

**The New New Financial Thing:  
The Origins of Financial Innovations**

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*The origins of financial innovations have attracted little empirical scrutiny. This paper examines which institutions were the key financial innovators between 1990 and 2002, using Wall Street Journal articles as an indicator. The evidence suggests that smaller firms account for a disproportionate share of the innovations. Less profitable firms innovate more, though in the years subsequent to the introduction of the innovation, the profitability of the innovators increases significantly. Finally, older, less leveraged firms located in regions with more financial innovations innovate more. While several of the determinants of patenting are similar, small and unprofitable firms do not patent disproportionately.*

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The significance of financial innovation is widely recognized. Many leading scholars, including Miller (1986) and Merton (1992), have highlighted the importance of new products and services in the financial arena. Empirically, Tufano (1989) showed that of all public offerings in 1987, 18% (on a dollar-weighted basis) consisted of securities that had not been in existence in 1974. These innovations are not just critical for firms in the financial services industry, but also affect other companies: for instance, enabling them to raise capital in larger amounts and at a lower cost than they could otherwise.

Yet despite this importance, the sources of financial innovation remain surprisingly poorly understood. In a recent review article, Frame and White (2004) highlight the paucity of empirical research in this area. While innovation in manufacturing industries has inspired literally thousands of academic studies, the authors are able to identify only 39 empirical studies of financial innovation. Moreover, this literature is highly concentrated on the “back end” of the innovation process, focusing on the diffusion of these innovations, the characteristics of adopters, and the consequences of innovation for firm profitability and social welfare. The authors can only identify two papers on the origins of innovation, Ben-Horim and Silber (1977) and Lerner (2002). This paucity of research can be contrasted with the abundant literature on the sources of manufacturing innovation.

This neglect is particularly puzzling given the special circumstances surrounding financial innovation. Several considerations—discussed in detail in Section 1—suggest

that the dynamics of financial innovation are quite different from that in manufacturing. Together, these considerations suggest the need to examine financial innovation as a phenomenon in its own right.

As Frame and White point out, one of the major barriers to the study of financial innovation has been a paucity of data. Studies of manufacturing innovation have traditionally focused on R&D spending and patenting. Given the rarity with which financial service firms report R&D spending and the infrequency of financial patents until recently, these measures are unlikely to be satisfactory. This paper seeks to take a first step towards addressing this gap, by developing a measure of financial innovation based on news stories in the *Wall Street Journal*. I address possible concerns about this measure of innovative activity through a variety of approaches, including rating the importance of the innovations.

The analysis focuses on the question of which institutions are associated with financial innovations, seeking to test a number of hypotheses suggested by the innovation literature. I find that, contrary to representations in the earlier literature, financial innovation has been characterized by a disproportionate role of smaller firms. More specifically, a doubling in firm size is associated with less than a doubling in innovations generated. Moreover, firms that are less profitable in their respective sectors are disproportionately innovative. These results are consistent with depictions by Silber (1975, 1983), which suggest that more marginal firms will contribute the bulk of

financial innovations. In addition, older, less leveraged firms located in regions with more financial innovations appear to be more innovative.

The final analyses in the paper explore three extensions. First, I examine differences across classes of innovations and financial firms. I find substantial variations. To cite two examples, there is no evidence for a disproportionate role of smaller firms in innovation among depository institutions, while low firm profitability seems particularly associated with process innovators. Second, I examine the extent to which the depressed profitability among financial innovators persists. I find that these firms in the years after the innovations experience a significant increase in profitability. This finding is consistent with the suggestion in the work of Silber that investment in innovation is a rational response to an unfavorable competitive position. Finally, I look at the determinants of patenting, employing a similar empirical specification. I find that, while some of the determinants of patents are similar to those of innovations, the disproportionate role of smaller firms is not seen here. Moreover, there are substantial inter-industry differences and few localized knowledge spillovers in patenting.

Two limitations should be acknowledged at the outset. First, the time span covered in this study is relatively limited, from 1990 to 2002. There is no reason, however, that this methodology could not be extended to a longer dataset, which would allow the more ready identification of the impact of major regulatory and tax policy changes.

The second limitation relates to the methodology employed. This paper focuses on developing a number of “stylized facts” about financial innovation. While many of the studies of manufacturing innovation have proceeded in a similar manner, others (e.g., Kortum (1997)) have sought to develop structural models of patenting, productivity, and R&D. Reflecting the early stage of the study of financial innovation and the lack of many meaningful measures of innovative performance, a simpler approach seemed desirable. It is hoped that this work will stimulate more theoretical and empirical work into the impact of financial institutions on innovation.

The organization of this paper is as follows. Section 1 describes the hypotheses that will be tested in the paper. The development of the dataset is summarized in Section 2. Section 3 presents the key patterns of financial sector innovation. Three supplemental analyses are discussed in Section 4. The final section concludes the paper.

## **1. Hypotheses**

In this initial section, I outline the hypotheses that motivate the analysis. I proceed in two parts. First, I highlight the relevant theoretical and empirical work on innovation in general. I begin here because innovation has been far more extensively studied in other sectors, particularly manufacturing. I then turn to a discussion of the specific context of financial services.

### *A. The Origins of Innovation in General*

I focus on three hypotheses regarding the determinants of differences in the innovation rate across firms. These highlight the consequences of the firms' size and age, capital constraints, and abilities to access knowledge spillovers. Each of these topics has been explored in the theoretical and empirical literature on manufacturing innovation. While this review is not exhaustive (Cohen (1995) provides a comprehensive overview of literature on manufacturing innovation), it is intended to suggest the broad outlines of the literature.

*Firm size and age.* The relationship between firm size and innovation has been a topic of enduring interest to economists at least since Schumpeter's (1942) argument that large firms were better suited to pursue innovation than were smaller firms. Whatever the advantages of small firms in insuring intense static price competition, he asserted, they were unlikely to have the incentives to engage in long-term R&D since many of the rents were likely to be subsequently competed away. He also suggested that there would be substantial economies of scale in the innovation process.

This literature inspired by Schumpeter has most frequently examined how firms' rate of innovation varies with their size. (This work has also inspired many cross-industry studies of how innovation at the industry level differs with market concentration.) While the empirical literature analyzing this question has been voluminous, few distinct conclusions have emerged. An illustration of these frustrations can be seen by comparing the two most comprehensive studies in this literature, Bound, *et al.* (1984) and Cohen, Levin, and Mowery (1987). While Bound and his co-authors found that R&D-intensity was highest

among very small and very large firms, the latter paper found that once industry effects were controlled for, R&D intensity did not change with firm size. Acs and Audretsch (1988), using a database of articles about innovations, suggested that small firms disproportionately contribute to innovative activity.

A number of theorists have suggested that younger firms may be more effective at introducing new products. Holmstrom (1989) argued that the established corporation primarily exists to fulfill production and marketing goals and that to pursue these goals effectively, it has to organize in a way that compromises incentives to innovate. Providing incentives for both types of activities within one organization is more costly than providing them through separate organizations. Aron and Lazear (1990) presented a model in which new firms pursue less risk-averse strategies and are hence more likely to undertake radical new research programs and to introduce new products.

Prusa and Schmitz (1994) tested these theories by examining the introduction of new software products. The authors suggested that new firms appear to be more effective at creating new software categories, while established firms have a comparative advantage in extending existing product lines. Similar conclusions emerged from Henderson's (1993) study of the photolithographic industry, which suggested that established companies failed to pursue successfully major technological opportunities, and from descriptive studies of the pharmaceuticals industry (reviewed in Pisano (2002)).

*Financial constraints.* Another extensively scrutinized question has been the extent to which financial resources affect firms' abilities to pursue innovations. Since Arrow (1962), it has been understood that the substantial information problems surrounding R&D projects make it difficult to raise external capital to finance them. As a result, firms with promising projects may be unable to pursue them. This intuition is formalized in models such as Stiglitz and Weiss (1981) and Myers and Majluf (1984).

Many early studies suggested a relationship between cash flow and R&D spending, a finding that could be interpreted in various ways. Recent works have examined these issues more systematically. Himmelberg and Peterson (1994) looked at a panel of small firms and showed that the sensitivity of R&D investments to cash flow seems to be considerably greater than that of physical investments. But the bulk of the attention has focused on the impact of leverage on R&D spending. Hall (1990) showed that firms that increase their leverage tend to reduce R&D spending. Similar conclusions emerged from Greenwald, Salinger, and Stiglitz (1992).

*Ability to access knowledge spillovers.* An extensive theoretical literature (e.g., Romer (1986)) has argued that spillovers of technological knowledge are an important spur to future innovation. As Krugman (1991) and others have hypothesized, these spillovers—particularly of tacit knowledge—are likely to be geographically concentrated.<sup>1</sup>

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<sup>1</sup>These knowledge flows are likely to be affected by the appropriability regime. The ability rigorously to appropriate knowledge—whether through strong patents or employee non-competition agreements—may limit the ability of other firms to utilize

Jaffe, Henderson, and Trajtenberg (1993) demonstrated that patents are more likely to be cited in patents awarded to other entities in the same region, an effect that they suggest is consistent with the localization of knowledge spillovers. Similarly, Audretsch and Feldman (1996) showed that not only is innovative activity more concentrated than manufacturing, but that this is particularly the case in industries where knowledge spillovers are important.

Another source of spillovers may be ties to academic institutions. Cohen and Levinthal (1989) hypothesized that firms may seek to build close connections to academia to boost their “absorptive capacity.” The authors hypothesized that these activities enhance firms’ abilities to interpret scientific discoveries and to translate them into innovations.

Some supporting evidence for these claims has been found in the life sciences. Henderson and Cockburn (1996) showed that pharmaceutical firms that embraced scientific-based research were particularly successful in developing new drugs. In related work, they showed that other practices—such as co-authorship between corporate scientists and public sector researchers—are also associated with enhanced drug discovery. Zucker, Darby, and Brewer (1998) demonstrated that the formation of new biotechnology firms in regions is largely driven by the presence of academic science.

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tacit knowledge flows. Alternatively, such property rights may facilitate licensing by firms.

To be sure, the list of potential explanations for innovation that I will examine here is far from exhaustive. The most important omission is demand side shifts, whose importance in spurring innovation was highlighted by Schmookler (1966). Many studies do not consider such shifts, largely because it is difficult to capture them effectively. Regulatory and tax policy shifts may also stimulate innovations. To the extent to which these shifts are correlated with the independent variables, these may introduce an omitted variables bias.

### *B. The Origins of Financial Innovation*

It is reasonable to assume that the dynamics of innovation in the financial services industry are quite different from those in manufacturing as a whole. Unfortunately, the literature on financial innovation to date provides relatively little guidance as to which institutions should be most prolific innovators.

At least three substantial differences exist between innovation in financial services and manufacturing:

- *Appropriability.* The financial services industry has historically differed from the bulk of manufacturing industries in regard to the ability of innovators to appropriate their discoveries. Until recently, financial firms have been very limited in their ability to protect new ideas through patents. Even when firms did apply for patents, they frequently did not expect to be able to enforce them readily. As a result, new product ideas have diffused rapidly across competitors (Tufano (1989)). While a theoretical analysis by Herrera and Schroth (2002) argues that even when

inventions cannot be patented, investment banks will have considerable incentives to develop new products, it might be anticipated that the lack of effective patent protection would shape the incentives to innovate.

- *Regulation.* Many product innovations in financial services have been subject to detailed review by public regulatory agencies. While certainly such reviews are not unknown in manufacturing (e.g., pharmaceuticals), the prevalence of the regulatory scrutiny is greater here. These reviews may raise the barriers to innovation, particularly for younger and inexperienced firms that may find that such reviews strain their resources. But such regulatory changes may also serve as incentives for financial innovation, as firms seek to find their way around such constraints.
- *Collaboration.* In many segments of the financial services industry, firms frequently engage in collaborative activities, whether syndications of innovative securities or joint ventures to market new products. The creation of standards is also important in facilitating interactions among financial institutions. While collaborations are certainly also seen in manufacturing industries and standardization is critical as well in information technology, the ubiquity of these relationships in financial services may shape the incentives to innovate and the nature of innovations.

While an extensive theoretical literature examines financial innovation (which Harris and Raviv (1989), Allen and Gale (1994), and Tufano (2003) review), the role of institutions has been relatively little scrutinized.<sup>2</sup> Many of the works have sought to

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<sup>2</sup>Tufano (2003), in fact, quotes Franklin Allen's observation that much of financial economics acts as if financial institutions do not exist, though he acknowledges that this observation does not perfectly characterize the literature on innovation. Ross (1989)

understand the impact on innovation of what Miller (1986) refers to as the “grain of sand in the oyster,” that is, external shocks such as shifts in taxes or user demands. The nature of the institutions actually undertaking the innovations has been less scrutinized.

The theoretical works that have examined the question of which financial institutions innovate are mixed in their conclusions. The question that has been most explored is whether institutions that are more or less well positioned competitively will account for the bulk of the innovations. Bhattacharyya and Nanda (2000) argued that investment banks with greater market power and more secure relationships with their customers are likely to innovate. Silber (1975, 1983), on the other hand, argued that the firms most constrained in their abilities to profit in the product market—which he implied are the weakest and smallest firms—will have the greatest incentives to introduce new products and services, and should be the most innovative. The other determinants of innovation discussed above—the impact of financial constraints and knowledge spillovers—have largely been unexplored in the context of financial innovation.

## **2. Developing the Data-Set**

As highlighted in the introduction, traditional measures of innovative activity—e.g., R&D spending and patenting—are unlikely to be very illustrative in this setting. An alternative measure is needed. This section summarizes the manner in which I develop the database of financial innovations and validate this measure; a more detailed discussion is in the Appendix.

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makes a similar argument about the relative neglect of institutions in the study of financial innovation.

I compile all such articles in the *Wall Street Journal* between 1990 and 2002 that related to new financial products, services, or institutions, using print and electronic indexes to identify stories. Given the *Journal's* intensive coverage of the financial services industry, the use of this measure seems particularly appropriate here. As discussed in the Appendix, I determine the Compustat GVKEY for the entities mentioned in these stories as innovators. I also compile a variety of supplemental data on these firms from Compustat and other sources.<sup>3</sup>

I identify all financial patents using the Patent and Trademark Office's on-line database that summarizes all patents awarded since 1976. Following the procedure in Lerner (2002), I identify all patents assigned to relevant U.S. Patent Classification subclasses. In all, I identify 1969 such patents awarded between 1990 and 2002. I compute the number of citations that each patent received through the end of 2002 using the data compiled by Bronwyn Hall and archived at <http://emlab.berkeley.edu/users/bhhall/bhdata.html>. I once again code the entity to which the patent was assigned (if any) with the appropriate Compustat GVKEY. There are 922 distinct patents where the assignee is listed in Compustat.

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<sup>3</sup>My empirical approach necessarily excludes private entities from the analysis, which tend to be smaller entities. This methodology may be unavoidably introduce some selection biases into the analysis. Since many of the innovators are privately held entities, I suspect that my methodology will lead to an upward-biased estimate of the elasticity of size on innovations.

Table 1 summarizes the articles and entities in the dataset. Panel A reports the timing of the 651 news stories meeting my criteria. No clear time trend is evident from the data. Panel B presents a breakdown of the types of innovations reported on. The bulk of the stories relate to the underwriting of novel securities or trading technology (33.5%), asset management (26.2%), and retail banking or mortgages (11.6%). Panel C shows the breakdown of stories over time, now focusing solely on the 387 stories about entities that listed in Compustat (as discussed below, I will focus on this subset of firms). The final panel shows the breakdown of the industry of the innovators (weighted by the number of innovations), by three-digit Standard Industrial Classification (SIC) code. Not surprisingly, the three most common classifications are subclasses of “finance, insurance, and real estate”: securities brokers and dealers (23.5%), commercial banks (22.3%), and other non-depository credit institutions (8.2%). Following these categories, however, are a wide variety of industries, ranging from computer programming to publishers to motor vehicle manufacturers.

One natural concern is that the shifts in stories about innovations in the *Journal* may have had little to do with variations in the fundamental innovativeness of the American financial services industry. For instance, the judicial decisions endorsing financial patents may have triggered firms to disclose more discoveries, since they no longer needed to rely as heavily on trade secrecy to protect ideas. I seek to address this concern in three ways.

First, I code the extent to which the stories unambiguously represented a true innovation. I employ an (admittedly subjective) three-part classification scheme, denoting stories as As, Bs, and Cs, depending on the extent to which I was sure that it described an innovative contribution. No evidence of changing quality appeared in the tabulations: for instance, between 1990 and 1998, 69.9% of the stories were classified as either an “A” or a “B.” In the period after the judicial decisions validating financial patents (*i.e.*, between 2000 and 2002), 68.5% of the stories were so classified. I repeat the analyses below, only employing the highest-rated innovations, which should be less prone to selection biases.

Second, I examine the correlation between the number of articles about innovations and patents awarded to each firm—a frequently employed proxy for innovative activity—over the sample period. The correlation coefficient, 0.34, is significant at the 0.001 significance level. This relationship continues to hold when I examine the Spearman rank order statistic, eliminate firms with no patents or innovations, and compute partial correlations controlling for firm assets and age. It might be objected that this test is of relative limited value, due to the questionable status that financial patents enjoyed for much of the period under study. It should be noted that the analysis of manufacturing firms in Kortum and Lerner (2003) found an even stronger correlation between *Wall Street Journal* stories and patenting.

Finally, I assess the importance of these innovations by examining the market reaction to these stories. In all, there are 305 distinct dates on which stories appear about

entities whose stock price is included in the databases of the Center for Research in Security Prices. (In some cases, Compustat-listed firms are not found in CRSP; in others, multiple stories about innovations at a single firm appear within one week of each other.<sup>4</sup>) The firms' equity returns around the time of the *Wall Street Journal* story are consistently positive and statistically significant. For instance, when I estimate a market model using a (-1, +1) window centered on the date the story appeared, the average cumulative abnormal return is +0.63% and the associated t-statistic is 2.68. (The result is significant at the one-percent level using a one-sided t-test.) (All observations must have at least three observations between one and twelve months before or after the event window, which is used to compute the correlation with the market. The value-weighted CRSP index is used as a benchmark.) The results are similar when I use longer or shorter windows, alternative indexes, or different specifications. For instance, when I estimate a market-adjusted model over the (-2, +1) window, the average cumulative abnormal return is +0.84% with an associated t-statistic of 3.04. These results suggest that the innovations are indeed significant ones to the firms in the sample.

Table 2 summarizes the innovators and patentees most frequently found in the databases. Panel A, which summarizes the distribution of innovators, highlights the frequency of stories about some of the largest financial institutions. The two most frequent innovators, Merrill Lynch and Citigroup, also appear on the list of leading

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<sup>4</sup>When multiple stories appear about a company within five trading days of each other, I only employ the first observation. The results are robust to using the latter observation or deleting these overlapping observations entirely.

patentees. Information technology firms and data vendors dominate the list of patentees. Two of these firms, IBM and Reuters, also appear on the list of financial innovators.

### **3. The Source of Financial Innovations**

I now turn to understanding how my measure of financial innovation relates to the characteristics of the potential innovators. I first perform some cross-tabulations, and then undertake a series of regression analyses.

#### *A. Univariate Comparisons*

Table 3 compares the features of all firms with at least one *Wall Street Journal* innovation with all firms with a primary assignment to the financial services industry. I examine the firms along several dimensions suggested by Section 1:

- *Total assets.* I use assets (rather than employees or revenues) for several reasons. The measure is more frequently available in Compustat than employees: using assets rather than employees increases the sample size by 56%. I also believe it better conveys the scale of activity for many institutions that may have considerable resources under management, but may have a relatively modest number of employees or revenue flows from fees. Assets are in millions of 2002 dollars.
- *Profitability of the firm.* I wish to capture a measure of relative profitability that is unaffected by capital structure choices. Thus, I use the ratio of earnings before interest, debt, taxes, depreciation, and amortization (EBITDA) to total revenues.

- *Other financial innovations in zip code.* In order to capture the presence of localized spillovers, I compute the number of total number of financial innovations in the same year by other firms with a headquarters in the same two-digit zip code as the firm.<sup>5</sup>
- *Time the firm has been publicly traded.* While ideally I would have a measure of the firm's overall age, this is a frequently used proxy.
- *Leverage.* I employ the ratio of the book value of the firm's long-term debt to total capitalization (the book value of its long-term debt and preferred stock plus the market value of its common stock).
- *The ratio of editorial board seats to assets.* I compute the total number of editorial board seats of and editorial sponsorships by each financial institution in a given year as described in the Appendix, and normalize it by the total assets (in billions of 2002 dollars) of the firm.<sup>6</sup>

To address partially the lack of controls for industry characteristics, I also undertake the comparisons for the subset of innovators whose primary assignment is to SIC codes 60 through 64 and 67 (the classifications encompassing financial service firms).

The table highlights the fact that innovators tend to be larger and older. They are more likely to be located in zip codes where there are many financial innovations. Innovators are likely to have stronger academic ties. The results regarding profitability

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<sup>5</sup>Thus, all innovations by firms based in zip codes 10000 through 10999 are considered together. (In unreported analyses, I employ three-digit zip codes and find it makes little difference. Results are dramatically weaker, and indeed often reversed in sign, when I use the number of innovations in the same five-digit zip code.)

<sup>6</sup>Correlation coefficients between the measures are modest. The highest correlations are between assets and age (a coefficient of 0.194) and assets and leverage (0.106).

(EBITDA margin) and leverage are mixed: the results in the sample as a whole are inconsistent or insignificant, but innovators are more profitable and more leveraged when only financial service firms are compared. In any case, my interpretation of these results must be cautious. Not only is the absence of controls for industry, time period, and company location troubling, but the observations are clearly not independent.

Table 4 examines how the propensity to innovate varies with firm size. I divide the firm-year observations into quartiles based on assets (expressed in 2002 dollars). In the table, I present the number of innovations awarded in each year per billion dollars of assets (again in 2002 dollars) for each size quartile. The greater propensity of smaller firms to innovate is apparent.<sup>7</sup> Once again, though, my interpretation of the patterns must be cautious.

### *B. Regression Analyses*

I address these concerns in Tables 5 through 7, which examine the determinants of innovations in a regression framework. The dependent variable is annual firm-level observations of the number of innovations attributable to that firm in that year. Following the template of Hausman, Hall, and Griliches (1984), I employ Poisson and negative binomial specifications. Both are well suited for handling this type of non-

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<sup>7</sup>These patterns also are present when I only use firms in financial services industries. These patterns—and those discussed below—continue to hold when I divide firms by employees rather than assets. The ratio of the count of innovations to employees is 13.7 times greater for the quartile of smallest firms than for the quartile of the largest firms. The ratio decreases monotonically with firm size: the ratio for the smallest firms is 5.8 times greater than for the second largest quartile and 3.0 times greater than the third largest quartile.

negative integer dependent variable, though the negative binomial specification is frequently preferred due to the fact that it allows for overdispersion of the count variable, that is, a variance in the dependent variable that is different from its mean.

Table 5 presents an analysis of the impact of firm size on innovation. I confine the analysis to all firms with a primary assignment to Standard Industrial Classification (SIC) codes 60 through 64 and 67. I report five specifications. In the first specification, I estimate a pooled negative binomial regression, employing each observation separately (though computing heteroskedastic-adjusted standard errors clustered by each firm). I then estimate a random effects negative binomial regression. I also report a pooled zero-inflated negative binomial regression, which controls for the possibility that observations with zeros are over-represented,<sup>8</sup> and a random effects regression employing a Poisson specification. The final regression presents a negative binomial regression with one observation for each firm, where the dependent variable is the total number of innovations over the sample period.

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<sup>8</sup>In the regressions using annual observations in Table 5, the dependent variable in 99.0% of the cases is equal to zero. In the analysis using cumulative innovation in the final column of Table 5, 97.1% of the observations are equal to zero. The incidence of annual observations with zero innovations varies across types of firms, ranging from 95.5% (securities/brokerage) to 99.4% (depository institutions) in the regressions reported in Table 7. The prevalence of zero observations in the patenting regressions is considerably higher when I employ as the dependent variable only process or technological innovations in Table 7 (99.8% in both cases) or patent applications in Table 9 (99.6%). The sample size is smaller in the zero-inflated negative binomial regression, because some observations are dropped from the logit regression that is used to characterize the excess zeros in the data.

In all regressions, I use as independent variables the variables employed in the cross-tabulations above.<sup>9</sup> In the pooled regressions, I include dummy variables to control for the nation in which the company has its headquarters, its three-digit SIC code, and the year of the observation; in the random effects ones, I only control for the year (due to the presence of firm-level controls).<sup>10 11</sup>

The size measures are consistently different from zero at the one-percent confidence level: larger firms, not surprisingly, produce more innovations. A critical question is whether the elasticity of innovations with respect to size is greater or less than one. In other words, does a 10% increase in size lead to more or less than a 10% increase in innovations? The reported coefficients on the independent variable measuring the

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<sup>9</sup>I employ the logarithm of all independent variables that are not ratios. In order to include observations with a value of zero, I add one to each independent variable before taking the logarithm.

<sup>10</sup>The final regression has independent variables similar to the others, but I now employ the average over the entire period that an entity with that GVKEY was in the sample. In the other regressions in Table 5, I employ dummy variables for the year of the observation. I still employ indicator variables for each year in this regression, but now they denote the years in which the firm appeared in the sample. Thus, a firm that was in the sample from 1995 to 2002 would have these years coded as one and the others as zero.

<sup>11</sup>As noted above, I am unable to control for shifts in the demand for financial innovations (aside from the time period dummies). For instance, a tax policy change may spark the introduction of new financial instruments geared to the taxpayers' particular needs. While tax policy changes may move out the demand curve for financial innovations, it is unlikely that they will affect the supply curve for innovations. Under the Internal Revenue Code § 41, the credit is limited to "research in the laboratory or for experimental purposes, undertaken for discovering information, technological in nature." In a series of decisions, tax courts have held that this definition does not include R&D performed by financial service institutions or involving software development more generally. Recent examples include *Tax & Accounting Software Corp. v. U.S.*, 301 F.3d 1254 (10th Cir. 2002) and *Eustace v. Commissioner*, 2002 U.S. App. LEXIS 25530 (7th Cir. 2002).

logarithm of assets can be interpreted as the elasticity of innovations with respect to assets. To illustrate this, consider a case where I regress  $Y$  on  $x$ , where  $x \equiv \log(X)$ . The expected value of the dependent variable in a negative binomial or Poisson regression is  $E[Y|x] = \exp(x\beta)$ . Differentiating, substituting, and rearranging, I obtain:

$$\frac{\partial E[Y | x]}{\partial x} = \beta \exp(x\beta)$$

$$\beta = \frac{1}{E[Y | x]} \frac{\partial E[Y | x]}{\partial x}$$

Since by definition,  $\partial x / \partial X = 1/X$ , the estimated coefficient  $\beta$  is the elasticity of  $Y$  with respect to  $X$ .

In the final line, I test whether these differences from one are significant. In four out of five cases, the null hypothesis that the elasticity is equal to one can be rejected at the one-percent confidence level; in the last regression, at the five-percent level. This finding of an elasticity of less than one can be contrasted with the consensus in the literature, which depicts innovation being undertaken disproportionately by the largest financial institutions (e.g., Tufano (2003)).

The other key results are as follows:

- Less profitable firms are consistently significantly more innovative. In the second regression in Table 5, a one standard deviation increase in the ratio of EBITDA to sales translates into a 29% decline in the predicted rate of innovation. This finding is consistent with the work of Silber (1975, 1983), who suggested that the bulk of innovations should be by the smallest and weakest firms.

- More financial innovations occurring in a firm's two-digit zip code are associated with more innovation. The first regression in Table 5 indicates that a doubling of the innovation rate in the firm's region is associated with a 35% increase in the innovation rate.
- Older firms appear to be associated with more innovations, though this coefficient is not significant in the final regression.
- More levered firms are less innovative in the regressions with random effects, though the effect is weaker in the pooled regressions.
- Closer ties to academia have no consistent statistical association with innovation.
- The (unreported) year dummy variables in the reported specifications are never jointly significant, and rarely significant on an individual basis. No discernable time-trend is present in the coefficients either.

In Table 6, I rerun the random effects negative binomial specification to explore the robustness of the results. In the first regression, I use as observations two additional sets of firms in addition to those with a primary assignment to Standard Industrial Classification (SIC) codes 60 through 64 and 67: non-financial firms with at least one *Wall Street Journal* innovation or at least five financial patents.<sup>12</sup> In the remaining regressions, firms not based in the United States are eliminated, an additional control for R&D spending is added,<sup>13</sup> only innovations ranked as particularly important (see the

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<sup>12</sup>The reason for using a higher cutoff for patenting is that there were many more such awards than innovations in my database.

<sup>13</sup>I assume that all firms that do not report R&D spending in their financial statements perform no R&D. In point of fact, most financial services firms do not report R&D

discussion in Section 2) are included,<sup>14</sup> and the weighted count of innovations is used, for instance, an innovation attributed to two investment banks is only counted as one-half an innovation for each.<sup>15</sup> The results are little changed.

#### 4. Supplemental Analyses

The analysis above suggests a number of follow-on questions. In this section, I examine three of these. First, do the patterns differ across classes of innovations and firms? Second, to what extent do firms that innovate continue to lag their peers in profitability? Finally, do the patterns of financial patenting display the same patterns as seen among innovations?

##### *A. Differences Across Firms and Innovation Classes*

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spending, even if they undertake substantial R&D (see Long (2003)). 98% of the firms in the sample with a primary assignment to the financial service industries do not report positive R&D. For instance, neither Citigroup nor Merrill Lynch report any R&D between 1990 and 2002. Thus, I must approach this measure with caution.

<sup>14</sup>The reported results here use all innovations classified as “As” and “Bs.” The results using only “As” are similar.

<sup>15</sup>In this case, in order to maintain the count nature of the dependent variable, I score an innovation with a single progenitor as 12, and scale fractions accordingly. In addition, I undertake a variety of additional analyses that are not reported. These including deleting trusts and real estate investment trusts, employing a piece-wise specification (with four separate independent variables taking on the value of the logarithm of size if size falls into that quartile, and zero otherwise), and employing each of the non-size control variables separately. The results are little changed. I also re-estimate the equations, adding up the three lags of the key independent variables. While the lags are in a few cases statistically significant, generally the bulk for statistical and economic significance is concentrated in the contemporaneous measure.

A natural question is whether these patterns are universal across financial services. To what extent are they seen consistently, or do these patterns vary across classes of firms and types of innovations? Table 7 explores these issues.

The first three columns examine the innovations across three classes of firms in the sample. Rather than using all observations of financial service firms as in Table 5, I confine the sample to firms assigned to two-digit SIC class 60, “Depository Institutions,” class 62, “Security And Commodity Brokers, Dealers, Exchanges, And Services,” and class 63, “Insurance Carriers,” respectively. Several clear differences appear:

- Unlike the regressions in Tables 5 and 6, as well of those in other industries (and unreported ones using other industry categories), the elasticity of innovations with respect to size is greater than one for depository institutions (though the difference from one is not statistically significant).
- The impact of age on innovation seems particularly strong for depository institutions.
- The only reported regression where profitability is statistically significant is the one employing securities and brokerage firms (though the coefficient is even more negative in the depository institution regression).

In the final columns of Table 7, I employ the entire sample in the regressions, but now use as my dependent variable two subsets of innovations. I examine the stories in the *Wall Street Journal*, and classify in as systematic a matter as possible the innovations being described. First, I divide innovations into those that involve “processes” and not.

I define as process innovations those changing the way a given good or service is produced or delivered, such as trading systems and strategies. I then divide the observations into those that are “technological” or not. I define technological innovations as those where the fundamental insight relates to a principle or method in the natural sciences or engineering, rather than (for instance) a new security pricing algorithm. (Examples would include advanced computer systems with financial applications and new network technologies for Automatic Teller Machines.)

The last two columns report the regressions for process and technological innovations. Compared to other innovations (the corresponding regression is not reported), less profitable firms and those located in regions with many innovations dominate process innovations. On the other hand, age is not an important driver of process innovations, while it is for other innovations. The other effects are similar. Technological innovations tend to be disproportionately undertaken by less leveraged firms, while less profitable firms dominate other innovations.

### *B. Impact of Innovations on Profitability*

The finding that firms who innovate tend to be less profitable raises a natural follow-on question. If, as Silber argues, investing in financial innovation is a rational response to a lagging competitive position, I should expect that innovations lead to increased subsequent profitability.

Table 8 explores these issues. It presents the measure of profitability used earlier (the EBITDA/revenues ratio) from the year before to four years after the story about the innovation. The analysis includes all financial innovators, even those that are not classified as financial services firms.

The table first presents the unadjusted ratio. An increase in the ratio in the years after the innovation is apparent. Of course, the interpretation of the result is clouded by the fact that the profitability ratio may be quite different across various industries. The second line presents the “abnormal” profits: the residuals from a regression (using all observations) of the EBITDA/revenues ratio on the logarithm of years since the firm’s initial public offering, the logarithm of assets, the ratio of the book value of the firm’s long-term debt to total capitalization, and dummies for the location of the company, the three-digit Standard Industrial Classification class of the firm, and the year of the observation. This tabulation also shows an increasing pattern of profitability as well, though the innovators remain below the average profitability throughout the period.

One issue with the above analyses is that some companies have multiple innovations over the sample period. In these cases, it may be difficult to determine clearly the impact of a single innovation on profitability. In the third line of Panel A, I again report the abnormal profitability, restricting the observations to those firms that innovate in a single year. The increase in profitability is even more dramatic in this subset of observations.

A natural concern is that these results may simply be an artifact of survivorship bias. By necessity, firms that cease making public securities filings or are acquired are dropped from the sample after those events. If the bulk of exits are of poorly performing firms, as some models of industry evolution (e.g., Jovanovic (1982)) suggest, then I might see increasing performance of all surviving firms, whether or not they innovated.<sup>16</sup>

The fourth row of Panel A addresses this concern by presenting the abnormal profits for the non-innovating financial service firms, computed as above. Here, the level of profitability is essentially flat, with no significant differences from zero. This helps alleviate the concern that the results are an artifact of survival bias.

Panel B presents the t-statistics and p-values from tests of the significance of these differences. Each of the differences is significant at least at the ten percent confidence level. The one exception is the comparison of non-innovators, where there are no significant differences. I also explore the robustness of the results to a variety of other divisions and approaches, such as only using financial service firms as in Tables 5 through 7, but the differences continue to be significant in economic and statistical terms. The results suggest that innovators experience a significant increase in profitability in the years after the product or process introduction.

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<sup>16</sup>In point of fact, press accounts suggest that many of the acquired firms in rapidly consolidating industries such as banking appear to have been top performers rather than laggards.

### *C. Patterns in Patenting*

The final supplemental analysis examines the filing of patent applications by the firms in my sample. I replicate the analyses above, now examining the determinants of patent filings. Since patents are often used as a proxy for innovation, it might be anticipated that the determinants of patenting would be similar to that of innovating. Earlier work (Lerner (2002)), however, suggests that the dynamics of financial patent filing and review are quite different from other areas with close connections to academia.

I examine patenting in a regression framework. A general consensus in the productivity literature is that it makes sense to examine the filing date of patent applications, rather than their award dates: the processing times for these awards differ across time. Moreover, studies suggest that the lag between the patent application filing and the R&D activity is minimal (Hall, Griliches, and Hausman (1986)). This approach, however, has the consequence of limiting the time period over which I can examine patenting behavior. Applications are often held confidential in the United States prior to award, so I cannot ascertain how many applications each firm has made in recent years. I consequentially restrict the analysis to patents applied for prior to 2000.

Table 9 corresponds to two of the analyses of innovations in Table 5. Like the innovators, patentees tend to be older and less leveraged. But other patterns, such as the disproportionate role of less profitable firms in the innovation regressions, are not seen here. The elasticity of patenting with respect to size is indistinguishable from one. One striking difference is the absence of a local spillover effect: in fact, the number of

innovations in the firm's region is significantly negative in the pooled regression. The results remain similar when other robustness checks, akin to those in Table 6, are undertaken, with the exception that when the broader sample (including non-financial firms) is used, the elasticity of patents with respect to size drops sharply and less profitable firms disproportionately patent.

The differences across the innovation and patenting regressions are puzzling. One possibility is that some classes of firms are simply much more prone to file large numbers of patents, and thus likely to patent financial discoveries even if the innovative component is quite marginal. One way to get at this question is to examine the extent to which patent awards are cited, which are often seen as a proxy for the importance of a discovery (see, for instance, Jaffe, Henderson, and Trajtenberg (1993)).

I undertake a preliminary exploration of these issues in Table 10. I examine the number of citations through the end of 2002 to all financial patents awarded to Compustat-listed firms between 1990 and 2001. I only include patents awarded through the end of 2001 to insure that the firms will have at least a minimum period to garner citations. I include all such awards, whether or not the awardee was a financial services firm. In the first regression, I employ as independent variables dummies for three classes of financial services firms as well as for non-financial companies (the baseline is other financial service firms). I also include dummies for the year of the award, to control for the fact that the patents have had different times to be cited. I find that the dummy for non-financial firms is significantly negative, but the coefficients for no other classes of

firms are significantly different from zero. When I add a variety of control variables, none of the firm type categories are significant: the only (weakly) significant explanatory variable is proxy for academic connections. Taken together, these do not suggest a ready explanation for the differences between innovating and patenting.

Figure 1 suggests that substantial disparities existed between patenting and innovations across industries. I present the ratio of successful applications filed to innovations for five classes of firms: depository institutions, securities/brokerage entities, insurers (all defined as above), all other financial service firms, and all other firms undertaking at least one financial innovation or at least five financial patents in this period. Because of the magnitude of year-to-year fluctuations, I compute the ratio on a biannual basis. I only include patent awards issued by the end of 2002, which explains why the ratio is zero in the final period (and declines in the penultimate period): many patent applications filed in these periods will not issue until later. (The low ratio in the first period, on the other hand, reflects the scarcity of financial patents in the early 1990s.) The chart makes the dramatic differentials in patenting rates clear. The ratio is the greatest by far for non-financial firms, while lowest for the depository institutions and securities/brokerage firms. This pattern suggests that differences in financial patenting activity may be driven not by variations in fundamental innovativeness, but rather by industry practice.

## **5. Conclusions**

In this paper, I analyze the sources of financial innovations between 1990 and 2002. I find evidence that suggests that small firms are more innovative than their larger peers. Less profitable firms innovate more, but firms that innovate enjoy enhanced profitability in subsequent years. Older, less leveraged firms located in regions with more financial innovations also innovate more. Patterns of patenting are in some ways similar to those of innovations, but the dominant role played by small, unprofitable firms and the presence of local spillovers are not seen here.

As noted above, this paper certainly is not the last word on these issues. I have already highlighted the need for more theoretical research exploring the relationship between financial institutions and innovation, which should shape future empirical work. In the interim, however, two empirical opportunities seem apparent.

First, more could be done to relate changes in innovators to shifts in the tax, regulatory, and overall economic environment. Do, for instance, the emergence of new industries with pronounced information asymmetries spur the introduction of novel financial products by smaller financial institutions, who might respond more quickly to these challenges? In order to explore these issues fully, it will probably be necessary to examine a longer time frame.

Second, this analysis has not distinguished between the introduction of successful and failed innovations. While Table 8 suggests the introduction of innovations was associated on average with increased profitability, it would be interesting to examine the

distribution of these changes. Do systematic differences appear in the parties who introduce successful and unsuccessful new financial products and services?

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## Appendix

Examining financial innovation is a challenging task. Not only are traditional approaches inadequate, as noted above, but most alternatives are also troubling. Consider, for instance, the listings of new securities compiled by Securities Data Company (which maintains the leading database of corporate new issues). First, much of the innovation in financial services has taken place outside the realm of publicly traded securities, such as new Automatic Teller Machines and insurance products. Second, as Tufano (2003) points out, many of the “novel” securities identified in the SDC database are minor variants of existing securities, often promulgated by investment banks seeking to differentiate themselves from their peers.

As a result, I need an alternative measure of innovative activity. I employ an approach here—originally developed in Kortum and Lerner (2003)—of examining articles in the *Wall Street Journal* concerning financial inventions and innovations. While such a measure is far less frequently used as a measure of innovation than R&D and patents, I am not the first to use counts of stories to study innovations: Acs and Audretsch (1988), Chaney, Devinney, and Winer (1991), and Cardinal and Opler (1995) are earlier examples. The latter two papers use counts of stories exclusively from the *Wall Street Journal*.

I wish to count both inventions (new products or processes) and innovations (the first time an invention is put to use).<sup>1</sup> The literature (e.g., Schmookler (1966) and Jewkes, Sawyers, and Stillerman (1969)) makes a distinction, however, between scientific and technological knowledge, the former being a set of general principles while the latter is a set of specific techniques, products, and processes. Scientific knowledge is expanded by discoveries about how the world works while technological knowledge expands via inventions. I want to count inventions but not discoveries.<sup>2</sup>

Schmookler makes the critical distinction between innovation and imitation:

When an enterprise produces a good or service or uses a method or input that is new to it, it makes a *technical change*. The first enterprise to make a given technical change is an *innovator*. Its action is *innovation*.

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<sup>1</sup>The following six paragraphs are from Kortum and Lerner (2003). Sam Kortum originally wrote the first two paragraphs. A related concern was insuring consistent coding of the databases by the research assistants. Before beginning working on the database, each research assistant coded the same test section. The responses were compared to the author’s coding of this section. When necessary, a second test section was coded as well. Frequent team meetings discussed questionable cases and helped insure consistency.

<sup>2</sup>Scholars also distinguish between invention and development, the latter being concerned with getting an invention to work in practice. I will not worry about this distinction (in the same way I want to include both inventions and innovations).

Another enterprise making the same technical change later is presumably an *imitator* and its action, *imitation* (pg. 2, emphasis in the original).

I do not want articles about imitation. Once invented, several firms can in principle use a technique at once without diminishing its performance. Thus, I do not want to include articles about firms that are simply expanding production. Some new products may be a direct consequence of scaling up production. For example, as the number of investment bankers at a financial institution increases, it is obvious that more transactions can be underwritten. Such behavior is simply expansion or replication of an existing production process. I would, however, count a story about the bank's development of a new product.

For the most part, I will not attempt to evaluate the importance of any invention or innovation, but will simply assume that if the *Wall Street Journal* finds it worth writing about it should be included. I use the *Wall Street Journal* due both to the consistency in its editorial mission over the years and the thoroughness of its indexing, which should lead to fewer biases. (The *New York Times*, for instance, launched a series of regional editions over the same period, and greatly enhanced their coverage of local news from outside the New York metropolitan area.)

I talked with a current and a former reporter of the *Wall Street Journal* in order to understand biases that may have been at work in the selection of stories. They highlighted two issues, which may make small firms appear more or less innovative than they actually are. First, lacking the distribution networks of established firms, small financial institutions may have more aggressively sought publicity for their discoveries. Second, the *Wall Street Journal* pays particular attention to the largest financial institutions, often assigning dedicated reporters to cover these firms. This intense coverage might have led to more articles about innovations by larger firms. They also noted that a significant—though difficult to ascertain—number of innovations never make it into the *Journal*: for instance, the development of a new pricing methodology for mortgage-backed securities by the proprietary trading group of an investment bank or a hedge fund is unlikely to be publicized.

Examples of included stories are:

- Announcements of new financial products and processes.
- Announcements of new products incorporating an improvement.
- Plans to develop or introduce new products or processes.
- Experimental new products.
- Joint ventures if an innovation is mentioned as the goal.
- Government grants and contracts to fund something new and innovative (even if government is only seeking to award a contract). (Unlike for new products and processes, for grants and contracts I required that there must be some clear evidence that something innovative is sought).
- Government approvals (or applications for approval) of new products, including approvals by foreign governments.
- Innovative new applications or combinations of existing products.

- Applications of new technology to finance: “High-yield junk bonds auctioned electronically.”
- Articles about innovation even if it concerned only the intention to surpass some technological hurdle. My reasoning is that an invention or innovation probably spurred the attempt. The fact that the research may ultimately fail is not a concern, as even many patented inventions turn out to be useless.
- Innovative applications on the Internet: “First application of online banking.” I do not include announcements of new web pages unless there is a clear innovation, *i.e.*, the first application of a new idea.

Examples of excluded stories are:

- Cases in which marketing issues are central and technological achievements only secondary.
- Reports on the spread or diffusion of an existing technology.
- Expansion of a market: “Branch banking to hit Hawaii.”
- Letters to the editor, editorials, or corrections.
- Political decisions, new laws, and regulations. (But patents issued and government approvals of new products are included.)
- Articles concerning standards, even if they are technological standards.
- Government grants or contracts for production of an existing product, or one that is not clearly innovative.
- New products or innovations occurring in foreign markets, which have no consequences for U.S. producers or consumers.<sup>3</sup>
- New issues of stocks or bonds where the security types.
- Patent infringement cases or stories about licensing technology. These cases concern ownership of intellectual property, not its creation.
- New scientific discoveries. Here, the discovery does not point to a specific new product or process; if it had, I would include it.

I identify stories between 1990 and 2002 using two sources. The *Wall Street Journal Index* (WSJI) is a printed volume with at least one entry for each article in the *Wall Street Journal*. In any given year, the entries in the WSJI are organized by topic. The same article may appear more than once as it may relate to more than one topic. Each WSJI entry contains a short summary of the article from which one can evaluate whether the article concerned an invention or innovation. Unfortunately, the length and detail of these summaries deteriorated over the 1990s, as most readers began relying on on-line sources. As a result, I also identify stories through a second source, the Factiva database. I search this database using a large number of keywords associated with new discoveries or product or service introductions.

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<sup>3</sup>I make this choice because I believe the *Wall Street Journal*'s coverage of U.S. innovations is much less likely to be affected by selection biases. I also take this route because this measure is closely analogous to the U.S. patents analyzed below (which can be applied for by any entity, foreign or domestic, but only cover the United States).

I combine the stories from both sources to construct the database. In each case, I identify the entities featured in the story. In some cases, articles list large numbers of firms (e.g., a review article recapping a set of innovations). In these cases, I identify only the four entities most prominently featured in the story, based on the number of words devoted to each entity in the original article. (In case of ties, I employ the entities mentioned earliest in the article.) In some cases, these entities included government bodies (e.g., “World Bank issues novel security,” “Commodities Future and Trading Commission approves new derivative contract”), exchanges, and other non-profit organizations.

I assume that articles about new products and services were in fact about innovations unless the article explicitly suggests otherwise. In other words, I err on the side of including new products even if they might be imitations.

In addition to the database of innovations, I collect a variety of additional information. These come from three sources: databases derived from U.S. Securities and Exchange Commission filings, academic-practitioner finance journals, and the U.S. Patent and Trademark Office’s (PTO) on-line patent database.

In order to characterize effectively the firms, I focus on only those firms that are contained in the Compustat database. This decision means that a variety of entries are excluded, including government agencies, non-profit organizations, and private entities that are not publicly traded (e.g., Fidelity Investments and Visa). Nonetheless, this choice is the only way to insure a consistent set of variables to analyze.

Each entry is assigned the Compustat identifier associated with the firm at the time of the innovation. These assignments are not always apparent, but can be determined by reviewing the corporation’s history using the Hoover’s directory, Lexis-Nexis, the SDC Mergers and Acquisitions database, and on-line searches. Thus, for instance, an innovation by Wachovia Bank in 1999 would be assigned to Compustat GVKEY 11247 (denoted “Wachovia Corp-Old”), while one by First Union Bank in that year would be assigned to GVKEY 4739 (denoted “Wachovia Corp,” reflecting the fact that First Union acquired Wachovia in 2001 and assumed its name). In some cases, Compustat has multiple listings for a single firm (typically when a firm has a highly visible subsidiary or a tracking stock, but also when the firm releases “pro forma” earnings in addition to those computed in a standard manner). In these cases, I assign the innovation to the record of the parent firm that uses the standard definition of earnings. I drop the other records associated with the firm from the analysis.

I download from Compustat a wide variety of financial data on all firms with at least one *Wall Street Journal* innovation and all firms with a primary assignment to Standard Industrial Classification (SIC) codes 60 through 64 and 67. The choice of these

industries is driven by the SIC scheme: I included all firms in “Finance, Insurance and Real Estate” except for SIC class 65, which contains real estate operators.<sup>4</sup>

The second source is academic-practitioner finance journals. I want to characterize the extent to which each firm is close to the academic frontier. I employ a proxy similar to that in Lerner (2002): the firm’s representation on the editorial boards of four leading academic-practitioner journals.<sup>5</sup> I calculate each firm’s editorial board seats at the beginning of each year. I count a firm that is a sponsor of a journal as having the equivalent of two editorial board seats. While this proxy is undoubtedly crude (the overwhelming majority of institutions never serve on such boards, even if they may have academic contacts in other ways), it nonetheless appears at least roughly to identify many firms that have strong academic ties.

The final source is the records of the PTO. The PTO has an on-line database that summarizes all patents awarded since 1976. Following the procedure in Lerner (2002), I identify all patents assigned to relevant U.S. Patent Classification subclasses. Patents are classified at the time they issue to one or more classifications. There are over one hundred thousand such classes. The PTO takes such classifications very seriously, because they insure that examiners will be able to identify the relevant earlier awards when they engage in subsequent patent searches. See Lerner (2002) for a detailed discussion. I use a somewhat broader set of patent subclasses than that paper for two reasons. First, because the innovations database includes a broad array of those by banks and insurers, I want to be sure that all relevant patents are captured. Second, the PTO initiated in 2000 a “second review” of patent applications in class 705, in which many of the most controversial Internet-related patents were classified. Since this date, there has been a tendency of applicants to seek to get their financial applications classified in Class 902. I employ all patents with a primary assignment to subclasses 705/4, 705/35 through 705/45, and 902/1 through 902/41.

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<sup>4</sup>I also use other sources to supplement Compustat for one measure: the time the firm has been publicly traded, a measure that is frequently incomplete in Compustat. If missing, I use the date of the IPO as reported in the SDC Corporate New Issues database. If not included here, I use the first date that the firm was listed in CRSP or Datastream. As a result, the earliest firms are listed as going public in December 1925.

<sup>5</sup>The journals employed were *Financial Analysts Journal*, *Financial Management*, the *Journal of Applied Corporate Finance*, and the *Journal of Portfolio Management*. These journals were selected using a variety of sources, including Alexander and Marby (1994), McNulty and Boekeloo (1999), and various on-line compilations by the Institute for Scientific Information.

**Table 1. Summary of stories about innovations.** The table provides information on the distribution of news stories about financial innovations in the *Wall Street Journal*. Panel A presents the breakdown of all news stories by year. Panel B provides a breakdown of the types of innovation. Panel C tabulates the mentions of Compustat-listed entities in these stories by year. Panel D presents the distribution of the firms in Panel C, weighted by the number of innovations, by their primary Standard Industrial Classification (SIC) code (at the three-digit level).

<b>Panel A: Total Stories by Year</b>		<b>Panel B: Breakdown of Innovation Types</b>		<b>Panel C: Mentions of Compustat-Listed Entities by Year</b>		<b>Panel D: Distribution of Compustat-Listed Innovators by 3-Digit SIC Code</b>	
1990	48	Security underwriting; trading	33.5%	1990	27	Securities brokers & dealers (621)	23.5%
1991	61	Asset management; pensions	26.2%	1991	32	Commercial banks (602)	22.3%
1992	47	Combination of classes; other	17.7%	1992	30	Other non-depository credit insts. (619)	8.2%
1993	49	Retail/mortgage banking	11.6%	1993	22	Computer programming & related (737)	6.7%
1994	38	Credit cards	5.2%	1994	28	Books (273)	4.4%
1995	29	Insurance	5.2%	1995	18	Newspapers (271)	3.5%
1996	34	Commercial banking	0.6%	1996	21	Motor vehicles & equipment (371)	2.9%
1997	54			1997	40	Miscellaneous business services (738)	2.6%
1998	49			1998	16	Fire, marine & casualty insurance (633)	2.1%
1999	55			1999	40	Petroleum refining (291)	2.1%
2000	74			2000	46	Telephone (481)	2.1%
2001	55			2001	25	Life insurance (631)	1.8%
2002	58			2002	42	Services w/ securities exchange (628)	1.5%

**Table 2. Most frequently represented Compustat-listed innovators and patentees. The table lists those firms that had the greatest number of *Wall Street Journal* stories about innovations and patent awards between 1990 and 2002 while listed in Compustat.**

<b>Panel A: Innovators</b>		<b>Panel B: Patentees</b>	
<i>Company Name</i>	<i>Number</i>	<i>Company Name</i>	<i>Number</i>
Merrill Lynch	20	Hitachi	76
Citigroup	15	International Business Machines	55
American Express	13	NCR	55
Citicorp	13	Citigroup	47
McGraw-Hill	13	Fujitsu	47
Charles Schwab Corp.	11	AT&T	33
Dow Jones	10	Diebold	30
Morgan Stanley	10	Toshiba	23
Goldman Sachs	9	Merrill Lynch	18
Bear Stearns	8	First Data	14
International Business Machines	8	Citicorp	13
Reuters Group	7	Microsoft	12
Bank of America	6	Xerox	12
Barclays	6	Electronic Data Systems	10
Chase Manhattan	6	Lucent	10
J P Morgan	6	Reuters Group	10
		Unisys	10

NOTE: These tabulations are based on the assignment to the Compustat GVKEY code, which typically continues with a firm even as it changes its name. Thus, Citigroup includes activity by Citigroup after the 1998 merger and by the Travelers Group (and predecessor entities) previously. Citicorp includes activity by Citicorp prior to the 1998 merger.

**Table 3. Characteristics of innovators and other financial firms. The sample consists of 20,916 annual observations of financial innovators and other financial service firms listed in Compustat between 1990 and 2002. The first column summarizes the characteristics of all firms with a primary assignment to the financial service industry. The second and third present the characteristics for all firms undertaking at least one financial innovation (reported in the *Wall Street Journal*) and all innovators who had a primary assignment to the financial service industry.**

	<b>All Financial Service Firms</b>	<b>Innovators</b>	
		<i>All Firms</i>	<i>Financial Service Only</i>
Assets			
Mean	10,899	90,112	132,304
Median	516	28,693	57,115
EBITDA Margin			
Mean	0.18	0.24	0.32
Median	0.28	0.23	0.31
Financial Innovations by Others in Two-Digit Zip Code			
Mean	3.14	5.44	5.83
Median	1	4	5
Years since IPO			
Mean	8.6	21.4	18.7
Median	6	16	18
Leverage			
Mean	0.28	0.29	0.33
Median	0.21	0.26	0.31
Editorial Board Seats/Assets Ratio			
Mean	0.0005	0.0031	0.0034
Median	0	0	0

All differences in means and medians between all financial service firms and innovators are significant at the one-percent confidence level, with the exception of the difference in mean leverage between all financial service firms and all innovators.

**Table 4. Distribution of innovations across firm size quartiles. The sample consists of 20,916 annual observations of financial innovators and other financial service firms listed in Compustat between 1990 and 2002. The table divides the firm-year observations based on assets (in 2002 dollars) in the year of the observation. The table then reports the average annual number of innovations per billion dollars of assets (also in 2002 dollars).**

<i>Asset Size Quartile</i>	<i>Number of Firm-Year Observations</i>	<i>Innovations/Assets (\$B 2002)</i>
Under \$148.27 million	5210	0.0389
Between \$148.27 and \$554.70 million	5211	0.0058
Between \$554.71 and \$2,487.26 million	5211	0.0043
Over \$2,487.26 million	5210	0.0012
p-Value, F-test of difference		0.022

**Table 5. Regression analyses of innovative activity.** The sample consists of 15,309 annual observations of financial service firms with financial data in Compustat between 1990 and 2002. The dependent variable in the first four regressions is the count of innovations by a given firm in a given year. The independent variables are the logarithm of assets (in millions of 2002 dollars), the ratio of its earnings before interest, taxes, depreciation and amortization to revenues, the logarithm of the number of financial innovations in that year by other companies based in the firm's two-digit zip code, the logarithm of years since the firm's initial public offering, the ratio of the book value of the firm's long-term debt to total capitalization (the book value of its long-term debt and preferred stock plus the market value of its common stock), and the ratio of the firm's editorial board seats on academic-practitioner journals to assets. Additional control variables in the pooled regressions (not reported) include dummies for the location of the company, the three-digit Standard Industrial Classification class of the firm, and the year of the observation; the random effects regressions employ year dummies. The third regression employs a zero-inflated negative binomial specification. In the last regression, only one observation per firm is used: the dependent variable is the sum of innovations, all independent values are averaged, and dummies control for the years for which there are observations. Standard errors (heteroskedastic-adjusted in the pooled regressions) are in parentheses.

	<i>Pooled Negative Binomial Specification</i>	<i>Random Effects Negative Binomial</i>	<i>Pooled Zero-Infl. Negative Binomial</i>	<i>Random Effects Poisson</i>	<i>Negative Binomial With Sum</i>
Logarithm of assets	0.76 ***(0.09)	0.74 ***(0.07)	0.73 ***(0.09)	0.73 ***(0.06)	0.79 ***(0.10)
EBITDA/revenues ratio	-0.92 ***(0.19)	-0.69 ***(0.22)	-0.88 ***(0.19)	-0.69 ***(0.21)	-1.28 ***(0.28)
Log of financial innovations by others in 2-digit zip code	0.35 **(0.16)	0.38 ***(0.11)	0.55 ***(0.15)	0.38 ***(0.11)	0.42 **(0.17)
Log of years since firm's IPO	0.31 **(0.14)	0.41 ***(0.13)	0.35 **(0.15)	0.41 ***(0.13)	0.25 (0.20)
Leverage ratio	-1.17 (0.85)	-1.14 **(0.49)	-1.74 *(0.97)	-1.26 ***(0.48)	-1.49 *(0.86)
Editorial board seats/assets ratio	-2.17 (7.93)	0.53 (2.35)	-18.93 (17.38)	0.41 (2.47)	9.29 (5.98)
Location dummy variables	Y	N	Y	N	Y
SIC code dummy variables	Y	N	Y	N	Y
Year dummy variables	Y	Y	Y	Y	Y
Number of observations	15,309	15,309	9,536	15,309	2,668
Log likelihood	-582.43	-671.11	-444.35	-618.93	-274.23
p-Value, chi-squared test	0.000	0.000	0.000	0.000	0.000
p-Value, test of equality of asset elasticity to 1	0.000	0.000	0.000	0.000	0.030

\* = significant at the 10% confidence level; \*\* = significant at the 5% level; \*\*\* = significant at the 1% level.

**Table 6. Robustness of the results.** The sample consists of 15,309 annual observations of financial service firms with financial data in Compustat between 1990 and 2002. (The first regression also includes in the sample all firms with at least one innovation or at least five financial patents; the second eliminates firms not based in the United States.) The dependent variable in the first three regressions is the count of innovations by a given firm in a given year; the fourth regression only uses discoveries ranked as highly innovative; and in the last regression, the dependent variable is a weighted count of innovations (with a solely developed innovation scored as 12). The independent variables include the logarithm of assets (in millions of 2002 dollars), the ratio of its earnings before interest, taxes, depreciation and amortization to revenues, the logarithm of the number of financial innovations in that year by other companies based in the firm's two-digit zip code, the logarithm of years since the firm's initial public offering, the ratio of the book value of the firm's long-term debt to total capitalization (the book value of its long-term debt and preferred stock plus the market value of its common stock), the ratio of the firm's editorial board seats on academic-practitioner journals to assets, and (in the third regression only) the ratio of R&D to assets. Additional control variables (not reported) are dummies for year of the observation. Standard errors are in parentheses.

	Random Effects Negative Binomial Specification				
	<i>With Other Firms</i>	<i>Eliminating Non-U.S. Firms</i>	<i>Using R&amp;D As Control</i>	<i>Only Using Major Innovations</i>	<i>Using Weighted Innovations</i>
Logarithm of Assets	0.65 ***(0.05)	0.80 ***(0.07)	0.74 ***(0.07)	0.75 ***(0.08)	0.66 ***(0.06)
EBITDA/revenues ratio	-0.59 ***(0.17)	-0.76 ***(0.21)	-0.69 ***(0.22)	-0.72 ***(0.24)	-0.51 **(0.24)
Log of financial innovations by others in 2-digit zip code	0.32 ***(0.09)	0.44 ***(0.11)	0.38 ***(0.11)	0.47 ***(0.13)	0.45 ***(0.10)
Log of years since firm's IPO	0.23 **(0.10)	0.28 **(0.14)	0.41 ***(0.13)	0.35 **(0.15)	0.44 ***(0.12)
Leverage ratio	-1.16 ***(0.39)	-1.15 **(0.50)	-1.14 **(0.49)	-1.42 **(0.58)	-1.05 **(0.46)
Editorial board seats/assets ratio	0.11 (0.09)	0.46 (2.60)	0.52 (2.35)	0.85 (2.43)	0.82 (1.66)
R&D/assets ratio			0.11 (0.40)		
Year dummy variables	Y	Y	Y	Y	Y
Number of observations	15,937	14,546	15,309	15,309	15,309
Log likelihood	-904.64	-575.51	-617.10	-469.00	-1137.25
p-Value, chi-squared test	0.000	0.000	0.000	0.000	0.000

\* = significant at the 10% confidence level; \*\* = significant at the 5% level; \*\*\* = significant at the 1% level.

**Table 7. Patterns across types of innovators and innovations. The sample consists of 15,309 annual observations of financial service firms with financial data in Compustat between 1990 and 2002. The dependent variable in the first three regressions is the count of innovations by a given firm in a given year; in the fourth regression, the dependent variable is the number of process innovations; and in the final regression, it is the number of primarily technological innovations. The independent variables include the logarithm of assets (in millions of 2002 dollars), the ratio of its earnings before interest, taxes, depreciation and amortization to revenues, the logarithm of the number of financial innovations in that year by other companies based in the firm's two-digit zip code, the logarithm of years since the firm's initial public offering, the ratio of the book value of the firm's long-term debt to total capitalization (the book value of its long-term debt and preferred stock plus the market value of its common stock), and the ratio of the firm's editorial board seats on academic-practitioner journals to assets. Additional control variables (not reported) are dummies for year of the observation. The first regression is confined to all firms with a primary classification in Standard Industrial Code (SIC) 60 (depository institutions); the second to those in SIC 62 (securities and brokerage); and the third to those in SIC 63 (insurers). Standard errors are in parentheses.**

	<b>Random Effects Negative Binomial Specification</b>				
	<i>Only Depository Institutions</i>	<i>Only Securities/ Brokerage</i>	<i>Only Insurers</i>	<i>Process Innovations</i>	<i>Technological Innovations</i>
Logarithm of Assets	1.15 ***(0.16)	0.82 ***(0.13)	0.68 ***(0.20)	0.59 ***(0.11)	0.72 ***(0.11)
EBITDA/revenues ratio	-1.47 (1.12)	-0.91 ***(0.24)	0.03 (2.25)	-0.78 ***(0.24)	1.10 (1.10)
Log of financial innovations by others in 2-digit zip code	-0.12 (0.22)	0.12 (0.22)	-0.20 (0.38)	0.64 ***(0.24)	0.37 *(0.20)
Log of years since firm's IPO	1.48 ***(0.32)	-0.003 (0.23)	0.11 (0.35)	-0.06 (0.23)	0.23 (0.21)
Leverage ratio	0.15 (0.86)	-2.14 *(1.13)	1.11 (1.60)	-2.08 *(1.14)	-2.99 ***(1.06)
Editorial board seats/assets ratio	12.94 (19.89)	-0.57 (4.92)	-4.99 (35.80)	-0.76 (13.51)	0.75 (2.88)
Year dummy variables	Y	Y	Y	Y	Y
Number of observations	8,634	1,036	1,972	15,309	15,309
Log likelihood	-209.45	-147.90	-50.71	-126.93	-163.78
p-Value, chi-squared test	0.000	0.000	0.049	0.000	0.000

\* = significant at the 10% confidence level; \*\* = significant at the 5% level; \*\*\* = significant at the 1% level.

**Table 8. The impact of innovation on future profitability.** The sample consists of annual observations of financial innovators with financial data in Compustat between 1990 and 2002. The first three rows of Panel A present the ratio of earnings before interest, taxes, depreciation, and amortization (EBITDA) to revenues for all innovators from the year before the innovation until four years after. The first row presents the unadjusted ratio; the others present the residuals from a regression (using all observations) of the EBITDA/revenues ratio on the logarithm of years since the firm's initial public offering, the logarithm of assets (in millions of 2002 dollars), the ratio of the book value of the firm's long-term debt to total capitalization (the book value of its long-term debt and preferred stock plus the market value of its common stock), and dummies for the location of the company, the three-digit Standard Industrial Classification class of the firm, and the year of the observation. The third row only includes firms with a single innovation. The fourth row presents a similar ratio for financial service firms that are non-innovators. Panel B presents the t-statistics and p-values from tests of the null hypothesis that the differences are equal to zero.

<b>Panel A: Profit Margin Patterns</b>						
	<i>Year Relative to that of Story About Innovation</i>					
	<i>-1</i>	<i>0</i>	<i>+1</i>	<i>+2</i>	<i>+3</i>	<i>+4</i>
Unadjusted EBITDA/revenues ratio, innovators	0.24	0.27	0.30	0.31	0.31	0.31
Adjusted EBITDA/revenues ratio, innovators	-0.12	-0.12	-0.07	-0.07	-0.07	-0.07
Adjusted ratio, firms with one innovation	-0.12	-0.10	0.01	0.01	0.02	0.01
Adjusted ratio, non-innovators	0.00	0.00	0.00	0.01	0.00	0.00

<b>Panel B: Tests of Null Hypothesis of No Difference</b>		
	<i>t-Statistic</i>	<i>p-Value</i>
Mean adjusted margin, years [-1→0] vs. [+1→+4]	2.49	0.013
Mean adjusted margin, years [-1] vs. [0→+4]	2.00	0.046
Mean adjusted margin, years [-1→+1] vs. [+2→+4]	1.89	0.059
Mean unadjusted margin, years [-1→0] vs. [+1→+4]	2.25	0.052
Median adjusted margin, years [-1→0] vs. [+1→+4]	1.89	0.059
Mean adjusted margin, years [-1→0] vs. [+1→+4], firms with just one innovation	2.15	0.032
Mean adjusted margin, years [-1→0] vs. [+1→+4], non innovators	0.65	0.517

**Table 9. Regression analyses of the impact of firm characteristics on patenting.** The sample consists of 11,461 annual observations of financial service firms with financial data in Compustat between 1990 and 1999. The dependent variable in each regression is the count of successful patent applications filed by a given firm (awarded before the end of 2002) in a given year. The independent variables are the logarithm of assets (in millions of 2002 dollars), the ratio of its earnings before interest, taxes, depreciation and amortization to revenues, the logarithm of the number of financial innovations in that year by other companies based in the firm's two-digit zip code, the logarithm of years since the firm's initial public offering, the ratio of the book value of the firm's long-term debt to total capitalization (the book value of its long-term debt and preferred stock plus the market value of its common stock), and the ratio of the firm's editorial board seats on academic-practitioner journals to assets. Additional control variables (not reported) in the first regression include dummies for the location of the company, the three-digit Standard Industrial Classification class of the firm, and the year of the observation, and in the second regression, dummies for the year of the observation. Standard errors (heteroskedastic-adjusted in the pooled regression) are in parentheses.

	Dependent Variable: Number of Patent Filings	
	<b>Negative Binomial Specification</b>	
	<i>Pooled</i>	<i>Random Effects</i>
Logarithm of assets	1.06 ***(0.12)	1.04 ***(0.13)
EBITDA/revenues ratio	1.93 (1.42)	0.38 (1.12)
Log of financial innovations by others in 2-digit zip code	-0.39 **(0.17)	-0.28 (0.20)
Log of years since firm's IPO	0.69 ***(0.20)	0.68 **(0.27)
Leverage ratio	-0.82 (0.90)	-1.54 *(0.84)
Editorial board seats/assets ratio	-5.11 (25.41)	-0.19 (22.70)
Location dummy variables	Y	N
SIC code dummy variables	Y	N
Year dummy variables	Y	Y
Number of observations	11,461	11,461
Log likelihood	-292.84	-280.77
p-Value, chi-squared test	0.000	0.000
p-Value, test of equality of asset elasticity to 1	0.628	0.764

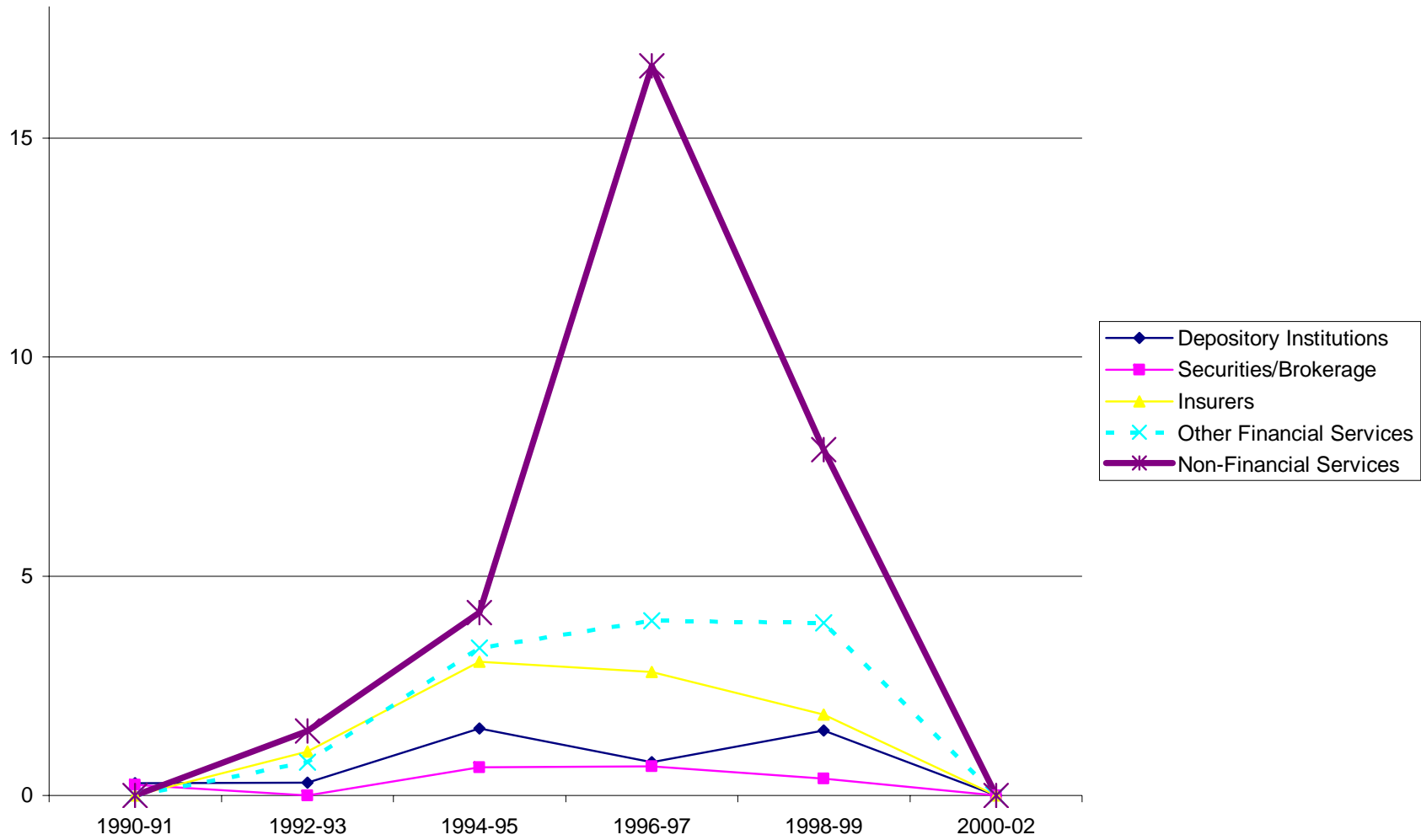
\* = significant at the 10% confidence level; \*\* = significant at the 5% level; \*\*\* = significant at the 1% level.

**Table 10. Regression analyses of citations to financial patents.** The sample consists of 675 financial patents awarded to Compustat-listed firms between 1990 and 2001. The dependent variable in each regression is the number of citations in other patent documents prior to the end of 2002. The independent variables in the first regression are dummy variables denoting whether the patentee is a depository institution, a securities or brokerage firm, an insurer, or a non-financial company. In the second regression, additional control variables include the logarithm of assets (in millions of 2002 dollars), the ratio of its earnings before interest, taxes, depreciation and amortization to revenues, the logarithm of the number of financial innovations in that year by other companies based in the firm's two-digit zip code, the logarithm of years since the firm's initial public offering, the ratio of the book value of the firm's long-term debt to total capitalization (the book value of its long-term debt and preferred stock plus the market value of its common stock), and the ratio of the firm's editorial board seats on academic-practitioner journals to assets. Additional control variables (not reported) are dummies for the year of the patent award and (in the second regression only) the location of the company. Heteroskedastic-adjusted standard errors are in parentheses.

	Dependent Variable: Number of Patent Citations	
	<b>Negative Binomial Specification</b>	
	<i>Pooled</i>	<i>Random Effects</i>
Depository institution	0.23 (0.22)	0.42 (0.32)
Securities/brokerage firm	-0.15 (0.27)	-0.34 (0.35)
Insurer	-0.38 (0.29)	-0.28 (0.44)
Non-financial company	-0.38 **(0.16)	-0.19 (0.29)
Logarithm of assets		-0.02 (0.05)
EBITDA/revenues ratio		0.21 (0.51)
Log of financial innovations by others in 2-digit zip code		0.004 (0.05)
Log of years since firm's IPO		0.01 (0.06)
Leverage ratio		-0.67 (0.44)
Editorial board seats/assets ratio		54.17 *(29.43)
Location dummy variables	N	Y
Year of award dummy variables	Y	Y
Number of observations	675	590
Log likelihood	-1689.80	-1441.57
p-Value, chi-squared test	0.000	0.000

\* = significant at the 10% confidence level; \*\* = significant at the 5% level; \*\*\* = significant at the 1% level.

**Figure 1: Patent Application/Innovation Ratio, 1990-2002**



NOTE: The table presents the ratio of successful financial patent applications filed (and issued prior to the end of 2002) to financial innovations between 1990 and 2002 for five classes of firms. The sample consists of 15,937 annual observations of financial service firms, financial innovators, and financial patentees with financial data in Compustat between 1990 and 2002.