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Employees, firm size and profitability in U.S. manufacturing industries

Abstract

We examine the relation between firm size and profitability within 109 SIC four-digit manufacturing industries. Depending on our measure of profitability, we find that profitability increases at a decreasing rate and eventually declines in up to 47 of our industries. No relation between profitability and size is found in up to 52 of our industries. These two categories account for 97 of our 109 industries. Profitability continues to increase as firms become larger in up to 11 industries. Hence, the relation between size and profitability is industry specific. But, regardless of the shape of the size profitability function, we find that profitability is negatively correlated with the number of employees for firms of a given size measured in terms of total assets and sales.

These results are puzzling in the context of work by others who report that common stock returns are negatively correlated with size when size is measured by the market value of a company or with the work of those who argue that size is a proxy for risk. Interpreted against these works, our findings may mean that large firms earn excess returns, that small firms fail to earn their cost of capital, or that accounting returns simply behave differently than market returns with respect to firm size.

Keywords: profitability, size, financial statement analysis.
JEL Classification: G30.

Introduction

Does a connection exist between the size of a firm and its profitability? According to theories of firm size based on economies of scale, the answer is yes. However, other theories of the firm make different predictions – including a prediction that no relation exists between size and profitability. But, what is the evidence?

Much of the existing empirical work that examines the relation between size and profitability was motivated by questions about whether size led to market power and economic rents and whether firms in highly concentrated industries were more profitable than those in less concentrated industries, the assumption being that concentration reduced competition and increased profitability. The immediate empirical question investigated was whether intra-industry differences in profitability existed and, if so, whether they were related to industry concentration. A byproduct of testing these hypotheses was indirect information about the relation between firm size and accounting measures of profitability.

The accumulated evidence is mixed. Representative early studies include Hall and Weiss (1967) who reported that size did tend to be associated with higher profit rates among the Fortune 500 companies for the years 1956 through 1962. Stekler (1963) and Osborn (1970), however, reached the opposite conclusion.

Later, Schmalensee (1989), using *IRS Statistics of Income: Corporations* data for 1953 through 1983 at the two-digit SIC level in a study seeking to determine whether systematic changes in intra-industry profitability occurred over time, found that large firms were more profitable than small firms within the same industry. Schmalensee, as the others did, defined size in terms of total assets and used a number of accounting profitability measures including profit margin and return on assets. But, earlier work by Schmalensee (1987) at the four-digit SIC level found that firm size and profitability were not strongly correlated within these narrower industry definitions. So, Schmalensee's results are sensitive to SIC classification choices.

As we noted, these early studies sought to inform the industry structure-conduct-performance debate and not what determines (explains) firm size *per se*. As interest in the structure-conduct-performance debate waned, though, interest in why firms existed and the determinants of firm size itself waxed with a variety of theories emerging. Kumar, Rajan and Zingales (2001) classify these theories into three categories: technological, organizational and institutional. They have different implications for the relation between firm size and profitability through what they say about the determinants of an optimal size firm and/or constraints on firm growth.

We describe these theories in Section 1. Here we note that given the existing theories, no *a priori* reason exists to assume that large firms are inherently more profitable than small firms. In fact, Dhawan (2001), who examines the relation between firm size and productivity for U.S. firms between 1970 and 1989 at highly aggregated levels of services and manufacturing actually finds the opposite situation to be the case. Using Compustat data, Dhawan finds that profitability measured as operating income to total assets is negatively related to firm asset size.

We examine the relation between firm size and profitability within 109 SIC four-digit manufacturing industries between 1987, when extended data became available on Compustat, and 2002. Depending on our measure of profitability, we find that profitability increases at a decreasing rate and eventually declines in up to 47 of our industries. No relation between profitability and size is found in up to 52 of our industries. These two categories account for 97 of our 109 industries. Profitability continues to increase as firms become larger in up to 11 industries. Hence, the relation between size and profitability is industry specific. But, regardless of the shape of the size profitability function, we find that profitability is negatively correlated with the number of employees for firms of a given size measured in terms of total assets and sales.

These results are puzzling in the context of work by others who report that common stock returns are negatively correlated with size when size is measured by the market value of a company or with the work of those who argue that size is a proxy for risk (e.g., Banz, 1981; Fama and French, 1992). Interpreted against these stylized facts and hypotheses, our findings may mean that large firms earn excess returns or that small firms fail to earn their cost of capital.

We describe our research method and the data we used for our statistical analyses in Section 2. Our statistical findings are reported in Section 3. Section 4 explores connections between profitability functions and capital intensity, industry concentration ratios, market-to-book ratios and firm diversification. The final Section contains our analysis and conclusions.

1. Theories of the firm

Theories of the firm can be classified as technological, organizational and institutional depending on whether they emphasize the production technology used by the firm, the firm's organizational architecture and relations among stakeholders or the legal and political environment where the firm operates. The theories often contain implicit assumptions about the relation between size and profitability, especially those theories that suggest the existence of an "optimal size" firm or limits to firm size due to diseconomies of scale or market size.

We briefly review these theories with respect to what they predict, if anything, about the relation between size and profitability. Our review follows the structure used by Kumar, Rajan and Zingales (2001).

1.1. Technological theories. Technological theories emphasize physical capital and economies of scale and scope as factors that determine optimal firm size and, by implication, profitability. These theories focus on the production process and the investment in physical capital necessary to produce output. Increasing economies of scale that permit lumpy fixed costs to be spread over large output volumes, thereby, decreasing the average cost of production and increasing the return on capital invested, are associated with increases in firm size. If no limit exists to economies of scale, the unregulated outcome would be one firm and a natural monopoly. However, if economies of scale cease to exist, at that point bigger is no longer better, at least in terms of lowering production costs and improving efficiency.

The relation between size and profitability due to economies of scale is depicted in Figure 1. Whether efficiency and profitability eventually fall (average costs increase) as firms expand under a purely technological story is unclear. One can assert that they do due to diseconomies of scale; but, the question then arises as to what causes these diseconomies. Organizational theories enter the picture here.

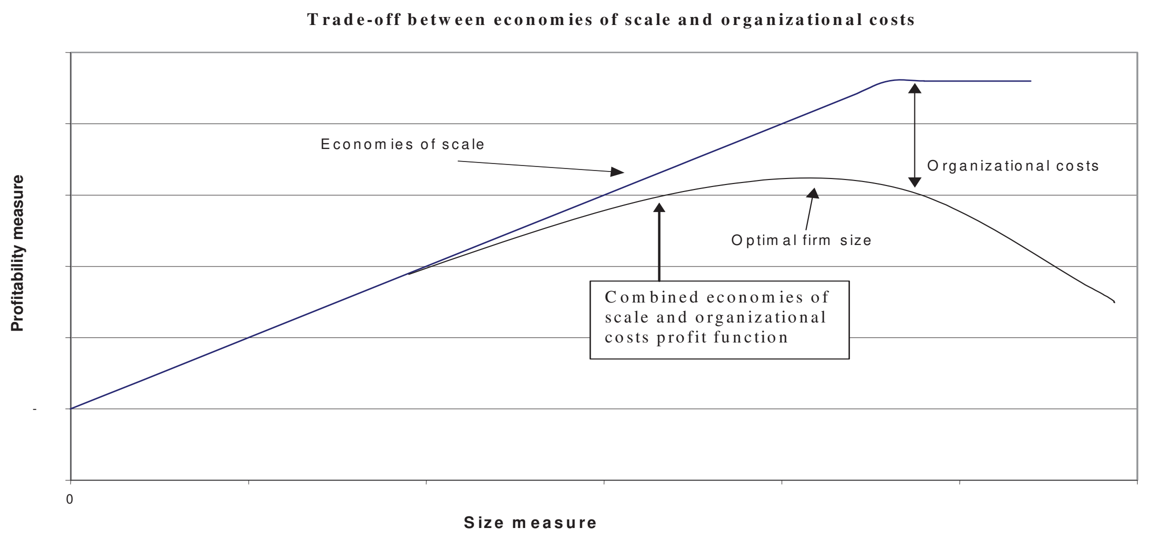

Fig. 1. Predicted relation between profitability and size

1.2. Organizational theories. Organizational theories have size affecting profitability through organizational transaction costs (Williamson, 1985), agency costs (Jensen and Meckling, 1976) and span of control costs. We also include under organizational theories critical resource (Grossman and Hart, 1986 and Rajan and Zingales, 2001) and competency (Foss, 1993 and Niman, 2002) theories of the firm.

Transaction costs are the costs of planning, adapting and monitoring task completion and performance in an organization. These costs include drafting and negotiating agreements as well as the costs of dealing with disputes and handling unintended outcomes.

Agency costs arise out of conflicts of interest among the stakeholders of the firm due to information asymmetries and self-seeking behavior. The underlying assumption for publicly owned firms is that managers and employees will seek to grow the firm even if it means making investments that do not cover their cost of capital because managerial and employee salaries, employment opportunities, perks and employment security are related to firm size.

Management can grow the firm by expanding its existing operations or through diversification and conglomeration. Both growth strategies may destroy shareholder wealth and some evidence exists that firms that pursue a diversification strategy sell at a discount to focused firms or that diversification strategies destroy shareholder value (Lamont and Polk, 2002).

Growing the firm is also equated with increasing layers of management and administrative staff which reduces the ability of the company to quickly respond to changing competitive conditions and to “log-rolling” within the firm’s bureaucracy with regard more to a function of politicking than of performance.

Other things being equal, the greater the span of control (number of administrative layers) in an organization, the greater the transaction and agency costs will be. A common proxy for the number of administrative layers is the number of employees. So, organizational theories of the firm based on transactions and agency costs and span of control costs predict that at some point average per unit transaction and agency costs would increase and offset economies of scale and scope, thus, establishing an optimal size for the firm in terms of profitability.

Critical resource theories of the firm emphasize the control that an entrepreneur or owner has over those resources – assets, technology, intellectual property – as determinants of firm size. Kumar, Rajan and Zingales (2001) find that as legal institutions and laws improve the protection afforded the owner of the company over these critical resources, the size of the firm increases. Rajan and Zingales (2002) go on to construct a model that ties firm size to the ability of the entrepreneur to maintain control over the intangible factors that make the firm profitable. The greater the importance of these intangible factors (relative to, say, fixed assets such as machinery), the less likely the firm is to grow (become larger). So, critical resource theories also tie firm size and profitability together in such a way that at some point, increased size leads to lower profits. However, under a critical resource theory of the firm “small” firms need not necessarily be less profitable than “large” firms within a given institutional environment.

Competency theories of the firm posit that the firm is a collection of competencies that allow it to earn more than its opportunity cost of capital (surplus, economic rents, positive net present value projects). These competencies can include superior production technologies, superior marketing skills and superior research and development skills. The important point is that one or more of these competencies permit the firm to remain competitive and earn more than an adequate return. But, in order for the firm to protect its position, it must make sure other companies do not acquire its superior competencies – also called secrets.

At this point, competency theories join critical resource theories. Think of competencies as the critical resources. One way to control the dissemination of secrets is to share them with as few people as possible and this implies restricting the size of the firm where size is defined in terms of employees. Consequently, this need to protect the secrets of the firm places a limit on its size.

Competency theories, however, do not assume that small firms are more or less profitable than large firms (or less than the size where secrets are disclosed). One of the appealing attributes of competency theory is that a “small” firm can be just as profitable as a “large” firm in a given industry because the firms have different competencies that let them both earn surplus returns. As described by Niman (2003), “Survival depends not on being better, but rather on being sufficiently different [due to different competencies] so that the advantages of others do not prove fatal”. In fact, a “small” firm may be more profitable than a “large” firm within its product niche due to its unique competencies. The reason the “small” firm does not grow is attributed to a “small” market for its product or services and/or to the loss of its secrets.

1.3. Institutional theories. Institutional theories tie firm size to such factors as legal systems, anti-trust regulation, patent protection, market size and the development of financial markets. Kumar, Rajan and Zingales (2001) report, for example, that capital-intensive firms are larger in countries with efficient judicial systems and that R&D intensive industries have larger firms in countries with stronger patent protection.

We have restricted our investigation to firms incorporated in the U.S. So, to some extent, we have controlled for many institutional factors. However, to the extent that some manufacturing industries may be more concentrated than others or subject to different regulations within the U.S., institutional and market structure factors may continue to affect observed relations between size and profitability.

1.4. Theory implications for firm size and profitability. The basic implication of combining technological and organizational theories emphasizing transaction and agency costs of firm size is that within a specific industry (common production technology) and within a common institutional environment, firm size and profitability may be linked through a trade-off of economies of scale, transactions costs and agency costs. Essentially, the story is the following:

Through some initial range, economies of scale lead to lower average unit costs. The benefits from these lower costs can be distributed among all the stakeholders of the firm or, through competitive pressures, lead to lower product prices. Let's take the case of competitive markets where the cost savings are passed on to the company's customers in the form of lower prices. The firm with the lowest unit production costs can charge the lowest prices. If unit costs are a decreasing function of size and the products of small firms are identical to that of large firms, then small firms will have to charge the same (or a lower) price as large firms resulting in lower per unit profits and a lower return on investment. Alternatively, at that point where economies of scale no longer exist, average unit costs would be unrelated to firm size. Then, one might observe, for example, medium and large firms being equally profitable, as depicted in Figure 1 where the graph for the line labeled economies of scales becomes level.

However, firms also face transaction, agency, and span of control costs (organizational costs), which, other things being equal, increase with firm size. Thus, at some point, organizational costs will overwhelm the benefits of economies of scale and firm profitability will begin to decline. In Figure 1, we have labeled the graph that depicts these trade offs as the "combined economies of scale and organizational costs profit function". The difference between this line and the economies of scale line is labeled organizational costs. At that size where economies of scale cease, continued growth results in ever-higher organizational costs and higher unit costs. Then, overall profitability falls. In essence, these organization costs place limits on how large a firm can grow in a competitive market where the governance of the firm is organized around the objective of owner wealth maximization.

Introducing critical resource and competency theories does, however, complicate this story. Both critical resource and competency theories imply a limit on firm size either directly so as to maintain secrets or indirectly through the size of the market for the firm's goods and services. Competency theories, in particular, pose a problem because the competencies firms possess may be a different means of production – the production functions of the technological theories. Therefore, overlaying a competency theory on a technological theory may or may not result in a prediction that size and profitability are negatively correlated. No relation may exist.

Whether firms with "secret" competencies incur transaction or agency costs as they become larger is another matter. If they do, size and profitability are negatively correlated; if not, again, no relation exists.

In summary, we are left with the following expectations about size and profitability: Either profitability initially increases and then levels off or it declines with respect to size or no relation exists between size and profitability.

2. Research method and data

In order to examine the relation between size and profitability, we must select proxies for size and profits. We also need to find a way to hold constant production technology and broad product classes where special competencies may exist across firms of different sizes.

2.1. Production technology issues. We confront the problem of holding constant production technology and broad product classes by analyzing manufacturing firms within the same industry where industry is defined by the four-digit SIC codes 2010 through 3990. Our underlying assumption is that firms in the same industry will use similar, if not identical, production technologies in a given year. Nevertheless, not all firms in a four-digit SIC produce identical products or are involved in a single line of business. Consequently, the less homogeneous the firms in a given SIC code are, the greater the likelihood that our underlying assumption of similar production technologies will be violated. We eventually control for diversification (nonhomogeneous firms) within an industry by including information about the number of business segments reported by our firms.

As for the competency complication: we assume that different competencies within an industry will be reflected in differences in product quality and performance as well as customer service and dependability. Therefore, the potential for finding no relation between size and profitability within a four-digit industry still exists.

2.2. Size measurements. The size of a firm can be measured in a number of ways: assets, sales, employees and value added are commonly used measures. Technological theories of the firm that focus on economies of scale arising out of capital inputs would argue for using assets or sales as a measure of size. However, assets or sales are not especially good measures of size for organizational theories of the firm. With these theories, the primary concern is with how transactions, agency and span of control costs affect profitability – costs that are associated primarily with how the organization is controlled through a hierarchy rather than with the value and number of physical assets. Therefore, value added or number of employees rather than assets or sales are better measures of firm size for organizational theories.

The advantage of value added is that it captures the complexity of an organization. Typically, complexity is associated with the need for more highly skilled employees and greater coordination and control costs. The implication is that the span of control, contracting and monitoring costs are likely to be higher for more complex operations than less complex operations.

The disadvantage of value added is that it is difficult to measure objectively. But, if most of the value added to a product arises from labor inputs, then the number of employees can also be used as a proxy for value added. An additional reason for using the number of employees is that coordination and control costs are likely to be highly correlated with both value added per employee and the number of employees. Finally, critical resource theories that predict entrepreneurs want to prevent secrets from leaving the firms would also suggest that, in a rough sense, the greater the number of employees, the more likely secrets will "leak". Therefore, our basic measure of size is the number of employees. But, we use the log of the number of employees in order to account for the fact that the median number of employees for firms in a given industry is considerably less than the mean.

2.3. Measuring profitability. Finding measures for profitability also poses problems. Traditionally, accounting profitability is measured by return on net worth (common stockholders' equity), return on assets, net profit margin, net income, earnings before interest and taxes (EBIT), earnings before interest, taxes, depreciation and amortization (EBITDA) and other related measures. We choose to use the following profitability measures: EBITDA margin, EBIT margin and EBITDA as a percent of total assets and EBIT to total assets.

Both EBITDA and EBIT measure earning flows before interest and taxes. This attribute is extremely important because we can separate the effects of management's financing decisions from the fundamental earning power of the company. For example, two companies may have identical EBITs but different net incomes and returns on net worth because one uses debt financing and incurs interest expense. We would expect the company that uses debt to have a higher return on net worth; but, whether this higher return on net worth is adequate for the increased risks associated with using financial leverage is another matter. By using EBIT and not net income after taxes, we avoid this problem.

We use EBITDA because it is a good proxy for cash earnings (operating cash flows). Depreciation and amortization are non-cash expenses. So, if one wants to know how much cash a company is generating – cash that can be used to pay dividends or reinvest in the company – EBITDA is the preferred metric. A related attribute of EBITDA is that it mitigates the distortions to operating income caused by arbitrary asset depreciation schedules.

We use EBITDA to total assets (EBITDA/TA) and EBIT to total assets (EBIT/TA) as our return on investment measures. It is possible that some firms in an industry may adopt a high margin, low volume sales strategy while others, a low margin, high volume strategy. The former would exhibit higher profit margins than the latter; but, both could be generating the same return on assets employed.

2.4. The data. Our data come from the year 2003 Standard and Poor's Compustat files and are for four digit manufacturing SIC codes with at least four firms. We collect the following yearly data for 1987 through 2002: company name, country of incorporation, dollar sales, dollar EBITDA, dollar EBIT, EBITDA margin, EBIT margin, total assets and number of employees. We use the data to calculate EBITDA to total assets and EBIT to total assets, our return on investment measures of profitability.

We then go through the following screening process: We eliminate all companies not incorporated in the U.S. We eliminate any firm-year observations with missing data. In order to remove potential distortions associated with barely functioning companies or with startups, we eliminate all firms that have sales of less than $10 million, fewer than 25 employees or an EBIT margin of less than a negative 50 percent. We then eliminate any industry that has fewer than four companies in any given year so that we have at least one degree of freedom in terms of estimating a second degree polynomial. We end up with the 109 industries listed in Table 1. The total number of firm years for each industry group during the sample period is also included in Table 1.

Table 1. SIC manufacturing industries

Sample industries for which there are at least three observations in a given year between 1987 and 2002. Number of observations is the total number of firm-years by industry during the sample period.

SIC	Name of industry	Number of observations
2015	Poultry, and eggs, prepared or preserved	121
2030	Fruits, vegetables, soups, preserves, jams and jellies; and sauces	178
2040	Grain mill products	160
2060	Sugar and confectionery products	153
2090	Miscellaneous food preparations and kindred products	168
2200	Textile mill products	194
2211	Broad woven fabrics, cotton	143
2253	Knit Outwear Mills	98
2273	Carpets and rugs	82
2300	Apparel and related products	227
2320	Men's or boys' shirts, trousers, nightwear, underwear, & neckwear; and females and infants knit shirts	229
2330	Women's, girls', and infants' dresses, blouses, coats, suits, and shirts, except knit shirts	277
2430	Millwork, plywood, and veneer	79
2451	Trailers and semi-trailers for housing or camping	124
2510	Household furniture	158
2511	Wood household furniture, except upholstered	111
2621	Paper mill products	247
2631	Paperboard	135
2650	Boxes of paper, of paperboard, of papier-mache, or any combinations thereof	103
2670	Converted paper and paperboard products, except containers and boxes	270
2711	Newspapers	279
2721	Periodicals	121
2731	Books and pamphlets	150
2750	Printed matter	270
2761	Manifold business forms	140
2810	Industrial inorganic chemicals	230
2821	Plastics materials and resins	158
2834	Pharmaceutical preparations	939
2835	Prepared diagnostic substances	272
2836	Biological products	220
2840	Soaps, detergents, and cleaning preparations, perfumes, cosmetics, and other toilet preparations	108
2842	Specialty cleaning, polishing, and sanitation preparations	75
2844	Toilet preparations	306
2851	Paints and allied products	136
2860	Industrial organic chemicals	185
2870	Agricultural chemicals	128
2890	Miscellaneous chemical products	198
2911	Petroleum refinery products	427
3021	Rubber and plastics footwear	96
3060	Druggist or medical supplies, (including gloves) of rubber or plastics	120
3080	Miscellaneous plastics products	145
3081	Plastics unsupported plates, sheets and film	128
3089	Plastics products	411
3100	Leather and leather products	85
3140	Footwear, except rubber	261
3270	Concrete, gypsum and plaster products, and lime	110

Table 1 (cont.). SIC manufacturing industries

SIC	Name of industry	Number of observations
3290	Abrasive, asbestos, and miscellaneous nonmetallic mineral products	108
3310	Blast furnace, steel works, rolling mill and finishing mill products	123
3312	Blast furnace, steel works, and rolling mill products	469
3317	Steel pipe and tubes	84
3350	Rolled, drawn and extruded nonferrous metal	167
3357	Nonferrous metal wire and cable, drawn and insulated	122
3411	Metal cans	83
3420	Cutlery, hand and edge tools, and hardware	216
3443	Fabricated plate work	133
3452	Bolts, nuts, rivets, and washers	126
3460	Metal forgings and stampings	168
3490	Fabricated metal products	256
3523	Farm machinery and equipment, and parts	145
3531	Construction machinery, and parts	140
3533	Oil and gas field machinery and equipment, and parts	141
3540	Metalworking machinery and equipment, and parts	193
3555	Printing trades machines and equipment, and parts	102
3559	Special industry machinery, and parts	571
3560	General industrial machinery and equipment, and parts	196
3561	Pumps and pumping equipment, and parts	124
3564	Fans and blowers, and parts	144
3569	General industrial machinery and equipment, and parts	179
3571	Computers, and parts	428
3572	Computer storage devices, and parts	307
3576	Computer terminals	622
3577	Computer peripheral equipment, and parts	602
3578	Calculating and accounting machines, and parts	135
3580	Refrigeration and service industry machinery, and parts	152
3585	Refrigeration and heating equipment	199
3590	Fluid power pumps and motors and scales and balances, except laboratory	125
3620	Electrical industrial apparatus, and parts	160
3621	Motors and generators, and parts	150
3634	Electric housewares and fans	117
3640	Electric lighting and wiring equipment	324
3651	Radio and tv receiving sets, phonographs, record players, record changers, turntables, and audio equipment	170
3661	Telephone and telegraph apparatus, and parts	683
3663	Radio, broadcast, and television communications equipment	747
3669	Other communications equipment, and parts	244
3670	Electronic components and accessories	132
3672	Printed circuit boards	292
3674	Semiconductors and related devices, and parts	1,074
3679	Electronic components	447
3690	Electrical machinery, equipment, and supplies, and parts	239
3711	Motor vehicles and passenger car bodies	168
3714	Motor vehicle parts and accessories	623
3716	Motor homes	98
3724	Aircraft engines and engine parts	131
3728	Aircraft equipment	122
3730	Yachts or pleasure boats, and parts	117
3812	Navigation, aeronautical, search, detection, guidance, and nautical systems, instruments, and equipments	358
3821	Laboratory apparatus and furniture	89
3823	Indust instrument for measurement, display, control process variables	298
3825	Instruments for measuring and testing electricity and elect signals	487

Table 1 (cont.). SIC manufacturing industries

SIC	Name of industry	Number of observations
3826	Laboratory analytical instruments, and parts and accessories	246
3827	Optical instruments, and parts	156
3829	Measuring and controlling devices, and parts	241
3841	Surgical and medical instruments and apparatus	431
3842	Orthopedic, prosthetic, and surgical appliances and supplies	518
3845	Electromedical and electrotherapeutic apparatus	577
3861	Photographic equipment and supplies	228
3944	Games, toys, and children's vehicles, except dolls and bicycles	148
3949	Sporting and athletic goods, and parts	255
3990	Miscellaneous manufactured products	196

Table 2 contains descriptive statistics for our consolidated sample of 25,890 firm-years across all 109 industries for the years 1987 through 2002.

Table 2. Descriptive statistics for firm size and profitability variables: 1987-2002

EBIT margin is calculated as EBIT divided by total sales. EBITDA margin is calculated as EBITDA divided by total sales. TA is total assets. All data are annual data obtained from Compustat. The data are for firms in 109 four-digit SIC manufacturing industries between 1987 and 2002.

Variable	Mean	Quartile 1	Median	Quartile 2
Employees, 000	5,586.6	279	904	3,400
Assets (millions)	$1,317.4	$37.5	$114.4	$486.4
Sales (millions)	$1,217.6	$43.0	$136.1	$546.3
EBIT margin	6.26%	2.43%	7.11%	11.68%
EBITDA margin	10.42%	5.75%	10.78%	15.88%
EBIT/TA	7.67%	2.91%	8.65%	13.93%
EBITDA/TA	12.23%	7.16%	12.98%	18.56%

2.5. The model. The basic model we use to estimate the relation between size and profitability for each industry is:

$$P_f = a + b_1\left(EMPL_f\right) + b_2\left(EMPL_f\right)^2, \quad (1)$$

where P_f = a profit measure for firm *f*, $EMPL_f$ = a measure of employment size for firm *f*; and, $EMPL_f^2$ = the square of the measure of employment size for firm *f*.

Our combined technological-organizational theory of the firm predicts that as the size of a firm increases, profitability would increase at a decreasing rate and then turn negative. Here, we would expect to find positive coefficients on *EMPL* and negative coefficients on $EMPL^2$.

A positive coefficient on *EMPL* and a zero coefficient on $EMPL^2$ would mean that profits were increasing at a constant rate as firms grew whereas a zero coefficient on both *EMPL* and $EMPL^2$ would *mean* that profitability was unrelated to size. Other possibilities include profitability constantly decreasing in terms of size or decreasing at a decreasing or increasing rate.

2.6. Control variables. We add yearly indicator and interactive variables to our basic model to control for industry wide macroeconomic shocks; for example, economy wide recessions and expansions. And, we use additional statistical techniques to isolate the unique effects of asset size and sales volume on firm profitability holding constant levels of employment.

2.6.1. Year indicator variables. Our first set of control variables are indicator variables that permit us to isolate the effects of year-to-year industry-wide economic conditions on profits. We use an indicator variable for each year, *Y*, except 2002 making 2002 the base year for our analysis. With the addition of yearly indicators, the model becomes:

$$P_{f,y} = a + b_1\left(EMPL_{f,y}\right) + b_2\left(EMPL_{f,y}\right)^2 + \sum_{y=1987}^{2001} b_y Y_y + e_{f,y}, \quad (2)$$

where Y_{1988} (1989 and so forth) takes on the value of 1 if the profit and size data are for 1988 (1989 and so forth); otherwise, Y_{1988} takes on the value of zero. The coefficients on *Y* tell us whether the average profits for the industry in, say 1991, were greater or less than 2002, our base year.

2.6.2. Asset and sales control variables. As we noted earlier, in addition to number of employees, total assets and sales are alternative measures of firm size. In fact, a very high correlation exists between the number of employees and total assets as well as between employees and sales and assets and sales. Therefore, we seek ways to isolate the effects of assets and sales volume on profitability; in other words, we seek to measure how differences in total assets and sales for firms with identical employment levels affect profitability.

We use the following procedure. First, we estimate the statistical relation between total assets and firm size in each industry by regressing the log of total assets against the log of employment with the following equation:

$$TA_{f,y} = a + b_1\left(EMPL_{f,y}\right) + TA\_RES_{f,y}, \quad (3)$$

where $TA_{f,y}$ = log of total assets in millions of dollars for firm f in year y; $EMPL_{f,y}$ = log of employment for firm f in year y; $TA\_RES_{f,y}$ = residual or error term for firm f in year y.

The residual, $TA\_RES_{f,y}$, is the difference between the actual level of assets for firm f and what its predicted level would be based on its number of employees. We collect the total assets residuals, $TA\_RES_{f,y}$, and use them as control variables in our complete model as shown in Equation (5).

A positive *TA_RES* means that employment under predicts asset levels. This outcome means that the firm is operating with fewer employees per dollar invested in assets than its competitors. But, does this mean the firm is likely to be more or less profitable than the average firm?

Quite possibly, the explanation for the lower-than-average employees per dollar of assets is that the firm has "over invested" in assets. Such "over investment" could then imply that the firm would have the same or lower-than-average sales per employee and, consequently, lower-than-average profitability. We isolate the effects of sales on profitability, holding constant employment and asset levels, by estimating the equation:

$$SALES_{f,y} = a + b_1\left(EMPL_{f,y}\right) + b_{f,y}\left(TA\_RES_{f,y}\right) + S\_RES_{f,y}, \quad (4)$$

where $SALES_{f,y}$ = the log of sales in millions for firm f in year y, $EMPL_{f,y}$ = log of employment for firm f in year y; $TA\_RES_{f,y}$ = residual or error term for firm f in year y; and, $S\_RES_{f,y}$ = the residual for firm f in year y in the estimating model.

A positive value for $S\_RES_{f,y}$ means that employment levels under predict sales volume after taking into consideration differences in asset levels for firms with the same number of employees and that sales per employee are higher than would be predicted given information about the number of employees and assets per employee. We include $S\_RES_{f,y}$ in our complete model along with $TA\_RES_{f,y}$. Our complete model is:

$$P_{f,y} = a + b_1\left(EMPL_{f,y}\right) + b_2\left(EMPL_{f,y}\right)^2 + \sum_{y=1987}^{2001} b_y Y_y + b_3\left(TA\_RES_{f,y}\right) + b_4\left(S\_RES_{f,y}\right) + e_{f,y}. \quad (5)$$

3. Empirical results

3.1. Functional forms. Table 3 contains partial regression results for each industry for our *EBIT Margin* profitability measure. The individual industry regressions for *EBITDA Margin*, *EBITDA/TA* and *EBIT/TA* are similar and are available from the authors. We report the coefficients on *EMPL*, $EMPL^2$, *TA_RES* and *SALES_RES*; we do not report the coefficients for the yearly indicator variables. Tables 4 and 5 contain summaries of the number of times the coefficients on *EMPL*, $EMPL^2$, *TA_RES* and *SALES_RES* are positive or negative and the number of times the indicated profitability functional forms appeared. Our primary interest is the shape of the profitability functions as reported in Table 5.

Table 3. EBIT margin partial regression results for individual SIC industries: 1987-2002

The full regression model is:

$$EBIT\ Margin_{f,y} = a + b_1\left(EMPL_{f,y}\right) + b_2\left(EMPL_{f,y}\right)^2 + \sum_{y=1987}^{2001} b_y Y_y + b_3\left(TA\_RES_{f,y}\right) + b_4\left(S\_RES_{f,y}\right) + e_{f,y}.$$

The dependent variable is *EBIT Margin* (EBIT/Sales). *EMPL* is the log employment. $EMPL^2$ is the log of employment squared. Y is a yearly indicator variable taking on the value of 1 if that year, otherwise 0. *TA_RES* is the residual from regressing the log of *EMPL* on the log of total assets. *S_RES* is the residual from regressing the log of *EMPL* and *TA_RES* on sales.

Bold numbers indicate the coefficient is significant at the 0.05 level or lower.

SIC	Ln(Employees)	Ln(Employees)^2	Total asset residual	Sales residual	Adjusted R^2
2015	**-0.06641**	**0.003717**	0.00264	-0.00472	15.72
2030	0.01801	-6.00E-06	**0.0172**	**0.04418**	38.92
2040	**0.10264**	**-0.00535**	**0.03075**	**0.02074**	39.63
2060	0.01172	-0.00088	**0.02855**	**-0.07361**	13.66
2090	0.10426	-0.00592	0.04307	0.05302	42.46
2200	0.01362	-0.00047	0.01277	0.01761	14.35
2211	-0.01026	0.000547	0.02782	-0.02648	18.02
2253	-0.05011	0.006433	0.0202	0.0658	11.79
2273	-0.0099	0.000255	0.02949	-0.01951	1.25
2300	0.00661	-0.00025	**0.01851**	**-0.05485**	9.27
2320	0.03198	-0.00076	0.07772	**-0.00563**	36.47
2330	-0.0291	0.002867	0.02918	**-0.01518**	12.94
2430	**0.07998**	-0.00304	-0.0034	-0.02986	46.41

Table 3 (cont.). EBIT margin partial regression results for individual SIC industries: 1987-2002

SIC	Ln(Employees)	Ln(Employees)^2	Total asset residual	Sales residual	Adjusted R^2
2451	**0.10254**	**-0.00714**	**0.06979**	**0.04631**	46.41
2510	**0.07296**	**-0.00373**	**0.04146**	-0.04207	43.80
2511	**0.28377**	-0.01777	0.03125	**0.0432**	20.92
2621	**0.09383**	**-0.00524**	0.01425	-0.02777	28.83
2631	**0.05718**	**-0.00365**	0.04277	0.01503	16.30
2650	-0.19873	0.012857	0.03732	0.00033	6.50
2670	0.00712	0.00007	**0.04658**	**-0.07638**	31.18
2711	**0.04819**	-0.00208	0.02797	**-0.08307**	21.92
2721	**0.15581**	**-0.0099**	0.03903	-0.00572	6.19
2731	0.00139	0.000528	0.00713	-0.05282	15.20
2750	**0.07231**	**-0.00389**	**0.03768**	**0.01213**	12.55
2761	**0.00167**	**0.000276**	0.00046	**-0.07618**	20.48
2810	-0.01069	0.001264	**0.03753**	**0.00943**	20.01
2821	**0.15029**	**-0.00909**	**0.05705**	-0.02269	38.71
2834	**0.08355**	**-0.00331**	**0.07753**	**0.12129**	30.36
2835	**0.26619**	**-0.01844**	**0.04738**	**0.34751**	36.29
2836	-0.09952	0.010647	**0.1207**	**0.34192**	41.11
2840	**0.06668**	**-0.00317**	-0.00906	-0.006	35.11
2842	**-0.01735**	**0.001918**	**0.01476**	**0.04494**	69.95
2844	-0.00287	0.000911	**0.03817**	**0.03525**	7.25
2851	**-0.03325**	**0.002293**	**0.05081**	-0.03599	39.38
2860	0.03044	-0.00183	**0.02966**	-0.02401	13.02
2870	0.06015	-0.00175	**0.03044**	**0.09512**	33.21
2890	**0.11912**	**-0.0067**	**0.02216**	**0.14288**	40.80
2911	**0.03243**	**-0.00147**	**0.02224**	0.00234	24.91
3021	0.06267	-0.00293	**0.05998**	**-0.09976**	13.73
3060	-0.00627	0.001092	**-0.01035**	0.02418	10.18
3080	0.07438	-0.00434	0.00506	**0.05109**	8.95
3081	**0.38762**	**-0.02602**	0.04571	**0.05242**	51.13
3089	**0.05844**	-0.00331	**0.04059**	**0.04562**	13.44
3100	0.08947	-0.00569	0.00609	0.00297	7.76
3140	**0.11785**	**-0.00728**	**0.0448**	-0.0149	2217
3270	0.09574	-0.00672	**0.08236**	**0.09583**	44.90
3290	0.01413	-0.00018	**0.05591**	**0.09686**	35.33
3310	0.00817	0.000012	**0.03955**	-0.00725	47.26
3312	**0.10528**	**-0.00663**	**0.0146**	**0.07293**	23.38
3317	0.3136	-0.02153	-0.02018	0.01754	0.00
3350	0.06873	-0.00296	0.01959	**0.06028**	36.02
3357	**0.15047**	**-0.00917**	**0.02305**	**0.06166**	39.30
3411	**0.17258**	**-0.0102**	0.02528	-0.05127	58.35
3420	0.11423	-0.00707	**0.03007**	0.01883	36.48
3443	**0.15858**	**-0.01117**	**0.07887**	**-0.06498**	27.41
3452	0.01208	-0.00074	-0.01388	0.00964	11.57
3460	0.04938	-0.00299	**0.04777**	0.00917	26.98
3490	**0.06176**	**-0.00323**	**0.06942**	**0.0508**	21.38
3523	0.04086	-0.00155	-0.02188	**0.03508**	28.87
3531	-0.02117	0.001767	-0.00911	0.00071	34.83
3533	-0.05404	0.003335	**0.08322**	0.05244	26.02
3540	-0.02174	0.002447	**-0.0355**	-0.00097	14.06
3555	0.00296	-0.00039	0.01977	0.03429	-0.06
3559	-0.01351	0.002726	**0.0554**	**0.18571**	33.12
3560	0.02344	-0.00102	**0.03046**	-0.00853	10.58
3561	-0.01057	0.000107	**0.03727**	**0.02463**	22.77
3564	0.08395	-0.00532	0.00609	-0.02838	9.45
3569	0.08168	-0.0041	0.01301	-0.00144	18.65

Table 3 (cont.). EBIT margin partial regression results for individual SIC industries: 1987-2002

SIC	Ln(Employees)	$Ln(Employees)^2$	Total asset residual	Sales residual	Adjusted R^2
3571	-0.0147	0.002157	0.01924	-0.00717	13.08
3572	0.00972	0.000864	**0.08808**	0.03777	23.29
3576	0.06902	-0.00334	**0.08564**	**0.12884**	30.91
3577	0.0405	-0.00096	**0.03634**	**0.07267**	9.42
3578	0.09446	-0.00522	**-0.00974**	**0.14523**	4.82
3580	**0.07854**	-0.00499	0.01905	**0.05038**	7.71
3585	**0.06744**	-0.00347	0.00287	0.01086	11.23
3590	0.06082	-0.00365	**0.05255**	**0.04911**	28.20
3620	**0.05404**	**-0.00335**	**0.07396**	-0.00925	30.61
3621	**-0.06446**	**0.005613**	-0.05525	0.06161	17.73
3634	**0.16331**	-0.0113	**0.025**	**-0.03128**	17.02
3640	**0.10377**	**-0.00647**	**0.03102**	**-0.03073**	20.53
3651	**0.12541**	**-0.00842**	-0.0249	0.05243	-0.03
3661	**0.06587**	-0.00289	**0.02786**	**0.11769**	17.54
3663	**0.08586**	**-0.00454**	0.00068	**0.08632**	13.72
3669	**0.24622**	**-0.01656**	-0.00301	**0.04346**	18.45
3670	0.10978	-0.0058	0.04034	**-0.06205**	23.80
3672	**0.1252**	**-0.00712**	**0.01464**	**0.02499**	21.77
3674	**0.16269**	**-0.00955**	**0.03352**	**0.10556**	22.33
3679	**0.1176**	**-0.00733**	**0.01774**	**0.03098**	10.90
3690	**0.16028**	**-0.00978**	**0.05584**	**0.16572**	23.42
3711	0.00253	0.000382	0.00594	**0.0381**	14.66
3714	**0.07809**	**-0.00464**	**0.02164**	-0.00538	11.28
3716	**0.09363**	**-0.00584**	**0.05879**	**0.1513**	40.80
3724	-0.00722	0.000359	**0.04458**	-0.01169	29.06
3728	0.02132	-0.00135	0.01855	**0.07297**	7.99
3730	**0.14351**	**-0.0082**	**0.05289**	**0.08971**	22.95
3812	0.0217	-0.00092	**0.05073**	**0.11625**	16.87
3821	0.07606	-0.0039	0.04166	**0.10543**	9.99
3823	**0.07098**	-0.00363	**0.05877**	**0.10304**	23.47
3825	0.10738	-0.00746	**0.03146**	**0.10981**	26.45
3826	0.05877	-0.00278	**0.03323**	**0.2337**	24.82
3827	**-0.18103**	**0.015225**	0.02069	**0.21815**	37.13
3829	-0.03428	0.003097	**0.07156**	**0.18158**	12.10
3841	**0.14842**	**-0.00873**	**0.04216**	**0.03678**	14.03
3842	**0.12103**	**-0.00653**	**0.06012**	**0.06707**	26.41
3845	0.0567	-0.00089	**0.06151**	**0.18822**	23.03
3861	**0.03973**	**-0.00186**	**0.02378**	**-0.06997**	12.82
3944	-0.05793	0.004965	0.00442	-0.03162	0.39
3949	**0.04576**	-0.00188	**0.04059**	-0.01351	11.16
3990	0.073	-0.00348	**0.04561**	**0.01363**	19.58

In nearly half of our industries, profitability increases at a decreasing rate, reaches a maximum, and then decreases. Depending on our profitability measure, from forty-one to forty-seven of our industries have significantly positive *EMPL* coefficients coupled with significantly negative $EMPL^2$ coefficients.

In forty-six to fifty-two industries, depending on the profitability measure, no relation exists between size and profitability. The coefficients on *EMPL* and $EMPL^2$ for these industries are not significantly different from zero.

What we have is a situation where accounting profitability either initially increases with increases in employees or is unrelated to the number of employees. We interpret our results as supporting competency and organizational theories of the firm in combination with a production-function technological theory. In other words, small firms can be just as profitable as large firms due to their unique competencies. And, economies of scale, if they do exist, are eventually offset by organizational costs that lead to a reduction in profitability as firms become larger. We find little evidence that small or medium-size firms are, on average, more profitable than larger firms when profitability is measured with financial statement variables. No industries have -,0 or -,- signs and only one industry has a -,+ joint signing.

Table 4. Summary of number of times explanatory variable coefficients are positive and negative in the profitability regressions for 109 industries

The number of times a coefficient estimate is positive or negative in the set of regressions using the four indicated measures of profitability as the dependent variable is reported in each cell. The underlying regression model is:

$$P_{f,y} = a + b_1\left(EMPL_{f,y}\right) + b_2\left(EMPL_{f,y}\right)^2 + \sum_{y=1987}^{2001} b_y Y_y + b_3\left(TA\_RES_{f,y}\right) + b_4\left(S\_RES_{f,y}\right) + e_{f,y}.$$

The dependent variable is our measure of profitability. *EMPL* is the log of employment. $EMPL^2$ is the log of employment squared. *Y* is a yearly indicator variable taking on the value of 1 if that year, otherwise 0. *TA_RES* is the residual from regressing the log of *EMPL* on the log of total assets. *S_RES* is the residual from regressing the log of *EMPL* and *TA_RES* on sales. The numbers in parentheses in each cell are the number of times the coefficient was significantly positive or negative at the 0.05 level or less.

	Dependent profitability variable, $P_{f,y}$							
	EBITDA Margin		EBIT Margin		EBITDA/TA		EBIT/TA	
Independent variable	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
EMPL	85 (50)	24 (2)	86 (50)	23 (5)	89 (65)	20 (5)	86 (53)	23 (4)
$EMPL^2$	27 (7)	82 (41)	29 (6)	80 (44)	21 (7)	88 (47)	25 (5)	84 (42)
TA_RES	101 (77)	8 (1)	97 (68)	12 (2)	59 (22)	50 (19)	72 (31)	37 (9)
SALES_RES	51 (25)	58 (30)	71 (44)	38 (14)	102 (82)	7 (1)	101 (79)	8 (1)

Table 5. Profitability functional forms: summary of the number of times the coefficients on *EMPL* and $EMPL^2$ have the indicated joint signs

Each cell for the profitability dependent variable contains the number of times the joint signs for *EMP*L and $EMPL^2$ take on the indicated joint values in the respective profitability regressions for the 109 industries. The regression model is:

$$P_{f,y} = a + b_1\left(EMPL_{f,y}\right) + b_2\left(EMPL_{f,y}\right)^2 + \sum_{y=1987}^{2001} b_y Y_y + b_3\left(TA\_RES_{f,y}\right) + b_4\left(S\_RES_{f,y}\right) + e_{f,y}$$

The dependent variable is our measure of profitability. *EMPL* is the log of employment. $EMPL^2$ is the log of employment squared. *Y* is a yearly indicator variable taking on the value of 1 if that year, otherwise 0. *TA_RES* is the residual from regressing the log of *EMPL* on the log of total assets. *S_RES* is the residual from regressing the log of *EMPL* and *TA_RES* on sales. A +,- means that the regression coefficient on *EMPL* was significantly positive and the regression coefficient on $EMPL^2$ was significantly negative at the 0.05 level; 0,0 means that the regression coefficients were not significantly different at the 0.05 level and so on.

Joint signs on *EMPL* and $EMPL^2$		Dependent profitability variable, $P_{f,y}$			
EMPL	$EMPL^2$	EBITDA Margin	EBIT Margin	EBITDA/TA	EBIT/TA
+	-	41	43	41	42
0	0	52	52	52	51
+	0	9	7	9	11
0	+	5	1	5	1
0	-	0	1	0	0
-	+	2	5	2	4

3.2. Asset and sales residuals. *TA_RES* is the residual from regressing log of employees on log of assets. A positive *TA_RES* means that employment underestimates assets.

The connection, if any, between employment underestimating assets and firm profitability is problematic. One interpretation is that firms with more assets per employee would be more profitable than other firms in the same industry because managers have controlled the number of employees needed to "work" the assets. Were this the case, profitability measures should be higher for those firms with a positive *TA_RES* and the coefficients of *TA_RES* should be positive.

However, an alternative interpretation is that firms with more assets than the average firm have more assets than needed or are underutilizing their assets. In this case, the coefficients on *TA_RES* should be negative.

Organizational theories of firm size and profitability would predict that the signs on *TA_RES* in equation (5) would be positive. Other things being equal, firms with fewer employees would incur fewer organization costs and, by implication, be more profitable, provided that the firms had not over invested in assets.

As it turns out, in Table 4 the signs on asset residual, *TA_RES*, are usually positive, especially for the profit margin regressions. When *EBITDA Margin* is the dependent variable, the signs on *TA_RES* are positive for 101 out of 109 regressions. They have statistically significant positive signs in 77 cases with only one statistically significant negative sign. A similar pattern is found among the *EBIT Margin* regressions. Here, 97 out of 109 are positive with 68 being significant at the 0.05 level or lower.

More positive than negative coefficients also appear on *TA_RES* for the return on asset profitability measures. For *EBIT/TA*, 72 out of 109 industries have positive coefficients with 31 being significant. *S_RES* is the residual from regression log employment and *TA_RES* on the log of sales. The results for *S_RES* ostensibly are inconclusive with respect to the margin regressions. For the *EBITDA Margin* regressions, 20 are significantly positive, 21 significantly negative and 23 not significantly different from zero. For the *EBIT Margin* regressions, 27 are significantly positive and 29 not significantly different from zero. However, the results for the *EBIT/TA* regressions are qualitatively different. Here, we observe positive signs on *S_RES* for 56 of the industries and statistically significant positive signs for 43 industries. In other words, firms with fewer employees per dollar of investment in assets and more sales per employees generate higher returns on assets as measured by EBIT to total assets.

Taken together, the signs on *TA_RES* in equation (6) and the signs on *TA_RES* and *S_RES* in equation (5) are consistent with the organizational hypotheses about firm with regard to the number of employees. The fewer the number of employees for a given size firm in terms of assets and sales, the more profitable the firm is. (We have also used a fixed effects estimator corrected for the unbalanced nature of the panel to analyze the data by allowing the intercept to vary over each firm within an industry but not over time. The results are qualitatively similar to those reported above.)

4. Implications of functional forms for some conventional wisdoms

4.1. Profitability functions and capital intensity. Conventional wisdom holds that economies of scale are typically associated with substantial investments in capital equipment (fixed assets) and high degrees of operating leverage (fixed costs). Hence, these industries would be expected to be those most likely to exhibit profitability at least initially increasing with size. Through a certain range, fixed capital costs would be spread over more and more units of production, thus, leading to increased profitability.

To examine this possibility, we classify our industries into seven categories depending on the joint signs on *EMPL* and $EMPL^2$. We then construct four measures of capital intensity and test for profitability differences among the seven categories with regard to our capital intensity measures.

Our measures of capital intensity are: depreciation to sales, capital expenditures to cost of goods sold, capital expenditures to sales and depreciation to total assets. The mean and median values of these measures for each profit function category are reported in Table 6.

Table 6. Capital intensity of firms in profitability functional form categories

The profitability functional form categories are based on the EBITDA/TA regressions as reported in Table 8. The top (bottom) number in each cell is the mean (median) value for all firm-years in all industries in the indicated profitability category. A plus (+) means that the coefficient on *EMPL* or $EMPL^2$ was significantly positive; a minus (-) means that the coefficient was significantly negative and a zero (0) means that the coefficient was not significantly different from zero at the 0.05 level. A + ,- superscript next to cell number means that its value is significantly greater (less) than the corresponding value for the first (+,-) functional form at the 0.05 level.

Joint signs on EMPL and $EMPL^2$		Measure of capital intensity			
		Depreciation / Sales	Capital expenditures / Cost of goods sold	Capital expenditures / Sales	Depreciation / Assets
EMPL	$EMPL^2$				
+	-	0.0443 (0.0368)	0.1171 (0.0681)	0.0630 (0.0429)	0.0466 (0.0427)
0	0	0.0402^- $(0.0340)^-$	0.1082^- $(0.0586)^-$	0.0536^- $(0.0371)^-$	0.0439^- $(0.0395)^-$
+	0	0.0421^- $(0.0349)^-$	0.1068^- $(0.0728)^-$	0.0489^- $(0.0387)^-$	0.0455 $(0.0405)^-$
0	+	0.0128^- $(0.0113)^-$	0.0227^- $(0.0134)^-$	0.0149^- $(0.0098)^-$	0.0244^- $(0.0215)^-$
0	-	0.0605^+ $(0.0634)^+$	0.1411^+ $(0.1019)^+$	0.0998^+ $(0.0740)^+$	0.0560^+ $(0.0583)^+$
-	+	0.0386^- $(0.0329)^-$	0.0852^- $(0.0601)^-$	0.0560^- $(0.0402)^+$	0.0483^- (0.0466)

All capital intensity measures are significantly higher for the economies of scale/organizational trade off industries (+,-) than for those industries where no relation (0,0) between profits and employees exists. The third most common profitability functional form was constantly increasing profits (+,0) with respect to number of employees. Again, we would expect industries that were capital intensive to exhibit increasing profitability with respect to size relative to less capital intensive industries.

Our results are consistent with this expectation. Every median measure of capital intensity is higher for the group of industries with constantly increasing profits in terms of size than for that group of industries exhibiting no relation between size and profitability. Differences in profitability among firms of different size, then, do seem to be due, in part, to economies of scale as measured by capital intensity.

4.2. Concentration, size and profits. The dominant theme in the industrial organization literature is that profitability is related to market power. Market power is usually measured with concentration ratios – a common one being the Hirschmann-Herfindahl Index (HH Index). This Index expresses the square of the largest firm's sales as a percent of the sum of the sales squared for every firm in the industry. The ratio takes on values from 0 to 1 with higher values indicating increasing concentration and decreasing competition.

Mean and median values for the HH Index are reported by functional form in Table 7. For example, the mean HH Index value for all industries where profits first increase and then decrease in terms of size (+,-) is 0.0212 and the median is 0.0155.

Table 7. Profitability functions and industry concentration

The profitability functional form categories are based on the EBITDA/TA regressions as reported in Table 8. The top (bottom) number in each cell is the mean (median) value for all firm-years in all industries in the indicated profitability category. A plus (+) means that the coefficient on *EMPL* or $EMPL^2$ was significantly positive; a minus (-) means that the coefficient was significantly negative and a zero (0) means that the coefficient was not significantly different from zero at the 0.05 level.

A + ,- superscript next to cell number means that its value is significantly greater (less) than the corresponding value for the first (+,-) functional form at the 0.05 level.

Joint signs on *EMPL* and $EMPL^2$		Hirschmann-Herfindahl Index
EMPL	$EMPL^2$	
+	-	0.0212 (0.0155)
0	0	0.0251^+ $(0.0212)^+$
+	0	0.0454^+ $(0.0394)^+$
0	+	0.0139^- $(0.0139)^-$
0	-	0.0238^+ $(0.0258)^+$
-	+	0.0313^+ $(0.0258)^+$

We might expect that the mean and median HH Index would be lesser in those industries where profits were an increasing function of size because the larger firms would be taking advantage of economies of scale and driving out smaller firms. Our data support this interpretation; the most competitive industries have an optimal firm size with respect to profitability.

4.3. Profitability, risk and market-to-book ratios. In the investment literature, security returns are empirically connected to market-to-book ratios and firm size where firm size is measured by the company's market value. For example, over the years, a number of researchers have found that the common stocks of small corporations outperformed (had higher returns) those of large companies – the small-stock premium. And, Fama and French (1992) report that a security's market return is negatively related to its market-to-book ratio and that within size ranked market-to-book portfolios, small firms had higher market returns than large firms.

The conventional wisdom for these empirical regularities is that size is a proxy for a risk factor(s) not captured by the market portfolio or other variables in existing asset pricing models. Fama and French (1993, 1995), subsequent to their 1992 work, form security portfolios based on market-to-book ratios and size measured in terms of market value and show that these factors outperform the Capital Asset Pricing Model (CAPM) in predicting security returns. Fama and French attribute the superior predictive power of size to its ability to capture risk.

We have shown that accounting based returns are either unrelated to size or increase, not decrease, with respect to size through a certain range for most of our industries. Thus, accounting based measures of profitability behave differently with respect to size than security returns do.

But, what about size as measured by employees and market-to-book ratios for manufacturing industries? Do small firms have smaller market-to-book ratios than large firms?

To investigate this question we estimate the following regression for firms in our two most common functional form categories: profits at first increasing and then decreasing in terms of size (+,-) and profits unrelated to size (0,0).

$$MKT/BK_{f,t} = a + b_1(EMPL)_{f,t} + b_2(EMPL^2)_{f,t} + \sum_{t=1987}^{2001} b_t Y_t, \quad (6)$$

where $MKT/BK_{f,t}$ = Market value of equity to book value of equity, $EMPL_{f,t}$ = log of employment for firm *f* in year *t*, $EMPL^2_{f,t}$ = log of employment squared for firm *f* in year *t*, and; Y_t = an indicator variable that takes on the value of 1 for the indicated year.

In neither case the coefficients on *EMPL* and $EMPL^2$ are statistically significant at the .39 level or less. Within our sample of manufacturing firms we found no relation between market-to-book ratios and size (measured by employees).

Our size and profitability results are more similar to those reported by Berk (1996) than to Fama and French (1992). Berk investigated cross sectional relations between firm size and market returns using non-market measures of size, including the number of employees. Berk concludes that the relation between market value and average return is unaffected when non-market measures of firm size are used to control for the size of the firm. He further concludes that, "…when the market value of the firm is controlled for, we find evidence of a *positive* (his italics) relation between the non-market size variables and average [market] return (Berk, 1996, p. 19).

4.4. Profitability and diversification. Many financial economists and practitioners, based upon a number of empirical studies (Villallonga, 2003), believe that diversified firms trade at a discount to focused firms and that diversified firms are less profitable than their focused counterparts. These beliefs also have implications for profitability functions.

Firms can grow by expanding existing business lines or diversifying into (adding on) new areas. Now, suppose that expanding existing operations is not profitable but the firm still wants to grow. The firm could do so by entering new businesses either through internal growth or acquisition – what can be described as diversification. But, this growth through diversification, as noted earlier, may lead to a reduction in overall profitability.

One measure of diversification within a firm is its number of business segments. The more business segments are, the more diversified the firm is. Therefore, we collected data about the number of business segments for firms within each of our profitability functional forms and calculated the mean and median number of business segments for firms within that form. If growth in firm size came through diversification, we could observe that firms in industries where profits eventually decreased in terms of size would have more business segments than those in industries where profits constantly increased as firms became larger. Our results appear in Table 8.

Table 8. Profitability functions and diversification

The profitability functional form categories are based on the EBITDA/TA regressions as reported in Table 8. The top (bottom) number in each cell is the mean (median) value for all firm-years in all industries in the indicated profitability category. A plus (+) means that the coefficient on *EMPL* or $EMPL^2$ was significantly positive; a minus (-) means that the coefficient was significantly negative and a zero (0) means that the coefficient was not significantly different from zero at the 0.05 level.

A + ,- superscript next to cell number means that its value is significantly greater (less) than the corresponding value for the first (+,-) functional form at the 0.05 level.

Joint signs on *EMPL* and $EMPL^2$		Diversification measure and asset size		
EMPL	$EMPL^2$	Herfindahl Index	Log of total assets	Number of business segments
+	-	0.6334 (0.5842)	5.0964 (4.8114)	3.2239 (2)
0	0	0.6729^{+} $(0.6485)^{+}$	5.0269^{-} $(4.7707)^{-}$	2.9632^{-} (2)
+	0	0.7165^{+} $(1.00)^{+}$	4.3945^{-} $(4.1677)^{-}$	2.4773^{-} $(1)^{-}$
0	+	0.8784^{+} (1.00)	4.3806^{-} $(4.2010)^{-}$	2.0606^{-} $(1)^{-}$
0	-	0.3949^{-} $(0.2746)^{-}$	5.8548^{+} $(5.8226)^{+}$	4.6875^{+} $(4)^{+}$
-	+	0.5307^{-} $(0.5111)^{-}$	5.1289 (5.1215)	2.9105 (3)

What we find among our three most common functional forms is that those industries with the highest mean and median of business segments were those with profits eventually decreasing in size (+,-). Firms in those industries with constantly increasing profitability (+,0) had the lowest mean and median of business segments. And firms in the no relation to profitability functional form (0,0) had fewer business segments than those in declining profitability industries but more than in the increasing profitability industry.

With respect to average size of the firm itself, measured by assets, the largest firms were in the declining functional form with the most business segments. The industries with the smallest average size firms were those with the fewest business segments and in the increasing profitability in size (+,0) functional form.

Our second measure of diversification is the Herfindahl Index (H Index). The Herfindahl Index measures the percentage of sales of the largest business segment of a firm to its total sales. A ratio of one means that the firm is a single segment company; the lower the ratio, the more diverse is the firm is.

Again, among the three most common functional forms, the highest value Herfindahl Index is for industries with profits continually increasing in terms of size (measured by employees). It is the lowest for the firms in trade-off function (+,-).

Our business segment results are similar to those reported by Maksimovic and Phillips (2002) with respect to the productivity of plants for conglomerate versus single-segment firms. Maksimovic and Phillips find that, "plants of conglomerate firms are less productive than are plants of single-segment firms of a similar size, except for firms of the smallest size" (p. 764).

Analysis and conclusions

Our results indicate that the relation between size, employees and profitability is industry specific and needs to be examined on an industry-by-industry basis. Overall, though, the profitability of most manufacturing firms as measured by *EBITDA Margin* (cash flow margin), *EBIT Margin*, EBITDA to total assets and EBIT to total assets either increases at a decreasing rate and then falls or bears no relation to size measured by the number of employees. The empirical results are consistent with a theory of firm size that posits trade-offs between economies of scale and organizational costs and with a theory that firms possess certain competencies that allow them to offset the advantages such as economies of scale often attributed to large firms.

Consistent with the above, we find that for firms of a given size as measured by sales and assets, the fewer the employees, the more profitable the firm is. And, for firms of a given size as measured by the number of employees, the fewer the assets, and higher the sales, the more profitable the firm is. We find virtually no evidence that small manufacturing firms are more profitable than larger firms.

We also find an association between the functional form of industry profitability and the number of business segments typical of firms within that functional form. The mean and median number of business segments for firms in industries with eventually declining profitability in terms of size is greater than for those where no relation between profits and size exists or where profits constantly increase with respect to size.

Our overall results have implications for investigations into the relation between firm size, risk, investor required rates of return and whether a firm is earning its cost of capital. These implications grow out of the empirical regularities between firm size, market-to-book ratios and market returns on small versus large companies.

For example, as noted earlier, Fama and French report that stock price returns are related to market-to-book ratios and to firm size. They find that smaller firms have higher returns and lower market-to-book ratios. Fama and French attribute this empirical regularity to risk.

If Fama and French are correct about size being a proxy for risk, then our results imply that either (1) large firms may be earning excess returns or (2) small firms may not be earning adequate risk adjusted returns. In either case we would expect large firms to exhibit larger market-to-book ratios than small firms. Yet, we find no evidence that market-to-book is related to size in any of our functional forms despite the fact that in over ninety percent of our industries accounting profitability either increases with size or is unrelated to size. We have no explanation for these empirical relations but believe it is a puzzle that deserves attention.

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