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Product Mix and Earnings Volatility at Commercial Banks: Evidence from a Degree of Total Leverage Model[1]

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We construct a degree-of-total-leverage framework to test whether and how shifts in product mix affect earnings volatility at 472 U.S. commercial banks between 1988 and 1995. Our framework, which accounts for cost and revenue synergies not captured in most previous studies, conceptually links earnings volatility to revenue volatility, expense fixity, and product mix. We find that replacing traditional lending activities with fee-based activities—an ongoing trend that may be strengthened by recent financial modernization—is associated with both higher revenue volatility and higher total leverage, which in this framework implies higher earnings volatility. *Journal of Economic Literature* Classification Numbers: G21, G32, D24.

Key Words: commercial banks; degree of total leverage; earnings volatility; fee-based actitivities; product mix.

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1. INTRODUCTION

Commercial banks' market share of loans and deposits has been in decline since the early 1980s.[3] These trends were set in motion by the end of regulatory restrictions on competition in banking product markets and geographic markets, and by advances in information technology that negated some of commercial banks' traditional comparative advantages. Banks have reacted to declining shares of their traditional lines of business in part by increasing the production and sale of fee-based financial services. Since 1984, noninterest income at FDIC-insured commercial banks increased from 25 to over 40% of aggregate operating income (i.e., revenues net of interest expenses).

Commercial banks have long earned noninterest income from providing traditional banking services such as checking, trust, letters of credit, and cash management, but recently banks have been generating noninterest income from a number of new sources. First, banks have expanded into less traditional fee-for-service products, such as insurance and mutual fund sales. Second, banks now charge explicit fees for financial services that used to be provided for free. Retail customers and correspondent banking customers can earn higher interest rates on their balances held at the bank, but in exchange they must pay for services such as travelers checks and data processing. Third, the growth of securitization in mortgage, credit card, and other loan markets presents banks with opportunities to earn fee income from originating and servicing loans separate from interest income earned by holding loans on the books. Fee-based activities are likely to expand further in the near future as the distinctions between the commercial banking, investment banking, and insurance industries become more blurred or disappear entirely.

This study examines whether, how, and to what degree these shifts toward noninterest and fee-based income affect the volatility of bank earnings. This is an important question for regulators charged with preserving the safety and soundness of commercial banks, for managers who hold a substantial financial and professional stake in the bank, and for customers with bank–borrower relationships that could be jeopardized by the consequences of increased earnings volatility.

The conventional wisdom among many bankers, bank regulators, and bank analysts is that fee-based earnings are more stable than loan-based earnings (because they believe that fee-based activities are less sensitive to movements in interest rates and to economic downturns), and that increasing the share of fee-based activities in a traditional portfolio of banking products reduces overall earnings volatility via diversification effects (because they believe that fee-based earnings covary

[3] Boyd and Gertler (1994), Kaufman and Mote (1994), Berger *et al.* (1995), Edwards and Mishkin (1995), and others have documented and analyzed these trends.

imperfectly with earnings from traditional banking products).[4] By extension, these arguments imply that combining banking activities with nonbanking activities such as securities, insurance, and real estate will further reduce the riskiness of commercial banks. Academic studies tend to be more circumspect—while these studies find that combining banking and nonbanking activities can potentially reduce risk, they also find that product-mix diversification benefits are limited, that some nonbank activities can potentially increase bank risk, and that bankers may offset any risk reductions by taking increased risk in other areas.[5]

Consider the following three fundamental observations, each of which suggests that fee-based income need not be more stable than income from traditional banking activities. First, banks can have qualitatively different relationships with fee-based customers than with their traditional loan-based customers. Revenue from a bank's traditional lending activities may actually be relatively stable over time, because switching costs and information costs make it costly for either borrowers or lenders to walk away from a lending relationship. In contrast, revenue from some fee-based activities may be relatively likely to fluctuate over time, because banks face high competitive rivalry, low information costs, and less stable demand in a number of these product markets (e.g., investment advice, mutual fund and insurance sales, data processing services). For example, fee income in the banking industry from mutual fund sales fell by about 50% in 1994, and commercial banks' trading revenues fell by 39% during the second quarter of 1999.[6] These short-run fluctuations in revenue would be unthinkable in the lending business where, even during an economic downturn, only a small percentage of loans stop making interest payments.[7]

Second, banks use substantially different mixes of inputs to produce fee-based financial services and intermediation-based products. Once a bank has established a lending relationship, increasing the amount of credit actually extended to that customer requires the bank to increase only its variable costs (interest expense). In contrast, expanding the production of certain fee-based services can require the bank to hire additional fixed labor inputs, which increases the bank's operating leverage. The key here is a high ratio of fixed-to-variable expenses (that is, high operating leverage) turns any given amount of revenue volatility into an even greater amount of earnings volatility. This point is underscored by the following quotation from a Standard & Poors analyst regarding J. P. Morgan & Co.: "Over

[4] Roger Fitzsimmons, chairman of Firstar Corp., stated that "there is a stability to [fee] income that we like." Banking analyst Richard X. Bove states that "Banks that have strong fee-based business and that do not have major commitments to the loan sector can weather the storm much better than those banks that are building a loan portfolio." Andrew Hove, Acting Chairman of the FDIC, stated that "the growth in the relative performance of noninterest income over the years reflects a diversifying industry, where risks are being spread." (All quotes from the *American Banker*, May 30, 1997.)

[5] We discuss a representative set of these studies in detail in Section 2 of this paper.

[6] The source of the mutual fund revenue figure is the *American Banker*, July 16, 1996. The source of the trading revenue figure is the *American Banker*, September 15, 1999.

[7] From 1984 through 1997, the percentage of real estate loans held by commercial banks that were 90 days past due or nonaccruing fluctuated only between 1.1 and 5.4% (*OCC Quarterly Journal*).

the last decade, the company's business mix has evolved, so that it has become increasingly reliant on...underwriting, advisory services, and trading. This profile has rendered earnings more volatile. The expense base has also become quite high, so that earnings could be vulnerable to revenue declines" (*American Banker*, January 26, 1998).

Third, bank regulators do not require banks to hold capital against most fee-based activities (see Spong (1994), p. 76), and banks that take advantage of this can increase their returns to equity. For example, a Dean Witter Reynolds analyst concluded that Mellon Bank Corp. redeemed $160 million of its in preferred stock in the aftermath of purchasing securities giant Dreyfus Corp. because the combined firms "...don't need as much capital for their fee business as they have for the spread business" (*American Banker*, December 21, 1994). Although most banks will internally allocate some capital to these activities, the lack of a regulatory capital requirement suggests a higher degree of financial leverage—and thus higher earnings volatility—for these lines of business. Related to this, banks have an incentive to arbitrage risk-based capital regulations by transforming (interest-based) on-balance sheet risk into (fee-based) off-balance sheet risk.[8]

These three observations provide the institutional underpinnings for the empirical tests in this study. We test whether and how increases in fee-based activities at commercial banks affect overall earnings volatility, using quarterly revenue and earnings data from 472 U.S. commercial banks between 1988 and 1995, and a degree of total (operating plus financial) leverage framework that conceptually links the volatility of a bank's earnings to its revenue volatility, its expense fixity, and its product mix. To our knowledge, this is the first study to use degree of total leverage concepts to analyze risk at financial institutions. We devise a new empirical framework based on these theoretical concepts, and we also modify standard degree of total leverage estimation techniques to make them compatible with the operational, financial, and strategic characteristics of banks. These innovations allow us to investigate more completely than in previous studies the manner in which alterations in product mix can affect the riskiness of financial institutions. Most previous studies measure correlations between the earnings streams of pairs of financial services produced by two unrelated firms, or produced by two affiliates of a financial services holding company that are related only by common ownership. In contrast, we observe combinations of financial services that are jointly produced within the same commercial bank, which allows us to capture in our estimates both cost synergies (scope economies) and revenue synergies (cross-selling).

Contrary to the conventional (nonacademic) wisdom about fee-based income, we find evidence that commercial bank earnings grow more volatile as banks tilt their product mixes away from traditional intermediation activities and toward fee-based activities. For the typical bank in our sample, both revenue volatility and the degree of total leverage increase with the share of bank revenue generated from

[8] See Jacques *et al.* (2000) for empirical evidence.

non-deposit-related, non-trading-related, fee-based activities. This implies that the volatility of bank earnings increases as banks expand their fee-based activities because, as we show, earnings volatility is the multiplicative product of revenue volatility and the degree of total leverage. We also find evidence that the level of bank earnings increases as banks expand into fee-based activities, suggesting a risk premium associated with these activities.

The remainder of the paper is organized as follows. In Section 2 we present a simple model of the degree of total leverage at a multiproduct firm, and establish our research plan-of-attack. In Section 3 we review the empirical literature on bank product mix and bank risk. In Section 4 we describe our data set, which consists of quarterly observations of revenues and earnings for 472 U.S. commercial banks between 1988 and 1995. In Section 5 we compute revenue volatility for each of our sample banks, and test the sensitivity of revenue volatility to changes in product mix. In Section 6 we estimate the degree of total leverage for each of our sample banks, and test the sensitivity of total leverage to changes in product mix. In Section 7 we combine the theoretical framework from Section 2 with the empirical results from Sections 5 and 6 to demonstrate that earnings and earnings volatility increase at the typical commercial bank when product mix shifts away from traditional lending activities and toward fee-based activities. In Section 8 we summarize our main results and discuss their implications for regulatory policy, business strategy, and future research.

2. APPLYING A DEGREE OF TOTAL LEVERAGE FRAMEWORK TO MULTIPRODUCT BANKING FIRMS

A firm that has a relatively high ratio of fixed-to-variable expenses is said to have a high "degree of leverage." This concept summarizes the relationship between the top and bottom lines on a firm's income statement. When sales revenues are increasing at a "highly levered" firm, the firm's earnings will increase more than proportionally because its low variable expenses allow it to retain a relatively large portion of each additional revenue dollar. Of course, this sword has two edges—when sales revenues are decreasing at a highly levered firm, losses will accumulate more quickly due to the firm's high fixed obligations. A firm's degree of total leverage (DTL) can be defined more precisely as the percentage change in earnings (π) caused by a 1% change in revenue (r):

$$\text{DTL} = \frac{\partial \pi}{\partial r} * \frac{r}{\pi} = \frac{\%\Delta\pi}{\%\Delta r}. \tag{1}$$

In other words, DTL is the revenue elasticity of profits. DTL is often expressed as the product of two other leverage concepts, the degree of operating leverage and the degree of financial leverage (i.e., DTL = DOL * DFL). DOL is the elasticity of earnings before interest and taxes (EBIT) with respect to sales revenue, and reflects

leverage in production. DFL is the elasticity of profits with respect to EBIT, and reflects the use of financial leverage. Of the two concepts, financial leverage is more familiar in the banking industry, where financial liabilities often outnumber financial capital by more than 10-to-1. We concentrate on DTL in this study because changes in bank product mix can affect both operating and financial leverage, and because accurately separating a bank's interest expenses into operating costs and financing costs is difficult.

By rearranging the terms in (1) we can show that a high degree of total leverage can amplify a given amount of revenue volatility ($\%\Delta r$) into an even greater amount of earnings volatility ($\%\Delta\pi$):

$$\%\Delta\pi = \text{DTL} * \%\Delta r. \tag{2a}$$

Assuming that the firm is a price taker in output markets, this formula decomposes earnings volatility into two parts: volatility due to largely external market conditions ($\%\Delta r$) and volatility due to internal production and financing considerations (DTL). Figure 1 shows how the degree of total leverage influences the relationship between bank revenues and bank earnings. In the figure, Firm I is highly levered: it has high fixed costs (low vertical intercept) and low variable costs (high slope). Firm II is less highly levered. (Note that in this framework we draw no distinction between fixed operating expenses and fixed interest payments on debt, both of which impose legal obligations to pay on the firm.) Thus, for a given change in sales revenues away from the center of the sales revenue distribution, profits at Firm I vary more than profits at Firm II. Note that an increase in revenue volatility makes earnings less stable at both banks, but the high degree of total leverage amplifies this effect at Firm I. (The figure assumes that revenue volatility is driven by changes unit sales, holding price constant.)

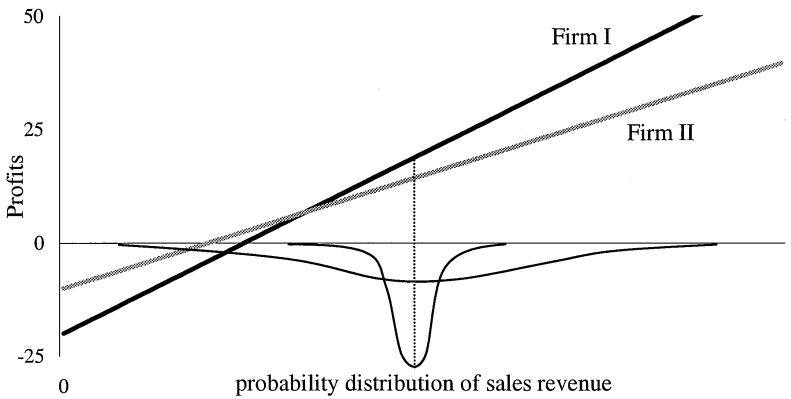

FIG. 1. Firm I has high fixed costs and low variable costs. Firm II has low fixed costs and high variable costs.

For multiple-product firms like banks, both $\%\Delta r$ and DTL are influenced by product mix. Multi-product firms face multiple output demand curves, some of which are more volatile than others, and as a result some product-specific revenue streams will be more volatile than others. For example, we could reasonably expect the stream of revenue from merger and acquisition financing to be more volatile than the stream of revenue from service charges levied on core depositors. Thus, a bank's overall revenue volatility can vary substantially depending on its product mix. Similarly, the degree of total leverage at a multiple-product firm depends on its product mix, because not all product lines are produced with the same ratio of fixed-to-variable expenses. For example, relative to lending activities, fee-generating activities such as trust services may employ higher fixed or quasi-fixed operating expenses (office space and labor), or higher fixed financing expenses (zero required regulatory equity capital), per dollar of revenue. Thus, we could rewrite Eq. (2b) as a function of product mix as

$$\%\Delta\pi = \sum_{j=1}^{J} \mathrm{DTL}_j * \%\Delta r_j, \tag{2b}$$

where j is an index of J different product lines.

Commercial banks report their sales revenues separately by product line, but they do not report their earnings separately by product line. Hence, while it is possible to generate the product-specific measures of revenue volatility suggested in Eq. (2b), it is not possible to generate the product-specific measures of DTL. Given this data restriction, we take the following practical approach to revealing the relationships embedded in Eq. (2b). First, we use time series data on individual bank revenues and earnings to measure the overall revenue volatility ($\%\Delta r$) and the DTL for each of the banks in our sample. Second, we use cross-section regressions to estimate the degree to which different product mixes (where $j =$ lending, investments, trading, deposit, and fee-based activities) are associated with different levels of $\%\Delta r$ and DTL. Finally, we use the coefficients from those cross-section regressions to demonstrate how a shift in product mix, away from traditional lending activities and toward less traditional fee-based activities, affects earnings volatility ($\%\Delta\pi$) indirectly through its two determinants, $\%\Delta r_j$ and DTL_j, as shown in Eq. (2b).

We recognize that earnings volatility ($\%\Delta\pi$) is not a good measure of risk within the context of a diversified portfolio. Barefield and Comiskey (1979) found that earnings variability and systematic risk are not highly associated, but earnings *forecast errors* and systematic risk are highly associated. Litzenberger and Rao (1971) drew similar conclusions: "Clearly, earnings variability per se is not the same thing as risk. To the extent that the direction and magnitude of a change in earnings is predicted, the variability will have no effect on the required rate of return." However, while this logic holds for an individual investor, it doesn't necessarily hold for bank regulators or bank managers, neither of which can diversify away the idiosyncratic risk associated with the volatility of individual bank

earnings, regardless of how predictable may be those earnings.[9] Bank regulators, who are vested with the responsibility of protecting the payments system and the insurance fund from the impact of bank failures, must contend with higher probabilities of bank failure when industry earnings grow more volatile. Bank managers, whose incomes and professional reputations are clearly linked to bank earnings, will fare poorly if increased earnings volatility leads to poor performance or, in the extreme, to insolvency.

An important implication of this model is that changes in commercial banks' product mixes may also change the fundamental mechanics of why banks fail. Although bank failure is generally associated with write-offs of nonperforming interest-bearing assets, earnings reductions from any and all product lines can hamper a bank's ability to accumulate or rebuild capital by retaining earnings. If fee-based revenues are more volatile than traditional interest-based revenues, and/or if the production and financing of fee-based activities require more fixed expenditures than traditional interest-based activities, then (barring large product-mix diversification effects) banks' earnings will become more volatile as they tilt their business mixes further toward fee-based activities. Holding capital constant, increases in earnings volatility increase the probability of insolvency.

3. A BRIEF REVIEW OF THE LITERATURE ON PRODUCT MIX AND BANK RISK

Over the past two decades, a substantial number of studies have investigated whether a repeal or revamp of the Glass–Steagall Act would allow commercial banks to reduce risk by diversifying into nontraditional financial services. These studies employ a variety of methodologies to compare earnings streams across financial services industries, across individual firms from different financial services industries, and across individual banking firms with different product mixes. In general, these studies find that combining banking and nonbank activities has the *potential* to reduce risk. However, these studies also find that the returns to product-mix diversification tend to diminish quickly, that diversifying into some nonbank activities could actually increase a bank's riskiness, and that any risk reduction achieved via such diversification can be undone by taking other risks, such as increased financial leverage.

The earliest group of studies provided suggestive evidence that banks could reduce their riskiness by diversifying into nonbank activities. Johnson and Meinster (1974), Heggestad (1975), Wall and Eisenbeis (1984), and Litan (1985) used industry-level IRS data from the 1950s, 1960s, and 1970s to compare the aggregate earnings stream of the banking industry to the aggregate earnings streams of other financial industries (e.g., securities firms, insurance companies, real estate

[9] Thus, it should not be surprising that both regulators and bankers have been champions of legislation to allow increased diversification via expansion into new geographic and product markets.

brokers, leasing companies, thrift institutions). While the results of these studies did not always agree across industries, a common thread ran through the studies: over long periods of time, banking industry earnings and nonbank financial industry earnings were quite uncorrelated with each other, and in extreme cases these correlations were close to 0 or even negative. This basic result suggested that if banks were allowed to add some nonbank financial products to their traditional mix of banking services, the resulting portfolio diversification effects could potentially increase banks' expected returns without increasing their riskiness (or, equivalently, reduce banks' riskiness without reducing their expected returns).

More recent studies have used firm-level data rather than industry averages, and some of these studies conclude that diversification into nonbanking activities increases the riskiness of banks. Boyd and Graham (1986) examined large bank holding companies (BHCs) that diversified into nonbanking activities during the 1970s and concluded that, in the absence of strict regulatory oversight and control, expansion into these activities can increase the risk of failure. Sinkey and Nash (1993) found that commercial banks that specialized in credit card lending (an often-securitized type of lending that generates substantial fee income) generated higher and more volatile accounting returns, and had higher probabilities of insolvency, than commercial banks with traditional product mixes during the 1980s. Demsetz and Strahan (1995) studied the stock returns of BHCs and found that greater diversification across product lines does not necessarily reduce risk because the diversifying BHCs tend to shift into riskier mixes of activities and hold less equity. Roland (1997) found that abnormal returns from fee-based activities were less persistent (more short-lived or volatile) than abnormal returns from lending and deposit-taking at large BHCs. Kwan (1998) found that the accounting returns of Section 20 securities affiliates tended to be more volatile, but not necessarily higher, than the accounting returns of their commercial banking affiliates.

Other firm-level studies have found that diversifying into nonbanking activities can reduce bank risk, although these gains tend to be limited in size, scope, or practice. Boyd *et al.* (1980) measured the correlations between accounting returns at the bank and nonbank affiliates of BHCs during the 1970s, and found that the potential for risk reduction was exhausted at relatively low levels of nonbank activities. Eisenbeis *et al.* (1984) found positive abnormal stock returns associated with the formation of one-bank holding companies between 1968 and 1970, a brief time period during which these firms were permitted to engage in a wide variety of nonbanking activities. Kwast (1989) examined the accounting returns of the securities and nonsecurities activities of commercial banking companies between 1976 and 1985, and found a limited potential for risk reduction by diversifying into securities activities. Gallo *et al.* (1996) found that high levels of mutual fund activity were associated with increased profitability, but only slightly moderated risk levels, at large BHCs between 1987 and 1994.

A final group of studies observes the actual returns of unrelated banking firms and nonbank financial firms, and then calculates the hypothetical reduction in earnings variability based on the covariances of those earnings streams. Wall *et al.*

(1993) constructed synthetic portfolios based on the accounting returns of banks and nonbank financial firms, and concluded that banks would have experienced higher returns and lower risk had they been able to diversify into small amounts of insurance, mutual fund, securities brokerage, or real estate activities during the 1980s. Using both accounting data and market data from the 1970s and 1980s, Boyd *et al.* (1993) concluded that BHCs could have reduced their riskiness by merging with life insurance or property/casualty insurance firms, but would likely have increased their riskiness by merging with securities or real estate firms. Laderman (1998) applied a similar synthetic merger approach to data from the 1980s and 1990s, and concluded that BHCs could have reduced the volatility of their accounting returns by offering "modest to relatively substantial amounts" of life insurance or casualty insurance underwriting. Allen and Jagtiani (2000) used stock market data to construct return streams for synthetic "universal banks" consisting of a commercial banking company, a securities firm, and an insurance company, and found that exposure to market risk increased with the addition of these nonbanking activities.

Our empirical approach is fundamentally different from the general approach taken in the literature. We begin our analysis at the top of the income statement with revenues, rather than at the bottom of the income statement with earnings as do all of the previous studies. Furthermore, we observe product-mix effects within established, integrated production processes, rather than artificially combining earnings streams generated by unrelated production and marketing processes. This should allow us to capture synergies in expenses and revenues among product lines that studies of unrelated or synthetic firms cannot capture.

4. DATA

Our initial data set was a balanced panel of 19,650 quarterly observations of revenues, profits, and other financial variables for 655 commercial banks over the 30 quarters between March 1988 and June 1995. All data were collected from the Reports of Condition and Income (call reports), and are expressed in June 1995 dollars. We included in the data panel only those banks that had greater than $300 million in assets as of June 1995 and whose charter existed continuously from the beginning of 1988 through the end of 1995. All of the financial statement variables are merger-adjusted—that is, in any given quarter, we set bank i's revenues (or profits, assets, etc.) equal to its own revenues *plus* the revenues of the banks it acquired during that quarter or in subsequent quarters during our 30-quarter sample period. From these 655 banks, we excluded 30 banks that had poor quality data in one or more quarters.[10] In addition, we excluded 153 banks

[10] We discarded 27 banks with negative quarterly sales revenues too large to be explained by quarterly losses from trading or investment activities. We discarded two banks with implausibly large deviations in reported quarterly sales revenues. We discarded the largest bank in our sample because its average quarterly revenues were 250% larger than the next largest bank.

that participated in more than three mergers during the 30-quarter sample period. These adjustments left us with a balanced panel of 14,160 quarterly observations of 472 banks.

The national economic climate varied substantially across these 30 quarters, including a recession, a period of rapid recovery, and a sustained period of low economic growth. Real GDP growth ranged from −2 to 4%, accompanied by a national unemployment rate that ranged from 5 to 8%. The 3-month Treasury rate fluctuated between 3 and 9%, and the 3-month/10-year yield curve ranged from nearly flat to a positive 300 basis points.

We expect that our calculations of revenue volatility will be positively associated with merger activity. In the aftermath of bank mergers, some acquired depositors run off to other banks, some acquired loan accounts are not renewed by the acquiring bank, and some branch offices are shut down in order to reduce fixed expenses or are divested in order to satisfy antitrust authorities. In addition, there can be disruptions to reported revenues because target banks may not file a complete, or completely accurate, call report for the quarter in which they are acquired. We take a number of precautions to control for these effects. First, we observe quarterly rather than annual data, because this allows us to gather a statistically meaningful sample size for each bank over a relatively short window in time, thus reducing the number of mergers in each time series. Second, we exclude the merger quarter from our time series calculation of revenue volatility. Third, we exclude from our sample any bank that participated in more than three mergers during our 30-quarter sample period. Fourth, we include a variable in our regression tests that controls for the number of mergers in which each bank has participated. Fifth, we check our results for robustness using the subsample of 250 banks that made no acquisitions during the sample period.

We expect that our estimates of the degree of total leverage will be biased toward 0 for banks that participate in mergers. Our time series' of merger-adjusted revenues and profits are constructed by combining data from banks with potentially different business strategies, organizational structures, corporate cultures, and efficiency levels—all phenomena that can influence the production process, and hence the degree of total leverage. For banks that made multiple acquisitions during the sample period, the quarter-to-quarter changes in merger-adjusted revenues may have little or no systematic relationship with the quarter-to-quarter changes in merger-adjusted profits, and as a result $\mathrm{DTL} = \%\Delta\pi/\%\Delta r$ will approach zero. As discussed above with regard to merger-induced revenue volatility, we attempt to mitigate this problem by excluding banks that made more than three mergers, by including a merger control variable in our regression tests, and by running robustness tests using data only from nonmerging banks. Apart from these biases, one might expect merging banks to have lower operating leverage because a stated objective for many bank mergers during our sample period was eliminating overhead (duplicative branches and back office systems) and excess capacity.

We measure product mix at bank i by disaggregating bank i's total revenues into five qualitatively different activities. *Loan revenue* is the sum of interest and fee income associated with the loans originated and/or held by the bank.[11] *Investment revenue* is the interest, dividend, and capital gains(losses) from the bank's investments in marketable securities that are not held in the bank's trading account. *Trading revenue* is the sum of gains(losses) and fees on securities that are held in the bank's trading account. *Deposit revenue* equals service fees charged to depositors. *Fee-based revenue* equals the revenue not included in the previous four categories, and includes fees associated with (among other items) trust services, mutual fund and insurance sales, standby letters of credit, loan commitments, credit cards, mortgage servicing, data processing, cash management, business consulting services, investment advice, correspondent banking, services provided by bank tellers, and gains(losses) from the sale of a variety of assets. These five categories capture 100% of bank revenue.

We define profits as net income before taxes, extraordinary items, and loan loss provisions, but after chargeoffs and recoveries. This adjusted profit definition corresponds well to the theoretical concept of degree of total leverage.[12] We use *gross* revenues from loans, investments, and depositor services rather than netting out expenses (e.g., interest expense, loan chargeoffs) associated with these revenues. We do this for three reasons. First, allocating total interest expenses across loans, investments, and deposit accounts would require us to make arbitrary expense allocations that would be inaccurate for all banks and especially inaccurate for some banks. These mistakes and mismatches would likely result in overstating the volatility of the resulting quarterly net revenue streams. Second, the concept of *net* interest revenues implies that interest expenses are strictly variable expenses. Rather than assuming this to be true, we treat deposit interest expenses like any other expense line item (i.e., as a potential mixture of fixed and variable costs)

[11] We use accrual accounting figures for all revenue categories. In any given quarter, accrued loan interest revenue can exceed actual (cash) loan interest revenue because of past due interest payments. Some of these interest payments will eventually be received; aside from a potential timing difference, accrual interest will equal actual interest for these loans. Loans that continue to be past due are eventually reclassified from accruing status to nonaccruing status (or equivalently, the terms of the loan are renegotiated); when this occurs, any unpaid accrued interest is backed out of the revenue account, and accrued interest revenue declines to equal actual interest revenue. We do not subtract either loan loss provisions or chargeoffs from the quarterly loan revenue figures, because provisions are based on expected, not actual, loan losses, and both provisions and chargeoffs are based on loan principal, not loan revenue.

[12] We use pretax profits because leverage is a pretax concept. We exclude extraordinary items because they are nonrecurring and hence are not systematic to either the production function or the financing function represented by the degree of total leverage. We include net chargeoffs (chargeoffs less recoveries) as an expense item rather than loan loss provisions, because chargeoffs are taken nearer to the actual reduction in loan interest revenue (provisions are made in anticipation of future losses) and because chargeoffs are less subject to managerial discretion than provisions. Regardless, there is evidence that commercial banks use their discretion over the timing of loan provisioning to manage bank capital, not bank earnings (see Ahmed *et al.* 1999).

and rely on our degree of total leverage estimation technique to reflect the actual variability and/or fixity of these expenses. Third, loan chargeoffs and/or loan loss provisions are accounting treatments for expense items (e.g., the complete or partial loss of invested principal), and hence it is more appropriate to make these adjustments to profits rather than revenues.

Our fee-based revenue variable combines noninterest revenues from many separate fee-based activities. This high level of aggregation is unavoidable given the construction of the call reports.[13] Aggregating across so many different types of activities may create diversification effects that reduce the measured volatility of fee-based activities in our tests. Another concern is that the call report includes some credit-related fees (e.g., fees from loan commitments, standby letters of credit, loan servicing) in the "noninterest income" category. Banks earn these fees by performing activities (e.g., risk analysis) that are traditionally associated with lending, and as such these activities share some of the fixed inputs (e.g., credit analysts) used to generate loan revenues. We will keep this issue in mind when we interpret our empirical results. In particular, we recognize that a change in product mix that simultaneously increases our fee-based revenue variable and decreases our loan revenue variable could indicate that a bank is doing one or both of the following: shifting its overall product mix away from traditional intermediation activities and toward less traditional fee-based activities, or maintaining its role as a financial intermediary but shifting away from the traditional way of making loans (originate and hold) toward a less traditional way of making loans (originate and securitize, and perhaps retain the servicing rights). *In either case*, observing such a shift in revenue mix would indicate that the bank is moving away from the traditional commercial banking model.

Summary statistics for our 472 banks are displayed in Table I. The average (mean) bank generated 64.29% of its revenue from lending activities, 19.38% from investment activities, 10.59% from fee-based activities, 4.29% from service charges on deposit accounts, and 1.44% from trading activities. Most of these banks had a traditional banking product mix: 425 banks generated the majority of their revenues from loans, 12 banks generated the majority of their revenues from investment activities, 7 banks generated the majority of their revenues from

[13] Since 1991 the call reports have separated out "other noninterest income," which includes a record gains(losses) from the sale of a variety of assets (e.g., loans, leases, strips, forward and futures contracts, OREO, premises, and fixed assets) from the main category "noninterest income." We do not employ this slightly finer categorization here because doing so would have reduced our time series' to only 18 quarters (1991:1 to 1995:2), a shorter slice of the business cycle and a substantial reduction in the degrees of freedom in our leverage estimation equations. However, we did employ this data in an earlier version of this study that used a different empirical approach. In that study, we used 30 quarters of data to compute the coefficients of variation for each of the five revenue classifications used in this paper, and then repeated that exercise using 18 quarters of data for the six-way revenue categorization that included "other noninterest income." For both sets of data, we found results similar to those that we find in this paper: for the average bank, the coefficient of variation of "noninterest income" (i.e., fee-based revenue) was significantly larger (at the 1% level) than the coefficient of variation of loan revenue.

TABLE I
Summary Statistics for 472 U.S. Commercial Banks

	N	Mean	Std. dev.	Median	Min	Max
30-quarter mean revenue	472	$65.39	$170.32	$20.56	$5.85	$2,307.06
30-quarter mean adjusted profit	472	$9.95	$21.53	$3.24	($7.51)	$234.49
30-quarter mean asset size	472	$2,193.37	$4,049.39	$797.29	$256.61	$52,676.45
Number of acquisitions (M)	472	0.758	0.963	0	0	3
Revenue shares:						
Mean loan share (w_{loans})	472	0.6429	0.1295	0.6646	0.0000	0.9743
Mean fee-based share ($w_{\text{fee-based}}$)	472	0.1059	0.1007	0.0753	0.0001	0.9996
Mean investment share (w_{invest})	472	0.1938	0.1195	0.1804	0.0001	0.9410
Mean trading share (w_{trading})	472	0.0144	0.0300	0.0011	−0.0084	0.3502
Mean deposit share (w_{deposits})	472	0.0429	0.0250	0.0409	0.0000	0.1539

Note. For each of these banks, we observed quarterly values of the variables in the left-hand column (except M) over the 30 quarters from 1988:1 to 1995:2, and then calculated the 30-quarter means of those variables for each bank. Each row in this table displays a set of statistics that describe the distribution of those mean values. These data are merger-adjusted and expressed in millions of 1995 dollars. Adjusted profits = net income + taxes + extraordinary items + loan loss provisions − net chargeoffs. Loan share = revenue from loans divided by total bank revenue. (Fee-based share, investment share, etc. are similarly calculated.) M = the number of acquisitions made by each bank during the sample period.

fee-based activities, and for the remaining 28 banks none of the five product lines generated over 50% of total revenues. The 30-quarter average for trading revenues was negative for 11 banks, and equaled zero for 164 banks.

Finally, we observe the data at the bank level. During our sample period, bank holding companies could own bank and nonbank affiliates that produced a variety of traditional banking and nontraditional banking products. While much of the previous literature examined the *potential* for risk-reducing diversification by constructing hypothetical combinations of sometimes loosely related affiliates, we examine the *actual* product-mix diversification effects across a more narrow range of bank-eligible financial products. Because our degree of total leverage framework is essentially a production function framework (as opposed to a portfolio approach), we feel it is most appropriately applied to the revenues, costs, and profits generated by integrated production processes at individual banks. Because our data set only includes the largest U.S. banks, we are analyzing predominantly lead banks that account for the bulk of the production in their holding companies.

5. THE EFFECT OF PRODUCT MIX ON REVENUE VOLATILITY

To calculate the revenue volatility at bank i, we begin by calculating the percent change in bank i's quarter-to-quarter revenues for each quarter t:

$$\%\Delta r_{it} = \frac{r_{i,t+1} - r_{i,t}}{r_{i,t}}. \tag{3}$$

For convenience, we will express the percentage change in both revenues and profits as a number between 0 and 1. We then transform the resulting time series of quarter-to-quarter changes into a single summary measure of revenue volatility over the entire sample period

$$\text{RV}_i = \text{std. dev. of } \%\Delta r_i = \sqrt{\frac{\sum_{t=1}^{N}(\%\Delta r_{it} - \bar{r}_i)^2}{N}}, \tag{4}$$

where $\bar{r}_i$ is the mean of $\%\Delta r_{it}$. As discussed above, before calculating RV for bank i we discard any observations of $\%\Delta r_{it}$ that were generated using revenues from quarters in which bank i made an acquisition. Our calculations use $N = 29$ for banks that made no acquisitions during the sample period, and $N = 27, 25$, and 23 for banks that made one, two, and three acquisitions during the sample period. Since this is an imperfect adjustment, we expect a positive bias in RV with respect to merger activity. RV is a growth-, inflation-, and merger-adjusted measure of revenue volatility that is scaled similarly for all banks, and is directly comparable across banks that made the same number of mergers during the sample period.[14] To the extent that changes in prices and quantities beyond the bank's control are largely responsible for its quarterly fluctuations in revenues, RV is an exogenous determinant of profit volatility.

5.1. Revenue Volatility and Bank Product Mix

Table II displays summary statistics for our calculations of revenue volatility. RV = 0.0772 for the median bank in our sample, i.e., one standard deviation of revenue volatility was equivalent to about an 8% change in this bank's quarterly revenues. Revenue volatility varied widely between the extremes of our sample (RV = 0.0147 for the most stable bank and RV = 0.8447 for the most unstable bank), but it varied over a much tighter range ($0.0297 \leq \text{RV} \leq 0.2677$) for the 90% of the banks at the center of the distribution. As expected, revenue volatility was higher for banks that made acquisitions during the sample period.

In Table III we test the degree to which the cross-sectional variation in revenue volatility displayed in Table II is systematically related to product mix. Column [1] display the results of an ordinary least-squares regression of RV on four of the five revenue shares w_j (j = deposit activities, investment activities, fee-based

[14] RV is growth-adjusted because systematic growth in revenues over time is netted out in the $(\%\Delta r_{it} - \bar{r}_i)$ terms.

TABLE II
Revenue Volatility (RV) for 472 U.S. Commercial Banks

	N	Mean	Std. dev.	Minimum	Median	Maximum		
All banks	472	0.1075	0.0921	0.0147	0.0772	0.8447		
0 acquisitions	250	0.0855	0.0759	0.0147	0.0599	0.5476		
1 acquisition	125	0.1172	0.0928	0.2239	0.0940	0.8447		
2 acquisitions	58	0.1580	0.1176	0.0363	0.1114	0.4844		
3 acquisitions	39	0.1419	0.1000	0.0291	0.1239	0.4058		
	N	1st %	5th %	10th %	Median	90th %	95th %	99th %
All banks	472	0.0240	0.0297	0.0349	0.0772	0.2238	0.2677	0.4669

Note. For each of these banks, we calculated RV (the standard deviation of quarter-to-quarter percent change in revenue) using Eqs. (3) and (4) and quarterly values of total sales revenue over the 30 quarters from 1988:1 to 1995:2. Each row in this table displays a set of statistics that describe the distribution of those bank-specific values of RV. All data are merger-adjusted. RV is calculated using 29 quarterly changes in revenue for banks that made no acquisitions during the sample period, 27 quarterly changes in revenue for banks that made one acquisition during the sample period, etc.

activities, and trading activities) and control variables for bank revenue size and merger activity. We excluded loan revenue shares to avoid perfect colinearity. As a result, the coefficients on the w_j variables are the estimated changes in revenue volatility that occur when one revenue share point of activity j is substituted for one revenue share point of lending activity, holding constant the revenue shares of the other three activities. Negative coefficients indicate that this substitution has volatility-reducing effects.

TABLE III
OLS Regressions for 472 U.S. Commercial Banks

	[1]	[2]
Intercept	0.0967***	0.0825***
Number of mergers (M)	0.0199***	—
Revenue ($ billions)	−0.2193***	−0.0312
Revenue^2 ($ billions)	0.0512*	−0.0194
w_{deposits}	−0.5826***	−0.5923***
$w_{\text{investments}}$	0.0095	0.0407
$w_{\text{fee-based}}$	0.1273***	0.1483***
w_{trading}	1.2448***	0.4241*
R^2	0.2652	0.1255
Adjusted-R^2	0.2541	0.1039
F	23.938***	5.811***
N	472	250

Note. The dependent variable is revenue volatility (RV). Estimated regression coefficients are reported in the cells, where ***, **, and * indicate a significant difference from 0 at the 1, 5, and 10% levels. Multiplying the coefficients on the w_j variables (i.e., the share of a bank's total sales revenue that it generates from activity j) by 0.01 gives an estimate of the change in RV when 1% of a bank's revenue is moved into activity j and out of lending activity.

The column [1] regression explains about a quarter of the variation in the dependent variable, and the specification is significant at the 1% level ($F = 23.938$). Trading activities have the largest effect on revenue volatility; moving one percentage point of revenue out of loans and into trading activities would increase revenue volatility at the average bank by 0.0124, or by about 11% ($1.2448 * 0.01/0.1075$). Fee-based activities also had a positive, although smaller, impact on revenue volatility; substituting one percentage point of fee-based revenue for loan revenue would increase revenue volatility at the average bank by 0.0013, or by about 1% ($0.1273 * 0.01/0.1075$). Deposit activities had the most stabilizing effect on bank revenues; increasing deposit-based revenue at the expense of less loan revenue would decrease the average bank's revenue volatility by 0.0058, or by about 5% ($-0.5826 * 0.01/0.1075$). There was no significant difference between the revenue volatilities of investment activities and loan activities. These results suggest that increased fee-based activities do not reduce the volatility of bank earnings. Note that the rank ordering of revenue volatility across the other four activities is rather orthodox (trading-related revenues are the most volatile, while deposit-related revenues the least volatile), which increases our confidence in the unorthodox result for fee-based revenues.

Revenue volatility declined at a decreasing rate with total sales revenue. This quadratic effect bottomed out at around $2 billion in quarterly revenues, just short of the size of the largest sample bank; this implies that banks of all sizes could reduce revenue volatility by getting larger, perhaps because larger banks can diversify more fully across product lines and across geographic regions. Even after controlling for these size effects, revenue volatility was still positively related to merger activity. The coefficient on the merger variable M was positive and significant; on average, a merger increased RV by about 2 percentage points.

As a further test, we reestimated the RV regressions for the subsample of 250 nonmerging banks, and report the results in column [2]. Although adjusted R^2 falls to 0.1039 in these regressions, the basic results are unchanged. The revenue share coefficients for investments, deposits, and fee-based activities are similar in sign, magnitude, and significance to those in the full sample regressions, and the coefficient on trading activity remains positive but is smaller and less precise. Hence, we have a high level of confidence that our results for fee-based activities are unaffected by any merger-induced bias in the way we constructed RV.

Interestingly, the sized-based diversification effect from column [1] is not present in column [2]. The asset-size and revenue-size distributions of the 250 nonmerging banks and the 222 merging banks are very similar, so any size-related diversification available to one group should be available to the other. One possible explanation is that internal growth is less likely to stabilize revenues than growth via acquisition, which can quickly diversify a bank's geographic or product-line exposures.

6. THE EFFECT OF PRODUCT MIX ON THE DEGREE OF TOTAL LEVERAGE

A bank that exhibits low revenue volatility will not necessarily experience low earnings volatility. For such a bank, earnings volatility could still be high if the bank has a high degree of total leverage. A typical textbook formula for the total degree of total leverage looks like this,

$$\text{DTL} = \frac{(p - v) * Q}{(p - v) * Q - \left(F + I + \frac{D_{\text{ps}}}{(1-\tau)}\right)}, \tag{5}$$

where p is the price of a unit of output, v is variable cost per unit of output, Q is number of units sold, and F, I, and $D_{\text{ps}}/(1 - \tau)$ are fixed expenditures for, respectively, operating costs, interest obligations, and the pretax equivalent dividend payments to preferred stockholders. Note that the denominator is pretax profits, while the numerator is the contribution made by sales to pretax profits. Thus, DTL can be expressed more simply:

$$\text{DTL} = \frac{\text{sales revenue} - \text{variable costs}}{\text{sales revenue} - \text{variable costs} - \text{fixed costs}}. \tag{6}$$

Note that Eq. (6) is a compact way to express the graphical relationships displayed in Fig. 1. Holding sales revenue constant, firms with high fixed operating or financing costs, but low variable operating costs, will have a relatively high degree of total leverage. Holding cost structure constant, but allowing sales revenue and hence short-run profits to vary, DTL fluctuates over the theoretical ranges displayed in Fig. 2. When the firm is operating above break-even (where break-even revenue = variable costs + fixed costs, so that the denominator in (6) equals zero), DTL is strictly positive and greater than 1.0, ranging between positive infinity very near break-even and declining asymptotically toward 1.0 as profits advance. When the firm is operating below break-even but above shut-down (where shut-down

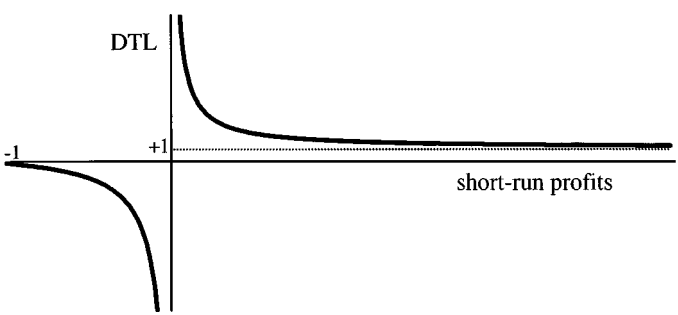

FIG. 2. Theoretical plot of DTL. Break-even profits = 0; shut-down profits = −1.

revenue = variable costs, so the numerator in (6) equals zero), DTL is strictly negative, ranging between negative infinity very near break-even and increasing toward 0 as profits decline further. Firms earning profits lower than this are not economically viable, and will shut down.[15] Thus, the degree of total leverage has a discontinuous range of theoretically acceptable values ($1.0 < \text{DTL} < 0$).

Although textbook total leverage formulas elegantly illustrate these concepts, the formulas themselves are not particularly useful in practice. To apply them, the analyst must use often arbitrary cost accounting rules to separate fixed operating costs (F) from variable operating costs (vQ), a procedure that becomes more difficult and less exact as the number of product lines produced by the firm increases. In most cases, the information needed to perform this task is unknown to outside analysts, because it is not typically included in firms' financial statements.[16] The alternative solution is to estimate DTL for each firm by regressing a time series of its profits on a time series of its sales revenues, resulting in an estimate of the firm's revenue elasticity of profits. This general approach was introduced for single-product firms by Mandelker and Rhee (1984) and subsequently was modified by O'Brien and Vanderheiden (1987), Dugan and Shriver (1992), and Lord (1998). We make additional modifications in order to accommodate the multiproduct nature of commercial banks.

We use a two-step statistical approach that allows us to estimate DTL for each firm in our data set without knowing the true allocation of fixed expenses across its J product lines. In the first stage, we correct for the growth in profits and revenues over time, and use the first stage results to estimate DTL in the second stage. The following first-stage regressions are estimated separately for each firm i,

$$\pi_{it} = \pi_{i0} + \gamma_{i\pi 1}t + \gamma_{i\pi 2}t^2 + \gamma_{i\pi 3}t^3 + \delta_{i1}q1 + \delta_{i2}q2 + \delta_{i3}q3 + \mu(\pi)_{it} \quad (7)$$

$$r_{it} = r_{i0} + \gamma_{ir1}t + \gamma_{ir2}t^2 + \gamma_{ir3}t^3 + \delta_{i1}q1 + \delta_{i2}q2 + \delta_{i3}q3 + \mu(r)_{it}, \quad (8)$$

where π_{it} and r_{it} are firm i's earnings and revenues in quarter t, π_{i0} and r_{i0} are

[15] Note that our data set may include some profit and revenue streams from banks that were not economically viable in the long run. During our data period, bank regulators "resolved" a substantial number of insolvent banks by arranging for them to be acquired by healthy institutions. If any of those banks were acquired by the banks in our sample (as seems likely), the premerger profit and revenue streams of those nonviable banks will be subsumed in the merger-adjusted time series' of the acquiring sample banks.

[16] For banks, these measurement problems are made worse by ambiguities in modeling the bank production process. Some economists have argued that only asset-based products such as loans and investments in securities should be considered outputs, because these assets represent the final stage of the process of financial intermediation. Others have argued that banks add value in a variety of ways related or unrelated to the intermediation process, and as such bank output should include not only assets, but also transactions and liquidity services (e.g., checking) and various fee-based services (e.g., mutual fund sales, trust services, cash management, mortgage servicing, credit enhancements). See Humphrey (1990), Berger and Humphrey (1992), and Tripplet (1992) for a discussion of these issues. We note here that the time series estimation approach that we use to measure the degree of total leverage circumvents most of these issues.

firm i's earnings and revenues in the initial quarter $t = 0$, the cubic specification of t ($t = 1, 30$) flexibly controls for firm i's revenue and earnings growth over the sample period, as well as any cyclical changes in its financial and economic environment, and $q1$, $q2$, and $q3$ are binary variables that control for accounting treatments or seasonal factors in the first, second, or third calendar quarter. In these specifications, the random disturbance terms $\mu(\pi)_{it}$ and $\mu(r)_{it}$ capture the growth-adjusted time series of earnings and revenues for firm i. The second-stage regression is also estimated separately for each firm i,

$$\mu(\pi)_{it} = \alpha_i + \beta_i \mu(r)_{it} + \varepsilon_{it}, \tag{9}$$

where α is a constant term and ε is a random disturbance term with zero mean. We transform each firm's estimated β coefficient into an elasticity measure as

$$\mathrm{DTL}_i = \beta_i * \left(\frac{\bar{r}_i}{\bar{\pi}_i}\right), \tag{10}$$

where $\bar{r}_i$ and $\bar{\pi}_i$ are the average (mean) revenues and profits for firm i over the sample period, thus using 30 quarterly observations for banks that made no acquisitions during our sample period, 29 quarterly observations for banks that made one acquisition, etc.

An assumption underlying these estimations is that each bank has a stable product mix, as well as stable values for the parameters Q, p, v, F, I, D, and τ, throughout the estimation period. These assumptions do not hold exactly in the data, and we take a number of precautions to limit any deleterious effects. First, we note that the variation in the five revenue shares across time tends to be small relative to the variation in the five revenue shares across banks; this suggests that most banks' product mixes are relatively stable.[17] In our regression tests in the following section, we perform robustness checks for subsamples of banks with especially stable product mixes. Second, including the nonlinear time trend in the first-stage regressions should control to some extent for exogenous changes in interest rates (i.e., the parameters p and v), which tend to move in cyclical patterns over time.[18] Third, we recognize that a merger can either temporarily alter (due to accounting charges and other adjustments) or permanently alter (due to changes in business strategy) the parameters in Eq. (5) and/or the product mix of the surviving bank. To control for these possibilities, we discard merger-quarter observations prior to

[17] For each of the 472 banks, we calculated the 30-quarter standard deviation for each of the five revenue shares. The mean intertemporal standard deviations are 0.0731 for loans, 0.0371 for fee-based, 0.0496 for investments, 0.0282 for trading, and 0.0104 for deposits. Each of these is smaller than the cross-sectional standard deviations in Table I.

[18] We also estimated DTL using a linear time trend. The cubic time trend specification generated a greater percentage of theoretically correct values for DTL. These results are available in the longer working paper version of this study (DeYoung and Roland, 1999).

TABLE IV
Degree of Total Leverage (DTL) for 472 U.S. Commercial Banks

	N	Mean	Std. dev.	Minimum	Median	Maximum	% > 1.0	% < 0
All banks	472	0.3087	17.2438	−214.4444	1.3817	63.3016	56.36%	25.85%
Profits > 0	449	2.2037	7.9092	−91.0823	1.4948	63.3016	58.57%	22.72%
0 acquisitions	250	1.7674	9.8166	−96.0150	1.8822	60.9262	66.80%	19.60%
0 acquisitions and profits > 0	238	2.9278	6.0295	−8.9404	1.9417	60.9262	69.33%	16.39%
	N	1st %	5th %	10th %	Median	90th %	95th %	99th %
All banks	472	−68.5510	−7.2194	−1.4405	1.3817	5.8018	9.6067	34.4415
Profits > 0	449	−8.7275	−1.6796	−0.8653	1.4948	5.8018	9.6067	34.4415
0 acquisitions	250	−26.882	−4.1514	−1.2129	1.8822	6.1275	9.7352	43.1045
0 acquisitions and profits > 0	238	−4.5016	−1.4405	−0.6387	1.9417	6.1242	9.8381	43.1045

Note. For each of these banks, we calculated DTL (the revenue elasticity of profits) using Eqs. (7) through (10) and quarterly values of total sales revenues and adjusted profits over the 30 quarters from 1988:1 to 1995:2. Each row in this table displays a set of statistics that describe the distribution of the bank-specific values of DTL. All data are merger-adjusted. DTL is calculated using 30 observations for banks that made no acquisitions during the sample period, 29 observations for banks that made one acquisitions during the sample period, etc. "Profits > 0" refers to banks with positive average quarterly merger-adjusted profits over the 30 quarters in our time series.

estimating Eqs. (7), (8), and (9).[19] In addition, our regression tests in the following section includes robustness checks for a subsample of nonmerging banks.

6.1. The Degree of Total Leverage and Bank Product Mix

Table IV displays summary statistics for our estimates of DTL. Consistent with the results of previous empirical studies of total leverage, our estimations generated a substantial number of very large positive and negative outliers. Because outliers influence the mean averages, the median averages are better measures of central tendency for our estimates. Median DTL = 1.3817 for the entire sample of 472 banks. Thus, for the typical bank a 1% change in gross revenue would yield an estimated 1.38% change in adjusted profits.

The cross sectional standard deviation is quite large (17.2438), indicating that these estimates may not be very precise. Still, a relatively large percentage of these estimates do fall within the acceptable theoretical range for DTL ($1.0 < \text{DTL} < 0$). For the entire sample of 472 banks, estimated DTL is greater than 1.0 for about 56% of all banks, and is less than 0 for about 26% of the banks. As expected, our estimates of DTL are lower for banks that made acquisitions. DTL is greater than 1.0 for 67% of the nonmerging banks, a result that compares quite favorably with

[19] In these regressions the time variable t still ranges from 1 to 30, but can have up to three missing entries. Although the reduced number of observations will reduce the efficiency of estimated β slightly for banks that made acquisitions, the missing quarters should not materially affect the shape of the fitted time trend.

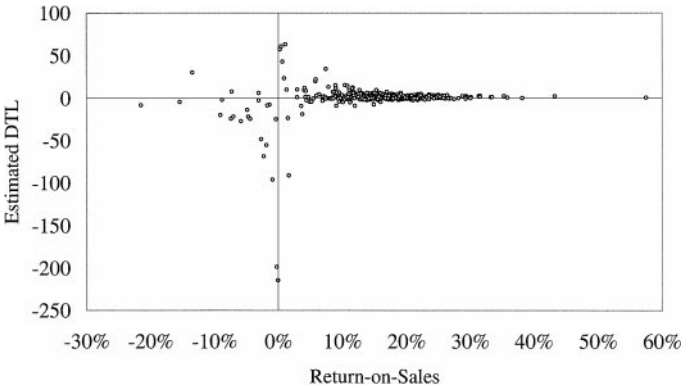

FIG. 3. Degree of total leverage, 472 sample banks.

degree of total leverage estimates from previous studies of nonfinancial firms.[20] Scatter plots of estimated DTL against average quarterly return-on-sales, displayed in Figs. 3 and 4, show a rough consistency with the theoretical pattern displayed in Fig. 2.[21] Note that estimated DTL is more likely to be negative for unprofitable banks: DTL was negative for only about 23% of the profitable banks and only about 16% of the profitable nonmerging banks.

In Table V we test the degree to which the cross-sectional variation in DTL displayed in Table IV is systematically related to product mix. DTL is the dependent variable in these eight regressions, and the right-hand-side is specified the same as in the revenue volatility regressions. Given the noisiness of the estimated dependent variable DTL, it is not surprising that the statistical fit is very low in some of these regressions. The coefficient on the merger variable *M* is negative and significant in two of the four regressions in which it appears, which is consistent with our expectations and with the patterns found in the DTL summary statistics. The coefficients on the bank size variables are significant in just one of the eight regressions. DTL declines at a decreasing rate with bank revenue size in regression [1]; although this is at best weak evidence, it suggests that larger banks may be better able to absorb short-run variations in sales revenues, perhaps due to more intensive use of hedging instruments, more geographically dispersed operations, or fuller utilization of fixed production capacity.

There is very little association between DTL and product mix. The lone exception is the revenue share of fee-based activities, which is positive and statistically

[20] O'Brien and Vanderheiden (1987) estimated the degree of operating leverage for firms in a variety of nonfinancial industries, and reported leverage estimates greater than 1.0 for 73% of the firms in their sample. Using a similar data set, Dugan and Shriver (1992) reported operating leverage estimates greater than 1.0 for 57% of their sample firms.

[21] For each bank, average quarterly return-on-sales (ROS) equals mean quarterly adjusted profit divided by mean quarterly gross revenues. We use ROS rather than return-on-assets (ROA) because our degree of leverage model is a revenue-based concept, not an asset-based concept. We use a profitability ratio in the graph, rather than raw profits, to neutralize the effects of bank size.

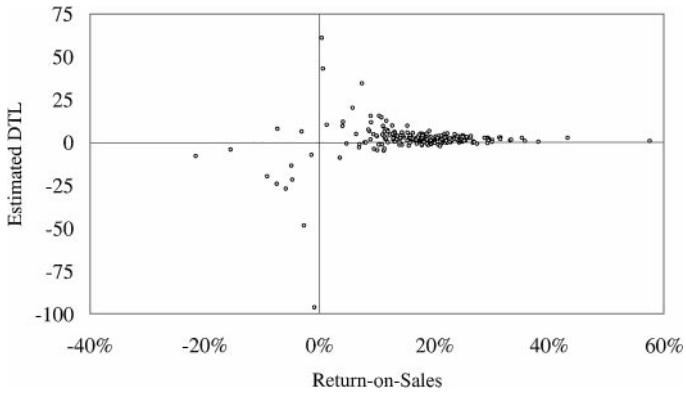

FIG. 4. Degree of total leverage, 250 nonmerging banks.

significant in all eight regression equations. Based on the results in column [1], substituting a percentage point of fee-based revenue for loan-based revenue would increase DTL at the median bank in our sample by 15% ($20.2887 * 0.01/1.3817$). For the nonmerging banks in column [2] the marginal impact of this substitution is smaller, only about 7% ($13.8777 * 0.01/1.8822$). Both of these point estimates are quite large, and are possibly overstated due to outlying values of DTL. In columns [3] and [4] we address this possibility by truncating the outlying values of the dependent variable at the 5th and 95th percentiles of its sample distribution. This substantially reduces the magnitudes of the revenue share coefficients, but has little impact on the signs and significance of these coefficients. For example, the column [3] results indicate that substituting a percentage point of fee-based revenue for loan-based revenue increases DTL by only about 3% ($3.9926 * 0.01/1.3817$), a more economically reasonable magnitude.[22] As a further test of robustness, we reestimated regressions [1] through [4] for the half of the banks whose product mixes were especially stable over the sample period.[23] These regressions are shown in columns [5] through [8]. The coefficient estimates are little changed in these subsample regressions, although the statistical fit is somewhat improved.[24]

[22] We tried other truncations as well (results not shown). Truncating DTL at the 1st and 99th percentiles produced point estimates virtually identical to those in columns [1] and [2]. Truncating DTL at the 10th and 90th percentiles produced point estimates that were slightly smaller, but more precise, than those in columns [3] and [4].

[23] We measure the stability of a bank's product mix by the standard deviation of its loan revenue share over the 30 observation periods. (Loan revenue share is the largest of the five revenue shares for 90% of banks in our sample; as such, loan revenue share is most likely to reflect changes in product mix over time.) Regressions [5] through [8] are estimated for subsamples of banks with standard deviations that are less than the median standard deviation for the sample in question.

[24] The longer working paper version of this study (DeYoung and Roland, 1999) includes additional robustness tests of the DTL regressions in Table V. In general, the working paper shows that the main results of Table V are robust to excluding especially unprofitable banks, and to substituting an alternative version of the dependent variable that was estimated using a linear rather than a cubic time trend.

TABLE V
OLS Regressions for 472 U.S. Commercial Banks

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Subsample	All banks	Nonmerging banks	All banks	Nonmerging banks	All banks (Half of sample with most stable product mix)	Nonmerging banks (Half of sample with most stable product mix)	All banks (Half of sample with most stable product mix)	Nonmerging banks (Half of sample with most stable product mix)
Truncation	None	None	5th and 95th	5th and 95th	None	None	5th and 95th	5th and 95th
Intercept	1.0627	−0.3762	1.4855***	1.8773***	−1.0153	−0.9352	0.8550	0.8932
M	−1.0881	—	−0.4159***	—	−0.7014	—	−0.6102***	—
Revenue	−40.2457***	−3.3487	1.0224	−0.5594	14.8833	4.7476	10.1455	2.5403
Revenue^2	19.0847***	−0.6199	0.8327	−0.3660	−27.3652	−11.0829	−14.8194	−6.8144
w_{deposits}	−19.1453	5.4856	−4.4184	−2.6502	−7.1499	2.8123	−5.7347	3.4584
$w_{\text{investments}}$	1.3899	1.8263	0.3538	−0.2001	3.6217	0.9872	1.7174	0.4433
$w_{\text{fee-based}}$	20.2887**	13.8777**	3.9926***	3.1261*	20.8009***	25.1506***	5.5397***	6.1822***
w_{trading}	32.6924	32.2941	−3.5553	12.8054	−16.9710	−46.5154	−1.1883	−13.9363
R^2	0.0369	0.0301	0.0525	0.0279	0.1324	0.1826	0.0739	0.0807
Adjusted R^2	0.0223	0.0061	0.0382	0.0039	0.1058	0.1410	0.0455	0.0340
F	2.537**	1.255	3.672***	1.161	4.971***	4.392***	2.600**	1.727
N	472	250	472	250	236	125	236	125

Note. The dependent variable is the degree of total leverage (DTL). The dependent variable is truncated at the 5th and 95th percentiles of its sample distribution prior to estimation. Estimated regression coefficients are reported in the cells, where ***, **, and * indicate a significant difference from 0 at the 1, 5, and 10% levels. Multiplying the coefficients on the w_j variables (i.e., the share of a bank's total sales revenue that it generates from activity j) by 0.01 gives an estimate of the change in DTL when 1% of a bank's revenue is moved into activity j and out of lending activity. M is the number of acquisitions made by the bank during the sample period. Revenues are in billions of 1995 dollars.

TABLE VI
Distribution of the Degree of Total Leverage (DTL) across Product-Mix Subsamples

Subsample of banks above the sample median in terms of:	*N*	[1] median DTL	[2] % of banks in subsample with DTL > 1.3817 (sample median)
Panel A: All banks ($N = 472$, median DTL = 1.3817)			
Deposit revenue share	236	1.3073	47.88%
Loan revenue share	236	1.3368	48.72%
Investment revenue share	236	1.3447	48.73%
Fee-based revenue share	236	1.7374***	56.35%**
Trading revenue share	236	0.8346***	42.80%**
Panel B: Nonmerging banks ($N = 250$, median DTL = 1.8822)			
Deposit revenue share	122	1.6331***	46.28%
Loan revenue share	122	1.7819	48.76%
Investment revenue share	122	1.7684	47.54%
Fee-based revenue share	122	2.1005*	55.74%
Trading revenue share	122	1.6271*	48.96%

Note. Data for 472 U.S. commercial banks. The ***, **, and * in column [1] indicate a significant difference from the sample median of 1.3817 at the 1, 5, and 10% levels in two-tailed tests. The ***, **, and * in column [2] indicate a significant difference from 50% at the 1, 5, and 10% levels in two-tailed tests.

We augment the weak multivariate results of Table V with a simpler univariate analysis in Table VI. Each of the panels in Table VI displays information on DTL for subsamples of banks whose product mixes were disproportionately concentrated in either deposit activities, lending activities, investments, fee-based activities, or trading. The statistics in the table corroborate the regression findings. Column [1] indicates that the median DTL for the most "fee-intensive" group of banks (1.7374 in panel A, 2.1005 in panel B) is significantly higher than the median DTL for all banks. Column [2] indicates that a higher than expected portion of the fee-intensive banks (56.35% in panel A) have values for DTL that are higher than the median DTL for all banks. Although these simple tests do not control for the effects of bank size, they are robust in suggesting that fee-intensive banks employ a relatively high degree of total leverage.

7. THE EFFECT OF PRODUCT MIX ON BANK EARNINGS

In this section we use our point estimates from the previous two sections to demonstrate the degree to which a shift in product mix toward fee-based activities can potentially increase the volatility of bank earnings. In addition, we present evidence suggesting that the typical bank in our sample could increase the level of its earnings by shifting its product mix in the direction of more fee-based activities.

Consider a change in a bank's business strategy that deemphasizes lending activities but increases its emphasis on fee-based activities. Assume that this shift in

product mix leaves the bank's gross revenues unchanged, but alters the composition of its gross revenues such that 10% of gross revenues is shifted from lending activities to fee-based activities. For the banks in our sample, this 10% shift is approximately equal to a one standard deviation reduction in loan revenue share, and a one standard deviation increase in fee-based revenue share (see Table I). Using Eq. (2a), this change in product mix will affect the volatility of bank earnings indirectly through its impact on revenue volatility and total leverage as follows: $\%\Delta\pi = \text{DTL} * \%\Delta r$. Prior to the change in product mix, our estimates of RV and DTL from Tables II and IV imply the following pretax earnings volatility for the median bank:

$$\%\Delta\pi = (1.3817) * (0.0772) = 0.1067. \tag{11}$$

That is, one standard deviation of revenue volatility, amplified by the degree of total leverage, translates into about an 11% change in pretax earnings.

From the RV regressions in Table III we know that shifting product mix from loans to fee-based activities will increase revenue volatility. Using the estimates from column [3] of that table, a 10 percentage point increase in fee-based revenue share will increase RV by 0.0127 (from 0.0772 to 0.0899), or about a 16% increase. From the DTL regressions in Table V we know that this shift in product mix will also increase the degree of total leverage. Using the estimate from column [3] of that table, a 10 percentage point increase in fee-based revenue share will increase the degree of total leverage DTL by 0.3997 (from 1.3817 to 1.7804), or about a 29% increase. The combined impact of these two effects increases the implied standard deviation of earnings volatility from 11 to 16%:

$$\%\Delta\pi = (1.7804) * (0.0899) = 0.1601. \tag{12}$$

In other words, a paired one standard deviation change in fee-based and loan revenue shares translates into a 50% change in pretax earnings volatility ($1.16 * 1.29 = 1.50$). Thus, our estimates suggest the changes in product mix that increase the revenue share of fee-based activities can have a substantial impact on the volatility of their earnings.

To the extent that the increased earnings volatility associated with fee-based activities reflects a higher degree of risk at these banks, we would expect this shift in product mix to generate higher earnings as well. We test this expectation by regressing ROA and ROS on the same right-hand-side specification that we used in the RV and DTL regressions. Table VII displays summary statistics for these profitability ratios. The ROA ratio (ROS ratio) is equal to mean adjusted profits divided by mean asset size (mean sales revenue), where both the numerator and the denominator are averages over the 30-quarter sample period.[25] The regression

[25] Although ROS is not a standard measure of bank profitability, we use it because the degree of total leverage is a sales revenue-based concept. We avoid using the return-on-equity profitability ratio because it is positively related by construction to the degree of financial leverage.

TABLE VII
Profitability Ratios for 472 U.S. Commercial Banks

	N	Mean	Std. dev.	Minimum	Median	Maximum		
ROA	472	0.0043	0.0030	−0.0081	0.0043	0.0266		
ROS	472	0.1612	0.0822	−0.2153	0.1728	0.5750		
	N	1st %	5th %	10th %	Median	90th %	95th %	99th %
ROA	472	−0.0021	0.0001	0.0014	0.0043	0.0064	0.0089	0.0188
ROS	472	−0.0881	0.0025	0.0025	0.1728	0.2438	0.2656	0.3529

Note. Return on assets (ROA) is equal to mean quarterly adjusted profits divided by mean quarterly assets over the 30 quarters from 1988:1 to 1995:2. Return on sales revenues (ROS) is equal to mean quarterly adjusted profits divided by mean quarterly sales revenue. The numerator and the denominator in both ROA and ROS are the quarterly averages for each sample bank from 1988:1 to 1995:2. Each row in this table displays a set of statistics that describe the distribution of the bank-specific values of ROA and ROS. All data are merger-adjusted.

results are displayed in Table VIII. Note that the coefficient on $w_{\text{fee-based}}$ is positive and significant in all cases, indicating that shifting one percentage point of revenue out of lending and into fee-based activities is associated with increased profits. Making this substitution would increase ROS at the median bank in our sample by about 1/2 % ($0.0857 * 0.01/0.1728$), and would increase ROA by almost 2% ($0.0079 * 0.01/0.0043$). The larger impact on ROA is not surprising, because

TABLE VIII
OLS Regressions for 472 U.S. Commercial Banks

	[1]	[2]	[3]	[4]
Dependent variable:	ROA	ROA	ROS	ROS
Subsample:	All banks	Nonmerging banks	All banks	Nonmerging banks
Intercept	0.0047***	0.0048***	0.1552***	0.1486***
Number of mergers (M)	−0.0002	—	−0.0058	—
Revenue ($ billions)	0.0065***	0.0144***	0.0568	0.1606*
Revenue^2 ($ billions)	−0.0031***	−0.0038*	−0.0413	−0.0423
w_{deposits}	−0.0200***	−0.0179**	−0.2740*	−0.0747
$w_{\text{investments}}$	−0.0019**	−0.0030**	0.0762**	0.0712*
$w_{\text{fee-based}}$	0.0079***	0.0071***	0.0857**	0.0852*
w_{trading}	−0.0086*	−0.0435***	−0.2781**	−0.7849***
R^2	0.2153	0.2913	0.0563	0.0620
adjusted R^2	0.2035	0.2738	0.0421	0.0388
F	18.187***	16.644***	3.957***	2.975**
N	472	250	472	250

Note. Dependent variable is alternatively return on assets (ROA) or return on sales revenue (ROS). Estimated regression coefficients are reported in the cells, where ***, **, and * indicate a significant difference from 0 at the 1, 5, and 10% levels. Multiplying the coefficients on the w_j variables (i.e., the share of a bank's total sales revenue that it generates from activity j) by 0.01 gives an estimate of the change in ROA or ROS when 1% of a bank's revenue is moved into activity j and out of lending activity.

shifting revenue from lending activities to fee-based activities will typically cause a net reduction in bank assets.

8. SUMMARY AND IMPLICATIONS FOR POLICY AND RESEARCH

Over the past two decades, noninterest income has outpaced interest income as a growth area for commercial banks. Despite a lack of supporting evidence, many in the banking community feel that this long-run trend in bank product mix will reduce the volatility of bank earnings, based on the belief that noninterest income is more stable than interest income. Our results contradict this view. We analyze the quarterly movements in revenues and profits at 472 large- and medium-sized banks between 1988 and 1995, using a degree of total leverage framework not typically applied to financial institutions. In this framework, the volatility of a bank's earnings is a function of two independent components: its revenue volatility, which is determined largely by market forces exogenous to the bank, and its degree of total leverage, which is determined by the fixity of its production and financing expenses.

Applying this theoretical framework to our data set, we find that both components of earnings volatility increase with the share of revenues generated by fee-based activities. More specifically, when the median bank in our sample reduces its interest revenue from traditional originate-and-hold lending activities, and replaces these revenues with increased noninterest income from fee-for-service activities (some of which are credit-related), the bank's earnings are likely to become more volatile. In addition, we find that this shift in product mix is accompanied by an increase in bank profitability, at least partially compensating banks for any increase in risk associated with the increase in earnings volatility.

These results would appear to follow naturally from the different demand and production characteristics of these two types of banking products. Traditional bank lending is a relationship business—it is costly for borrowers and/or lenders to walk away from lending relationships because of switching costs and information costs—so revenues from lending business are likely to be stable over time. Once the lending relationship is established and the fixed costs of credit evaluation have been incurred, the ongoing production costs are mostly variable (interest) costs, which reduces operating leverage. Furthermore, the bank must hold some equity capital against outstanding loan balances, which reduces financial leverage. In contrast, many fee-based activities (e.g., mutual fund and insurance sales, fee-driven credit card business) are likely to have less stable bank–customer relationships, because information costs are low and competitive rivalry is high. Finally, the degree of total leverage associated with fee-based activities may be high due to relatively high fixed-to-variable operating cost ratios and relatively low (or zero) regulatory capital requirements.

Our findings have implications for bank regulatory policy. If, as seems likely, the share of commercial bank revenues generated by fee-based activities continues

to trend upward, our results imply that bank earnings may become more volatile. While most bank shareholders could neutralize the effects of these changes on the riskiness of their portfolios by adjusting their holdings of nonbank stocks, bank regulators cannot similarly adjust their regulatory amd supervisory portfolio. Holding bank capital constant, higher earnings volatility (regardless of its source) increases the probability that a bank will become insolvent. Although Basel-style risk-based capital standards could be altered to require banks to hold capital in various quantities against their fee-based activities, determining the appropriate asset equivalents for these activities would be problematic, and in any event this approach cannot account for any diversification benefits from expanding into fee-based activities. A policy of allowing banks to set their own capital requirements based on internal risk models, coupled with requiring banks to issue subordinatated debt, could potentially work better for large sophisticated banking firms. Banks' internal models would determine the optimal amount of risk capital conditional on the full portfolio effects from all lines of business, and signals from the debt market would arguably discipline banks (or alert regulators about banks) with models that set the "optimal" amount of capital too low.

We advise caution about using our results to draw inferences about the eventual impact of the expanded insurance and securities powers granted to banking companies under the Gramm–Leach–Bliley Financial Institutions Modernization Act of 1999. On one hand, insurance and securities activities are primarily fee-generating businesses; on the other hand, the demand and production characteristics associated with these expanded activities may be quite different from those of the fee-based activities in which banks were allowed to engage during the time period encompassed by our study. The degree to which our historical results usefully describe the future ultimately depends on the degree to which the production characteristics of fee-based activities permissible during the 1980s and 1990s are similar to the production characteristics of expanded fee-based powers permissible for banks after 1999.

Our findings also have implications for researchers studying the intersection of risk and production in multiproduct firms. To our knowledge, all previous studies that estimated the degree of total leverage used single-product frameworks and applied those frameworks exclusively to nonfinancial firms. We modify the models from previous studies in order to apply them to multiproduct financial firms, but our modified techniques can also be applied to multiproduct nonfinancial firms. Our innovations have a number of advantages. The multiproduct framework captures the effects of production and marketing synergies across product lines. Because we do not estimate our models in natural logarithms (as do all previous studies), our model accepts economically viable firms that suffer negative profits in the short run. We use a nonlinear adjustment for growth, so our model may be especially useful for estimating the degree of total leverage at firms in the early growth phase of their industry or product life cycle. We encourage other researchers to test the robustness of our approach using data from both financial and nonfinancial industries.

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