# Does one bank size fit all?
# The role of diversification and monitoring

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## Abstract

Using a sample of US Bank Holding Companies from the period 2001 to 2012, we provide evidence that the relationship between size and bank charter value is an inverse U shape which implies the existence of an optimal size. More importantly, motivated by Diamond's (1984) theoretical model of financial intermediation as delegated monitors, we provide evidence that the inverse U shape relationship, and consequently the optimal size, is affected by the diversification benefits and by monitoring costs, decomposed to the direct monitoring cost of bank assets and to the delegation cost for debtholders and shareholders.


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# 1. INTRODUCTION

The size of the average bank in the U.S. has increased considerably in the past years, primarily through mergers and acquisitions, but also as a result of organic growth. For example, in 2001 the five largest commercial banks held 30% of total assets, while in 2011 this number rose to 48%, (Stiroh 2010; Wheelock and Wilson 2012). The appearance of large money market centers, offering a diverse range of financial services, was interpreted as the outcome of higher competition due to de-regulation, globalization and the technological evolution which called for economies of scale and scope (Hughes Mester & Moon 2001). Indeed, in the absence of capital market frictions, consolidation activities and asset growth will increase the value of shares owned by existing shareholders (Berger Demsetz and Strahan 1999). In practice, however, various market frictions often represent an offsetting force (Milburn Boot and Thakor 1999).

In this paper we address the following questions: Has the growth in bank size contributed to the market value of banks? Does an "optimal" bank size exist? If so, how does it depend on key bank characteristics?

The literature on the impact of bank assets size on bank value has produced conflicting results. Boyd and Runkle (1993) find that size has a negative effect on Tobin's q (charter value) for the 1981-90 period, while the effect is positive but insignificant for the 1971-80 period. Conversely, De Niccolo (2001) finds that for large banks, charter value decreases with size. However, he finds that for small banks in the US charter value is increasing with size. Other papers have tested the effect of diversification, and hence indirectly bank size, on bank value. A bigger bank is usually better diversified, (Demsetz and Strahan 1997) either in terms of scale, i.e., geography, or scope, i.e., activity. Diversification, in turn, has positive and negative effects on bank value. The positive effect arises from the combination of assets with less than perfect correlation, or from being present in different geographic areas[4]. The negative effect is due to higher agency costs or the undertaking of riskier activities[5].

De Nicolo (2001) used a sample of international banks to show that for medium to large banks, charter value decreased with size but this relationship is reversed for small banks. More recently, but in the context of bank risk taking, De Haan and Poghosyan (2012) observed that the relationship between size and earnings volatility is non-monotonic. Except for these two studies, most papers in the literature have assumed and estimated a monotonic relationship between size (or some diversification proxy) and bank value. The mixed results outlined may be the outcome of misspecification. That is, if the true underlying link is the outcome of two opposing forces, the relationship may be non-monotonic. Our paper offers a more comprehensive examination of the underlying forces that determine the relationship between size and charter value. We propose and estimate a non-monotonic relationship in a sample of US bank holding companies (BHC) for the period 2001 to 2012.

Theoretically, the relationship between size and charter value of financial institutions derives from two opposing forces: increasing the size brings about benefits from diversification; at the same time there is an increase in the monitoring costs. In his seminal paper, Diamond (1984) finds that financial intermediation is viable only for a sufficiently diversified portfolio of obligors and that the larger the intermediary the more efficient it is. Nevertheless, if some risk cannot be diversified away, i.e., the systematic risk, and if monitoring costs increase with size, then an optimal size should exist (Krasa and Villamil 1992). Beyond this size, the marginal increase in monitoring costs will exceed the marginal

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[4] Deng and Elyasiani (2008) show empirically that geographic diversification is associated with a valuation premium and they explain theoretically that this result is due to enlarged depositors base, synergy gains and the "coinsurance effect".

[5] Goetz et al (2013) find negative effects for the geographic diversification that are attributed to higher agency problems and particularly to the incidence and magnitude of loans to corporate insiders and the decline in loan performance. Similarly, Deng and Elyasiani (2008) show that the distance between the headquarters and branches reduces market valuation due to weakened monitoring and other distance-related agency problems. Stiroh and Rumble (2005) find a different negative effect for income diversification due to the higher volatility of non-interest income – i.e. income from trading and other investment activities.

benefit of diversification rendering the relationship with a downward slope. We confirm that the relationship between size and charter value has an inverse U-shape, implying that there exists an optimal bank size.

Provided that an optimal size for financial intermediaries exists, the subsequent question arises: is the optimal size influenced by some bank specific characteristics? Existing literature has explored the role of institutional, that is macro-level, factors and showed that the information sharing environment (Houston, Lin, Lin and Ma 2010), the legal environment (Djankov, McLiesh and Schleifer 2007), or regulation (Laeven and Levine 2009) can affect intermediation and credit markets as a whole. In this paper, we take a micro-level approach by looking at certain bank traits that affect bank size. In addition, our study contributes to the existing literature since we do not examine bank size determinants but rather how the optimal size is affected by changes in the size determinants, a comparative static exercise.

Krasa and Villamil (1992) posit theoretically that the optimal size decreases as the systematic risk component of the assets increases. Intuitively, for a bank with assets of higher systematic risk the marginal benefit from diversification is smaller compared to the marginal benefit to a bank with assets of lower systematic risk. In our paper we establish the moderating role of systematic risk by presenting evidence that the optimal size of a bank decreases as the systematic risk of its assets takes higher values. To our knowledge this is the first empirical study that provides evidence of the interaction between a bank's optimal size and systematic risk.

By producing private information, banks lend to private firms for which capital markets are too costly in the presence of market frictions (Leland and Pyle 1977; Campbel and Kracaw 1980.) Given the opaque nature of loans (Morgan 2002), banks with larger loan portfolios will incur higher direct (physical) cost of monitoring. We establish the relationship between monitoring cost and bank optimal size by presenting evidence that optimal size decreases as bank's assets opaqueness increases.

Although the information production task is effectively delegated from the lenders to financial intermediaries, it raises an intermediary incentives concern known as the "monitoring the monitor" issue. According to Diamond (1984), the cost of providing incentives to the monitor in order to align their interests with those of the lenders, is called the cost of delegation. There are two groups of bank capital providers: the debtholders and the shareholders.

For debtholders, the cost of delegation comes in the form of bankruptcy costs (Diamond 1984). Then again, there are benefits associated with leverage as well. Investors, especially prior to the crisis, have favored higher leverage by banks due to the higher tax and adverse-selection costs of financing through equity capital (Calomiris and Nissim 2014; Aiyar et al. 2014). Moreover, in the presence of the deposit guarantee from FDIC, depositors (senior bank debtholders) do not incur any bankruptcy costs (Merton 1977). Similarly, the implicit state bail-out option mitigates bankruptcy cost for unsecured junior debtholders too (Krishnan, Ritchken and Thomson 2005). Hence, the financial safety-net has alleviated the bankruptcy cost, especially before the financial crisis of 2008, and altered the theoretical relationship of bankruptcy cost and size. In particular, using leverage as a proxy to bankruptcy, we find evidence that bank's optimal size increases with higher leverage, a significant departure from Diamond's model which did not account for the too big to fail phenomenon.

In the case of shareholders, previous studies identify links between firm's size growth and managerial self-interest for manufacturing companies (Jensen and Murphy 1990) and for banks (Bliss and Rosen 2001). In this case, the cost of delegation comes in the form of ownership sharing or other pecuniary incentives provided to the bank managers. Insider's ownership, as it is known, provides management with the right incentives but the accumulation of ownership and control from insiders could exacerbate agency issues and hence it represents a delegation cost from the side of shareholders. Similarly, pecuniary incentives may alleviate agency issues but come at the expense of shareholders. Hence, using banks' insider ownership and other pecuniary incentives as delegation cost proxies, we provide empirical evidence that optimal size decreases when insider ownership and other pecuniary incentives are high.

To sum up, our paper provides empirical evidence that optimal size of financial intermediaries does exist. Furthermore, higher asset systematic risk, higher direct monitoring costs and higher insider ownership reduce a bank's optimal size. In contrast to the theoretical model of Diamond (1984), but in line with the empirical evidence of the protection of large financial institutions, we show that higher leverage increases the optimal size of financial intermediary.

The remainder of the paper is structured as follows. Section 2 presents the data and describes the variables that are used in the study. Section 3 depicts the empirical analysis of the relationship between bank size and bank charter value as well as the robustness tests that have been employed. Section 4 concludes.

## 2. DATA AND VARIABLES

The sample consists of bank holding companies (BHC) listed in the NYSE, AMEX, and NASDAQ over the period 2001 to 2012. Annual balance sheet and income statement data are collected by the Federal Reserve and published in the Financial Statements for Bank Holding Companies, known as the Y-9C reports. Daily stock returns are derived using the closing prices supplied from the Center of Research in Security Prices (CRSP). The data on analysts' earnings forecasts were collected from the Institutional Brokers Estimate System (I/B/E/S). The data on management compensation were collected from EXECUCOMP (COMPUSTAT).

### 2.1 *Charter Value*

The standard measures of profit maximization or cost minimization have been proven inadequate as managerial objective function (Hughes Mester & Moon 2001). Modigliani and Miller (1958) proposed value maximization as the more appropriate objective to managers because in contrast to profit maximization, it accounts for production risk. We acknowledge that bank management operates under the logic of shareholder value maximization and therefore we use the going concern (charter) value of the bank, in excess of its accounting book value, as our dependent variable. In particular, we follow the literature and define charter value as the ratio of the market value of equity plus the book value of preferred shares plus the book value of total debt over the book value of total assets which represents the present value of future cash flows divided by the replacement cost of tangible assets.[6]

### 2.2 *Systematic Risk*

We approximate the asset volatility from the market volatility of equity using the Merton approach (Merton 1974). To measure the systematic risk of bank's equity requires fitting a factor model in order to estimate the sensitivity of the banks' expected return to changes of broad market and macro-economic indicators. There is evidence that bank's expected returns are driven by systematic factors not adequately captured by market index return but from economic indicators such as interest rate and credit risk changes[7]. We therefore estimate systematic risk using the multifactor model of Demsetz and Strahan (1997). In particular, the excess stock return $R_{i,t} - R_{f,t}$ for bank *i* at time *t* is:

$$R_{i,t} - R_{f,t} = \beta_{0,i} + \beta_{1,i}(R_{m,t} - R_{f,t}) + \beta_{2,i}\Delta YIELD_t + \beta_{3,i}\Delta TERM_t + \beta_{3,i}\Delta CSRPEAD_t + u_{i,t}$$

[6] See Laeven and Levine (2007) and De Nicolo (2001).

[7] Demsetz and Strahan (1997) find that adding interest rate and credit risk variables to the market model increases the explanatory power of the model by 5% to 10% on average.

where market return $R_{m,t}$ is the value weighted return on all stocks listed in the NYSE, AMEX, and NASDAQ, the risk free rate $R_{f,t}$ is measured by the three month Treasury bill rate, ΔYIELD is the change in the three-month Treasury Bill rate, ΔTERM is the change in the spread between the 20-year Treasury Bond and the three-month Treasury Bill rates, ΔCSPREAD is the change in the spread between the BBB-rated corporate bond and the 20-year Treasury Bond rates. Systematic risk is then measured as the $R^2$ of the regression line.

Another way to measure systematic risk of bank equity is by using the standard approach in asset pricing, the Fama-French-Carhart (FFC) four factors model.[8] In particular, the excess stock return $R_{i,t} - R_{f,t}$ for bank *i* at time *t* is:

$$R_{i,t} - R_{f,t} = \beta_{0,i} + \beta_{1,i}(R_{m,t} - R_{f,t}) + \beta_{2,i}HML_t + \beta_{3,i}SMB_t + \beta_{4,i}UMD_t + u_{i,t}$$

where HML is the book-to market risk premium factor; SMB is the size risk premium factor and UMD the returns momentum factor.[9] As previously, systematic risk is the percentage of the stock return variability attributed to the market factors, equivalently the $R^2$ of the regression line. We use the systematic risk estimate derived from FFC-model as a robustness test.

### *2.3 Direct (Physical) Monitoring Cost*

Direct monitoring cost is proportional to asset opaqueness which can be approximated using accounting-based proxies, opinion-based proxies or market microstructure-based proxy.[10] In our study, the first proxy for asset opaqueness employed is the standard error of analysts' EPS forecast. In particular, although I/B/E/S data include the summary statistics on analysts' (EPS)

[8] See , Fama and French (1993) and Carhart (1997).

[9] Daily data for the Fama-French and Carhart factors were collected from French's web site (http://mba.tuck.dartmouth.edu/ pages/faculty/ken.french/data_library.html).

[10] See Aboody and Lev (2000), Brennan and Subrahmanyam (1995) and Flannery, Kwan and Nimalendran (2004) respectively for the three types of proxies.

forecasts (U.S. Summary History data set), we employ the file that contains individual analysts' forecasts (Detail History data set) organized by the date on which the forecast was issued to address concerns that the summary file makes use of outdated analysts' forecasts (Diether, Malloy, and Scherbina, 2002).

As a second proxy, we follow Flannery, Kwan and Nimalendran (2004) and use the account based measure of loans as percentage of total assets, on the assumption that bank loans are informationally opaque since bank insiders may possess valuable private information about loan customers' credit condition (Campbell and Kracaw 1980).

Finally, we employ earnings management as a third proxy. In the case of commercial banks, loan loss provisions are a main tool used by management to control earnings. As managers increase loan loss provisions net income decreases, while a decrease in the recording of loan loss provisions increases net income. Management in banks with less opaque assets are less likely to be involved in manipulation of accruals.

To calculate discretionary loan loss provisions, we follow Cornett, McNutt and Tehranian (2009) and run an OLS regression of reported loan loss provisions (LLP) as a percentage of total loans with time fixed effects:

$$LLP_{i,t} = \beta_{0,i} + \beta_{1,i} lnAssets_{i.t} + \beta_{2,i} NPL_{i.t} + \beta_{3,i} LLR_{i.t} + \beta_{4,i} REL_{i.t} + \beta_{5,i} CIL_{i.t} + \\ + \beta_{6,i} DL_{i.t} + \beta_{7,i} AL_{i.t} + \beta_{7,i} CL_{i.t} + \beta_{8,i} FGL_{i.t} + u_{i,t}$$

where NPL is the non performing loans, LLR is the loan loss reserves, REL the real estate loans, CIL the commercial and industrial loans, DL the loans to depository institutions, AL the agricultural loans, CL the consumer loans and FGL the loans to foreign governments, all measured as percentage of total loans. The discretionary component of loan loss provisions is the error term ($u$) from this regression. Furthermore, because loan loss provisions is reported in percentage of total loans, we alter the standardizing factor of the error term from loans to assets. That is, the estimate of discretionary loan loss provision is [(error term * total loans)/total assets].

In addition to the loan loss provisions, banks manage their earnings through the realization of security gains and losses which is a relatively unregulated and unaudited discretionary management action. To calculate the discretionary realized security gains and losses, we again follow Cornett, McNutt and Tehranian (2009) and run an OLS regression of reported realized security gains and losses (RSGL) as a percentage of total assets with time fixed effects

$$RSGL_{i,t} = \beta_{0,i} + \beta_{1,i} lnAssets_{i.t} + \beta_{2,i} USGL_{i.t} + u_{i,t}$$

where USGL denotes the unrealized security gains and losses (includes only unrealized gains and losses from available-for-sale securities) as a percentage of total assets. The discretionary realized security gains and losses is the regression's error term. Finally, our estimate of discretionary accrual for banks is the sum of the discretionary loan loss provision and the nondiscretionary realized security gains and losses.

### *2.4 Cost of Delegation*

The cost of delegation is assumed by both debthoders and shareholders alike. Diamond (1984) suggested that the incentive contract for monitoring the bank is debt with bankruptcy penalties and high leverage. To proxy the cost of delegation from the debtholders perspective, we employ two measures. First, the interest expenses of a bank expressed as a ratio over the bank's total liabilities. And second, the leverage of a bank defined as total assets over capital.

From the perspective of the shareholder, the delegation cost is denoted by the pecuniary incentives ceded from banks' owners to the management in order to ameliorate the principal agent problem. We employ two proxies to measure the cost of delegation. The first quantifies the pecuniary incentive as the dollar value of annual compensation other than the salary, over net income.[11]

The second proxy is the insider ownership. This is defined as the number of shares granted to executive management, excluding options that are exercisable or will become exercisable within 60 days over total outstanding shares.

### *2.5 Control Variables*

The independent variable of interest in this paper is the size of the bank and it is measured using the log of total assets. Charter value may be affected by other bank characteristics apart from size. By including them as control variables we reduce the possibility that the independent variable is correlated with the error term due to some omitted variable. For example, the management of a highly capitalized bank may have fewer incentives to engage in excessive risk taking implying a lower volatility of earnings which should reflect positively on the charter value (Cebenoyan and Strahan 2004). In addition, higher capital implies that the bank has the ability for further investment, i.e., risk taking, which again will increase the growth prospects and hence its charter value (Froot and Stein 1998). Therefore, we control for capital adequacy using the ratio of book value of equity over risky assets i.e. assets net of cash, FED funds and highly liquid securities.

[11] The annual compensation includes items such as: perquisites and other personal benefits, above market earnings on restricted stock, options/SARs or deferred compensation paid during the year but deferred by the officer, earnings on long-term incentive plan compensation paid during the year but deferred at the election of the officer, tax reimbursements and the dollar value of difference between the price paid by the officer for company stock and the actual market price of the stock under a stock purchase plan that is not generally available to shareholders or employees of the bank.

Charter value is also affected by deposits which is measured as a percentage of assets, and it identifies the bank's access to low cost, subsidized funding. It is expected that deposits is positively related with charter value.

Furthermore, since charter value incorporates market expectations for future growth, we include the income growth over the last year. However, it is likely that income growth is driven by bank's higher risk taking and given the option like payoff of stocks, market capitalization will favor higher risk taking. Hence we control bank's risk taking using the non-performing loans (NPL).

Another factor that influences charter value is its exposure to liquid assets. We control for liquidity which is gauged using the ratio of cash, FED funds, and highly liquid securities to the total assets. Economies of scale imply that larger banks will be more cost efficient and therefore enjoy higher valuation. We control for efficiency using the ratio of non-interest income to total non-interest expenses.

Finally, product market competition may influence the charter value of banks, as institutions with a large market power enjoy higher valuation. To account for product market competition we include bank's market share of loans as a proxy of the market share. We use all the listed as well as the non-listed BHC to derive bank's market share per year.

After merging the different datasets our panel data consists of 4,544 bank-year observations which correspond to 648 Bank Holding Companies for the period 2001-2012. Table 1 provides descriptive statistics for all our variables.

[Insert Table 1 About Here]

## 3. EMPIRICAL ANALYSIS

Besides the control variables presented above, we also account for unobservable bank level, time-invariant heterogeneity using bank fixed effects. Furthermore, we account for time trends using year fixed effects. We use robust clustered estimates of errors (Wooldridge, 2002) across all our regressions to curb possible biases of error heteroscedasticity and within cluster correlation. To curb the impact of spurious extreme values on our findings, we winsorize the data at the 1st and 99th percentile. Finally, all independent variables are one year lagged to limit the effect of time simultaneity and Granger reverse causality.

### *3.1 The relationship between size and charter value*

Initially, we examine the relationship of size and charter value:

$$CHV_{i,t} = \alpha_0 + \alpha_1 SIZE_{i,t} + \alpha_2 SIZE_{i,t}^2 + \alpha_i X_{i,t} + b_i + y_t + \varepsilon_{i,t} \quad (1)$$

The results are presented in Table 2. Specification (1) fits the standard linear monotonic model. Since the effect of size on charter value is insignificant we reject a monotonic linear relationship between size and charter value. Specification (2) includes size's second order effect. , In this case, both the linear and the second order effects of size become significant. The significance is maintained after controlling for all other observable bank characteristics that affect charter value as well as all the unobservable bank and time effects. In particular, the linear effect of size in specification (3) is positive and statistically significant ($\alpha_1$=0.222, p < 1%) while the quadratic effect is negative and statistically significant ($\alpha_2$=-0.00755, p < 1%) confirming the concavity of size effect on charter value.

The inverse-U relationship indicates that marginal increase in size of a medium-sized bank has a lower marginal positive impact on charter value compared to a small-sized bank.

Furthermore for medium to large banks every extra increase in size has a higher marginal negative impact on charter value. The inflection point where the optimal size is attained is the value of – α1 / 2 α2 = 14.70 (log of assets). This figure is close to the average value of size and more than one third of banks in our sample exceed it.

[Insert Table 2 About Here]

### *3.2 The role of systematic risk*

To examine the moderating role of systematic risk on the optimal size of banks, we add to the non-linear regression equation (1), the interaction between the second order effect of size and systematic risk:

$$CHV_{i,t} = \alpha_{0,i} + \alpha_1 SIZE_{i,t} + \alpha_2 SIZE_{i,t}^2 + \alpha_3 SIZE_{i,t}^2 \times SYSRISK_{i,t} + \alpha_i X_{i,t} + b_i + y_t + \varepsilon_{i,t} \quad (2)$$

Indeed, if the estimates of equation (2) are significant, then the implied optimal size is attained at the value of – $\alpha_1$ / 2 ($\alpha_2$+ $\alpha_3$ SYSRISK). That is, the systematic risk of assets affects the optimal bank size.

The results are presented in Table 3. In specification (1) the interaction between the second order effect of size and systematic risk is negative and statistically significant ($\alpha_3$=-0.000326, $p < 1\%$), confirming the impact of systematic risk on optimal size. To quantify this impact we create a dichotomous interaction variable using systematic risk: we compare the banks with lower than average systematic risk (Systematic risk =0) to banks with one standard deviation higher systematic risk (Systematic risk =1). The linear effect of size in specification (2) remains positive and statistically significant ($\alpha_1$= 0.146, $p < 1\%$). For the banks with the lower systematic risk, the quadratic effect is negative and statistically significant ($\alpha_2$ = -0.00484, $p < 1\%$) and the implied optimal size is reached at the value –$\alpha_1$ / 2 $\alpha_2$ = 15.08. For the banks with the higher systematic risk, the interaction of the quadratic size effect with high systematic risk is also negative and statistically significant ($\alpha_3$ = -0.000274, $p < 1\%$) and the implied optimal size is attained at the value $-\alpha_1 / 2 (\alpha_2 + \alpha_3) = 14.27$, a distance of half of a standard deviation of size from the optimal size of lower systematic risk banks.

To test the robustness of our results, we repeat the analysis but now using the systematic risk estimate from the Fama-French Cohort (FFC) model. The linear effect of size in specification (3) is positive and statistically significant ($\alpha_1$= 0.234, $p < 1\%$), the quadratic effect is negative and statistically significant ($\alpha_2$ = -0.00755, $p < 1\%$) and the interaction of the quadratic size effect with the alternative proxy of systematic risk is also negative and statistically significant ($\alpha_3$ =-0.000255, $p < 5\%$). We conclude that there is sufficient empirical evidence that optimal size decreases as the systematic risk of bank's assets increases since the benefits from additional diversification are diminished.

[Please Insert Table 3 About Here]

### *3.3 The role of direct monitoring cost*

To examine the moderating role of direct monitoring cost of bank's assets on optimal size of banks, we include in the non-linear regression equation (1), the interaction between the second order effect of size and the proxies measuring asset opaqueness:

$$CHV_{i,t} = \alpha_{0,i} + \alpha_1 SIZE_{i,t} + \alpha_2 SIZE_{i,t}^2 + \alpha_3 SIZE_{i,t}^2 \times OPAQ_{i,t} + \sum \alpha_i X_{i,t} + b_i + y_t + \varepsilon_{i,t} \quad (3)$$

If the estimates of equation (3) are significant, then the implied optimal size is attained at the value of $-\alpha_1 / 2 (\alpha_2 + \alpha_3 OPAQ)$. Essentially then, the direct monitoring cost, as reflected by the opaqueness of assets affects the optimal bank size.

The results are presented in Table 4. In specification (1), the interaction between the second order effect of size and the standard deviation of analysts' forecast errors is negative and statistically significant at 5%. To quantify the effect of direct monitoring cost on optimal size we create a dichotomous interaction variable using analysts' forecast errors: we compare banks with lower than average asset opaqueness (High F/cast Error SD =0) to banks with one standard deviation higher than average asset opaqueness (High F/cast Error SD =1). The linear effect of size in specification (2) is positive and statistically significant ($\alpha_1$= 0.163, $p < 1\%$). For the banks with the lower asset opaqueness, the quadratic effect is negative and statistically significant ($\alpha_2$ = -0.00546, $p < 1\%$) and the implied optimal size is attained at the value of $– \alpha_1 / 2 \alpha_2$ = 14.93. For the banks with higher asset opaqueness, the interaction of the quadratic size effect with asset opaqueness is also negative and statistically significant ($\alpha_3$ = -0.000154, $p < 1\%$) and the implied optimal size is achieved at the value$– \alpha_1 / 2 (\alpha_2 + \alpha_3)$ = 14.5, a distance of one fourth of a standard deviation of size from the optimal size of banks with the lower asset opaqueness.

To test the robustness of our results regarding the validity of the direct monitoring cost proxy, we repeat the analysis but now using the two alternative measures of asset opaqueness, the bank's loans (the higher the ratio of loans the higher the opaqueness given the private information of banks' loan) and the discretionary accruals (higher discretionary accruals means higher earnings opaqueness). In specification (3) the interaction between the second order effect of size and loans is negative and statistically significant at 1%. Similarly, the interaction between the second order effect of size and discretionary accruals in specification (4) is negative and statistically significant at 1%. We conclude that there is sufficient empirical evidence that optimal size decreases as the direct monitoring cost of a bank increases.

[Insert Table 4 About Here]

### *3.4 The role of delegation cost*

To examine the moderating role of delegation cost on the optimal size of banks, we include in the non-linear regression equation (1), the interaction between the second order effect of size and the proxies measuring delegation cost:

$$CHV_{i,t} = \alpha_{0,i} + \alpha_1 SIZE_{i,t} + \alpha_2 SIZE_{i,t}^2 + \alpha_3 SIZE_{i,t}^2 \times DELCOST_{i,t} + \sum \alpha_i X_{i,t} + b_i + y_t + \varepsilon_{i,t} \quad (4)$$

As previously, if the estimates of equation (4) are significant, then the implied optimal size is attained at the value– $\alpha_1$ / 2 ($\alpha_2$+ $\alpha_3$ DELCOST). That is, the delegation cost affects the optimal bank size.

The results for the debtholders delegation cost are presented in Table 5. In specification (1), the interaction between the second order effect of size and the proxy of delegation cost for debtholders, the interest expense, is positive and statistically significant at 1%. As argued earlier, this finding is counterintuitive to the theoretical mechanism that assumes higher delegation costs will reduce optimal size. At the same time, it is in line with the empirical evidence that suggests the elimination of the effect of bankruptcy on charter value due to the explicit and implicit bail-out. To quantify the effect of interest expense on optimal size we create a dichotomous interaction variable: in specification (2) we compare banks with lower than average interest expenses (High interest expense = 0) and compare it to banks with one standard deviation higher than average interest expenses (High interest expense = 1). For the banks with the lower interest expenses, the optimal size is realized at the value of – $\alpha_1$ / 2 $\alpha_2$ = 14.75. For the banks with higher interest expenses, the interaction of the quadratic size effect is positive and statistically significant ($\alpha_3$ =0.000189, $p < 1\%$) and the implied optimal size is reached at the value of – $\alpha_1$ / 2 ($\alpha_2$ + $\alpha_3$) = 15.18, a distance of one fourth of a standard deviation from the optimal size of banks with the lower bankruptcy costs.

To test the robustness of our results regarding the validity of the delegation cost for debtholders proxy, we repeat the analysis but now using the alternative measure of financial leverage. In specification (3), the interaction between the second order effect of size and leverage is positive and statistically significant at 1%. We conclude that there is sufficient empirical evidence that optimal size increases as the financial leverage of bank increases. This is a theoretical counterintuitive relationship attributed to the absence of a bankruptcy effect on charter value and the rents earned by larger financial intermediaries from the implicit guarantee.

The results for the shareholders delegation cost are presented in Table 6. In specification (1), the interaction between the second order effect of size and the insider ownership proxy for shareholder delegation cost, is negative and statistically significant at 5%. To quantify the effect of delegation cost for shareholders on optimal size we create a dichotomous interaction variable: in specification (2) we compare banks with lower than average insider ownership (High insider ownership = 0) to banks with one standard deviation higher than average insider ownership (High insider ownership = 1). For the banks with the lower insider ownership, the optimal size is realized at $-\alpha_1 / 2\alpha_2 = 15.73$. For the banks with higher agency cost, the interaction term is negative and statistically significant ($\alpha_3$ =-0.000444, $p < 5\%$) and the implied optimal size is attained at $-\alpha_1 / 2(\alpha_2 + \alpha_3) = 14.06$, a distance of one standard deviation from the optimal size of banks with the lower insider ownership.

We further test the robustness of our results using the alternative delegation cost measure of incentives to management. In specification (3) the interaction between the second order effect of size and incentives is negative and statistically significant at 1%. We conclude that there is sufficient empirical evidence that optimal size decreases as the bank shareholders' delegation cost increases.

[Insert Tables 5 and 6 About Here]

### *3.5 Further Robustness Tests*

A potential concern regarding our findings is the reverse causality that may exist between size and charter value. That is, banks with higher market value may enjoy better access to capital (lower capital constraints) so they grow bigger than their counterparties. Although by construction, bank's size and charter value are not contemporaneous (we use lagged bank's size), this practice only ensures that size precedes charter value in time but it does not necessarily preclude reverse causality. Another concern is the omission of some bank characteristic which interacts both with size and charter value and will yield significant correlation between size and the error term.

To address these two endogeneity concerns, that could potentially lead us to incorrect interpretations regarding the relationship between size and charter value, we apply the Instrumental Variables (IV) approach (Wooldridge, 2002). The IV model requires the specification of some instruments highly correlated with the independent variable bank's size but with no direct effect on the dependent variable (charter value).

We construct two such instruments. The number of employees is a highly correlated variable with size and at the same time there is little evidence that it directly affects bank's charter value. In addition, the Y-9C reports of BHC characterize a bank as complex or noncomplex organization. Since operational complexity is often related to size, we expect that this index will serve as a good instrument to our analysis. Hence, we perform the IV approach using the number of employees and the complexity index as instruments for size, while following Wooldridge (2002) we use the squared number of employees as a separate instrument for the second order effect of size.

Furthermore, when the errors do not satisfy the homoscedasticity assumption, the simple 2SLS IV estimate is consistent but inefficient (Baum, 2006). Therefore, we use the Generalized

Method of Moments (GMM) estimation, which is robust to both heteroscedasticity and intra-cluster correlation. To test the validity of the instruments, we perform two tests: one for overidentification (the instruments are independent of the error), and one for weak identification (the instruments are sufficiently correlated with the included endogenous covariate). We test overidentifying restrictions using Hansen's J-statistic, the equivalent of Sargan test for the GMM estimator (Baum, 2006). The Hansen J-statistic for the instrumented regression of size on charter value is not significant (J=0.819, p-value=0.366); thus, we do not reject the null hypothesis that all instruments are uncorrelated with the error term. Further, for weak identification test, we report the Kleibergen-Paap $r_k$ Wald F-statistic, which unlike the traditional Cragg-Donald F-statistic, remains valid in the presence of heteroskedastic errors. The F-statistic of our sample is close to 20 indicating that our instruments are relevant and strong.

Specification (1) in Table 7 contains the result of the instrumented regression estimated using GMM method. The linear and the second order effects of size are statistically significant at 1%. Furthermore, their estimated values ($\alpha_1$= 0.287 and $\alpha_2$= -0.0097) do not depart significantly from the estimates derived using the simple OLS in regression equation (1).

In specifications (2)-(5), we also test using instrumental variables the interactions of second order effects of size with the systematic risk of bank's assets, the direct monitoring cost and the delegation cost for debtholders and shareholders. Note that following Wooldridge (2002), we use as instruments of the interaction terms the interactions between each factor (i.e. the systematic risk of bank's assets, the direct monitoring cost and the delegation cost of debtholders and shareholders) with the instrumental variables of second order effects of size. In specification (2), we find that the instrumented effect of systematic risk of bank's assets on optimal size is significant at 1%. In specification (3), the instrumented effect of direct monitoring cost of bank's assets on optimal size is significant at 5%. In specification (4), we find that the instrumented effect of the delegation cost for debtholders on optimal size is not significant at conventional levels a result that can be attributed to the confound effect of the safety net. Finally, in specification (5), the instrumented effect of the delegation cost for shareholders on optimal size is significant at 5%.

[Insert Table 7 About Here]

In addition to the above, we apply a random effects model, and examine whether the intercept should be left to vary across banks by using random – rather than fixed – effects. This is specification (1) in Table 8. However, the classic Hausman test is invalid in the presence of heteroscedasticity or clustered errors, so we use the Hansen's J statistic of overidentifying restrictions (orthogonality conditions). Under conditional homoscedasticity, this test statistic is asymptotically equivalent to the usual Hausman fixed-vs-random effects test. We conduct the Hansen's J test for the regression model (1) where the null hypothesis is that the preferred model captures random effects vs. the alternative of fixed effects. The reported test value is significant at p<1%, and we therefore reject the null hypothesis of random effects.

We perform a final robustness test, by running the OLS regression not on levels but on differences. The difference-in-differences regression model examines the effect of a change in bank’s size to the change in its charter value. If the observed inverse U-shape relationship of size and charter value is driven due to a common unobserved factor, then the level regression can lead us to incorrect conclusion regarding the causal effect of size on charter value. By differencing, we eliminate any unobserved fixed common factor and we examine the causal effect of a change in bank size on charter value. The results of the difference-in-differences regression model are presented in specification (2), Table 8. The linear effect of size’s change is positive and statistically significant at 10% while the second order effect of size’s change is negative and statistically significant at 5%.

[Insert Table 8 About Here]

The results of the instrumented regression and the difference-in-differences regression together with the introduction of several controls to account for the observed heterogeneity and the fixed and time effects to account for the unobserved heterogeneity indicate that our estimates are consistent and that our findings are unlikely to be driven by endogeneity. We therefore conclude that there is empirical evidence of an inverse U-shape relationship between bank's size and charter value. In addition, we have robust evidence that bank's optimal size is affected by the systematic risk of its assets, the direct monitoring cost and the delegation cost, primarily of the shareholders.

## 4. CONCLUSION

A common theme in the current banking literature, with few exceptions, is that the relationship of size to the various performance and risk measures has been modeled as monotonic. However, the co-existence of different countervailing forces that drive bank size, such as the benefits from diversification and the costs of monitoring, indicates that a non-monotonic relationship appears more plausible. Indeed, banking theory (Millon and Thakor 1985; Krasa and Villamil 1992) has argued in favor of the existence of optimal size as the result of the diminishing returns of diversification and the exponentially increasing monitoring costs. In this study, we provide robust empirical evidence of an inverse U-shape relationship between size and charter value using a large sample of US Bank Holding Companies. Furthermore, we provide evidence that optimal size is exceedingly driven by the level of bank's asset systematic risk and the monitoring and delegation costs. Specifically, we show that less diversified banks have a higher optimal size than their highly diversified counterparts, all else equal, because the additional benefits from diversification for these low diversified banks exceed the additional monitoring and delegation costs. Similarly, we provide evidence that banks with more opaque assets have a lower optimal size than their counterparts with less opaque assets, all else equal, because the additional direct monitoring costs surmount any benefits from diversification. We also provide evidence that banks with higher delegation cost for shareholders have a lower optimal size, all else equal, because the additional delegation cost surmounted any benefit from diversification. Finally, the relationship between delegation cost for debtholders and optimal size is less straightforward, due to the existence of the implicit and explicit bailout of large financial institutions which effectively annihilates any delegation cost.

Our findings have important policy implications. First, the interaction of optimal size and systematic risk provides a mechanism that explains the emergence of banking crisis. In periods of low systematic risk, a value maximizing bank management will seek to grow larger in size in order to benefit from the additional, yet unrealized, diversification. But the bank's systematic risk changes either exogenously (a macro-economic shock) or endogenously (the increase in size will imply higher systematic risk for the bank and effectively will lower its optimal size). In either circumstance, the bank ends up with a size far above its optimal and it will seek to scale down its activities by restricting new credit or by fire sales which effectively will exacerbate the financial instability.

Second, the interaction of optimal size and monitoring cost reveals that the current focus on scale and scope is incomplete. Bank management that operates under the objective of value maximization and pursues asset growth as a value creation mechanism due to diversification benefits and other economies of scale, should be aware of the dark side of asset growth, the increase in monitoring and delegation costs. These market frictions work in the opposite way and reduce charter value. The net effect from the benefits and costs will eventually depend on the characteristics of the banks. Those institutions that have a significant margin for further diversification are likely to benefit from asset growth. In contrast, institutions with high monitoring costs due to asset opaqueness, or high delegation cost due to agency issues are more likely to lose value from further asset growth.

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**Table 1**. Summary statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| *Charter Value* | 4544 | 1.047 | 0.144 | 0.678 | 5.230 |
| *Size* | 4544 | 14.619 | 1.630 | 11.919 | 21.58 |
| *Systematic risk* | 4542 | 0.236 | 0.235 | 0.000 | 0.881 |
| *Systematic risk FFC* | 4542 | 0.198 | 0.202 | 0.000 | 0.804 |
| *EPS forecast error* | 2776 | 0.267 | 1.836 | 0.000 | 67.82 |
| *Discrete. Accruals* | 4410 | 0.021 | 0.018 | 0.000 | 0.380 |
| *Loans* | 4544 | 0.608 | 0.220 | 0.000 | 0.945 |
| *Leverage* | 4544 | 8.276 | 2.466 | 2.542 | 16.11 |
| *Interest expenses* | 4544 | 2.154 | 1.118 | 0.077 | 8.050 |
| *Insider ownership* | 1179 | 2.484 | 8.336 | 0.000 | 239.7 |
| *Incentives* | 1179 | 0.041 | 0.285 | -0.341 | 6.819 |
| *Capital adequacy* | 4544 | 0.139 | 0.103 | -0.020 | 2.033 |
| *Deposits* | 4544 | 0.738 | 0.141 | 0.000 | 0.948 |
| *Diversification* | 4544 | 0.345 | 0.204 | -2.025 | 0.995 |
| *Efficiency* | 4544 | 0.389 | 0.237 | -0.612 | 2.352 |
| *Income growth* | 3919 | 0.060 | 0.200 | -0.969 | 3.650 |
| *Market share* | 4544 | 0.244 | 1.321 | 0.000 | 17.19 |
| *NPL* | 4436 | 0.288 | 5.970 | 0.000 | 342.1 |
| *Liquidity* | 4544 | 0.268 | 0.120 | 0.021 | 0.945 |

**Table 2**. OLS regressions: Bank's charter value and linear and second order effect of size

| VARIABLES | (1)<br>Charter Value | (2)<br>Charter Value | (3)<br>Charter Value |
|---|---|---|---|
| Size | -0.00102 | 0.203*** | 0.222*** |
| | (0.00464) | (0.0319) | (0.0313) |
| Size^2 | | -0.00696*** | -0.00755*** |
| | | (0.00107) | (0.00105) |
| Capital Adequacy | | | 0.0193 |
| | | | (0.0417) |
| Deposits | | | 0.0505** |
| | | | (0.0199) |
| Efficiency | | | 0.0584*** |
| | | | (0.0104) |
| Income growth | | | 0.00862 |
| | | | (0.00576) |
| Market share | | | 0.00723 |
| | | | (0.00521) |
| NPL | | | -0.00186 |
| | | | (0.00191) |
| Liquidity | | | 0.0229 |
| | | | (0.0188) |
| Constant | 1.013*** | -0.457* | -0.688*** |
| | (0.0701) | (0.241) | (0.238) |
| Bank fixed effects | yes | yes | yes |
| Year effects | yes | yes | yes |
| Observations | 3,919 | 3,919 | 3,821 |
| R-squared | 0.568 | 0.592 | 0.619 |
| Number of banks | 542 | 542 | 537 |

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Table 3**. OLS regressions: Bank's charter value, size and the interaction with systematic risk

| Variables | (1)<br>Charter Value | (2)<br>Charter Value | (3)<br>Charter Value |
|---|---|---|---|
| Size | 0.229*** | 0.146*** | 0.234*** |
| | (0.0299) | (0.0300) | (0.0306) |
| Size^2 | -0.00733*** | -0.00484*** | -0.00755*** |
| | (0.00101) | (0.00103) | (0.00104) |
| Systematic Risk | 0.0971*** | | |
| | (0.0307) | | |
| Size^2*Systematic Risk | -0.000326*** | | |
| | (0.000123) | | |
| High systematic risk(=1) | | 0.0542*** | |
| | | (0.0206) | |
| Size^2*High systematic risk(=1) | | -0.000274*** | |
| | | (8.89e-05) | |
| Systematic Risk (FF) | | | 0.0829*** |
| | | | (0.0275) |
| Size^2*Systematic Risk (FF) | | | -0.000255** |
| | | | (0.000114) |
| Capital Adequacy | 0.100** | 0.0427 | 0.0966** |
| | (0.0485) | (0.0454) | (0.0485) |
| Deposits | 0.0486** | 0.0406** | 0.0484** |
| | (0.0193) | (0.0204) | (0.0193) |
| Efficiency | 0.0515*** | 0.0613*** | 0.0515*** |
| | (0.0107) | (0.0112) | (0.0106) |
| Income growth | -0.0250*** | 0.00616 | -0.0252*** |
| | (0.00634) | (0.00575) | (0.00634) |
| Market share | 0.00679 | 0.00543 | 0.00757 |
| | (0.00567) | (0.00852) | (0.00585) |
| NPL | -0.00281 | -0.00124 | -0.00285 |
| | (0.00201) | (0.00185) | (0.00200) |
| Liquidity | -0.00161 | 0.0142 | 0.000143 |
| | (0.0197) | (0.0201) | (0.0197) |
| Constant | -0.853*** | -0.141 | -0.888*** |
| | (0.229) | (0.225) | (0.232) |
| Bank fixed effects | yes | yes | yes |
| Year effects | yes | yes | yes |
| Observations | 3,819 | 3,219 | 3,819 |
| R-squared | 0.564 | 0.618 | 0.566 |
| Number of BHC | 537 | 532 | 537 |

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Table 4**. Bank's charter value, size and the interaction with the direct monitoring cost

| Variables | (1)<br>Charter Value | (2)<br>Charter Value | (3)<br>Charter Value | (4)<br>Charter Value |
|---|---|---|---|---|
| Size | 0.181*** | 0.163*** | 0.200*** | 0.211*** |
| | (0.0468) | (0.0436) | (0.0323) | (0.0319) |
| Size^2 | -0.00615*** | -0.00546*** | -0.00652*** | -0.00711*** |
| | (0.00148) | (0.00136) | (0.00110) | (0.00107) |
| F/cast Error SD | 0.0110 | | | |
| | (0.00764) | | | |
| Size^2* F/cast Error SD | -0.000066** | | | |
| | (3.32e-05) | | | |
| High F/cast Error SD(=1) | | 0.0296** | | |
| | | (0.0129) | | |
| Size^2* High F/cast Error SD(=1) | | -0.000154*** | | |
| | | (5.89e-05) | | |
| Loans | | | 0.146*** | |
| | | | (0.0262) | |
| Size^2* Loans | | | -0.000437*** | |
| | | | (9.18e-05) | |
| Discr Accruals | | | | 0.606** |
| | | | | (0.240) |
| Size^2* Discr Accruals | | | | -0.00353*** |
| | | | | (0.00114) |
| Capital Adequacy | -0.0162 | -0.00275 | 0.0345 | 0.0136 |
| | (0.0543) | (0.0533) | (0.0422) | (0.0418) |
| Deposits | 0.0401 | 0.0441* | 0.0526*** | 0.0514** |
| | (0.0246) | (0.0250) | (0.0198) | (0.0203) |
| Efficiency | 0.0636*** | 0.0636*** | 0.0576*** | 0.0580*** |
| | (0.0124) | (0.0122) | (0.0103) | (0.0102) |
| Income growth | 0.00768 | 0.00788 | 0.00854 | 0.00904 |
| | (0.00740) | (0.00710) | (0.00566) | (0.00573) |
| Market share | 0.00455 | 0.00384 | 0.00788 | 0.0202** |
| | (0.00491) | (0.00453) | (0.00674) | (0.00817) |
| NPL | -0.00434 | -0.00426 | -0.000851 | -0.00136 |
| | (0.00285) | (0.00281) | (0.00182) | (0.00187) |
| Liquidity | 0.00568 | 0.00706 | 0.0671** | 0.0223 |
| | (0.0235) | (0.0236) | (0.0296) | (0.0189) |
| Constant | -0.352 | -0.248 | -0.627** | -0.623** |
| | (0.379) | (0.358) | (0.244) | (0.245) |
| Bank fixed effects | yes | yes | yes | yes |
| Year effects | yes | yes | yes | yes |
| Observations | 2,336 | 2,336 | 3,821 | 3,813 |
| R-squared | 0.647 | 0.650 | 0.627 | 0.623 |
| Number of BHC | 384 | 384 | 537 | 536 |

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Table 5**. Bank's charter value, size and the interaction with the cost of delegation (debtholders).

| VARIABLES | (1)<br>Charter Value | (2)<br>Charter Value | (3)<br>Charter Value |
|---|---|---|---|
| Size | 0.188*** | 0.198*** | 0.206*** |
| | (0.0319) | (0.0307) | (0.0341) |
| Size^2 | -0.00649*** | -0.00671*** | -0.00728*** |
| | (0.00107) | (0.00104) | (0.00109) |
| Interest expense | -0.0272*** | | |
| | (0.00421) | | |
| Size^2* Interest expense | 7.92e-05*** | | |
| | (1.64e-05) | | |
| High Interest expense(=1) | | -0.0462*** | |
| | | (0.00700) | |
| Size^2* High Interest expense(=1) | | 0.000189*** | |
| | | (3.21e-05) | |
| Leverage | | | -0.00802*** |
| | | | (0.00258) |
| Size^2* Leverage | | | 3.23e-05*** |
| | | | (1.20e-05) |
| Capital Adequacy | 0.0172 | 0.0250 | |
| | (0.0407) | (0.0411) | |
| Deposits | 0.0437** | 0.0511*** | 0.0541*** |
| | (0.0185) | (0.0197) | (0.0202) |
| Efficiency | 0.0523*** | 0.0561*** | 0.0561*** |
| | (0.0107) | (0.0104) | (0.0107) |
| Income growth | 0.000306 | 0.00894 | 0.00812 |
| | (0.00655) | (0.00587) | (0.00579) |
| Market share | 0.00617 | 0.00697 | 0.00695 |
| | (0.00551) | (0.00521) | (0.00583) |
| NPL | -0.00116 | -0.00103 | -0.00157 |
| | (0.00177) | (0.00178) | (0.00188) |
| Liquidity | 0.0259 | 0.0243 | 0.0193 |
| | (0.0182) | (0.0184) | (0.0184) |
| Constant | -0.403* | -0.510** | -0.496* |
| | (0.244) | (0.233) | (0.271) |
| Bank fixed effects | yes | yes | yes |
| Year effects | yes | yes | yes |
| Observations | 3,821 | 3,821 | 3,821 |
| R-squared | 0.629 | 0.626 | 0.623 |
| Number of BHC | 537 | 537 | 537 |

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Table 6**. Bank's charter value, size and the interaction with the cost of delegation (shareholders).

| VARIABLES | (1)<br>Charter Value | (2)<br>Charter Value | (3)<br>Charter Value |
|---|---|---|---|
| Size | 0.127* | 0.118* | 0.246*** |
| | (0.0706) | (0.0686) | (0.0724) |
| Size^2 | -0.00400* | -0.00375* | -0.00731*** |
| | (0.00215) | (0.00209) | (0.00224) |
| Insider Ownership | 0.0109** | | |
| | (0.00497) | | |
| Size^2* Insider Ownership | -0.0000459** | | |
| | (1.95e-05) | | |
| High Insider Ownership(=1) | | 0.108* | |
| | | (0.0557) | |
| Size^2*High Insider Ownership(=1) | | -0.000444** | |
| | | (0.000207) | |
| Incentives | | | 0.0667*** |
| | | | (0.0166) |
| Size^2* Incentives | | | -0.000235*** |
| | | | (6.20e-05) |
| Capital Adequacy | -0.0642 | -0.0598 | 0.0696 |
| | (0.0615) | (0.0628) | (0.0881) |
| Deposits | 0.0568 | 0.0528 | 0.0785* |
| | (0.0385) | (0.0382) | (0.0425) |
| Efficiency | 0.0614*** | 0.0608*** | 0.0596*** |
| | (0.0201) | (0.0201) | (0.0202) |
| Income growth | 0.00215 | 0.00138 | -0.0314*** |
| | (0.00970) | (0.00953) | (0.0113) |
| Market share | 0.00342 | 0.00375 | 0.00999 |
| | (0.00542) | (0.00526) | (0.00652) |
| NPL | -0.00738** | -0.00732** | -0.00991** |
| | (0.00354) | (0.00347) | (0.00403) |
| Liquidity | 0.00591 | 0.0100 | -0.00995 |
| | (0.0393) | (0.0395) | (0.0426) |
| Constant | -0.0372 | 0.0425 | -1.149* |
| | (0.599) | (0.580) | (0.600) |
| Bank fixed effects | yes | Yes | yes |
| Year effects | yes | yes | yes |
| Observations | 1,009 | 1,009 | 1,009 |
| R-squared | 0.672 | 0.672 | 0.589 |
| Number of BHC | 142 | 142 | 142 |

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Table 7**. Robustness tests: Bank's charter value, size estimated using instrumental variables and interaction with systematic risk, direct monitoring cost, and delegation cost for debtholders and shareholders.

| Variables | (1) CharterValue | (2) CharterValue | (3) CharterValue | (4) CharterValue | (5) CharterValue |
|---|---|---|---|---|---|
| Size (IV) | 0.287*** | 0.233** | 0.719** | 0.286*** | 0.142*** |
| | (0.0848) | (0.0996) | (0.330) | (0.102) | (0.0467) |
| Size^2(IV) | -0.00974*** | -0.00784** | -0.0237** | -0.00908** | -0.00451*** |
| | (0.00294) | (0.00349) | (0.0109) | (0.00356) | (0.00143) |
| Size^2(IV)*SYSRISK | | -7.71e-05*** | | | |
| | | (2.23e-05) | | | |
| SYSRISK | | 0.0311*** | | | |
| | | (0.0111) | | | |
| Size^2(IV)*OPAQ | | | -2.12e-05** | | |
| | | | (9.20e-06) | | |
| OPAQ | | | -0.00331* | | |
| | | | (0.00184) | | |
| Size^2(IV)*DELCOST_DEBT | | | | -1.19e-05 | |
| | | | | (1.08e-05) | |
| DELCOST_DEBT | | | | -0.00828*** | |
| | | | | (0.00211) | |
| Size^2(IV)*DELCOST_STOCK | | | | | -3.03e-05** |
| | | | | | (1.48e-05) |
| DELCOST_STOCK | | | | | 0.000437 |
| | | | | | (0.00688) |
| Capital Adequacy | 0.0261 | 0.0367 | 0.0493 | 0.100** | -0.0835* |
| | (0.0355) | (0.0385) | (0.0635) | (0.0445) | (0.0478) |
| Deposits | 0.0469*** | 0.0382** | 0.0498** | 0.0387*** | 0.0551* |
| | (0.0133) | (0.0149) | (0.0207) | (0.0149) | (0.0308) |
| Efficiency | 0.0589*** | 0.0608*** | 0.0573*** | 0.0529*** | 0.0645*** |
| | (0.00668) | (0.00772) | (0.00868) | (0.00780) | (0.0116) |
| Income growth | 0.00901* | 0.00506 | 0.0188* | -0.0346*** | -0.000656 |
| | (0.00536) | (0.00573) | (0.00969) | (0.00670) | (0.00920) |
| Market share | 0.00905 | 0.00799 | 0.0643** | 0.00509 | 0.00405 |
| | (0.00838) | (0.0135) | (0.0312) | (0.00937) | (0.00480) |
| NPL | -0.00130 | -0.000342 | -0.272*** | -0.00303 | -0.00726* |
| | (0.00193) | (0.00191) | (0.0653) | (0.00210) | (0.00421) |
| Liquidity | 0.0265** | 0.0238* | 0.0370* | -0.000580 | 0.0175 |
| | (0.0127) | (0.0143) | (0.0203) | (0.0142) | (0.0248) |
| Bank fixed effects | yes | yes | yes | yes | yes |
| Year effects | yes | yes | yes | yes | yes |
| Observations | 3,772 | 3,163 | 1,882 | 3,772 | 1,053 |
| R-squared | 0.621 | 0.617 | 0.632 | 0.558 | 0.662 |
| Number of BHC | 488 | 476 | 287 | 488 | 137 |

**Table 8**. Further robustness tests: Bank's charter value and size.

| | (2) CharterValue | | (3) ΔCharterValue |
|---|---|---|---|
| Size | 0.156*** | ΔSize | 0.111* |
| | (0.0205) | | (0.0605) |
| Size^2 | -0.00498*** | ΔSize^2 | -0.00614*** |
| | (0.000681) | | (0.00212) |
| Capital Adequacy | 0.0171 | ΔCapital Adequacy | -0.324*** |
| | (0.0360) | | (0.0481) |
| Deposits | 0.0348** | ΔDeposits | 0.0134 |
| | (0.0171) | | (0.0131) |
| Efficiency | 0.0674*** | ΔEfficiency | -0.000356 |
| | (0.00937) | | (0.00594) |
| Income growth | 0.00995* | ΔIncome growth | 0.0141*** |
| | (0.00566) | | (0.00499) |
| Market share | 0.00886*** | ΔMarket share | -0.00318 |
| | (0.00304) | | (0.0104) |
| NPL | -0.00228 | ΔNPL | -0.0847 |
| | (0.00193) | | (0.0606) |
| Liquidity | 0.0296* | ΔLiquidity | 0.0364*** |
| | (0.0161) | | (0.0137) |
| Constant | -0.263* | Constant | 0.00746*** |
| | (0.154) | | (0.00137) |
| Bank random effects | yes | Bank fixed effects | yes |
| Year effects | yes | Year effects | yes |
| Observations | 3,821 | Observations | 3,365 |
| R-squared | | R-squared | 0.391 |
| Number of BHC | 537 | Number of BHC | 489 |