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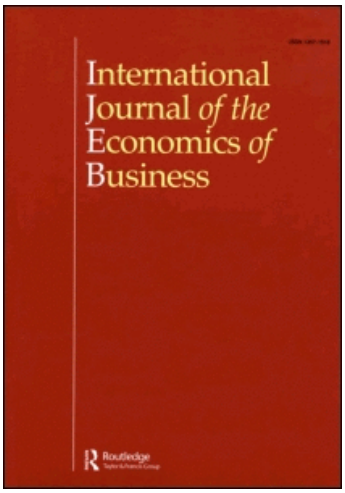

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Does Size Matter in Firm Performance? Evidence from US Public Firms

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Does Size Matter in Firm Performance? Evidence from US Public Firms

JIM LEE

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ABSTRACT *This paper reexamines the determinants of firm performance and, in particular, the role that firm size plays in profitability. A fixed-effects dynamic panel data model for over 7,000 US publicly-held firms during the period 1987–2006 provides evidence that profit rates are positively correlated with firm size in a non-linear manner, holding an array of firm- and industry-specific characteristics constant. In addition, industry-specific fixed effects play a negligible role in the presence of firm-specific fixed effects.*

Key Words: Profit Rates; Panel Data; Firm Size; Industry Effects; Firm Effects.

JEL classifications: L25, D21, C61.

1. Introduction

Are larger firms more profitable better than smaller firms? Discussions of the role of firm size in explaining firm performance have been ongoing in the fields of business organization and industrial economics. Early research, notably by Scherer (1973) and Shepherd (1972), emphasizes the importance of scale economies and other efficiencies in larger firms. On the other hand, the structure-conduct-performance paradigm highlights the importance of market concentration and conduct in explaining profitability. In particular, Baumol (1967) argues that the advantages of larger firms stem from their market power and greater access to capital markets. Caves and Porter (1977), and Porter (1979) also attribute variations in profitability to group strategic behavior in different industries.

With a few exceptions, notably Shepherd (1972), there is considerable evidence in early empirical studies (e.g. Scherer, 1973; Hall and Weiss, 1967) to support a positive relationship between firm size and profitability. However, as Caves and Pugel (1980) point out, many of these studies neglect the possible effects of other factors, such as market structure, entry barriers and firm strategies. More recent studies have attempted to control for these market and firm-

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specific characteristics and found more equivocal support for a relationship between firm size and profitability. For instance, Amato and Wilder (1985) find a firm's market share instead of its size plays a significant role in explaining its relative performance. Amato and Amato (2004) find evidence in US retailing industries to support Porter's (1985, 1998) conjecture that both small and large firms can effectively capture niche markets, while middle-sized firms are 'stuck in the middle' in the sense that they are less competitive than their counterparts in either end of the firm size distribution.

While recent studies have provided additional evidence on the determinants of firm performance, their empirical results are difficult to generalize as they are drawn mostly from data of large firms, a single year or industry. This paper aims at filling this gap. More specifically, we examine the determinants of firm profitability and particularly the role of firm size by considering a dataset sufficiently large to represent Corporate America. Moreover, we employ a regression method that pools panels of cross-section data over time between 1987 and 2006. This panel data model allows us to provide insight into the dynamic nature of firm performance in the past two decades.

The rest of the paper proceeds as follows. Section 2 contains a brief review of the existing literature on the relative role of firm-oriented versus market-oriented determinants of firm profit rates. Section 3 presents the data and model specification. Section 4 discusses the empirical results. Section 5 contains a summary and conclusion.

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2. Previous Literature

Other than the absolute size of a firm, firm performance is conceivably affected by a variety of market-oriented and firm strategic factors. In order to analyze the firm size-profitability relationship, these variables have to take taken into consideration as well. Because an extensive review of the large body of literature on the determinants of firm performance is beyond the scope of this paper, this section instead focuses on the major contributions that affect our empirical work. From the viewpoint of empirical methodology, research work on firm profitability can be divided into two groups: cross-section and time-series oriented studies.

2.1 Cross-Sectional Evidence

The bulk of research relying on cross-sectional data includes measures of firm size and market power as the key variables for explaining firm profits. Considerable evidence supports the convention wisdom of a positive firm size-profitability relationship. However, Caves and Porter (1977) and Porter (1979) point out that the relationship between firm size and profitability may vary across industries. Ratchford and Stoops (1998) find diseconomies to scale at the upper end of the size distribution among retail firms. Similarly, Amato and Amato (2004) find a nonlinear relationship in retailing industries that supports Porter's 'stuck in the middle' hypothesis about the extent of inefficiencies of medium-sized firms.

Ravenscraft (1983) and Amato and Wilder (1985) show that the explanatory power of a firm's absolute size in determining its profitability is sensitive to the presence of such variables as its market share and market concentration. In line with the structure-conduct-performance paradigm, they instead find market share to be the key factor in explaining profitability. While Ravenscraft (1983)

interprets market share as a measure of firm efficiency, Shepherd (1972) considers it to be a source of market power. Nevertheless, Szymanski *et al.* (1993) review the results from 76 empirical studies on the relationship between market share and profitability, and conclude that the evidence supports neither the market power nor the firm efficiency hypothesis. Mariuzzo *et al.* (2003) also report that in markets of differentiated products, such as soft drinks, market power does not increase for firms with a larger market share.

While a firm's market share is widely regarded as an empirical proxy of market power, various studies (e.g. Amato and Wilder, 1985; Mueller, 1990; Amato and Amato, 2004) also find strong support for other variables reflecting the extent of market power, such as capital intensity, advertising intensity, R&D expenses and market concentration. Capital requirements, R&D and advertising expenses are widely considered as sources of entry barriers, thus raising the market power of firms in an industry. Advertising intensity also serves as a proxy for product differentiation. Bain (1956) argues that these forms of entry barriers affecting market structure and thus market profitability.

Similar to market share at the firm level, market concentration is regarded as a key source of market power at the industry level. Weiss (1974) hypothesizes that firms in highly concentrated industries have a greater tendency to collude, driving up the price-cost margin. However, Qualls (1979) argues that a stable profits-concentration relationship exists only if industries have high entry barriers. Shepherd (1972) and Ravenscraft (1983) find that market share dominates the explanatory power over market concentration in explaining profitability. Ravenscraft (1983) further shows that the estimated relationship between profits and concentration is negative when market share is also present in a regression model. These results further suggest considerable interactions between the alternative measures of market power.

In line with the structure-conduct-performance thesis, the factors as presented above reflect in different degrees the role of the industry in firm performance. An alternative line of research recognizes firm-specific characteristics and emphasizes that some firms in the same industry are better managed than others. For instance, Miller (1981), and Amato and Amato (2004) find evidence in retailing industries that higher profit rates are associated with lower inventory to sales ratios, which reflect a firm's efficiency in inventory management.

Amato and Amato (2004) also consider the financial conditions of firms by looking at their bad debt to sales ratios and net worth to assets ratios. They find both variables to be negatively correlated with profit rates. While a large amount of bad debt relative to sales obviously hinders firm performance, the adverse effect of a relatively high net worth on profit rates can be explained by the agency theory that increased borrowing tends to raise scrutiny by the lending institutions, thus giving the firm's managers greater access to lenders' expertise in managing its financial conditions.

In a competitive market, risk can play a role in explaining variations in firm returns. A firm tends to perform better in the long run by taking more risk. However, there is no consensus on how to measure risk. Gschwandtner (2005) measures risk by the standard deviation of profit returns and find it to be a marginally insignificant variable in explaining varying firm profitability. Mueller (1990) considers alternative measures of risk and find a statistically significant estimate for a firm's stock market return beta, which measures the sensitivity of its individual stock price to broad market movements.

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Other than industry and firm characteristics, it is widely believed that firm performance responds to overall business cycle conditions. Qualls (1979) asserts that the business cycle affects firms, particularly oligopolists, to coordinate behavior. This assertion is partially supported by Domowitz *et al.* (1986), who find that the relationship between market concentration and profits varies over the course of the business cycle.

2.2 Time-Series Evidence

While earlier studies examine firm profitability from the cross-sectional perspective, a growing literature since Mueller (1977, 1986) explores the dynamics of profitability over time using autoregressive models. Some studies (e.g. Kessides, 1990) find substantial persistence in firm profits over time. The evidence of high persistence in profit rates suggests that firms can enjoy market power through high entry barriers and that market competition is ineffective in eliminating excess profits from firms. Mueller (1990) examines this competitive environment hypothesis for two periods, 1950–72 and 1964–84, and finds profits to be less persistent and thus markets more competitive in the more recent period. It would be interesting to see if such a trend continues through the present.

Most of the traditional time-series based studies focus on the overall patterns of profits over time, ignoring heterogeneity among firms within industries. Gschwandtner (2005) find that profit persistence is associated with industry characteristics, such as concentration and growth, and larger firms tend to enjoy higher long-run profit rates. When she divides the sample into surviving and exiting firms, then she also finds exiters to behave more competitively than survivors before exiting the market.

2.3 Evidence from Panel Data

A few recent studies apply panel techniques to accommodate unobserved firm-specific effects in time-series regression. Panel models pool cross-section and time-series data together. However, the focus of these studies (e.g. Gersoki *et al*., 2003; Glen *et al.,* 2003; Goddard *et al*., 2006) remains on the degree of persistence in firm profits over time, which might be less interesting than the determinants of profits across firms or industries, at least from the policy perspective.

In addition to the potential insight into firm performance over time, panel data models can account for unobserved heterogeneity among firms, also known as individual effects. As shown in the next section, one way to capture such effects is to include additional dummy variables into the regression to capture unobserved firm-level or industry-level effects that are constant over time. Schmalensee (1985), and Cubbin and Geroski (1987), among others, use this least-squares dummy variable (LSDV) technique to show that industry-specific effects dominate firm-specific effects.

Notwithstanding the extensive research on firm profitability, the bulk of the literature concerns mainly manufacturing industries. Interestingly, Amato and Amato (2004) find that the typical firm size-profitability relationship established in those studies using data of manufacturing firms does not hold in retailing industries. From this perspective, we contribute to the existing literature in two directions. First, rather than confining our results to a single industry or a few firms, we consider a rather comprehensive sample of firms that represent a

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sufficiently broad range of firm sizes in nearly all sectors of the US. Second, we incorporate the time dimension of firm-level data in a panel framework so that we can evaluate whether the US markets in the past two decades have become more or less competitive.

3. Model Specification and Data

3.1 Model Specification

The general panel data model for firm i's profit rate in period t,π_{it} can generally be expressed as:

$$\pi_{it} = \alpha + \rho\pi_{i,t-1} + X'_{it}\beta + \varepsilon_{it}, \qquad \text{for } i = 1,\cdots,N; t = 1,\cdots,T \tag{1}$$

where $X_{it} = [x_{1it}\ldots x_{kit}]$ is a vector of independent variables with their corresponding coefficients included in β. The subscript i denotes an individual firm and the subscript t denotes a time period. The error term ε_{it} may vary across the N individual firms (individual effects) as well as across the T time periods (time effects), such that it can be expressed as:

$$\varepsilon_{it} = \lambda_i + \mu_t + \eta_{it}, \tag{2}$$

where λ_i is the component that varies across firms, μ_t is the component that varies over time, and η_{it} is a normally distributed random error.

The panel data model, as captured by equations (1) and (2), offers two advantages over traditional least-squares models. First, the model allows us to control for unobserved factors that differ from one firm to another, such as location advantages, but are constant over time. Second, the time-series dimension of the panel model allows us to control for variables that vary through time, such as increased global competition, but do not vary across firms. Moreover, equation (1) differs from the typical panel model by the inclusion of the lagged dependent variable, which renders the specification a dynamic panel as opposed to a static model. This specification provides potential insight into the degree of persistence in profits over time, while evaluating the explanatory power of other explanatory variables.

The next step in model specification is to identify the variables in X_{it}. The literature reviewed in section 2 offers considerable guidance on the list of variables to be included in the model for firm profitability. The factors that determine profit variations can be grouped into three categories: general economic conditions, industry-specific factors, and firm-specific factors.

The general economic conditions are proxied by the annual growth rate of US GDP, and the variable representing a firm's market environment is market concentration, as measured by the four-firm concentration ratio (CR4). The list of variables that capture observable firm-specific characteristics include: (1) firm size (LSIZE), as measured by the log value of total assets; (2) market share (SHARE), calculated as the share of a firm's total sales in its industry; (3) capital intensity (CAP), measured by the ratio of total assets over sales; (4) advertising intensity, measured as the ratio of advertising expenses over sales; (5) R&D intensity (R&D), measured by the ratio of R&D expenses over sales; (6) bad debt management (DEBT), measured by the ratio of bad debt expenses over total sales; (7)

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inventory management (INV), measured by the ratio of inventory stock over total sales; (8) the stock beta coefficient (BETA), which measures the volatility of a firm's stock price relative to the stock price volatility of the S&P 500 aggregate; and (9) a firm's sales growth (GROWTH), measured by the percentage change in sales from the previous year. All ratios are multiplied by 100 so that the variables are expressed in percentage terms.

Most of these explanatory variables and their data specifications have been discussed in detailed by Mueller (1990), and Amato and Amato (2004) in their examination of firm performance. Because advertising intensity, capital intensity and R&D intensity are widely considered as sources of entry barriers, these variables are commonly regarded (e.g. Schmalensee, 1985) as industry-oriented factors. As discussed in section 2 above, firm size, market share, capital intensity, and R&D intensity all raise the market power of a firm and are therefore expected to enter with a positive sign in the regression for profits. Similarly, the coefficient estimate for the stock beta is expected to be positive. On the contrary, the hypothesized signs for bad debt and inventory are negative.

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3.2 Data

Our sample is obtained from the *Compustat* database. All firm data are accessed through Standard & Poor's *Research Insight*.[1] The dataset consists of a total of 7,158 US publicly-held corporations listed in US stock exchanges over the 20-year period between 1987 and 2006 (i.e. N=7,158). Because of the use of the one-period lagged dependent variable, 1988 is the first period of regression (T=19). Because not all firms in the sample were listed over the entire observation period due to late entry or attrition, the data are unbalanced over time. Including firms with missing data minimizes survivorship bias that arises from excluding firms that dropped out before the end of the observation period.

The particular measure of profitability varies across studies. For example, Amato (1995), and Brown and Brown (2001) define a firm's profit rate as its price-cost margin (i.e. gross profits-to-sales ratio), Amato and Amato (2004) consider the return on assets gross of advertising, Goddard *et al.* (2006) define it as the ratio of pre-tax profit plus interest paid to total assets, and Gschwandtner (2005) define it as net income over total assets (i.e. return on assets). Our regression results with all these alternative measures show that the main findings, particularly on the size-profit relationship, are robust to the alternative measures of profit rates. To conserve space, we report only the results for Amato and Amato's (2004) measure of return so that the profit rate in percentage terms is defined as 100 × (net income + advertising expenses)/total assets. This definition is used to resolve the bias of estimating a model in which some explanatory variables, such as advertising expenses, are also part of the composite dependent variable.

In addition to firm-level data, our regressions involve industry-level data, such as a measure of market concentration. Concentration data are obtained from various volumes (1987, 1992, 1997 and 2002) of the *Economic Census* of the US Bureau of Census.[2] According to the 4-digit codes of the NAICS classification system, the sample firms are grouped into 46 industries, one of which is 'unclassified'. The industries are listed in the Appendix. Before 1997, the Census used the SIC definitions so that the industry definitions before and after 1997 are matched using the Census' NAICS/SIC conversion table.

Table 1 displays summary statistics for profit rates and other characteristics of the sample. For ease of exposition, the statistics are computed using a cross-section of firm data averaging over the full 20-year sample period, although model estimations below entail pooling the cross-sectional and time dimension together. Firm size, as measured by assets, varied widely across the sample. The smallest firms operated with no declared assets. Similarly, the intensities of capital, R&D and advertising expenses varied widely among firms. Firms that invested the most on R&D and capital were in the biotechnology industry, and those with relatively higher advertising to sales ratios (over 10%) tended to be in the motion pictures and consumer product manufacturing industries.

The mean profit rate is negative. About 45% of the sample (3,267 firms) experienced a loss on average over the observation period. The negative mean profit rate is also heavily influenced by firms that experienced substantial negative returns, particularly those in the biotechnology and airline industries. Similar observations have recently been reported by Habib and Ljungqvist (2005). The median profit rate of 1.37% is more informative. The rather low median profit rate reflects the competitive nature of US markets.

Market competitiveness is commonly considered to be an outcome of market concentration. The mean four-firm concentration ratio is 20.37. The auto manufacturing industry had the highest ratio of nearly 66%, while the agricultural industry was least concentrated. However, the market shares of individual firms convey a better perspective on market competition at the firm level. The mean market share is 0.63%. Firms with the largest market shares also tended to be the largest in size. These firms include Procter & Gamble (37% market share), Wal-Mart (30%) and Intel (21%).

Similar to the indicators of market environment, the data of firm-oriented factors at the bottom four row of Table 1 show substantial heterogeneity across firms. Not surprisingly, the median beta ratio is rather close to one, indicating that a typical firm's stock return is as volatile as the broad market return. Similar to the beta ratios, the means of inventory and debt ratios are skewed upward (i.e. higher than their respective medians) by a few firms that are riskier or relatively less efficient in their operations.

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Table 1. Summary statistics, firm averages over 1987–2006

	Mean	Median	Std. Dev.	Maximum	Minimum
Assets ($ millions)	2,390.78	84.49	18,935.11	606,774.05	0.00
(Net income + adv. expenses) / assets (%)	−102.16	1.37	1973.46	48100.00	−86500.00
Market share (%)	0.63	0.02	2.78	61.61	0.00
Annual sale growth (%)	4.34	0.17	90.96	−20.54	5216.95
R&D / sales (%)	2.87	0.04	26.80	416.88	0.00
Advertising / sales (%)	0.12	0.01	0.81	11.10	0.00
Assets / sales (%)	1,707.30	172.38	3,023.32	2,076,907.66	−5,120.35
CR4 (%)	20.37	16.52	15.54	65.87	0.70
Beta	3.16	0.83	137.83	6856.71	−3573.39
Inventory / sales (%)	16.85	6.13	82.11	3,662.65	0.00
Debt / sales (%)	2,307.75	2.48	76,548.74	5,090,890.00	0.00

4. Empirical Findings

4.1 Least Squares Results

We begin our preliminary empirical work by applying ordinary least-squares (OLS) to the panel data with the regression model captured by equation (1). In OLS regression, all coefficients, including the intercept term, are fixed across firms and time periods. Table 2 shows the estimation results for several specifications. Estimations allow for possible serial correlation and heteroskedasticity using the heteroskedasticity and autocorrelation consistent covariance matrix suggested by White (1980).[3]

Table 2. OLS regression results with firm data over 1987–2006

	OLS Models		OLS with Industry Effects	
	(A)	(B)	(C)	(D)
Intercept	–99.92 ***	–151.79 ***	–56.69 **	–144.18 **
	(–3.51)	(–7.25)	(–2.46)	(–1.98)
$\pi_{i,t-1}$	0.11	0.10	0.13 **	0.12 ***
	(0.87)	(0.42)	(2.24)	(2.75)
LSIZE		28.19 ***		31.65 ***
		(6.38)		(5.59)
SHARE		5.62 ***		6.37 ***
		(4.36)		(3.22)
CAP		0.01 *		0.01 ***
		(1.73)		(1.90)
ADV		1.98		1.17 **
		(1.22)		(2.05)
R&D		5.09 **		4.96 **
		(2.42)		(2.35)
GROWTH		4.15 ***		2.61 **
		(3.10)		(2.17)
BETA		–0.01		–0.01
		(–0.66)		(–0.65)
DEBT		–0.49 **		–0.48 **
		(–2.11)		(–2.09)
INV		68.39		67.02 *
		(0.36)		(1.71)
CR4		0.94 **		4.41
		(2.53)		(1.10)
RGDP		1.03		0.86
		(0.40)		(0.31)
IND_j			Included	Included
Adjusted R^2	0.01	0.11	0.12	0.13
Log-Likelihood	–47698.6	–33902.0	–47644.9	–33862.3
Observations	84,236	84,236	84,236	84,236
Breusch-Pagan Test:				
Individual effects	1.40 ***	1.66 ***	1.10 *	1.12 *
Time effects	0.82	0.54	0.78	0.45

Notes: t-statistics are in parentheses. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

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For comparison purposes, column A shows the results of a model specification that includes the lagged profit rate as the only explanatory variable. The coefficient estimate around 0.1 reflects a modest level of persistence over time, and the past profit rates explain a mere 1% of current profit variations among firms. This estimate of profitability persistence is in par with Mueller's (1990) finding for a sample of 551 manufacturing firms over the period 1950–72, but somewhat lower than Kessides' (1990) estimate with industry-level data in manufacturing over the period 1967–82.

In addition to the lagged dependent variable, the model specification shown in column B includes 11 additional regressors that are discussed in section 3 above. The first regressor is the real GDP variable (RGDP), which reflects the general macroeconomic condition; and the second regressor is the four-firm concentration ratio (CR4), which serves as a direct measure of market power. The other variables capture firm-specific effects: Absolute firm size measured as the log value of assets (LSIZE), firm market share (SHARE), capital intensity (CAP), advertising intensity (ADV), R&D intensity (R&D), sales growth (GROWTH), stock volatility (BETA), debt to sales ratio (DEBT), and the inventory to sales ratio (INV). Except for the beta coefficient, all estimates carry the expected sign, even though not all of them are statistically significant. In particular, the coefficient estimate for RGDP suggests that profit rates are not associated with the business cycle. Such a finding is at odds with the results reported by Domowitz *et al.* (1986). Together, these independent variables explain another 10% of profit rate variations in addition to the lagged profit rate. In particular, the results support that larger firms tend to be more profitable.

Columns C and D of Table 2 report estimation results that correspond to the results in columns A and B but also allow for unobserved industry characteristics. More specifically, the regressions include a set of 45 dummy variables, IND_j (j=1,…,45) each equals one for firms in one particular industry (all industries listed in the Appendix except 'unclassified') and zero otherwise.[4] Each dummy variable captures unobserved industry-level effects that are the same for all firms within the industry, such as regulations and cost structures. The inclusion of industry dummies does not appreciably alter the original estimates of the independent variables except CR4, which is perhaps correlated with the industry effects. The lagged dependent variable is statistically meaningful, but their coefficient estimates again show only modest persistence in profit rates over time. The $\chi^2(45)$ statistic for restricting all coefficients of the dummy variables to zero is 155.41, which is significant at the 1% level. The adjusted R^2 statistics indicate that these dummy variables together account for about 10% of profit rate variations. This estimate of industry effects is larger than the 5% reported by Amato and Amato (2004) for retailing industries, but smaller than the 20% reported by Schmalensee (1985) and Powell (1996) for other industries. Such disparities are attributable to differences in samples and industry definitions.[5]

The bottom two rows of Table 2 report the Breusch-Pagan test statistics for individual effects and time effects, each distributed as χ^2 (1). The null hypothesis for individual firm effects is $H_0{:}\sigma_\alpha^2 = 0$, and the null hypothesis for time effects is $H_0{:}\sigma_\varepsilon^2 = 0$. While the χ^2 statistics provide no evidence of time effects in all cases, the results support the presence of individual effects. The absence of time effects is in line with the insignificant estimates for RGDP. When unobserved industry-specific effects are taken into account, the evidence of individual effect weakens considerably, although the statistics remain marginally significant at the 10%

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level. These test results motivate us to fit the panel data with a model that allows the coefficients to vary across firms but remain fixed across different years.

4.2 Results with Fixed Effects

Motivated by the diagnostic statistics from OLS estimations, we proceed to panel data regression with unobserved firm-specific or individual effects. In the context of equation (2), an individual-effects model simply allows the residual term to vary by firm such that $\varepsilon_{it} = \lambda_i + \eta_{it}$. An individual-effects model can be estimated using a fixed-effects estimator, which is an LSDV method that handles unobserved firm-specific effects using $N - 1$ dummy variables, with computational shortcuts to avoid having to run a regression with all the extra variables.[6]

An alternative to the fixed-effects estimator is the random-effects estimator, which employs a generalized least-squares (GLS) method to decompose unobserved firm-specific effects from the error term ε_i instead of using dummy variables. There are advantages and disadvantages in the treatment of individual effects by the alternative estimators, and Hausman's (1978) specification test can shed light on their relative reliability. Under the null hypothesis, the error term is independent of the regressors, i.e., $H_0 : E(Z_{it}\varepsilon_{it}) = 0$ where $Z_{it} = [\pi_{it} \vdots X_{it}]$, such that the GLS estimator is applicable and its estimates are both consistent and efficient. Under the alternative, the GLS estimator is inconsistent. On the other hand, the LSDV fixed-effects estimator is consistent under both the null and the alternative. The bottom row of Table 3 shows the χ^2 statistics for testing the difference between the covariance matrices of the two estimators with the number of degrees of freedom equal to the number of regressors. All test statistics are statistically significant at conventional levels, implying that the random effects estimator would yield inconsistent estimates.

Table 3 also reports regression results of several model specifications using the fixed-effects estimator. Estimates for the firm-specific intercepts are not displayed to conserve space. The first two specifications (columns A and B) correspond to the OLS regression model specifications in Table 2. The difference between the two fixed-effects (Table 3) and OLS estimators (Table 2) is the consideration of unobserved time-invariant firm-specific characteristics in the former. The coefficient estimates appear to be robust to the inclusion of the industry dummy variables. Despite differences in the estimation method, firm size and variables reflecting market power (including market share and R&D intensity) remain significant at conventional statistical levels.

The adjusted R^2's indicate that unobserved firm-level factors explain about 10% of profit variations. These factors dominate unobserved industry-level factors in explaining the dependent variable. The finding on the relative role of unobserved firm-level factors versus industry-level factors confirms the finding of Cubbin and Geroski (1987), but contrasts with that reported by Schmalensee (1985). Based on the implied log-likelihood values of the fixed-effects model estimated with and without industry dummies, the likelihood ratio (LR) test cannot reject the null of no difference between the two models.[7] However, a comparison of the implied log-likelihood value of the fixed-effects estimator (model A in Table 3) and the OLS estimator (model B in Table 2) lends strong support to the role that unobserved firm-level factors play in explaining variations in profitability. The observed differences between the coefficient estimates of these two estimators highlight the extent of bias due to unobserved firm heterogeneity.

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Table 3. Regression results with panel data

	Fixed Effects Models			
	(A)	(B)	(C)	(D)
$\pi_{i,t-1}$	0.23 ***	0.24 ***	0.18 ***	0.17 ***
	(5.37)	(5.45)	(4.40)	(4.18)
LSIZE	33.67 ***	34.08 ***	131.63 ***	105.00 ***
	(5.43)	(5.36)	(4.32)	(8.37)
$LSIZE^2$			−10.69 ***	−10.64 ***
			(−9.90)	(−9.67)
SHARE	6.53 ***	6.35 ***	5.81 ***	11.38 ***
	(4.90)	(4.49)	(4.51)	(6.18)
CAP	0.01	0.01	0.01	0.01
	(0.26)	(0.24)	(0.15)	(0.33)
ADV	3.10	9.19	6.93	7.72
	(0.48)	(0.80)	(1.17)	(0.71)
R&D	4.18 **	4.13 **	4.41 ***	4.32 ***
	(2.48)	(2.45)	(2.87)	(2.84)
GROWTH	1.13	0.95	1.00	1.18
	(0.79)	(0.66)	(0.76)	(0.91)
BETA	−0.005	−0.005	−0.004	−0.004
	(−0.15)	(−1.22)	(−0.31)	(−0.69)
DEBT	−0.30	−0.21	−0.24	−0.20
	(−0.27)	(0.31)	(−0.22)	(−0.24)
INV	50.12 **	43.38	42.32 *	38.76
	(1.97)	(1.43)	(1.65)	(1.22)
CR4	1.47	1.63	0.87	3.71 **
	(1.01)	(0.75)	(0.65)	(1.91)
RGDP	0.76	0.81	1.22	4.62
	(0.27)	(0.28)	(0.47)	(0.98)
ADV*SHARE				1.79 ***
				(3.44)
ADV*CAP				1.75 ***
				(3.04)
CR4*ADV				0.07
				(0.12)
CR4*CAP				0.81 ***
				(9.18)
CR4*RGDP				0.14
				(0.82)
IND_j		Included		
Adjusted R^2	0.21	0.15	0.34	0.35
Log-Likelihood	−33566.0	−33557.4	−33123.6	−33071.9
Observations	84,236	84,236	84,236	84,236

Notes: t-statistics are in parentheses. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

The next two columns in Table 3 show results of other specifications without industry dummies. In column C, a squared term of the firm size variable ($LSIZE^2$) is added to explore the nature of nonlinearity in the firm size-profits relationship, as suggested by Porter (1985) and empirically supported by Amato and Amato (2004).

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The coefficient estimate for the squared term is negative and statistically significant at conventional levels. The estimates for the two firm size variables together suggest that larger firms tend to experience higher profitability but the rate of profit gains reduces as firms continue to grow.

Column D of Table 3 reports the results of a model that takes into account possible interactions between the existing explanatory variables, particularly advertising intensity, capital intensity, market share, market concentration, and GDP growth. The empirical importance of these interactive terms in revealing the complex relationships among the explanatory variables is supported by prior studies, such as Ravenscraft (1983), Mueller (1990), Domowitz *et al.* (1986), Amato and Wilder (1985) and Amato and Amato (2004). For our data sample, the estimates are statistically meaningful for the interactions between advertising intensity and market share, between advertising intensity and market share, and between market concentration and capital intensity. Interestingly, while capital intensity does not meaningfully explain profitability, the interaction between capital intensity and market concentration does. Moreover, the roles of firm size and market share remain robust to the inclusion of the interactive terms.

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5. Summary and Conclusion

A major line of research in business organization and industrial economics is to evaluate factors that help explain firm profitability. Other than various market-based factors, the absolute size of a firm is widely considered to be a key determinant. The conventional wisdom is that larger firms tend to be more profitable than their smaller counterparts, either due to efficiency gains or higher market power. We have investigated this hypothesis using a sample of more than 7,000 US publicly-held firms observed over a recent period between 1987 and 2006. In addition to firm size, the explanatory variables encompass an array of firm and industry-specific factors considered in the existing literature.

The finding of substantial individual effects in the panel data suggests that firms' profit experience differs from those of their rivals within the industry. Industry-specific fixed effects play a negligible role in the presence of firm-specific fixed effects. However, observed industry-level factors, such as market concentration and entry barriers, do play a meaningful role in explaining firm profitability.

The US marketplace appears to be competitive, with about 45% of firms in our sample experiencing losses on average over the 20-year sample period. Moreover, regressions with the dynamic panel model indicate that profits are short-lived rather than persistent over time. Past profit experience *per se* accounts for no more than 20% of current profits. There is also scant evidence to suggest that the extent of competition has changed in any meaningful manner over time.

Along with market share, absolute firm size plays a dominant role in explaining variations in profitability. Estimation results support the conventional wisdom of a positive firm size-profit relationship. The estimated relationship is nonlinear in the sense that gains in profitability reduces for larger firms.

While a typical firm's absolute size matters for its profit experience, perhaps some other factors matter even more. As in most studies in the related literature, our empirical models indeed explain no more than 50% of profit variations among firms. While our sample covers more firms than those in prior studies, the regressions suffer from pooling firms in less closely related industries. As such,

much remains to be done in order to better understand the driving factors behind firm performance.

Notes

1. In order to control for the effects of inflation over time, the nominal values of assets are deflated by the producer price index. All other variables are expressed in ratios instead of levels so that no corresponding adjustments are needed. Because many firms are multinationals and export to other countries so that using their total sales and assets to measure market power is misleading. From this perspective, we subtract the amounts of assets and sales associated with foreign operations to obtain firm data associated with operations only in the US. The foreign-dependent data are obtained from *Research Insight*'s Geographic Segment database.
2. The Bureau of Census does not publish concentration data for the construction and agricultural sectors, so that we calculate the four-firm concentration ratios for these two industries as the ratio of the total market shares of the largest four firms in the sample over the total industry receipts reported by the Census. Since the data are available only every five years, we interpolate the data using a weighted average method for intermittent years such that, for example, $CR4_{1988}$ (concentration ratio for 1988) equals $0.75\times CR4_{1987}+0.25\times CR4_{1992}$. Data beginning 2002 equal the values for 2002.
3. We have also looked for possible multicollinearity by examining the partial correlation matrix of the explanatory variables. Most estimates in absolute terms are below 0.5, suggesting no severe problem of multicollinearity among the regressors.
4. To avoid the singularity problem, the last industry on the list ('unclassified') does not have a dummy variable.
5. While the four-digit level of NAICS industry definition is arbitrary, using the five-digit level definition requires substantially more dummy variables, thus dramatically reducing the degrees of freedom in estimation.
6. See Greene (2000, chapter 16) for detailed discussions of panel data regression.
7. The likelihood ratio test statistic is computed as two times the difference of the log-likelihood values. A χ^2 test on coefficient restrictions also confirms that the industry dummy variables together provide no marginally significant explanatory power in the model for profit rates.

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Appendix: Industry List

Agricultural Products
Oil & Gas Extraction
Mining
Utilities
Construction
Food/Beverage Manufacturing
Apparel Manufacturing
Wood/Paper Manufacturing
Oil Refineries & Chemical
Concrete Manufacturing
Iron/Steel Manufacturing
Machinery Manufacturing
Computer & Electronic Manufacturing
Electrical Equipment
Auto/Transportation Manufacturing
Furniture Manufacturing
Medical Instrument Manufacturing
Wholesale
Retail
Airlines
Railroads
Water Transportation
Trucking
Pipeline Distribution
Freight Transportation
Media Publishing
Motion Pictures/Videos
Broadcasting
Telecommunications
Internet Service
Banking
Brokerages & Financial Services
Insurance
Real Estate
Rental
Professional Services
Office Administrative Services
Waste Management
Education Services
Physician/Medical Offices
Sports Clubs
Hotel/Casinos
Restaurants
Auto Repair
Other Services
Unclassified/Conglomerate

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