/managerial innovation the range was between 0.05% and 0.5%.
- **Although innovation is widespread across industry, expenditure is highly concentrated in a small number of businesses.** This pattern is evident across all business size classes and industries. The conclusion that can be drawn from these data is that innovation and R&D expenditure intensity is strongly focused on a small proportion of the business population.
- **The scope and coverage of the *Innovation in Australian Business 2003* survey provides a unique dataset for research.** Some of the analysis in this paper suggests that further research is needed as this preliminary work generates new questions that have not been answered. Nonetheless, the innovation survey represents a major step forward in the collection of innovation data, and this is important for informing public policy development.

CHAPTER 1 INTRODUCTION

This paper provides an analysis of innovation across Australian businesses, undertaken by the Department of Industry Tourism and Resources (DITR) and the Australian Bureau of Statistics (ABS). The analysis uses micro-level data from the *Innovation in Australian Business 2003* survey to explore the key characteristics and patterns of innovation in Australian industry. A brief overview of the background and history of innovation surveys is provided, followed by a discussion of the importance of understanding and measuring innovation and the methodology used in the current Australian survey. Finally, the paper presents a broad analysis of the main results.

It is now accepted that although innovation is a key driver of economic growth, it is a complex process that is difficult to measure. Innovation is usually defined in terms of novelty – the creation of something qualitatively new in terms of product performance or process characteristics, and its introduction to the market. Because innovation rests on learning and knowledge creation (if a business did not need to learn to innovate, then there would be nothing really new) then many aspects of the innovation process are somewhat intangible. This makes the measurement of innovation difficult. However difficult it is to measure innovation, and to interpret the data that arise from measurement exercises, such data are of strategic importance, both for our understanding of innovation in Australia, and for the discussion and formation of policy.

Until the early 1990s research and development (R&D) and patent data were the main sources of information on innovation. Although these indicators have value in terms of analysing innovation they also have limitations. R&D data is an input measure of expenditure, while patents are a measure of invention. Neither R&D nor patents may ever lead to innovation outcomes or to the introduction of new or improved products[1] and processes onto the market. Furthermore, the amount of R&D and patents vary among different industries and are particularly strong in certain sectors (eg. pharmaceutical and electronics) while in most industries other methods of informal intellectual property protection are used such as secrecy or the complexity of product design.

These data shortcomings encouraged researchers to develop new indicators of innovation activities and innovation outputs. In the late 1980s business-level quantitative studies of innovation were conducted in Canada, the USA and Europe (in France, Germany, Italy, the Netherlands and the Nordic countries). These studies demonstrated that new data collection methods were possible but the variety of methodological approaches used made it difficult to compare data. This led the OECD to initiate a study to establish international guidelines for collecting standardised innovation

1 The term product is used interchangeably with goods or services in this paper.

data, and the first edition of the *Oslo Manual, Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*, was published in 1992.

Also in 1992 the European Commission initiated a project for the collection of innovation data in Europe, with the aim of creating a coordinated innovation survey. The first Community Innovation Survey (CIS) was completed in 13 European countries in 1993–94. Canada conducted its first innovation survey in 1993. The European and Canadian innovation surveys initially covered manufacturing only, but moved to include services from the second surveys in 1996.

The ABS conducted its first comprehensive innovation survey of the Australian manufacturing industry in 1993–94. The survey was consistent with the guidelines in the *Oslo Manual* and CIS, however it also included questions on organisational and managerial (non-technological) innovation. This type of innovation was acknowledged in the *Oslo Manual* (OECD, 1992) but measurement guidelines focussed on technological innovation mainly because it was seen as able to provide economic indicators that were consistent across businesses and industries. According to Pattinson, Ovington and Finlay (1995), the ABS and various government departments believed that non-technological innovation was important so they decided that it would be measured in the Australian survey. A second Australian survey was also conducted in 1993–94 measuring technological and non-technological innovation across all non-manufacturing industries with the exception of Agriculture, Forestry and Fishing and Government Administration and Defence.

Following this, two more Australian innovation surveys were conducted in the manufacturing and mining industries in 1996–97, and once again, these surveys included non-technological innovation. In addition, up until 1997–98 the ABS collected some innovation data in its business longitudinal, telecommunications, construction and agricultural surveys (ABS, 2004). At the end of the 1990s innovation surveys were discontinued in Australia. Internationally, innovation surveys have been conducted on a regular basis in the European Union (CIS is conducted every four years) and Canada and on an irregular basis in countries such as Japan, China, South America and Hungary.

In 2002, the ABS, with strong support from government departments, made the decision to undertake further innovation surveys. A Technical Reference Group involving government agencies with a policy interest in innovation and users of innovation data was established in 2003 to assist the ABS on the conceptual framework, scope, coverage, and potential analytical uses of the innovation survey. The ABS also consulted other users and held seminars in Australian universities. Section 3 below discusses the survey methodology in more detail.

CHAPTER 2 UNDERSTANDING AND MEASURING INNOVATION

Innovation can be seen as the creation and use of qualitatively new products, production processes and organisational methods. Innovation is based on learning and the creation of knowledge about things such as product characteristics and performance, market needs, and production technologies. However new technologies, which are the most tangible outcomes of innovation, do not simply rest on new knowledge. They also require investment by governments and businesses in the activities that create, develop and test new knowledge and new techniques. This chapter briefly explores the type of research on these processes, and what we might uncover through innovation surveys of the ABS type.

The past three decades have seen a major expansion of research on innovation (for a comprehensive overview of such research, see Fagerberg et al, 2005). An important stimulus to this research effort has been the idea that although innovation is an important distinguishing feature of our society, it has been poorly understood. This wide-ranging research program has looked at such issues as the nature of innovation processes at the business level, the determinants of technology diffusion, the links between innovation and economic growth, the role of technological collaboration in innovation, and the role of science in innovation. This research has been carried out in three main ways. Firstly, through case studies (of technologies, sectors or businesses), secondly through econometric studies using mainly R&D and patent data, and thirdly through surveys (which have studied national innovation patterns, regions, or specific themes such as technological collaboration).

Both case study research and the statistical studies based on R&D and patents, have limitations. Case studies are often rich in detail, but there is always a question about how generalisable the results are. This can be a problem, since within innovation research the case study approach has overwhelmingly focused on a relatively narrow group of industries and technologies – information and communication technology (ICT) and biotechnology sectors or businesses, for example, account for a very large part of the case study literature. It sometimes happens that theories of innovation generalise from these studies, neglecting the fact that they cover only a small part of the economic system. Statistical studies using R&D and patent data have limitations that were mentioned above. R&D is concentrated in a narrow group of industries, and is an input to innovation. Patents are often treated as an output, but they also are concentrated on a small group of industries (especially pharmaceuticals and electronics) and are an invention indicator rather than an innovation indicator.

Innovation surveys of the ABS type go some way to overcoming these limitations. They enable us to ask a number of questions that cannot be addressed with existing methods. These include:

How much innovation *activity* (meaning activity aimed at the creation of new product or processes, or new forms of organisation) is distributed across industries? Is innovation behaviour concentrated in the way that R&D and patenting are concentrated?

How is innovation activity distributed within industries? Within a particular industry, is it relatively evenly spread, or is it focused on small groups of businesses?

How are innovation outputs (in the form of turnover from new and changed products) distributed among businesses and industries, and what proportion of turnover is due to these outputs?

When businesses invest in innovation, what exactly are they investing in? What is the balance between R&D and non-R&D investments in innovation? How do innovation activity and outputs depend on investment, and what resources do businesses commit to such investment?

CHAPTER 3 METHODOLOGY

Before turning to the results, this chapter discusses the methodology underpinning the 2003 *Innovation in Australian Business* Survey. During 2003 a survey instrument was developed and tested by the ABS. Many of the questions in the survey were based on previous innovation questionnaires, particularly the ABS 1997 survey, the Canadian 1999 survey, and the Eurostat 2001 CIS3 survey. The survey is broadly consistent with the international framework outlined in the *Oslo Manual* (OECD, 1997).

A range of field-testing was conducted including:

- cognitive testing of the draft topics to assess the respondents understanding of the survey terms and concepts;
- observation testing of the draft survey form, which involved observational studies of how respondents dealt with the survey form; and
- postal testing of the final survey form, which involved sending draft forms to providers and the evaluation of responses.

Minor layout, wording and sequencing changes were made as a result of the tests. In February 2004, around 8,500 businesses across Australia were mailed a questionnaire based on a random sample that was stratified by state and territory, industry and number of employees in the business.

The 2003 *Innovation in Australian Business* Survey covered businesses in all ANZSIC divisions with the exception of:

- Agriculture, Forestry and Fishing (Division A);
- Government Administration and Defence (Division M);
- Education (Division N);
- Health and Community Services (Division O); and
- Personal and Other Services (Division Q).

These divisions were excluded because of statistical and cost constraints. In particular, the ABS rationale was that a different survey format would be required for these industries. Although Agriculture, Forestry and Fishing is seen as an innovative industry it was argued to be predominately made up of micro businesses, with most innovation activity conducted through Rural Research and Development Corporations. Government Administration and Defence, Education and Health and Community Services have significant government involvement so market forces do not necessarily apply. (This does not of course mean that such industries are not innovative). As with Agriculture, Forestry and Fishing, the Personal and Other Services division was excluded because of heavy provider burden.

The sampling of industries was designed to produce acceptable standard errors at the one-digit divisional level of ANZSIC with the exception of Manufacturing and Property and Business Services which covered output at the two-digit sub-division level. The statistical unit or sample frame used for the survey was based on an Australian Business Number (ABN) for businesses with a simple structure, and the Type of Activity Unit (TAU) for businesses with complex structures. (For further information see ABS, 2005: 76.)

The survey was designed to cover businesses with employment of 5 or more people. The sample was designed to provide reasonable standard errors for the following three broad size bands (although output can be presented using any employment range greater than four employees):

- 5–19 (small businesses);
- 20–99 (medium businesses); and
- 100 or more (large businesses).

The reference period for the survey is mainly the three-year calendar period 2001–03. Some data relate to the calendar year 2003, and financial data relate to the most recent financial year ended on or before 30 September, 2003.

The survey questionnaire covered the following issues:

- the characteristics of businesses that are innovators;
- the types of innovations occurring;
- innovating businesses performance, in the sense of turnover deriving from new or changed products;
- the extent of cooperative linkages between businesses and research institutions;
- the source of innovation ideas;
- the drivers and barriers to innovation; and
- investment in innovation, in terms of expenditures on R&D and non-R&D costs related to product, process and organisational change.

The survey was conducted under the authority of the Census and Statistics Act (1905). The innovation survey dataset contains data on more than 6,000 Australian businesses, with weighting factors used to construct the whole-population estimates.

The difference between information obtained from a sample of businesses and the information that that would have been produced if the data had been obtained from all businesses is known as sampling error. Standard errors can be used to measure sampling error. They indicate the degree to which information may vary from the value that would have been obtained if all businesses in the population had completed the survey. In this paper, sampling variability is measured by relative standard errors (RSEs) as this provides a direct indication of the relative size of errors that may have occurred due to sampling, and thus avoids the need to refer also to the size of the estimate. Where RSEs associated with data reported in this paper are greater than 50% they are marked with a double asterix symbol (**) which is consistent with data reported in the ABS publication Innovation in Australian Business 2003[2]. The ABS considers data with a RSE of greater than 50% too unreliable for general use. Some data reported here do have RSEs greater than 50% and should be treated with extreme caution.

Inaccuracies or non-sampling errors may also occur as a result of reporting from businesses, form design or ABS data processing. However, every effort was made by the ABS to reduce non-sampling error by:

- careful design and testing of the questionnaires and data processing systems;
- providing detailed instructions to providers on how to respond to questions; and
- detailed checking of reported data to ensure that it is logical, consistent and complete.

The data input editing process was supported by a post enumeration survey, which was conducted by the ABS with data providers in several states and territories. It was used to identify problems with the quality of reported data. Quality issues were then targeted during the output editing stage of the survey to minimise survey bias.

Overall, no significant problems were identified through the post enumeration survey. However, the estimates of expenditure on innovation should be treated with some caution. Standard accounting practices do not necessarily cover detailed information on innovation expenditure. As a result negligible amounts were recorded against some expense items and this may be due to the unavailability of information rather than minimal spending. Similarly, overestimates may have been reported for related reasons.

2 See ABS (2005: 80–81) for a full account of data quality and the reliability of estimates.

As mentioned above, the survey was designed to cover businesses with five or more employees. At the time of the survey businesses were asked to provide information on the number of employees currently employed in the business. Some businesses had less than five employees when they completed the questionnaire, and these businesses remain in the dataset. For the purpose of analysis in this paper businesses with less than five employees are included in the '5–9 employees' category, as this aligns with the data published in the ABS Catalogue (2005).

CHAPTER 4 INNOVATION IN AUSTRALIAN INDUSTRY

The ABS survey defined innovation as:

- The introduction of any new or significantly improved *goods or services*. Examples of new goods or services are a change in materials such as a breathable textile material and the introduction of a telephone or internet bill payment system.
- The introduction of new *operational processes* (the methods of producing or delivering goods or services). Examples of new operational processes are the digitalisation of printing processes and the introduction of an automated ticketing system.
- The implementation of new *organisational/managerial processes* (meaning strategies, structures or routines that aim to improve business performance). Examples of organisational/managerial innovations are changed corporate directions and significant workplace reorganisation.[3]

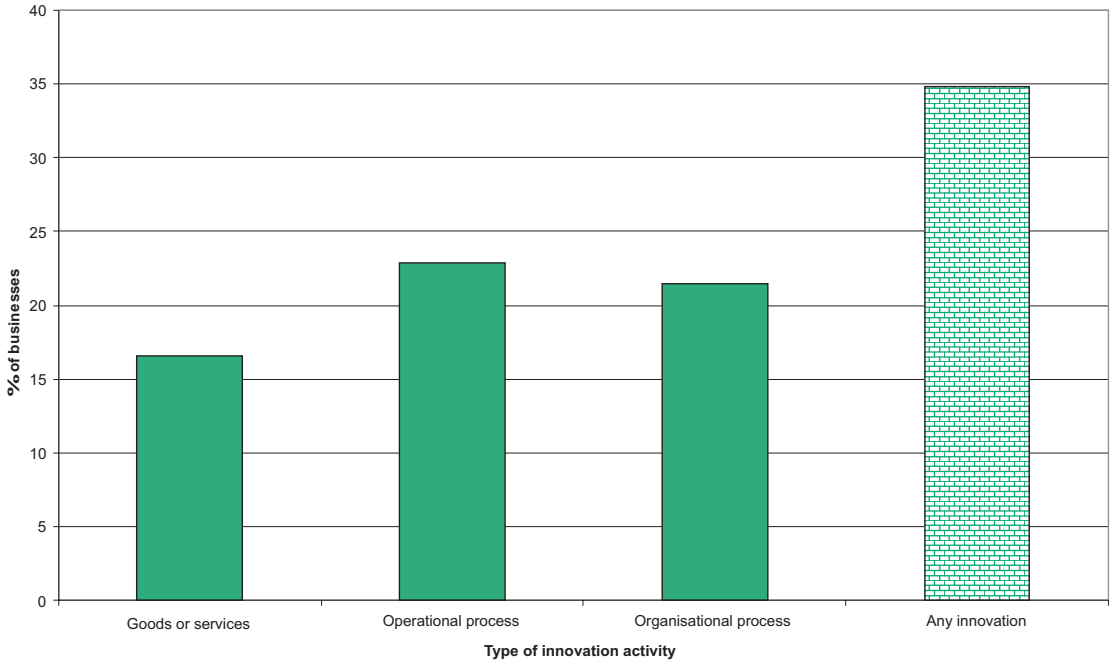
Businesses were considered 'innovators' if they had introduced at least one of these types of innovation during 2001–2003. Businesses could of course report more than one type of innovation.

3 Organisational/managerial innovation has been shortened to organisational innovation in this paper but the data refer to both organisational/managerial processes.

Figure 1 shows that 35% of Australian businesses undertook one or more of these forms of innovation. About 17% of businesses introduced new or changed goods or services, about 23% introduced process innovations, and slightly fewer (about 21%) introduced organisational or managerial changes.[4]

It should be noted that this paper focuses on presenting data from the *Innovation in Australian Business 2003* survey. This paper does not address whether the level of innovation in Australia is at an appropriate level or not.

FIGURE 1 PROPORTION OF BUSINESSES INNOVATING IN AUSTRALIA, 2001–2003

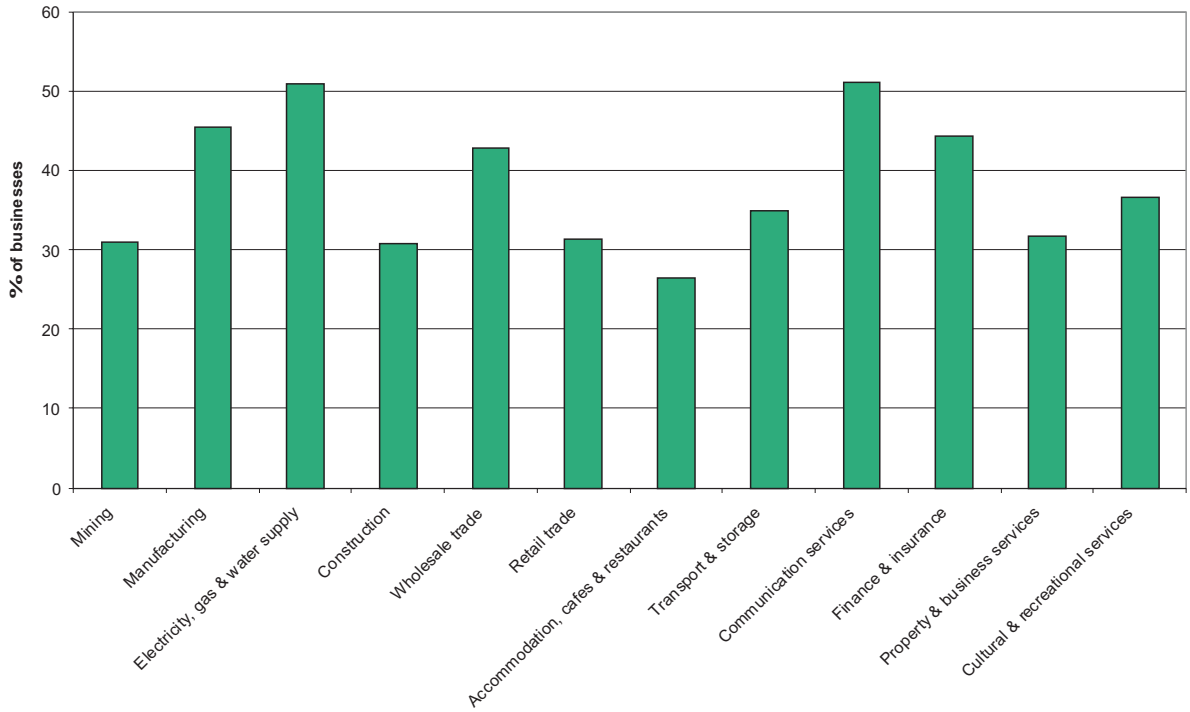


Source: ABS, 2005, Innovation in Australian Business 2003, Catalogue 8158.0.

4 The differences between the proportions are statistically significant (see Appendix 1).

The distribution of innovation activity across industries is shown in Figure 2. The proportion of innovating businesses varied from a high of around 50% in Electricity, gas and water supply and Communication services to 27% in Accommodation, cafes and restaurants. Innovation is not confined to particular industries as it is wide in scope. Even though innovation is likely to take very different forms across different industries an important point to be drawn from these data is that they illustrate that innovation is occurring across the economy. Industries that may be perceived as less likely to innovate such as utilities (ie Electricity, gas and water), have very similar proportions of innovating businesses to those in Communication services, which are frequently regarded as the cutting edge of modern innovation.[5]

FIGURE 2 PROPORTION OF BUSINESSES INNOVATING BY INDUSTRY, 2001–2003



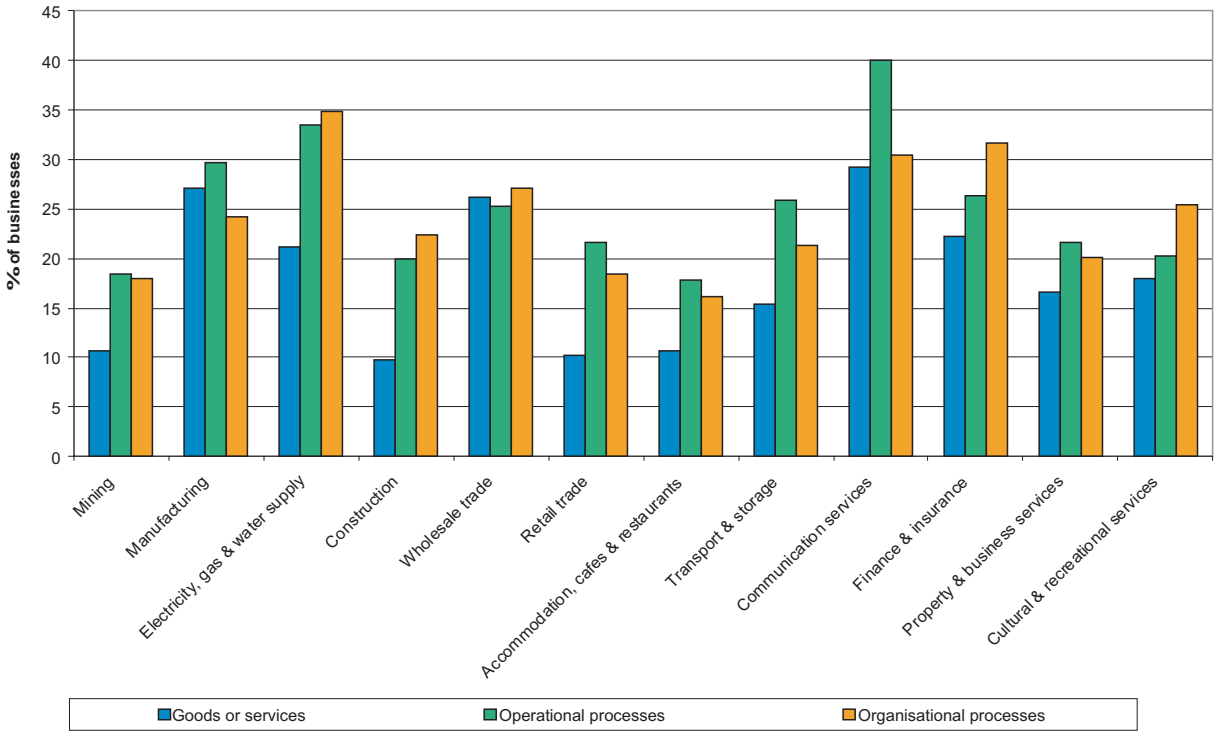
Source: ABS, 2005, Innovation in Australian Business 2003, Catalogue 8158.0.

5 Tests (see Appendix 1) show the proportion of firms undertaking innovation in Electricity, gas and water not to be significantly different from the proportion in Communication services.

4.1 TYPE OF INNOVATION

Just as innovation as a whole occurs across all industries, so do the three types of innovation covered by the survey, as Figure 3 shows. These types of innovation undertaken within each industry vary, but they vary in a way that is generally quite consistent with the variation of aggregate innovation across the industries. That is, goods or service innovation is lower than operational process change and organisational innovation in most industry sectors. It is only in Manufacturing and in Wholesale trade that goods or service innovation matches the frequency of either process or organisational change. This result suggests that businesses in most industries are largely concentrating innovative efforts on their operational processes rather than on new goods or services. (The impact of this on innovation expenditures will be discussed below).

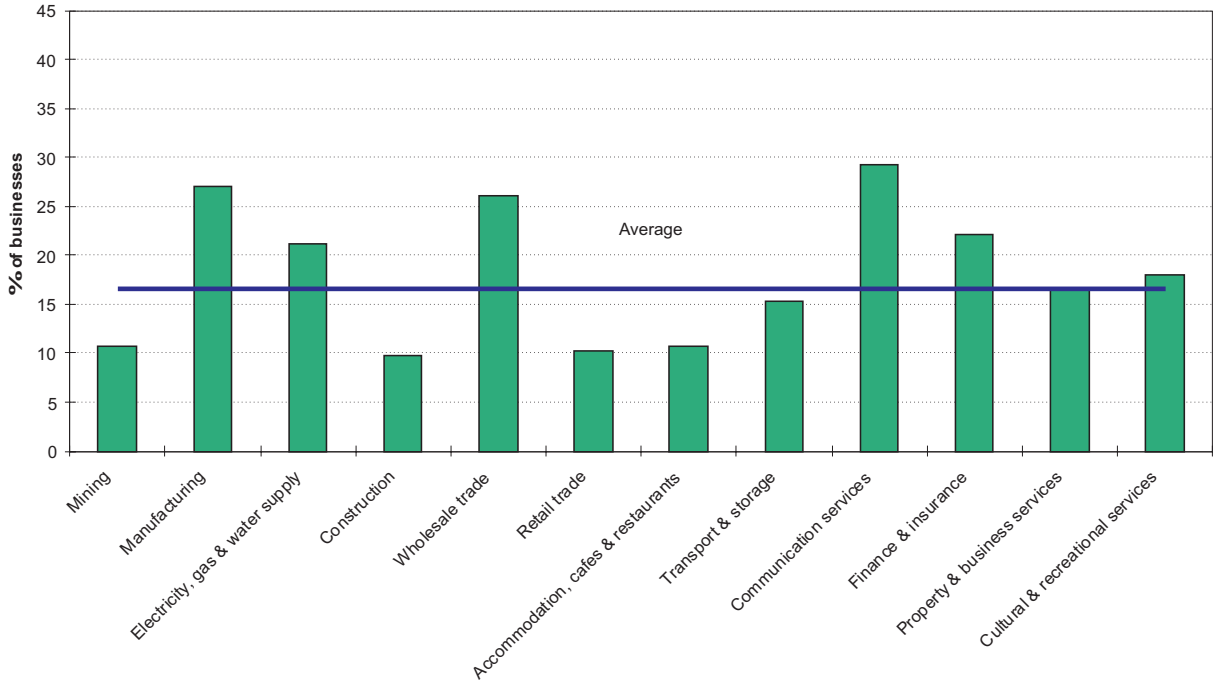
FIGURE 3 PROPORTION OF BUSINESSES INNOVATING BY TYPE OF INNOVATION AND INDUSTRY, 2001–2003



Source: ABS, 2005, Innovation in Australian Business 2003, Catalogue 8158.0.

The following three figures present each of these three types of innovation separately across industries, showing the industry differences for each type of innovation reported.[6] Goods or service innovation is occurring in around 10% of businesses in Mining, Construction, Retail trade and Accommodation, cafes and restaurants but in more than 20% of businesses in Manufacturing, Electricity, gas and water supply, Wholesale trade, Communication services and Finance and insurance. This latter group comprises the above average set of industries within the industries examined here.

FIGURE 4 PROPORTION OF BUSINESSES UNDERTAKING GOODS OR SERVICE INNOVATION BY INDUSTRY, 2001–2003

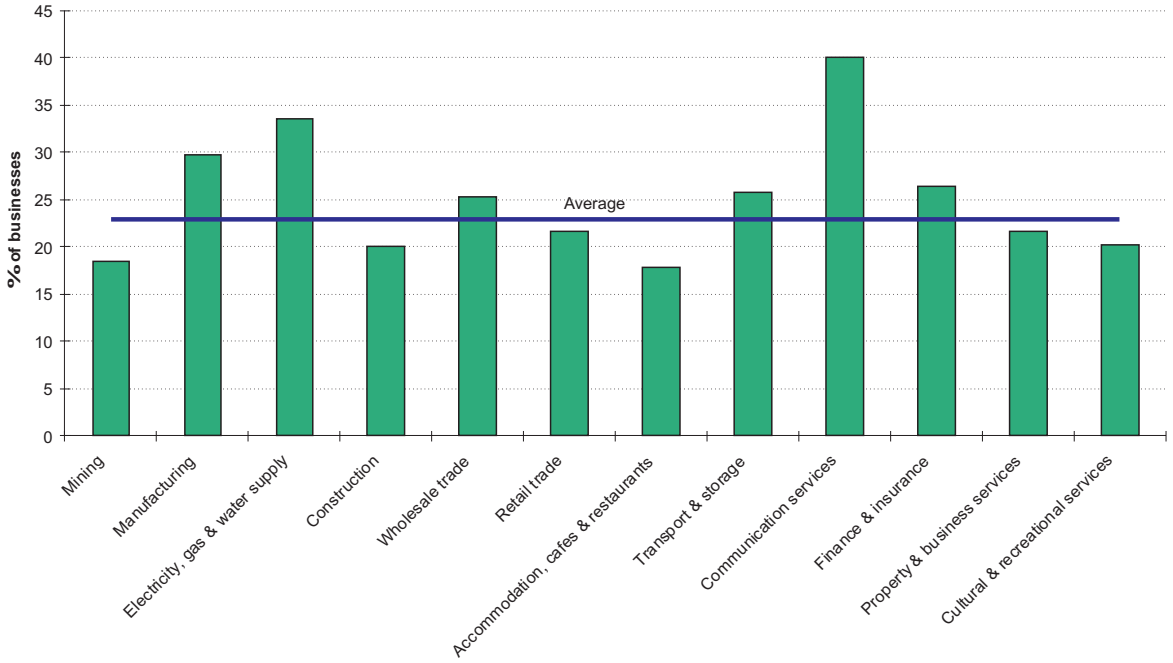


Source: ABS, 2005, Innovation in Australian Business 2003, Catalogue 8158.0.

6 A chi squared test rejects the hypothesis of independence of innovation and industry (see Appendix 2).

Figure 5 looks at operational process change. In this case, there are three substantially above-average industries: Manufacturing, Electricity, gas and water supply and Communications services. In general this suggests that those industries that are more commonly engaging in goods or service innovation are also engaging in operational process innovation.

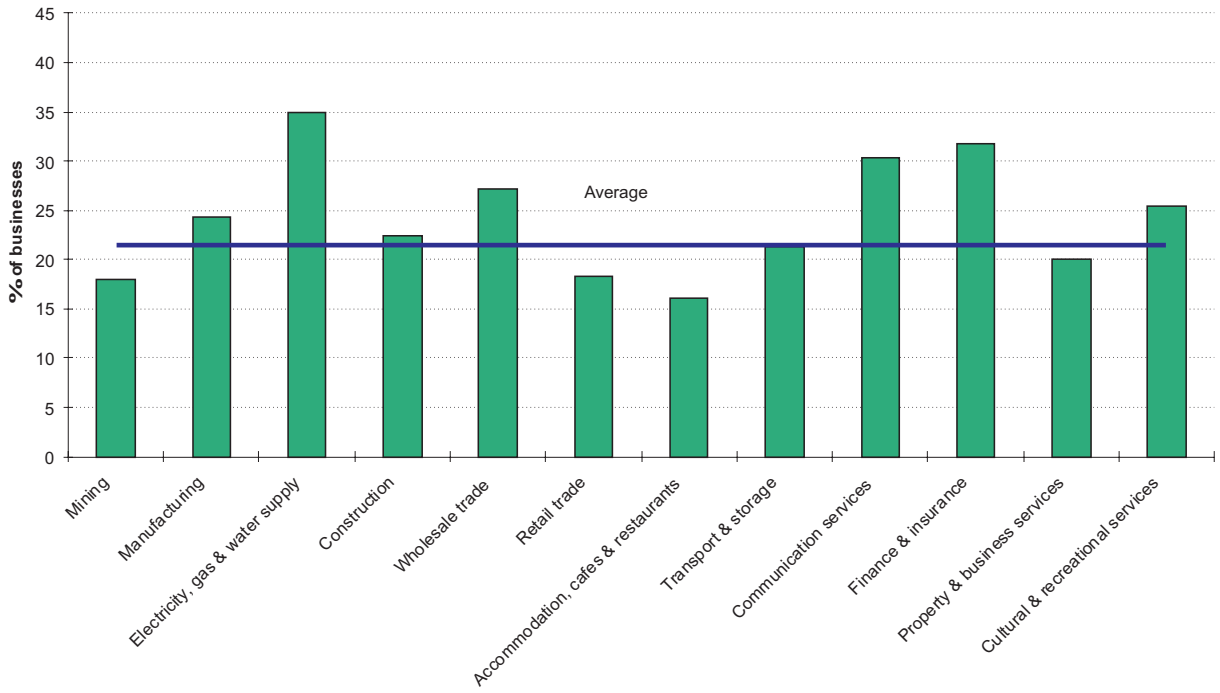
FIGURE 5 PROPORTION OF BUSINESSES UNDERTAKING OPERATIONAL PROCESS INNOVATION BY INDUSTRY, 2001–2003



Source: ABS, 2005, Innovation in Australian Business 2003, Catalogue 8158.0.

In terms of organisational and managerial innovation a similar picture emerges, with the addition of Finance and insurance to the above-average group (Figure 6). It is perhaps no surprise to find Manufacturing and Communications services as across-the-board above average in terms of the proportions of innovating businesses. However utility sectors such as Electricity, water and gas – while historically important areas of innovation – have often been regarded as somewhat static. Their relatively strong showing might direct attention to the innovation implications of reform and deregulation in these industries.

FIGURE 6 PROPORTION OF BUSINESSES UNDERTAKING ORGANISATIONAL INNOVATION BY INDUSTRY, 2001–2003

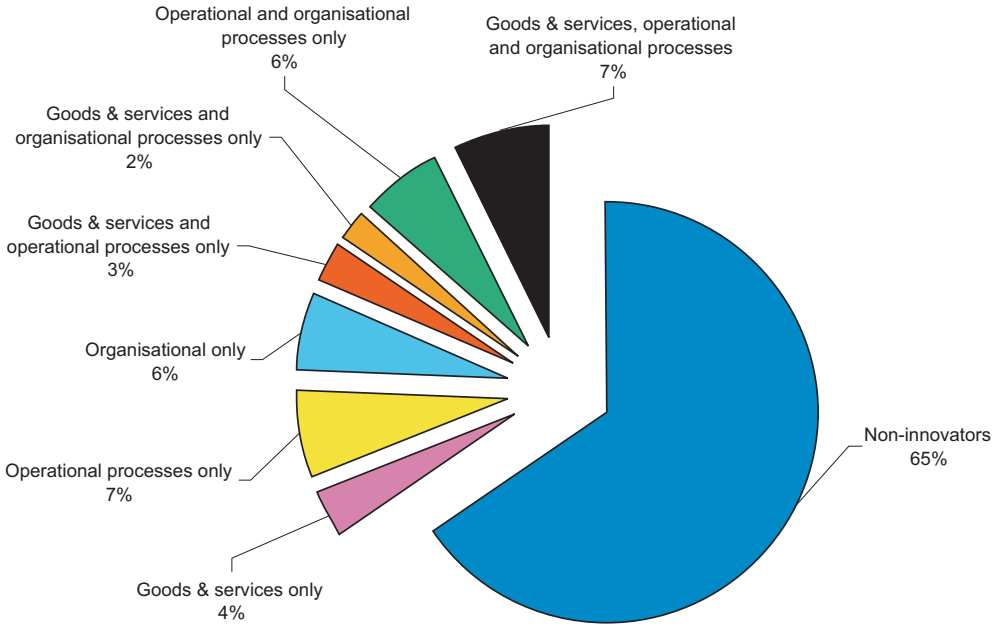


Source: ABS, 2005, Innovation in Australian Business 2003, Catalogue 8158.0.

4.1 TYPE OF INNOVATION *continued*

Moving from the industry level to the firm level, the paper now looks at how the businesses are distributed across these innovation categories. How many businesses are reporting one, two or all three of these types of innovation? Do the results imply that innovation activity in one field tends to involve innovation activity in another field? Figure 7 shows how businesses divide across combinations of innovation. Most businesses (65%) are non-innovators. Among the innovators, roughly half (18% of all businesses) are engaging two or more forms of innovation activity. The remaining half engage in one form only.

FIGURE 7 EXTENT AND TYPES OF INNOVATION, 2001–2003



Source: ABS, unpublished data

4.2 INNOVATION NOVELTY

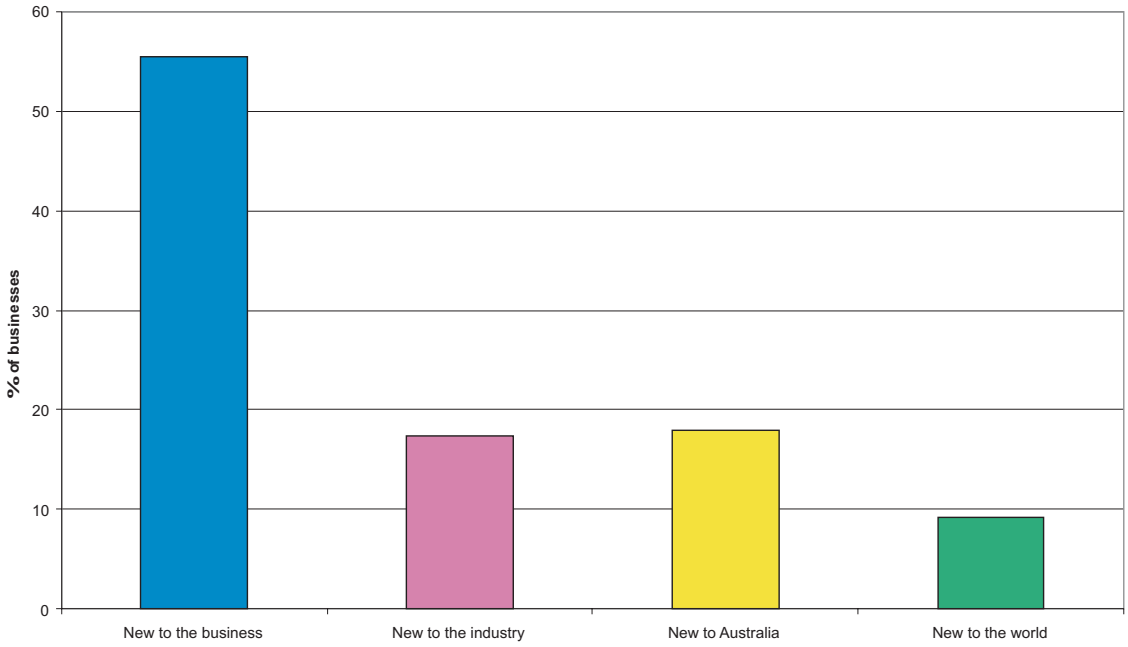
Innovation was broadly defined above in terms of novelty, however it is of interest to investigate more dimensions of this phenomenon. The question that was asked is how 'new' were the innovations introduced by these businesses. For example, an innovation can be totally new to the world, or new to a country, an industry or a business.

The concept of innovation used in this survey focuses primarily on new or significantly improved goods, services, operational and/or organisational processes that are new to the *business* concerned. This means that innovators are not necessarily engaged in the development of radical, new to the world goods, services and processes. They can be reproducing goods that are already on the market, perhaps using off the shelf technology inputs, and making small incremental improvements to their goods or services, or implementing well-understood forms of organisational change. Thus, innovation is used in the broad sense so that it captures a range of activity including technology diffusion and small-scale incremental change at the firm-level. As a result, the proportion of innovators provides a basic indicator of how many businesses are innovating but it does not capture the complexity or novelty of the innovation introduced.

However, distinctions between the degrees of novelty can be made when analysing goods or service and operational process innovation. Businesses were asked to distinguish between new goods or services that were new to the business, new to the industry, new to Australia and new to the world.[7] Figure 8 shows the results in terms of goods or service innovation. Overwhelmingly the highest degree of novelty of innovating businesses was new to the *business* product innovation (56%), with only 9% engaged in new to the world activities.[8] It seems that most innovation in Australia consists of the adaptation of existing technologies or service forms to existing businesses or sectors, or to Australian conditions.

Around 17% of businesses reported that their highest degree of goods or service novelty was new to the industry. The figure for the category new to Australia was around 18%.[9]

FIGURE 8 NOVELTY OF GOODS OR SERVICES INNOVATION, 2001–2003



Source: ABS, unpublished data

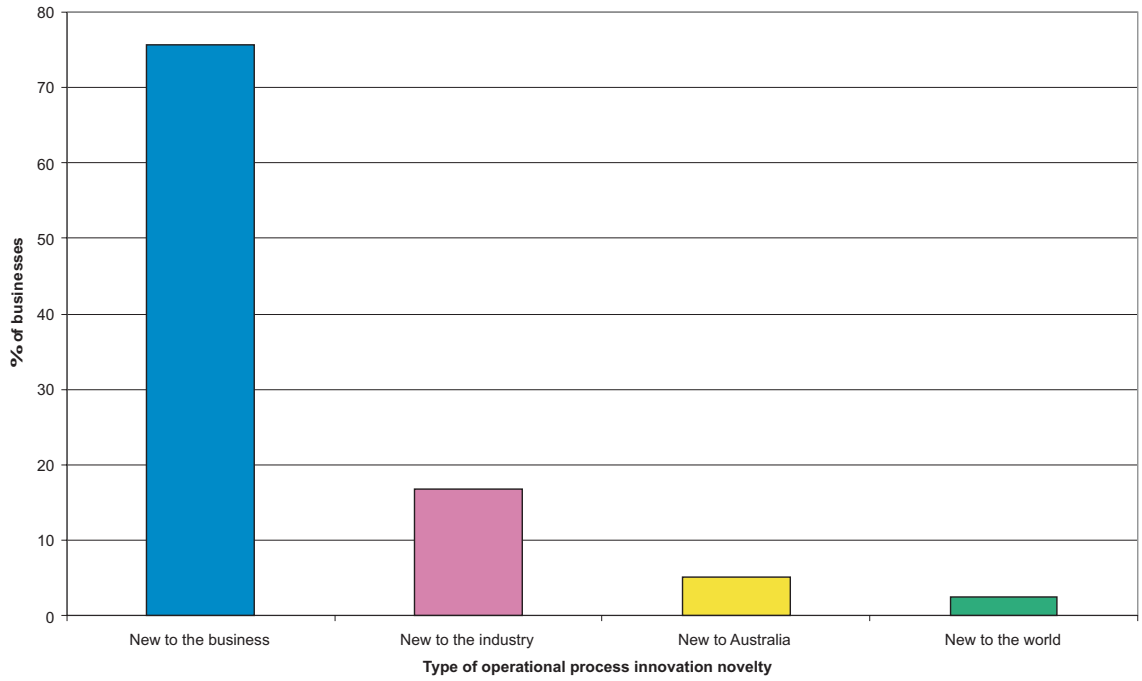
7 In the analysis that follows only the highest degree of novelty reported was counted rather than each individual response as this approach avoids multiple counting. Consequently, the numbers differ from those published by the ABS (2005).

8 The differences between the proportions are statistically significant (see Appendix 1).

9 The difference between the proportions 'new to the industry' and 'new to Australia' is not statistically significant, while the differences between the other categories are statistically significant (see Appendix 1).

A similar pattern emerges with even greater force to process innovations (Figure 9). Here, very few businesses are introducing new to the world processes (about 3%), and 75% of innovators are focusing on new to the business activities.[10]

FIGURE 9 NOVELTY OF OPERATIONAL PROCESS INNOVATION, 2001–2003

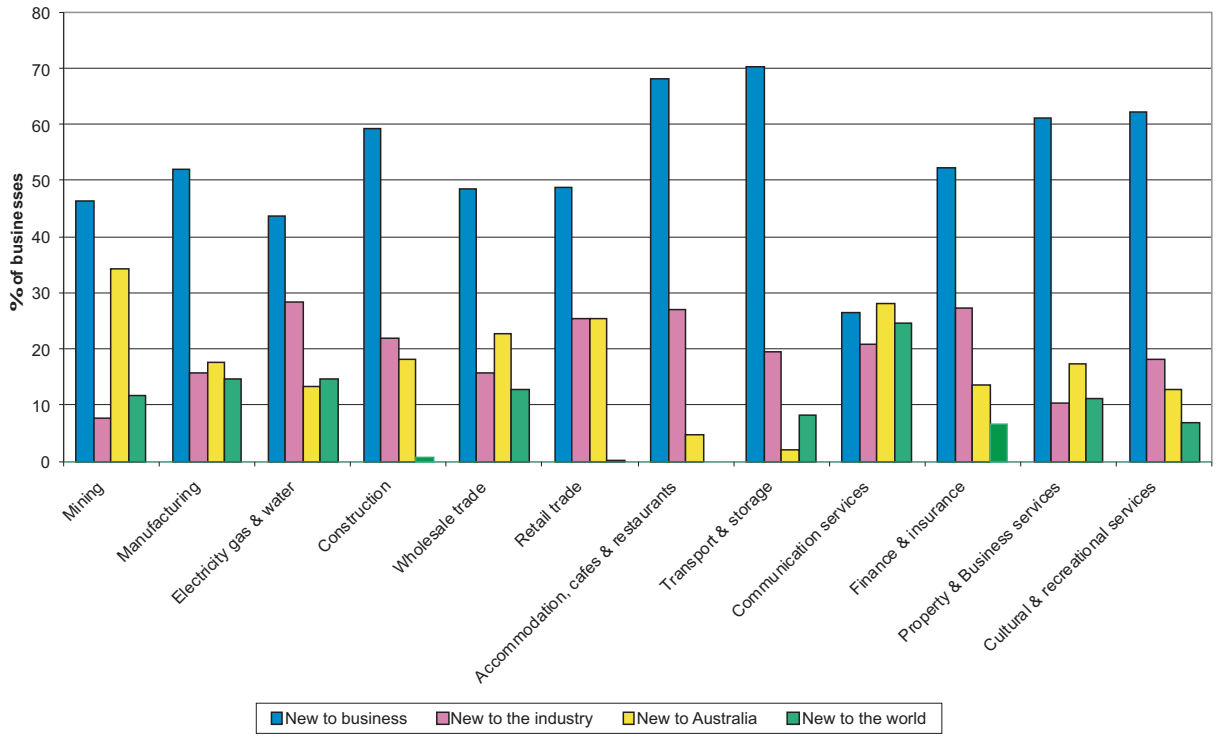


Source: ABS, unpublished data

10 The differences between the proportions are statistically significant (see Appendix 1).

This strong emphasis on new to the business types of goods or services innovation characteristics occurs not only for the economy as a whole, but also for nearly every individual industry within it. Figure 10 suggests that the general pattern of inter-sectoral differences is not substantial, and that only Communication services has a roughly equal division between these different types of novelty in innovation.[11]

FIGURE 10 NOVELTY OF GOODS OR SERVICES INNOVATION BY INDUSTRY, 2001–2003



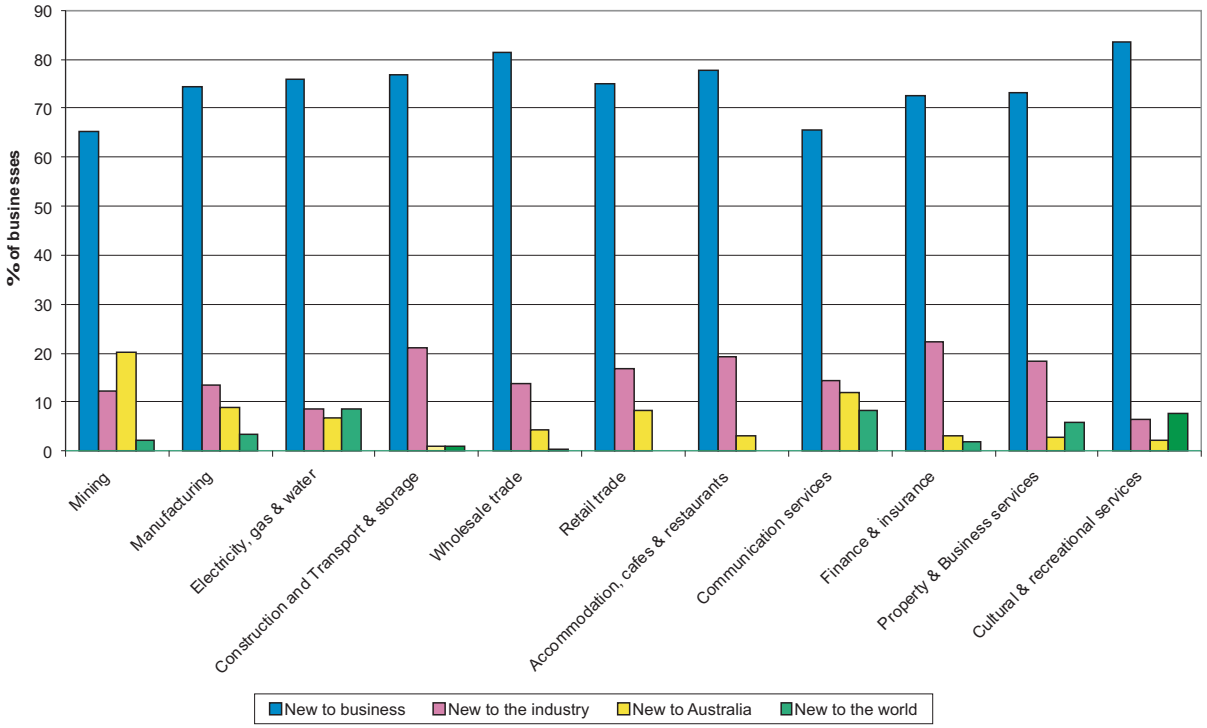
Note: ** The following estimates in the figure above have a RSE greater than 50%: Construction – new to the industry; Retail trade – new to Australia; Accommodation, cafes and restaurants – new to Australia; Transport and storage – new to the industry, new to Australia; Finance and insurance – new to the world; Property and business services – new to the world; Cultural and recreational services – new to the world.

Source: ABS, unpublished data

11 A chi squared test rejects the hypothesis of independence of degree of novelty and industry (see Appendix 2).

This phenomenon is also found when looking at the industry distribution of process change. Figure 11 below shows that the overall characteristics found in Figure 10 above also applies across all industries, but this time Communication services is not qualitatively different.[12]

FIGURE 11 NOVELTY OF OPERATIONAL PROCESS INNOVATION BY INDUSTRY, 2001–2003



Note: Construction and Transport and storage have been aggregated to maintain confidentiality. ** The following estimates in the figure above have a RSE greater than 50%: Transport and storage – new to Australia and new to the world; Wholesale trade – new to the world; Retail trade – new to Australia; Accommodation, cafes and restaurants – new to Australia; Communication services – new to the world; Finance and insurance – new to Australia; Property and business services – new to Australia, new to the world; Cultural and recreational services – new to Australia.

Source: ABS, unpublished data

12 A chi squared test rejects the hypothesis of independence of degree of novelty and industry (see Appendix 2).

4.2 INNOVATION NOVELTY *continued*

How should this emphasis on new to the business innovation be understood? Does it mean that Australia is weak at generating 'radical' innovation, and is only successful in adapting innovations developed elsewhere? There are three main points here. First, Australia is not radically different from other countries with respect to these indicators. Wherever innovation surveys have been carried out, this strong emphasis on new to the business innovation has been found.[13] In other words, this is not a peculiarly Australian phenomenon, but appears to be a general characteristic of innovation at a global level. Second, new to the business innovation requires learning, adaptation, effort, and the commitment of resources. This will be studied in more detail in later chapters, but it should be noted that this is not an easy or costless process. Finally, it should be noted that this kind of innovation is precisely how innovation translates itself into productivity or growth gains. Inventions have no economic impacts until they become innovations (that is, they are introduced to the market). But equally, innovations have no real impact until they are diffused – until they are taken into widespread use. New to the business product and process innovation, even if they are incremental in character, are forms of diffusion that have powerful economic impacts over the long term. Nathan Rosenberg pointed out some years ago that the ultimate impacts of sustained incremental change are far greater than those of some radical innovation (Rosenberg, 1976).

4.3 SHARE OF TURNOVER FROM NEW GOODS OR SERVICES

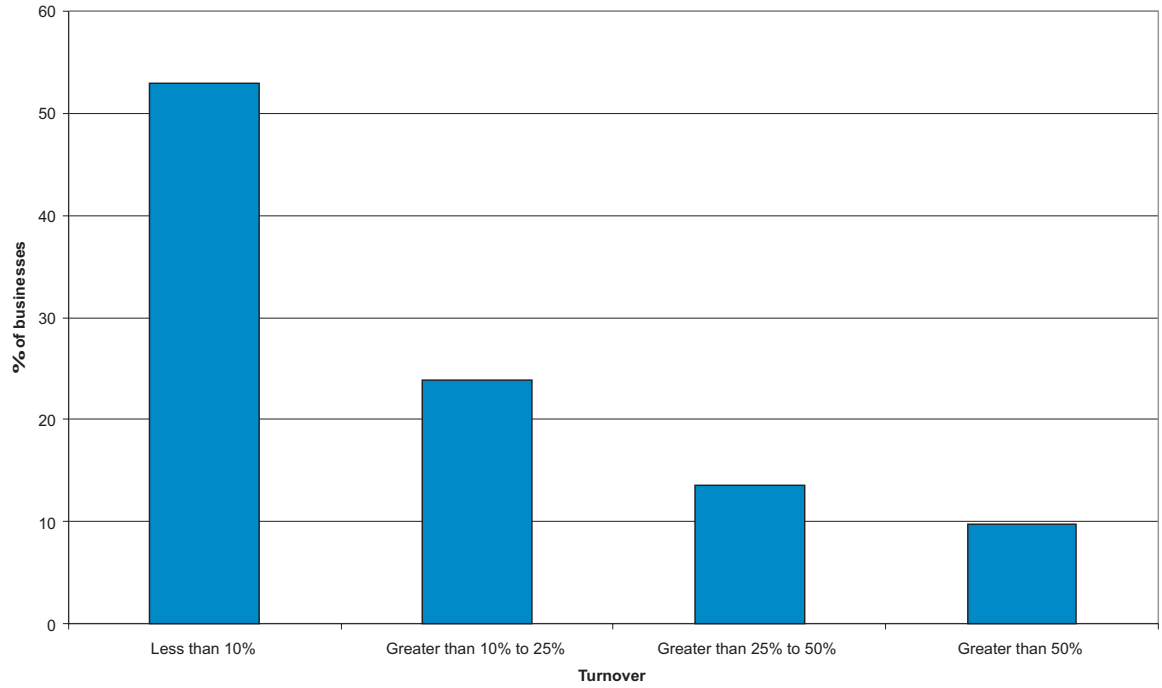
This paper now investigates how the kinds of innovation activity discussed above translate into turnover for businesses. The survey asked businesses to estimate the proportion of total turnover that arises from *new* products (i.e. not including products that were unchanged or products that had been changed only in minor ways). This indicator provides data that allow some comparison of innovation performance across businesses and industries, since it translates innovation activity into a common monetary indicator. It also reflects the scale of goods and service replacement over the period covered, providing some indication of technological renewal and upgrading, in value terms.

13 For example, the European Union proportion of new to the business product and process innovators was 51% (Eurostat, 2004), whereas in Canada this figure was 83% (Statistics Canada, 2002). However, these comparisons are indicative only and need to be treated with caution due to different survey methodologies, industry coverage and questionnaire design.

4.3 SHARE OF TURNOVER FROM NEW GOODS OR SERVICES *continued*

Figure 12 looks at businesses reporting goods or services innovation, and reports on the extent to which businesses generate different proportions of turnover from innovations. More than half of the innovating businesses generate less than 10% of their turnover from new products, whereas about 10% generate more than 50% of their turnover from new innovations. Given that only 17% of total businesses are introducing new goods or services at all, this suggests that really intensive innovation (in terms of new products as a proportion of turnover) is concentrated in only a small group of businesses.

FIGURE 12 PROPORTION OF TURNOVER ATTRIBUTED TO NEW GOODS OR SERVICES, 2003



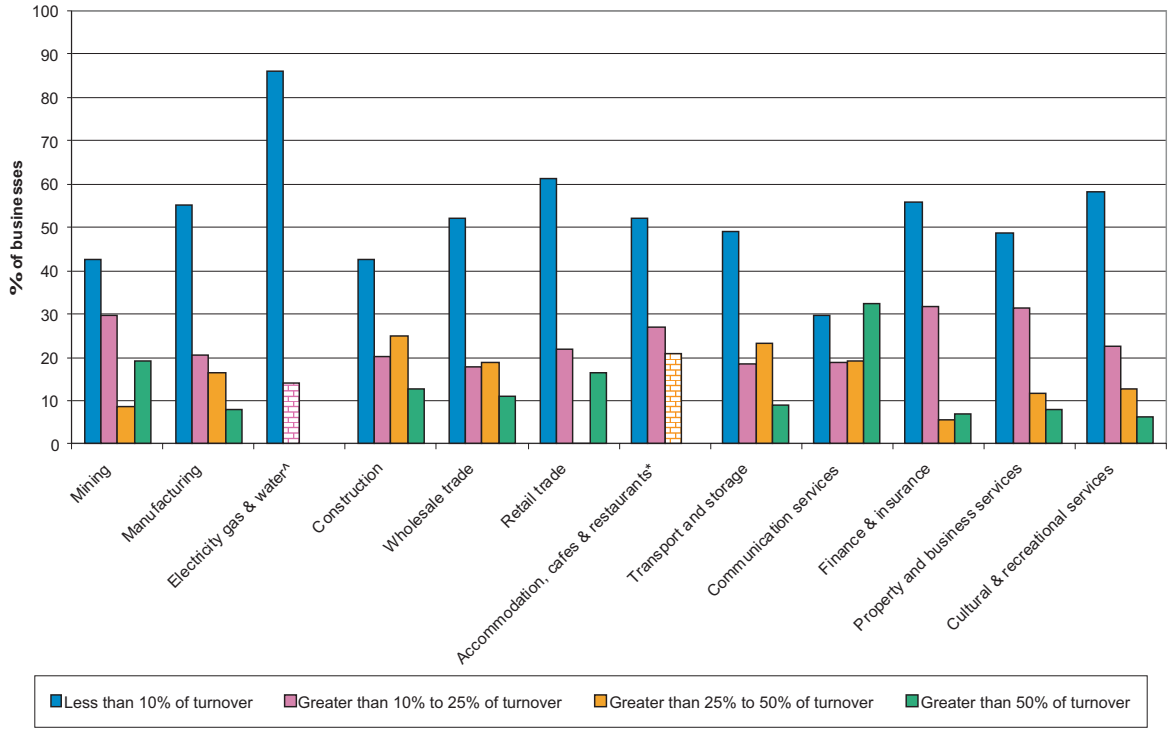
Note: Data for the proportion of turnover attributed to new goods or services have undergone a basic quality assurance process only by the ABS and should be viewed as indicative.

Source: ABS, unpublished data

4.3 SHARE OF TURNOVER FROM NEW GOODS OR SERVICES *continued*

It can be noted that the general structure sketched above in Figure 12 – namely a small group of businesses with high proportions of new goods or services turnover – is found not only in the economy as a whole, but across most industries. Figure 13 shows that in most industries, the majority of innovating businesses report lower turnover attribution to new goods or services.

FIGURE 13 DISTRIBUTION OF TURNOVER ATTRIBUTED TO NEW GOODS OR SERVICES BY INDUSTRY, 2003



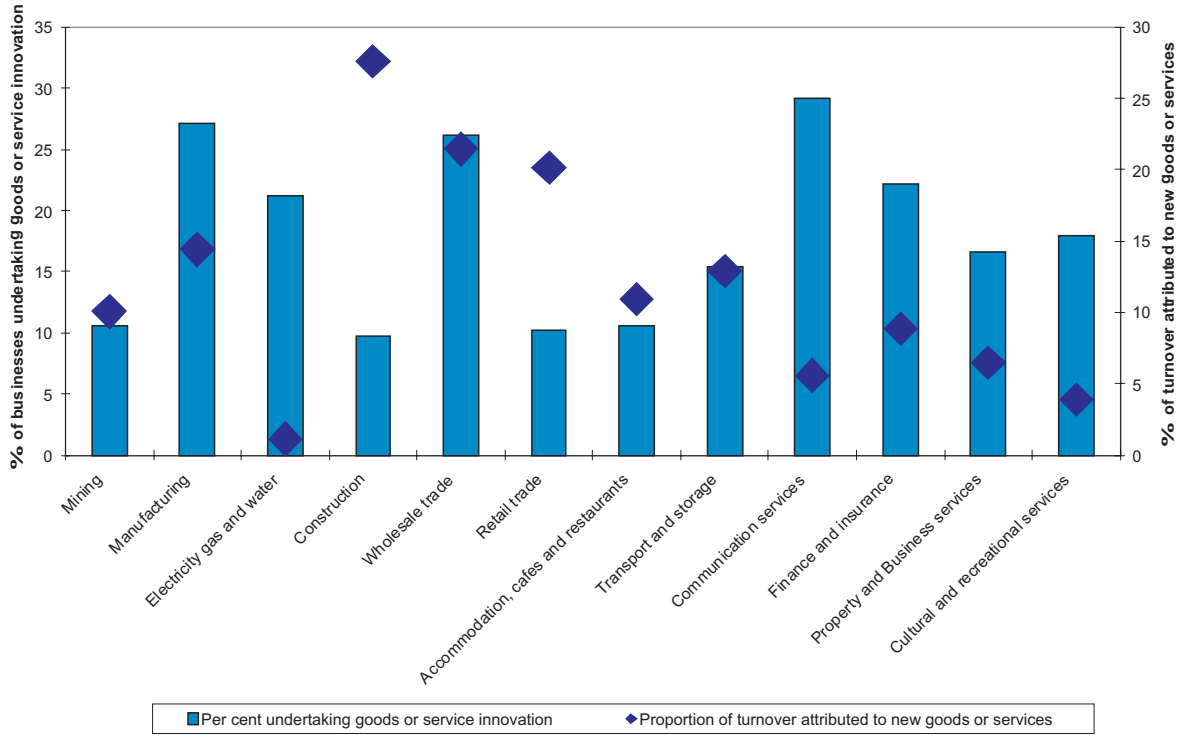
Note: Two turnover categories have been aggregated to maintain confidentiality. (^ represents greater than 10% and * represents greater than 25%). ** The following estimates in the figure above have a RSE greater than 50%: Mining >50% of turnover; Electricity, gas & water >10% of turnover; Construction >10 % to 25%, >25% to 50% and >50% of turnover; Retail trade >50% of turnover; Accommodation, cafes and restaruants >25% of turnover; Trnasport and stroage >50% of turnover; Property and business services >25% to 50% and >50% of turnover; Cultural and recreational services >25% to 50% of turnover.

Source: ABS, unpublished data

4.3 SHARE OF TURNOVER FROM NEW GOODS OR SERVICES *continued*

Figure 14 shows the variation across industries in the proportion of innovating businesses, and the average proportion of turnover emanating from new products among those businesses. The variation in the average proportion of turnover from new products is markedly greater than the variation in the proportion of businesses reporting goods or services innovation. Electricity, gas and water, Communication services, Property and business services and Cultural and recreational services are relatively low in the proportion of turnover derived from innovations from new product, while Construction and Wholesale and Retail trade are relatively high. This may reflect reporting differences (that is, the different interpretation of a 'new product') but equally it may reflect industry differences in the rates at which new goods or services enter the market.

FIGURE 14 GOODS OR SERVICE INNOVATION (2001–2003) AND TURNOVER ATTRIBUTED TO NEW GOODS OR SERVICES (2003) BY INDUSTRY



Note: The survey asked businesses to estimate how their turnover was distributed between new and unchanged/marginally modified goods or services, however data on turnover was not collected. The diagram above was constructed using 'gross income' as a proxy for turnover.

Source: ABS, unpublished data

One conclusion that suggests itself from this analysis is that although innovation activity is widely spread across industries, the proportion of turnover attributed to new goods or services are highly concentrated among businesses. Put more strongly, there are no especially innovative industry sectors, but there are strongly innovative businesses. Understanding the characteristics, dynamics and long term performance of such businesses may be an important challenge, both for analysis and policy formation and, worthy of further research.

CHAPTER 5 BUSINESS CHARACTERISTICS AND INNOVATION

The ABS 2003 innovation survey generates a range of data that allows analysis of business characteristics that most strongly correlate with innovation activity. This chapter of the paper examines innovation according to business size, ownership structure and length of business operation.

5.1 BUSINESS SIZE

Much research has been conducted on the relationship between business size and innovation and the broad consensus is that the propensity to innovate increases with business size (for an overview see Tether, 1998 and Cohen, 1995). In general, large businesses are seen as more innovative for reasons including:

- they have access to more resources, particularly access to finance;
- they have aspects of economies of scale and scope; and
- they are better able to spread the risk of innovation.

However, there are numerous counter-arguments to this view that present a different perspective. For example, it has been argued that:

- the organisation of small businesses is generally more informal and this promotes creativity and innovation;
- as businesses grow larger the effectiveness of their innovation can be diminished by a reduction in managerial control; and
- small businesses introduce more innovations per employee than large businesses.

While it is beyond the scope of this paper to enter this debate it is important to explore the relationship between business size and innovation using the *Innovation in Australian Businesses 2003* survey data. As noted in the methodology chapter above, the sample was designed to provide reasonable standard errors for the following three size bands (although output can be presented using any employment range greater than four employees):

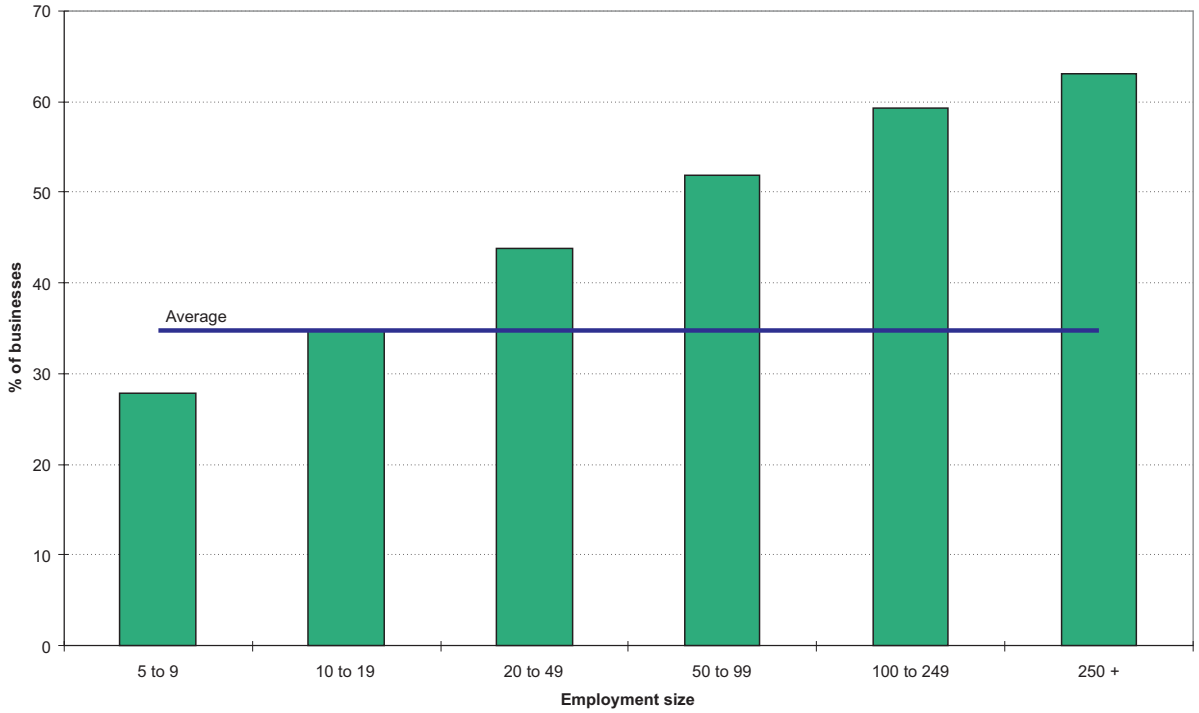
1. 5–19 employees;
2. 20–99 employees; and
3. 100 or more.

For the purpose of analysis in this paper the data have been classified into six business size categories as this gives a more detailed picture of the differences between the groups.[14]

14 As mentioned earlier in Section 3, businesses with less than 5 employees have been included in the category '5–9 employees' even though the survey was designed to exclude micro-businesses.

The data presented in Figure 15 show a roughly linear relationship between business size and innovation.[15] The innovation rate in businesses with 5–9 employees was 28% and this increased to over 60% in businesses with 250 or more employees. This result is not surprising in view of the fact that large businesses generally have a large range of goods or services and dedicated staff responsible for organisational functions (for example training and establishing communication networks). It is more likely that at least one of their goods, services, operational and/or organisational processes were new, changed and/or improved over the three-year period. In contrast small businesses generally have fewer goods or services and are less likely to have specialist staff responsible for new or improved organisational processes.

FIGURE 15 PROPORTION OF BUSINESSES INNOVATING BY EMPLOYMENT SIZE. 2001–2003

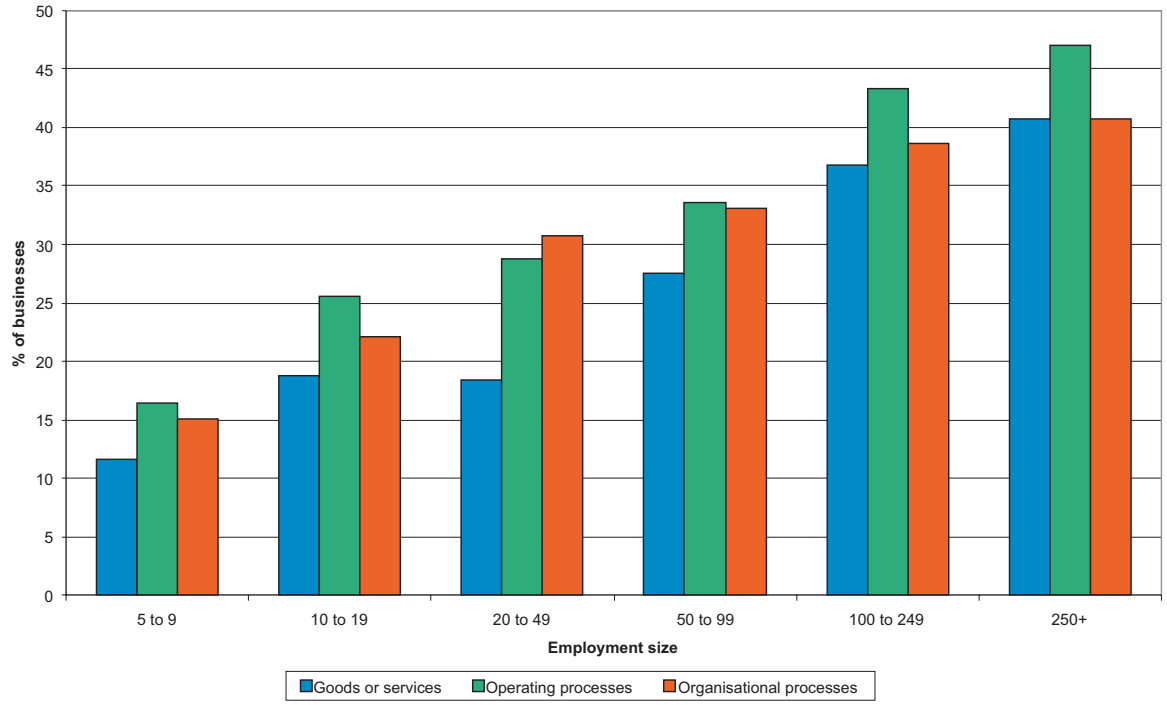


Source: ABS, unpublished data

15 The differences between the proportions are statistically significant (see Appendix 1). A chi squared test rejects the hypothesis of independence of innovation and business size (see Appendix 2).

Figure 16 shows the same information above broken down by the type of innovation. Once again the data indicate a roughly linear relationship between business size and innovation across all of the categories of innovation.

FIGURE 16 PROPORTION INNOVATING BY TYPE OF INNOVATION AND EMPLOYMENT SIZE, 2001–2003

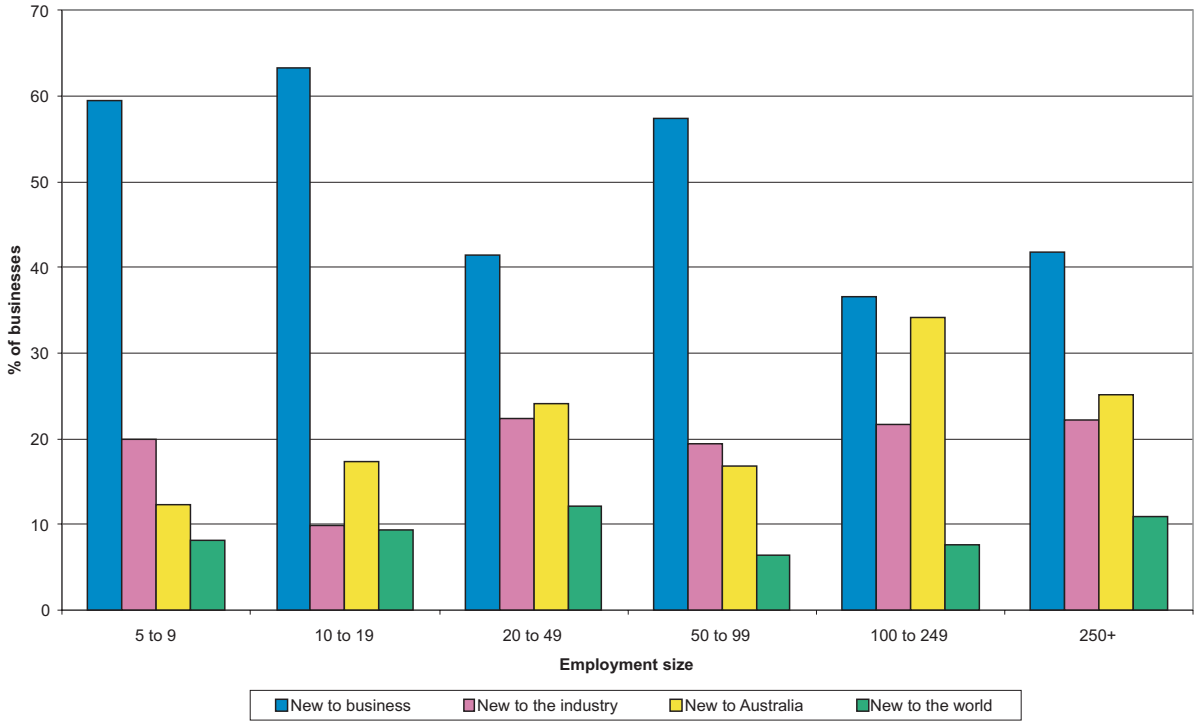


Source: ABS, unpublished data

The innovation activities of small businesses are of particular policy interest in the Australian context given the large number of small businesses in the economy. Seventy-five per cent of the innovation survey population was in the 5–19 employees category, so gaining a better understanding of innovation in small businesses is important given the wide-ranging policy implications. It is important therefore to look beyond this aggregate data, to better capture the innovation activities of small businesses. Do small businesses focus more on new to the world innovations, for example? Analysing the highest degree of novelty of goods, services and operational processes by business size reveals that the differences between the size categories become less clear and is no longer necessarily increasing with size.

Figure 17 shows that the proportion of new to the world innovations is broadly similar across all business size groups, ranging between 6% and 12%. The result for new to Australia goods and service innovations is more varied. While businesses with '250 plus' employees reported more new to Australia innovations than those in the '5–9', '10–19', '20–49' and '50–99' employee size categories, the '100 to 249' group is nine percentage points higher than the '250 plus' category.[16]

FIGURE 17 NOVELTY OF GOODS OR SERVICES INNOVATION BY EMPLOYMENT SIZE, 2001–2003



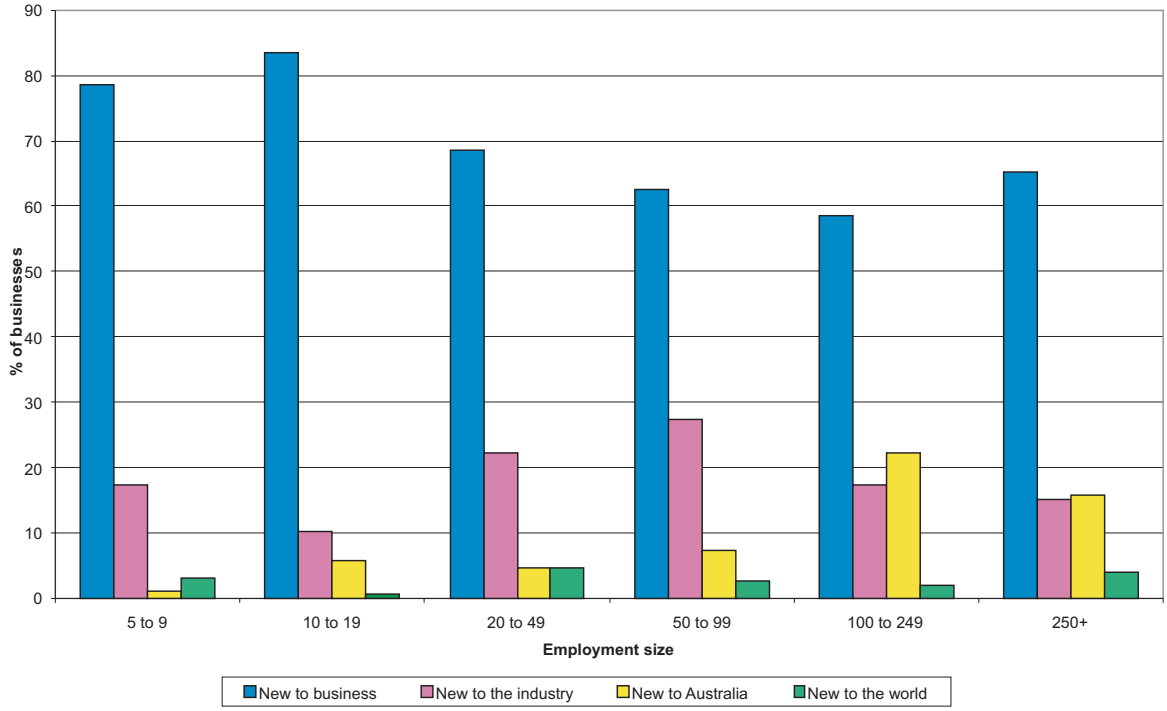
Source: ABS, unpublished data

16 A chi squared test failed to reject the hypothesis of independence of degree of novelty and business size (see Appendix 2).

5.1 BUSINESS SIZE *continued*

Figure 18 looks at the highest degree of operational process novelty by business size. The relationship between business size and operational process novelty does not show a strong trend as shown in Figure 15.[17] Businesses in the 20 to 49 group reported the highest proportion of new to the world operational processes (5%) whereas the highest proportion of new to Australia processes was in the 100 to 249 size group (22%).

FIGURE 18 NOVELTY OF OPERATIONAL PROCESS INNOVATION BY EMPLOYMENT SIZE, 2001–2003



Note: ** The following estimates in the figure above have a RSE greater than 50%: 5 to 9 – new to the world; 10 to 19 – new to Australia; 50 to 99 – new to Australia.

Source: ABS, unpublished data

5.2 FOREIGN OWNERSHIP

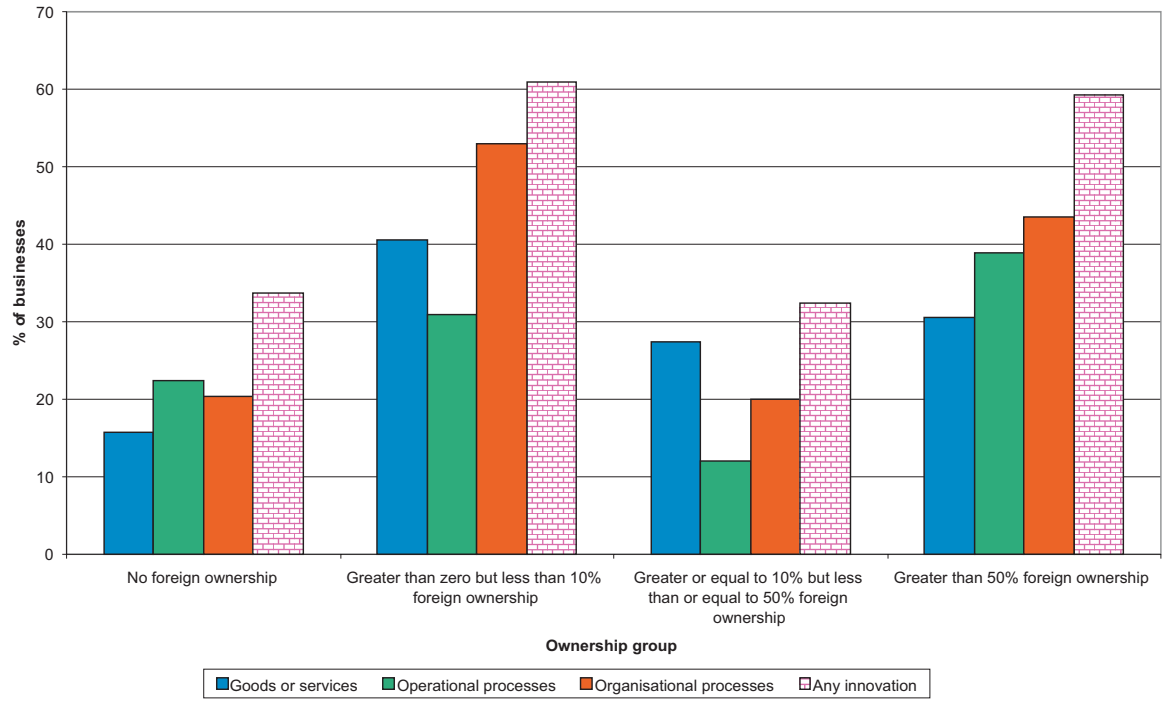
The ABS survey asked businesses to report the percentage range of foreign ownership (ie. the percentage of ordinary shares or voting stock held by non-residents of Australia). As at December 2003 the estimated number of businesses employing 5 or more persons that were wholly Australian owned was 128 490, which represents 95% of the total number of businesses. As shown in Figure 19, 34% of wholly Australian owned businesses undertook innovation activities between 2001 and 2003. The type of innovation activity reported by wholly Australian owned businesses ranged between 16% and 22%.

17 However, a chi squared test rejects the hypothesis of independence of degree of novelty and business size (see Appendix 2).

5.2 FOREIGN OWNERSHIP *continued*

Figure 19 also illustrates innovation activity in businesses with various degrees of foreign ownership. The results show that the relationship between innovative activity and ownership status is not clear when analysed according to the four groups, since businesses with '10% to 50%' foreign ownership reported slightly less innovative activities (32%) than entirely Australian owned businesses (34%).[18] In addition, the innovative activity of businesses in this category was about half that of businesses in the classes 'less than 10%' and 'more than 50%' foreign ownership, with the overall rate of innovation in these categories being 61% and 59% respectively.[19]

FIGURE 19 PROPORTION OF BUSINESSES INNOVATING BY TYPE OF INNOVATION AND OWNERSHIP, 2001–2003



Source: ABS, unpublished data

It is important to note that other business characteristics such as industry sector may have a bearing on these results. For example, the degree of foreign ownership is higher in some industries; therefore it is possible that some of the industry characteristics of businesses will be associated with foreign ownership and vice-versa, but these data are not presented here. Further research which controls for these factors is needed to resolve this issue.

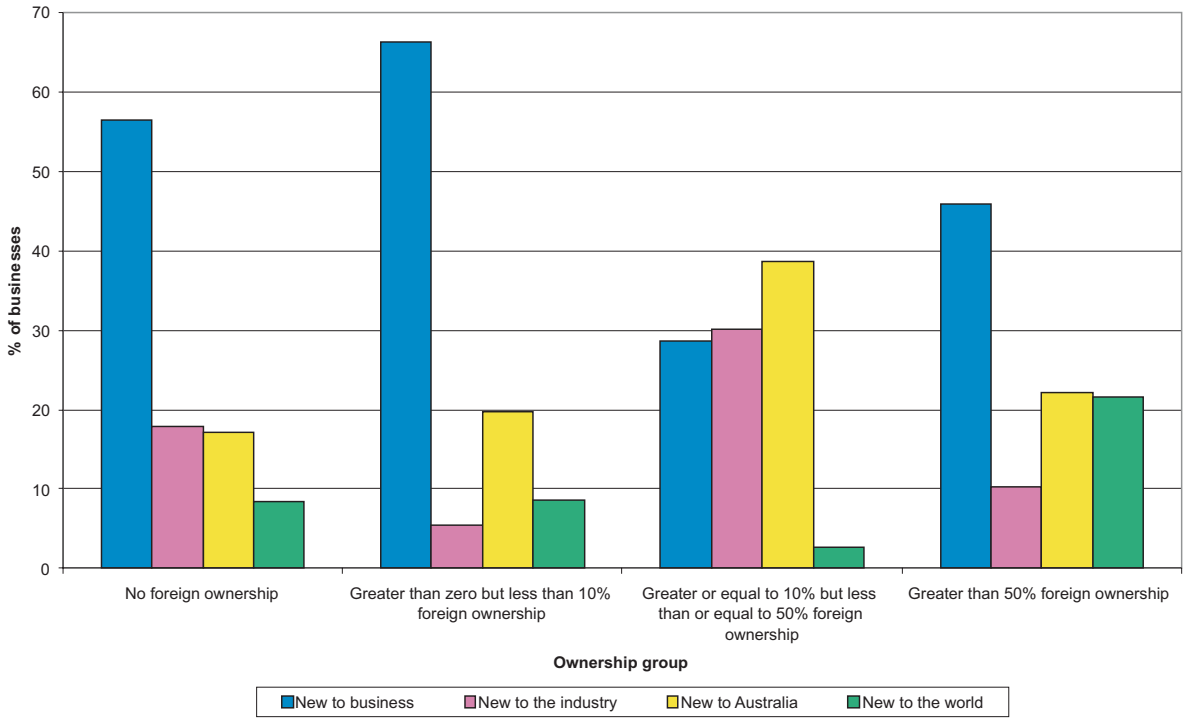
18 When the data are aggregated into two classes of foreign ownership – more than 0% but less than or equal to 50% and greater than 50% – the differences become more apparent as the proportion of innovators is 43% and 59% respectively.

19 A chi squared test rejects the hypothesis of independence of innovation and ownership (see Appendix 2).

5.2 FOREIGN OWNERSHIP *continued*

Despite the need to conduct more research that takes into account the relationship between foreign ownership and industry it is still possible to make some observations of interest in relation to the aggregate data according to business ownership and highest degree of innovation novelty. Figure 20 shows that the proportion of new to the world goods or services was largest in the 'more than 50%' foreign ownership group, which was more than double the proportions reported in the other categories. It was also about twice as much as the overall new to the world amount (refer to Figure 8).[20] Even though these results are probably influenced by industry compositions it suggests that these businesses may have some advantage in that they are able to access expertise, specialised knowledge and technological capabilities of their parent and/or subsidiary companies overseas, including access to foreign markets.

FIGURE 20 NOVELTY OF GOODS OR SERVICES INNOVATION BY OWNERSHIP, 2001–2003



Note: ** The following estimates in the figure above have a RSE greater than 50%: Greater than zero but less than 10% foreign ownership – new to Australia, New to the world.

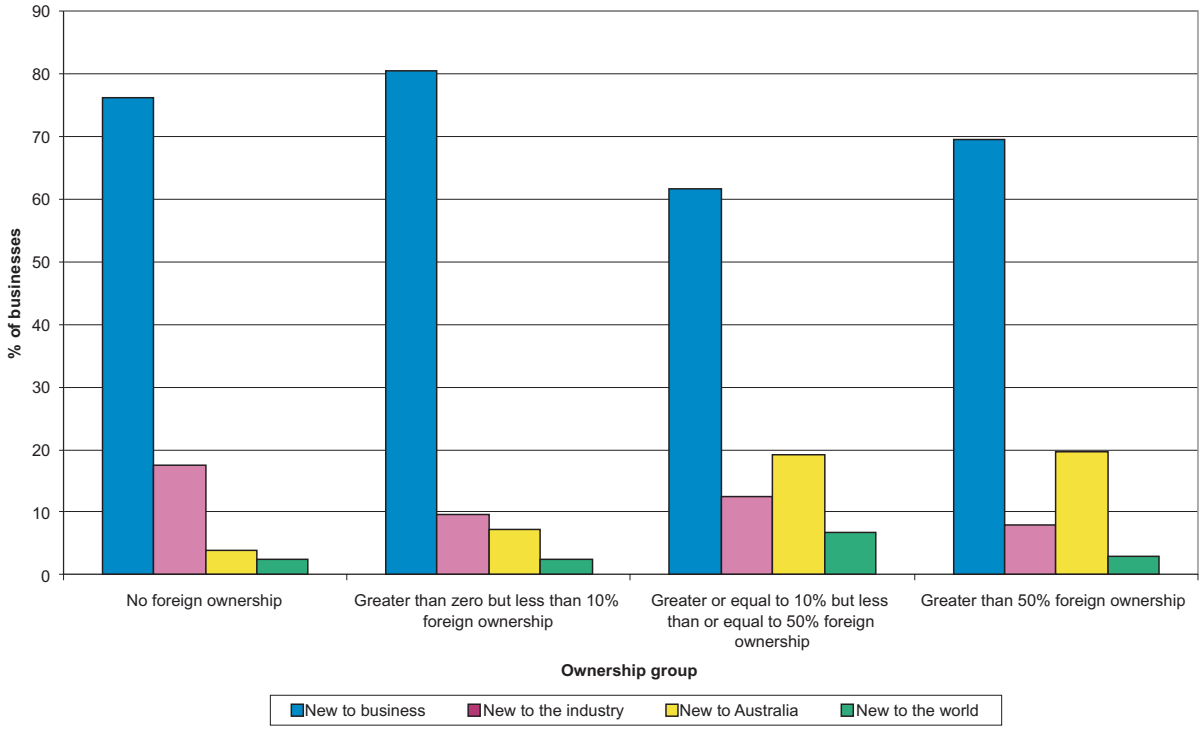
Source: ABS, unpublished data

20 A chi squared test rejects the hypothesis of independence of degree of novelty and ownership (see Appendix 2).

Looking at the breakdown of highest degree of operational process novelty by ownership (Figure 21) it appears that the variation between ownership categories is less marked.[21] The difference between entirely Australian-owned businesses and the businesses in the 'less than 10%' foreign ownership group, and those with 'more than 10%' foreign ownership , is that the latter introduce a higher proportion of world first and Australia first operational processes. The noteworthy difference is in the new to Australia group as businesses with 10% or more foreign ownership report a much higher degree of process innovation here. While this pattern may be related to the size and industry distribution of foreign owned businesses, it still suggests that businesses with a higher degree of foreign ownership are at the forefront of adopting and implementing new process technologies in Australian industry.

It is also of interest to note the divergence between 'new to the world' and foreign ownership for goods or services compared with operational process innovation in the '10% to 50%' foreign ownership category. This group has the lowest proportion of 'new to the world' goods or services (Figure 20) but the highest proportion of 'new to the world' operational processes (Figure 21). This result requires further research.

FIGURE 21 NOVELTY OF OPERATIONAL PROCESS INNOVATION BY OWNERSHIP, 2001–2003



Note: ** The following estimates in the figure above have a RSE greater than 50%: Greater than zero but less than 10% foreign ownership – new to Australia, new to the world; Greater or equal to 10% but less than or equal to 50% foreign ownership – new to Australia.

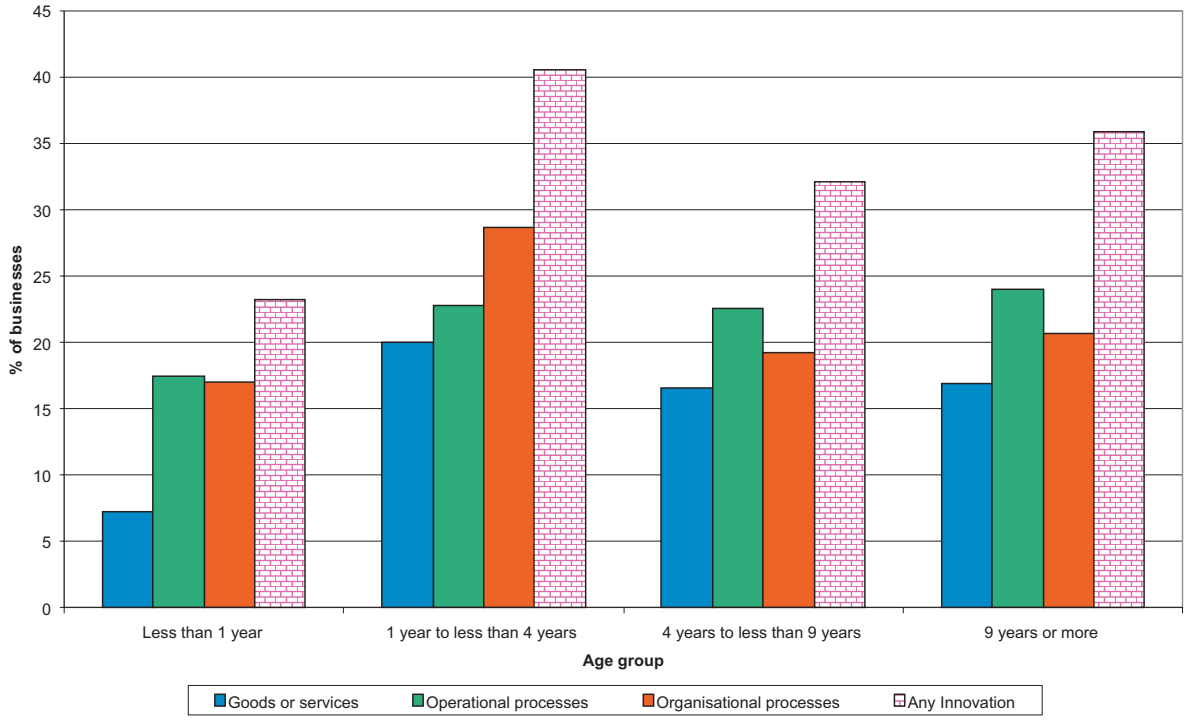
Source: ABS, unpublished data

21 However, a chi squared test rejects the hypothesis of independence of degree of novelty and ownership (see Appendix 2).

5.3 AGE OF THE BUSINESS

The age of the business provides information on business characteristics and innovation. The relationship between innovation and the age of the business appears unclear. Figure 22 shows some variation in innovation between the four age categories. Businesses that were less than one year old had the lowest rate of innovation at 23%. Goods or service innovation was only 7% in this category, which was less than half the amount reported in more established businesses. However, the rate of innovation reported in the less than one year old cohort is likely to be biased in that the survey measured innovation over a three year period. Given that these businesses had been in operation for less than one year the shorter reference period may have had an impact on these results. The difference between the remaining three categories was minor. The shape of the distribution does not suggest any particular relationship between the four age categories.[22] Further analysis revealed that a chi squared test failed to reject the hypothesis of independence of degree of novelty and the age of the business (these results are not presented).

FIGURE 22 PROPORTION OF BUSINESSES INNOVATING BY TYPE OF INNOVATION AND AGE OF BUSINESS, 2001–2003



Source: ABS, unpublished data

22 However, a chi squared test rejects the hypothesis of independence of innovation and business age (see Appendix 2).

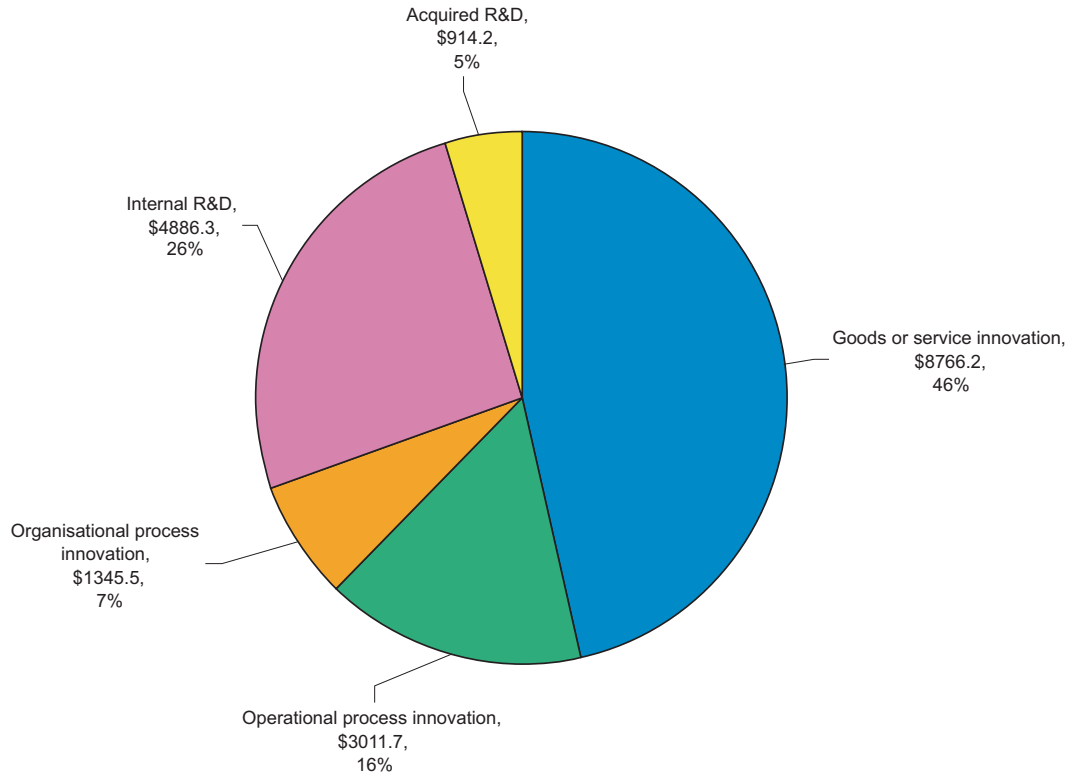
CHAPTER 6 EXPENDITURE ON INNOVATION

A unique feature of innovation surveys is that they gather data on both R&D and non-R&D expenditure inputs.[23] Usually, however, non-R&D expenditure inputs are complex categories that do not typically align with standard accounting practices, so businesses do not necessarily keep records of these types of expenditure. This means that businesses usually have to offer estimates of their non-R&D innovation expenditures. As a consequence the quality of the data on innovation expenditure should be treated with some caution, and given these concerns RSEs have not been constructed for these data. It should also be noted that 9% of innovators did not respond to the questions on innovation expediture. Despite the limitations, the data provide a valuable indication of the resources committed to innovation by Australian businesses. It is important to bear in mind that the problems with the expenditure questions are not confined to the Australian innovation survey as similar issues have been identified in the Community Innovation Surveys. (For further information see OECD, 2000a)

23 The expenditure data collected in the survey covers the financial year 2002–03.

However the picture that emerges from Figure 23 is clear. Non-R&D expenditure on innovation represents 69% of total innovation expenditure whereas expenditure on R&D represents only 31% of the total. This suggests that innovation inputs are much broader than R&D. Overall, innovating businesses expenditure on R&D represented 0.7% ($5800.6m) of total business expenditure whereas non-R&D innovation expenditures represented 1.7% ($13,123.4m).

FIGURE 23 EXPENDITURE ON INNOVATION AND R&D, 2002–2003 (Innovating businesses)



Source: ABS, unpublished data

Further analysis of the data confirmed that innovation is a lot broader than R&D. In fact only 31% of innovating businesses report R&D expenditure. Broken down by the type of innovation the data reveal that of the 17% of businesses undertaking goods or service innovation 46% reported R&D expenditure. Twenty-three per cent of businesses undertook operational process innovation and of these, 37% reported R&D expenditure. Of the 21% of businesses reporting organisational process innovation 32% reported R&D expenditure.

The survey asked all businesses (innovators and non-innovators) to report their R&D[24] and innovation expenditure. Non-innovating businesses spent $733.3m on R&D and $6.2m on innovation, which represented a total of 0.2% of total business expenditure.[25]

It should be noted that total expenditure on R&D (including innovating and non-innovating businesses) amounted to $6533.8m which slightly differed from the amount reported in the ABS catalogue *Research and Experimental Development Businesses 2003–04* ($6527m).[26] This difference is common in innovation surveys (see OECD 2000 for discussion) and can be attributed to a number of factors including:

- in R&D surveys, the definition of R&D is explained in more detail (includes a comprehensive list of exclusions);
- the innovation survey captures businesses performing both occasional and extramural R&D; and
- the target population for the R&D survey seeks to cover all businesses performing R&D (a census) whereas the innovation survey is based on a stratified random sample which is later weighted up to represent the population.

As shown in Figure 23 above, expenditure on goods or service innovation by innovating businesses represents the largest proportion of expenditure on innovation and R&D (46% or $8766.2m).

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24 The R&D expenditure figures contained in this paper differ for non-innovating businesses from those published previously in ABS (2005). The ABS located an error ($633.1m) in R&D expenditure figures after the release of the publication and revised figures will be published in future iterations of ABS catalogue 8158.0.

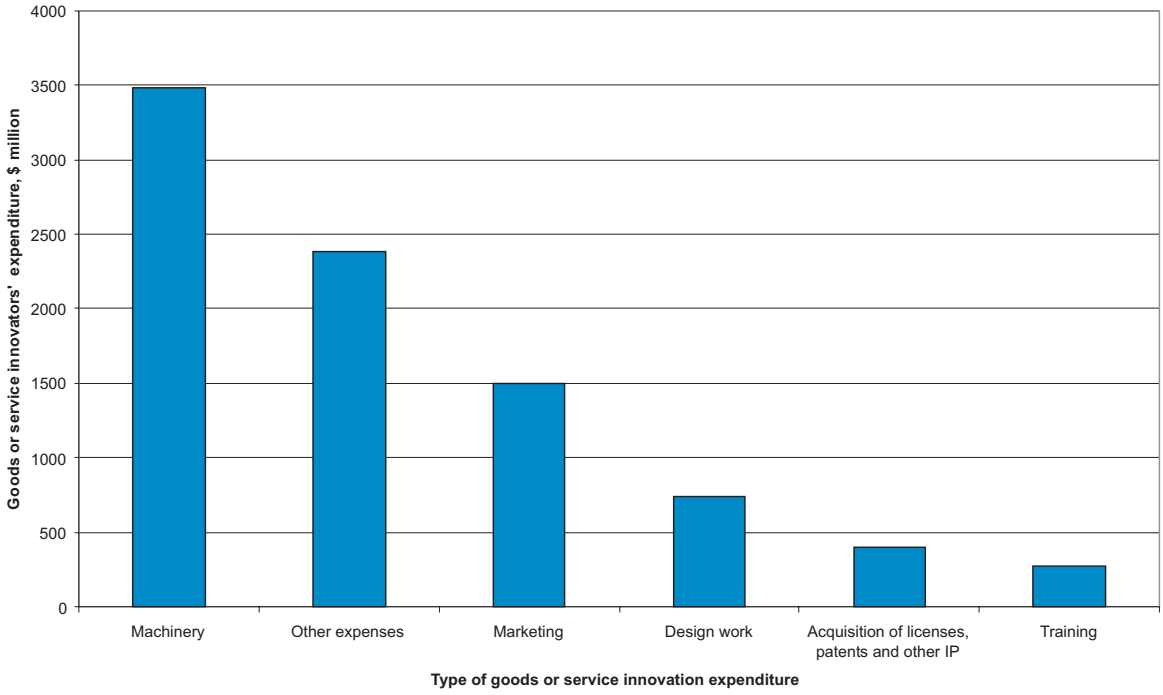
25 Innovation was defined as the *introduction* of any new or significantly improved goods, services, operational and organisational processes. Thus while some businesses reported innovation and R&D expenditure they were not considered innovators because they had not actually introduced an innovation during the period 2001–2003.

26 The revised BERD figures for 2002–03 are used here. These are published in the 2003–04 catalogue (ABS 2005a).

Figure 24 below shows the distribution of expenditure in this category. The acquisition of machinery and equipment to develop new goods or services comprised 40% ($3477.9m) of the total. This is an important category since it represents what is often called 'embodied technology' – that is knowledge, R&D results, or other technological capabilities that are inherent in capital and intermediate goods. The second largest share was the category 'other expenses' which included pre-production work such as the demonstration of commercial viability, tooling up and trial production runs. The acquisition of intangible technology (eg. market research etc) accounted for 17% ($1499.4m), which was followed by design work (8% or $737.8m) licences, patents and other intellectual property (5% or $397.5m) and training (3% or $274.5m).

It is important to note that expenditure is an indicator of cost and not necessarily an indicator of the value of the activity. Innovation is a complex process involving a range of activities, so acquiring intellectual property and/or undertaking design work, for example, may be a crucial part of the overall innovation process even though businesses reported spending less on these activities. Nevertheless, expenditure on innovation represents real financial commitments by businesses towards the creation of tangible and intangible assets that promote innovation. It is widely recognised that R&D is not the only, or even the most important, input to innovation in an economy-wide sense, and these data give an important indication of the scope of non-R&D innovation related inputs across Australian innovating businesses.

FIGURE 24 EXPENDITURE ON GOODS OR SERVICE INNOVATION ACTIVITIES, $million, 2002–2003

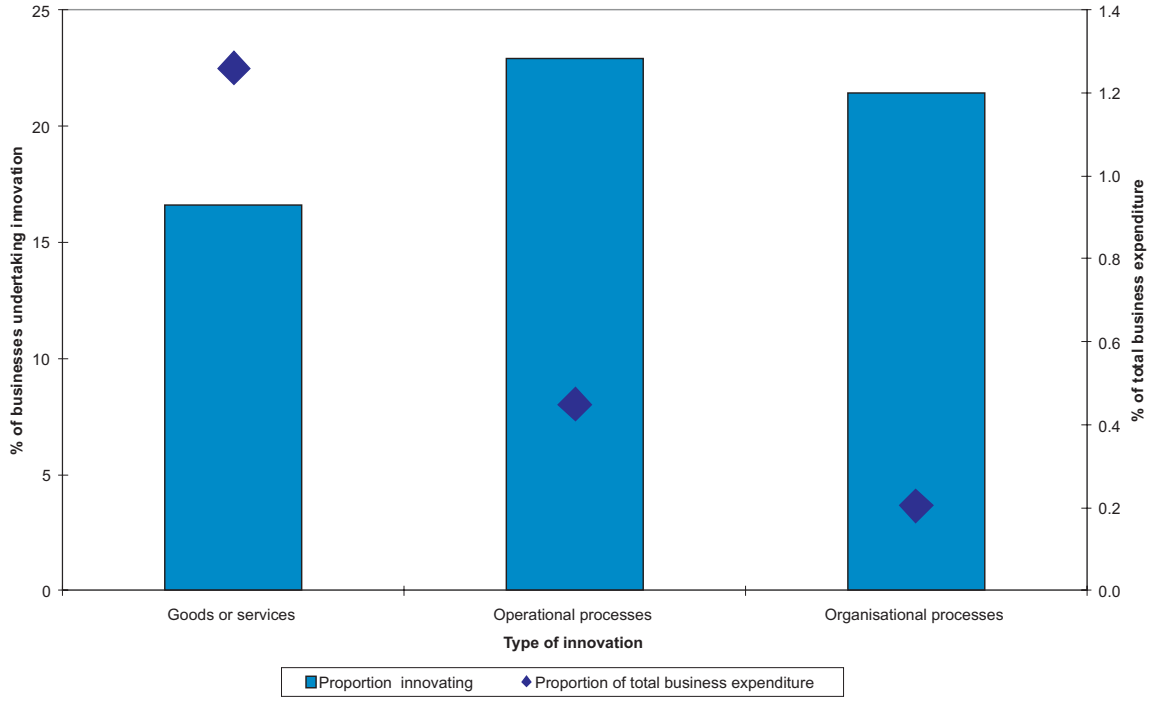


Source: ABS, 2005, Innovation in Australian Business 2003, Catalogue 8158.0.

The following four figures (Figure 25 to Figure 28) present data based on the ratio of innovation expenditure, and in some instances R&D expenditure, to total business expenditure.[27] These ratios give a guide to innovation and R&D intensity.

The proportion of businesses innovating and the type of innovation expenditure as a proportion of total business expenditure are presented below (Figure 25). This figure suggests that although the proportion of businesses reporting operational (23%) and organisational (21%) innovation is higher than goods or service innovation (17%), these types of innovations in fact do not require substantial expenditure in comparison with goods or service innovation. Business expenditure on organisational innovation (0.20%) and operational processes (0.45%) as a proportion of total expenditure is much lower than on goods or service innovation (1.26%).

FIGURE 25 INNOVATION EXPENDITURE (2002–03) BY TYPES OF INNOVATION (2001–03)



Source: ABS, unpublished data

27 Aggregate data in this chapter may vary from ABS (2005) aggregates published in Cat. 8155.0 due to the different treatment of data. The ABS editing strategy for innovation expenditure data is currently being reviewed.

The results presented above are perhaps not surprising given the types of activity that fall under this category. Organisational/ managerial innovation was defined in the survey as a significant change in strategies, structures or routines that aim to improve the performance of the business. The following examples were provided in the questionnaire:

- changed corporate directions;
- introduction of new management techniques;
- improved business diagnostics or performance measures;
- significant workplace reorganisation; and
- significant changes to communication and information networks.

These are not necessarily items on which substantial direct expenditure is required.

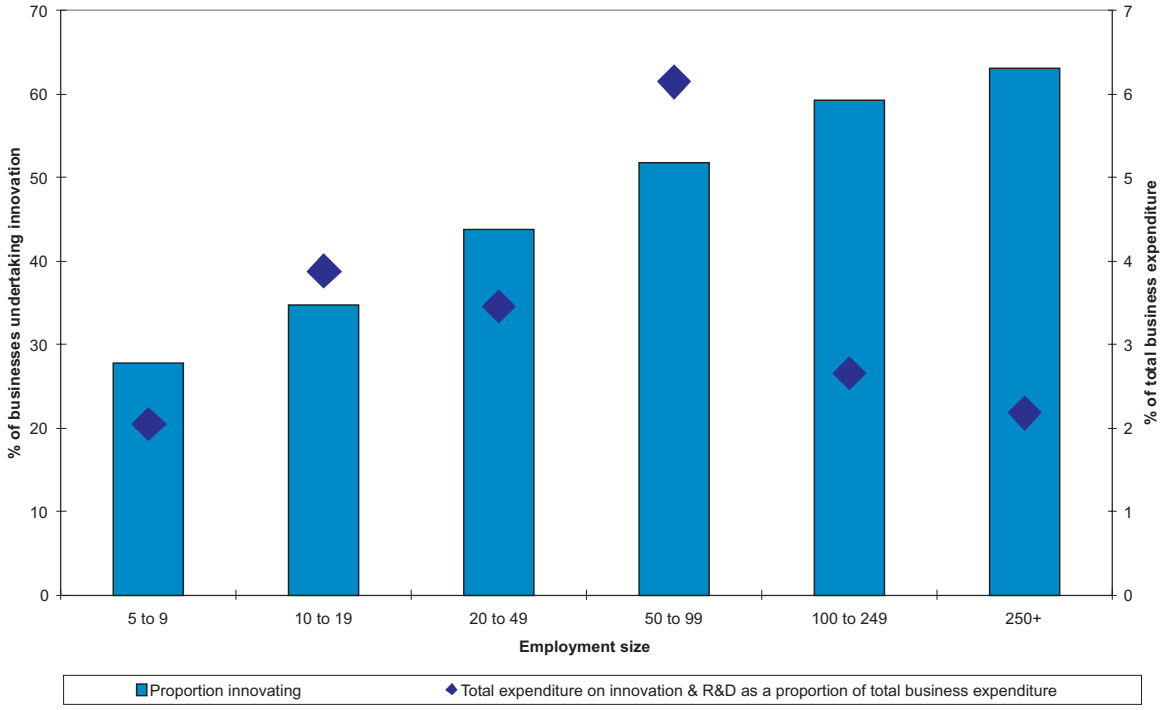
The survey defined an operational innovation as a new or significant change in the methods of producing or delivering goods or services. Examples of operational processes provided in the survey included:

- digitalisation of printing processes;
- introduction of computer-assisted/based methods for product development;
- introduction of digital product labelling (e.g. scanner barcodes);
- reconstruction or reorganisation of sales rooms, if this enables easier shopping for customers; and
- introduction of automated or electronic ticketing system.

The development of most of these types of operational process innovations are captured under the goods innovation category. While it costs businesses to buy in technology and adapt it to their particular work environment most of the novelty or new knowledge is already embodied in the product which explains why expenditure in the goods or service innovation category is much higher than in the operational and organisational process categories.

As mentioned in chapter 5 (Business size) the relationship between business size and innovation appears linear, however Figure 26 demonstrates that the relationship between innovation and R&D expenditure intensity by business size is not so straightforward. While the rate of innovation gradually increases with business size from 28% to 63% the expenditure ratio does not follow a similar pattern. Businesses in the 5 to 9 employee category had an intensity ratio that was similar to large businesses. These results do not take into account the uneven distribution of expenditure within business size categories and this is discussed in more detail below (see Figure 31).

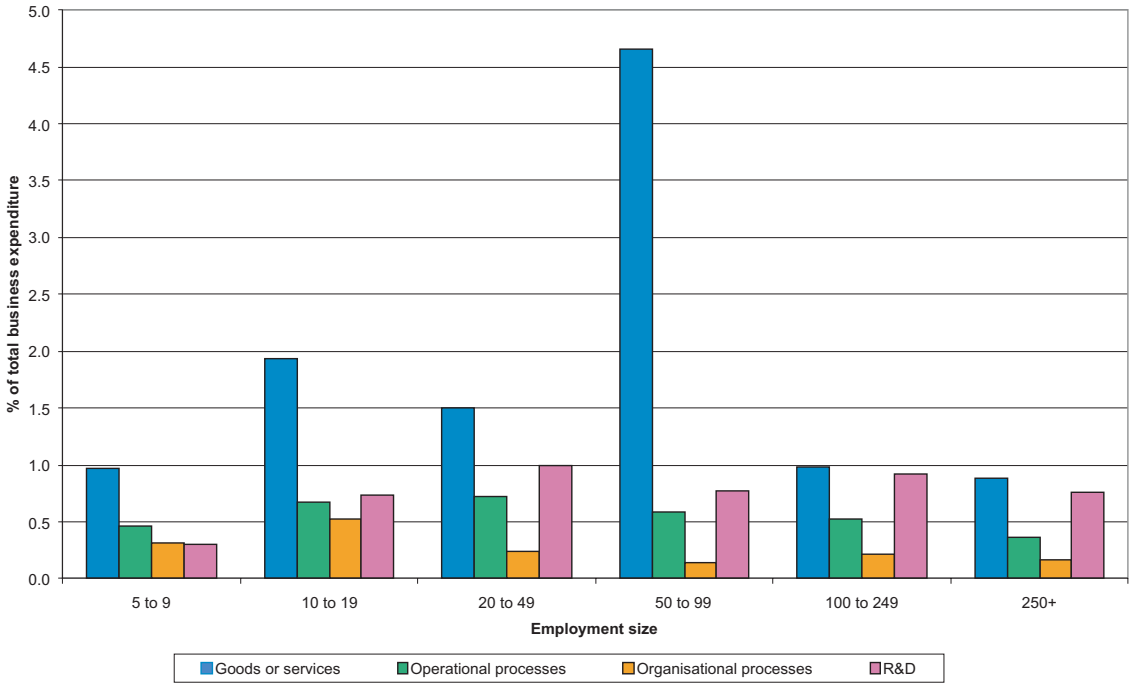
FIGURE 26 INNOVATION AND R&D EXPENDITURE (2002–03) BY INNOVATORS (2001–03) AND EMPLOYMENT SIZE



Source: ABS, unpublished data

Figure 27 shows expenditure on different types of innovation and R&D, by innovating businesses as a proportion of total business expenditure across different business size categories. It appears that the relationship between goods or service innovation intensity and business size is particularly unclear. Overall, innovating businesses across all of the size categories spent in the range of 1.4% to 5.4% of total business expenditure on innovation. Expenditure on operational process innovation ranged from 0.4% to 0.7% and for organisational process innovation the figures were between 0.1% and 0.5%. There is more variation between the size groups in goods and service innovation as expenditure ranged from 0.9% to 4.7%. It is important to remember that the ratios reported in this figure do not give an indication of the distribution of expenditure (these data are shown in Figure 30 to Figure 32) – the peak seen in goods and service innovation in the 50 to 99 employee category, for example, is a result of a small number of businesses with a very high degree of expenditure relative to total expenditure.

FIGURE 27 TYPE OF INNOVATION AND R&D EXPENDITURE BY BUSINESS SIZE, 2002–03 (Innovating businesses)

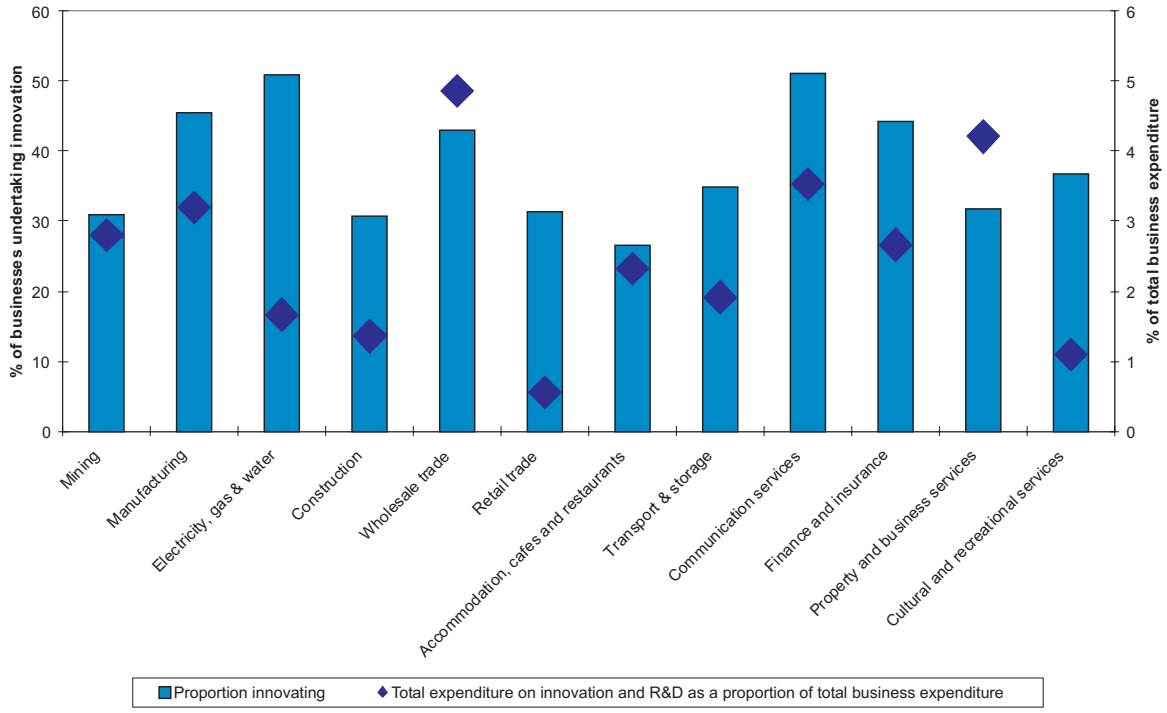


Source: ABS, unpublished data

The data in Figure 27 above also indicate that R&D intensity is similar across all business size categories, apart from the 5 to 9 employees grouping, representing about 1% of total business expenditure. While large businesses are known to spend more on R&D than small businesses in absolute terms the R&D intensity is similar among a number of business size categories.

Figure 28 looks at the proportion of businesses innovating and the proportion of total business expenditure on R&D and innovation by industry. There is wide variation between the proportion of businesses innovating and the intensity of expenditure reported across industry. In five industries expenditure on innovation and R&D represented less than 2% of total business expenditure although the proportion innovating in these groups was between 31% and 51%. These results seem to suggest that these industries are undertaking innovation that does not require substantial financial investment. Three industries spent around 4% to 5% of total business expenditure on innovation and R&D and the proportion innovating varied between 32% and 51%, which is very similar to the range for low expenditure industries.

FIGURE 28 INNOVATION AND R&D EXPENDITURE (2002–03) BY INNOVATORS (2001–03) AND INDUSTRY

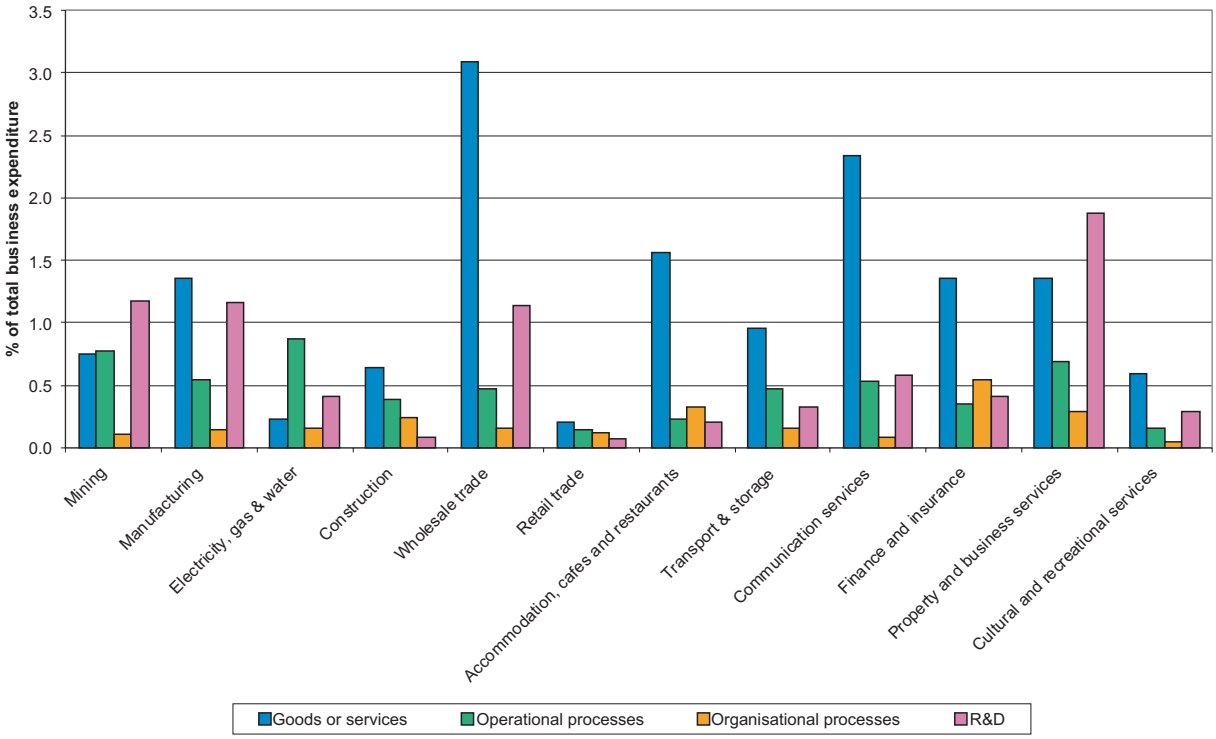


Source: ABS, unpublished data

The detailed distribution of innovation and R&D expenditure as a proportion of total business expenditure by industry sector is reported in Figure 29. The data show that expenditure on R&D and goods or service innovation varied markedly across industries. Overall, the range was between 0.2% and 3.1% of total business expenditure for goods or services and 0.1% and 1.9% for R&D. Businesses in Wholesale trade and Communication services reported expenditure that represented more than 2% of total business expenditure on goods or service innovation. For Manufacturing and Accommodation, cafes and restaurants this figure was just over 1.5%. In terms of R&D expenditure as a proportion of total business expenditure Property and business services, Manufacturing, Mining and Wholesale trade spent more than 1%. It is important to note that Property and business services includes ANZSIC industry groups such as Scientific research, Technical services and Computer services.

The variation between industries expenditure on operational and organisational innovations was not as marked. For operational processes expenditure was between 0.1% and 0.9% of total business expenditure whereas for organisational innovation the figure was between 0.05% and 0.5%.

FIGURE 29 INNOVATION AND R&D EXPENDITURE BY INDUSTRY, 2002–03 (Innovating businesses)

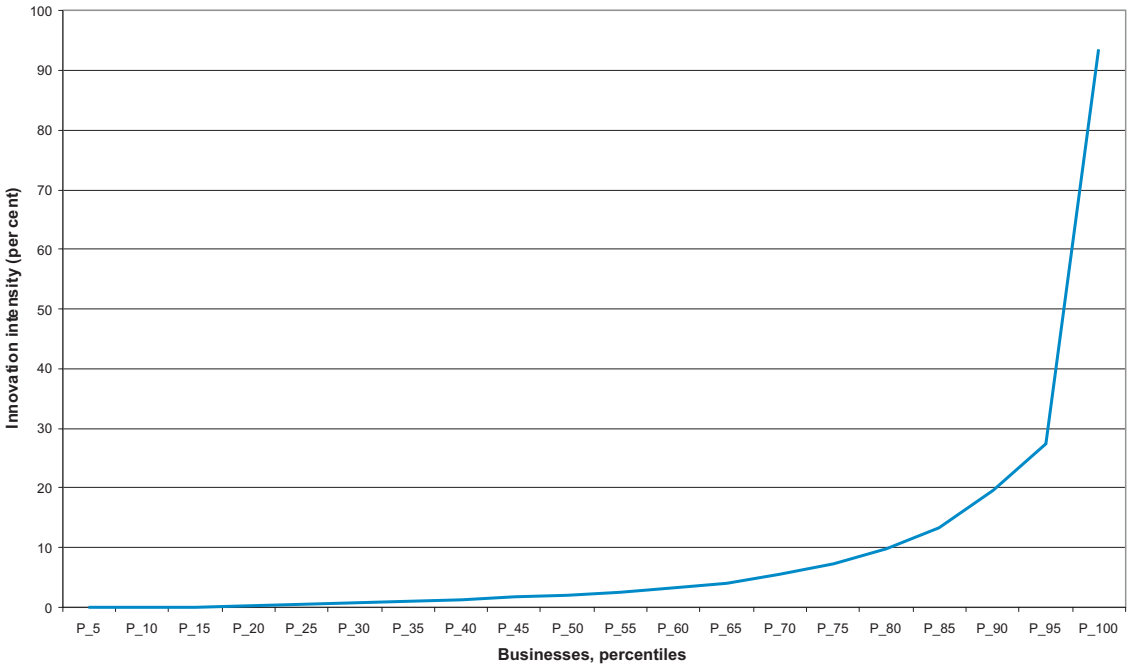


Source: ABS, unpublished data

It is very important to note that, quite independently of any differences across industries, there can be major expenditure differences within industries. The following figures look at this by examining the distribution of innovation and R&D expenditure intensity among innovating businesses.

Figure 30 suggests that there is a highly skewed distribution across businesses as most of the innovation and R&D expenditure intensity is concentrated in a small group of businesses.

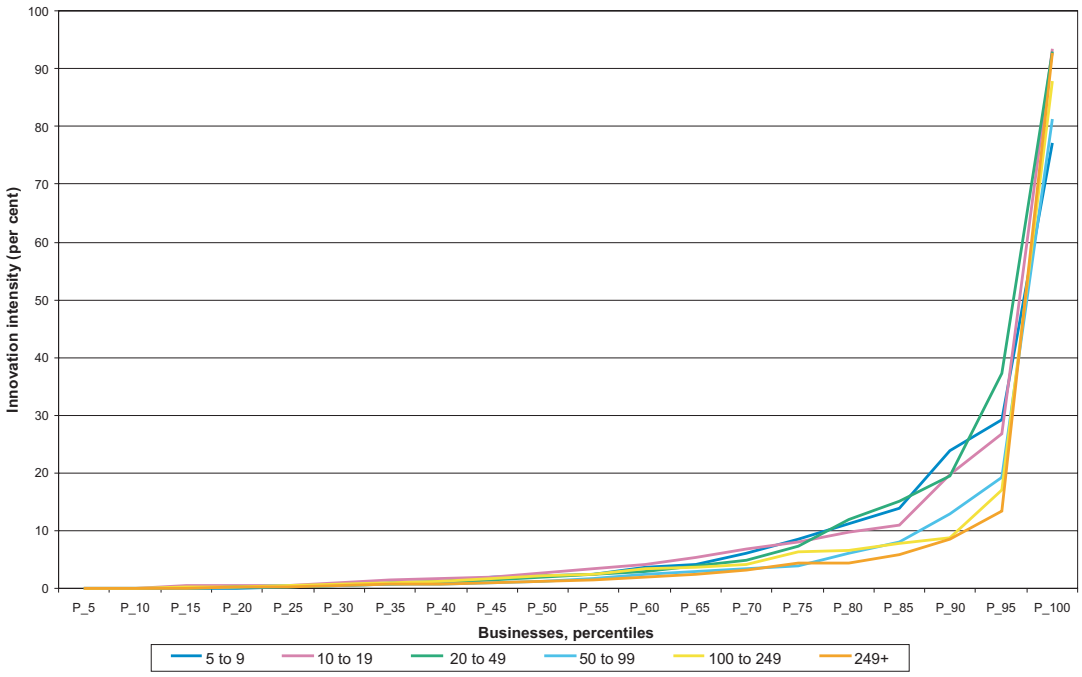
FIGURE 30 PERCENTILE DISTRIBUTION OF INNOVATION AND R&D INTENSITY, 2002–03



Source: ABS, unpublished data

Following this the question that naturally arises is to what extent does this distribution simply reflect the fact that some businesses are larger than others, and innovate more frequently? To allow for this, Figure 31 looks at the distribution of expenditure within various business size categories. It is clear that the skewed distribution remains – even within a particular business size category, most high innovation and R&D expenditure intensity is concentrated among a very small group of businesses.

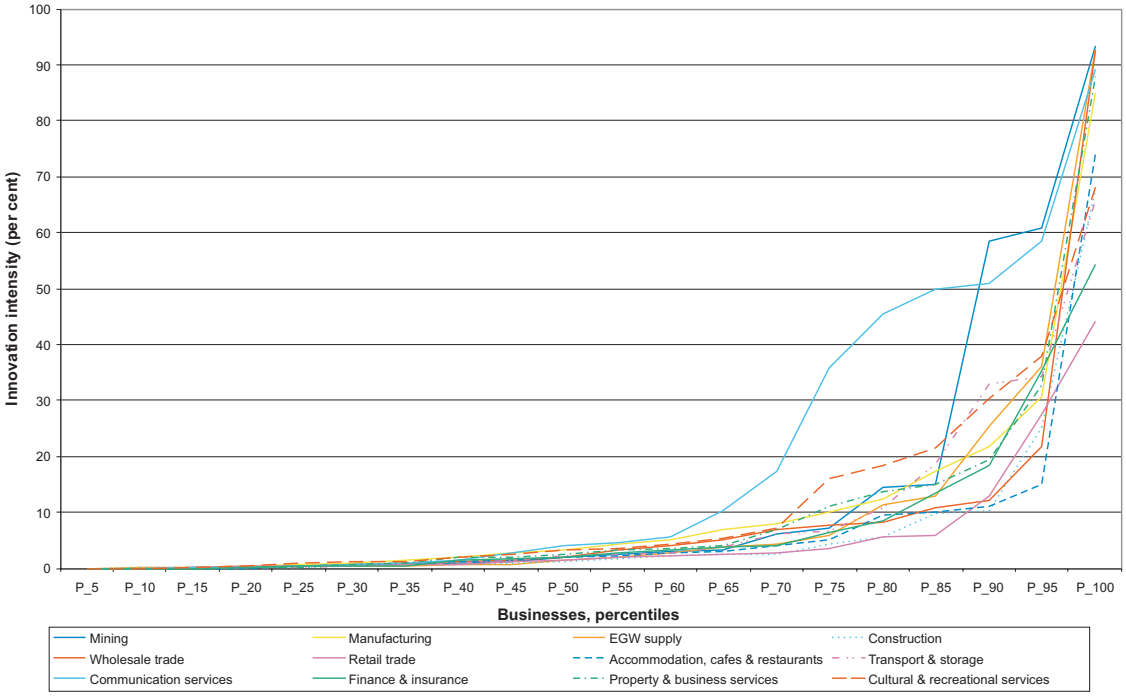
FIGURE 31 PERCENTILE DISTRIBUTION OF INNOVATION AND R&D INTENSITY BY EMPLOYMENT SIZE, 2002–03



Source: ABS, unpublished data

Finally, it is important to consider whether the skewness could simply arise from some industries being higher investors in innovation and R&D than others. Looking across industries, as in Figure 32, it is clear that this is not the case. Each industry exhibits this uneven, highly skewed distribution of innovation and R&D expenditure intensity, although communication services is less skewed.

FIGURE 32 PERCENTILE DISTRIBUTION OF INNOVATION AND R&D INTENSITY BY INDUSTRY, 2002–03
(Innovating businesses)



Source: ABS, unpublished data

The preliminary conclusions that can be drawn from these data are that innovation and R&D expenditure intensity is strongly focused on a relatively small proportion of the business population. It was suggested above that the same result holds for innovation outputs, as measured by the proportion of new product sales in turnover, where most of the sales appeared to accrue to a small group of businesses. This result does not appear to reflect particular size of business or industry characteristics as it seems to be a general characteristic of innovation in Australia. It would be important therefore to explore the relative performance of these highly innovative businesses. Are they growing faster? Are they exporting more? What is the level and quality of their employment? These are important issues both for the analysis of the impact of innovation on economic performance, and also for the design of public policy.

CHAPTER 7 CONCLUSION

This paper has attempted to provide a broad overview of innovation patterns in Australian businesses. It uses selected micro-data collected in the ABS *Innovation in Australian Business 2003* survey to analyse the main patterns of innovation, the characteristics of innovators and expenditure on innovation. A summary of the key results and main conclusions follow.

The data captured in the 2003 innovation survey represent a significant step forward in understanding innovation in Australian businesses. The 2003 survey can be seen as the first comprehensive innovation survey in Australia as the earlier surveys conducted by the ABS in the 1990s were largely exploratory in nature or restricted to particular industries (mainly manufacturing). The importance of these data is worthy of mention. The data are based on a national level survey covering businesses with 5 or more employees across most of the market sector, with weighting factors used to construct estimates for the whole population. This means that the results are generalisable across most of the economy. The data can be used to inform the development of public policy, which requires comprehensive and reliable information.

The analysis conducted in this paper is preliminary as only particular selections of data have been used. However, this 'first' cut demonstrates that the 2003 survey can help answer a number of questions that could not previously have been addressed as comprehensively. These include:

- The extent and types of innovation activity occurring across industries;
- The degree of innovation novelty and the innovation output (measured as the proportion of turnover from new products) across industries;
- The balance between R&D and innovation expenditure across industries and the distribution of expenditure across businesses; and
- The characteristics of innovators according to business size, degree of foreign ownership and age of the business.

The key results that emerge from the analysis are:

- Innovation is wide in scope and is not confined to particular industries. It occurs across the economy. For most businesses the highest degree of innovation novelty is 'new to the business' goods, services and/or operational processes.
- In most industries, the majority of goods or service innovating businesses report that less than 10% of their turnover is attributed to new goods or services. Although innovation activity is widely spread across industries, the proportion of turnover attributed to new goods or services is concentrated in relatively few businesses.

- Innovation inputs are much broader than just R&D. Non-R&D expenditure on innovation represents around two-thirds of innovators' total expenditure on innovation and R&D. In fact only 31% of innovating businesses report R&D expenditure.
- The proportion of businesses innovating and the intensity of expenditure reported across industry varied markedly. This suggests that in some industries the nature or extent of the innovation requires relatively less financial investment.
- Although innovation is widespread across industry expenditure is highly concentrated in a small number of businesses. This pattern is evident across all business size classes and industries, indicating that innovation and R&D intensity is concentrated among a relatively small proportion of businesses.

The *Innovation in Australian Business 2003* dataset contains a wealth of valuable information, and this paper presents a broad overview of this. In some instances the analysis conducted here suggests that further research is needed as the results generate new questions. In addition, the data are based on a set period of time which means that causal relationships can not be tested. The ABS is planning to undertake another innovation survey in early 2006, which should enable researchers to take the first steps in investigating causality. The ABS will also shortly be commencing a Business Characteristics Survey involving longitudinal panels, with results (including core innovation data) to be progressively added to a Business Longitudinal Database (BLD). The BLD will eventually include data from a range of business surveys, including the innovation survey, so that analysts can better utilise the full range of business data provided by the ABS.

In the meantime, the 2003 dataset allows us to analyse patterns of innovation, associations and correlations between variables. Measuring and understanding the characteristics and dynamics of innovation in Australia is critical in informing policy development, and program design and implementation.

APPENDIX 1 Z TEST STATISTICAL RESULTS

The standard statistical test used to compare two population proportions is a z test. It usually assumes a binomial distribution of data, implying sampling with replacement. However, when sampling is carried out without replacement the underlying distribution is hypergeometric and the standard z test comparing two population proportions requires some adjustments in the formula to compute the z value.

The difference between a z test based on a binomial distribution and a hypergeometric distribution reduces as the population size becomes large relative to the sample size.

As sampling within the *Innovation in Australian Business 2003* was without replacement, statistical tests of significance on the difference between proportions used a z test based on the hypergeometric distribution. The concept and the formula derived to calculate the z statistic presented below is taken from Krishnamoorthy and Thomson (2002).

Let X_1 and X_2 denote the number of units with the characteristic of interest in the two samples. Then

$$Z = \frac{X_1/n_1 - X_2/n_2}{\sqrt{V_{X_1X_2}}}$$

where $V_{X_1X_2}$ is the estimate of the variance of $X_1 / n_1 - X_2 / n_2$ under $H_0: p_1 = p_2$.

The formula for calculating $V_{X_1X_2}$ is:

$$V_{X_1X_2} = \left(\frac{N_1 - n_1}{n_1(N_1 - 1)} + \frac{N_2 - n_2}{n_2(N_2 - 1)}\right) x \left(\frac{X_1 + X_2}{n_1 + n_2}\right)\left(1 - \frac{X_1 + X_2}{n_1 + n_2}\right)$$

It follows from the central limit theorem that $Z_{X_1, X_2} \sim N(0,1)$ approximately when H_0 holds.

TABLE 1: Z TEST RESULTS

Figure Number	Statistical test	Degrees of freedom	Null hypothesis	Level of significance	Estimated value of Z	Critical value of Z	Decision taken
1a	Z test	n.a.	The proportion of goods/service innovation is the same as operation process innovation	5 per cent	–8.72	–1.96	Reject the null hypothesis
1b	Z test	n.a.	The proportion of goods/service innovation is the same as organisational process innovation	5 per cent	–4.41	–1.96	Reject the null hypothesis
1c	Z test	n.a.	The proportion of operational process innovation is the same as organisational process innovation	5 per cent	4.32	1.96	Reject the null hypothesis
2	Z test	n.a.	The proportion of innovation in Electricity, gas and water is the same as in Communication services	5 per cent	0.84	1.96	Fail to reject the null hypothesis
8a	Z test	n.a.	The proportion of businesses undertaking new to the world innovation is the same as the proportion undertaking new to Australia innovation	5 per cent	5.58	1.96	Reject the null hypothesis
8b	Z test	n.a.	The proportion of businesses undertaking new to the industry innovation is the same as the proportion undertaking new to Australia innovation	5 per cent	–0.22	–1.96	Fail to reject the null hypothesis
8c	Z test	n.a.	The proportion of businesses undertaking new to the industry innovation is the same as the proportion undertaking new to the business innovation	5 per cent	19.04	1.96	Reject the null hypothesis
8d	Z test	n.a.	The proportion of businesses undertaking new to the industry innovation is the same as the proportion undertaking new to the world innovation	5 per cent	5.36	1.96	Reject the null hypothesis
8e	Z test	n.a.	The proportion of businesses undertaking new to the business innovation is the same as the proportion undertaking new to the world innovation	5 per cent	23.81	1.96	Reject the null hypothesis
8f	Z test	n.a.	The proportion of businesses undertaking new to the business innovation is the same as the proportion undertaking new to Australia innovation	5 per cent	18.84	1.96	Reject the null hypothesis
9a	Z test	n.a.	The proportion of businesses undertaking new to the world innovation is the same as the proportion undertaking new to Australia innovation	5 per cent	9.06	1.96	Reject the null hypothesis
9b	Z test	n.a.	The proportion of businesses undertaking new to the industry innovation is the same as the proportion undertaking new to Australia innovation	5 per cent	–5.89	–1.96	Reject the null hypothesis
9c	Z test	n.a.	The proportion of businesses undertaking new to industry innovation is same as the proportion undertaking new to business innovation	5 per cent	36.54	1.96	Reject the null hypothesis
9d	Z test	n.a.	The proportion of businesses undertaking new to the industry innovation is the same as the proportion undertaking new to the world innovation	5 per cent	14.44	1.96	Reject the null hypothesis

...continued

TABLE 1: Z TEST RESULTS

Figure Number	*Statistical test*	*Degrees of freedom*	*Null hypothesis*	*Level of significance*	*Estimated value of Z*	*Critical value of Z*	*Decision taken*
9e	Z test	n.a.	The proportion of businesses undertaking new to the business innovation is the same as the proportion undertaking new to the world innovation	5 per cent	46.63	1.96	Reject the null hypothesis
15a	Z test	n.a.	The proportion of businesses undertaking innovation in the 5–9 employees category is the same as the proportion in the 10–19 employees category	5 per cent	–5.81	–1.96	Reject the null hypothesis
15b	Z test	n.a.	The proportion of businesses undertaking innovation in the 5–9 employees category is the same as the proportion in the >250 employees category	5 per cent	–23.75	–1.96	Reject the null hypothesis
15c	Z test	n.a.	The proportion of businesses undertaking innovation in the 10–19 employees category is the same as the proportion in the 20–49 employees category	5 per cent	–3.85	–1.96	Reject the null hypothesis
15d	Z test	n.a.	The proportion of businesses undertaking innovation in the 20–49 employees category is the same as the proportion in the 50–99 employees category	5 per cent	–2.01	–1.96	Reject the null hypothesis
15e	Z test	n.a.	The proportion of businesses undertaking innovation in the 50–99 employees category is the same as the proportion in the 100–249 employees category	5 per cent	–2.66	–1.96	Reject the null hypothesis
15f	Z test	n.a.	The proportion of businesses undertaking innovation in the 100–249 employees category is the same as the proportion in the >=250 employees category	5 per cent	–3.98	–1.96	Reject the null hypothesis

APPENDIX 2 CHI-SQUARE TEST STATISTICAL RESULTS

A Chi-square test was used to test the hypothesis of independence of chosen pairs of attributes: for example the hypothesis that the degree of novelty of innovation is independent of business size. The test statistic is obtained by summing the squared differences between observed and expected frequencies divided by the expected frequencies in the cells of a contingency table. A test statistic that was greater than the critical value at the 5% significance level for an appropriate number of degrees of freedom led to the rejection of the null hypothesis that attributes in question were independent. Under the hypothesis of independence this test statistic has a Chi-square asymptotic distribution.

TABLE : CHI-SQUARE TEST RESULTS

Figure Number	*Statistical test*	*Degrees of freedom*	*Null hypothesis*	*Level of significance*	*Estimated value of chi-square*	*Critical value of chi-square*	*Decision taken*
4	Chi-square	11	Being a goods or services innovator is independent of being in a particular industry	5 per cent	163.53	19.68	Reject the null hypothesis
5	Chi-square	11	Being an operational process innovator is independent of being in a particular industry	5 per cent	98.08	19.68	Reject the null hypothesis
6	Chi-square	11	Being an organisational process innovator is independent of being in a particular industry	5 per cent	46.5	19.68	Reject the null hypothesis
10	Chi-square	33	Degree of novelty in goods or services innovation is independent of being in a particular industry	5 per cent	83.27	43.77 and 55.76	Reject the null hypothesis
11	Chi-square	30	Degree of novelty in process innovation is independent of being in a particular industry	5 per cent	57.56	43.77	Reject the null hypothesis
15	Chi-square	5	Being an innovator is independent of being in a particular size	5 per cent	1 231.43	11.07	Reject the null hypothesis
17	Chi-square	15	Degree of novelty in goods or service innovation is independent of being in a particular firm size	5 per cent	17.72	25	Fail to reject the null hypothesis
18	Chi-square	15	Degree of novelty in operational process innovation is independent of being in a particular firm size	5 per cent	42.69	25	Reject the null hypothesis
19	Chi-square	3	Being an innovator is independent of firm ownership	5 per cent	138.92	7.82	Reject the null hypothesis
20	Chi-square	9	Degree of novelty in goods or services innovation is independent of firm ownership	5 per cent	46.88	16.92	Reject the null hypothesis
21	Chi-square	9	Degree of novelty in process innovation is independent of firm ownership	5 per cent	73.26	16.92	Reject the null hypothesis
22	Chi-square	3	Being an innovator is independent of firm age	5 per cent	13.06	7.82	Reject the null hypothesis

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