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The Causes of Profit Heterogeneity in Large Australian Firms

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Abstract

The objective of this paper is to investigate the causes of heterogeneity in firm performance. In particular, the study decomposes unobserved heterogeneity in profitability into firm and industry effects and quantifies the relative importance of both these effects. For a sample of large Australian firms for the period 1995-2005, the estimation results indicate that almost two thirds of the heterogeneity can be explained by differences across firms, and that industry effects are of much less importance. Another result is that the level of total factor productivity, as a component of firm effects, significantly enhances profitability, but also that this relationship is not identical among firms.

JEL-Classification: C23, D24, L25

Keywords: firm performance, determinants of profit, multi-level analysis, firm effects

1 Introduction

The purpose of this paper is to investigate firm profitability and its determinants. Using a dataset comprising large Australian firms for the period 1995-2005, the study applies multi-level modelling to decompose unobserved profit heterogeneity into firm and industry effects and quantifies their relative contribution. A particular aspect of the analysis is to examine the influence of productivity on profitability. Therefore, the model directly includes measures of total factor productivity. It also tests for variation in the relationship across firms and attempts to explain its properties.

Heterogeneity in firm performance is of fundamental importance in economic analysis because the prosperity of an economy ultimately depends on the success of firms. Theoretical contributions, such as the seminal article by Bain (1951), link performance differences to industry attributes. The underlying rationale, formulated in the structure-conduct-performance (SCP) model, is that an exogenously given market structure determines firm behaviour and performance. Conceptually opposite, firm effect models emphasise fundamental differences in firm characteristics and highlight their impact on profitability.[1]

Numerous empirical studies provide evidence for heterogeneity in firm performance and, for a broad range of industries and time periods, document that firm profitability differs widely across firms and industries. Overall, there seems to be consensus that heterogeneity in firm performance is linked to factors at both the firm and industry level. Disparity exists, however, about the relative importance of both these influences.

Recently, a handful of studies, for example Hough (2006), Misangyi et al. (2006) and Short et al. (2006), apply multi-level modelling to analyse firm profitability. The basic idea is that multi-level models overcome a number of methodological problems associated with prevailing techniques, such as ANOVA and (single-level) regression analysis. The present study connects with this research and employs a multi-level model that is based on a reduced-form profit

[1]The literature also refers to this class of models as revisionist, heterogeneity or resource-based models. Prominent examples are Rumelt (1991), Hawawini et al. (2003) and Grossmann (2007).

function and explicitly incorporates firm and industry variables that have, theoretically and empirically, been recognised to influence firm profitability.

The remainder of the paper is organised as follows. The subsequent section looks at the related literature. Section 3 specifies the multi-level model of firm profitability and presents the definition of the variables. Descriptive statistics can be found in Section 4, while Section 5 produces estimation results. Section 6 concludes.

2 Related Literature

There is an abundance of empirical research on firm profitability, comprehensively surveyed in, for example, McGahan and Porter (2002) and Slade (2004). Two methodologies dominate the applied literature: variance decomposition and regression analysis. Variance decomposition, including variance components analysis (VCA) and analysis of variance (ANOVA), partitions the total variation in profitability into firm, industry, year and interacted effects assigning a dummy variable to each component. Variance decomposition provides evidence on the relative importance of industry and firm effects.

Schmalensee (1985) was the first to use the ANOVA framework to study the contribution of industry- and firm-level factors in explaining cross-sectional differences in profitability concluding that industry effects are dominant and firm effects non-existent. Aiming at replicating Schmalensee's results, Rumelt (1991) uses an extended dataset (and also distinguishes between corporate and business-unit effects) but comes to different conclusions. In his study, firm effects account for the majority of the total variation in profit rates, and industry factors explain only a small proportion of the variance.

Motivated by these controversial findings, a number of studies have emerged that examine the relative influence of firm and industry effects using variance decomposition. Bowman and Helfat (2001), for instance, survey the research on this topic. Table 1 summarises the results of selected variance decomposition studies and illustrates that, depending on the size and period of the sample either firm or industry effects play a central role in determining firm profitability.

Table 1: Comparison of Results from Selected Variance Decomposition Studies.

	Relative Importance (in %) of			
Study	Year Effects	Industry Effects	Firm Effects[a]	Residual
Schmalensee (1985)	–	19.6	0.6	80.4
Wernerfelt and Montgomery (1988)[b]	–	19.5	3.6	77.0
Rumelt (1991)[c]	–	4.0	45.8	44.8
Roquebert et al. (1996)[d]	0.4	10.2	55.0	32.0
Mauri and Michaels (1998)[e]	–	5.8	25.4	68.8
McGahan and Porter (1997)	2.4	18.7	36.0	48.4
McGahan and Porter (2002)	0.4	10.3	47.6	41.7
Hawawini et al. (2003)[f]	1.0	8.1	35.5	51.9
Chen and Lin (2006)[f]	2.5	0.6	41.6	55.3
Bou and Satorra (2007)[g]	–	8.2	78.8	13.1

[a]Firm effects comprise corporate and business-unit effects. [b]Without correction for intangible assets. [c]Results from sample B (including small businesses). [d]Averages across samples. [e]15-year sample. [f]Results from return on assets. [g]Sum of permanent and transitory components. The table is based on McGahan and Porter (2002). See also the related work by Mackey (2008).

The studies presented in Table 1 detect the magnitude of firm and industry effects and advance our understanding of what factors drive firm performance. The fundamental criticism of these studies, however, is that, due to the operationalisation through dummy variables, variance decomposition does not allow a break down of effects. As a consequence, it is impossible to relate profitability differences across firms to specific factors and to answer the question as to what, exactly, determines performance heterogeneity. McGahan and Porter (2002) stress that variance decomposition documents relationships but, crucially, without stipulating causality. The reason for that is that the only regressor is the constant and no other, potentially relevant, explanatory variables are included.[2]

The second methodology, regression analysis, examines the impact of specific variables on profitability. Many studies, surveyed in (for example) Schmalensee (1989), argue in favour of firm effect models and indicate that specific firm-level variables, such as market share, firm size, financial risk, R&D expenditure or proxies for the quality of the management, significantly contribute to explaining firm profits and its dispersion. Likewise, there is a large

[2]Another shortcoming of these studies is the large magnitude of the residual since it contains the effect of unobserved factors. In the cross-sectional sample in Schmalensee (1985), for example, most of the total variation (80.4 per cent) is related to neither industry nor firm effects.

number of empirical articles which report a significant influence of specific industry-level variables, for instance the market structure or size.

Despite this, Brush et al. (1999) assert that the use of regression analysis has several limitations. In most cases, regression analysis overlooks the fact that firms are nested within industries. This is important because, by definition, firms within an industry are more similar to one another than firms from different industries. Failure to account for the nested structure of the data violates the assumption of the independence of observations and results in the reporting of understated standard errors and overstated statistical significance.

Recently, a handful of studies emerged from the literature that suggest the use of multi-level modelling to overcome these problems.[3] A multi-level model, as the one presented in the following section, explicitly accounts for the hierarchical structure of the data and the lack of independence of observations.

Misangyi et al. (2006), for example, uncover significantly positive impacts of the industry concentration and resource environment on firm profits. Hough (2006) and Short et al. (2006) reveal positive effects of R&D intensity on the performance of U.S. business segments. However, a potential criticism of both studies is the selection of explanatory variables. The only external variable in Hough (2006) is firm-level R&D investment, and Short et al. (2006) only include organisational slack and industry R&D intensity to proxy for firm and industry effects.

The present study contributes to the limited literature in the area. The following analysis employs a multi-level model that includes firm and industry variables that have, theoretically and empirically, been recognised to influence firm profitability. The virtue of multi-level modelling is that it combines the analytical power of variance decomposition and regression analysis. It produces unbiased parameter estimates for the impact of specific variables and identifies determinants of profitability. Simultaneously, it decomposes unobserved heterogeneity in firm profitability into firm and industry factors and quantifies the relative importance of both ef-

[3] The multi-level model is also known as the general linear mixed model, the hierarchical linear model and the mixed effect regression model. Overviews of multi-level modelling can be found in Bickel (2007).

fects. Based on the results it is possible to make inferences about the plausibility of the SCP and firm effect models.

3 A Multi-Level Model of Firm Profitability

Consider the following multi-level model. At the first level, (1) specifies a linear relationship between firm profits and a number of explanatory variables

$$\pi_{ijt} = \eta_{ij} + \beta X_{ij,t-1} + \epsilon_{ijt}, \tag{1}$$

where π_{ijt} is the profit of firm i in industry j at time t, $X_{ij,t-1}$ is a vector of lagged, time-varying firm characteristics and β the corresponding parameters. The random error, $\epsilon_{ijt} \sim i.i.d.N(0, \sigma_{\epsilon}^2)$, has no systematic effect on the dependent variable. Unobserved heterogeneity in firm profitability is captured in η_{ij}. The indices i and j indicate that η_{ij} depends on factors at both the firm and industry levels.

The second level introduces variation of average profitability between firms. Equation (2) decomposes η_{ij} into fixed and random components

$$\eta_{ij} = u_j + \gamma Z_{ij} + e_{ij}, \tag{2}$$

with Z_{ij} as time-invariant firm characteristics, γ as the corresponding parameters and e_{ij} as a random variable with $e_{ij} \sim i.i.d.N(0, \sigma_e^2)$. The common intercept for all firms in industry j is denoted u_j. Adding e_{ij} to the equation permits firm-specific variation around u_j.

The third level considers the impact of industry variables on firm profitability. Equation (3) decomposes the average industry effect u_j into fixed and random components

$$u_j = \alpha + \delta W_j + \zeta_j, \tag{3}$$

where W_j are industry attributes, δ the corresponding parameters and ζ_j a random variable, $\zeta_j \sim i.i.d.N(0, \sigma_{\zeta}^2)$.[4] The intercept α denotes the sample-wide average profitability, and ζ_j accounts for variation of α between industries.

[4] Ideally, the regression would include time-varying industry variables, but this is due to lack of suitable data not feasible. A possible interpretation of W_j is as a vector of structural industry characteristics.

Substituting (3) into (2) and the resulting expression into (1) creates a linear multi-level model that decomposes firm profitability into fixed and random components

$$\pi_{ijt} = \underbrace{\alpha + \beta X_{ij,t-1} + \gamma Z_{ij} + \delta W_j}_{fixed\ \ components} + \underbrace{\epsilon_{ijt} + e_{ij} + \zeta_j.}_{random\ \ components} \tag{4}$$

The model contains explanatory variables at the firm (X, Z) and industry (W) levels and, thus, implies cross-level interaction. The random variables e_{ij} and ζ_j ensure that the intercept $(\alpha + e_{ij} + \zeta_j)$ is random and unique to every firm and industry. The term ϵ_{ijt} is the residual. The model is fitted using an iterative maximum likelihood algorithm in which the fixed and random components are estimated simultaneously until the model converges.[5]

Let $\hat{\sigma}_e^2$ and $\hat{\sigma}_\zeta^2$ be the estimated variances of the firm-level and industry-level intercepts and $\hat{\sigma}_\epsilon^2$ the estimated variance of the residual

$$\hat{\sigma}_\epsilon^2 = \widehat{Var}(\epsilon_{ijt}), \quad \hat{\sigma}_e^2 = \widehat{Var}(e_{ij}) \quad \text{and} \quad \hat{\sigma}_\zeta^2 = \widehat{Var}(\zeta_j). \tag{5}$$

Findings of statistically significant variances would provide evidence that significant variation in profitability across firms and industries exists. It would also provide prima facie evidence for firm and industry effects.

The estimated variances are used to compute the intra-class correlation (ICC)

$$\hat{\rho}_s = \frac{\hat{\sigma}_s^2}{\hat{\sigma}_\epsilon^2 + \hat{\sigma}_e^2 + \hat{\sigma}_\zeta^2} \qquad \text{for} \quad s = \epsilon, e, \zeta. \tag{6}$$

Values of $\hat{\rho}_e$ and $\hat{\rho}_\zeta$ describe the degree of dependence in profitability across firms and industries, respectively. Specifically, $\hat{\rho}_e$ and $\hat{\rho}_\zeta$ indicate the proportion of variability in firm profits that occurs between firms and industries, respectively. An estimated value of, for example, $\hat{\rho}_e = 0.66$ implies that two thirds of heterogeneity in profitability is due to differences across firms. The value $(1 - \hat{\rho}_\epsilon)$ measures the explained variation, whereas $\hat{\rho}_\epsilon$ gives the proportion of variability that is left unexplained by the model.

Depending on theoretical considerations, some coefficients in (4) can be specified to differ across firms and industries in a stochastic manner. Model I, defined in (1) to (4), is regarded

[5] Alternatively, the model in (4) could be specified using non-linear functional forms. However, due to the lack of a convincing intuitive justification this study considers a linear profit model, a procedure which is well in line with the applied literature in this field. See McGahan and Porter (2002).

as the reference model on which a sequence of extensions is built. In the first model, the intercept is random and all slope coefficients are fixed, implying that all slope parameter estimates are identical across firms and industries.

A particular aspect of this investigation is to explore the relationship between productivity and profitability at the firm-level. Following Demsetz (1973), the level of productivity is regarded as one of the major drivers of profitability. The model in (4) accounts for this by including measures of productivity in the set of lagged explanatory variables $X_{ij,t-1}$. The way the model is specified it examines the impact of productivity on profitability but does not, however, account for the feedback effects of past profitability on current productivity, which potentially causes endogeneity problems.

Following the concept of firm heterogeneity, it could be argued that the process of transforming productivity into profits is not identical across firms. The rationale behind is that there are factors that cause some firms to perform better that others. Extending this argument, these, potentially unobserved, idiosyncrasies can be responsible for firm-level variation in the link between productivity and profitability. For example, some firms can be very effective to turn productivity advantages into profit, whereas others might struggle to benefit from productivity gains. The purpose of the following specification is to test this hypothesis.

Model II allows, in addition to the random intercept, a random coefficient for the effect of productivity on profitability

$$\beta_2 = \kappa_2 + e_{1ij}, \tag{7}$$

while all other coefficients remain fixed. The parameter κ_2 is the portion of slope coefficient for productivity that is common among all firms. The newly added term e_{1ij} is a random variable and assumed to be normally distributed with $e_{1ij} \sim i.i.d.N(0, \sigma^2_{e1})$ and $Cov(e_{ij}, e_{1ij}) = \Omega_{e,e1}$. It allows for deviation from κ_2 and enables the coefficient β_2 to differ across firms.

Model III takes this logic a step further and investigates the sources of the variation in the productivity-profitability relationship. The specification below is motivated by the idea that persistent productivity differences lead to profit heterogeneity. Model III considers β_2 to be a function of firm-level factors

$$\beta_2 = \kappa_2 + \kappa_{21} S_{ij,t-1} + \kappa_{22} \Psi_{ij,t-1} + e_{1ij}, \tag{8}$$

where $S_{ij,t-1}$ proxies for the lagged firm size and $\Psi_{ij,t-1}$ for persistent high productivity levels. The specification in (8) postulates that the impact of productivity on profitability depends on firm size and on persistence of high productivity levels.

Unlike most existing research, the present study directly includes measures of total factor productivity (TFP) in the profit equation. The firm-specific and time-variant estimate for productivity is obtained from estimating a cost function, in which productivity refers to the level of cost-efficiency in the production process. The following equation describes cost-efficiency as the log-difference between predicted and empirical costs

$$\ln \hat{A}_{ijt} = \ln \hat{C}(Y_{ijt}, W_{jt}) - \ln C_{ijt}(Y_{ijt}, W_{jt}), \tag{9}$$

where $\ln \hat{C}$ are the predicted and $\ln C_{ijt}$ are the empirical costs of firm i in sector j at time t. W_{jt} and Y_{ijt} are the sectoral factor prices and firm-individual output, respectively. The resulting value $\ln \hat{A}_{ijt}$ denotes the productivity level, and larger values imply higher levels of cost-efficiency or productivity. It is an estimate and contains standard errors.

The model in (4) also includes quantities that proxy for the persistence of high productivity levels. Based on $\ln \hat{A}_{ijt}$, measures of persistent high productivity are obtained in three steps. The first step derives a continuous measure of productivity persistence at the firm level. The mean relative deviation from the within-firm average productivity is given as

$$\theta_{1i} = \Sigma_t \Big| \frac{\hat{a}_{ijt} - \bar{\hat{a}}_i}{\bar{\hat{a}}_i} \Big| / T_i, \tag{10}$$

where $\hat{a}_{ijt} = \ln \hat{A}_{ijt}$, $\bar{\hat{a}}_i = \Sigma_t \hat{a}_{ijt} / T_i$ and T_i is the number of periods firm i is observed.

Using θ_{1i}, the sample is divided into firms that show a persistent pattern of productivity evolution and firms with a moderate or low degree of persistence. A persistence dummy d_i takes the value unity if firm i's value of θ_{1i} exceeds the sum of the sample average by one standard deviation. Otherwise, $d_i = 0$. The findings presented in Section 5 are robust to alternative specifications of productivity persistence.[6]

[6] For example, the intertemporal autocorrelation (IAC) is given as $\theta_{2i} = \frac{\lambda_i \cdot \sigma_\omega^2}{1-\lambda_i^2}$, where λ_i is the AR(1) parameter in the specification $\hat{a}_{ij,t} = c_i + \lambda_i \cdot \hat{a}_{ij,t-1} + \omega_{ij,t}$ and σ_ω^2 the variance. Other metrics are

Using this persistence measure, a proxy for persistent high productivity levels is constructed as the product of the productivity level itself and the persistence dummy variable, $\Psi_{ij,t} = d_i \cdot \hat{a}_{ijt}$. In the case of productivity persistence, it takes the value of $\hat{a}_{ijt}$ and is zero otherwise. Say, for instance, there is a highly productive firm with $\hat{A}_{ijt} = 1.5$. If the firm maintains this level over the observed periods, the productivity dummy detect persistence and, hence, $d_i = 1$ and $\Psi_{ij,t} = 1.5$.

4 Data and Characteristics of the Sample

The empirical analysis employs an unbalanced panel of 603 large Australian firms. The sample comprises firms listed on the Australian Stock Exchange (ASX) and covers the period 1995 to 2005. The sample comprises all constituent firms of the Standard and Poor's/ASX All Ordinaries Index (All Ords) which represents the 500 firms with the largest market capitalisation in the Australian equity market. At the end of the financial year 2004-05, the All Ords had a market capitalisation of AU$980 billion.

The main source of data is the Integrated Real-Time Equity System (IRESS), a financial information system providing information on balance sheet items and figures from profit and loss and cash flow statements. The database is supplemented with information from the Australian Bureau of Statistics (ABS) and the Australian Securities and Investments Commission (ASIC). Although not representative of the economy, the panel comprises firms from a wide range of economic activity.

The sample has a number of distinct features. The data are hierarchically organised and each firm is assigned to a single industry comprising, on average, 17 firms. Further, all firms are traded on the ASX, which introduces a selection bias because it is initially the firm's decision to seek and maintain an ASX listing. Lastly, the average firm size in the sample, whether by

based on the within-firm variability of the productivity level, for instance $\theta_{3i} = \sigma_{ai}/\bar{\hat{a}}_i$ as the coefficient of variation. Furthermore, using different thresholds for the persistence dummy variable, for instance the sample-wide 75th percentile, does not affect the results much.

turnover or employment, is greater than the average in the population of Australian firms, implying that small firms are under-represented.[7]

The dependent variable is firm profitability and its measurement is not a trivial matter. Following Rumelt (1991) and Misangyi et al. (2006), this study employs the accounting profit level, net profit before tax (NPBT).[8] Schmalensee (1989) and Mueller (1990) discuss the strengths and weaknesses associated with the use of accounting profits and indicate that the principal drawback is the exclusion of the costs and benefits from intangible capital. The regression includes a set of firm- and industry-level variables, such as proxies for the firm size, age and measures of financial and income risk and also variables that account for the industry structure.

Table 2 produces descriptive statistics for the firm and industry variables. The sample contains 2,949 observations for 603 large Australian firms nested within 36 two-digit ANZSIC sub-industries. Firms in the sample earned, on average, AU$33.3 million in accounting profit. Naturally, there are firms earning profits while some firms made a loss in some years. The large standard deviation of almost three times the size of the mean illustrates that profits are widely dispersed. The sample of large Australian firms is not homogenous in terms of profitability.

The estimate for total factor productivity level varies significantly among firms. This finding is consistent with the applied literature on firm-level productivity comprehensively surveyed in, for example, Syverson (2010). Values for firm total assets and number of employees differ substantially among firms, as do proxies for firm income stream and stock market risk. Looking at industry-level variables, it becomes evident that some industries are much more concentrated and riskier than others.

[7]The Corporation Act (2001), which sets the institutional framework, does not explicitly specify a minimum size requirement for listed firms. However, it is reasonable to assume that a firm needs to exceed a critical size to consider a listing on the stock market.

[8]A correlation matrix would demonstrate a statistically significant and positive relationship between alternative measures, such as NPBT, profit rates and Tobin's q. The qualitative nature of the results presented in Tables 3 and 4 is not affected by using alternative profitability measures.

Table 2: Descriptive Statistics for the Sample.

Variable	Mean	Median	Std. Dev.	Min.	Max.
Firm-level variables					
Firm accounting profit level	33.274	4.096	85.922	-27.494	703.606
Firm productivity estimate	0.030	0.017	0.148	-0.873	0.907
Firm total assets	493.325	64.303	1,224.814	0.275	10,684.100
Firm number of employees	1.696	0.237	6.893	0.001	213.000
Firm age	12.980	10.000	10.656	0.000	43.000
Firm income stream risk	1.116	0.026	4.767	0.000	83.606
Firm stock market risk	0.398	0.350	0.352	-0.832	1.593
Industry-level variables					
Industry income stream risk	0.678	0.231	1.469	0.002	8.646
Industry HHI	57.968	52.643	54.159	1.902	269.770
Industry no. of businesses	66,648	12,070	114,822	44	371,203
Number of observations			2,949		
Number of firms			603		
Number of industries			36		

Std. Dev. - Standard deviation. Firm accounting profit level (NPBT) and firm total assets in AU$m and adjusted for inflation according to the producer price index. Firm number of employees in thousands.

5 Estimation Results

The purpose of the following section is to present the results from estimating the multi-level model specified in (4). Before looking at the estimation results, it is instructive to first inspect the findings from variance decomposition. Results from variance decomposition reveal whether there is systematic profit variation at the firm and industry levels that, if present, justifies utilising multi-level modelling. Then, results from several variants of multi-level models are produced that include a set of explanatory variables.

Discarding all independent variables X, Z and W in (4) yields variance decomposition. The only remaining regressor is the sample-wide constant α. The model also contains two random variables, e_{ij} and ζ_j, that account for firm and industry variation around α and an idiosyncratic error ϵ_{ijt}

$$\pi_{ijt} = \alpha + e_{ij} + \zeta_j + \epsilon_{ijt}. \tag{11}$$

Table 3 produces results from estimating (11) using a multi-level approach and, for comparison, using ANOVA techniques.

Table 3: Results from Variance Decomposition.

Variables	Multi-Level Model	ANOVA
Fixed Components		
Intercept ($\hat{\alpha}$)	41.186***	-2.644
	(7.217)	*(24.211)*
Random Components		
Residual ($\hat{\sigma}^2_\epsilon$)	1,167***	1,658***
	(33.930)	*(34.239)*
Firm-level variance ($\hat{\sigma}^2_e$)	4,248***	3,792***
	(271.489)	*(159.237)*
Industry-level variance ($\hat{\sigma}^2_\zeta$)	1,220***	1,428***
	(514.002)	*(241.360)*
Variance Decomposition		
Residual ($\hat{\rho}_\epsilon$)	17.6%	14.3%
Firm-level ($\hat{\rho}_e$)	64.0%	75.0%
Industry-level ($\hat{\rho}_\zeta$)	18.4%	10.6%
Number of observations	2,949	
Number of firms	603	
Number of industries	36	

Note: Statistical significance: *** at 1%, ** at 5%, * at 10%. Standard and mean errors in parentheses. For the multi-level model, $\log L = -15,454$. For ANOVA, F(602; 2,346)=26.94. The models are estimated in Stata 9.2 using the commands -xtmixed- and -anova-, respectively.

The parameter estimates in Table 3 for both variances $\hat{\sigma}^2_e$ and $\hat{\sigma}^2_\zeta$ are significantly different from zero. Specifically, $\hat{\sigma}^2_\zeta \neq 0$ implies that the average profitability varies across industries. The non-zero estimate for the firm-level variance, $\hat{\sigma}^2_e \neq 0$, indicates that there is significant variation in average profitability across firms. Together, these findings verify the existence of profitability differences across industries and firms.

Variance decomposition analysis quantifies the relative importance of factors at the firm and industry level with respect to firm profitability. According to Table 3, roughly two thirds (64.0 per cent) of variation in profits can be explained with differences across firms. Differences across industries account for 18.4 per cent of profit variation in the sample, and 17.6 per cent are left unexplained.[9]

The third column in Table 3 produces results from ANOVA regression. The figures validate the previous findings that average profitability significantly varies at the firm and industry level and that firm effects are much larger than industry effects. In comparison to multi-level model estimates, ANOVA reports slightly higher firm effects and smaller industry effects. Results from both approaches differ because of the estimation method employed. While ANOVA relies on least-squares estimation techniques, the multi-level model uses non-linear iterative maximum-likelihood methods.[10]

Taken together, it can be concluded that average profitability significantly differs across firms and industries. This finding means that industry and firm characteristics are empirically relevant in determining profitability differences, implying that utilising a multi-level model in the context of firm profitability is justified. Further, firm effects are almost four times more important than industry effects, which only play a minor role in explaining firm profitability.

The finding of dominant firm effects is well in line with the empirical literature (using ANOVA) that lends support to the firm effect models, for instance Rumelt (1991), McGahan and Porter (2002) and Hawawini et al. (2003). Evidently, there are unique firm-level characteristics that enable some firms to be more profitable, on average, than their rivals. However, a major drawback is that using variance decomposition the components of the effects remain unclear. Estimating the full model reveals the components of firm and industry effects.

Table 4 produces estimation results from three specifications of the profit model in (4). Model I estimates a multi-level model with a random intercept and fixed slope coefficients. Model II, additionally, considers a random slope coefficient for the effect of lagged productivity, and Model III explains the random productivity coefficient using firm-level variables.

The coefficient for lagged firm productivity is positive and statistically significant in all three models, implying that higher levels of total factor productivity lead to higher profits. This

[9] Testing for heteroscedasticity in profit level measures, the finding of dominant firm effects is robust to the use of log levels and a profit rate measure. Table A-1 in the Appendix documents the results.

[10] Raudenbusch and Bryk (2002), for example, provide mathematical details of the procedure.

result supports the argument discussed in Demsetz (1973) and Jovanovic (1982). Productivity is, in this study, measured as the degree of cost-efficiency in the production process. There are a number of reasons why some firms are more productive and profitable than others. Potential factors are lower average costs of production, better quality of products and services or higher output quantities produced with fewer inputs. Higher productivity levels, can also be the result of strategic management or of employing state-of-the-art technologies or a highly skilled workforce.

There is another way of interpreting the positive link between productivity and profitability. It could be that the level of productivity is the result of firms' innovative activity. The rationale behind it is that investments into research and development (R&D) raise the probabilities of introducing product, process, managerial or organisational innovation which, if successful, lead to increases in productivity and, according to Table 4, profitability. Applications of these ideas can be found in, for instance, Crépon et al. (1998), who formulate a structural model of the innovation process in order to quantify these relationships at the firm level. Chudnosvky et al. (2006) survey the related empirical literature.

The coefficients for lagged total assets and lagged number of employees are significantly positive. Both variables proxy for the size of the firm and illustrate that, within the sample of large Australian firms, larger firms are more profitable than smaller firms. Firm size can be an estimate for a firm's ability to access capital financing, where, in comparison to small firms, large firms have easier access to external sources of financing lowering costs and boosting profits. Another argument is that larger firms earn higher profits because they benefit from economies of scope (for instance in the treatment of suppliers) and exploit scale economies in the production process.

Table 4 reveals that firm age has a significantly positive impact on profitability. One could argue that the variable firm age captures the profit-enhancing effects of intangible capital. The accumulation of intangible capital, for example the building of a reputation for products and services or the optimisation of the corporate structure, takes time. Older firms are more likely to benefit from these factors than younger firms. Another potential explanation for the positive age effect is that older firms have gained more market experience during their existence and are less prone to demand-side shocks and other adverse exogenous events.

Following Cornell and Shapiro (1987), who relate variability in profits with the risk of financial default, the regression includes several measures of income stream risk. Risk is, in this study, defined as the variance of profits over the entire period at the firm- and industry-level, respectively.[11] Both coefficients are statistically significant and positive, implying that risk has a positive impact on profit performance. A potential explanation is that a high fluctuation of income streams implies less predictable future earning which increases the likelihood of bankruptcy for which stakeholders need to be compensated for. Another interpretation is that firms operating in industries that bear high risks need to reward their investors with high profits.

Another dimension of risk is financial risk. In the regression in Table 4, it is approximated with the variable market beta and defined as the slope coefficient in the market model regression. The significantly positive coefficient for firm stock market risk indicates that firm profitability and market beta are positively correlated, supporting the predictions of the capital asset pricing model. Firms associated with larger systematic, non-diversifiable financial risk are more profitable than less risky rivals. The finding is consistent with the empirical literature on the influence of financial risk on profits surveyed in, for example, Anderson et al. (2007).[12]

Following Wong et al. (2005), the Hirschman-Herfindahl-Index, defined as the sum of the squared market shares, and the total number of firms serve as proxies for the market structure. Table 4 illustrates that the two industry-level variables have a positive but statistically not significant impact on firm profitability. This result does not support the hypothesis of the SCP model which states that the market structure determines firm profitability. In Models II and III the coefficient for number of firms proves positive and statistically significant.

[11] Replacing the variance of profits with other metrics, such as the standard deviation or the coefficient of variation, does not affect the conclusions drawn.

[12] The market model was estimated for the period for which stock price data were available (March 2000 to June 2006) using the equation: $Ret_{it} = c_{0i} + b_i Ret_{st} + \xi_{it}$, where Ret_{it} and Ret_{st} are the weekly individual and index stock market returns, respectively, and c_{0i} and ξ_{it} are the constant and the residual. The results produced in Table 4 are robust to a number of alternative financial risk measures. See Bromiley et al. (2001).

Table 4: Results from Multi-Level Models.

Variables	Model I	Model II	Model III
Fixed Components			
Intercept	-24.768***	-22.897***	-23.255***
	(3.890)	*(3.919)*	*(3.948)*
Firm lagged total assets	0.048***	0.048***	0.047***
	(0.001)	*(0.001)*	*(0.001)*
Firm lagged productivity	19.381***	20.504***	16.511**
	(5.981)	*(6.063)*	*(6.419)*
Firm lagged no. of employees	4.444***	4.146***	4.197***
	(0.556)	*(0.539)*	*(0.540)*
Firm age	0.227**	0.176*	0.165*
	(0.996)	*(0.096)*	*(0.962)*
Firm profit risk	0.003***	0.004***	0.004***
	(0.000)	*(0.000)*	*(0.000)*
Firm stock market risk	5.381*	5.214*	5.243*
	(3.057)	*(2.921)*	*(2.909)*
Firm lagged productivity and lagged total assets interacted	–	–	0.013**
	–	–	*(0.007)*
Firm lagged productivity and productivity persistence interacted	–	–	1.499
	–	–	*(14.432)*
Industry concentration	0.042	0.046	0.049
	(0.028)	*(0.030)*	*(0.030)*
Industry no. of businesses	0.016	0.019*	0.020*
	(0.011)	*(0.011)*	*(0.111)*
Industry profit risk	1.794**	2.184*	2.293**
	(0.863)	*(0.956)*	*(0.970)*
Random Components			
Residual	823.742***	817.873***	817.571***
	(23.695)	*(23.538)*	*(23.546)*
Firm-level variance	383.239***	342.757***	337.838***
	(33.477)	*(31.460)*	*(31.354)*
Lagged productivity coefficient	–	849.467***	886.931***
		(401.489)	*(399.570)*
Covariance between firm-level intercept and lagged productivity coefficient	–	539.584***	547.390***
		(127.801)	*(123.814)*
Industry-level variance	21.760*	31.280***	33.773*
	(16.473)	*(20.195)*	*(20.193)*
Number of observations		2,949	
Number of firms		603	
Number of industries		36	

Statistical significance: *** at 1%, ** at 5%, * at 10%. Standard errors in parentheses. All models are estimated in Stata 9.2 using the command -xtmixed-.

This finding is in contrast to the classical Cournot theory of competition which posits that profitability decreases with the number of firms on the market. Telser (1972) explains this with a competitive disequilibrium theory in which high profitability of incumbent firms attracts entrants.

The findings that industry concentration has no statistically significant effect on firm profitability is somewhat surprising. Results from variance decomposition analysis in Table 3 indicate, in general, the importance of industry characteristics. Further, most of the literature, see especially Weiss (1974), suggests that the market structure is, to some extent, relevant. Potential reasons for the absence of a concentration effect in this study are measurement difficulties associated with the economic meaningful definition of markets and industries.[13]

Looking at the random components, the estimated variances $\hat{\sigma}_e^2$ and $\hat{\sigma}_\zeta^2$ are significantly different from zero. This implies that there exists significant random variation in average profitability across firms and industries. After controlling for a set of industry and firm variables, some firms and industries still perform better, on average, than others. This finding also illustrates that the multi-level aspect of the data is empirically important. Failure to account for it would lead to biased statistical inference of the parameters.

Notably, the result of non-zero variances for random components has already been shown in Table 3 utilising variance decomposition. The difference is that in Table 4, the results are obtained from a model that includes a set of firm and industry explanatory variables. Comparing the point estimates of the variances in Table 3 to those in Table 4, it can be seen that the magnitude of $\hat{\sigma}_e^2$ and $\hat{\sigma}_\zeta^2$ is reduced by roughly 90 per cent, which justifies the inclusion of explanatory variables in the model.

Model II differs from Model I by assuming a random coefficient for the effect of lagged productivity. The hypothesis to be tested is that the process of transforming productivity into profits is not identical across firms. Table 4 illustrates that the estimation results for fixed and random components in Model II are similar to those in Model I. Lagged productivity,

[13] Due to the limited availability of data, industry-level variables are not measured on a yearly basis. For the industry concentration, the three-year average 1999-2001 is used and the five-year mean 2002-2006 for number of firms.

size, age and income risk all have a statistically significant and positive influence on profitability. Industry size and industry income stream risk are significantly positive and industry concentration is positively correlated with firm profits.

In Model II, the estimated variance for the random component of the productivity coefficient is significantly different from zero, implying that the slope coefficient for lagged productivity is random. Productivity enhances profitability, but the effect is not uniformly distributed across firms. Furthermore, the estimate for the covariance between the random component of the firm-level intercept and the random component of the lagged productivity coefficient is statistically significant and positive. This indicates that the coefficient for lagged productivity is larger for firms that are more profitable on average.[14]

Firm-level variation in the productivity-profitability relationship is a striking result which, to the best of my knowledge, has not yet been raised in the literature on firm profitability. An interpretation is not straightforward and the multiple dimensions that are compressed into the concept of total factor productivity need to be considered. The figures in Model II might imply that the optimisation of organisational structures or an advanced managerial strategy not only raises the productivity and profit levels but also stimulates self-enforcing dynamics which, in turn, strengthen the positive link between the two indicators of firm performance.

Model III explains the sources of heterogeneity in the relationship between productivity and profitability using firm-level variables. The fourth column in Table 4 shows that the positive effect of productivity on profitability is stronger for large firms. A potential explanation is that, in comparison to small firms in the sample, large firms generate scale efficiencies that enhance the transformation of productivity advantages into profits. Alternatively, large firm size can be an indicator of reduced competition on a market, implying less threat to imitate the productivity advantage, for instance, in the form of a low-cost production technology.

The positive coefficient for the interaction term between productivity and productivity persistence indicates that persistence of high productivity levels intensifies the positive influence on

[14] Comparing Models I and II, a likelihood ratio test safely rejects the restricted Model I and the null hypothesis that the random components $\hat{\sigma}_{e1}$ and $\hat{\Omega}_{e,e1}$ are equal to zero. $LR_{I,II} = -2[logL_I - logL_{II}] = 17.258 \sim \chi^2(2)$, p-value=0.0003.

profitability. The longer a firm operates at high productivity levels, the stronger the impact on its profitability. This result can be interpreted as evidence in favour of a class of models that emphasises that the interfirm differences are fundamental and the major determinants of firm profitability, such as Jovanovic (1982) and Lambson (1991). However, the coefficient is statistically not significant.[15]

In summary, the evidence in Tables 3 and 4 suggests that average profitability varies substantially across firms and sectors, implying that characteristics at the industry and firm level are empirically relevant in determining profitability. Results from variance decomposition analysis illustrate that firm effects are almost four times more important than industry-level influences. Estimating several multi-level models reveals that, among firm effects, productivity enhances profitability but also that this relationship is not identical across firms.

The findings presented in this section are sensitive to a number of factors. In particular, the methods and quality of measurement of key variables, such as productivity and profits, are crucial. Another caveat is that, due to limited availability of data, the model can not include time-varying industry variables but relies on the use of three- and five-year averages. Lastly, in comparison to the variance decomposition in Table 3, the portion (but not the magnitude) of unexplained variation is larger in Models I-III, indicating that other (potentially relevant) variables are omitted. Allowing for randomness in the coefficient for lagged productivity in Models II and III reduces $\hat{\rho}_\epsilon$ considerably.

The analysis leaves a number of questions unanswered. One possibility for future work is to examine the effect of intangible capital on profitability and, in particular, on the relationship between productivity and profitability. However, the availability of improved datasets is essential in order to pursue this question. Another option can be motivated by the observation in related studies that profitability is serially correlated. However, including a lag-dependent variable in the regression would result in biased parameter estimates, as pointed out by Nickell (1981). The integration of a dynamic profit model into a multi-level approach can be the subject for future work.

[15] Comparing II to III, a likelihood ratio test rejects the unrestricted Model III, $LR_{II,III} = -2[logL_{II} - logL_{III}] = 4.098 \sim \chi^2(2)$, p-value=0.1288. The LR test does not reject the null $\kappa_{21} = \kappa_{22} = 0$ which leaves Model II as the preferred model.

6 Conclusion

The purpose of this study was to investigate firm profitability and its determinants. Using multi-level modelling, the study decomposed unobserved profit heterogeneity into firm and industry effects and quantified their relative contribution. A particular aspect of the analysis was to examine the influence of productivity on profitability. Therefore, the model included measures of productivity, tested for variation in the relationship across firms and attempted to explain its properties.

For a sample of large Australian firms for the period 1995-2005, the analysis revealed that profits differ widely. Estimation results indicated that almost two thirds of the variation in firm profitability can be explained by differences across firms, and that industry effects are of much smaller magnitude. The determinants of profitability are firm size, productivity, age and financial risk. Industry concentration has a positive but statistically not significant impact. Another important result was that the level of total factor productivity enhances profit performance, although the influence was not homogenous across firms but dependent on firm size and productivity persistence.

Taken together, the main finding was that there is a substantial amount of heterogeneity in firm profitability which is, to a large extent, related to differences across firms. The analysis also illustrated that productivity enhances profitability, however not to the same extent for all firms. There seemed to be little support for the SCP model, implying that heterogeneity in profit performance is not necessarily linked to market failure that would justify the implementation of competition policy.

Appendix

Results from Alternative Profitability Measures

Table A-1: Results from Variance Decomposition, Alternative Profitability Measures.

Variables	Log Profit Level	Adjusted Profit Rate
Fixed Components		
Intercept	2.215***	5.105***
	(0.166)	*(1.960)*
Random Components		
Residual	0.611***	192.113***
	(0.022)	*(5.649)*
Firm-level Variance	2.899***	530.371***
	(0.221)	*(36.100)*
Industry-level Variance	0.539**	68.323**
	(0.226)	*(23.907)*
Variance Decomposition		
Residual	15.1%	24.3%
Firm-level	71.6%	67.1%
Industry-level	13.3%	8.6%
Log L	-3,043.936	-12,686.762
Number of observations	2,039	2,949
Number of firms	436	603
Number of industries	36	36

Note: Statistical significance: *** at 1%, ** at 5%, * at 10%. Standard errors in parentheses. Adjusted profit rate is defined as [EBITDA - (fixed assets · 10year interest rate)] / total assets. The models are estimated in Stata 9.2 using the command -xtmixed-. In the second column, the number of observations is reduced because taking logs eliminates negative profit values.

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