Federal Reserve Bank of New York

Volume 20 Number 2

Economic Policy Review

Special Issue: Large and Complex Banks

Forthcoming Version of

Do Big Banks Have Lower Operating Costs?

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March 2014

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Do Big Banks Have Lower Operating Costs?

- Concern that some banks remain "too big to fail" has prompted many calls for limits on bank holding company (BHC) size.
- But such limits could have adverse effects if they were to undercut the economies of scale associated with large banking firms.
- Reasoning that scale economies may be achieved in part through lower operating costs, the authors of this study examine the relationship between BHC size and noninterest expense.
- Their analysis, which considers these costs at a finer level of detail than in past studies, reveals a robust negative relationship between BHC size and scaled noninterest expenses, including employee compensation, information technology, and corporate overhead costs.
- The results suggest that limits on BHC size may, in fact, increase the cost of providing banking services—a drawback that must be weighed against the potential financial stability benefits of limiting firm size.

1. Introduction

The largest U.S. banking firms have grown significantly over time, their expansion driven by a combination of merger activity and organic growth. In 1991, the four largest U.S. bank holding companies (BHCs) held combined assets equivalent to 9 percent of gross domestic product (GDP). Today, the four largest firms' assets represent 50 percent of GDP, and six BHCs control assets exceeding 4 percent of GDP. Despite recent financial reforms, there is still widespread concern that large banking firms remain "too big to fail"—that is, policymakers would be reluctant to permit the failure of one or more of the largest firms because of fears about contagion or damage to the broader economy (see, for example, Bernanke [2013]).

A growing number of market observers advocate shrinking the size of the largest banking firms in order to limit the problem of too-big-to-fail. The most direct approach would be to simply impose a firm cap on the size of assets or liabilities; for example, Johnson and Kwak (2010) propose a size limit of 4 percent of nominal GDP. An alternative would be to impose levies or progressively higher capital requirements on large banking firms to encourage them to shed assets.

Would such policies impose any real costs on the economy? A number of recent academic papers suggest that the answer may be "yes" because of the presence of economies of scale in banking. Scale economies imply that the cost of producing an additional unit of output (for example, a loan) falls as the

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The authors thank Peter Olson for outstanding research assistance and Gara Afonso, Jan Groen, Joe Hughes, Don Morgan, an anonymous referee, and workshop participants at the Federal Reserve Bank of New York for helpful comments and suggestions. The views expressed are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

quantity of production increases. A number of papers find evidence of scale economies even among the largest banking firms (Hughes and Mester 2013; Wheelock and Wilson 2012; Feng and Serletis 2010). Taken at face value, this research implies that the introduction of limits on bank size would impose deadweight economic costs by increasing the cost of providing banking services.

We contribute to this line of research by studying the relationship between size and components of noninterest expense (NIE), with the goal of shedding light on the *sources* of scale economies in banking. NIE includes a wide variety of operating costs incurred by banking firms: examples include employee compensation and benefits, information technology, legal fees, consulting, postage and stationery, directors' fees, and expenses associated with buildings and other fixed assets. Our hypothesis is that lower operating costs may be a source of scale economies for large BHCs, because large firms can spread overhead such as information technology, accounting, advertising, and management over a larger asset or revenue base. Our analysis therefore tests for an inverse relationship between BHC size and scaled measures of different components of NIE.

One novel contribution of this paper is to make use of detailed noninterest expense information provided by U.S. banking firms in the memoranda of their quarterly regulatory FR Y-9C filings. The Y-9C reports contain detailed consolidated financial statements and other data for U.S. BHCs (see Section 3 for details). Since 2001, about 35 percent of total noninterest expense is classified in the Y-9C as part of a broad "other noninterest expense" category. For the period 2008 to 2012, we disaggregate this line item into nine author-defined categories, using memoranda information from Schedule HI of the Y-9C. In part, this involved manually classifying about 5,500 individual "write-in" text fields reported by individual BHCs. To our knowledge, ours is the first paper to make use of these data.

We start by estimating the relationship between bank holding company size (measured by the natural logarithm of total assets) and total noninterest expense scaled by net operating revenue, assets, or risk-weighted assets. We find a statistically and economically significant negative relationship between BHC size and these NIE ratios, robust to the expense measure or set of controls used. Quantitatively, a 10 percent increase in assets is associated with a 0.3 to 0.6 percent decline in noninterest expense scaled by income or assets, depending on the specification. In dollar terms, our estimates imply that for a BHC of mean size, an additional $1 billion in assets reduces noninterest expense by $1 million to $2 million per year, relative to a base case in which operating cost ratios are unrelated to size.[1]

[1] For details of this calculation, see Appendix B, available as a separate file at http://www.newyorkfed.org/research/epr/2014/1403kovn_appendixB.pdf. The appendix was omitted from the main document because of space constraints.

These results hold across the size distribution of banking firms, and over different parts of our sample period. We find no evidence that these lower operating costs flatten out above some particular size threshold. The point estimate of the slope of the relationship steepens, if anything, although the statistical uncertainty associated with the estimate becomes larger owing to the small sample.

The relationship between size and the NIE ratio is negative for each of the three main components of noninterest expense reported in BHC regulatory filings: employee compensation, premises and fixed asset expenses, and other noninterest expense. Using our novel by-hand classification of other NIE into nine subcomponents, however, we find significant variation in the size-expense relationship among the subcomponents. The inverse relationship between size and expense is particularly pronounced for corporate overhead (for example, accounting, printing, and postage); information technology (IT) and data processing; legal fees; other financial services; and directors' fees and other compensation. In contrast, large BHCs spend proportionately *more* on consulting and advisory services than do smaller firms, relative to revenue or assets. Large BHCs also incur proportionately higher expenses relating to amortization and impairment of goodwill and other intangible assets.

Overall, our results are consistent with the presence of scale economies in banking, as found in recent academic literature (for example, Wheelock and Wilson [2012]; Hughes and Mester [2013]; Feng and Serletis [2010]) and industry research (Clearing House Association 2011). In particular, our findings suggest that these scale economies stem in part from an operating cost advantage of large BHCs in areas such as employee compensation, information technology, and corporate overhead expenses.

We emphasize that a number of caveats apply to our results. First, our estimates represent reduced-form statistical correlations; caution should be exercised in drawing a causal interpretation from them. Although our regressions control for a wide range of BHC characteristics, firm size may still be correlated with omitted variables that are also associated with lower expenses, such as the quality of management. This caveat also seems to apply more generally to the existing literature on scale economies in banking.

Second, our results may also reflect factors other than scale economies. One possibility, closely related to scale economies but conceptually distinct, is that large firms operate closer to their production frontier on average; that is, they have greater *X-efficiency* (see Section 2 for a discussion).[2]

[2] Our analysis does not attempt to separate the effects of X-efficiency from those of scale economies. We note, however, that Hughes et al. (2001) and Hughes and Mester (2013) find that estimated scale economies are larger for more efficient banks than for less efficient ones, controlling for size.

Another possibility is that large banking firms have greater bargaining power vis-à-vis their suppliers and employees. If cost differences are due only to bargaining power effects, then limiting the size of the largest BHCs would not necessarily generate deadweight economic costs, although it might instead reallocate rents to employees or suppliers. An additional possibility is that our results are influenced by too-big-to-fail subsidies for large BHCs. Our prior is that such subsidies would be more likely to be manifested as a lower cost of funds for large firms, or a more leveraged capital structure, than as lower operating costs. However, it is still possible that a too-big-to-fail banking firm could respond by reducing expenditures on functions such as information technology or risk management; these would show up as part of noninterest expense.

These caveats aside, our results and those of related research suggest that imposing size limits on banking firms is unlikely to be a free lunch. For example, taking our estimates at face value, a back-of-the-envelope calculation implies that limiting BHC size to no more than 4 percent of GDP would increase total industry noninterest expense by $2 billion to $4 billion per quarter.[3] Limiting the size of banking firms could still be an appropriate policy goal, but only if the benefits of doing so exceeded the attendant reductions in scale efficiencies.

A second contribution of this article is to present new evidence on other determinants of BHC operating costs. In particular, we find that proxies for organizational complexity (for example, the number of distinct legal entities controlled by the BHC), as well as measures of the diversity of business activities, are robustly correlated with higher expense ratios. This result appears consistent with prior research on the diversification discount in banking (for example, Goetz, Laeven, and Levine [2013]). A third contribution is to present new stylized facts about the composition of noninterest expense, based on our data collection efforts. For example, we document the large share of NIE that is composed of corporate overhead, investment technology and data processing, consulting and advisory services, and legal expenses.

The remainder of the article proceeds as follows: Section 2 presents background and reviews the literature on economies of scale in banking. Section 3 describes the data, discusses our method for classifying other noninterest expense, and presents descriptive statistics. Section 4 presents multivariate analysis of the relationship between size and noninterest expense ratios. Section 5 studies components of noninterest expense. Section 6 summarizes our findings.

[3] Details of this calculation are presented in Appendix B, http://www.newyorkfed.org/research/epr/2014/1403kovn_appendixB.pdf.

2. Background and Literature

Our analysis is closely related to academic literature on scale economies and organizational efficiency in banking. In a microeconomic production model, the cost function traces out the relationship between output and the minimum total cost required to produce that output, for a given set of input prices. A firm exhibits economies of scale if minimum cost increases less than proportionately with output—for example, if the firm could double its output by less than doubling its costs, holding input prices fixed.

A large literature empirically estimates the cost function for banks and/or BHCs, and tests for the presence of scale economies by measuring whether the elasticity of total costs with respect to output is greater than, equal to, or less than unity (indicating diseconomies of scale, constant returns to scale, or economies of scale, respectively).

The earliest studies of scale economies in banking (for example, Benston [1972]), estimated during an era when U.S. banking organizations were on average much smaller than today, found evidence of modest economies of scale. Subsequent research, using more flexible cost functions, found that these scale economies were limited to small banks (for example, Benston, Hanweck, and Humphrey [1982] and Peristiani [1997]; see also Berger and Humphrey [1994] for a survey).

More recent research, however, has found evidence of scale economies even among the class of large banks and bank holding companies. Examples include Wheelock and Wilson (2012), Hughes and Mester (2013), Feng and Serletis (2010), and Hughes et al. (2001). This departure from earlier findings reflects greater statistical power, attributable to the use of larger datasets with many more observations for large banking firms, as well as the evolution of empirical techniques. For example, Wheelock and Wilson (2012) estimate a nonparametric cost function rather than the typical parametric translog function estimated in earlier literature, while Hughes and Mester (2013) and Hughes et al. (2001) endogenize bank risk and capital structure decisions. The difference in time periods may also play a role (for example, the greater use of information technology may have changed the extent to which scale economies are present).

The theoretical derivation of the cost function assumes that the bank maximizes profits, or equivalently, minimizes costs for any given level of output. A related body of literature on bank efficiency, however, finds evidence of surprisingly large cost differences between otherwise similar banks. These differences are viewed as evidence of *X-inefficiencies*, that is, firms operating inside their production possibilities frontier because of agency conflicts, management problems, or other

inefficiencies (DeYoung 1998; Berger, Hunter, and Timme 1993; Berger and Humphrey 1991).

Rather than analyzing total scale economies or X-efficiency, this paper instead presents disaggregated evidence on the relationship between firm size and detailed components of noninterest expense. We have in mind the idea that operational and technological efficiencies related to size are likely to show up in the data in the form of lower operating costs in areas such as information technology and corporate overhead (for example, accounting and human resources) because large BHCs are able to spread the fixed component of these costs over a broader revenue or asset base. Our goal is to shed additional light on the mechanisms driving differences in efficiency between small and large firms. We note that our empirical finding that large BHCs have lower average operating costs could be driven by the presence of scale economies in the production of banking services, higher average X-efficiency for large firms, or both. For some categories of NIE, it could also be possible that lower costs for larger banking firms not only reflect technological efficiencies, but also greater bargaining power relative to suppliers, customers, or employees.

Our analysis is related to recent research by the Clearing House (2011) that uses proprietary management information systems data from a number of large banks to estimate product-specific scale curves in seven areas: online bill payment, debit cards, credit cards, wire transfers, automated clearing house, check processing, and trade processing. The Clearing House finds that in each of these areas, unit costs are decreasing in production volume, a conclusion that suggests the presence of fixed costs or other technological benefits of size. The economies of scale associated with these seven services are estimated to total $10 billion to $25 billion per year.

Although our approach is similar in some respects to the analysis by the Clearing House, we make use of data from audited regulatory filings, rather than internal management information system data, and study components that together sum up to total noninterest expense, rather than just a subset of NIE (the seven items studied by the Clearing House together cover only 7 to 10 percent of NIE). We also study the entire cross-section of BHCs, while the Clearing House sample consists of only six firms.

Our approach is related to the literature on banking mergers that uses accounting variables to estimate the effects of mergers on operating performance. Kwan and Wilcox (2002) find evidence that bank mergers reduced operating costs, although more so for the early 1990s than the late 1980s. Cornett, McNutt, and Tehranian (2006) examine different measures of efficiency improvements for large mergers, and find evidence for cost-efficiency improvements in addition to other revenue improvements. Hannan and Pilloff (2006) show that cost-efficient banks tend to acquire relatively inefficient targets. Using German banking data, Niepmann (2013) finds a negative correlation between size and scaled operating costs—a result consistent with our findings for U.S. firms.

Davies and Tracey (2014) argue that standard estimates of scale economies for large banks are influenced by too-big-to-fail (TBTF) subsidies, and that scale economies are no longer present after controlling for TBTF factors. Hughes and Mester (2013) dispute this conclusion, arguing that the cost function used by Davies and Tracey is misspecified. One potential advantage of our focus on noninterest expense is that operating costs (for example, information technology, printing, postage, and advertising) may be relatively more likely to reflect technological features of the firm's production process than any distortions due to TBTF. Instead, TBTF seems most likely to affect the firm's funding costs and capital structure. It seems difficult, however, to rule out the possibility that TBTF subsidies may affect our results or those of previous literature.

3. Data and Descriptive Statistics

Our analysis is based on quarterly FR Y-9C regulatory data filed by U.S. bank holding companies. The Y-9C filings include detailed balance sheet and income data, as well as information about loan performance, derivatives, off-balance-sheet activities, and other aspects of BHC operations. Data are reported on a consolidated basis, incorporating both bank and nonbank subsidiaries controlled by the BHC (see Avraham, Selvaggi, and Vickery [2012] for more details). Our analysis considers only "top-tier" BHCs—that is, the ultimate parent U.S. entity. Our sample includes top-tier U.S. BHCs with a foreign parent, although it excludes "stand-alone" commercial banks that are not owned by a BHC, and BHCs that are too small to file the Y-9C (the Y-9C reporting threshold varies over time, but is currently $500 million). Our sample excludes investment banks, thrifts, and other types of financial institutions, unless those firms are owned by a commercial BHC.

Noninterest expense is reported in the consolidated Y-9C income statement (Schedule HI), broken down into five categories. Note that noninterest expense does not include loan losses due to defaults, trading losses, gains and losses on owned securities, or taxes; these are recorded in other parts of the income statement.[4] Our analysis focuses on noninterest

[4] BHC net income in Schedule HI is calculated as follows: net income = net interest income + noninterest income – noninterest expense – provision for loan and lease losses + realized securities gains (losses) – taxes + extraordinary items and other adjustments – net income attributable to noncontrolling interests. See Copeland (2012) for descriptive information on how the main components of BHC income have evolved over time.

expense because it is the most likely area in which firms would realize operating cost advantages from size.

We compute several normalized measures of noninterest expense. The first measure, widely used by practitioners and industry analysts, is the "efficiency ratio," defined as the ratio of noninterest expense to "net operating revenue," the sum of net interest income and noninterest income:

$$Efficiency\ ratio = \frac{noninterest\ expense}{net\ interest\ income + noninterest\ income}$$

A higher efficiency ratio indicates higher expenses, or equivalently, lower efficiency. Effectively, this ratio measures the operating cost incurred to earn each dollar of revenue. Efficiency ratios vary widely across BHCs, as we document below, but typical values range from 50 to 80 percent. Efficiency ratios are sometimes computed excluding certain noncash items from noninterest expense, such as amortization of intangible assets. We refer to such measures as "cash" efficiency ratios.

One limitation of the efficiency ratio is that it is sensitive to quarter-to-quarter movements in net operating revenue. For example, ratios spiked for many BHCs during the financial crisis, because of trading losses and other noninterest losses. (In rare cases, the efficiency ratio even flips sign, because the sum of net interest and noninterest income is negative.) To provide an alternative normalization that is less sensitive to these concerns, we also present results based on scaling noninterest expense by total assets or risk-weighted assets (RWA), rather than net operating revenue:

$$Expense\ asset\ ratio = \frac{noninterest\ expense}{total\ assets\ (or\ risk\text{-}weighted\ assets)}$$

These normalizations can be computed for total noninterest expense, or for NIE subcomponents such as compensation.

3.1 Descriptive Statistics

Table 1 presents descriptive statistics for noninterest expense over the period from first-quarter 2001 to fourth-quarter 2012. We selected this period to take advantage of additional detail on noninterest income expense that was added to the Y-9C in 2001, thereby allowing us to separate noninterest income (which we use as a control) into components such as investment banking fees, income from insurance fees, deposit fees, and servicing fees. Note that the sample period for our regression analysis in Section 4 begins in first-quarter 2002 because we incorporate lagged income variables from the previous four quarters. A total of 2,810 BHCs are present in the sample for at least one quarter.

Panel A of the table reports summary statistics for four normalized measures of noninterest expense: the efficiency ratio, the cash efficiency ratio (which excludes goodwill impairment and amortization from noninterest expense), noninterest expense scaled by total assets, and noninterest expense scaled by RWA. The industry efficiency ratio averages 66.3 percent over 2001-12, although it is somewhat higher (71.7 percent) in 2012. The standard efficiency ratio and the cash efficiency ratio differ little on average, reflecting the fact that goodwill impairment and amortization expense generally represent a small total of total noninterest expense.

The distribution of the expense ratios is skewed to the right. For example, the difference between the 5th percentile of the efficiency ratio and its median is 19.5 percent, significantly smaller than the difference of 28.0 percent between the median and the 95th percentile value. Furthermore, the right tail includes some extremely high values (for example, the 99.5th percentile is 198.4 percent), likely driven by one-time spikes in revenue. To reduce the influence of outliers, our regression analysis winsorizes the top and bottom 0.5 percent of observations for each noninterest expense ratio (all data below and above the bottom and top 0.5th percentiles, respectively, are set equal to the 0.5th and 99.5th percentiles).

We examine the components of noninterest expense in Panel B of the table, based on the five noninterest expense categories reported on Schedule HI.[5]

- *Compensation* (49.4 percent of industry total over the sample time period, reported on FR Y-9C as "salaries and employee benefits"). This category includes wages and salaries, bonus compensation, contributions to social security, retirement plans, health insurance, employee dining rooms, and other components of employee compensation.
- *Premises and fixed assets* (11.6 percent of total, reported on Y-9C as "expenses of premises and fixed assets net of rental income") includes depreciation, lease payments, repairs, insurance and taxes on premises, equipment, furniture, and fixtures. It excludes mortgage interest on corporate real estate.
- *Goodwill impairment* (1.8 percent of total, reported on Y-9C as "goodwill impairment losses") represents losses incurred when goodwill exceeds implied fair value and is revalued downwards. This item is reported separately from "other noninterest expense" from 2002 onwards.
- *Amortization expense* (1.9 percent of total, reported on Y-9C as "amortization expense and impairment losses for other intangible assets") includes amortization of goodwill

[5] A detailed definition of these five variables can be found in the Federal Reserve Microdata Reference Manual data dictionary, available at http://www.federalreserve.gov/apps/mdrm/data-dictionary.

Table 1

Noninterest Expense Summary Statistics

	Industry		Individual Observations								
	Full Sample	2012	p0.5	p5	p25	p50	p75	p95	p99.5	Mean	Standard Deviation
Panel A: Efficiency Measures, in Percent: 2001-12											
Efficiency ratio	66.32	71.68	29.07	46.31	58.26	65.77	74.44	93.71	198.40	68.10	18.69
Cash efficiency ratio	63.29	70.39	28.69	45.81	57.72	65.17	73.72	92.07	168.11	67.05	16.64
Expense-to-asset ratio	0.82	0.82	0.25	0.45	0.63	0.75	0.88	1.25	3.95	0.80	0.37
Expense-to-RWA ratio	1.22	1.35	0.35	0.61	0.87	1.05	1.28	1.89	6.02	1.15	0.58
Panel B: Components of Noninterest Expense, as a Percentage of Total: 2001-12											
Compensation	49.36	48.68	18.08	40.45	50.31	54.67	58.58	64.59	74.30	53.96	13.54
Premises and fixed assets	11.63	9.64	2.79	7.78	11.47	13.67	16.01	20.16	26.53	13.84	5.45
Goodwill impairment	1.75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	16.28	0.29	5.03
Amortization expense	1.93	1.78	-0.03	0.00	0.00	0.00	0.97	3.57	9.03	0.76	1.72
Other	34.95	39.88	10.02	20.93	26.22	30.04	34.71	45.82	69.29	31.11	16.15

Source: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data).

Notes: The table reports summary statistics for 2,810 unique bank holding companies from 2001:Q1 to 2012:Q4, a total of 58,217 firm-quarter observations. The column labeled "industry" reports the average industry efficiency ratio, calculated by summing across all bank holding companies each quarter, taking the ratio, and then taking the time-series mean, either over the 2001:Q1 – 2012:Q4 sample period or over calendar year 2012. The denotation "p" refers to percentiles of individual observations (for example, "p50" is the median). Variables are defined in Appendix A. RWA is risk-weighted assets.

and other intangible assets owned by the BHC, as well as impairment losses for intangible assets other than goodwill. This item is also available from 2002 onwards.

- *Other* (35.0 percent of total) includes a broad range of other operating costs, such as telecommunication and information technology costs, legal fees, deposit insurance, advertising, printing, postage, and so on. Additional information on these expenses is provided in the memoranda to Schedule HI, as we explain in detail below.

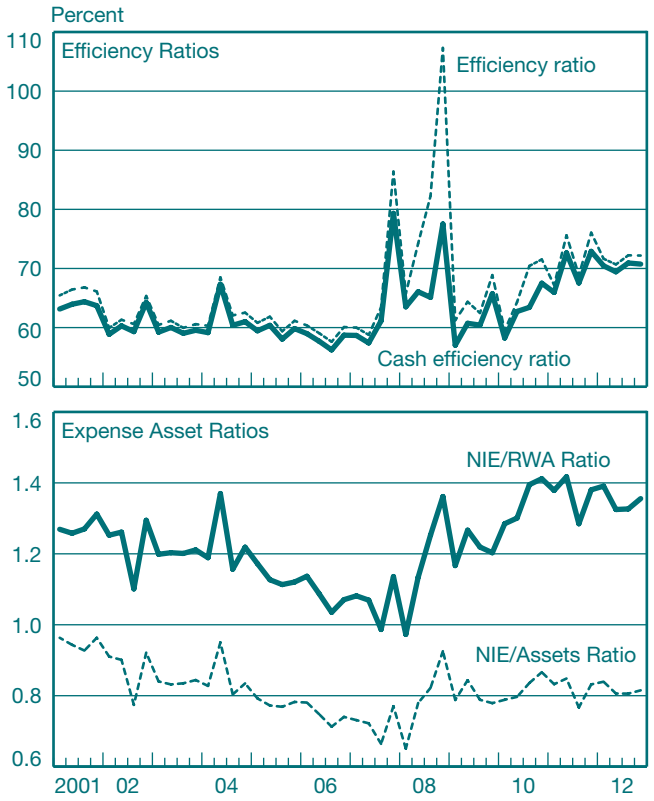
Chart 1 plots the time series evolution of the four normalized measures of total industry NIE. Each expense measure declined between 2001 and mid-2007, a period when the revenues and assets of the banking system grew rapidly. For example, the industry efficiency ratio fell from 65.4 percent in quarter-one 2001 to 58.8 percent in quarter-two 2007, while the expense asset ratio declined from 0.96 percent to 0.72 percent over the same period. This downward trend was reversed during the 2007-09 financial crisis. Since the efficiency ratio is mechanically inversely related to net operating revenue, the reversal for that NIE measure is perhaps unsurprising. However, the expense asset ratio also increased, whether normalized by total assets or risk-weighted assets. In recent years noninterest expense ratios have stabilized at levels higher than those prevailing prior to the onset of the crisis. The rise in the efficiency ratio in part simply reflects the decline in net operating revenue and measures of profitability for the banking industry, owing to compression of net interest margins and lower noninterest income.

Appendix B also plots the evolution of the relative shares of the five noninterest expense subcategories.[6] Goodwill impairment expenses are almost entirely concentrated in 2008, with negligible levels for this expense category before and after 2008. Other noninterest expense makes up a progressively larger fraction of total NIE over the past five years. (In 2012, this category represented 39.9 percent of total NIE, a share similar to that held by compensation expenses).

As a first look at the relationship between firm size and normalized noninterest expense, the main focus of this paper, we present scatter plots of BHC size and the efficiency ratio (Chart 2). The plots are based on year-to-date 2012 expense data and assets as of the end of 2012. A striking feature of the chart

[6] Appendix B is available at http://www.newyorkfed.org/research/epr/2014/1403kovn_appendixB.pdf.

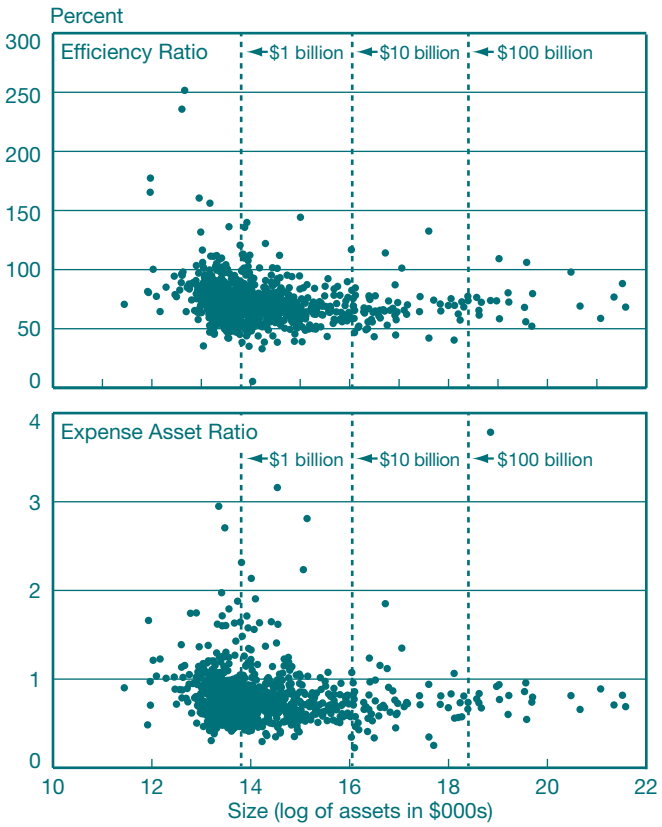
Chart 1
Noninterest Expense Ratios over Time



Source: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data).

Notes: Income data are quarterly and are not annualized. Ratios are reported in percentages. NIE is noninterest expense; RWA is risk-weighted assets.

Chart 2
Scatter Plots of Operating Cost Ratios and BHC Size



Source: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data).

Notes: Scatter plots are based on average quarterly noninterest expenses over 2012 and total BHC assets as of the end of 2012. BHC is bank holding company.

is the variability in noninterest expense across firms, particularly among smaller BHCs. This finding is also borne out in our multivariate analysis in Section 4. The variability points to the importance of adding controls for those observable differences in BHCs' activities that are associated with different types of expenses. These controls are described in Section 3.3.

3.2 Classifying Other Noninterest Expense

The category "other NIE" represents more than one-third of industry noninterest expenses since 2001. To shed light on these costs, we examine data from the memoranda to Schedule HI. Since 2008, Schedule HI has allowed BHCs to classify other NIE into eleven standardized subcategories;[7] in addition, space is provided for BHCs to report additional "write-in" expense items that were not captured by the standardized fields. For the eleven standardized subcategories, BHCs are instructed to record items for amounts greater than $25,000 that also exceed 3 percent of total other noninterest expense. Write-in items bear the additional requirement that the expense item exceed 10 percent of total other noninter-

[7] The eleven standardized memoranda categories are (a) data processing expenses, (b) advertising and marketing expenses, (c) directors' fees, (d) printing, stationery, and supplies, (e) postage, (f) legal fees and expenses, (g) FDIC insurance assessments, (h) accounting and auditing expenses, (i) consulting and advisory expenses, (j) automated teller machine (ATM) and interchange expenses and (k) telecommunications expenses. See FR Y-9C Schedule HI Memorandum Item 7.

est expense. Since 2008, amounts in the eleven standardized categories have made up 38 percent of total other noninterest expense, while the write-in fields have constituted another 28 percent of other NIE. The remaining 34 percent of other noninterest expense is not reported in the Schedule HI memoranda, presumably because it does not meet the reporting thresholds described above.

It is particularly challenging to classify and analyze items recorded in the write-in expense fields, because these amounts are reported using nonstandardized language by each BHC. For example, noninterest expenses related to foreclosures and to properties that are "other real estate owned"[8] are variously written in as "reo," "ore," "R.E.O," "oreo," "foreclose," and so on, as well as various misspelled text strings such as "oero" and "forclosuer" (sic). Overall, more than 30,000 text strings are written in by the BHCs in our sample between 2008 and 2012. Approximately 5,500 of these strings are unique. Individual BHCs often tend to use the same text field from one quarter to the next when referring to a given data item, a practice that reduces the total number of fields to be classified.

We classify each unique text string into broad categories, proceeding in two steps. First, we classify each string into one of ninety subcategories, such as "card rewards," "custodian fees," "affordable/low-income housing," "servicing," "dues/memberships/subscriptions," and "lockbox fee." We chose these subcategories by grouping together apparently similar items, employing our institutional knowledge where possible, as well as internet searches and our best judgment. A list of these subcategories, along with the percentage of nonmissing values, is presented in Appendix B to this paper. This classification was in part done by hand, and in part via Stata code that conducted Boolean searches for keywords within each text string. The subcategories include four separate "miscellaneous/other" categories, one for text strings that are well-defined but do not fit into any obvious category (for example, "cattle feed," "livestock," and "image processing"), one for items that we did not understand (for example, "tops expense"), one for items that are vague or otherwise unclassifiable (for example, "sundry loss"), and one for text strings that combine multiple items with values listed.

Since most of the subcategories are fairly sparsely populated, as documented in Appendix B, we then aggregate them into nine categories that are better suited to statistical analysis. We also assign each of the eleven standardized memoranda items to one of the same nine author-defined categories. By doing this, we are able to classify 66.2 percent of other noninterest expense into the nine high-level categories, which are listed below:

- *Corporate overhead* (18.6 percent of other NIE). This category, which is intended to measure general corporate expenses, includes four standardized Y-9C items: "accounting and auditing," "printing, stationery, and supplies," "postage," and "advertising and marketing." It also includes write-in expenses related to corporate overhead costs, such as travel, business development, recruitment, professional memberships and subscriptions, and charitable contributions.
- *Information technology and data processing* (12.6 percent of other NIE). This category covers the standardized Y-9C item "data processing expenses," as well as write-in expenses related to information technology, software, and internet banking.
- *Consulting and advisory* (11.1 percent of other NIE). This category is the standardized Y-9C item "consulting and advisory expenses." It does not include any write-in expenses.
- *Legal* (6.7 percent of other NIE). This category includes the standardized Y-9C item "legal fees and expenses," as well as write-in line items related to "litigation," "settlement," "records retention," "legal reserve," and similar items.[9]
- *Retail banking* (6.4 percent of other NIE). This category is intended to reflect operating costs related to lending and deposit-taking. It includes the standardized NIE category "ATM and interchange expenses," as well as write-in items related to loans, retail banking, or credit cards (for example, costs related to real estate owned properties, credit reports, credit card rewards, branch closing costs, lockbox fees, check fraud, and so on).
- *Federal Deposit Insurance Corporation (FDIC) assessments and other government-related expenses* (5.8 percent of other NIE). This category includes the standardized Y-9C item "FDIC deposit insurance assessments" and write-in expenses related to the Community Reinvestment Act, compliance with regulation, and other items. In practice, deposit insurance fees make up the bulk of these expenses.
- *Other financial services* (3.0 percent of other NIE). This category embraces written-in expense items for financial activities other than traditional lending and depository services—in particular, asset management, insurance, and miscellaneous derivatives- and trading-related expenses.
- *Directors' fees and other compensation* (0.3 percent of other NIE). This category includes the standardized Y-9C category "directors' fees," as well as write-in fields related to director compensation or other compensation costs.

[8] "Other real estate owned" refers to real estate owned by a bank as a result of the foreclosure of a mortgage loan.

[9] The standardized "legal fees and expenses" other NIE category includes fees and retainers paid for legal services obtained, but excludes legal settlements and legal expenses associated with owned real estate. Legal settlements and legal reserves established against expected future settlements are recorded in the write-in text fields, if separately reported.

Table 2

Components of Other Noninterest Expense

Panel A: FR Y-9C Classification of Other Noninterest Expense: 2008-12

Category	Percentage of Total Other Noninterest Expense, Industry
In Y-9C	37.99
Text classified	28.21
Unclassified	33.80
Total	100.00

Panel B: Components of Other Noninterest Expense, as a Percentage of Total Other Noninterest Expense: 2008-12

		Individual Observations								
Component (Author-Defined)	Industry	p0.5	p5	p25	p50	p75	p95	p99.5	Mean	Standard Deviation
Corporate overhead	18.63	0.00	2.43	10.29	16.26	22.70	34.58	50.95	17.07	10.07
Information technology and data processing	12.63	0.00	0.64	8.21	13.84	19.81	29.91	45.01	14.54	8.69
Consulting and advisory	11.07	0.00	0.00	0.00	2.31	5.78	12.73	29.97	3.74	5.23
Legal	6.68	0.00	0.00	0.00	3.53	6.19	12.43	24.71	4.16	4.71
Retail banking	6.35	0.00	0.00	0.00	6.41	13.48	29.64	55.24	9.24	10.55
FDIC assessments and other government	5.81	0.00	0.00	6.80	11.53	16.95	25.54	37.34	12.26	7.58
Other financial services	3.01	0.00	0.00	0.00	0.00	0.00	4.00	15.85	0.56	2.72
Directors' fees and other compensation	0.25	0.00	0.00	0.00	0.00	3.45	6.99	14.60	1.91	2.85
Miscellaneous	1.76	0.00	0.00	0.00	0.00	0.00	5.75	24.91	0.84	3.98
Total classified	66.20	4.02	35.11	55.83	66.87	75.05	85.72	95.35	64.32	15.73
Unclassified	33.80									

Source: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data).

Notes: The table reports summary statistics for 2,810 unique bank holding companies from 2008 to 2012. Annual data are as of year-end, for a total of 4,999 firm-year observations. Panel A summarizes information on the following types of noninterest expense: (i) FR Y-9C line items: eleven standardized other noninterest expense items reported in FR Y-9C Schedule HI: Memoranda, (ii) text classified: other noninterest expense items reported in Schedule HI: Memoranda as text fields, and (iii) unclassified: other noninterest expense items not classified in Schedule HI (for example, because the amounts do not exceed the reporting threshold). Panel B includes summary statistics for the nine author-defined other noninterest expense categories, which are constructed from the FR Y-9C line items and the text fields. These data are described in Section 3.2. FDIC is Federal Deposit Insurance Corporation.

- *Miscellaneous* (1.8 percent of other NIE). The final category reflects the four types of miscellaneous categories described above—that is, items that cannot be easily classified or are not understood by us based on the content of the write-in field.

In a small minority of cases, the write-in field content suggests an expense item that may have been classified as other NIE by mistake (for example, costs related to employee compensation). We did not attempt to reclassify these expenses, given the limited context and detail in the write-in fields.

Descriptive statistics for these nine author-defined categories of other NIE are presented in Panel B of Table 2. Note that the individual percentiles and standard deviations reported in the table are based on annual expenses, rather than quarterly values. We adopt this approach because of the significant number of zero values reported for even these nine aggregated categories. Our analysis of the other NIE subcategories is based on these year-end cumulative expenses.

The variation across BHCs in the relative size of different components of other NIE is striking. For example, the category "other financial services," which includes noninterest expense related to insurance and other nonbanking financial services, has a median value of zero, but at the 99.5th percentile, it is 15.9 percent of total other noninterest expense. This varied distribution of expenses is consistent with the dispersion in products and services offered by BHCs.

3.3 Controls

Operating costs are likely to vary significantly across BHCs engaged in different business activities. While the decision to enter different businesses is endogenous, and may be related to size, we are primarily interested in understanding how size is related to operating expenses on an apples-to-apples basis. For this reason, our regression analysis controls for a variety of BHC characteristics reported in the FR Y-9C. Summary statistics for these controls are presented in Table 3. In order to show how these controls are related to bank size, we also present industry averages for the following size cohorts: largest 1 percent, 95 to 99 percent, 75 to 95 percent, 50 to 75 percent, and smallest 50 percent.[10] Differences in BHC characteristics by size are clear from differences in sample means within the cohorts. However, there is substantial variation in business models apparent within size cohorts as well.

The controls in Table 3 are grouped into six categories, as follows:

- *Asset shares*. Our asset composition control variables measure the fraction of balance sheet assets held in various types of loans and other assets (for example, trading assets, securities, cash, and fixed assets). As shown in Table 3, small firms hold a higher fraction of total assets in the form of loans, while trading assets are a significantly higher share of total assets for the largest BHCs than for any other group.
- *Risk*. We control for two additional measures of asset risk: risk-weighted assets as a percentage of total assets, and nonperforming loans (NPLs) as a percentage of total loans. The relationship between firm size and risk is non-monotonic for both risk measures, although we note that the largest firms have significantly higher nonperforming loan ratios than other BHCs.
- *Revenue composition*. Revenue composition refers to the percentage of net operating revenue (the sum of interest and noninterest income) that is earned from different sources: (i) interest income, (ii) trading income, and (iii) five different components of noninterest nontrading income. Since these components can be volatile, in the regressions we include these variables in the form of a four-quarter rolling average lagged value. (The standard deviation reported in the table is based on this four-quarter rolling average.) It is notable that large BHCs earn a significantly higher percentage of revenue from noninterest income.
- *Funding structure*. In some specifications, we include two controls for funding structure, the ratio of deposits to assets, and a dummy for whether the BHC is a publicly traded company (firms with foreign parents are coded as private, regardless of whether their ultimate parent is public). Large firms fund less of their assets with deposits, on average.
- *Business concentration*. Research in organizational economics has found that diversified firms tend to be less efficient and less profitable than focused firms. In studies that are most relevant to our analysis, Goetz, Laeven, and Levine (2013) find that geographically diversified commercial banks have lower valuations, while Laeven and Levine (2007) find a diversification discount (based on the firm's activity mix) in an international cross-section of banks. In the spirit of these studies, we include Herfindahl-Hirschman Index (HHI)–style measures of asset and income concentration, computed as the sum of squared asset weights and income weights, respectively, based on the categories presented in Table 3. Higher values of these measures indicate greater concentration. As the table shows, large firms have more diversified assets and activities (lower HHI), reflecting their greater reliance on financial activities outside of traditional lending and deposit taking.
- *Organizational complexity*. Organizationally complex firms may also have higher operating costs, because of various internal inefficiencies (for example, duplication of efforts across different subsidiaries or divisions within the same firm). It is important to attempt to disentangle the effects of size and structure, given that large firms are likely to be organizationally complex. Our analysis includes three measures of organizational structure, the log number of subsidiaries (following Avraham, Selvaggi, and Vickery [2012]), the percentage of subsidiaries domiciled overseas, and a dummy for whether the BHC has a foreign parent. As shown by the sample means across size cohorts, large firms have more complex organizational structures than small firms on each of these dimensions. The differences are striking: the largest BHCs (those in the top 1 percent of the size distribution) have 962 subsidiaries on average, 22.7 percent of which are domiciled overseas. BHCs below the sample median in size, however, have only 4 subsidiaries on average, and only 4.8 percent of these subsidiaries are domiciled outside the United States.

[10] To compute the industry average for the asset and income ratios, we sum the numerator and denominator of the ratio across all firms in the size cohort, and then take the ratio of the two sums. In contrast, the mean and standard deviation reported in the first two columns represent the unweighted mean and standard deviation of the individual observations in the sample. Of course, the mean of the individual observations may differ substantially from the industry mean if the ratio in question is correlated with firm size.

Table 3

Summary Statistics for Control Variables

	Industry, by Size Cohort						Individual Observations	
	Top 1%	95-99%	75-95%	50-75%	Bottom 50%	Industry	Mean	Standard Deviation
Asset shares (percentage of total assets)								
Total loans	42.08	59.58	64.65	67.84	67.57	48.39	66.44	13.36
Residential real estate loans	14.94	16.63	16.55	17.32	18.08	15.53	17.78	10.62
Commercial real estate loans	4.26	15.65	28.12	31.47	29.77	9.48	28.27	15.02
Commercial and industrial loans	8.64	12.54	11.20	10.25	9.94	9.65	10.42	6.84
Credit card loans	3.53	2.33	0.59	0.26	0.17	2.93	0.32	2.93
Other consumer loans	4.68	6.11	4.19	3.72	3.87	4.89	4.25	5.14
All other loans	6.03	6.32	4.00	4.83	5.73	5.91	5.40	7.83
Trading assets	15.52	1.45	0.24	0.04	0.04	10.89	0.20	1.75
Federal funds and repurchase agreements	13.67	2.20	1.24	1.61	2.07	9.95	2.14	3.93
Cash	5.49	5.76	4.41	4.65	4.91	5.43	4.64	4.01
Investment securities	12.65	20.60	22.94	20.56	20.46	15.34	21.35	12.38
Other real estate owned	0.11	0.12	0.31	0.42	0.49	0.14	0.36	0.89
Fixed assets	0.70	1.24	1.62	1.92	2.02	0.93	1.90	1.05
Investments in unconsolidated subsidiaries	0.33	0.18	0.09	0.12	0.07	0.27	0.09	1.38
Investments in real estate ventures	0.08	0.05	0.02	0.03	0.02	0.07	0.02	0.94
Intangible and other assets	8.02	6.77	3.89	3.19	2.97	7.24	3.19	2.11
Risk								
Risk-weighted assets (percentage of total assets)	63.85	75.08	71.72	72.95	71.82	67.04	71.68	11.89
Nonperforming loans (percentage of total loans)	2.94	1.85	2.05	1.83	1.95	2.51	1.65	2.65
Revenue composition (percentage of net operating revenue)								
Interest income	50.61	51.56	65.08	73.25	77.26	53.01	77.62	12.54
Trading income	7.38	1.58	0.28	0.08	0.09	5.44	0.19	1.14
Noninterest nontrading income	45.38	46.85	34.65	26.68	22.66	43.90	22.26	12.30
Fiduciary income	7.86	9.63	4.54	3.96	2.64	7.83	2.84	4.97
Investment banking fees	12.96	7.32	8.60	1.38	0.83	10.73	0.99	2.83
Service charges on deposits	5.43	6.53	7.40	7.84	7.79	5.93	7.87	4.56
Net servicing fees	3.48	1.52	0.65	0.47	0.52	2.69	0.60	1.58
Other income	15.55	21.85	13.45	13.03	10.88	16.66	9.77	9.32
Funding structure								
Deposits/assets (percent)	43.67	62.76	74.85	79.58	81.17	51.49	79.21	10.42
Publicly traded (percentage of sample)	76.85	79.16	60.18	30.81	12.69	30.02	27.75	44.78
Business Concentration								
HHI assets	0.25	0.41	0.48	0.51	0.51	0.29	0.52	0.13
HHI income	0.53	0.56	0.59	0.64	0.67	0.53	0.69	0.17
Organizational complexity								
Number of subsidiaries	962.25	68.78	10.76	6.22	4.07	18.29	15.75	139.99
Percentage of subsidiaries foreign	22.71	14.46	3.88	4.54	4.83	16.15	0.75	5.18
BHC is foreign-owned (percentage of sample)	23.15	18.06	3.28	0.39	0.62	2.02	1.78	13.24

Table 3 (continued)
Summary Statistics for Control Variables

	Industry, by Size Cohort					
	Top 1%	95-99%	75-95%	50-75%	Bottom 50%	Industry
Sample statistics: Regression sample (2002-12)						
N	604	2,405	12,197	15,181	27,830	58,217
Average number of firms	14	56	282	352	705	1,410
Average asset size (millions of dollars)	599,180	42,761	3,153	838	424	9,065

Source: Board of Governors of the Federal Reserve System, *Consolidated Financial Statements of Bank Holding Companies* (FR Y-9C data).

Notes: The table reports summary statistics for 2,810 unique bank holding companies from 2001:Q1 to 2012:Q4, a total of 58,217 firm-quarter observations. The first six columns are industry ratios (computed by first summing numerator and denominator across all firms in the relevant size class), or are statistics weighted by firm size, except for the two indicator variables "publicly traded" and "BHC is foreign-owned." Size cohorts are recalculated in each quarter. The last two columns are unweighted statistics across all firms. Note that the sample period for the regression analysis begins in 2002:Q1, not 2001:Q1, because specifications include lagged income variables from the previous four quarters. See Appendix A for variable definitions. HHI is Herfindahl-Hirschman Index; BHC is bank holding company.

4. Analysis

In this section, we study the relationship between BHC size and measures of total noninterest expense scaled by revenue or assets, examining how this relationship is affected by controlling for differences in firms' business models and by the normalization of noninterest expense used. Our analysis progressively adds controls for a wide range of measures of the composition of BHC assets and sources of income, on the presumption that some types of assets or activities are likely to be more complex and time-consuming to manage than others. For example, a BHC with a large portfolio of other real estate owned assets will likely incur significant property maintenance and management expenses associated with these assets, compared with an otherwise similar banking firm that has liquidated such properties in return for cash, government securities, or other simple assets. Similarly, a portfolio of consumer loans is likely to have different screening and monitoring costs than a portfolio of commercial loans. Including these controls seems particularly important given that asset composition varies significantly by firm size, as documented in Section 3.

4.1 Total Noninterest Expense

Table 4 presents ordinary least squares estimates of the relationship between the efficiency ratio and BHC size measured by the log of total assets. We find a statistically and economically significant inverse relationship between size and the efficiency ratio in each regression specification. That is, noninterest expenses per dollar of net operating revenue are lower for large BHCs.

The first column of results controls only for time-series variation in the efficiency ratio, through the inclusion of quarter fixed effects. Each subsequent regression specification successively adds more explanatory variables associated with differences in BHCs' business activities. We begin with simple controls for the composition of BHC assets and add more detailed measures of the risk of those assets, the composition of revenue, funding structure, business concentration, organizational complexity, and geography.

Looking across the models, we see that the inclusion of additional controls tends to *steepen* the inverse relationship between BHC size and the efficiency ratio. Including controls for BHC asset composition (for example, the percentage of assets in fixed assets, residential real estate loans, trading assets, and so on) increases the magnitude of the coefficient on bank size by 54 percent (from -1.32 in specification 1 to -1.96 in specification 3), and increases the explanatory power of the model by 13 percentage points. Controlling for the percentage of income generated by different activities (for example, trading, investment banking, and deposit service charges) shifts the coefficient to -2.63 (specification 6). The inclusion of controls for organizational complexity further steepens the association between BHC size and the efficiency ratio; the coefficient increases in magnitude from -2.98 (specification 8) to -4.13 (specification 9).

For the model including all controls but excluding firm fixed effects (specification 10), the coefficient on size of -4.151

Table 4

BHC Size and the Efficiency Ratio

	Specification										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Log assets	-1.320***	-1.892***	-1.962***	-2.044***	-2.509***	-2.631***	-2.886***	-2.983***	-4.131***	-4.151***	-2.471*
	(0.235)	(0.228)	(0.226)	(0.246)	(0.239)	(0.240)	(0.271)	(0.273)	(0.334)	(0.326)	(1.156)
Asset shares (percentage of total assets)											
Total loans		-50.105***									
		(7.446)									
Residential real estate loans			-41.250***	-42.777***	-28.889**	-30.446***	-31.136***	-23.170*	-21.549*	-22.379*	-31.408**
			(7.850)	(8.211)	(8.877)	(8.367)	(8.579)	(9.415)	(8.859)	(8.910)	(10.472)
Commercial real estate loans			-55.329***	-63.050***	-46.223***	-46.866***	-47.723***	-38.003***	-36.868***	-31.123**	-45.328***
			(7.452)	(9.352)	(10.172)	(9.729)	(9.922)	(10.596)	(9.990)	(9.894)	(10.340)
Commercial and industrial loans			-41.365***	-43.923***	-30.428**	-32.324**	-32.581**	-24.657*	-25.291*	-15.721	-43.188***
			(8.235)	(10.014)	(10.676)	(10.189)	(10.276)	(10.748)	(10.249)	(10.201)	(10.512)
Credit card loans			-70.539***	-84.648***	-79.998***	-81.301***	-80.567***	-69.742***	-66.710***	-59.817***	-36.635
			(11.455)	(10.068)	(11.430)	(10.945)	(10.950)	(12.164)	(11.620)	(10.812)	(19.167)
Other consumer loans			-63.106***	-67.709***	-54.509***	-53.905***	-54.258***	-45.243***	-45.078***	-34.291**	-37.861***
			(8.749)	(9.973)	(10.805)	(10.353)	(10.466)	(11.060)	(10.654)	(10.619)	(11.343)
All other loans			-69.382***	-74.193***	-59.828***	-61.058***	-60.776***	-52.092***	-51.257***	-41.791***	-60.073***
			(8.442)	(9.793)	(10.711)	(10.216)	(10.442)	(10.901)	(10.321)	(10.233)	(13.084)
Trading assets	-2.154	-2.418	-1.657	-3.909	-12.428	-10.508	-5.105	-3.128	-1.641	-9.133	
	(18.177)	(18.105)	(17.966)	(17.525)	(16.434)	(16.871)	(18.359)	(17.552)	(18.084)	(33.833)	
Federal funds and repurchase agreements	-20.466*	-18.125	-22.468*	-17.305	-19.636*	-18.727*	-18.063	-16.537	-15.062	-16.323*	
	(9.526)	(9.598)	(9.278)	(9.253)	(9.194)	(9.378)	(9.220)	(8.875)	(8.654)	(7.514)	
Investment securities	-44.233***	-46.246***	-47.976***	-35.704***	-36.532***	-36.918***	-35.623***	-32.975***	-29.990***	-28.246***	
	(7.538)	(7.420)	(7.135)	(7.792)	(7.487)	(7.660)	(7.625)	(7.248)	(7.193)	(6.448)	
Other real estate owned	511.223***	516.118***	218.441***	224.027***	227.645***	228.260***	224.115***	223.890***	248.885***	264.291***	
	(59.960)	(58.233)	(50.156)	(52.325)	(51.683)	(51.743)	(52.201)	(51.959)	(51.125)	(54.925)	
Fixed assets	195.591***	195.896***	213.179***	182.093***	190.166***	197.031***	187.538***	189.759***	223.443***	289.553***	
	(31.754)	(31.448)	(30.379)	(29.035)	(29.664)	(29.974)	(29.496)	(28.939)	(29.775)	(36.789)	
Investments in unconsolidated subsidiaries	-74.519***	-64.972***	-56.758***	-69.983***	-75.613***	-74.270***	-75.580***	-86.452***	-81.657***	7.582	
	(13.295)	(16.201)	(13.768)	(12.469)	(11.868)	(12.733)	(13.733)	(13.632)	(13.386)	(42.429)	
Investments in real estate ventures	-72.295***	-64.503***	-54.043***	-66.178***	-71.900***	-70.348***	-29.115	-42.377*	-36.690*	58.462	
	(15.963)	(16.499)	(15.216)	(14.355)	(13.837)	(14.470)	(19.204)	(19.251)	(17.849)	(50.434)	
Intangible and other assets	92.308***	90.825***	55.478**	34.231	31.273	26.103	23.238	19.702	16.813	0.999	
	(18.720)	(17.868)	(21.111)	(20.543)	(19.928)	(20.804)	(20.893)	(20.411)	(20.255)	(21.117)	
Revenue composition (percentage of net operating revenue)											
Trading income					49.008	45.614	47.794	44.346	30.746	46.602	35.616
					(26.304)	(25.079)	(25.203)	(26.351)	(25.803)	(25.765)	(43.903)
Noninterest nontrading income					19.746***						
					(3.151)						
Fiduciary income						30.172***	29.695***	25.165***	27.327***	24.057***	34.635***
						(4.570)	(4.580)	(4.793)	(4.822)	(4.718)	(8.471)
Investment banking fees						37.832**	37.510**	33.487**	29.794**	35.915***	46.586**
						(12.036)	(12.140)	(11.527)	(11.075)	(9.925)	(14.453)

Table 4 (continued)

BHC Size and the Efficiency Ratio

	Specification										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Revenue composition (continued)											
Service charges						13.020*	13.072*	3.950	5.965	14.567*	49.324***
on deposits						(6.356)	(6.284)	(6.448)	(6.294)	(7.094)	(10.446)
Net servicing fees						-1.060	1.707	-5.177	-1.426	14.615	-9.113
						(16.367)	(16.477)	(16.582)	(16.699)	(14.275)	(15.153)
Other noninterest income						21.814***	21.688***	20.629***	20.181***	21.462***	0.801
						(3.837)	(3.919)	(3.751)	(3.716)	(3.730)	(3.656)
Funding structure											
Deposits/assets (percent)							-0.497	-2.194	-0.643	-1.061	4.577
							(3.119)	(3.075)	(2.980)	(2.903)	(3.770)
Public [1=yes]							1.474*	1.314*	1.787**	1.418*	-0.704
							(0.606)	(0.608)	(0.621)	(0.626)	(1.705)
Business concentration											
HHI assets								-10.565*	-9.828*	-10.531**	-10.581*
								(4.220)	(4.093)	(3.907)	(5.091)
HHI income								-8.101**	-7.205*	-8.681**	-8.903**
								(3.023)	(2.934)	(2.902)	(3.447)
Organizational complexity											
Log number of subsidiaries									1.883***	1.771***	1.404**
									(0.395)	(0.396)	(0.534)
Percentage of subsidiaries									-3.813	-5.668	2.694
that are foreign									(5.341)	(5.139)	(8.515)
Foreign-owned [1=yes]									14.895***	13.512***	15.046**
									(2.481)	(2.436)	(5.529)
Constant	101.061***	143.904***	146.053***	144.782***	136.250***	138.941***	142.911***	152.872***	161.137***	157.186***	122.139***
	(3.377)	(8.397)	(8.432)	(8.075)	(8.276)	(8.036)	(9.438)	(9.380)	(9.324)	(9.372)	(19.637)
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects										Yes	
Firm fixed effects											Yes
R^2	0.080	0.195	0.207	0.247	0.258	0.261	0.262	0.264	0.271	0.296	0.549
N	58,217	58,217	58,217	58,217	58,217	58,217	58,217	58,217	58,217	58,217	58,217

Source: Authors' calculations.

Notes: The table presents an analysis of the relationship between size, measured by log of total assets, and efficiency ratio, defined as total noninterest expense normalized by net operating revenue. All explanatory variables are lagged by one quarter. Revenue composition variables are the rolling average for the absolute value of the income share over net operating revenue. HHI (Herfindahl-Hirschman Index) assets is the sum of squared asset shares, by asset type, and HHI income is the sum of squared four-quarter rolling average income shares, by income type. See Appendix A for further detail on controls included in the models. Models are estimated with robust standard errors and two-way clustering by firm and quarter. Standard errors are in parentheses.

*** p<0.01
** p<0.05
* p<0.1

implies that a 10 percent increase in size is associated with a 42 basis point decrease in the efficiency ratio, equivalent to 0.6 percent of the sample average efficiency ratio. In dollar terms, the coefficient implies that for a BHC at the mean of the data ($9.1 billion in assets), an increase in size of $1 billion is associated with a reduction in operating expenses of $437,000 per quarter, relative to a counterfactual in which the efficiency ratio is not associated with size. The corresponding calculation for the smaller coefficient from column 2 implies a reduction in operating expenses of $199,000 per quarter.

The final specification in Table 4 includes BHC fixed effects, and thus examines only changes in size within bank holding companies. This within-firm analysis includes both size changes from organic growth and size changes from mergers. While still statistically significant, this coefficient is somewhat smaller in magnitude than that of specification 10 (-2.47 compared with -4.15). There is some evidence that noninterest expenses after mergers are inflated by one-time merger related costs (Kwan and Wilcox 2002), which may account for this difference. The standard error of the size coefficient estimate from specification 11 is much larger than in the other specifications; in other words, the coefficients are estimated with lower power, owing to the smaller residual variation in the efficiency ratio not absorbed or accounted for by the fixed effects and other controls.

As expected, observable differences among BHCs explain a significant fraction of the variation in noninterest expenses. Simple asset controls alone more than double the adjusted R^2 of the initial specification. However, even the fixed effects specification in column 11 has an R^2 of only 54.9 percent, implying a large amount of residual variation in operating costs. Furthermore, the inclusion of BHC fixed effects nearly doubles the R^2 relative to specification 10, a result suggestive of large persistent differences in operating costs across observably similar firms. This finding seems consistent with prior literature on X-inefficiency, which shows that many banking firms operate significantly inside the efficient production frontier (see, for example, Berger, Hunter, and Timme [1993]). It is worth noting that BHC size alone explains only a very small fraction (less than 1 percent) of the total variation in noninterest expense in the data, as illustrated graphically in Chart 2.

In sum, Table 4 provides consistent evidence that large BHCs have lower operating costs as measured by the efficiency ratio, although the strength of the relationship is sensitive to the set of controls used. Instead of taking a strong stance on the "appropriate" set of controls, throughout the paper we present results for specifications using controls from columns 1, 2, and 10 from Table 4. A comparison of the results across these specifications enables the reader to observe how the relationship between noninterest expenses and size is influenced by the inclusion or exclusion of controls for the mix of BHC assets and business activities.

Although our main focus is on the relationship between operating costs and firm size, estimates for several of the controls included in Table 4 are also of independent interest. In particular, BHC organizational complexity, measured by the log number of subsidiaries, is associated with higher noninterest expense ratios. BHCs with a foreign parent also have higher expenses. Proxies for greater organizational focus are associated with lower noninterest expense: BHCs that have more concentrated asset portfolios and more concentrated sources of noninterest income have lower expenses, all else equal, although the marginal explanatory power of additional concentration is relatively low. Each of these relationships is robust to the inclusion of BHC fixed effects (column 11). Although not shown in Table 4, these relationships are also robust to specification changes that allow for a more flexible linkage between size and the efficiency ratio. This finding suggests that our results are not likely to be driven only by the largest BHCs.

Caution should be exercised in applying a causal interpretation to these associations, given that we do not have a convincing econometric instrument for organizational complexity or focus. But taken at face value, each of these estimates implies that complex, diversified firms have higher operating expenses than focused or organizationally simple firms, consistent with the conclusions of prior literature on the diversification discount in banking (Goetz, Laeven, and Levine 2013; Laeven and Levine 2007).

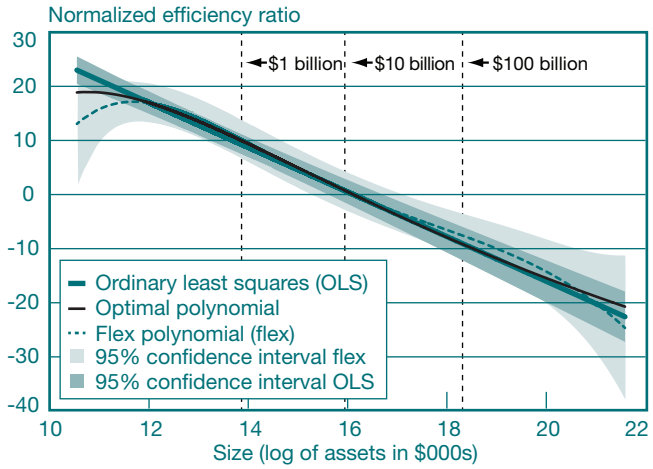
4.2 Other Functional Forms

The specifications so far assume a log-linear relationship between BHC size and the efficiency ratio. Next we allow for a more flexible functional form by estimating fractional polynomial specifications that permit the data to determine the shape of the relationship between size and the NIE ratio. An alternative to regular polynomials, fractional polynomials provide flexible parameterization for continuous variables. We use the Stata function *fracpoly* to determine an optimal polynomial specification (optimal polynomial) and also estimate a specification with exponents ranging from -2 to 2—that is, log assets raised to the -2, -1, 0, 1, and 2 power (flex polynomial). These best-fit polynomials are shown in Chart 3 along with the ordinary least squares line of best fit.

Overall, the log-linear functional form assumed in Table 4 appears to be a good approximation, although we note that, based on point estimates, the point-estimated relationship between log assets and the efficiency ratio is somewhat con-

Chart 3

Efficiency Ratio and BHC Size, Flexible Functional Forms



Source: Authors' calculations, based on statistical analysis of FR Y-9C data.

Note: Functional forms are partial predictions based on varying log of assets ($000s), holding other covariates fixed at their sample means. The efficiency ratio is normalized to be equal to zero for a bank holding company with $10 billion in assets.

cave at the tails. Specifically, the relationship between BHC size and the NIE ratio is relatively flat among small BHCs (those with assets below $150 million), while the relationship is steeper among the largest BHCs (those with assets above $750 billion). For the vast range of asset sizes, the relationship between log size and efficiency ratio is close to linear, and the 95 percent confidence interval of the alternative forms is very similar. Thus, we use a log-linear specification for the remainder of the analysis.

In addition to investigating flexible polynomial specifications, we separate the sample into different size cohorts, re-sorted in each quarter, and estimate separate specifications for each cohort. This approach allows the relationship between NIE and control variables, as well as size, to vary by BHC size class. (In the fractional polynomial approach, the coefficients on explanatory variables other than size are unrelated to size.) Each column of Table 5 represents specifications 1, 2, and 10 of Table 4 estimated on a subset of the BHCs sorted by size in each year. The first column replicates the results on the entire sample, for comparison. Without including controls for BHC asset mix, it appears that much of the coefficient on size is driven by BHCs below the median asset size (column 6). As additional controls are included, economies of scale become apparent in many of the size cohorts. In the specification including all controls, the estimated coefficient on size is negative in all cohorts and statistically significant. As suggested by the flexible polynomial specifications, the point estimate coefficient on size is largest in the top 1 percent of the sample.

What do these findings imply for the policy debate around size limits for the largest BHCs? We find no evidence that the inverse relationship between size and operating costs disappears above any particular size threshold; indeed, our point estimates suggest that, if anything, the relationship is steeper among the largest firms. This result is consistent with scale economies from sources other than bargaining power to the extent that we believe that differences in bargaining power may be small within the top 1 percent of BHCs. The statistical precision of our estimates is limited, however, given the small number of observations for the largest BHCs.

4.3 Alternative Measures of Operating Costs

The efficiency ratio may be distorted in periods when net operating income is temporarily low.[11] Next, we test the sensitivity of our results to other normalizations of noninterest expense: the expense asset ratio discussed in Section 3 (NIE / total assets), NIE / risk-weighted assets, and a "cash" efficiency ratio, which excludes noncash expenses such as goodwill amortization in the numerator. We do this because noncash expenses are often associated with one-time costs relating to mergers and acquisitions that are not likely to persist, and may be associated with size. We also estimate a specification using the log of noninterest expense as an alternative measure of operating costs.

As before, for each normalization of NIE, we re-estimate specifications with the set of right-hand-side variables from columns 1, 2, and 10 of Table 4 and present the coefficient on asset size. Results are presented in Table 6. Regardless of the normalization used, the coefficient on size is negative and statistically significant once BHC controls are included. In the specification including all controls, the estimated coefficient on size is approximately 7 to 10 percent of the average expense ratio.

For the specifications using the log of noninterest expense as the dependent variable, the coefficient on log assets can be directly interpreted as the *elasticity* of operating costs with respect to size. In line with our other results, this elasticity is less than unity—in other words, a 10 percent change in BHC size is associated with a less than 10 percent change in NIE

[11] During the 2007-08 financial crisis, trading losses and other losses brought net operating income close to zero for several large BHCs.

Table 5

Coefficient on Log Assets, by Size Cohort

	(1)	(2)	(3)	(4)	(5)	(6)	
	All	Top 1%	95-99%	75-95%	50-75%	Bottom 50%	Controls
Table 4, Specification (1)	-1.320***	1.860	1.273	-1.790**	-0.768	-6.140***	Time fixed effects
	(0.235)	(1.647)	(1.164)	(0.687)	(1.509)	(1.633)	
Table 4, Specification (2)	-1.892***	-2.864	-0.379	-1.888**	-1.914	-3.195*	Asset shares
	(0.228)	(2.020)	(1.278)	(0.674)	(1.352)	(1.334)	
Table 4, Specification (10)	-4.151***	-8.018*	-5.138***	-4.132***	-4.238***	-5.055***	All controls
	(0.326)	(3.931)	(1.442)	(0.696)	(1.204)	(1.311)	
N	58,217	604	2,405	12,197	15,181	27,830	

Source: Authors' calculations.

Notes: The table presents an analysis of the relationship between size, measured by the log of total assets (lagged by one quarter), and efficiency ratio, defined as total noninterest expense as a percentage of net operating revenue. Each row represents the coefficient on size for specifications (1), (2), and (10) of Table 4, estimated on a subset of bank holding companies sorted by size in each quarter. Specification (1) includes time fixed effects. Specification (2) includes time fixed effects as well as controls for the percentage of assets in each broad category (asset shares). Specification (10) includes the controls from specification (2) as well as controls for types of loans, revenue composition, funding structure, business concentration, organizational complexity, and headquarters state fixed effects. Robust standard errors reported in parentheses are clustered by bank holding company and quarter.

*** p<0.01
** p<0.05
* p<0.1

Table 6

Alternative Measures of Operating Costs

	Noninterest Expense/ Risk-Weighted Assets			Noninterest Expense/ Assets			Cash Noninterest Expense/ Net Revenue (Cash Efficiency Ratio)			Log Noninterest Expense		
Table 4, Specification:	(1)	(2)	(10)	(1)	(2)	(10)	(1)	(2)	(10)	(1)	(2)	(10)
Log assets	0.007	-0.044***	-0.115***	0.003	-0.018**	-0.083***	-1.686***	-2.239***	-4.339***	0.993***	0.979***	0.899***
	(0.010)	(0.011)	(0.013)	(0.006)	(0.007)	(0.009)	(0.231)	(0.217)	(0.303)	(0.007)	(0.007)	(0.008)
Asset share controls		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
All controls			Yes			Yes			Yes			Yes
R^2	0.016	0.231	0.487	0.007	0.171	0.430	0.078	0.208	0.325	0.935	0.949	0.968
N	58,217	58,217	58,217	58,217	58,217	58,217	58,217	58,217	58,217	58,192	58,192	58,192

Source: Authors' calculations.

Note: The table presents an analysis of the relationship between size, measured by the log of total assets (lagged by one quarter), and different measures of efficiency. The dependent variables in the first three specifications are cash efficiency ratio, defined as total noninterest expense less goodwill impairment and amortization expense over net operating revenue; in the next three specifications, NIE/assets ratio, defined as total noninterest expense (NIE) over total assets; and in the final three specifications, NIE/RWA ratio, defined as total noninterest expense over total risk-weighted assets (RWA). For each alternative measure of efficiency ratio, specifications (1), (2) and (10) of Table 4 are presented. Specification (1) includes controls for quarter fixed effects. Specification (2) includes the controls from specification (1) as well as controls for the percentage of assets in each broad category. Specification (10) includes the controls from specification (2) as well as controls for types of loans, revenue composition, funding structure, business concentration, organizational complexity, and headquarters state fixed effects. Models are estimated with robust standard errors and two-way clustering by firm and quarter.

*** p<0.01
** p<0.05
* p<0.1

operating costs, a finding consistent with the presence of scale economies in operating costs. For the specification including all controls, the operating cost elasticity is 0.899, much smaller than one, although it is significantly closer to one for the specification just including asset controls (0.979). Both these estimates are statistically significantly smaller than unity.

5. Decomposition of Noninterest Expense

This section examines the relationship between BHC size and components of noninterest expense. First, we consider the five major components of noninterest expense reported in the Y-9C income statement. Probing more deeply, we then analyze the nine subcomponents of "other noninterest expense," using our manual classification of these expenses as described in Section 3.

One goal of this disaggregated analysis is to shed additional light on the sources of the lower operating costs enjoyed by large BHCs. Although these lower costs could be due to scale economies or other efficiency benefits of size, they could also reflect implicit government guarantees for large BHCs, or the greater bargaining power of these firms. For example, large banks may endogenously select riskier activities, but invest less in risk management because of implicit insurance associated with being "too big to fail." Alternatively, large banks may simply take advantage of greater bargaining power to reduce expenses. These different explanations have very different normative welfare implications. Efficiency benefits of size imply that limiting size would impose deadweight economic costs, while explanations relating to bargaining power and TBTF primarily relate to the allocation of economic rents. Although the breakdown of expenses in the Y-9C does not allow us to fully disentangle these different explanations, we are able to draw some suggestive conclusions.

5.1 Major Components of Noninterest Expense

We begin by studying the five expense categories reported on Schedule HI: compensation (49.4 percent of noninterest expense), premises and fixed assets expense (11.6 percent), goodwill impairment (1.8 percent), amortization (1.9 percent), and other (35.0 percent). Results are presented in Table 7. As before, we normalize each expense by net operating revenue, and for parsimony, focus on the coefficient on log assets for specifications 1, 2, and 10 from Table 4.

Each of the three largest categories of noninterest expense declines as a percentage of net revenue as size increases, all else equal, with or without the inclusion of controls for BHC characteristics. The final column of the table presents the estimated coefficient scaled by the mean of the dependent variable in question (that is, an elasticity of the component efficiency ratio with respect to firm size). Focusing on the specifications including these controls (either for asset composition alone, or for all controls), we find that the inverse relationship between BHC size and scaled noninterest expense is steepest for compensation, followed by other noninterest expense, based on this calculated elasticity. For the specifications including all controls, a 10 percent increase in size is associated with a 0.735 percent decline in compensation scaled by net operating revenue and a 0.683 percent decline in the corresponding ratio for other noninterest expense. The result for employee compensation is perhaps surprising, given that large BHCs have more employees in highly compensated roles such as investment banking and trading. However, the higher productivity and additional revenue earned by these employees (the denominator of the efficiency ratio) appears to offset this higher compensation.

Expenses related to premises and fixed assets may represent a category of operating costs for which scale efficiencies are lower (for example, building lease costs are roughly proportionate to the size of the leased space, at least within a specific geographic area). Given this, it is perhaps unsurprising that estimated economies of scale are smaller for premises and fixed assets expense: for this category, our point estimate implies that a 10 percent increase in size is associated with a 0.478 percent decline in expenses scaled by operating revenue.

Significantly, expenses related to the impairment and amortization of goodwill and other intangible assets are actually proportionately *higher* for large firms—a fact that distinguishes these expenses from the other categories. We estimate a positive, statistically significant (in most specifications) coefficient on these expenses. The likely key reason for this finding is that large BHCs often have grown by way of acquisitions, which will sometimes result in goodwill when the acquisition purchase price exceeds the tangible book value of assets purchased. Consequently, these firms report higher expenses related to the amortization or impairment of these assets. Although the positive slope for these two expense categories is economically significant, the two categories together make up only a relatively small proportion (3.7 percent) of total industry NIE.

Table 7

Bank Holding Company Size and the Efficiency Ratio, by Component of Noninterest Expense

	Table 4 Specification	Log Assets	Standard Error	Significance Level	Adjusted R^2	Mean (Percent)	Controls	Coefficient/ Mean (Percent)
Total noninterest expense	1	-1.320	(0.235)	***	0.080		Time FE	-1.99
	2	-1.892	(0.228)	***	0.195	66.32	Asset shares	-2.85
	10	-4.151	(0.326)	***	0.296		All	-6.26
Components of noninterest expense								
Compensation	1	-1.135	(0.126)	***	0.048		Time FE	-3.50
	2	-1.472	(0.133)	***	0.103	32.44	Asset shares	-4.54
	10	-2.385	(0.175)	***	0.242		All	-7.35
Premises and fixed assets	1	-0.265	(0.045)	***	0.025		Time FE	-3.47
	2	-0.103	(0.048)	*	0.135	7.64	Asset shares	-1.35
	10	-0.365	(0.073)	***	0.257		All	-4.78
Other	1	-0.283	(0.127)	*	0.111		Time FE	-1.22
	2	-0.658	(0.125)	***	0.256	23.20	Asset shares	-2.84
	10	-1.585	(0.167)	***	0.354		All	-6.83
Amortization expense	1	0.181	(0.016)	***	0.077		Time FE	14.00
	2	0.164	(0.018)	***	0.106	1.29	Asset shares	12.68
	10	0.159	(0.024)	***	0.163		All	12.29
Goodwill impairment	1	0.044	(0.015)	**	0.031		Time FE	3.01
	2	0.042	(0.014)	**	0.032	1.46	Asset shares	2.88
	10	0.017	(0.011)		0.039		All	1.16
Components of other noninterest expense								
Corporate overhead	1	-0.002	(0.073)		0.018		Time FE	-0.04
	2	-0.212	(0.063)	***	0.074	4.77	Asset shares	-4.45
	10	-0.334	(0.074)	***	0.212		All	-7.00
Information technology and data processing	1	-0.106	(0.044)	*	0.006		Time FE	-3.28
	2	-0.150	(0.054)	**	0.023	3.23	Asset shares	-4.64
	10	-0.213	(0.068)	**	0.139		All	-6.59
Consulting and advisory	1	0.285	(0.047)	***	0.069		Time FE	9.92
	2	0.208	(0.053)	***	0.097	2.87	Asset shares	7.24
	10	0.053	(0.054)		0.210		All	1.84
Legal	1	0.006	(0.035)		0.008		Time FE	0.33
	2	-0.022	(0.034)		0.141	1.79	Asset shares	-1.23
	10	-0.118	(0.045)	**	0.263		All	-6.57
Retail banking	1	-0.225	(0.058)	***	0.017		Time FE	-13.59
	2	-0.068	(0.087)		0.108	1.66	Asset shares	-4.11
	10	-0.205	(0.118)		0.208		All	-12.38
FDIC assessments and other government	1	-0.249	(0.048)	***	0.242		Time FE	-16.51
	2	-0.103	(0.042)	*	0.393	1.51	Asset shares	-6.83
	10	-0.036	(0.068)		0.536		All	-2.39
Other financial services	1	0.038	(0.019)	*	0.009		Time FE	4.86
	2	-0.022	(0.011)		0.146	0.78	Asset shares	-2.81
	10	-0.058	(0.017)	***	0.211		All	-7.42

Table 7 (continued)
Bank Holding Company Size and the Efficiency Ratio, by Component of Noninterest Expense

	Table 4 Specification	Log Assets	Standard Error	Significance Level	Adjusted R^2	Mean (Percent)	Controls	Coefficient/ Mean (Percent)
Directors' fees and other compensation	1	-0.142	(0.012)	***	0.095		Time FE	-221.31
	2	-0.182	(0.015)	***	0.139	0.06	Asset shares	-283.65
	10	-0.190	(0.019)	***	0.259		All	-296.12
Miscellaneous	1	0.026	(0.014)		0.002		Time FE	5.62
	2	0.017	(0.017)		0.010	0.46	Asset shares	3.68
	10	-0.004	(0.022)		0.042		All	-0.87
Unclassified other noninterest expenses	1	-0.129	(0.115)		0.004		Time FE	-1.48
	2	-0.063	(0.102)		0.147	8.72	Asset shares	-0.72
	10	-0.289	(0.134)	*	0.229		All	-3.32

Source: Authors' calculations.

Notes: The table presents an analysis of the relationship between size, measured by the log of total assets (lagged by one quarter), and the components of noninterest expense normalized by net operating revenue. The first nineteen rows present the specifications for NIE and its large components: compensation, premises and fixed assets, other, amortization expense, and goodwill impairment. The remaining rows present three specifications each for the nine subcomponents of other, as well as for unclassified expense, the total other noninterest expense less the nine constructed components of other noninterest expense. All noninterest expense components are normalized by net operating revenue. Each row presents specifications (1), (2), and (10) of Table 4 for each main component of noninterest expense. Specification (1) includes time fixed effects. Specification (2) includes time fixed effects as well as controls for the percentage of assets in each broad category (asset shares). Specification (10) includes the controls from specification (2) as well as controls for types of loans, revenue composition, funding structure, business concentration, organizational complexity, and headquarters state fixed effects. See Appendix A for further detail. The sample mean for each component is presented, and the final column is the estimated coefficient on size normalized by the sample mean for the NIE component. Robust standard errors reported in parentheses are clustered by BHC and quarter. FE is fixed effects; FDIC is Federal Deposit Insurance Corporation.

*** p<0.01
** p<0.05
* p<0.1

5.2 Subcomponents of Other Noninterest Expense

In this section, we examine the nine subcomponents of "other NIE" identified in section 3.2. (Recall that these categories reflect both standardized memoranda items reported on the Y-9C since 2008 and "write-in" text strings classified by us.) Previous work estimating scale curves for these disaggregated categories has been based on case studies or has had limited sample size (for example, Clearing House Association [2012]).

Overall, we find evidence that scaled expense falls with size for most, but not all, components of other noninterest expense, especially after including controls for BHC asset and income composition. When controls for the composition of assets and income sources are included in the specification, large BHCs exhibit lower expenses in categories in which a fixed cost can be spread across an expanded scale of operations, such as corporate overhead, information technology, and data processing.

The lower part of Table 7 presents results for the other NIE components, listed in descending order of size. Corporate overhead is the largest component of other noninterest expense, and a component for which we estimate significant scale efficiencies (a high estimated coefficient on size relative to mean level of expense). Corporate overhead includes expenses such as accounting and auditing, advertising and marketing, treasury expenses, travel and business development, charitable donations, insurance, and utilities. These expenses appear to have significant operational leverage; the estimated coefficient on size is -0.33, approximately 7 percent of the mean level of corporate overhead expenses.

Similar scale economies are observed for expenses associated with information technology and data processing, with an estimated coefficient on size that is -6.6 percent of mean IT

expense. This finding is consistent with the view that spreading overhead expenses associated with technology may be one source of cost advantage for large banking firms.

In contrast to these two categories, we find that expenses associated with consulting and advisory services are proportionately *higher* for large BHCs. Prior to adding controls for BHC characteristics, our estimates show that the coefficient on size and consulting expenses is positive and statistically significant. This coefficient remains significant when asset composition controls are included, although once all controls are included, the coefficient is positive but no longer statistically significant. This suggests that consulting and advisory services may be related to noninterest income, rather than to the composition of BHC assets. Despite recent publicity surrounding large BHCs' legal issues and large-dollar-value settlements, over the 2008-12 period, legal expenses also increase less than proportionately with BHC size, particularly in the specification including the full set of controls (specification 10 from Table 4). This expense category includes both legal fees and retainers paid for legal services performed, as well as expenses associated with legal settlements and reserves, to the extent we can identify these expenses from the write-in text fields. Some part of this finding may reflect the fact that small banks may lack internal legal departments, for which expenses would be recorded as part of compensation, and thus have higher external legal fees.

The assignment of write-in fields to retail banking requires perhaps the most judgment on our part. This category includes collection expenses, credit reports, mortgage-related expenses such as appraisal and title fees, branch expenses, checks, lockboxes, and robbery, among many others. After including asset composition controls, the estimated coefficient remains negative although not statistically significant. This result may reflect the wide variation in the types of retail banking businesses that are not well captured by our BHC characteristics. Alternatively, economies of scale may be limited or not present for branch banking (at least among the set of expenses classified into this category), since many costs only scale until the next branch is opened.

Similarly, we find a negative but statistically insignificant relationship between size and normalized FDIC assessments and other government-related expenses after including the full complement of BHC characteristics. The majority of the expenses in this line item are due to deposit insurance, and thus it would be surprising to uncover economies of scale once we control for the amount of deposit financing. This coefficient would likely shrink further if our regression specification included a control for the fraction of insured deposits, rather than total deposits.

The category "other financial services" represents the sum of expenses associated with BHCs' non-banking businesses, such as asset management, trust and custody services, and insurance. Given likely differences in the noninterest expenses of these businesses, it is not surprising that the estimated coefficient changes sign from positive to negative once we control for the composition of BHCs' assets and noninterest income. Banking firms that earn a high percentage of income from fee income should naturally have higher expenses. But holding all else equal and controlling for income composition, we find that larger BHCs have *lower* scaled expenses in this category: we estimate a coefficient of 7.4 percent of the mean value. This result is consistent with cost economies of scale in noncompensation expenses associated with businesses such as insurance and asset management.

The component of other noninterest expense for which scale economies are largest in percentage terms is directors' fees and other compensation. For this category, the coefficient on size is almost three times as large as the sample mean. This makes intuitive sense; even though directors of large BHCs have higher compensation, board size does not increase dramatically with firm size. This coefficient is negative and significant regardless of the set of controls used.

Miscellaneous expenses include items as varied as expenditures for cattle feed and reducing gold to market. It also includes nonspecific write-in text fields such as "miscellaneous expense," "miscellaneous fee," and "other expense." Regardless of the controls for bank businesses used, we do not see economies of scale in these varied expenses, although some economies may exist in the residual category "other expenses," which includes all noninterest expenses not otherwise classified.

6. Conclusion

We find a robust inverse relationship between the size of bank holding companies and scaled measures of operating costs. Quantitatively, a 10 percent increase in assets is associated with a 0.3 to 0.6 percent decline in noninterest expense scaled by income or assets, depending on the specification. In dollar terms, our estimates imply that for a BHC of mean size in our sample, an additional $1 billion in assets reduces noninterest expense by $1 million to $2 million per year, relative to a base case where operating cost ratios are unrelated to size. This inverse relationship is robust to various changes in model specification, although the magnitude of the relationship is sensitive to the set of controls used.

Unpacking our results, we find that while size is associated with lower scaled operating costs for most components of noninterest expense, the largest contributions in dollar terms

come from employee compensation, premises and fixed assets, corporate overhead, and information technology and data processing. While not a large component of total noninterest expense, directors' fees and other compensation account for the largest proportionate savings, presumably a reflection of the fact that corporate boards do not expand with firm size, even if their members are better paid on average.

Our results likely reflect a combination of three factors: First, large BHCs benefit from "operational leverage" or economies of scale, whereby they effectively spread costs over a higher revenue or asset base. Second, "X-efficiency"—a factor closely related to operational leverage—may be higher for large BHCs; that is, these firms may operate closer to the production frontier on average. Third, large BHCs may have greater bargaining power than smaller firms with suppliers or employees. We are not able to pin down with confidence the relative contribution of these three factors. We emphasize, however, that the inverse relationship between BHC size and scaled measures of NIE is not limited to particular components of expense or particular segments of the BHC size distribution.

Consistent with recent research that identifies the presence of scale economies in banking, our results suggest that imposing size limits on banking firms would be likely to involve real economic costs. Although the limitations of our econometric methodology must be borne in mind, a back-of-the-envelope calculation applied to our estimates implies that limiting BHC size to be no larger than 4 percent of GDP would increase total noninterest expense by $2 billion to $4 billion per quarter. These costs should be weighed against the potential benefits of size limits as policymakers address the "too-big-to-fail" problem.

Appendix A: Variable Definitions

Income Statement Variables

Variable	Definition	Y-9C Mnemonic Construction/Variable Source
Net interest income		bhck4074 [1981:Q2 - present]
Noninterest income		bhck4079 [1981:Q2 - present]
Trading revenue	Includes the net gain or loss from trading cash instruments and off-balance-sheet derivative contracts (including commodity contracts) that has been recognized during the calendar year-to-date	bhcka220 [1996:Q1 - present]
Fiduciary income	Includes income from fiduciary activities, fees and commissions from annuity sales, underwriting income from insurance and reinsurance activities, and income from other insurance activities	bhck4070 + bhckb494 [2001:Q1 - 2002:Q4], bhck4070 + bhckc386 + bhckc387 [2003:Q1 - 2006:Q4], bhck4070 + bhckc887 + bhckc385 + bhckc387 [2007:Q1 - present]
Investment banking income	Includes venture capital revenue, fees and commissions from securities brokerage, and investment banking, advisory, and underwriting fees and commissions	bhck b491 + bhckb490 [2001:Q1 - 2006:Q4], bhckb491 + bhckc886 + bhckc888 [2007:Q1 - present]
Service charges on deposits	Service charges on deposit accounts in domestic offices	bhck4884 [1981:Q2 - present]
Net servicing fees	Includes income from servicing real estate mortgages, credit cards, and other financial assets held by others	bhckb492 [2001:Q1 - present]
Other income	Total noninterest income not accounted for in the five categories listed above	Derived
Net operating revenue	Net interest income plus noninterest income	bhck4074 + bhck4079 [1981:Q2 - present]
Noninterest expense		bhck4093 [1981:Q2 - present]
Compensation	Salaries and employee benefits	bhck4135 [1981:Q2 - present]
Premises and fixed assets		bhck4217 [1981:Q2 - present]
Amortization expense	Amortization expense and impairment losses for other intangible assets	bhckc232 [2002:Q1 - present]
Goodwill impairment	Goodwill impairment losses	bhckc216 [2002:Q1 - present]
Other	Total noninterest expense not accounted for in the four categories listed above	Derived
Data processing expenses	Eleven standardized other noninterest expense items reported in Schedule HI: Memoranda of the FR Y-9C beginning either in 2002 or in 2008. BHC filers only report amounts greater than $25,000 that exceed 3 percent of total other noninterest expense	bhckc017 [2002:Q1 - present]
Advertising and marketing expenses		bhck0497 [2002:Q1 - present]
Directors' fees		bhck4136 [2002:Q1 - present]
Printing, stationery, and supplies		bhckc018 [2002:Q1 - present]
Postage		bhck8403 [2002:Q1 - present]
Legal fees and expenses		bhck4141 [2002:Q1 - present]
FDIC deposit insurance assessment		bhck4146 [2002:Q1 - present]
Accounting and auditing expenses		bhckf556 [2008:Q1 - present]
Consulting and advisory expenses		bhckf557 [2008:Q1 - present]
ATM and interchange expenses		bhckf558 [2008:Q1 - present]
Telecommunications expenses		bhckf559 [2008:Q1 - present]
TEXT8565	Description of the "write-in" components of other noninterest expense. BHCs only report amounts that exceed 10 percent of total other noninterest expense	bhck8565 [1994:Q1 - present]
TEXT8566		bhck8566 [1994:Q1 - present]
TEXT8567		bhck8567 [1994:Q1 - present]

Consolidated Balance Sheet Variables

Variable	Definition	Y-9C Mnemonic Construction/Variable Source
Total assets		bhck2170 [1991:Q1 - present]
Total loans		bhck2122 [1991:Q1 - present]
Residential real estate loans	The sum of 1) all other loans secured by one-to-four-family residential properties: secured by first liens; 2) all other loans secured by one-to-four-family residential properties: secured by junior liens; 3) revolving, open-end loans secured by one-to-four-family residential properties and extended under lines of credit	bhdm1797 + bhdm5367 + bhdm5368 [1991:Q1 - present]
Commercial real estate loans	The sum of 1) one-to-four-family residential construction loans; 2) other construction loans and all land development and other land loans; 3) real estate loans secured by multifamily (five or more) residential properties; 4) loans secured by owner-occupied nonfarm nonresidential properties; 5) loans secured by other nonfarm nonresidential properties	bhdm1415 + bhdm1460 + bhdm1480 [1990:Q3 - 2006:Q4], bhckf158 + bhckf159 + bhdm1460 + bhckf160 + bhckf161 [2007:Q1 - present]
Credit card loans	Loans to individuals for household, family, and other personal expenditures (that is, consumer loans). Includes purchased paper: credit cards	bhck2008 [1991:Q1-2000:Q4], bhckb538 [2001:Q1 - present]
Other consumer loans	The sum of 1) loans to individuals for household, family, and other personal expenditures—that is, consumer loans (includes purchased paper): other revolving credit plans; 2) automobile loans to individuals for household, family, and other personal expenditures—that is, consumer loans (includes purchased paper); 3) other consumer loans to individuals, for household, family, and other personal expenditures (includes single payment, installment, and all student loans)	bhck2011 [1991:Q1 - 2000:Q4], bhck2011 + bhckb539 [2001:Q1 - 2010:Q4], bhckb539 + bhckk137 + bhckk207 [2011:Q1 - present]
All other loans	Total loans minus the sum of residential real estate loans, commercial real estate loans, credit card loans, and other consumer loans	derived
Cash and balances due from depository institutions	The sum of 1) non-interest-bearing balances and currency and coin; 2) interest-bearing balances in U.S. offices; 3) interest-bearing balances in foreign offices, edge and agreement subsidiaries, and international banking facilities	bhck0081 + bhck0395 + bhck0397 [1991:Q1 - present]
Trading assets	Assets held in trading accounts include but are not limited to U.S. Treasury securities; U.S. government agency and corporation obligations; securities issued by states and political subdivisions in the United States; other bonds, notes, and debentures; certificates of deposit; commercial paper; and bankers acceptances. Assets held in trading accounts also include the amount of revaluation gains from the "marking to market" of interest rate, foreign exchange rate, and other off-balance-sheet commodity and equity contracts held for trading purposes	bhck2146 [1981:Q2 - 1994:Q4], bhck3545 [1995:Q1 - present]
Federal funds and repurchase agreements	The sum of 1) outstanding amount of federal funds sold—that is, immediately available funds lent (in domestic offices) under agreements or contracts that have an original maturity of one business day or roll over under a continuing contract, excluding such funds lent in the form of securities purchased under agreements to resell and overnight lending for commercial and industrial purposes; 2) securities resale agreements, regardless of maturity, if the agreement requires the bank to resell the identical security purchased or a security that meets the definition of substantially the same in the case of a dollar roll, and purchases of participations in pools of securities, regardless of maturity	bhck1350 [1981:Q2 - 1988:Q1][1997:Q1 - 2001:Q4], bhck0276 + bhck0277 [1988:Q2 - 1996:Q4], bhdmb987 + bhckb989 [2002:Q1 - present]
Investment securities	Held-to-maturity securities (at amortized cost) plus available for sale securities (at fair value)	bhck0390 [1981:Q2 - 1993:Q4], bhck1754 + bhck1773 [1994:Q1 - present]
Other real estate owned	The book value (not to exceed fair value), less accumulated depreciation, if any, of all real estate other than bank premises actually owned by the bank and its consolidated subsidiaries.	bhck2150[1981:Q2-1990:Q2][2001:Q1 - present], bhck2744 + bhck2745 [1990:Q3 - 2000:Q4]
Premises and fixed assets		bhck2145

Consolidated Balance Sheet Variables

Variable	Definition	Y-9C Mnemonic Construction/Variable Source
Investments in unconsolidated subsidiaries and associated companies	Includes the amount of the bank holding company's investments in subsidiaries that have not been consolidated; associated companies; and corporate joint ventures, unincorporated joint ventures, general partnerships, and limited partnerships over which the bank exercises significant influence (collectively referred to as "investees"). Also includes loans and advances to investees and holdings of their bonds, notes, and debentures	bhck2130 - bhck3656 [1981:Q2 - 2009:Q1], bhck2130 [2009:Q2 - present]
Investments in real estate ventures	The book value of direct and indirect investments in real estate ventures	bhck3656 [1981:Q2 - present]
Intangible and other assets	Other identifiable intangible assets plus other assets	bhck3165 + bhck2160 + bhck2155 [1985:Q2 - 1991:Q4], bhck3164 + bhck5506 + bhck5507 + bhck2160 + bhck2155 [1992:Q1 - 1998:Q4], bhck0426 + bhck2160 + bhck2155 [2001:Q1 - 2005:Q4], bhck0426 + bhck2160 [2006:Q1 - present]
Nonperforming loans	The sum of 1) total loans and leasing financing receivables that are ninety days or more past due and still accruing; 2) total loans and leasing financing receivables in nonaccrual status.	bhck5525 - bhck3506 + bhck5526 - bhck3507 [1990:Q3 - present]
Risk-weighted assets	BHC risk-weighted assets net of all deductions	bhcka223 [1996:Q1 - present]
Total deposits	1) Non-interest-bearing deposits 2) total interest-bearing deposits in foreign and domestic offices	bhdm6631 + bhdm6636 + bhfn6631 + bhfn6636 [1981:Q2 - present]

Other Characteristics and Organizational Structure Variables

Variable	Definition	Y-9C Mnemonic Construction/Variable Source
Public	Dummy=1 if firm has PERMCO, Dummy=0 otherwise	Federal Reserve Bank of New York. 2013. CRSP-FRB Link
Number of subsidiaries	Total number of offspring entities whose relationship to the bank holding company is regulated, that is, governed by applicable banking statutes, which are either federal or state banking laws	NIC Top Holder Table: top holder variable rssd9003
Foreign subsidiaries	Total number of offspring entities that are not domiciled in the United States	NIC Country Name Directory: domestic indicator rssd9101
Foreign parent	Dummy=1 if the highest entity in the organization is not domiciled in the United States, Dummy=0 otherwise	NIC Board Derived Items Table: foreign family ID rssd9360

Source: Board of Governors of the Federal Reserve System, Microdata Reference Manual.

Note: BHC is bank holding company; FDIC is Federal Deposit Insurance Corporation; CRSP is Center for Research in Securities Prices; NIC is National Information Center.

Note to Readers: Appendix B, "Additional Materials," is available as a separate file at http://www.newyorkfed.org/research/epr/2014/1403kovn_appendixB.pdf.

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