# Rethinking The "Innovative Firm": Innovation Creation In The Australian Water Technology Industry

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ABSTRACT

A positive relationship between innovation and export success is assumed in much of the economic literature. This assumption is tested with firms from the Australian water technology industry, defined as manufacturing activities that are related to water treatment. Empirical evidence from over 80 firms in this industry reveals that quantitative relationships between innovation proxies (R&D and patents) and firm-performance measures (export proportion and productivity) are generally weak. This paper argues that a broader concept of innovation, expressed as appropriate technology, offers a better explanation of why exports develop for these firms. This finding has implications for formulating industry policy and for further theoretical development of the concept of innovation.

Keywords: *Innovation, Exporting, Patents, R&D, Technological change, Appropriate technology, Environmental technology, Australian water industry*

## I. Introduction

There is a rich tradition of economic literature that explains how and why innovation is fundamental to the competitive success of firms and regions (e.g. Cainelli et al, 2006; Fagerberg, 1994; Freeman and Soete, 1997; von Hippel, 1988; Nelson and Winter, 1982; Nelson and Winter, 2002; Porter, 1990; Schmookler, 1966; Schumpeter, 1934; Verspagen, 2005; Wakelin, 1997; Wakelin, 1998). Innovation can be defined as the introduction or improvement of a product, process or service that results in better or cheaper goods and services. Innovation includes not only technical change to a product or process, but new and better approaches to marketing, distribution and servicing. It can arise from a firm's internal efforts at current research and development (R&D), as well as cumulative learning from experience (Dosi et al, 1988; Nelson and Winter, 1982). Innovation can also originate from networks of market intelligence, such as information from suppliers and buyers (i.e. a 'demand-pull' process) (Cainelli et al, 2006; Cornish, 1997; Walker, 2007). Inter-firm networks, such as joint ventures and alliances, are another importance source of innovation that complements internal efforts by the firm (Freeman and Soete, 1997; Oerlemans et al, 1998).

The self-reinforcing feedback mechanism between innovation, productivity, competitiveness and trade can be explained as follows. Innovation should result in greater productivity (i.e. higher profits per employee, or greater output in value per unit of capital) because a larger quantity or better product is produced. Firms that achieve higher productivity relative to the average of their industry gain a competitive advantage over less productive rivals, thereby increasing their propensity to access distant markets (Fagerberg, 1994; Wakelin, 1997). Innovation can involve virtually any activity in the value chain (Porter, 1990). Innovations allow a firm to pursue a cost strategy because of more output per unit of labour or capital (referred to as process change), or a differentiation strategy because new or higher quality goods or services can be produced, leading to an increase in the price of the output per unit of factor input (referred to as product innovation) (Porter, 1990, pp. 37-47; Silverberg and Soete, 1994).

It is beyond argument that innovation is essential at the micro and macroeconomic level. The contention is trying to quantify the intensity of innovation because the concept embraces economic as well as social and cultural aspects (von Hippel, 1988). Proxies for measuring technological innovation include R&D expenditure, number of patents, technology adoption and skills intensity (i.e. employment share with university degrees) (Gu and Tang, 2004; Wakelin, 1997). These proxies have inherent limitations, even when used in combination. This paper uses empirical evidence from an industry case study to demonstrate that for a medium-technology manufacturing industry, the exclusive reliance on R&D and patents to quantify innovative activity may obscure important non-quantifiable aspects of innovation. The subsequent discussion is structured as follows. Section 2 overviews the current knowledge about measuring innovation in manufacturing firms. Section 3 presents the empirical evidence. The industry sample comprises about 80 Australian firms that manufacture water treatment equipment; approximately half of these firms are exporters. The main finding is that traditional measures of innovation fail to capture the 'essence' of how innovation is expressed in this particular medium-technology industry. Section 4 synthesises the findings and highlights the implications.

## 2. The Slippery Nature Of Measuring Innovation

There is unanimous agreement that innovation is vital for economic progress, yet contention remains over what is the most accurate method of measuring innovation. Different quantifiable approaches only capture certain aspects of the innovation process which can lead to conflicting results in empirical studies (Gu and Tang, 2004; Nelson and Winter, 1982; Nelson and Winter, 2002; Wakelin, 1997). The most common proxy, R&D expenditure, is an input measure that does not indicate the success of efforts to produce an innovative output (Fagerberg, 1994). The other common proxy is patent counts for firms, argued by some researchers as being more accurate because patents are an output measure of the number of innovations actually realised (Pavitt, 1985;

Wakelin, 1997). Yet some patented inventions are not always commercially viable innovations, and many successful innovations are never patented (Arundel and Kabala, 1998).

There is an array of other methods. One method is to combine proxies, such as R&D and patent counts as a proportion of the market asset value of the firm (Fagerberg, 1994; Industry Research and Development Board, 1998). Another approach is to introduce a labour productivity measure with a patent index (Verspagen, 2005). Yet another measure is assigning a mathematical weight according to the age of the patent, with recent patents given a greater weight (Wakelin, 1997). Different depreciation rates to account for R&D stock variables can also be used. In a study of Canadian manufacturing industries, Gu and Tang (2004) use four indicators - R&D, patents, technology adoption and skills - and find a strong link between innovation and productivity, although the reliability of these indicators varies across industries.

Problems persist with using quantifiable proxies to measure innovative activity. Much innovation in practice is incremental, consisting of small, mundane improvements to a product or process that may not produce patents (Cornish, 1997; Kleinknecht, 1990; Porter, 1990). Furthermore, firms in high-tech industries typically have more formalised R&D expenditure and propensity to patent compared with firms in medium and low-tech industries. Of course, innovations also occur in these latter groups, although maybe not with the same intensity. Quantifying innovation proxies can also underestimate the contribution of innovative smaller firms that may have no formalised research budget (Wakelin, 1997).

Other problems with measuring innovation include the practical difficulties in disentangling the direct impact of innovation from other effects on a firm's productivity (e.g. capital improvement, upgrading the skills of the labour force, or improved marketing). Another problem is that patent counts do not capture the diffusion of innovation from its original sector to other sectors. Furthermore, international comparisons of innovative activity can be unreliable because of different national definitions of R&D and different legal frameworks for the granting of patents (Pavitt, 1985; Wakelin, 1997).

In addressing some of these recognised limitations, methods have been developed that involve qualitative judgements. One example is to determine the actual number of innovations (as defined by a panel of experts) within a nation over a period of time (Greenhalgh et al, 1994; Wakelin, 1997; Tether et al, 1997). This method avoids the size bias of R&D expenditure. Another method is to determine the market success of different innovations by firms (Greenhalgh, 1994 et al; Wakelin, 1997; Wakelin, 1998).

A pertinent criticism of relying on traditional innovation proxies is that they fail to capture innovation in service industries, especially for smaller firms. Encouragingly, there has been progress with developing measures to capture innovative activity in this sector (Cainelli et al, 2006). Methods used to quantify innovative activities in the service sector include using expenditure per employee on training, expenditure per employee on information and communication technology, sales volume and growth per employee, reduction in customer complaints, and customer satisfaction surveys (Cainelli et al, 2006; Walker, 2007).

Building on this current state of knowledge, the next section reports the results from testing the relationship between innovation intensity and export proportion for the Australian water technology industry. The empirical work uses a combination of R&D expenditure and patent counts as the proxies. The main limitation is that some of the other methods discussed above are not investigated because of methodological constraints. In addition, the sample of firms studied for this paper were predominantly manufacturers; testing how innovation is expressed in service industries requires a broader sample. Notwithstanding, the combination of quantitative surveys and qualitative interviews used for this sample provides a deeper appreciation of how the process of innovation evolves and influences the economic performance of the firm.

## 3. Innovation In The Australian Water Technology Industry: 'Keeping It Simple'

To test the assumption of a positive relationship between innovation, productivity and export success, the empirical evidence is from the Australian water technology industry. This industry is defined as encompassing manufacturing activities that produce components and equipment used by water utilities and industry to treat wastewater and provide potable water (AWA, 2003; EDC, 1995). The Australian-based industry is diverse, comprising small and large firms, both domestic and foreign-owned. It is not considered a high technology industry (AWA, 2003; Bainbridge, 1997); hence it serves as an interesting case study to test ideas about innovation. Additionally, understanding innovation in this industry has policy significance because in the 1990s it was identified as part of a potentially robust environmental technology exporting sector (EDC, 1995). Because this industry is diverse, with activities encompassing several industry classification codes and lacking official definition by the Australian Bureau of Statistics, information had to be obtained from primary sources by conducting surveys and interviews (Nadolny, 2004).

Section Three is in two parts. Firstly, the results of quantitative analysis are reported. There is only statistically weak support that innovation, as measured by standard proxies, leads to greater productivity and export success. The second part presents qualitative evidence which demonstrates that a broader concept of innovation, expressed as appropriate technology which can involve simplifying products for users, offers a better explanation of why exports develop for these firms in the water technology industry. Evidence is also reported that shows innovation creation for firms is a synergy of both internal and external sources.

### 3.1. Quantitative Analysis

Based on assumptions about innovation from the literature (e.g. Wakelin, 1997; Fagerberg, 1994; Gu and Tang, 2004; Industry Research and Development Board, 1998), three hypotheses are tested:

- Among exporting and non-exporting firms that do have R&D expenditure and patents, the exporting group has a greater proportional level of these proxies than the non-exporting group:
    - Non-exporters (R&D %; patent %) < Exporters (R&D %; patent %)

- For exporters, there is a relationship between innovation proxies (as a proportion of revenue) and export proportion: Export % = f (R&D %; patent %)

- There is a relationship between innovation proxies, firm-size and productivity (expressed as revenue/ employee):

  - Revenue/ employee = f (R&D %; firm-size; patent %).

Before proceeding with these tests, three provisos are noted. First, because R&D expenditure and patent registrations usually apply to product and process developments relating to tangible goods, the sample comprises manufacturers of water technology equipment. Service providers (such as software designers and consulting engineering firms) are not included. Second, while the literature review acknowledged the limitations of using R&D and patents as proxies for innovation, the logistical challenges of collecting information from mainly small private sector firms meant that there was insufficient information to use other proxies. Third, in most of the tests using regression analysis, data is transformed into natural logarithms to make any underlying relationships linear.

**Hypothesis 1**

There is a detectable difference between the exporters and non-exporters, with exporters having a higher proportion of R&D and patents. This result is expected because supposedly the more R&D expenditure and patents a firm has, the more innovative the firm is and the more likely it is to export. A larger sample would be required to strongly support causation but theoretical expectations are supported.

**Table 1: Comparison Of Proportion Of R&D Expenditure And Patent Counts Between Manufacturing Exporters And Non-Exporters (N = 80)**

| Grouping<br>Innovation proxy | Exporter | Non-exporter | Statistical summary [1] |
|---|---|---|---|
| R&D expenditure as proportion of revenue (includes firms with zero R&D expenditure) | N = 57<br>Mean = 0.07<br>(s.d. = 0.15)<br>Median = 0.02 | N = 23<br>Mean = 0.04<br>(s.d.= 0.08)<br>Median = 0 | Mann-Whitney U test<br>U (78) = 476.5<br>p = 0.03* (one-tailed) [2] |
| No. of patents per A$ M (million) of revenue (includes firms with no patents) [3] | N = 55<br>Mean = 0.54<br>(s.d. = 1.24)<br>Median = 0 | N = 20<br>Mean = 002<br>(s.d. = 0.07)<br>Median = 0 | Mann-Whitney U test<br>U (73) = 319.5<br>p < 0.01**(one-tailed) |

Notes: Source: author's surveys and interviews (Nadolny, 2004); for patent information: Intellectual Property Australia database (www.ipaustralia.gov.au) (Retrieved Nov- Dec, 2003).

1. Mann-Whitney U tests are used for two reasons: i) Data are not normally distributed; ii) The tests intentionally include zero values for R&D expenditure and patent counts.

2. One-tailed test (i.e. detecting difference in one direction) is used because the hypothesis is that exporters have a higher mean.

3. Patent counts for this table and subsequent tables refer to patents registered in Australia only.

**Hypothesis 2**

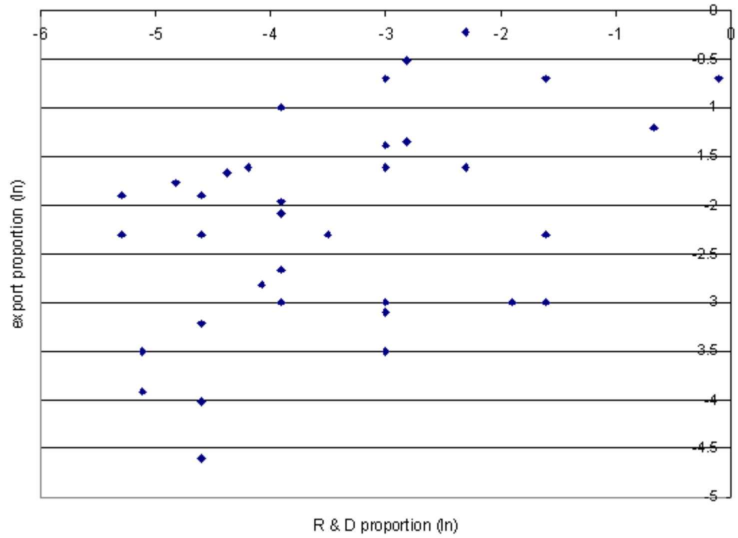
Regression analysis is used to test the relationship between R&D proportion (i.e. R&D expenditure as a proportion of revenue) and number of patents (per $1 million of revenue), and export proportion. The two proxies are the independent variables; export proportion is the dependent variable. The testing is done in three stages by using the two independent variables separately and then combining them.

*R&D proportion*

Regression analysis is used to test the relationship between R&D proportion and export proportion. To lessen the likelihood of a Type 2 error, the variables are transformed into natural logarithms. This reveals a weak relationship, but still statistically significant ([log transformed] adjusted $R^2 = 0.15$; $F (1, 38) = 7.85$; $p < 0.01$**; N = 40). (Note that exporters with no R&D [i.e. zero values] are eliminated by default in the log transformation). However, the small adjusted $R^2$ value indicates that the relationship is not substantially significant. Figure 1 illustrates this weak relationship.

**Figure 1: Relationship Between R&D Proportion And Export Proportion**

**(N = 40) (Exporters Only) (Log Transformed) *Ln* Export Proportion = – 1.05 + 0.41*(*Ln* R&D Proportion)**




*Notes*:

1. 40 cases of exporting manufacturing firms where both export proportion and R&D proportion are known.

2. Another correlation was performed on untransformed data (with zeros eliminated) using Spearman's ρ. The result is also significant ($r_s = 0.42$; $p < 0.01$**; $n = 40$).

3. *Source*: Nadolny (2004)

*Patent proportion*

Substituting patent proportion as the independent variable results in a model with no predictive value. Log transformation of the data reveals no evidence of a relationship ([log transformed] adjusted $R^2 = -0.04$; $F(1,22) = 0.03$; $p = 0.87$; $N = 24$). The lower sample size is because only firms with patents are included in this test.

*Combining R&D and patent proportion*

Table 2 summarises the results of a regression analysis using the two innovation proxies to represent the independent variables. No evidence of relationships between variables is detected.

**Table 2: Multiple Regression Analysis For Export Proportion (Dependent Variable) And R&D Proportion And Patent Proportion (Independent Variables) (N = 21)**

**(Exporters Only) (Log Transformed)**

**Ln Export Proportion = – 1.19 + 0.33* (Ln R&D Proportion) – 0.003* (Ln Patent Proportion)**

| Variable | Result |
|---|---|
| Proportion of total variance | adjusted $R^2 = 0.008$ |
| F (2,18) value = 1.08 | p = 0.36 |
| R&D per revenue (log transformed) | p = 0.17 |
| Patents per revenue (log transformed) | p = 0.99 |

*Notes*

1. Source: Nadolny (2004)

**Hypothesis 3**

The final hypothesis tested is to determine if there is a relationship between innovation proxies and revenue (i.e. as a proxy for firm-size), and productivity. Revenue per employee (as a proxy for productivity) represents the dependent variable; R&D proportion, patent proportion, and revenue represent the independent variables. Non-exporters are included because the concern is testing the relationship between competitiveness and innovation proxies. No evidence is found of a correlation between the dependent and independent variables (Table 3). The null hypothesis cannot be rejected.

**Table 3: Multiple Regression Analysis For Revenue Per Employee (Dependent Variable) And Innovation Proxies And Revenue (Independent Variables) (N = 75)**

**(Exporters And Non-Exporters)**

**Revenue Per Employee = 0.33 + 0.14*(Patent Proportion) + 0.10*(Revenue) – 0.09*(R&D Proportion)**

| Variable | Result |
|---|---|
| Proportion of total variance | adjusted $R^2 = -0.007$ |
| F (3, 71) value = 0.83 | p = 0.48 |
| Patents per revenue | p = 0.25 |
| Revenue (A$ M) | p = 0.40 |
| R&D per revenue | p = 0.47 |

*Notes:*

1. A log transformation of the data also produced a non significant result (N = 21) (exporters & non-exporters) (log transformed): ln Revenue per employee = – 1.52 + 0.34*(ln revenue) – 0.15*(ln patent proportion) + 0.14*(ln R&D)

**2.** Source: Nadolny (2004)

### 3.1.1. Discussion

For manufacturing firms that supply inputs for the water industry, exporters generally have proportionally more R&D expenditure and patent registrations than non-exporters (Hypothesis 1). Although firms with R&D and patents have increased propensity to export, the evidence is weak that an increase in these innovation proxies leads to a proportional increase in exports (Hypothesis 2). There is a weak relationship detected between R&D proportion and export proportion (Hypothesis 2), but not with patents. Testing for Hypothesis 3 reveals that no statistically significant relationship is detected between innovation proxies and productivity (revenue per employee) and revenue (as a proxy for firm-size).

These results are in disagreement with expectations from the literature. Several reasons are proposed for this:

- The proxies used are not sensitive enough to detect a stronger relationship between innovation and trade. This is because proxies have inherent limitations as Section 2 reviewed. For instance, R&D expenditure is an input measure that may not translate into a proportional output of innovations.

- The proxies only measure innovation created within the firm, whereas external acquisition of knowledge for innovation is also common. This is elaborated in Section 3.2.

- The characteristics of the industry also help explain this disagreement with the theory. Technological change in the water industry is characterised more by incremental innovations, rather than ‘hi-tech’ breakthroughs (Bainbridge, 1997). This is not necessarily reflected in R&D expenditure or increased patents. In interviews, several respondents emphasised this industry characteristic (Nadolny, 2004). As one respondent explained: “With the water sector, it is very slow in the uptake of new ideas. There is about a twenty-year uptake period. …Overall it still uses very basic technology. Although management systems and telemetry have changed, in general there have not been enormous breakthroughs in technology” (Interview Code #106, Nadolny, 2004).

- The lack of relationship between productivity and innovation proxies could simply mean that other factors determine productivity. For this industry, higher revenue per employee may be more contingent on corporate alliances, improved marketing and back-up service, and upgrading the skills of employees, rather than new innovative product with embedded R&D. Also, some new firms with a high expenditure on R&D could have low revenue per employee because markets are only becoming established.

These findings, however, certainly do not demolish the argument that innovation is a crucial enhancer of economic performance. For this empirical sample, innovation is still occurring; a different methodology **is required to uncover its influence rather than relying on narrow quantitative proxies that are confined to processes within the firm.**

## 3.2. Qualitative Analysis

### 3.2.1. Importance Of Appropriate Technology

Evidence from interviews demonstrates that innovation can be expressed as a broader concept than simply technical change measured by quantifiable proxies. Relevant to the water industry, innovative can mean simplifying a product or process where necessary so it will be reliable and appropriate in its geographic setting, often a developing country in the Asia Pacific region. Some R&D expenditure may still be required, although it would be quite minimal compared with a ‘high-tech’ product. The concept of appropriate technology for developing countries is not a recent realisation. For example, Bishop (1986) notes that the success of technology transfer in water technology depends on appreciating local cultural, economic and technological conditions.

Table 4 demonstrates how competitive advantage can result from developing products that utilise ‘appropriate technology’. One example of innovation by applying simplicity was the development of an oil/water separator for an industrial complex in China.

“(This version) has lower maintenance requirements and is easier to use than more complicated products that require specialised training to operate, as well as imported replacement parts” (Interview Code #78, Nadolny, 2004). The simpler product is arguably innovative because it meets client’s expectations but is cheaper, requires less maintenance and is possibly more reliable than its rival with a more complicated design. Simplifying a design is also a form of specialisation if rivals are still adhering to designs that are more complex. Thus firms using appropriate technology are often pursuing a dual marketing positioning strategy of differentiation and cost competitiveness.

**Table 4 Select Quotations Demonstrating Appropriate Technology As A Competitive Factor (N = 5 Firms)**

| Interview quotation | Type of firm |
|---|---|
| “Every water system in the world is run differently, different legislation, and different systems. What we do is develop a product based on simple packages that can easily be installed rather than developing computer software from scratch and hard coding it, because the first thing you will be doing is rewriting 20% of it for the first sale” (Interview Code #106). | Medium size Commercialised arm of corporatised water utility |
| “One of the things that became clear after doing market research was that high-tech becomes part of the cost because you can’t sell these countries a lot of the cost of high-tech components in your plants. The plants are still computerised but built with simplified components. ....Our products are more efficient and less complicated than our competitor’s” ( Interview Code #78). | Small wastewater specialist ASX listed firm [Australian owned] |
| “We found selling products to China, someone has to be trained to run the plant. (With our products) everything is simplified so the person doesn’t have to do an extensive training course to operate and maintain it. This gives us competitive advantage” ( Interview Code #80). | Small wastewater specialist. ASX listed firm [Australian owned] |
| “Often they (Asian clients) want the best high technology which is above their operational skills. Part of our job is to talk them out of it. This gives us export success in the long-run. The reason is because if you are providing things which are over-engineered then you get a bad name” (Interview Code #98). | Large engineering firm (French parent company.) |
| “In many cases, particularly for agency work, the implementation priorities are simplicity, reliability and affordability…. Product innovation is not always relevant but the context always is” (Interview Code #99). | Large engineering firm (German parent company.) |

*Notes*

1. Source: Nadolny (2004)

Importantly, the ability to develop appropriate technology is contingent on designers having a cultural affinity with overseas clients as the following quotes exemplify: “Australian competitive advantage is from having a synergy between users, suppliers, and operators. Also there is a demonstrable feeling for South East Asia – Australians are prepared to listen” (Interview Code 108, Nadolny, 2004). Another quote further reinforces this point: “The nature, individuality, the characteristics of Australians probably suit Asian associates and clients in that we are a bit easier to deal with, little less bombastic perhaps….” ( Interview Code 100, Nadolny, 2004).

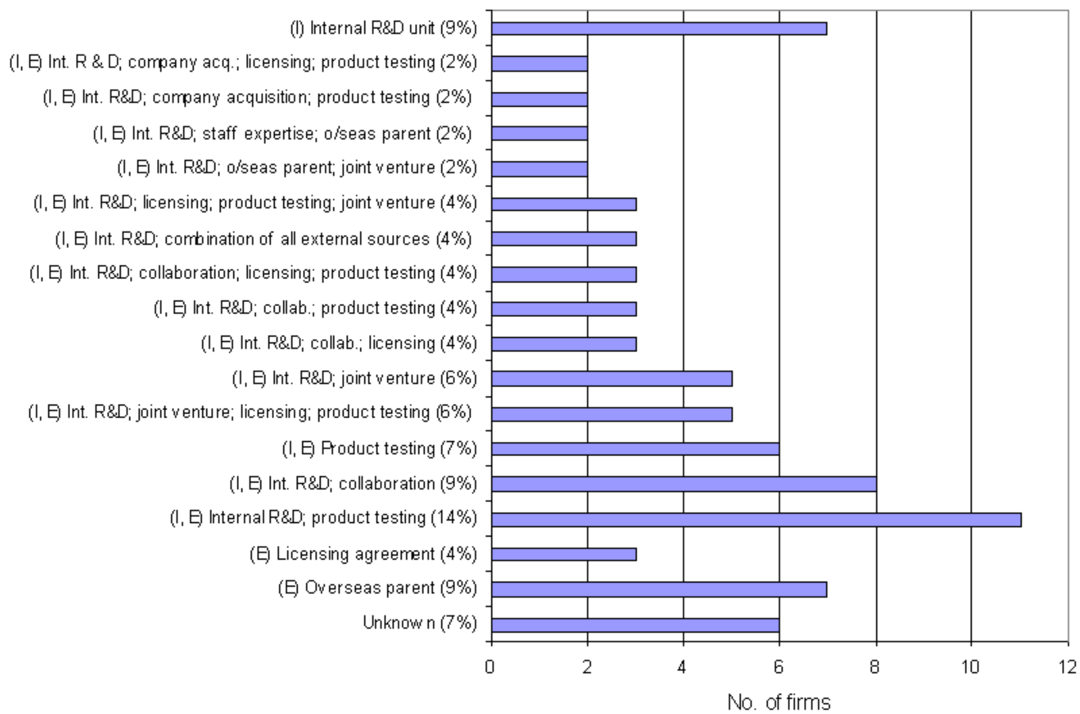
### 3.2.2. Innovation As An Internal And External Process

One problem with relying on innovation proxies such as R&D and patents is that they only detect innovation generated from within the firm. Yet the importance of external sources of innovation for firm-competitiveness is highlighted in the literature (Cornish, 1997; von Hippel, 1988; Oerlemans et al 1998; Pavitt, 1985). Indeed, creation of innovation for firms is a combination of internal and external sources. Internal sources include transformation functions (i.e. R&D and tacit knowledge); external sources include transaction functions (market intelligence) and the influence of the institutional capacity of regions such as public knowledge infrastructure. By using several sources, firms are more likely to gather the necessary knowledge to innovate, rather than relying solely on internal R&D. The lack of internal resources or specific expertise motivates the firm to search for external sources by utilising networks (Freeman and Soete, 1997; Oerlemans et al, 1998).

As Figure 2 shows, only 9% of firms in the sample rely exclusively on internal R&D. The importance of market intelligence feeding back into the innovative process is evident, with 43% listing product testing with leading clients, often in combination with other sources. Inter-firm linkages associated with joint ventures and collaborations also contribute greatly to innovation. The fluid interface between the internal and external environment of the firm is an important space for the creation and diffusion of knowledge. Furthermore, the type of corporate strategy used is often determined by the asymmetry of power networks (Nadolny, 2004).

**Figure 2 Sources Of Knowledge/ Innovation Acquisition For Manufacturing Firms**

**(N = 81) (Exporters And Non-Exporters)**



(I) Internal R&D unit (9%)
(I, E) Int. R & D; company acq.; licensing; product testing (2%)
(I, E) Int. R&D; company acquisition; product testing (2%)
(I, E) Int. R&D; staff expertise; o/seas parent (2%)
(I, E) Int. R&D; o/seas parent; joint venture (2%)
(I, E) Int. R&D; licensing; product testing; joint venture (4%)
(I, E) Int. R&D; combination of all external sources (4%)
(I, E) Int. R&D; collaboration; licensing; product testing (4%)
(I, E) Int. R&D; collab.; product testing (4%)
(I, E) Int. R&D; collab.; licensing (4%)
(I, E) Int. R&D; joint venture (6%)
(I, E) Int. R&D; joint venture; licensing; product testing (6%)
(I, E) Product testing (7%)
(I, E) Int. R&D; collaboration (9%)
(I, E) Internal R&D; product testing (14%)
(E) Licensing agreement (4%)
(E) Overseas parent (9%)
Unknown (7%)
0
2
4
6
8
10
12
No. of firms

*Notes*

(I) Internal source (e.g. in-house staff; internal R&D unit)

(E) External source (e.g. product testing; overseas parent company; licensing agreement; corporate strategy such as joint venture or collaboration)

(I, E) Combination of internal and external sources

Source: Nadolny (2004)

## 4. Conclusion

This paper has argued that a broader concept of innovation offers a better explanation of why exports develop for firms in this medium-technology industry, rather than a simplistic assumption of a direct linear relationship between R&D and patent intensity and export activity. It has been revealed that innovation can be a subtle process, manifesting as appropriate technology and diffusion of ideas from both inside and outside the firm. Arguably, the characteristics of innovation that have been identified in this industry case study would likely be common for other medium and low-technology industries.

These findings have implications for formulating industry policy and for further theoretical development of the concept of innovation. For instance, public research funding and most econometric studies have too much emphasis on quantifiable measures of innovation. Of course for some industries, such as aerospace, electronics and pharmaceuticals, increased R&D spending and more patents would be expected to be directly related to better firm-performance. Yet for other industries, a broader, more qualitative concept of innovation should be used to assess relationships between innovation, productivity and exports. Understanding and measuring innovative activity needs to be considered on an industry by industry basis, using a combination of quantitative and qualitative research methods.

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