The Dynamic Performance of Australian Enterprises*

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Abstract

This paper investigates the interaction of discretionary investments (R&D, capital investment, training and advertising), innovation, productivity and profitability within a dynamic framework of firm performance. A dynamic and closed model of firm performance is set up, and the resulting empirical model is tested as a series of recursive equations, using a four-year balanced panel data set of Australian firms drawn from the *Business Longitudinal Survey*. The results indicate that current economic profit has an important role to play in enabling firms to invest, and the findings indicate which of these investments are complements and which are substitutes. The paper explores the impact of these discretionary investments on innovation and total factor productivity performance. Finally, the impact of past discretionary investments both directly and indirectly (that is, *via* innovation and productivity performance) on current profitability is examined. Past values of these investments have a significant influence on current profit, effectively closing the model. The various results enable the paper to draw a number of other policy conclusions, in particular, some concerns about the potentially negative impact of own-market share on dynamic performance.

1. Introduction

The purpose of this paper is to examine the relationship between the discretionary investments of the firm (which include R&D, advertising, training, and tangible and intangible investments), and the subsequent innovation, productivity and profitability performance of Australian enterprises. The paper develops a dynamic framework, which is then estimated using a four-year balanced panel set drawn from the Australian Bureau of Statistics (ABS) *Business Longitudinal Survey* (*BLS*).[1] Recent developments in the literature suggest that innovation, firm size, market structure, conduct and performance are in fact endogenously determined, in that previous investments in innovations made by firms can increase their sales and in some cases their market share.

This paper not only explores the determinants of the principal discretionary investments of the firm (that is, R&D, advertising expenditures, and investment in tangible and intangible assets), but also their relationship with innovation and their impact on firm performance. In particular, it is argued that these discretionary activities, which are largely funded out of economic profit (Mueller, 1967; Grabowski and Mueller, 1975), are investments in future monopoly power (Cowling and Mueller, 1978 and 1981). Other than price, they are the main mechanisms for achieving the strategic goals of the firm, primarily influencing the perceived or actual quality of the product or service. Thus, insofar as they lead to differential company performance, they have the power to change the structure of the sector in which the firms operate and, thereby, influence future discretionary investments. The following section provides an overview of this relationship.

Section three outlines the empirical framework and estimation technique, starting with a set of discretionary investment equations in which current economic profit appears as a key explanatory variable. These investment equations then form the basis of the innovation equation, which in turn feed into the productivity equation, estimated using a value-added production function. Profit is the last performance outcome to be examined, and the associated empirical specification incorporates past discretionary investments, innovation and total factor productivity (calculated from the value-added equation). Taken together, the set of equations can be viewed as a dynamic system, in which past profit leads to current and future profit. While, ideally, such a system requires more dynamic and

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[1] Also known as the *Growth and Performance Survey*.

simultaneous equations estimation techniques, the need to incorporate lags limits the estimation to a recursive system of equations when using the four-period *BLS* panel. Thus, while the panel nature of the data set is used wherever possible, the need to account for lagged effects means that a small number of the estimates are, in effect, based on cross-sectional information.

Section four describes the *BLS* and outlines the empirical measures of the variables adopted. While there are problems in obtaining a consistent and comprehensive set of measures for all four years of the survey, the *BLS* is almost unique in the range of measures it provides. For example, many studies have focused on the determinants of R&D or the effects of R&D on enterprise performance, but these studies have rarely (if ever) also been able to explore the determinants and role of R&D alongside the other discretionary investments of the firm, such as advertising and training expenditures. Thus the present paper is able to move towards a more comprehensive and strategic empirical model of firm behaviour and firm-market interaction. Section five presents the results, and section six concludes.

2. Dimensions of the relevant literature

Given the range of equations that need to be estimated to obtain an overview of the determinants of the discretionary activities of the firm, and the effects of these discretionary investments on a variety of different measures of enterprise performance, a comprehensive review of the literature clearly cannot be attempted. However, it is important to give some insights about the main strands of the literature, and the main findings that have been reported. The remainder of this section begins with the work focusing on the determinants of discretionary investments, such as R&D, advertising, training, and other investments in tangible and intangible assets. This is followed by an examination of the literature concerned with the determinants of innovation, productivity and profitability.

2.1. Determinants of discretionary investments

When examining the determinants of discretionary investments, the principal focus of economists has been on the determinants of investments in tangible assets and in R&D. The "dynamic" structure-conduct-performance (S-C-P) models were probably the first example of an empirical focus on the determinants of inventive inputs (i.e. R&D

employment or expenditure) or R&D outputs (patents and innovations).[2] The general focus was on the Schumpeterian hypothesis, which was concerned with whether it was the larger more monopolistic companies that were the primary source of technological change (see, for example, Freeman and Soete, 1997, pp. 227-241). A considerable amount of the early empirical work utilised industry-level data, but, more recently, the literature has turned to firm-level data, particularly panel data sets. A fairly recent and detailed review of the whole empirical literature relating to firm-level determinants of R&D intensity can be found in Cohen (1995). In addition, there has been some interest in the relationship between R&D inputs and outputs—in other words the "productivity of the R&D process" (Giliches, 1998). Again, the early interest was particularly concerned with whether the productivity of R&D differed across firm size and market structure (Fisher and Temin, 1973), and this is examined further below, as it is relevant to the innovation and productivity equations. Other empirical studies have focused on particular drivers of R&D, such as various forms of government support, including tax concessions, competitive grants and concessional loans (Bernstein, 1986; Scott, 1993, pp. 203-214). A particularly detailed review of the role and impact of R&D in Australia is provided by the Industry Commission (1995).

A similar literature exists on the determinants of advertising, which arose out of the (two-way) relationship between market structure and advertising (for a review of the early literature, see Devine, *et al*. 1985, pp. 260-3; Sawyer, 1981, pp. 111-8). However, there has also been some interest in the links between R&D, innovation (particularly new product launch) and marketing activity (for a review, see, for example, Freeman and Soete, 1997, pp. 198-226). The Industry Commission (1995, p. 61) noted that if the full economic benefits of R&D were to be realised, then new products must be effectively marketed. This inter-relationship between R&D, innovation and market promotional activities has been a major focus of the management, innovation and new product launch literatures. The first interest in this was perhaps the argument concerning the concept of "technocracy", that in large, monopolistic companies the technocracy drove the rate and direction of technological change, and persuasive advertising was used to ensure that the customers purchased the new goods on offer (Galbraith, 1985). However, technology management researchers, mainly working with case study materials, soon suggested that success in

[2] The static counterparts focused on the determinants of firm profit, which is examined in Section 2.4 below.

innovation was more likely when the R&D was market driven (Anderson and Pine, 1997; Freeman and Soete, 1997; Grupp and Maital, 2001). The flow of information between the marketing and R&D departments was crucial in determining that the R&D (and thereby the new product) was customer-relevant.

The empirical models of investments in tangible assets such as plant and machinery have tended to be more macro-oriented, examining the need for additional capacity to meet expected future demand, as well as the effects of interest rate changes on the capital intensity of production, and thereby the incentive to invest. A considerable part of the focus has not been on the investment decision itself, but on the multiplier and accelerator effects that operated through the supplier industries to influence the growth of the economy as a whole.

In contrast, the investment decision of the firm relies on a number of different factors, including the availability of finance, which, for small firms, is often restricted to internal funding from economic profits and bank borrowing (Giudici and Paleari, 2000; Weinberg, 1994). Even when equity finance is used, it is usually provided by the “principal owner” (Berger and Udell, 1998; Giudici and Paleari, 2000). In terms of investment decisions, most empirical work suggests that the investment decision of small firms is reliant primarily on access to finance, rather than technological and product market opportunities (Weinberg, 1994). Even for large firms, if the investment is particularly risky, there may be some difficulty in raising external capital to finance it, and the ability to do so is directly related to the economic profit of the firm. In addition, factors such as the expected net return, the cost of capital (the weighted average cost of debt and equity finance), operating costs, capacity utilisation, technology and government policy have also been recognised as having a role to play in the determining investment decisions (Grossman, 1977).

Two early studies form an important foundation on which the present work is based. The first of these, by Mueller (1967) recognised that discretionary investments, particularly the more risky ones such as R&D, were largely funded from profit. Even if additional funds were raised, for example, to undertake investments in tangible assets, the extent of the external funding was still driven by the profitability of the company. Thus, Mueller argued that all of the discretionary investments competed to be funded from the profits of the firm. The result is a set of equations, one for each dimension of discretionary activity, where profit is a right hand side variable. The system is not closed because current profit is not dependent on current discretionary investments, but on the past values of such investments. Mueller did not investigate this more dynamic problem, which is an important focus of the present study. Rather than describe the Mueller equations in detail at this point, they are left until Section 3.1, where they are outlined in the context of the set of equations to be used in the current analysis.

The second study, by Grabowski and Mueller (1975) made a further important contribution in distinguishing economic from accounting profit. Economic (as opposed to accounting) profit is a measure of the total surplus generated by firms. Economic profit (π^e) is equal to accounting profit (π^a), plus the discretionary expenditures on R&D (R), advertising (A) and training (T) that are expensed in the firm's accounts, but whose effects impact on subsequent performance. Thus, following Grabowski and Mueller (1975) economic profit is defined as,

$$\pi^e = \pi^a + R + A + T = I + D + Tx + R + A + T$$

where, in addition, I, D and Tx represent retained profit for physical investment, dividend payments and profits tax respectively. All of the variables—with perhaps the exception of Tx, over which the firm has relatively little control—can be thought of as investments in future monopoly power, and drive future economic profit (Cowling and Mueller, 1978).[3] The success of these investments should, in principle, be seen against what would have happened to the firm if it had not made them—the counterfactual. In a traditional discounted cash flow setting, the optimal level of investment in each is where the contribution of the last $1 spent on each is equal to an addition on $1 to the discounted sum of future economic profit.[4] It should be borne in mind, however, that these investments carry some degree of risk, which can affect both the investment decision and the distribution of returns to such activities across companies.

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[3] Dividend payments can be thought of as an indirect method of investing in future monopoly power, as the amount of dividend paid can influence the ease and cost with which the firm raises stock market funding in the future.

[4] In a real options setting, there may be a value in continuing R&D even if discounted future returns are less than current costs. This arises because doing R&D enables the firm to exploit future opportunities that would be closed to a company that does not undertake R&D.

2.2. Innovation

Discussions of discretionary investments invariably lead to the issue of their likely impact on innovative activity (particularly in the case of R&D), which can in turn influence productivity and profit outcomes. Work by Geroski (1994) and Griliches (1998) recognises that while investment in R&D might lead to new innovations within the firm, there exist a vast number of firms that introduce innovations without having recourse to expensed R&D. It may be the case that it is better to simply use another firms' innovations, as there is evidence to suggest that the knowledge embodied in the innovation itself has a larger impact on productivity growth than the knowledge generated from the inputs into the innovation (Geroski, 1994). However, one of the benefits of investing in R&D, training and advertising is that it can improve the likelihood of successful innovation using someone else's idea (Geroski, 1994, p. 124). This is a particularly salient point in light of the observation that (in the UK at least) around 70 *per cent* of innovations produced are first used *outside* the sector that produced them (Geroski, 1994, p. 95). This then has implications for the determinants of productivity and profit growth, as the ability to successfully innovate can impact on the performance of the firm.

There are two main views that have been put forward about the relationship between innovation and performance (Geroski, 1994). The first relates primarily to profit, and argues that if innovation is a product, then the firm will enjoy transitory rents through an improved market position. In extreme cases the new product can create an entirely new market for the firm. In reality, the best-case scenario is one in which the development of a new product or the improvement of an existing one increases firm sales and profitability. The extent to which the firm is also able to command a greater market share will depend on whether the new/improved product is a substitute for rival products, or whether it simply expands the market for all firms. These rents are eroded once other firms in the industry begin mimicking their product, although the innovating firm can use a variety of levers (such as patents, trademarks, licensing and advertising) to extend the period over which the firm earns monopoly rents.

The second view is that if the innovation involves a process change, then productivity gains may be made, insofar as it changes the internal capabilities of the firm. If these lead to lower cost techniques that cannot be replicated by other businesses, this will allow the organisation to lower prices and expand at the expense of its rivals, which may also lead to an increase in profit. Once the firm controls enough of the market, the ability to maintain these efficiency advantages may be reinforced by factors such as economies of scale.[5] Alternatively, such investments may affect the level of barriers to entry by influencing the minimum efficient scale required to profitably enter the industry.

2.3. Productivity

The next step is to determine how discretionary investments and innovation fit into the traditional productivity equation. Productivity is usually defined as labour productivity (Y/L), capital productivity (Y/K) or total factor productivity, TFP,

$$TFP = \frac{Y}{E^{\alpha} K^{\beta}} = \tau$$

where Y is value added, E is a measure of the labour input, K denotes the capital input, τ denotes the "level of technology"[6]; α and β represent the factor shares of labour and capital respectively. As Solow (1956) pointed out in his pioneering study of the US economy, τ is a "catchall" that embodies institutional arrangements, and a wide variety of other factors reflecting managerial and organizational efficiency. Although there is little guidance from theory as to exactly what factors should be included, most empirical work typically includes variables that broadly capture technology (such as innovation), managerial ability (such as high level work practices and human resource management techniques) and organizational characteristics (such as unionisation or the use of part-time employees). The general conclusion of the Solow paper was that only 1/7th of the total output growth could be attributed to the growth in physical inputs of labour and capital, 6/7ths—the so-called residual factor—was left unexplained. Subsequent work by Griliches and Jorgenson (1971) and others "chipped away" at the residual by the use of much less aggregate data that allowed some aspects of the changing quality of inputs to be accounted for, such as the occupation or education level of workers and the age of capital (see, for example, Jorgenson and Fraumeni, 1992).

[5] This "optimal" market share level can differ considerably between industries (see for example, Bhattacharya and Bloch, 2000a, 2000b; Feeny, Harris and Loundes, 2001).

[6] The level of τ is not independent of the units of measurement, but this problem does not affect the rate of change in τ.

A particularly important strand of the literature relates to what is often termed the knowledge production function (Hall and Mairesse, 1995; Mairesse and Sassenou, 1991). Here, some measure of current and past R&D or the stock of R&D knowledge (generally constructed using a perpetual inventory measure) is used to proxy the variables that drive TFP,

$$Y = \tau E^{\alpha} K^{\beta} R_{-1}^{\rho_1} R_{-2}^{\rho_2} R_{-3}^{\rho_3} \ldots X^{\gamma}$$

where R denotes R&D expenditure, and the subscript denotes the year in which it took place; X denotes a vector of other variables, which often include measures of market structure. It can immediately be seen that total factor productivity is viewed as a function of (appropriately weighted) past R&D. These studies, which have generally been estimated using large-scale firm-level panel data sets, have had considerable success in explaining the rate of change in total factor productivity, but, insofar as they focus on the effects of R&D alone, they miss many of the other potential drivers of efficiency change (see for example, the review of longitudinal studies by Bartelsman and Doms, 2000).

2.4. Profitability

Early versions of the profitability literature posited that market structure (barriers to entry, market share, concentration, product differentiation) influenced firm strategy and behaviour (conduct), which in turn determined performance outcomes, in particular, the profitability of the company (Capon, 1996; Scherer and Ross, 1990; Schmalensee, 1989; Shepherd, 1972). These studies were often referred to as "static" structure-conduct-performance models, to differentiate them from their "dynamic" counterparts that focused on the firm's commitment to R&D or its patenting or innovation activity. The present paper is interested in whether the results imply that there is a strong cumulative process, with higher current economic profit leading to higher discretionary investments (i.e. higher R&D), which in turn (through innovation and productivity growth) lead to higher future profits, and so on.

Although a value-added measure of productivity performance is used in the present paper, it is well worth saying a few words about the market valuation function approach because profits are also used as a measure of firm performance. There are strong theoretical linkages between the knowledge production function and the market valuation function empirical literatures (for a discussion of the mathematical linkages see Bosworth and

Ghaneh, 1996). The market valuation functions use the stock market value of the company (that is, the sum of the values of ordinary shares, preference shares and debt) as a forward-looking measure of performance. In particular, the market value reflects the discounted sum of future dividends, which, given a constant retention ratio, also reflects the discounted sum of future profits (Sawyer, 1981, p. 157). While current profit tends to vary more than market value because of short-term influences, the two tend to give quite similar results in firm performance regressions (Murray, 1996).

This market valuation approach has been widely adopted by researchers from different disciplines. Thus, in addition to R&D as a driver of market value, researchers from an HR background have also used high-level work practices (Youndt, *et al.* 1996). Both of these variables, as well as advertising expenditure (Hall, 1993), have been shown to be important in explaining market value. A further useful finding of these studies is that, while the absolute value of the estimated coefficient differs, in practice, it appears to make little difference whether R&D expenditure (a flow variable) or an R&D stock measure is used in the estimation.

3. The empirical framework for innovation, productivity and profitability

A key purpose of this paper is to bring these various strands of research together, and to attempt to model the dynamics that move the firm from past to future profit. There have already been some attempts in the literature to do this—the work by Crépon *et al.* (1998), for example, uses a cross-section of firm level data on French manufacturing firms, to examine the determinants of R&D, and then consider the impact of R&D on innovation, before finally linking innovation to labour productivity. The current paper has several similarities to Crépon *et al.* (1998), but takes the analysis several steps further. First, panel estimation is used, which allows for the explanatory variables to affect the various performance measures with a lag, as well as allowing for unobserved heterogeneity to be accounted for. Second, profitability is included as a performance measure. Thus, the present paper explores both the extent to which discretionary investments in future monopoly power are determined by current economic profit, and also the degree to which such investments improve subsequent firm performance, such as total factor productivity, generating higher future profits.

The initial stage of the empirical work is to estimate a set of discretionary investment equations, including R&D, capital investment, advertising expenditure and training, where each is determined out of current economic profits. The second stage is then to link these investments to innovative output, measured as the probability of introducing new products or services. The third stage is to examine the feedback from these investments into enterprise performance, first in terms of the intermediate measure of value added and then in terms of business profit.

While value added measures take a fairly standard form, in the context of the present study they may give misleading results because of the failure to measure quality changes. Ideally, an appropriate official deflator would deflate each nominal price series in the data, but in practice such deflators do not exist.[7] In effect, at best, one or two deflators would need to be used (such as the CPI) across all of the nominal variables. In addition, official deflators are rarely pure-price deflators that fully purge the changes in price of the changes in the quality of the item under discussion (for a full discussion see Bosworth, *et al.* 2001a and 2001b). There is a real danger, therefore, that, even if detailed deflators existed, they would purge an important element of quality change from the resulting real value estimates. Work with the variables in nominal prices is therefore preferred, realizing that their values will be increased over the duration of the panel by pure-inflation effects. These inflationary effects are accounted for by including time dummies, bearing in mind that this adjustment may also reflect other influences.

3.1. Discretionary Investments

The estimation procedure adopted for the discretionary investment equations is an extension of the original approach of Mueller (1967) in which, in the present instance, five different discretionary investment equations are in principle identified[8], and the original accounting profit is replaced by the economic profit measure preferred by Grabowski and Mueller (1975),

$$R_{it} = f(\pi^e_{it}, A_{it}, T_{it}, TI_{it}, II_{it}, X_{it}, IND_{it})$$
$$TI_{it} = f(\pi^e_{it}, R_{it}, A_{it}, T_{it}, II_{it}, X_{it}, IND_{it})$$

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[7] While official deflators do not exist for all of the variables, a number of unofficial deflators have been developed for certain activities, such as UK R&D (Schott, 1976; Bosworth, 1983).

[8] We return to the issue of the restrictions placed on the estimation by the *BLS* below.

$$II_{it} = f(\pi^e_{it}, R_{it}, A_{it}, T_{it}, TI_{it}, X_{it}, IND_{it})$$
$$A_{it} = f(\pi^e_{it}, R_{it}, T_{it}, TI_{it}, II_{it}, X_{it}, IND_{it})$$
$$T_{it} = f(\pi^e_{it}, R_{it}, A_{it}, TI_{it}, II_{it}, X_{it}, IND_{it})$$

A full definition for each of the variables used in the empirical estimation is given in the Appendix. The idea that underpins this set of equations is that expensed items, such as R&D, advertising and training compete to be funded from economic profit, along with items such as dividend payments. Other types of borrowing cannot generally fund risky discretionary investments of this type (or it's availability is a direct function of current economic profit, π^e). Thus, insofar as one type of expenditure is a substitute for another, other things equal, raising one will reduce the other. However, some forms of expenditure may be complementary, and raising one will involve raising the other. Which of these activities are substitutes and which are complements is an empirical question to be determined by the data.[9]

The present study has information about R&D expenditure (R). Although, during the period under analysis here (1995-1998), there was a change in the tax concession available to firms for expenditure on R&D from 150 to 125 *per cent*, there is not enough information to examine the impact of this tax change on R&D expenditure by Australian firms—limiting this analysis to the inclusion of an indicator (dummy) variable to represent the year the change was introduced. Advertising and other market promotional expenditures are only available for manufacturing for new products launch activities (A), but total advertising expenditure at the divisional industry level is included to control for the advertising activity of the sector. As such, advertising at the firm level is excluded from the full-sample estimates, but is discussed (in the main body of the text) in relation to additional estimations using only manufacturing firms. Training expenditure (T) is only available as an indicator variable for whether or not there have been any changes in expenditure (and therefore sits a little uncomfortably alongside the other variables, measured in levels). Investment is also included, and is defined as capital expenditure in

[9] Although this set of equations appears as though it should be estimated as a system, the panel nature of the data precludes system estimation.

tangible (TI) and intangible (II) assets – the latter relate to extramural expenditures on licences, etc., as opposed to own-R&D.[10]

The set of control variables, X, comprises the effective number of full-time employees, total assets, economic profit, whether the firm is incorporated, whether the firm is a family business, whether the firm exports, the debt to equity ratio, union density, the number of locations the firm has, whether it has a documented business plan, and whether it contracts out work previously done by its own employees. In the earlier work of Mueller (1967) an industry index of R&D intensity was included in his equation on R&D, and its significant positive coefficient was put down to the possibility that it was measuring the firm's response to R&D outlays by its competitors. The inclusion of such an industry "pool" also captures the idea of spillovers from research being done by other firms within industries that are "close" to the firm (Griliches, 1998). For this reason, the industry pool of R&D is measured at the 2-digit level of aggregation in order to include the general knowledge available to firms that may be outside their own immediate market. The other industry variables, IND, are industry advertising expenditure divided by industry income, the four firm concentration ratio, market share and a set of industry dummies. As it is common for firms to operate in more than one industry, especially at the 4-digit level, it would be ideal to also include a variable to capture diversification. Unfortunately, this was not possible with the present data, although the use of the panel should net out this "unobserved" heterogeneity.

Each of the dependent variables in the equations, in principle at least, has two dimensions: a 0,1 component, which, relates to the probability that the firm will undertake discretionary investments, and a continuous part, showing how much firms spend on their investments. As there are a significant number of firms reporting zero for the dependent variable—causing the data to be "left censored"—a Tobit model is adopted and extended to incorporate the panel nature of the information (see Kennedy, 1996, p. 239 for more information on this type of model).

[10] There are, however, no separate data on dividend payments, these are subsumed under "other operating expenses", alongside a number of other items.

3.2. Innovation

Measuring the innovative process for use in empirical work has always been an issue for applied researchers (see Geroski, 1994, for a review of the various innovation measures, and papers reviewed in Rogers, 1998). Innovation counts would be an ideal measure (Geroski, 1994), but is unfortunately is not available from the *BLS*. The only measure available is a dummy variable that measures whether or not a business introduced any new or improved products or services, and for non-manufacturing businesses, whether new or improved procedures for the supply of services were introduced. Therefore, unless otherwise stated, "innovation" in the empirical analysis refers to the introduction of a new product or service. The following represents the innovation equation:

$$Inn_{it} = f(\pi^{e}_{it}, R_{it-n}, T_{it-n}, I_{it-n}, X_{it}, IND_{it})$$

where π^e is economic profit, and R&D (*R*), tangible investment (*T*) and intangible investment (*I*) are included with a lag. The control variables, *X*, and the industry variables, *IND*, are the same as those for the discretionary investment equations.

3.3. Productivity

An important issue that arises in estimating productivity equations is the assumption about the functional form adopted. In the definition of total factor productivity in Section 2.3, if constant returns to scale are assumed, then α and β will sum to 1. In this case, α and β can be constructed from the labour and capital shares of total expenses. However, this is a relatively strong assumption to adopt because the technology in use may not be characterised by constant returns to scale. To account for this possibility, the data is allowed to determine returns to scale by estimating the value added function as follows:

$$V_{it} = g(\tau, E_{it}, K_{it}, X_{it}, IND_{it}, Z_{it}, Z_{it-1}, \ldots, v_i, \varepsilon_{it})$$

where: *V* is value added, τ is a technology constant, *Z* represents discretionary investments and innovation, *E* is labour, *K* is capital, *X* are the firm characteristics and *IND* are the industry characteristics. The error terms are denoted by v and ε, where v_i represents the random disturbance characterising the *i*th firm and is constant through time. The functional form is log-linear (Cobb-Douglas). The labour input measure is the effective number of full-time employees, which is calculated as the sum of full-time employees plus 0.426*the number of part-time employees.[11] Labour utilisation (that is, hours of work per employee) would be a more ideal measure of labour input into the production process, but this information is not available from the BLS. However, in the absence of an hours of work *per* employee variable, it is still possible to make adjustment for the length of working period by constructing an hours per week variable from the hours per day and days per week information collected in the BLS. The capital stock measure, *K*, is based on the book value of assets. This variable is available separately for "plant machinery and equipment" and "other"[12]. One of the issues surrounding the use of the book value of assets is that the rate of depreciation applied is typically an over-estimate of the true rate, leading to an underestimate of the capital stock. In order to adjust for this problem, the age of the firm is also included as an explanatory variable.

3.4. Profit

The next issue we turn to concerns the most appropriate measure of profit. Large companies tend to generate higher dollar amounts of profit. For this reason, rates of return on assets or equity (that is, profit divided by total value of assets or equity) and price-cost margins are commonly used in research on profitability. The approach adopted here however is to include size variables on the right-hand side of the equation and to work with the level of economic profit, as this is considered more flexible than working with a rate with no scale effect on the right hand side.

The profitability performance for businesses in the full sample is estimated using the following equation:

$$\pi_{it}^{e} = h(TFP_{it}, K_{it}, Z_{it}, X_{it}, IND_{it}, v_{it}, \varepsilon_{it})$$

where π_{it}^{e} is the level of economic profit, TFP is total factor productivity calculated from the results of the value-added estimation, and all other variables are the same as that in the productivity equation.

[11] The value 0.426, used to scale the number of part-time employees to full-time equivalents, is calculated as the ratio of average hours worked by part time employees to the average hours worked by full-time employees, using data from the ABS *Labour Force Survey*.

[12] "Other" comprises property (land and buildings), capitalised interest and goodwill (ABS, 1997-98 questionnaire, question 49).

4. The Business Longitudinal Survey

Table 1 presents variable definitions and descriptive statistics for the variables to be used in the estimation. The sample used for the present study is the Australian Bureau of Statistics (ABS) *Business Longitudinal Survey* (*BLS*), which uses the ABS Business Register to provide a population frame.[13] 13,276 individual "live" business units[14] have been surveyed in the four years between 1994-95 and 1997-98. The balanced panel is formed from the 4,231 business units surveyed in all four years, although the number of usable responses is lower at 3569. The present analysis is based on the confidentialised unit record file provided by the ABS for public use. Several restrictions are placed on this database to maintain confidentiality (i.e. it excludes firms with 200 or more employees and those under foreign ownership). Each business unit is allocated to a two-digit ANSZIC industry code based on it's principle product or service, which allows for the control of sectoral differences across business units. Finance firms are removed from the analysis as profit for these firms is typically based on interest earned on financial assets, which tends to distort the aggregate pooled results (for more detail on how the *BLS* is constructed and the issues surrounding its use, see Will and Wilson, 2001).

Table 1: Variable Definitions and Descriptive Statistics, pooled data, 1994/95 – 1997/98 (n=8708)

Variable	Type	Mean
Discretionary investments		
Undertakes R&D (1=yes)	0,1	0.13
R&D intensity/total income	*Per cent*	0.58
Undertakes marketing of new products (1=yes)[a]	0,1	0.07
Marketing expenditure on new products/total income	*Per cent*	0.06
Undertakes tangible investment (1=yes)	0,1	0.62
Investment in tangibles/total income	*Per cent*	11.04
Undertakes intangible investment (1=yes)	0,1	0.13

[13] Business units that are excluded from the survey are those that have not registered as group employers with the Australian Taxation Office and all Government enterprises. They also include businesses classified to the following sectors: agriculture, forestry and fishing; electricity, gas and water supply; communication services; government administration and defence; education; health and community services; other services; private households employing staff; libraries; museums; parks and gardens.

[14] The business unit (also termed "management unit") is the "highest level accounting unit within a business, having regard for industry homogeneity, for which detailed accounts are maintained; in nearly all cases it coincides with the legal entity owning the business. … In the case of larger diversified businesses, however, there may be more than one management unit, each coinciding with a 'division' or 'line of business'." (ABS, December 1999, p. 3)

Variable	Type	Mean
Investment in intangibles/total income	*Per cent*	0.76
Increased training (1=yes)	0,1	0.14
Decreased training (1=yes)	0,1	0.01
Innovation		
Developed or introduced any new or substantially changed product or service (1=yes)	0,1	0.28
Productivity		
Value added	$000	1967
Profitability		
Economic profit	$000	1282
Firm characteristics		
Effective number of full-time employees	Number	27
Hours per week	Number	58
Capital stock	$000	2905
Age of firm	Years	15
Incorporated or unincorporated business (1=incorporated)	0,1	0.69
Family or non-family business (1=family)	0,1	0.55
Exporter (1=yes)	0,1	0.02
Debt to equity ratio	Ratio	18.11
Union density	*Per cent*	8.57
Number of business locations	Number	1.75
Compares itself to other business (1=yes)	0,1	0.29
Has a documented business plan (1=yes)	0,1	0.36
Contracts out work previously done by own employees (1=yes)	0,1	0.07
Industry characteristics		
Market share (income/industry income)[b]	*Per cent*	0.00
Four firm concentration ratio[b]	*Per cent*	24.84
Industry advertising expenditure/industry income[b]	*Per cent*	0.05
Industry R&D expenditure/industry income[b]	*Per cent*	0.05
Mining	0,1	0.01
Manufacturing	0,1	0.42
Construction	0,1	0.06
Wholesale trade	0,1	0.17
Retail trade	0,1	0.11
Accommodation, cafes, restaurants	0,1	0.04
Transport and storage	0,1	0.04
Property and business services	0,1	0.13
Cultural and recreational services	0,1	0.02
Personal and other services	0,1	0.02

a. Available for manufacturing firms only

b. The four firm concentration ratio and industry income are calculated from unpublished Australian Tax Office data; the consumer price index is from the ABS *Consumer Price Index, Australia,* Cat. No. 6401.0; industry advertising expenditure is unpublished ABS data from *Australian National Accounts: Input-Output Tables (Product Details)*, Cat. No. 5215.0; industry R&D expenditure is unpublished ABS data from *Research and Experimental Development, Businesses, Australia,* Cat. No. 8104.0.

5. Results

Given that the *BLS* is a sample of a larger population, the preferred estimation method for the discretionary investment equations is the random effects approach (Kennedy, 1996, p. 222). The primary practical consideration for adopting this approach (at least for the discretionary investment and innovation equations) is that it is computationally difficult to condition the fixed effects out of the likelihood for a panel tobit or probit. The main drawback of the random effects approach is that it assumes that the error associated with each cross section unit is uncorrelated with the other regressors. Before progressing, it is worth mentioning several issues surrounding the types of estimation techniques adopted here. For both the tobit and the probit estimations (the discretionary investment equations and the innovation equation), the resultant coefficients cannot be interpreted as the marginal effect of a change in the explanatory variable on the mean (or expected value) of the dependent variable (Griffiths, *et al*. 1993, p. 742). Although it is often useful to report marginal effects, this is not going to be particularly helpful with the panel information here. To compute marginal effects, we typically evaluate at sample means. However, with panel data, it is not clear whether the mean for an individual firm over time or the mean of all firms should be used to compute marginal effects. Thus, for discretionary investments and the innovation equation, the direction and significance of the outcome is discussed, but not the magnitude.

As mentioned earlier, expenditure on the marketing of new products is only available for manufacturing firms, and thus do not appear in the full set of results. Additional estimations were conducted on a manufacturing sub-sample to allow for the inclusion of advertising as a discretionary investment, and are discussed in the text.

5.1. Discretionary investments

Table 2 presents the results of the estimations for R&D, tangible investment, intangible investment and an increase in training. Industry dummies were not included in this estimation, as it was thought that their inclusion would swamp any impact of the other industry level variables, that is market share, concentration ratio, industry advertising and industry R&D.[15] Before discussing the individual regressions, the main feature of the

[15] Preliminary analysis indicated that this was indeed the case, although it had no significant impact on the firm-level variables. As this was thought that there was some degree of collinearity between the industry dummies and industry characteristics, it was decided to exclude the industry dummies.

results is that higher levels of economic profit result in higher levels of all the discretionary investments. As noted in the description of the *Business Longitudinal Survey*, the firms covered by this data set are primarily small to medium enterprises. As discussed earlier, small to medium firms tend to have to rely largely on internal sources of financing or bank borrowing for investment purposes, and the significant results found for the economic profit measure reinforce this view.

In terms of which discretionary investments are complements and substitutes, the results suggest that R&D and increased training are complementary investments, indicating that firms recognise the need for improved workforce skills if R&D is going to pay off. Although not reported in Table 2, these regressions were also estimated for just manufacturing firms, thereby allowing the inclusion of advertising expenditure. These results indicate that advertising is complementary to R&D expenditure, supporting the view that firms will not tend to undertake R&D if they are not also willing to invest in marketing the final product arising from this expenditure. Advertising is also complementary to an increase in training. Intangible investments, such as the payment for licence rights, might act as a substitute or stimulation to own-R&D. In practice, the results suggest that, intangible asset investment competes with R&D and tangible assets to be funded from economic profit (although the coefficient on R&D is only approaching significance at the 10 *per cent* level).

Previous analysis of Australian data suggests that firms operating in more highly concentrated industries tend to spend less on R&D (Rogers, 2000). An important finding of the present study is that, while the market concentration ratio does not appear to play a significant part in determining R&D or investment in tangible assets, there is a clear indication that businesses with higher market share within a given market are less likely to devote resources to discretionary investments. However, there is some indication that concentration is an important factor determining whether firms invest in intangible assets, suggesting that the purchase of items such as patents, licences, computer software and goodwill is a strategic investment for firms operating in concentrated industries. Nevertheless, the result remains that the firms with greater market share in more concentrated industries are significantly less likely to invest in intangible assets. The results here are consistent with a “leap-frogging” of companies, for example, if lower levels of own-market share result in higher R&D, which improves future monopoly power, this will, in turn lead to lower future levels of R&D.

While the spillover literature (Griliches, 1992 and 1995) suggests that firms do not take into account the effect of their own-R&D on the aggregate outcome of all firms (hence, R&D is associated with externalities), it does suggest that the firm takes into account the general pool of knowledge (as a given) when taking its R&D decision. This view is supported by the present estimates, which show that the industry pool of R&D has a significant effect on own-R&D expenditures, as well as intangible investments. In other words, while each firm is not able to significantly affect the pool, they take into account the size of the pool in their own investment decisions, and a larger pool raises the returns to own-R&D. In contrast, industry advertising expenditure has a significant negative effect on own-R&D. This could be indicative of greater competitiveness within the industry, where it may be better *not* to be first in with new ideas, but rather wait and utilise ideas other firms in the industry have developed.

Business ownership appears to play an important role. In particular, family owned businesses are more likely to invest in tangible assets (i.e. plant, equipment, land and buildings), but this form of ownership is not significantly related to other forms of investment expenditure. Tangible assets are perhaps the least risky form of investment and the type for which external funding is most easily obtained, especially in the case of relatively small businesses. Incorporated firms are more likely to invest in R&D. Again, it is probable that external sources of funding may be more readily available for these companies and, in addition, such investments do not carry as much risk for these firms as compared to their unincorporated counterparts, as one of the features of incorporated firms is that they have limited liability.

A number of other factors can be seen to have varying degrees of association with discretionary investments. In particular, exporters are more likely to devote resources to R&D than are those who only service the domestic market, although this does not appear to influence the decisions to undertake other forms of discretionary investment. The rate of unionisation does not seem to have a particularly important influence on investment decisions, with the exception of investment in intangible assets. Businesses with multiple workplaces are more likely to invest in intangible assets than single workplace organizations. This may be a reflection of intra-firm licensing and other transfer activities, although it is perhaps more likely simply the result of that different workplace units have a need for different forms of intangible assets, raising the probability that they will reply positively to this question. In contrast, multiple workplace businesses are less likely to invest in R&D.

Businesses with a documented business plan are more likely to undertake discretionary investment expenditures in R&D, intangible assets and increased levels of training than those without such a plan. This implies that these types of investments are less likely to be undertaken on an *ad hoc* basis, and more likely to be part of an overall strategy for the firm. It almost certainly also reflects the fact that retention of economic profits for such investments, rather than payment in the form of dividends, needs to be justified to shareholders.[16] In relation to training, businesses that compare themselves to other firms are more likely to have reported an increase in training. Businesses that have contracted out work previously done by their own employees are also more likely to have increased training. It is likely that the move to contract out certain activities is part of a broader strategy to concentrate on areas of key competencies, part of which would include improving the skill levels of the existing employees. Similar results were found for advertising expenditures of manufacturing firms—those that compared themselves to other firms, and those who had contracted out work were also more likely to report investment in advertising.

[16] Indeed, the level and mix of such investments might need justifying to all stakeholders in the company, including the workforce, buyers and suppliers, etc.

Table 2: Determinants of discretionary investments

	R&D (Panel tobit)		Tangible investment (Tobit)[(a)]		Intangible investment (Panel tobit)		Increased training (Panel probit)	
	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error
Constant	-0.642	(0.052)***	-11.988	(1.055)***	-0.764	(0.071)***	-1.872	(0.381)***
R&D	-	-	-0.275	(1.242)	-0.145	(0.114)	0.863	(0.578)
Tangible investment	-0.007	(0.009)	-	-	-0.002	(0.001)**	-0.004	(0.012)
Intangible investment	-0.084	(0.052)	0.214	(0.734)	-	-	0.277	(0.326)
Increase training	0.020	(0.005)***	0.189	(0.183)	0.014	(0.009)*	-	-
Log employees	0.007	(0.005)	-0.248	(0.092)***	-0.040	(0.006)***	0.215	(0.036)***
Log profit	0.034	(0.003)***	1.196	(0.062)***	0.058	(0.004)***	0.029	(0.022)
Incorporated	0.058	(0.008)***	0.160	(0.141)	0.014	(0.011)	0.019	(0.055)
Family business	0.005	(0.007)	0.531	(0.131)***	0.012	(0.011)	-0.004	(0.050)
Exports	0.026	(0.011)***	0.293	(0.465)	0.020	(0.023)	0.081	(0.161)
Debt to equity ratio	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Union density	0.000	(0.000)	-0.002	(0.003)	-0.001	(0.000)***	-0.001	(0.001)
Number of locations	-0.003	(0.001)***	-0.008	(0.023)	0.005	(0.002)***	-0.007	(0.008)
Compares with other businesses	-0.003	(0.005)	0.057	(0.143)	0.003	(0.008)	0.269	(0.048)***
Business plan	0.019	(0.005)***	-0.102	(0.142)	0.018	(0.008)**	0.239	(0.048)***
Contract out work	0.008	(0.007)	-0.102	(0.240)	-0.001	(0.013)	0.315	(0.077)***
Log market share	-0.017	(0.002)***	-0.190	(0.050)***	-0.018	(0.003)***	-0.005	(0.018)
Concentration ratio	0.018	(0.018)	0.741	(0.412)*	0.079	(0.027)***	0.022	(0.150)
Log industry advertising expenditure	-0.003	(0.001)***	-0.008	(0.013)	0.001	(0.001)	0.005	(0.005)
Log R&D pool	0.007	(0.001)***	0.009	(0.021)	0.005	(0.002)***	0.003	(0.008)
Year dummies	Yes		Yes		Yes		Yes	
σ_μ	0.102	(0.003)***	-		0.169	(0.007)***	0.598	(0.040)***
σ_ε	0.072	(0.002)***	-		0.120	(0.003)***		
ρ (fraction of variance due to μ_i)	0.670	(0.017)***	-		0.663	(0.019)***	0.263	(0.026)***
Number of observations	8708		8708		8708		8708	
Groups	2177		-		2177		2177	
Wald χ^2	423.71***		672.72***		289.07***		568.96***	
Log likelihood	-945.84		-18307.47		-1679.31		-3075.94	

***, ** and * denotes significance at the 1 *per cent*, 5 *per cent* and 10 *per cent* level of significance respectively in a two-tailed test.

a. Tangible investment was estimated as a standard tobit as initial analysis indicated that ρ was not significantly different from zero, i.e. there are no individual effects. As such, the Wald test is the LR test for tangible investment.

5.2. Innovation

Table 3 demonstrates that the probability of a business introducing a new product or service is improved by several factors.[17] The earlier discussion regarding the impact of discretionary investments on innovation suggested that investing in R&D might result in inventions that lead to innovations within the firm. In addition, however, the indirect benefit of investing in R&D, training, etc. is that it may increase the chance to innovate successfully using someone else's idea. While it is not possible to distinguish between the direct and indirect effects of R&D, the results in Table 3 support show a significant positive impact of R&D in the previous year on current innovation (that is, past R&D is a prelude to the release of a new product or service). The industry pool of R&D also has a significant positive influence on the probability of innovating, again supporting the role played by spillover effects suggested by the earlier literature. Increased training in the previous year also increases the likelihood that a new product or service will be introduced (alternatively, it might be argued that the expectation that innovation will take place leads the firm to undertake additional training of its workforce). Again, while not reported here, the innovation equation was also estimated only on manufacturing firms to allow for the inclusion of advertising, and shows that advertising expenditure in the previous year is indeed significantly related to the probability of introducing a new product or service.

The chance of innovating appears to increase with firm size (as measured by the number of employees), in contrast to Rogers (2000), who found no statistically significant relationship between employment and innovation. There may be several reasons for the difference in the results. First, his analysis was on a cross-section of businesses, rather than the panel estimation method used here. Second, the estimation was undertaken on four different employment groupings, which may have masked the overall effect of employment differences.

The Schumpeterian hypothesis is generally interpreted as suggesting that larger firms with greater market power are more likely to innovate than smaller firms with lower market power. It is clear from our initial results that the probability of innovating increases significantly with firm size, but the Schumpeterian hypothesis requires information about

[17] Again, for reasons outlined in the discussion on discretionary investments, industry dummies were not included.

whether the probability increases more than proportionately or less than proportionately with size. The inclusion of the square of employment indicates that there is a limit to the size effect, in that the probability of innovating increases at a decreasing rate with firm size. With regard to market share, the results suggest that higher shares are significantly negatively related to the probability of innovation (the concentration ratio for the market is not significant). Again, we believe this is an important result, which, in the case of Australian companies appears to run counter to the majority of empirical work on market share and innovation (Blundell *et al*. 1999). However, the result is consistent with the earlier findings with regard to its influence on R&D expenditure and, thereby, the links between R&D and innovation.

Table 3: Determinants of innovation (panel probit)

	Coefficients	Standard Error
Constant	-2.753	(0.408)***
$R\&D_{t-1}$	5.186	(0.738)***
Tangible $investment_{t-1}$	0.003	(0.004)
Intangible $investment_{t-1}$	0.279	(0.303)
Increased $training_{t-1}$	0.270	(0.067)***
Employees	0.538	(0.102)***
$Employees^2$	-0.054	(0.019)***
Incorporated	0.127	(0.063)**
Family business	0.056	(0.057)
Exports	-0.021	(0.178)
Debt to equity ratio	0.000	(0.000)*
Union density	-0.005	(0.001)***
Number of locations	0.010	(0.010)
Compares with other businesses	0.160	(0.054)***
Business plan	0.387	(0.052)***
Contract out work	0.207	(0.089)***
Market share	-0.056	(0.020)***
Concentration ratio	0.174	(0.171)
R&D pool	0.017	(0.009)*
Year dummies	Yes	
Number of observations	6531	
Groups	2177	
Log likelihood	-3385.5	
Wald χ^2	329.07*	
ρ	0.421	(0.024)

***, ** and * denotes significance at the 1 *per cent*, 5 *per cent* and 10 *per cent* level of significance respectively in a two-tailed test.

Incorporated businesses have a higher probability of innovation. Again, this may stem from their improved ability to undertake “risky” investments in the first instance, which allows them to then move onto the next stage of realising the benefits of these investments. Similarly to the results on training and advertising, having a formal business plan and contracting out work previously done by their own employees improves the likelihood that firms will innovate. Again, the same reasoning could be applied—such firms have a strategy that they are working to in order to improve their performance, part of which includes the introduction of new products or services. Such a strategy also seems to take into account what other firms are doing, as comparing the business to other businesses is also significantly associated with innovation.

The debt to equity ratio is positively (albeit weakly) associated with innovating, indicating that liquidity may have some role to play in determining innovative activity. That is, owners equity and internally generated funds are important sources of finance for the initial stage of development (that, is, discretionary investments) but once the product is closer to the final stage, debt-financing becomes a more important method of launching the new product or service. In their analysis of the financing needs of Italian technology based small firms, Giudici and Paleari (2000, p. 39) illustrate that the financial needs of the firm are considerably different during the various stages of the lifecycle of an innovative product. Once the firm has reached the point of introducing a new product onto the market, the amount of finance required is at its peak, thus compelling the firm to resort to outside financing.

Although the rate of unionisation does not appear to have a significant influence on the level of discretionary investments, it does seem to hinder the chances of being innovative. Taken at face value, the present results suggest that Australian unions may operate restrictive work practices that detract from innovation activity.

5.3. Productivity

The results in Table 4 indicate value added increases with factor inputs, although, just looking at the tangible inputs of physical assets and employment (including hours *per* week), it appears that there are decreasing returns to scale. There are at least two explanations for this. First, there is the issue of that the book value of assets is likely to mismeasure the true capital stock, because of the depreciation rate adopted in accounting practice. The second is that the stock of intangible assets also contributes to value added. In this second line of argument, it should be remembered that inputs can affect both the volume of output and the price at which the product or service sells (and the value added function moves away from the purely technical relationship that underlies traditional production theory).

With regard to the issues of the mismeasurement of the physical capital stock, the age of the business was included as an explanatory variable to capture the difference in the depreciation of the book value of the assets compared to the true value of the services provided by the capital stock (Tseng and Wooden, 2001). Similarly to Tseng and Wooden (2001), age was positively related to value added. While this may be attributed to the underestimation of the capital stock, it may also be the result of learning effects (i.e. productivity improving with experience).[18]

Past R&D and investments in intangible assets will contribute to this stock, and earlier studies have suggested that these flows can be taken as approximately proportional to the stock, although (for the reasons stated in the footnote to the previous paragraph) the coefficients on the flows are proportionately larger than the corresponding stocks. It is therefore prudent to also look to the contribution of these variables to value added. Expenditure on R&D in the previous year and an increase in training in the previous year are both positively (albeit not significantly) related to value added, while the contribution of investments in intangible assets is both positive and significant, although its effect takes somewhat longer. In the absence of a longer time series to the panel data set, it is not possible to be certain, but it looks likely that the sum of the returns to labour and all capital (tangible and intangible) will be much closer to unity.

We include advertising expenditure where it is available (i.e. revised results for the manufacturing sector). It is not clear that advertising should be present in a production function that describes a purely technological relationship, but it may have an impact on differential firm prices and therefore impact on our measure of value added. In practice, the results (not reported in Table 4) show no significant impact of advertising on value-added, even when experimenting with various lags. This finding is consistent with the results of

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[18] The reason for suggesting this second explanation lies in the fact that the over-estimation of the depreciation rate in accounting practice will tend to under-state the true physical capital stock. As the book value is likely to be smaller, but closely correlated with the true value, this suggests that the associated coefficient estimate will be greater than the coefficient that would be obtained on the true value of physical capital.

cigarette and food advertising (Duffy, 1996 and 1999), that one firm's advertising off-sets that of its competitors, but may impact on the total size of the market for the product.

Table 4: Determinants of value added (random effects)

	Coefficients	Standard Error
Constant	7.213	(0.320)***
Employees	0.364	(0.023)***
Capital stock	0.317	(0.013)***
$R\&D_{t-1}$	0.645	(0.535)
Tangible investment_{t-1}	0.001	(0.002)
Intangible investment_{t-2}	0.313	(0.149)**
Increased training_{t-1}	0.038	(0.030)
Innovation_{t-1}	0.041	(0.024)*
Interaction $(R\&D \text{ \& innovation})_{t-1}$	-0.368	(0.584)
Hours per week	0.047	(0.039)
Age of firm	0.029	(0.016)*
Incorporated	-0.001	(0.034)
Family business	-0.208	(0.031)***
Exports	0.119	(0.107)
Union density	0.001	(0.001)*
Number of locations	-0.003	(0.006)
Compares with other businesses	0.031	(0.027)
Business plan	0.093	(0.027)***
Contract out work	0.090	(0.063)
Market share	0.258	(0.012)***
Concentration ratio	-1.198	(0.101)***
Industry dummies	Yes	
Year dummies	Yes	
σ_μ	0.564	
σ_ε	0.500	
ρ (fraction of variance due to μ_i)	0.560	
Number of observations	4354	
Groups	2177	
Wald χ^2	10799.87*	

***, ** and * denotes significance at the 1 *per cent*, 5 *per cent* and 10 *per cent* level of significance respectively in a two-tailed test.

The earlier discussion of the role of innovation for productivity suggested that process innovation was the most likely method by which innovation can affect total factor productivity. However, the results in Table 4 suggest that the introduction of a new product or service in the previous year also has a part to play. Part of the explanation may lie in the fact that, in order to introduce this new innovation, there may have had to be some changes to processes within the firm, which were productivity enhancing. A more likely explanation, however, is that the product or service innovation has allowed the company to raise the price of its product vis-a-vis that of its competitors, which will be reflected in its value added.

The effects of concentration are again interesting. The coefficient on industry concentration (as measured by the 4-firm concentration ratio) is significantly negative and the corresponding coefficient on the firm's own share of the market is significantly positive. While the own-share result might be interpreted as showing that larger market share is positively and significantly related to the firm's productivity, it is more likely that it is an indication that firms with greater market power can raise their price and, hence, other things equal have higher value added (and total factor productivity). The latter argument is also consistent with the negative coefficient on the industry concentration ratio, indicting that for a given own-market share, the greater the degree of concentration in the industry the lower the monopoly power of the firm and the lower the price it can charge in the market.

The unionisation rate is positively related to value added (and, thereby, to total factor productivity), a result that is also found in Loundes (1999) and Wooden (2000). Several hypotheses may explain this result.[19] In particular, a higher degree of unionisation may make it easier for workplaces to disseminate information about the productivity enhancing workplace changes that are to be implemented. Additionally, negotiating with unions about implementing these changes may be easier than trying to convince unrepresented groups of employees. This suggests evidence of a "union voice" effect, whereby unions give employees a "voice" at the workplace, thereby reducing absenteeism and quits, which may in turn improve productivity (see Freeman and Medoff, 1984 for a more detailed examination of this issue). Finally, it is worth contrasting the productivity result, where the union effect is significant positive, with the innovation result, where the corresponding coefficient is significant negative. This suggests, at least, that unions might be more uncertain about the implications of product as opposed to process change.

There is some evidence that the various time lags involved in the impact of discretionary investments, innovation, etc. are both recognised and factored into an overall strategy. Having a business plan is important for discretionary investments (including intangible assets) and is also significantly positive in terms of value added and total factor productivity.

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[19] Given the present results relate to the level, rather than the rate of change in total factor productivity, it is not possible to say whether highly unionised firms are playing "catch-up" to their less unionised counterparts (see for example, Blanchflower and Machin, 1996 and Nickell *et al,* 1992).

With regard to the effects of ownership, the coefficient on whether or not the firm was a family owned business was negative and significant, which, according to Tseng and Wooden (2001) may reflect the observation that in such businesses, family members are counted as employees yet have little involvement with the operation of the business. It may also reflect the different aims of the firm, whereby family owned enterprises follow non-profit goals, such as lower effort and/or increased leisure time (Bosworth and Jacobs, 1989).

5.4. Profitability

This final section now closes the model, by exploring the determinants of current economic profits that will themselves form the basis for funding current discretionary investments. The inclusion of the capital stock variable can now be viewed in the light of the market valuation models, where we have proxied the discounted sum of future profits by the current profit. Table 5 shows that the coefficient on the capital stock variable is positive and significant, reflecting the observation that the surplus generated by firms is directly related to their ability to effectively utilise their capital stock.

Having controlled for the size of the current capital stock, higher levels of tangible investment (that is, expenditure on plant, equipment, land and buildings) in the previous year appears to have (an approaching significant) negative impact on profitability. Experimentation with other lags indicated that investment in earlier years was positively (although not significantly) related to profit, suggesting that such expenses may result in lower reported profitability in the short-term, with the primary benefits coming over a more extended period of time. Taking a somewhat controversial line, the findings with regard to tangible assets are consistent with Ruthven's (1994) view that the main source of firm performance is their intangible assets and that tangibles should be set to a minimum. Ruthven suggests not only concentrating on core competencies and sub-contracting all work outside such areas, but also hiring rather than buying costly physical capital, wherever economic to do so. Some further evidence is presented by the contracting-out variable. Contracting out work previously done by their own employees also appears to help the bottom line (although the significance is relatively weak). However, whether this is the result of pure cost-cutting or because it has allowed the firm to concentrate on its core business could be a matter of some debate. Nevertheless, the observation that contracting out also has an impact on the likelihood of innovation suggests that the latter might be a more appropriate explanation.

The results give further support for this view because of the strong role played by various measures related to intangible assets. In particular, Table 5 shows that R&D expenditure in the previous year and a reported increase in training in the previous year both have a positive and significant impact on profitability. In addition, expenditure on items such as patenting, licensing and goodwill also have a major positive influence on profitability, although this occurs in the second year after their purchase. Similarly to the value-added results, the results from the estimation using the sample of manufacturing businesses show that advertising expenditure does not have a significant impact on profitability.

Table 5: Determinants of profitability (random effects)

	Coefficients	Standard Error
Constant	4.970	(0.272)***
Log capital stock	0.536	(0.012)***
Log total factor productivity$_{t-1}$	0.228	(0.016)***
R&D$_{t-1}$	1.580	(0.597)***
Tangible investment$_{t-1}$	-0.003	(0.002)
Intangible investment$_{t-2}$	0.607	(0.163)***
Increased training$_{t-1}$	0.073	(0.033)**
Innovation$_{t-1}$	0.030	(0.027)
Interaction (R&D & innovation)$_{t-1}$	0.230	(0.672)
Debt to equity ratio	0.000	(0.000)
Incorporated	-0.155	(0.034)***
Family business	-0.157	(0.031)***
Exports	0.015	(0.119)
Union density	0.002	(0.001)**
Number of locations	-0.006	(0.006)
Compares with other businesses	0.021	(0.030)
Business plan	0.100	(0.029)***
Contract out work	0.136	(0.063)**
Log market share	0.228	(0.011)***
Concentration ratio	-0.879	(0.103)***
Industry dummies	Yes	
Year dummies	Yes	
σ_μ	0.476	
σ_ε	0.550	
ρ (fraction of variance due to μ_i)	0.428	
Number of observations	4354	
Groups	2177	
Wald χ^2	11042.73*	

***, ** and * denotes significance at the 1 *per cent*, 5 *per cent* and 10 *per cent* level of significance respectively in a two-tailed test.

As might be expected, total factor productivity in the previous year has a positive and significant effect on current profit. Thus, more efficient firms or those able to charge higher prices for their output, other things being equal, are associated with a higher level of profit. Innovation, however, appears to have no significant impact on profitability according to these estimates[20] and we cannot find any evidence that the interaction between the degree of commitment to R&D and innovation gives rise to higher profit. One explanation may be that innovation is a noisy variable and such activity is better measured by the R&D and investment in intangibles variables. Given that these two forms of investment are important influences on innovation, it would not be appropriate to suggest that the results suggest however that the introduction of new products or services does not have any long-term value.

In line with standard theory, firm profitability increases with market share. There are several hypotheses as to why large market share improves profit outcomes. The first is that higher market share translates into greater power, thereby allowing firms to charge higher prices and realise larger profits (Gale and Branch, 1982). An alternative view is that previous investments in innovations can lead to an increase in market share *via* an increase in sales (if the innovation is a product or service) or an increase in efficiency (if the innovation is process related), which allows the firm to expand at the expense of its rivals (Brozen, 1971; Demsetz, 1973). Once the firm controls enough of the market, the ability to maintain these advantages may be reinforced by factors such as economies of scale. This interpretation is consistent with the market power, higher price-cost margin interpretation. The earlier results show that the firm's own market share is significantly negatively related to product and service innovation; in addition, the interpretation of the positive impact on value added (total factor productivity) was that the significant positive effect of own-market share was operating through the higher prices that the firm could command, rather than through higher physical output *per* unit of physical input.

Similarly to recent work by Feeny *et al.* (2000), firms operating in more concentrated industries exhibit poorer profit performance – at least having controlled for own-market share. Studies of US data have found a critical level of four firm concentration to be between

[20] Although the inclusion of extra lags of innovation did not reveal any significant impact on profitability, it may be that the four-year time frame that this analysis is restricted to is not long enough to measure the true impact of innovation or that the impact of innovation adds incremental value over time, such that in any one year the impact is not particularly noticeable, but over a long time period, the cumulative effects may be significant.

46 and 60 *per cent*, and that there is little evidence that increases in seller concentration to levels below 50 have any effect on profitability (Scherer and Ross, 1990). Feeny *et al.* (2000) found that the critical bounds for Australian firms were of the order of between 30 and 70 *per cent*, although even this held only for a limited number of industries. Our results suggest that higher market concentration has a negative impact on Australian industry. In Table 3, we showed that it was insignificantly related to product innovation, while in Table 4 we demonstrated a significant negative impact on total factor productivity. Thus, its negative impact on profitability appears to operate through higher relative inefficiency of sectors with greater monopoly power.

Controlling for everything else, incorporated (as compared to unincorporated) and family owned businesses are characterised as generating lower profits. Again however, the importance of having a formal, documented business plan shows up in the results.

6. Conclusion

Several important conclusions arise from the results of the present study. In the first instance, internally generated funds are a critically important determinant of the ability of small to medium enterprises to undertake "risky" discretionary investments, whether it is R&D, patents, licensing, plant, equipment, land, buildings or advertising. Our results show that R&D, training and (for manufacturing firms) advertising are complementary investments, suggesting that an increase in expenditure on one of these items will typically result in higher expenditure on the others. In contrast, intangible asset expenditure, which is more likely to be external to the firm, tends to compete with the internal activities to be funded from economic profit. While the precise relationship between the various discretionary investments was an empirical question, the reported findings appear to make a great deal of sense.

A second area where the analysis supports fairly strong policy conclusions concerns the role of market power in determining the performance of Australian companies. In terms of discretionary investments likely to have a positive impact on the dynamic performance of enterprises, it is found that own-market share has a significant negative impact in the majority of cases. Sector concentration is insignificant except in encouraging investment in intangible assets, where it has a significant positive impact. Thus, sector concentration appears more likely to impact on external than internal sources that might influence dynamic performance. These rather negative results are reinforced by the findings in terms of innovation and total factor productivity. Own-market share has a significant negative impact on product and service innovation (sector concentration is insignificant), suggesting companies with less market power are likely to be more innovative in a sector of given concentration. In the case of productivity, it is found that own market-share has a positive impact on total factor productivity, having controlled for the overall concentration of the sector. However, this is probably because the firm with greater market power can raise their price-cost margins, increasing the value of output per unit of input. This is particularly the case in sectors where market concentration is lower. Finally, it is found that own-market share has a positive impact on profitability, and again this is particularly true in sectors with lower industry concentration ratios. Where concentration is high, the small-medium sized firms will be competing against relatively large companies, with a negative impact on their own performance.

There is evidence that a formal strategy has a key role to play in the dynamic process of the firm. At all stages, whether it is discretionary investment expenditure, the introduction of a new product or service, or the ability to generate higher value-added and higher profits, the existence of a formal, documented business plan was strongly significant. This suggests that an important determinant in the success of the firm is the ability to clearly state goals and requirements and make decisions accordingly that will assist in achieving those goals, such as investment in R&D or the introduction of a new product or service.

Most importantly however, there is evidence of a dynamic relationship between investment, innovation, productivity and profitability. While current profit has an important role to play in enabling firms to invest, past values of these investments are also found to have a significant influence on current profit. Such investments also have an indirect influence on profits through their relationship with innovation and productivity. R&D, training and (for manufacturing firms) advertising in the previous year were positively associated with the introduction of a new product or service, lending support to the view that although investing in R&D can lead to new innovations within the firm, investing in R&D, training and advertising also improves the chances of being able to successfully innovate using someone else's idea. Productivity is determined primarily by factor inputs (albeit with decreasing returns to scale), although there still appears to be some role for investment and innovation. All discretionary investment expenditures were positively related to productivity, although only intangible asset purchases had any significant influence. Past productivity in turn has a significant association with profit, although there appears to be no obvious significant role for innovation (we have noted that the role of innovation seems to be taken up by past R&D and investment in intangible assets). As such, the above analysis lends support to the view that many of the factors influencing firm performance are endogenously determined, with choices made today having an important influence on what might be possible tomorrow.

Appendix: Variable Definitions and Results for the Manufacturing Estimation

Discretionary Investments

R&D intensity: The value of R&D as a proportion of the firm's total income.

Advertising expenditure: The value of the marketing of new products as a proportion of the firm's total income. This variable was only available for manufacturing firms.

Tangible investment expenditure: The value of capital expenditure on plant, machinery, land, and buildings as a proportion of the firm's total income.

Intangible investment expenditure: The value of capital expenditure on intangibles (*e.g.* patents, licences, goodwill) as a proportion of the firm's total income.

Increase in training: Takes a value of one if there was an increase in other training during the last financial year, and zero otherwise.

Innovation

Innovation indicator: Assumes a value of one if the firm has developed or introduced any new or substantially changed product or service, or changed the way of delivering the service.

Productivity

Value added: Sales plus (closing stock minus opening stock) minus employee costs, minus depreciation, minus interest expenses, minus purchases, plus total investment.

Total factor productivity: log value added – αlog employees – βlog capital stock – γlog hours per week

Capital stock: Total non-current assets plus leasing stock.

Effective number of full-time employees: The number of full-time employees plus 0.426*the number of part-time employees. 0.426 is used to scale the number of part-time employees to full-time equivalents, and is calculated as the ratio of average hours worked by part time employees to the average hours worked by full-time employees.

<u>Profitability</u>

Economic profit: The sum of accounting profit, interest expense, depreciation, investment expenditure, leasing capital and R&D expenditure.

<u>Firm characteristics</u>

Type of legal organisation: Takes a value of one if incorporated and zero otherwise.

Whether a family business: Takes a value of one if a family business and zero otherwise.

Age of the business (years): Calculated as the midpoint of the range of responses. That is, up to 2 years=1, 2-4=3, 4-6=5, 6-8=7, 8-10=9, 10-12=11, 12-14=13, 14-16=15, 16-18=17, 18-20=19, 20-22=21, 22-24=23, 24-26=25, 26-28=27, 28-30=29, over 30=35.

Hours per week: Days per week times hours per day.

Debt to equity ratio: The sum of creditors, loans and overdrafts divided by derived owners' equity.

Exports: Takes a value of one if the firm exports, and zero otherwise.

Union density: The percentage of employees belonging to a union. This variable is calculated as the midpoint of the range of responses. That is, none=0, up to 10=5, 11-25=18, 26-50=37.5, 51-75=63, 76-100=88.

Business locations: The number of business locations operated by the firm.

Comparison with other businesses: Takes a value of one if the firm compares its performance to other businesses, and zero otherwise.

Documented business plan: Takes a value of one if the firm has a formal strategic (or business) plan, and zero otherwise.

Contracting out: Takes a value of one if the firm has contracted out work previously done by own employees, and zero otherwise.

Market characteristics

Market share: Total income of the firm as a proportion of the income for the industry in which they mainly operate.

Concentration: The proportion of industry income accounted for by the largest four firms in the industry.

Advertising expenditure by industry: Advertising expenditure by 4-digit ANZSIC classification (from the ABS input-output tables) as a share of industry income.

R&D industry pool: Expenditure on research and development by industry (from the ABS) as a share of industry income.

Table 6: Determinants of discretionary investments (manufacturing)

	R&D (Panel tobit)		Tangible investment (Panel tobit)		Intangible investment (Panel tobit)		Marketing new products (Panel tobit)		Increased training (Panel probit)	
	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error	Coefficients	Std. Error
Constant	-0.419	(0.057)	-1.493	(0.181)	-1.304	(0.168)	-0.096	(0.021)	-2.200	(0.879)
R&D	--	--	0.162	(0.180)	-0.054	(0.133)	0.119	(0.011)	0.564	(0.807)
Tangible investment	-0.007	(0.009)	--	--	0.007	(0.011)	-0.002	(0.004)	-0.001	(0.087)
Intangible investment	-0.068	(0.040)	0.163	(0.099)	--	--	-0.016	(0.013)	-0.357	(0.626)
Marketing new products	2.344	(0.163)	0.835	(0.744)	0.112	(0.592)	--	--	7.363	(3.162)
Increase training	0.021	(0.005)	0.019	(0.019)	-0.007	(0.013)	0.004	(0.002)	--	--
Log employees	0.012	(0.004)	-0.028	(0.013)	-0.029	(0.012)	0.004	(0.002)	0.202	(0.065)
Log profit	0.024	(0.002)	0.115	(0.007)	0.069	(0.007)	0.001	(0.001)	0.102	(0.037)
Incorporated	0.015	(0.005)	0.010	(0.017)	0.028	(0.019)	0.004	(0.002)	0.029	(0.087)
Family business	-0.006	(0.004)	0.020	(0.014)	0.023	(0.016)	0.003	(0.002)	0.012	(0.071)
Exports	0.025	(0.012)	0.013	(0.044)	0.017	(0.032)	-0.002	(0.004)	0.028	(0.221)
Debt to equity ratio	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Union density	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	-0.001	(0.002)
Number of locations	-0.002	(0.001)	0.001	(0.004)	0.005	(0.003)	0.000	(0.001)	-0.042	(0.023)
Compares with other businesses	-0.008	(0.005)	0.004	(0.016)	0.012	(0.012)	0.004	(0.001)	0.183	(0.074)
Business plan	0.020	(0.004)	-0.011	(0.015)	0.021	(0.011)	0.006	(0.001)	0.155	(0.069)
Contract out work	0.005	(0.006)	0.001	(0.023)	-0.018	(0.017)	0.004	(0.002)	0.405	(0.102)
Log market share	-0.020	(0.003)	-0.046	(0.008)	-0.043	(0.009)	-0.002	(0.001)	-0.060	(0.042)
Concentration ratio	-0.057	(0.022)	0.172	(0.072)	0.252	(0.060)	0.012	(0.007)	0.117	(0.341)
Log industry advertising expenditure	-0.002	(0.002)	0.025	(0.008)	0.023	(0.009)	0.003	(0.001)	0.114	(0.041)
Log R&D pool	0.017	(0.003)	-0.029	(0.008)	-0.020	(0.008)	-0.002	(0.001)	-0.053	(0.043)
Year dummies	Yes		Yes		Yes		Yes		Yes	
Number of observations	3596		3596		3596		3596		3596	
Groups	899		899		899		899		899	
Wald χ^2	537.22*		376.84*		171.85*		288.15*		260.38*	
Log likelihood	45.0		-1433.4		-382.0		886.5		-1291.8	

Table 7: Determinants of innovation (manufacturing)

	Coefficients	Standard Error
Constant	-3.289	(0.994)
$R\&D_{t-1}$	13.574	(1.604)
Tangible $investment_{t-1}$	-0.010	(0.101)
Intangible $investment_{t-1}$	1.048	(0.536)
Marketing new $products_{t-1}$	7.393	(3.310)
Increased $training_{t-1}$	0.182	(0.106)
Employees	0.698	(0.195)
$Employees^2$	-0.055	(0.036)
Incorporated	0.107	(0.109)
Family business	0.040	(0.089)
Exports	-0.173	(0.260)
Debt to equity ratio	0.000	(0.000)
Union density	-0.003	(0.002)
Number of locations	-0.019	(0.029)
Compares with other businesses	0.099	(0.088)
Business plan	0.390	(0.081)
Contract out work	0.180	(0.127)
Market share	-0.083	(0.045)
Concentration ratio	0.149	(0.400)
R&D pool	0.043	(0.040)
Year dummies	Yes	
Number of observations	2697	
Groups	899	
Log likelihood	-1316.8	
Wald χ^2	235.32*	
ρ	0.396	(0.040)

Table 8: Determinants of productivity (manufacturing)

	Coefficients	Standard Error
Constant	8.797	(0.517)
Employees	0.321	(0.038)
Capital stock	0.296	(0.022)
R&D$_{t-1}$	1.845	(1.321)
Tangible investment$_{t-1}$	0.004	(0.026)
Intangible investment$_{t-2}$	0.527	(0.250)
Marketing new products$_{t-1}$	-0.425	(2.243)
Increased training$_{t-1}$	0.031	(0.041)
Innovation$_{t-1}$	0.062	(0.035)
Interaction (R&D & innovation)$_{t-1}$	-1.305	(1.478)
Hours per week	0.085	(0.056)
Age of firm	0.050	(0.023)
Incorporated	0.012	(0.052)
Family business	-0.113	(0.045)
Exports	0.120	(0.136)
Union density	0.000	(0.001)
Number of locations	-0.003	(0.015)
Compares with other businesses	-0.009	(0.038)
Business plan	0.094	(0.036)
Contract out work	-0.006	(0.083)
Log market share	0.356	(0.022)
Concentration ratio	-0.893	(0.133)
Year dummies	Yes	
σ_μ	0.527	
σ_ε	0.425	
ρ (fraction of variance due to μ_i)	0.605	
Number of observations	1798	
Groups	899	
Wald χ^2	5106.31	

Table 9: Determinants of profitability (manufacturing)

	Coefficients	Standard Error
Constant	6.171	(0.451)
Log capital stock	0.521	(0.021)
Log value added$_{t-1}$	0.237	(0.026)
R&D$_{t-1}$	0.609	(1.589)
Tangible investment$_{t-1}$	-0.064	(0.031)
Intangible investment$_{t-2}$	0.728	(0.277)
Marketing new products$_{t-1}$	2.199	(2.630)
Increased training$_{t-1}$	0.098	(0.048)
Innovation$_{t-1}$	0.023	(0.042)
Interaction (R&D & innovation)$_{t-1}$	2.930	(1.757)
Debt to equity ratio	0.000	(0.000)
Incorporated	-0.115	(0.053)
Family business	-0.112	(0.045)
Exports	-0.108	(0.159)
Union density	0.001	(0.001)
Number of locations	0.001	(0.015)
Compares with other businesses	-0.010	(0.044)
Business plan	0.128	(0.041)
Contract out work	0.029	(0.086)
Log market share	0.279	(0.020)
Concentration ratio	-0.630	(0.141)
Year dummies		
σ_μ	0.448	
σ_ε	0.489	
ρ (fraction of variance due to μ_i)	0.457	
Number of observations	1798	
Groups	899	
Wald χ^2	5021.17*	

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