DIVERSIFICATION, INFORMATION ASYMMETRY, COST OF CAPITAL, AND PRODUCTION EFFICIENCY

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ABSTRACT

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This study examines how diversification changes firms' key characteristics, which consequently alter firms' value. The reason why I focus on this topic is because of the mixed findings in literature about the valuation effect of diversification. This study offers deeper insights to the influence of diversification on important valuation factors that are already identified in finance literature. Specifically, it examines if diversification affects firms' information asymmetry problem, firms' cost of capital and cash flow, and firms' production efficiency. The study looks at both the financial industry and non-financial industry and the chapters are arranged in the following order.

Firstly, empirical studies show that investors do not value BHCs' pursuit of non-interest income generating activities and yet these activities have demonstrated a dramatic pace of growth in the recent decades. An interesting question is what factors drive the discontent of the investors with the diversification endeavors of the BHCs in non-interest income activities. The first chapter examines the subject from the view point of information opaqueness, which is unique in the banking industry in terms of its intensity. We propose that increased diversification into non-interest income activities deepens information asymmetry, making BHCs more opaque and curtailing their value, as a result. Two important results are obtained in support of this proposition. First, analysts' forecasts are less accurate and more dispersed for the BHCs with greater

diversity of non-interest income activities, indicating that information asymmetry problem is more severe for these BHCs. Second, stock market reactions to earning announcements by these BHCs signaling new information to the market are larger, indicating that more information is revealed to the market by each announcement. These findings indicate that increased diversity of non-interest income activities is associated with more severe information asymmetry between insiders and outsiders and, hence, a lower valuation by shareholder.

Secondly, since Lang and Stulz (1994) and Berger and Ofek (1995), corporate literature has taken the position that industrial diversification is associated with a firm value discount. However, the validity and the sources of the diversification discount are still highly debated. In particular, extant studies limit themselves to cash flow effects, totally overlooking the cost of capital as a factor determining firm value. Inspired by Lamont and Polk (2001), the second chapter examines how industrial and international diversification change the conglomerates' cost of capital (equity and debt), and thereby the firm value. Our empirical results, based on a sample of Russell 3000 firms over the 1998-2004 period, show that industrial (international) diversification is associated with a lower (higher) firm cost of capital. These findings also hold for firms fully financed with equity. In addition, international diversification is found to be associated with a lower operating cash flow while industrial diversification doesn't alter it. These results indicate that industrial (international) diversification is associated with firm value enhancement (destruction). Given the fact that the majority of the firms involved in industrial diversification also diversify internationally, failing to separate these two dimensions of

diversification may result in mistakenly attributing the diversification discount to industrial diversification.

Thirdly, financial conglomerates have been increasingly diversifying their business into banking, securities, and insurance activities, especially after the Gramm-Leach-Bliley Act (GLBA, 1999). The third chapter examines whether bank holding company (BHC) diversification is associated with improvement in production efficiency. By applying the data envelopment analysis (DEA), the Malmquist Index of productivity, and total factor productivity change as a decomposed factor of the index, are calculated for a sample of BHCs over the period 1997-2007. The following results are obtained. First, technical efficiency is negatively associated with activity diversification and the effect is primarily driven by BHCs that did not diversify through Section 20 subsidiaries before GLBA. Second, the degree of change in diversification over time does not affect the total factor productivity change but is negatively associated with technical efficiency change over time. This latter effect is also primarily shown on BHCs that did not have Section 20 subsidiaries before GLBA. Therefore, it can be concluded that diversification is on average associated with lower production efficiency of BHCs, especially those BHCs without first-mover advantage obtained through Section 20 subsidiaries.

These chapters explores the possible channels through which diversification could alter firms' valuation. They contribute to the literature by offering further knowledge about the effect of diversification.

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CHAPTER 1

NON-INTEREST INCOME DIVERSIFICATION AND INFORMATION ASYMMETRY OF BANK HOLDING COMPANIES

1.1 Introduction

Since 1980s, non-interest income of U.S. banks has grown at roughly twice the rate of net interest income at the national level. The share of the net revenues attributable to non-interest activities has increased from 20% in 1980 to 42% in 2004.[1] The composition of non-interest income has also changed markedly, especially in the most recent decade, as bank holding companies (BHCs) have diversified their businesses into a variety of fee-based activities, insurance, and investment banking.

Several factors on both financial and production side of banking activity can account for the recent growth of non-interest income. First, technological advances and financial innovations such as securitization have opened up new sources of non-interest income by allowing BHCs to offer a much wider set of products and services.[2] Second, deregulatory moves in the financial services industry such as Gramm-Leach-Bliley Act (GLBA) 1999 have opened new frontiers for product diversification by allowing banks to enter securities and insurance markets. Third, the general trend toward deregulation has

[1] Source: Federal Deposit Insurance Corporation, www.fdic.gov. Also see Stiroh (2006).

[2] See Saunders and Cornett (2006), chapter 14, for a discussion of a wide array of products brought to the market place as a result of advancement in technology. At the wholesale corporate level these include cash management products such as controlled disbursement accounts, account reconciliation, wholesale lockboxes, electronic lockboxes, funds concentration accounts, electronic initiation of letters of credit, etc. At the retail level they include ATMs (Automated teller machines), P.O.S (Point-of-sale debit cards), home banking, pre-authorized debits/credits, e-mail billing, online banking, telephone banking, and smart cards. Chapter 21 of this book discusses product diversification and its effect on performance.

intensified competition in the markets for intermediation services, lowering net interest margins and driving banks to seek alternative areas of activities in domestic and international spheres, as a result. The advent of risk-based capital and risk-based insurance premia has further strengthened the attractiveness of these alternative outlets of activity. Fourth, fee-based earnings are less sensitive to economic and interest rate fluctuations, than interest income, and have a low correlation with the latter, allowing risk reduction through diversification. These factors, too, have encouraged banks to switch to fee-based activities.[3] Increased reliance on non-interest income activities, however, is not necessarily associated with decreased risk (see Stiroh and Rumble, 2006 for a detailed review of literature).

On the physical production side, at least theoretically, expansion of non-interest activities has the potential to create scope economies. Diamond (1991), Saunders and Walter (1994), and Stein (2002) argue that banks can use the information they gather about their clients during their long-term contractual relationships, as a valuable input to produce non-interest income with little additional costs. Similarly, non-interest income activities, e.g., securities underwriting and insurance services, in turn produce information that can facilitate lending. Scope economies also arise from the spreading of fixed costs over an expanded product mix. Cost complementarities and scope economies made possible through these channels boost BHC's performance.

Some empirical studies produce contrary to this position. For example, Laeven and Levine (2007) show that market values of financial conglomerates engaged in multiple activities (e.g., lending and non-lending financial services) are lower than if

[3] See DeYoung and Roland (2001).

these conglomerates were broken down into several financial intermediaries, each specializing in one of these activities. This may be an indication that scope diseconomies, rather than economies, are the modus operandi in bank production. Other evidence in this regard includes Berger et al. (1987) and Jagtiani and Khanthavit (1996), who find scope diseconomies among bank products. Similarly, Acharya et al. (2006) show that diversification of bank loan portfolio is not guaranteed to produce superior return performance and/or greater safety for banks.

Given the fact that GLBA (1999) clears the obstacles for BHCs to enter investment banking and insurance markets, and the fact that hundreds of financial holding companies (FHCs) have already been established to take advantage of these opportunities, an important question is why investors do not value financial conglomerates while the legislators and bank managers favor them? Since the banking industry is under close supervision and regulation by government agencies, the agency explanations such as cross-subsidization and manager empire-building and entrenchment, used for diversification discount in non-financial industries, are less than convincing. These explanations simply assume that investors know that managers are destroying firm value and, therefore, they value the firm at a discount. However, there exists an alternative scenario where investors may have less information about the firms' operation because it is highly diversified and, therefore, opaque. If information asymmetry problem worsens along with the firm's business diversification, investors may simply value the firm at a discount because of their information disadvantage compared to investing in focused firms. This scenario may be especially prominent in the banking industry, where information asymmetry plays a more important role than the other industries. Recent

examples of such information asymmetry problem include the striking disclosure by Bear Stearns about the two subprime hedge funds losing nearly all of their value triggered by the subprime crisis. This study examines the diversification discount controversy in the banking industry by looking at the information asymmetry problems associated with increased non-interest income activities.

Information asymmetry is of special interest in banking because financial industry, especially banking sector is unique in terms of opaqueness. Morgan (2002) describes the information asymmetry problem in banking as follows:

Banks are black boxes. Money goes in, and money goes out, but the risks taken in the process of intermediation are hard to observe form outside of the bank.[4]

Dan Borge, a former managing director at Bankers Trust (acquired by Deutsche Bank in 1999) summed up the problem as:

Financial institutions are complex, they're opaque, and people don't trust them because they're opaque.[5]

As a consequence of this opaqueness, in spite of the government supervision and regulations such as disclosure requirements, investors in the banking shares have trouble accessing accurate and up-to-date information. Accordingly, an interesting question is whether the opaqueness problem (information asymmetry problems prevailing between corporate insiders and shareholders) becomes more severe after BHCs expand their

[4] Morgan, Donald P., 2002. Rating banks: Risk and uncertainty in an opaque industry. *American Economic Review* Vol 93, p874.
[5] Knowledge @ Wharton article "Hey, What's that opaque financial institution worth?" http://knowledge.wharton.upenn.edu/article.cfm?articleid=797&CFID=7645684&CFTOKEN=96366812&jsessionid=a8304c71b3d672912538#

business into a wider range of non-traditional commercial banking, investment banking, and insurance activities. This study examines this question.

The existing literature confirms the link between diversification and firm value through the information asymmetry channel. According to Best et al. (2004), if diversification indeed increases information asymmetry, shareholders are likely to value financial conglomerates at a discount because of the more severe information disadvantage. Therefore, at least part of the diversification discount can be attributed to information discount. Bens and Monahan (2004) also show that higher quality disclosure from industrial firms is associated with a reduction of the diversification discount, offering strong support for the argument that diversification may change firms' information opaqueness and, consequently, firms' valuation. Specifically, the channel how information asymmetry affect firm value is identified by Easley and O'Hara (2004) and Easley et al. (2002), where they show that information is an important pricing factor of firms' asset returns.

In this study, two approaches are used to test the association between information asymmetry and diversification; the increase in the level of information asymmetry in response to increased bank diversification, and the market reaction to announcements of earnings by differentially diversified BHCs. Following the extant literature, the proxy measures employed for information asymmetry between bank insiders and outside shareholders include both the forecast error and analyst forecast dispersion. Diversification in BHC's non-interest income is taken into consideration by 1) the ratio of non-interest income to the sum of interest and non-interest income, as in Stiroh and Rumble (2006); and 2) the diversification among individual non-interest income

activities. The first measure actually pays more attention on the importance of non-interest income as a whole, while the second is a more accurate measure of diversity across different activities.

Our empirical results show that, after controlling for the common factors identified in the literature as determinants of analysts' forecast accuracy, an increase in the ratio of non-interest income to total income does *not* generally lead to less accurate analyst forecasts. What is interesting, however, is that an increase in the diversification among the non-interest activities *does* significantly increase the analyst forecast error and analyst forecast dispersion. From this latter finding, it may be argued that when diversification in non-interest income activities increases, information asymmetry problem intensifies. As a consequence to this, investors will have less information available to them on the BHC, will have more difficulty making an accurate assessment of it, and will be less willing to pay for it.

In addition, our event study on the market reaction to earning announcements shows that the adjusted abnormal returns around such announcements are significantly larger for BHCs with higher ratio of non-interest income and or greater diversification in non-interest income activities. These results indicate that earning announcements by BHCs with a larger share and/or a greater diversity of non-interest income reveal more substantial private information to the market participants, confirming the higher depth of the information asymmetry problem between insiders and outsiders of such BHCs.

This study focuses on BHCs with a broad range of non-interest income activities over the most recent years and examines the association between the level of information asymmetry and non-interest income diversification. The contributions of the study

include the following: First, this study provides an alternative explanation for the diversification discount for BHCs from the perspective of information opaqueness, which is a unique characteristic of the banking industry. Morgan (2002) shows that banking and insurance are the two most opaque industries. GLBA allowed financial holding companies to perform both activities plus investment banking activity under one roof. It would be interesting to test whether this move alleviate the information asymmetry problem. Unfortunately, there is no empirical evidence showing how information asymmetry between insiders and outside investors of BHCs are associated with non-interest income diversification. This study fills the gap.

Second, the format changes in 2001 and afterwards in the quarterly *Reports of Income* filed with regulators by banks enables researchers to study non-interest income with detailed information that were heretofore unavailable. To my best knowledge, this study is the first to focus on how BHCs' pursuit of non-interest income affects their information asymmetry. A similar study, Flannery et al. (2004), fails to take into consideration the recent booming of the non-interest income activities.

Third, the results of this study contribute to a better understanding of the contradiction between theoretical prediction that diversification benefits BHCs (e.g., Saunders and Walter, 1994) and empirical finding indicating a value discount of BHCs (e.g., Laeven and Levine, 2007). Diversification is accompanied with increased information asymmetry, which in turn results in an "information discount". This finding calls for better disclosure on the part of the BHCs and in particular those expanding into investment banking and insurance activities. In this matter, this study relates to the literature on the quality of disclosure and diversification discount for industrial firms.

This study also contributes to the analyst forecast literature because financial firms have been largely ignored in previous studies of analysts forecast. Identification of diversification as an additional factor that affects the accuracy of analyst forecast suggests that both investors and researchers should take it into their consideration while looking at the earning forecasts.

The evidence shown here is also relevant to policymakers. The GLBA (1999) allowed banking institutions to commingle with securities firms and insurers. The finding here shows that investors may suffer from insufficient information about BHCs' new activities, and, therefore, may find it difficult to predict the BHC earnings. The problem of information asymmetry heightens the importance of information disclosure parallel to a supervision structure focused on ensuring the safety and soundness of BHC operation. Without detailed and up-to-date information, equity and debt holders can not effectively play their monitoring role, and, therefore, regulators will be needed to provide additional safeguards to the banking industry. This result contradicts Herring and Santomero's (2000) study, who argue that the optimal regulation for the purposes of safety and soundness may be no regulation at all.

The paper proceeds as follows. Section 1.2 reviews related literature and develops the hypotheses. Section 1.3 describes the sample selection process and variable measurements. Section 1.4 reports the empirical results and Section 1.5 concludes.

1.2 Hypothesis Development

The passage of the GLBA allowed BHCs to affiliate with a wide range of financial services outside the traditional banking, including insurance, investment banking, and merchant banking, broadly classified as non-interest income activities.[6] BHCs have long been producing non-interest income, e.g., from trust services, safe box fees and servicing of securitized loans. In the last decade, however, non-interest income has grown from a supportive role into a major contributor to bank revenues based on a diversified set of products.

The banking industry is known to be more information-intensive than any other industry because banks make loans to information-intensive borrowers as the "delegated monitors" (Diamond, 1984; Denis and Mihov, 2003). Carey et al. (1998) also offer extensive evidence that banks serve information-problematic borrowers. This nature of banks' business activities may consequently result in information opaqueness between insiders and outside shareholders of the bank (Morgan, 2002). A major concern is that as BHCs expand further into non-interest income activities, the information asymmetry problem between bank insiders and outsiders may intensify due to the proliferation of their activities and the complex nature of their interdependencies.

Several factors contribute to the deepening of the information asymmetry. First, while the information needed to evaluate a diversified BHC is large in magnitude and

[6] GLBA authorizes FHCs to engage in activities that are financial in nature including: 1) securities underwriting and dealing; 2) insurance agency and underwriting; and 3) merchant banking. FHCs may engage also in any other activities that the Federal Reserve Board determines to be financial in nature or incidental or complementary to financial activities after consultation with the Secretary of the Treasury. Prior to GLBA, section 20 subsidiaries were a channel for BHCs to engage in limited investment banking.

multifaceted, the level of information available to public is limited. BHCs perform a multitude of interest and non-interest activities in many subsidiaries or functional units. Detailed information about each activity is available to the subsidiary manager but only limited and aggregated information is reported to the public. Transmission of detailed and credible information to outsiders is highly costly. This also serves as the rationale for the existence of internal capital markets in diversified industrial firms according to Weston (1970) and Stein (1997). Starting from 2001, the FDIC has required BHCs to report detailed information about their non-interest income in their income statements. Nonetheless, because of the ex post nature of the reported information, it can only partially alleviate the information asymmetry between insiders and outsiders.

Second, information asymmetry in banking may become deeper because of the information intensity of the enterprise and the high volatility of the BHC non-interest revenues. Although portfolio theory suggests that involving in a variety of activities reduces bank risk when the correlation among the cash flows is low, recent empirical studies find that the expansion into non-interest income activities is indeed associated with increased risk (see, DeYoung and Roland, 2001; and Stiroh, 2006, among others). Stiroh and Rumble (2006) and Stiroh (2004) point out that even if diversification benefits do exist, they would be obscured by the increase in direct exposure of the banks to high-volatility activities such as trading revenue.[7] Lim (2001) argues that financial analysts make less accurate forecasts on firms posting more volatile earnings. Therefore, facing

[7] Activities of rogue traders have resulted in major losses and even failure of some major banks. See chapter 10 of Saunders book for 213 and 506. Barings (UK merchant bank) went insolvent in 2/95. Daiwa Bank branch in New York had major losses in stock futures in 9/95. A rogue trader of Sumitomo Corp lost $2.6B in commodity futures in 1996. AllFirst/ Allied Irish lost $691 million. Allfirst was eventually sold to Buffalo based M&T Bank due to dissatisfaction among stockholders of Allied Irish Bank of America and Chase lost $100sM in the Asian and Eastern European crises in 1997 and the Russian government bond crisis and the collapse of the Ruble in1998.

more complex and volatile information would make it more difficult for investors and financial analysts to efficiently evaluate the BHCs.

The third reason lies in analyst's specialization in individual industries. In the post-GLBA era, BHC activities potentially include traditional banking, investment banking, insurance, and other financial services. Since equity analysts generally specialize within one particular industry, following diversified BHCs may fall beyond their capability. According to Dunn and Nathan (2005), analysts following more business segments and a greater diversification of industries make less accurate earnings forecasts. Hence, investors and financial analysts will be less likely to effectively process the information on more diversified BHCs. In additional to these three factors, information asymmetry and opaqueness problem may also result from the more complicated organizational structure of diversified BHCs. Investment banking and insurance activities are generally performed in different subsidiaries from commercial banking unit. Therefore, BHCs' diversification into more activities will be inevitably accompanied by more complex structure for the financial conglomerates. Outside shareholders may consequently have more trouble to obtain accurate and up-to-date information about the BHCs.

There do exist counter arguments to this view. First, BHCs with a greater diversity in non-interest income may experience less information asymmetry problems because assets that generate non-interest income are more liquid than traditional banking assets and, hence, easier to evaluate. In general, most bank loans do not trade in active secondary markets and investors have very limited information about those assets unless banks make announcements about their loans. On the other hand, security trading

activities of BHCs occur much more frequently on open markets. Hence, outsiders should be better able to value the trading assets of the BHCs, than their traditional activities, with the help of up-to-date market value information available. Benston and Kaufman (1988) offer similar arguments.

Second, because of the aggregate nature of analyst forecast on the individual BHC as a whole, the information error for each non-interest income activity may be diversified away, resulting in a smaller overall forecast error. Based on Thomas' (2002) argument, if we assume that the errors made by analysts in forecasting individual non-interest income activities are imperfectly correlated to each other, then even if analysts make larger errors in forecasting non-interest income, than in forecasting traditional interest income, the absolute value of the percentage error in forecasting the whole BHC's income may still be smaller than forecasting traditional interest income. In this scenario, unless all the forecast errors are perfectly correlated, the more activities an analyst has to cover, the more accurate the forecast may become. BHCs with a greater diversity in non-interest income activities may actually benefit from the fact that in construction aggregate information measures, some noise is diversified away and, hence, the information asymmetry between insiders and outsiders of these BHCs may be less severe.

It is notable that in some cases, the positive effects dominate the negative ones, and in some others the reverse will hold true. Hence, the question whether information asymmetry worsens or improves with diversification in non-interest income is an empirical matter that we will address. The following sections will utilize forecast accuracy of financial analysts and stock market reaction to earning announcement as proxies for information asymmetry to test the two competing hypothesis.

H_{1A} *complexity hypothesis*: Greater non-interest income diversification is associated with more severe information asymmetry between insiders and outsiders of BHCs.

H_{1B} *aggregation hypothesis*: Greater non-interest income diversification is associated with less severe information asymmetry between insiders and outsiders of BHCs.

1.3 Data Description and Summary Statistics

1.3.1 Proxy for Information Asymmetry and Data Source

Analyst forecasts have received much attention in both accounting and finance literature. Equity analysts used to have better access to firms' information than investors before the passage of the Fair Disclosure regulation (October 2000) through meetings with managers of corporations (see, e.g., Bailey et al., 2003; Brown et al. 1987; Kross and Ro, 1990). Even if analysts have the same information about the firms as outside investors, their expertise enables them to better interpret the information and to generate more accurate estimates about firms' earnings than general investors can. For this reason, the accuracy and the dispersion of analysts' forecasts have long been used as proxies for information asymmetry between insiders and outsiders. The larger the forecast error and the more dispersed the analysts' forecast, the more intense the information asymmetry is considered to be (Thomas, 2002; Flannery et al., 2004; and Bailey et al., 2003).

Another commonly used method for studying information asymmetry is to examine the market reaction to firms' earning announcements. Quarterly earning

announcements reveal material firm information, which may not be heretofore available to outsiders. The magnitude of the stock market reaction to such announcements is often used as proxy for the amount of new information made available by the insiders through these announcements (e.g., Bailey et al., 2003; Herflin et al., 2003; and Dierkens, 1991, among others). If non-interest income diversification deepens information asymmetry, one would expect that BHCs with greater diversity in non-interest income may receive larger market reactions to earning announcement as indicated by the complexity hypothesis. The aggregation hypothesis would indicate the reverse.

The time period covered in this study (2001-2005) is determined by the events that significantly altered the range of banking activity and the requirement for information disclosure. These include the passage of the GLBA (1999), Fair Disclosure requirement (2000), and requirement of more detailed reporting on non-interest activities in 20001. First, the GLBA (1999) allowed full affiliation of commercial banking with investment and merchant banking, and insurance activities under the umbrella of a financial holding company (FHC).[8] As a result, many BHCs exploited these new sources of revenue and put more emphasis on non-interest income.

Second, the U.S. Securities and Exchange Commission's Fair Disclosure (FD) regulation, adopted in October 2000, mandated that all publicly traded companies must disclose material information to all investors at the same time. By prohibiting selective disclosure, in which some investors (often large institutional investors) receive material information before other investors, FD regulation fundamentally changed how companies communicate with their investors. Opponents of FD argue that this regulation may

[8] See Furlong (2000). The Gramm-Leach-Bliley Act and Financial Integration. Federal Reserve Bank of San Francisco Economic Letter, 2000-10, March 31-2000.

decrease the quality and quantity of publicly available information because firms will be reluctant to disclose proprietary information to all market participants, especially their rival firms. Indeed, Irani and Karamanou (2003) have verified a decrease in analyst following, and an increase in forecast dispersion, following the passage of the Fair Disclosure regulation.

Third, prior to 2001, banks were only required to report the level of their non-interest income including service charges on deposit accounts, fiduciary (trust) income, and revenues from trading operations on the Y-9C reporting form. Any other sources of non-interest income were reported in the residual categories of "other fee income" and "all other non-interest income". The new report format, introduced in the first quarter of 2001, still includes fiduciary income, deposit service charges, and trading revenues, but it now also breaks out income from investment banking, venture capital investments, servicing fees, asset securitization activities, insurance commissions and fees, and proceeds from sales of loans, other real estate, and other assets.[9] With the new information available, it is possible to examine the relative importance of each of these income sources to bank revenues (Appendix A details the reporting format changes of non-interest income).

Based on these three changes in the banking industry, the sample is set to begin on the first quarter of 2001 to avoid possible contamination. The ending period for the sample is set at the last quarter of 2005 due to data availability. The sample is constructed on a quarterly basis. Three databases are employed in sample construction: the Bank Holding Company (BHC) database from the Federal Reserve Bank of Chicago, the

[9] See "New Reporting Offers Insight Into Bank Activities", FDIC, Internet access: http://www.fdic.gov/bank/analytical/fyi/2002/041802fyi.html

Institutional Brokers Estimate System (I/B/E/S) database, and the Center for Research in Security Price (CRSP) database.

The sample selection procedure is as follows. For a BHC to be included in the sample, it has to be listed in both the BHC Database and Russell 3000 index. Under the GLBA, BHCs may elect to become FHCs. However, since becoming a FHC is not a necessary condition for banks to be involved in insurance and underwriting activities, this study extracts data on all BHCs and not just FHCs (actually BHCs have limited access to such activities before GLBA through loopholes and interpretative freedom of legislation such as Section 20 subsidiaries and operational subsidiaries, please see Barth et al., 2000 for detail). The Russell 3000 index members are the largest firms in terms of stock market capitalization. Since this study examines the equity analysts' forecasts and stock market reactions to earning announcements, the choice of the Russell 3000 index members offers a cut-off point for the size of the publicly traded BHCs. The procedure results in a starting group of 326 BHCs, which are rather homogenous in terms of size and activities.

For each BHC and each quarter, the BHC Database offers information from Consolidated Financial Statement for BHCs (form FR Y-9C) with detailed income composition including all the previously mentioned items of non-interest income and BHC's characteristic data. Analyst coverage data are collected from I/B/E/S Detail Earnings Estimate History File, which offers earning forecasts and stock recommendations from thousands of individual security analysts. The forecast period ending date in I/B/E/S is matched to the date in BHC database. For each forecast period ending quarter, all of the analyst forecasts made one quarter prior to the current quarter

ending date are collected as the universe of forecasts. I require that each BHC has at least three analyst forecasts for each quarter. It is well known that forecast horizons will influence forecast accuracy (Brown, 1993). By taking similar forecast horizons, such influences will be minimized. Lastly, the CRSP database offers the daily stock price and the number of stocks outstanding for each BHC.

1.3.2 Variable Construction

Three groups of variables describing non-interest income activities, analyst forecast variables, and control variables are described in this section.

1.3.2.1 Non-interest Income Diversification Measures

To measure BHC's reliance on non-interest income, a variable RATIO is constructed as the ratio of non-interest income to the sum of interest income and non-interest income.[10] An alternative measure can be constructed in a way similar to a Hirschman-Herfindahl-Index (HHI) using interest and non-interest income as the two components. A weakness of this measure is that it treats a BHC with a RATIO of 0.4 and a BHC with a RATIO of 0.6 as the same since the shares of interest income and non-interest income have to add up to 1. This study examines the association between information asymmetry and increases in the share of non-interest income in total income (Ratio), and diversification in the non-interest activities of BHCs. Stiroh and Rumble (2006) follow a similar variable construction.

On the FR Y-9C report format started in 2001, there are 13 different items reported as non-interest income (with minor variation after 2003, see Appendix A for

[10] Note that the FR Y-9C report does not offer the sum of interest income and non-interest income. Net income is calculated as interest income minus interest expense, plus non-interest income, and then minus non-interest expense.

detail). They are: a) income from fiduciary activities; b) service charges on deposit accounts in domestic offices; c) trading revenue; d) investment banking, advisory, brokerage, and underwriting fees and commissions; e) venture capital revenue; f) net servicing fee; g) net securitization income; h1) underwriting income from insurance and reinsurance activities; h2) income from other insurance and reinsurance activities; i) net gains (losses) on sales of loans and leases; j) net gains (losses) on sales of other real estate owned; k) net gains (losses) on sales of other assets (excluding securities); and l) other non-interest income. Items h1 and h2 are combined together as insurance income and items i, j, and k are combined together as net gains on sales. Therefore, non-interest income is classified into ten categories. Following Hughes et al. (1999) and Deng et al. (2007), a Hirschman-Herfindahl-Index like diversification measure (NDIV) is constructed for the ten different items listed under non-interest income. The NDIV is computed as one minus the sum of the squares of each item's proportion of the total.

$$NDIV = 1 - \sum_i \left(\frac{Income_i}{\sum_i Income_i} \right)^2, \quad \text{i=1, 2, ..., 10 for each non-interest income} \qquad (1\text{-}1)$$

A higher score on NDIV means the BHC is more diversified among non-interest income activities. As a robustness check, a similar diversification measure is also tested using the 13 components of non-interest income. In addition, a comprehensive total activity diversification measure is constructed by adding interest income as an additional item into the 10 non-interest income in (1). This variable takes into consideration all the activities a BHC perform; both interest income and non-interest income activities. It, however, cannot separate the relative importance of non-interest income shown by

RATIO. Empirical tests are performed using alternative diversification measures and the analysis yields similar results (see Section 1.4.4).

1.3.2.2 Analyst Forecast Measures

To measures the accuracy of analyst forecasts, three variables are constructed. First, following Hong and Kubik (2003) and Flannery et al. (2004), the forecast error is calculated as the absolute value of the difference between forecasted and actual earnings per share, for each individual forecast observation. At the next step, for each BHC and each quarter, the analysts forecast error (ERROR) is defined as the median of all individual errors across the analysts, divided by stock price at the end of the quarter (multiplied by 10,000 for ease of viewing). This is the primary measure that will be used in our empirical analysis.

Second, following Bailey et al. (2003) and Duru and Reeb (2002), the absolute consensus forecast error (C-ERROR) is used as an alternative measure of forecast accuracy. This is defined as the absolute value of the difference between the median of individual forecasts and actual earnings, divided by stock price at the end of the quarter (multiplied by 10,000 for ease of viewing). This measure will be used in the robustness test section. BHCs with larger information asymmetry between insiders and outsiders regarding firm earnings are expected to have larger ERROR and C-ERROR values. Finally, analyst forecast dispersion (STD) is defined as the standard deviation of analysts' forecasts deflated by the stock price at the end of the quarter (again multiplied by 10,000 for ease of viewing). As a measure of disagreement among analysts, STD also proxies lack of transparent information available to outsiders. BHCs with larger information problems are expected to have a larger STD.

1.3.2.3 Market Reaction Measures

Following the standard event study methodology, this study examines the abnormal stock returns in response to the quarterly earning announcements in order to determine the depth of information asymmetry in BHC diversification. The earning announcement date, which is obtained from I/B/E/S, is defined as day zero. A one-factor market model is estimated using BHC's daily stock return and return of CRSP value-weighted index over days -210 to -11. Daily abnormal return is defined as the difference between the observed return and the estimated return based on the market model. Following Thomas (2002), the cumulated abnormal return ($\left|\mathrm{CAR}\right|$) is defined as the absolute value of the cumulated abnormal return (AR) over the 3-day period from -1 to 1. Since the purpose of using abnormal return is to measure the amount of new information, the primary interest should be put on the magnitude of the shock. Hence, we will focus on the absolute value of abnormal return $\left|\mathrm{CAR}\right|$, instead of the direction of it.

1.3.2.4 Control Variables

In order to examine the relationship between analyst forecast accuracy and non-interest income activity diversification, it is necessary to control for other BHC's characteristics that can impact forecast quality. Based on Brown et al. (1985) and Brown (1993), the following factors are included as control variables.

Firm size is a common control factor in the literature. Atiase (1985) shows that firm size may improve forecast accuracy and reduce forecast dispersion. BHC size (SIZE) is measured as the natural log of the book value of total assets at the end of each quarter. Thomas (2002) suggests that firms with a larger growth opportunity set would be relatively more difficult to predict, than firms with less growth potential. Market-to-book

ratio (MTB) is used to proxy for the growth opportunities of a BHC and it is included in the model as a control variable. Book value is the book value of total asset at the end of the quarter. Market value is the product of the number of shares outstanding and the quarter-end stock price. Similarly, leverage may increase the volatility of earnings and, therefore, increase the difficulty of forecasting (Flannery et al., 2004). This effect is controlled for by introducing leverage (LEVG), defined as the ratio of total liabilities to total assets. The effect of profitability of BHC is controlled for by including the ratio of net income to total assets (ROA).

Following Alford and Berger (1999), to control for firm-specific information, variable VOLATILITY, calculated as the standard deviation of the market model residuals over the last 24 months before the current quarter ending date, is introduced as a regressor. This variable is a measure of the amount of price-relevant information that arrives daily to the market about a particular BHC. Thomas (2002) and Alford and Berger (1999) argue that as the information to be processed by analysts increases, the analysts' ability to provide accurate forecasts declines. Therefore, an increase in VOLATILITY would be associated with an increase in forecast error and forecast dispersion.

Brown (2001) finds that analysts are more likely to issue more optimistic forecasts in loss periods. Following Duru and Reeb (2002), a dummy variable (LOSS) is used to control for the loss period effect. This variable takes the unit value for a negative actual earning, and zero otherwise. In addition, the number of forecasts offered by analysts (# ANALYSTS) is included to control for how much attention a BHC receives from analysts Lys and Soo (1995) find that after controlling for firm-specific forecasting difficulty factors, forecast accuracy increases with analyst following because of the

competition among analysts. However, under severe information asymmetry condition, different analysts may not obtain same set of information, and therefore more analysts following do not necessarily yield more accurate forecasts. Lastly, as in Atiase (1987), a dummy variable is also introduced to control for BHCs listed on NASDAQ (NASDAQ). Finally, Year dummy variables are included to control for the possible effects of changes in macroeconomic conditions and technology.

To examine the relationships between the size of the market reaction and the degree of diversification in non-interest income, following Bailey et al. (2003), several control variables are used in the cross-sectional regression employed for this purpose. ERROR and SIZE are used to control for return volatility and the amount of information available about the firm, respectively. STD serves as a proxy for pre-announcement disagreement among analysts. Thomas (2002) also uses market to book (MTB) and leverage (LEVG) to control for growth opportunity and risk, respectively. All these variables are as defined earlier.

1.3.3 Descriptive and Univariate Statistics

To reduce the influence of extreme values, we employ Grubbs' Test (1969) and winsorizes outliers of ERROR. Outliers are defined as observations that are three standard deviations away from the mean. The process reduces the sample size by less than 1.5%. The results of regression analysis remain qualitatively similar after winsorization but the explanatory power of analysis is significantly higher.

Table 1-1 provides the definitions and descriptive statistics for the key variables used in this chapter. Panel A and B offer detailed variable construction. ERROR values are nonnegative by construction. The more accurate the analysts' forecasts, the smaller

Table 1-1: Variable definition and sample statistics.
Quarterly observations during 2001-2005

Panel A: Dependent Variables

ERROR	The median of absolute errors of individual forecasts, divided by stock price at the end of the quarter and multiplied by 10000 for ease of viewing.
C-ERROR	Absolute consensus forecast error. It is defined as the absolute value of the difference between the median of individual forecasts and actual earnings, divided by stock price at the end of the quarter and multiplied by 10000 for ease of viewing.
STD	Forecast dispersion. It is defined as the standard deviation of analysts' forecasts deflated by the stock price at the end of the quarter and multiplied by 10000 for ease of viewing.
|CAR|	Cumulated abnormal return, defined as the absolute value of cumulated abnormal return over the (-1, +1) window (announcement date as 0), where abnormal return is based on a one-factor market model estimated using BHC's daily return and return of CRSP value-weighted index over days -210 to -11 and multiplied by 100 for ease of viewing.
ACAR	Adjusted cumulated abnormal return, defined as the |CAR| divided by VOLATILITY. VOLATILITY is defined in Panel B.

Panel B: Independent Variables

NDIV	Hirschman- Herfindahl Index like measure for the dispersion among non-interest income activities.
RATIO	The ratio of BHC's non-interest income to the sum of interest income and non-interest income.
MTB	The market to book ratio, defined as the sum of book value of debt and market value of equity divided by the book of value of total assets.
SIZE	The natural log of book value of total assets at the end of each quarter.
LEVG	Leverage, which is defined as the ratio of total liabilities to total assets.
ROA	Profitability measure defined as the ratio of net income to book value of total assets.
# ANALYSTS	The number of analysts offered forecasts on the BHC one quarter prior to the current quarter.
VOLATILITY	The standard deviation of the market model residuals on daily stock returns over the last 24 months before the current quarter ending date.
LOSS	A dummy variable that takes a value of 1 for a negative actual earning, and 0 otherwise.
NASDAQ	A dummy variable that takes a value of 1 for BHCs listed on NASDAQ market, and 0 otherwise.

Panel C: Descriptive Statistics

Variable	Description	NOBS	Mean	Median	St.d.	Max	Min
ERROR	Mdian forecast error	2212	8.945	4.756	12.400	98.385	0
C-ERROR	Absolute consensus forecast error	2212	8.371	4.389	12.471	98.421	0
STD	Forecast Dispersion	2212	5.595	3.265	10.444	254.030	0
NDIV	Non-interest income diversification	2212	0.646	0.681	0.143	0.861	0.008
RATIO	Ratio of non-interest income	2212	0.239	0.206	0.139	0.841	0.006
TA ($billion)	Total assets	2212	50.004	6.617	172.324	1547.789	0.258
SIZE	Natural log of total assets (thousands)	2212	15.944	15.705	1.620	21.160	12.460
MTB	Market to book ratio	2212	1.112	1.098	0.093	2.115	0.882
LEVG	Leverage	2212	0.905	0.907	0.023	0.951	0.774
ROA	Net income/Total assets	2212	0.008	0.007	0.005	0.043	-0.002
# ANALYSTS	Number of analyst forecasts	2212	9.499	6	8.144	49	3
VOLATILITY	Root mean square error of market model	2212	0.016	0.016	0.005	0.045	0.006

Panel D: Sample distribution over time

Year	NOBS
2001	307
2002	363
2003	455
2004	510
2005	577

the value of ERROR. Therefore, factors that are positively related to ERROR are associated with less accurate forecasts. Panel C describes sample data distribution. BHCs included in the sample are the largest in the U.S., with a mean book value of assets of $50 billion over the 2001-2005 sample period. BHCs in our sample are also highly leveraged, with a mean leverage of 0.9. At the mean level, a typical BHC has about 24% of its income from non-interest income activities and a non-interest diversification index (NDIV) value of 0.646. In addition, a median BHC receives 6 analyst forecasts in a particular quarter. Panel D shows that the data are evenly distributed across years.

Table 1-2 shows the Pearson correlation matrix for the variables used in our analysis. The following points are noteworthy. The correlation coefficient between forecast error (ERROR) and the ratio of non-interest income to the sum of interest income and non-interest income (RATIO) is insignificant indicating that BHCs relying more on non-interest income do not necessarily get less accurate forecasts. However, for the BHCs with larger diversification among non-interest income activities, analysts are likely to offer less accurate forecasts because the correlation between ERROR and NDIV is significantly positive. Greater diversification among non-interest income activities is also positively associated with the standard deviation of forecasts, indicating that analysts would have more dispersed opinions on earnings of more diversified BHCs. In addition, a larger number of forecasts offered in particular quarter for a particular BHC is associated with less accurate forecasts and larger standard deviation among forecasts. The implication is that, given the opaqueness of the non-interest activities, as the number of analysts following increases the analysts agree with one another to a lesser extent and, hence, their forecasts will be less informative.

Table 1-2: Pearson simple correlation coefficients among variables

	ERROR	C-ERROR	STD	NDIV	RATIO	SIZE	MTB	LEVG	ROA	# ANALYSTS
C-ERROR	0.988									
	<.0001									
STD	0.355	0.300								
	<.0001	*<.0001*								
NDIV	0.058	0.051	0.052							
	0.007	*0.017*	*0.014*							
RATIO	0.026	0.023	-0.003	-0.149						
	0.219	*0.282*	*0.876*	*<.0001*						
SIZE	-0.004	-0.012	0.030	0.233	0.564					
	0.848	*0.563*	*0.161*	*<.0001*	*<.0001*					
MTB	-0.155	-0.145	-0.131	-0.199	0.144	-0.060				
	<.0001	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*0.005*				
LEVG	0.040	0.034	0.031	0.018	-0.100	-0.026	-0.016			
	0.057	*0.110*	*0.152*	*0.394*	*<.0001*	*0.226*	*0.445*			
ROA	-0.106	-0.100	-0.102	-0.080	0.181	0.108	0.239	-0.238		
	<.0001	*<.0001*	*<.0001*	*0.000*	*<.0001*	*<.0001*	*<.0001*	*<.0001*		
# ANALYSTS	0.070	0.049	0.132	0.113	0.516	0.748	0.058	-0.078	0.119	
	0.001	*0.021*	*<.0001*	*<.0001*	*<.0001*	*<.0001*	*0.007*	*0.000*	*<.0001*	
VOLATILITY	0.091	0.089	0.074	-0.259	-0.167	-0.366	-0.036	0.023	-0.128	-0.245
	<.0001	*<.0001*	*0.001*	*<.0001*	*<.0001*	*<.0001*	*0.089*	*0.279*	*<.0001*	*<.0001*

Note: This table reports simple correlation between pairs of variables used in the study with significance levels given underneath. Variable definitions are given in Table 1-1.

Based on the correlation coefficients reported in Table 1-2, certain BHC characteristics also seem to affect the degree of diversification and the accuracy of forecasts. Larger BHCs are more likely to diversify into non-interest income activities. This is shown by the positive coefficients between SIZE and RATIO and/or between SIZE and non- interest income diversification measure (NDIV). In addition, BHCs with higher market to book ratio (MTB), higher profitability (ROA), and less firm-specific information in their stock returns (VOLATILITY) are found to receive more accurate forecasts from analysts. The positive signs on MTB and ROA indicate that BHCs with better growth opportunity and better profitability are more likely to reveal their information to the stock market. Lastly, larger BHCs are likely to be followed by a larger number of financial analysts. This relationship is supported by the high correlation between the number of FORECAST and SIZE and it is a common finding in the literature on financial analysts (e.g., Duru and Reeb, 2002, among others).

1.4 Regression Analysis

In this section, three procedures will be employed to examine the association between information asymmetry and diversification into non-interest income activities. These include Tobit regression models based on the pooled (cross-section time-series) data explaining analyst forecast accuracy in Section 1.4.1, Tobit models explaining analyst forecast dispersion in Section 1.4.2, and Tobit models investigating the response of the stock market to BHCs' quarterly earning announcement (revealing new

information) in Section 1.4.3. Regression results based on the ordinary least square regressions (OLS) are similar.

1.4.1 Analyst Forecast Accuracy

If an increase in the share of non-interest income activities (RATIO) or an increase in non-interest income diversification (NDIV) in BHCs strengthens information asymmetry, one would expect to observe less accurate analysts' forecasts for BHCs with larger RATIOs and more diversified BHCs (NDIV), ceteris paribus. Following Thomas (2002), the following Tobit model is estimated to determine the association between information asymmetry and diversification:

$$\text{ERROR} = \beta_0 + \beta_1\text{RATIO} + \beta_2\text{NDIV} + \beta_3\text{SIZE} + \beta_4\text{MTB} + \beta_5\text{LEVG} + \beta_6\text{ROA} + \beta_7\#\text{Analysts} + \beta_8\text{VOLATILITY} + \beta_9\text{LOSS} + \beta_{10}\text{NASDAQ} + \beta_{11}\text{YearDummy} \quad (1\text{-}2)$$

The variables in the model are as defined earlier. The parameters of interest are β_1 and β_2, which measure the strength of the relationship between information asymmetry on one side and the ratio and diversification of non-interest income, on the other side, respectively. Positive values of coefficients β_1 and β_2 will support the complexity hypothesis and indicate increasing information asymmetry when BHCs increase their non-interest income ratio and/or non-interest income diversification, respectively.[11] Below, we first include the non-interest income share (RATIO) and diversification (NDIV) as alternative explanatory variables for information asymmetry and then introduce them simultaneously as regressors in the model.

[11] The extent of multicollinearity is tested using Variance Inflation Factors (VIF) and other testing criteria None of the independent variables obtain a VIF score larger than 4. The results show that collinearity does not pose a serious problem.

1.4.1.1 Non-Interest Income Share versus Diversification

Table 1-3 reports the regression results using RATIO as the proxy for non-interest income activity to explain analysts' forecast errors (ERROR). Using RATIO as the measure of BHC's reliance on non-interest income allows our results to be compared with other studies using aggregate measures of non-interest income activities (e.g., Stiroh 2004 and 2006). Following Thomas (2002), the control variables are added in a step-wise manner in order to check the robustness of the findings to various model specifications. In Model 1, the explanatory variables are RATIO, SIZE, and year dummies. The results show that changes in the ratio of non-interest income to total income (RATIO) are not significant associated with the accuracy of analyst's forecasts. The results of this basic model may be unreliable, however, because it suffers from possible omitted variable problem.

In Model 2, the regression model is extended to include three additional control variables representing BHCs' characteristics; market to book (MTB), leverage (LEVG), and profitability (ROA). As shown in Table 1-2, these variables are all correlated with analyst forecast accuracy as measured by forecast error (ERROR). In this extended model, an increase in non-interest income share (RATIO) is found to be associated with less accurate forecasts. The size of the BHC is found to be negatively correlated with analysts' forecast error, indicating higher forecast accuracy for larger BHCs. The explanation for this finding may be twofold: First, larger BHCs are more transparent and make more public information available to outsiders. Second, larger BHCs receive more attention and closer scrutiny from analysts because of the more important role they play in the banking system. This result is consistent with Thomas (2002), who finds larger

Table 1-3: Tobit regressions of the pooled sample explaining forecast error (ERROR)

This table presents results of Tobit regressions in which the dependent variable is forecast error (ERROR), defined as the median of absolute errors of individual forecast (times 10,000), divided by stock price at the end of the quarter. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. Control variables are as follows. MTB is the market to book ratio, defined as the sum of book value of debt and market value of equity divided by the book of value of total assets. SIZE is the natural log of the book value of total assets at the end of each quarter. LEVG is defined as the ratio of total liabilities to total assets. ROA is the ratio of net income to book value of total assets. # ANALYSTS is the number of analysts offering one quarter ahead forecasts on the particular BHC for the current quarter. VOLATILITY is calculated as the standard deviation of the market model residuals over the last 24 months before the current quarter ending date. The LOSS dummy takes a value of 1 for a negative actual earning, and zero otherwise. The NASDAQ dummy takes the unit value for BHCs listed on NASDAQ.

Dependent Variable: Analysts' Forecast Error					
Models	1	2	3	4	5
Intercept	8.577***	9.04	9.173	12.60	3.792
	(2.63)	(1.50)	(0.69)	(0.95)	(0.29)
RATIO	3.302	3.699**	3.472	3.262	
	(1.31)	(1.99)	(1.34)	(1.27)	
NDIV					7.594***
					(3.62)
SIZE	-0.165	-0.437**	-0.930***	-1.140***	-1.126***
	(-0.77)	(-2.03)	(-3.00)	(-3.43)	(-3.58)
MTB		-21.18***	-22.25***	-21.91***	-19.22***
		(-6.57)	(-6.96)	(-6.88)	(-6.05)
LEVG		19.91	25.90**	26.21**	25.37**
		(1.54)	(2.03)	(2.06)	(2.00)
ROA		-205.7***	-145.0**	-139.4**	-111.5*
		(-3.15)	(-2.24)	(-2.16)	(-1.74)
# ANALYSTS			0.349***	0.339***	0.357***
			(6.62)	(6.45)	(6.85)
VOLATILITY			478.9***	486.5***	569.5***
			(6.13)	(6.24)	(7.21)
LOSS DV				21.93***	21.32***
				(3.83)	(3.73)
NASDAQ DV				-1.421*	-1.530**
				(-1.89)	(-2.05)
Year DV	Yes	Yes	Yes	Yes	Yes
No. of obs	2212	2212	2212	2212	2212
Pseudo R^2	0.011	0.043	0.077	0.091	0.091

*, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

industrial firms to be subject to less information asymmetry. Profitability is also found to be negatively associated with analyst forecasts error, indicating that more profitable BHCs tend to display a lesser information asymmetry problem because they do not need to hide the good information. The market to book variable (MTB), used to proxy growth opportunities, is negatively associated with the forecast error (ERROR), indicating that BHCs with better growth opportunities receive more accurate forecasts. This finding can be explained by a couple of reasons. First, BHCs with better growth opportunities are more likely to reveal company specific information to the market than BHCs with worse prospect. Financial analysts are therefore more likely to generate accurate forecasts based on more company specific information. Second, MTB also contains information about BHCs' valuation (Tobin's Q) in addition to growth opportunities. Specifically, if a BHC is subject to a more severe information asymmetry between insiders and outsiders, investors would be willing to pay less for its stock and, therefore, its MTB ratio would be lower. Such information asymmetry would in the same time also increase the error of analyst's forecasts, engendering a negative correlation between MTB and forecast error.

Model 3 in Table 1-3 introduces two additional control variables: the number of forecasts in a particular quarter, and the standard deviation of the market model residual for BHC's stock. The regression result shows similar patterns as in Model 2, except that the ratio of non-interest income becomes insignificant. Besides, leverage is positively associated with forecast error. This is consistent with the expectation that higher leverage of BHCs would add to the volatility of earnings and, therefore, increase the difficulty of forecasting (Thomas, 2002). The number of forecasts available in a particular quarter is positively associated with forecast error. This result offers strong support for the

hypothesis that banks are opaque. Analysts do not have access to accurate and complete information about BHCs and as a result, more analysts following on one particular BHC actually increases the forecast error. Otherwise, given a limited set of accurate information, more analysts following would yield more accurate forecasts. Lastly, VOLATILITY, which accounts for the level of BHC-specific information that arrives daily to the market, is positively associated with forecast error. When a greater amount of information needs to be processed, the difficulty of providing a good forecast increases. The result shown here is consistent with the finding in Alford and Berger (1999) and Thomas (2002), where they both show that analysts' forecast accuracy is inversely related to the variance of information observation.

In Model 4, the results show that analysts' forecasts would be less accurate for a quarter when a BHC reports a loss based on the positive sign of LOSS dummy variable.[12] Brown (2001) provides evidence that analysts on average would issue less accurate forecasts in loss periods. This result is also consistent with the finding of Duru and Reeb (2002). They consider this effect to be the result of a "big bath" effect, based on the argument that managers would like to exaggerate the losses in the loss periods in order to leave room for later recovery. The negative coefficient on NASDAQ shows that BHCs listed in NASDAQ market would generally receive more accurate forecasts, when size is controlled for. Flannery et al. (2004) have shown that BHCs listed on NASDAQ are traded much less frequently. They conclude that those BHCs are "boring" in terms of information. Their argument is that analysts can offer more accurate forecasts for

[12] This study also tried to test whether the magnitude of loss is associated with the magnitude of forecast error but the regression coefficient is not significant.

NASDAQ because the amount of information to process is much less on NASDAQ listed BHCs. The result shown here is consistent with their argument.

Taken together, the results in Table 1-3 can be interpreted as follows. Reliance on non-interest income, in terms of higher ratio of income coming from non-interest activities, does not seem to affect the accuracy of analysts' forecasts, as only one out of the four models shows a significant relationship between those two variables.[13] However, the main focus of this study is on the diversity, rather than the level, of non-interest income activities. Therefore, Model 5 employs non-interest income diversification (NDIV) as a substitute to RATIO. In this model, all the control variables are found effects similar (both in terms of magnitude and significance) as in Model (4). The NDIV index has a positive and significant coefficient indicating that diversification among non-interest income activities does increase analysts' forecast error. Deng et al. (2007) also concentrate on diversification among non-interest income activities, rather than the ratio of non-interest income to total income. The models in Table 1-3 may be misleading because they fail to consider the non-interest income share (RATIO) and Diversification (NDIV) simultaneously, and as such, they may be subject to the omitted variable problem. Below, we remedy this shortcoming.

1.4.1.2 Joint Consideration of the Non-Interest Income Share and Diversification

Table 1-4 offers regression results using both non-interest income share (RATIO) and diversification (NDIV) to explain analyst' forecast errors. Model 1 in this table, includes RATIO, NDIV, and SIZE as explanatory variables, in addition to the year dummies. In this model, both the ratio of non-interest income (Ratio) and the

[13] Again, according to the result of the VIF test, this finding is not due to collinearity.

Table 1-4: Tobit regressions of the pooled sample explaining forecast error (ERROR)

This table presents results of Tobit regressions in which the dependent variable is forecast effort (ERROR), defined as the median of absolute errors of individual forecast (times 10,000), divided by stock price at the end of the quarter. NDIV is a Hirschman-Herfindahl Index like measure for the dispersion of non-interest income activities. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. Control variables are as follows. MTB is the market to book ratio, defined as the sum of book value of debt and market value of equity divided by the book of value of total assets. SIZE is the natural log of book value of total assets at the end of each quarter. LEVG is defined as the ratio of total liabilities to total assets. ROA is the ratio of net income to book value of total assets. # ANALYSTS is the number of analysts offering one quarter ahead forecasts on the particular BHC for the current quarter. VOLATILITY is calculated as the standard deviation of the market model residuals over the last 24 months before the current quarter ending date. The LOSS dummy takes a value of 1 for a negative actual earning, and zero otherwise. The NASDAQ dummy takes the init value for BHCs listed on NASDAQ.

Dependent Variable: Analysts' Forecast Error				
Models	1	2	3	4
Intercept	8.147**	16.74	2.437	6.100
	(2.50)	(1.32)	(0.18)	(0.46)
RATIO	6.694**	11.01***	6.759**	6.471**
	(2.48)	(4.06)	(2.52)	(2.42)
NDIV	7.885***	5.817***	9.317***	9.109***
	(3.56)	(2.65)	(4.24)	(4.16)
SIZE	-0.496**	-0.670***	-1.215***	-1.424***
	(-2.12)	(-2.89)	(-3.84)	(-4.21)
MTB		-20.22***	-20.55***	-20.26***
		(-6.24)	(-6.40)	(-6.33)
LEVG		20.71	27.15**	27.48**
		(1.60)	(2.14)	(2.17)
ROA		-200.3***	-128.4**	-123.6*
		(-3.07)	(-1.99)	(-1.92)
# ANALYSTS			0.353***	0.343***
			(6.70)	(6.53)
VOLATILITY			544.9***	551.3***
			(6.86)	(6.96)
LOSS DV				21.21***
				(3.72)
NASDAQ DV				-1.456*
				(-1.95)
Year DV	Yes	Yes	Yes	Yes
No. of obs	2212	2212	2212	2212
Pseudo R^2	0.016	0.045	0.083	0.091

*, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

diversification among non-interest income activities (NDIV) are positively associated with analyst's forecast error, indicating a lesser forecast accuracy. In contrast to the finding in Model 1 of Table 1-3, when both the ratio and diversification of non-interest income are taken into consideration, both of these two factors are found to significantly decrease the accuracy of analyst's forecasts. Model 2 adds three additional BHC characteristic variables, including market to book (MTB), leverage (LEVG), and profitability (ROA). Model 3 further considers the number of forecasts about the BHC and the amount of BHC firm-specific information. Model 4 adds dummy variables to control for BHCs reporting a loss and for BHCs listed on NASDAQ. Results in Table 1-4 show that coefficient estimates for all the control variables are similar to those in Table 1-3; larger BHCs tend to receive more accurate forecasts while BHCs with higher leverage, greater BHC-specific information, and lower profitability receive less accurate forecasts. Notably, in all models, both RATIO and NDIV are positive and highly significant.

Results in Table 1-4 indicate that when a BHC expands its business into few non-interest income activities, even if the ratio of non-interest income is large, its information property may not change significantly. However, when BHCs increase the share of non-interest income (Ratio) in their total revenues and/or diversify into a multitude of non-interest income activities, the information asymmetry between insiders and outsiders increases, making it more difficult for security analysts to forecast BHC performance. According to these findings, the *complexity hypothesis* dominates the *aggregation hypothesis*. The finding that diversification among non-interest income, as well as the ratio of non-interest income matter for information asymmetry, raises a question about studies based on aggregate measures of non-interest income alone, which overlooks the

diversification dimension and treats non-interest income as a whole (e.g., Stiroh, 2006). For BHCs expanding into investment banking, insurance, and other non-interest income generating business, the effect will be masked and the findings will be misleading if non-interest income is considered as a sole measure of expansion.

1.4.2 Analyst Forecast Dispersion

The Tobit regression results using the non-interest income share (RATIO) and diversification (NDIV) as joint explanatory variables for dispersion among analysts' forecasts (STD) are reported In Table 1-5. The model is described as:

$$STD = \beta_0 + \beta_1 RATIO + \beta_2 NDIV + \beta_3 SIZE + \beta_4 MTB + \beta_5 LEVG + \beta_6 ROA + \beta_7 \#Analysts + \beta_8 VOLATILITY + \beta_9 LOSS + \beta_{10} NASDAQ + \beta_{11} YearDummy \quad (1\text{-}3)$$

In Model 1 of this table, the explanatory variables are RATIO, NDIV, SIZE, and year dummies. The coefficient on NDIV is positive and significant, but the coefficient on RATIO fails to show significance. These results show that while the non-interest income share (Ratio) fails to exert a significant effect on the dispersion of the analysts' forecasts, these forecasts are more dispersed for BHCs diversifying into multiple non-interest income activities. SIZE does not affect the dispersion of forecasts in this basic model specification.

Model 2 includes three additional control variables on BHCs' characteristics; market to book ratio (MTB), leverage (LEVG), and profitability (ROA). In this specification, the analyst forecast dispersion (STD) is positively related to NDIV confirming the earlier finding that increased non-interest income diversification widens the analysts' forecast error dispersion (STD). STD is negatively associated with the control variables MTB and profitability (ROA) indicating that analysts have narrower

Table 1-5: Tobit regressions of the pooled sample explaining forecast dispersion (STD)

This table presents results of Tobit regressions in which the dependent variable is forecast dispersion (STD), defined as the standard deviation of analysts' forecasts (times 10,000) deflated by the stock price at the end of the quarter. NDIV is a Hirschman-Herfindahl-Index-like measure for the dispersion of non-interest income activities. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. Control variables are as follows. MTB is the market to book ratio, defined as the sum of book value of debt and market value of equity divided by the book of value of total assets. SIZE is the natural log of book value of total assets at the end of each quarter. LEVG is defined as the ratio of total liabilities to total assets. ROA is the ratio of net income to book value of total assets. # ANALYSTS is the number of analysts offering one quarter ahead forecasts on the particular BHC for the current quarter. VOLATILITY is calculated as the standard deviation of the market model residuals over the last 24 months before the current quarter ending date. The LOSS dummy takes the value of 1 for a negative actual earning, and zero otherwise. The NASDAQ dummy takes the unit value for BHCs listed on NASDAQ.

Dependent Variable: Analysts' Forecast Dispersion				
Models	1	2	3	4
Intercept	0.409	11.72	9.935	14.79*
	(0.16)	(1.16)	(0.94)	(1.77)
RATIO	-0.211	2.566	-0.943	-1.718
	(-0.098)	(1.18)	(-0.44)	(-1.02)
NDIV	3.089*	1.670*	3.788**	2.394**
	(1.76)	(1.79)	(2.18)	(1.97)
SIZE	0.208	0.114	-0.794***	-0.873***
	(1.12)	(0.62)	(-3.16)	(-4.13)
MTB		-12.42***	-13.72***	-12.06***
		(-4.80)	(-5.37)	(-6.03)
LEVG		6.379	13.23	9.297
		(0.62)	(1.31)	(1.17)
ROA		-174.2***	-129.7**	-79.81**
		(-3.35)	(-2.52)	(-1.98)
# ANALYSTS			0.373***	0.327***
			(8.91)	(9.95)
VOLATILITY			310.8***	301.1***
			(4.91)	(6.06)
LOSS DV				132.0***
				(36.5)
NASDAQ DV				-1.548***
				(-3.32)
Year DV	Yes	Yes	Yes	Yes
No. of obs	2212	2212	2212	2212
Pseudo R^2	0.004	0.034	0.065	0.093

*, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

dispersion in their forecasts of those BHCs with greater growth opportunities and/or greater profitability. The explanations for these effects were described earlier. As a consequence of the asymmetry of information, investors discount the stock and, therefore, the market value will be lower. The result on profitability (ROA) is consistent with the argument that profitable BHCs will be more willing to release information to outsiders and, consequently, financial analysts will generate more accurate forecasts.

Model 3 adds the number of forecasts and VOLATILITY to the set of explanatory variables in the regression. The results again show that the ratio of non-interest income does not affect forecast dispersion but diversification among non-interest income activities is positively associated with it. The coefficient of leverage is statistically insignificant, indicating the lack of an association between STD and leverage. More analysts following of a particular BHC actually increases the forecast dispersion. This finding strongly supports the information asymmetry hypothesis because if information is adequate and clear, forecasts would more likely to agree with each other.[14] After controlling for the number of analysts following, the size of BHC becomes negatively associated with STD. This is consistent with the argument that larger BHCs will release more information to outsiders. Lastly, VOLATILITY, which measures the level of BHC-specific information, is positively associated with forecast dispersion; more firm-specific information increases the difficulty of making earning forecast and, therefore, results in a more dispersed set of opinions.

In Model 4, the regression includes all the control variables. LOSS dummy is positively associated with STD, indicating that analysts' forecasts are more dispersed

[14] Given the fact that BHC size and number of forecasts are positively correlated, multicollinearity tests were conducted. No indication of serious multicollinearity was found.

when BHCs report a loss. The NASDAQ dummy is negatively associated with forecast dispersion because the amount of information to process is much less on NASDAQ listed BHCs. These results are consistent with findings in Tables 1-3 and 1-4. Explanations of these findings were given earlier.

In brief, all the four model specifications in Table 1-5 reach the same conclusion: the coefficient on RATIO is not significant in any of the models while the coefficient on NDIV is positive and significant in all of the models. Analysts would have more dispersion in their earning forecasts for BHCs involved in multiple and diversified non-interest income activities but not in BHCs merely increasing the ratio of non-interest income while maintaining the number of non-interest income products. The coefficients on the other control variables remain similar to the previous models. Based on the empirical results reached here on forecast error and forecast dispersion, one can conclude that BHCs suffer from more severe information asymmetry problems when they diversify into multiple non-interest income activities. In other words, outsiders (here analysts) would have more difficulty in acquiring and processing information about BHCs' non-interest income activities.

1.4.3 Market Reaction to Earning Announcement

If a BHC is subject to severe information asymmetry between insiders and outsiders, then the stock market will react significantly to BHCs' quarterly earning announcements because the announcement will reveal material information previously unavailable to outsiders. This phenomenon provides us with an alternative method to test the degree of information asymmetry in diversified BHCs. Specifically, if BHCs moving into investment banking and insurance activities are subject to a deeper level of

information asymmetry, earning announcements by these BHCs will engender a larger abnormal return than the other BHCs. To investigate this issue, this section will examine the relationship between the cumulative abnormal returns around earning announcement $|CAR|$ and non-interest income diversification (NDIV).

To correctly measure the magnitude of the information released by quarterly earning announcements, $|CAR|$ has to be adjusted by the magnitude of the constantly released BHC-specific information, proxied e.g., by the VOLATILITY measure constructed in Section 1.3. VOLATILITY is defined as the standard deviation of the one factor market model residuals on daily stock returns over the last 24 months before the current quarter's ending date. It serves as a good proxy for the amount of BHC-specific information that is available to the market on a daily basis. The adjusted measure, $|CAR|$/VOLATILITY will be referred to as the "Adjusted Cumulative Abnormal Return (ACAR)" (See Appendix B for detail). The regression model, given below, is similar to those employed by Bailey et al. (2003) and Thomas (2002).

$$ACAR = \gamma_0 + \gamma_1 RATIO + \gamma_2 NDIV + \gamma_3\ R\text{-}ERROR + \gamma_4\ R\text{-}STD + \gamma_5\ LOSS + \gamma_6\ NASDAQ \quad (1\text{-}4)$$

R-ERROR is the residual forecast error generated in Tobit regression in Model 4 of Table 1-4. It is the orthogonalized forecast error that is not explained by RATIO, NDIV and other control variables in Model 4 of Table 1-4. Similarly, R-STD is the residual forecast dispersion generated in Tobit regression in Model 4 of Table 1-5. It is the orthogonalized forecast dispersion that is not explained by RATIO, NDIV and other control variables in Model 4 of Table 1-5. The orthogonalization process is widely

applied in empirical test to reduce the possible linear relationship among the independent variables.[15]

Table 1-6 reports the results of Tobit regressions with a step-wise increase in the number of explanatory variables. Model 1 uses RATIO and NDIV as the only explanatory variables. The coefficient estimates show that both the ratio of non-interest income and diversification among non-interest income categories are positively associated with the adjusted abnormal return. This finding shows that when BHCs increase their share of the non-interest income (RATIO) or diversify among non-interest income categories to a larger extent, their quarterly earning announcements will have more information content, when scaled by their daily information content. The result serves as indirect evidence for a positive relationship between information asymmetry between insiders and outsiders and non-interest income share and diversity.

Model 2 adds the residual forecast error (R-ERROR) as an additional explanatory variable. The coefficient estimates on RATIO and NDIV remain positive and significant confirming our previous finding. The coefficient estimate on residual forecast error is also positive, indicating that the further away the analysts' forecasts are from the announced earnings, the larger the market reaction will be. This, in turn, is an indication that such earning announcements reveal more material information to the market. This finding is consistent with information asymmetry story between insiders and outsiders.

[15] In Thomas (2002), the forecast error and dispersion are used directly rather than the orthogonalized counterparts as control variables along with measures of diversification. Using these variable may generate multi-collinearity since as shown earlier in Section 4.1 and 4.2. Diversification may increase analysts' forecast error. Therefore, the specification employed here is more reliable. As a robustness test, unorthogonalized forecast error and dispersion were also used. Results remained similar.

Table 1-6: Tobit regressions of the pooled sample explaining adjusted cumulative abnormal return (ACAR)

This table presents results of Tobit regressions in which the dependent variable is ACAR, defined as the ratio of │CAR│ to VOLATILITY. │CAR│ is the absolute value of cumulated abnormal return over the 3-day period from -1 to 1 (announcement date as 0) based on a one-factor market model estimated using BHC's daily return and return of CRSP value-weighted index over days -210 to -11. VOLATILITY is calculated as the standard deviation of the market model residuals over the last 24 months before the current quarter ending date. NDIV is a Hirschman-Herfindahl-Index-like measure for the dispersion of non-interest income activities. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. Control variables are as follows. R-ERROR is the residual forecast error generated in Tobit regression in Model 4 of Table 1-4. It is the orthogonalized forecast error that is not explained by RATIO, NDIV and other control variables in Model 4 of Table 1-4. R-STD is the residual forecast dispersion generated in Tobit regression in Model 4 of Table 1-5. It is the orthogonalized forecast dispersion that is not explained by RATIO, NDIV and other control variables in Model 4 of Table 1-5. The LOSS dummy takes the value of 1 for a negative actual earning, and zero otherwise. The NASDAQ dummy takes the unit value for BHCs listed on NASDAQ.

Dependent Variable: Adjusted Cumulative Abnormal Return around Earning Announcements				
Models	1	2	3	4
Intercept	0.893***	0.880***	0.896***	1.447***
	(3.84)	(3.79)	(3.85)	(5.53)
RATIO	1.113***	1.106***	1.110***	0.444
	(3.69)	(3.67)	(3.68)	(1.34)
NDIV	0.852***	0.865***	0.850***	0.599**
	(2.90)	(2.95)	(2.89)	(2.01)
R-ERROR		0.0120***		0.0152***
		(3.35)		(4.04)
R-STD			-0.00716	-0.0137**
			(-1.37)	(-2.50)
LOSS DV				0.0232
				(0.025)
NASDAQ DV				-0.428***
				(-4.56)
Year DV	Yes	Yes	Yes	Yes
No. of obs	2071	2071	2071	2071
Pseudo R^2	0.021	0.057	0.028	0.061

*, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Model 3 adds the residual forecast dispersion (R-STD) to the regression. RATIO and NDIV are still positively related to adjusted cumulative abnormal return (ACAR), which is consistent with our previous findings. The coefficient estimate on R-STD is insignificant, indicating that the market reactions are not impacted by the dispersion of analysts forecasts in this model specification.

Model 4 includes all the variables in the regression setting. The previously identified relationship between ACAR and NDIV and R-ERROR is still valid but the coefficient on RATIO is no longer significant. In this specification, R-STD is negatively associated with adjusted cumulative abnormal returns, indicating that less dispersed forecasts will result in larger market reactions. This result can be explained as follows. Less dispersed forecasts are not necessarily an indication that forecasts are more accurate. If the announced earning is out of the range of everyone's forecast, there will be a large market reaction to such a surprise. On the other hand, largely dispersed ex-ante analyst forecasts may give investors more dispersed views about the available information. Consequently, the ex-post announced earning would be less likely to be a surprise relative to the whole set of those forecasts. Therefore, the market reaction to earning announcement would be smaller in magnitude.

The LOSS dummy variable is positively related to the adjusted cumulative abnormal return, indicating that, in addition to the effect of earning surprise (accounted for by R-ERROR), BHC's announcement of a loss in earning results in a larger market reaction than a positive earning. Therefore, a negative earning reveals substantially more information, *in addition to* the surprise coming out of earning amount. NASDAQ dummy variable is not significantly associated with ACAR, indicating that BHCs listed on

NASDAQ generally release similar amount of information through their earning announcement as BHCs listed on NYSE and/or AMEX.

Taken together, Table 1-6 shows that quarterly earning announcements by BHCs with higher ratio of non-interest income to total income, and/or greater diversification among non-interest income activities, reveal more information to the market relative to the magnitude of their firm-specific information. This finding supports the hypothesis that diversification among non-interest income activities worsens BHCs' information asymmetry problem.

1.4.4 Robustness Tests

Literature on earning forecasts of financial analysts generally uses the consensus forecast error as an alternative measure of the forecast accuracy. Consensus forecast is defined as either the median or the mean of all the available analyst forecasts. The absolute value of the difference between consensus forecast and the announced earning is the consensus forecast error (C-ERROR. In this section, models similar to those in Section 1.4.1 are performed using C-ERROR to substitute for ERROR, and the results are reported in Table 1-7. From this table, it is easy to see that both RATIO and NDIV are positively associated with C-ERROR, indicating that increased BHC diversification into non-interest income is associated with larger consensus forecast errors. This finding is consistent with the *complexity hypothesis* of information asymmetry. The control variables have the same signs as in Table 1-4. Similar tests are conducted on stock market reactions around quarterly earning announcements using C-ERROR as proxy for earning surprises. The results (not reported) are very similar in sign and magnitude to those in Table 1-6.

Table 1-7: Tobit regressions of the pooled sample explaining consensus forecast error (C-ERROR)

This table presents results of Tobit regressions in which the dependent variable is C-ERROR. C-ERROR is defined as the absolute value of the difference between consensus forecasts (the median of individual forecasts)(times 10,000) and actual earnings, divided by stock price at the end of the quarter. NDIV is a Hirschman-Herfindahl-Index-like measure for the dispersion of non-interest income activities. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. Control variables are as follows. MTB is the market to book ratio, defined as the sum of book value of debt and market value of equity divided by the book of value of total assets. SIZE is the natural log of the book value of total assets at the end of each quarter. LEVG is defined as the ratio of total liabilities to total assets. ROA is the ratio of net income to book value of total assets. # ANALYSTS is the number of analysts offering one quarter ahead forecasts on the particular BHC for the current quarter. VOLATILITY is calculated as the standard deviation of the market model residuals over the last 24 months before the current quarter ending date. The LOSS dummy takes a value of 1 for a negative actual earning, and zero otherwise. The NASDAQ dummy takes the unit value for BHCs listed on NASDAQ.

Dependent Variable: Analysts' Forecast Accuracy (C-ERROR)				
Models	1	2	3	4
Intercept	6.871**	17.36	3.249	6.644
	(2.07)	(1.34)	(0.24)	(0.49)
RATIO	6.545**	10.58***	7.020**	6.758**
	(2.39)	(3.84)	(2.56)	(2.47)
NDIV	7.428***	5.406**	8.368***	8.221***
	(3.30)	(2.41)	(3.72)	(3.67)
SIZE	-0.423*	-0.590**	-0.938***	-1.139***
	(-1.79)	(-2.50)	(-2.90)	(-3.29)
MTB		-19.81***	-19.77***	-19.52***
		(-5.90)	(-5.91)	(-5.86)
LEVG		17.73	22.72*	23.13*
		(1.35)	(1.75)	(1.78)
ROA		-165.0**	-100.8	-97.53
		(-2.48)	(-1.52)	(-1.48)
# ANALYSTS			0.275***	0.267***
			(5.11)	(4.96)
VOLATILITY			480.9***	487.8***
			(5.91)	(6.01)
LOSS DV				17.57***
				(2.98)
NASDAQ DV				-1.363*
				(-1.78)
Year DV	Yes	Yes	Yes	Yes
No. of obs	2211	2211	2211	2211
Pseudo R^2	0.016	0.045	0.082	0.091

*, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Additionally, this study also applied the measure for diversification among all activities (interest income plus the 10 categories of non-interest income, please refer to Section 1.3.2.1) to test whether diversification is associated with deepened information asymmetry problem. In empirical analysis similar to those described in previous section, this diversification measure substitutes both RATIO and NDIV. The Tobit regressions yield statistically identical results and therefore the finding of this study is also robust to different diversification measurements. It is important to notice that RATIO and NDIV contains more information about BHCs' activity diversification than the single measure because these two separate interest income and non-interest income activities.

1.5 Conclusion

The banking industry has long been identified as information-intensive and opaque to outsiders (Morgan, 2002). The recent trend of growth in non-interest income, coupled with the mergers and acquisitions of financial conglomerates, has significantly increased the scope of activities for BHCs. The passage of the GLBA (1999) cleared the way for further activity diversification by BHC into securities and insurance business. An important question is whether the diversification of non-interest income activities is accompanied with a deeper information asymmetry between insiders and outsiders of BHCs. The answer to this question will help the understanding of firm-value related issues coupled with diversification for BHCs, e.g. diversification discount in BHCs found in Laeven and Levine (2007).

Using financial analysts' earning forecast error and forecast dispersion as proxies for the degree of information asymmetry, this study finds that a higher ratio of non-interest income does not necessarily increase the degree of information asymmetry of BHCs, but the combination of it with diversification among non-interest income activities does. In other words, BHCs with higher ratio of non-interest income and higher diversification of non-interest income activities would be the subject of the most severe information asymmetry problems. An event study on BHCs' quarterly earning announcements confirms this finding. Specifically, the earning announcements of more diversified BHCs are found to reveal more information to the markets relative to the information content of their stocks' daily behavior. Put together, our findings support the *complexity hypothesis* about the relationship between BHCs' diversification and information asymmetry problem, indicating that diversification into non-interest income activities deepens the information opaqueness of BHCs. Investors will have more difficulty in getting access to and processing information about BHCs with greater diversification in non-interest income activities.

The finding that increased non-interest income diversification by BHCs has resulted in a higher level of information asymmetry between insiders and outsiders, at least partially, explains why stock holders avoid diversified BHCs. In other words, the diversification discount identified in literature can at least be partly attributed to the "information discount". The argument may also explain why many BHCs that are allowed to engage in investment banking and insurance activities, through formation of FHCs, have refrained from doing so. The finding also benefits practitioners and legislators in that it calls for improvements in information transparency of BHCs. Only

when accompanied with better information release, BHCs can avoid the unwanted by-product of information opaqueness during their diversifying expansion.

CHAPTER 2

INDUSTRIAL DIVERSIFICATION, INTERNATIONAL DIVERSIFICATION AND FIRM COST OF CAPITAL

2.1 Introduction

Corporate diversification has been an issue of major interest in financial research during the last decade. A stream of literature, originated by Berger and Ofek (1995) and Lang and Stulz (1994), suggests that industrial diversification is associated with a substantial reduction in firm value. Studies by Servaes (1996) and Lins and Servaes (1999) confirm these findings for different countries and in different time periods. However, despite the multitude of studies associating industrial diversification and value loss, these findings cannot be readily interpreted as proof that industrial diversification per se destroys firm value. Indeed, questions about the validity and the interpretations of these findings are multifaceted.

First, the aforesaid studies use the book value, rather than the market value, of debt to calculate firm market value. Mansi and Reeb (2002) have demonstrated that diversification discounts calculated in that manner are present mostly in leveraged firms, but not in all-equity firms, indicating that the value discounts result from the lack of adjustment for increased bond value as firms diversify. The implication is that diversification may reduce equity value but at the same time increase debt value and therefore leave firm overall value unchanged.

Second, industrial and international diversification may behave as complements in the sense that a large percentage of conglomerates diversify both across different

industries and across different countries (Denis et al., 2002). Given that international diversification affects firm value (e.g., Denis et al., 2002; and Bodnar et al., 2000), failure to control for its effect is likely to create an omitted variable problem and to confound the assessment of the relationship between industrial diversification and firm value.

Third, the finding of firm value discount may also be due to the data and methodology limitations including measurement errors (Whited, 2001), sample selection bias (Chevalier, 2004), and endogeneity problem (Campa and Kedia, 2002; and Graham et al., 2002). Finally, it is notable that diversification continues to be a common business strategy even under the stronger corporate governance structures witnessed after the Sarbanes-Oxley Act (2002), and also that no specific policy actions have been taken against diversification by the policy makers for the purpose of protecting the shareholders' interests. These observations may serve as an indication that the corporate sector and policy makers do not put much value in the findings on diversification discount in the academic literature. Overall, the question whether diversification destroys firm value is still very much an open question.

For a diversified firm to be valued at a discount relative to a portfolio of single segment firms, the former has to have either a lower expected cash flow, or a higher expected return, or both. While a large body of literature has been devoted to testing the conglomerates' cash flow patterns, the expected return component has received little attention. Lamont and Polk (2001) show that variations in expected returns contribute to a significant portion of the value differences between diversified and single-segment firms. Their results confirm the importance of expected returns, side by side of cash flows, in determining firm value. However, their study did not offer direct evidence whether

diversified firms *on average* have different expected returns relative to single-segment firms. In addition, the study is subject to three further restrictions: it commits the endogeneity problem (Campa and Kedia, 2002) by comparing conglomerates to a portfolio of single-segment firms because these two type of firms are systematically different; it fails to control for cross-sectional differences in the cost of debt (Mansi and Reeb, 2002); and it fails to control for international diversification's effect on cost of capital (Denis et al., 2002). The current study will try to address these issues.

Not many, if any, empirical study has heretofore offered clear evidence on whether and/or how diversified firms and single-segment firms are dissimilar in terms of expected returns, by performing direct cross-sectional comparison. This paper fills this void. It examines the effects of industrial and international diversification on firm cost of capital, including both equity and debt, simultaneously. In some literature, cost of capital refers to equity capital only (e.g., Lambert et al., 2007; Easley and O'Hara, 2004) but here cost of capital is a measure of expected return on both equity and debt. Examining the cost of capital offers an alternative avenue to study firm total value while avoiding the problem of lack of data on market value of debt.

Specifically, this paper explores the following three questions: 1) Are industrial and international diversifications associated with an increase or a decrease in firm cost of capital? 2) If the benefits of diversification come primarily from increased debt value, as described in Mansi and Reeb (2002), Reeb et al. (2001), and Li and Li (1996), what are the diversification effects for cost of equity of the all-equity firms? Should diversification increase cost of equity for diversified all-equity firms since there is no counter balance factor from the debt side? 3) Do industrial and international diversifications change

firms' cash flows? Answering these questions will help our understanding of the value effect of diversification.

Using the cost of capital data on the Russell 3000 Index firms over the period of 1998-2004, this paper analyzes the effects of both industrial and international diversifications on firm cost of capital. According to Russell Investment Group, these firms represent approximately 98% of the U.S. equity market.[16] Several interesting results are obtained. First, after controlling for the factors affecting the cost of capital (e.g. risk, size, etc.), industrial diversification is found to be negatively associated with the firm's cost of capital. An increase of one standard deviation in industrial diversification from the mean level, ceteris paribus, can save an average firm approximately $4.76 million per year. Second, international diversification is positively associated with the firm's cost of capital. An increase of one standard deviation in international diversification from the mean level, ceteris paribus, would be associated with an approximate cost of $6.85 million each year. These results are robust to alternative diversification measures.

Third, when similar tests are applied to a sub-sample of all equity firms, the results show that industrial (international) diversification is associated with a lower (higher) cost of equity. This indicates that all equity firms also benefit from industrial diversification but are hurt by international diversification. This study also investigates the potential endogeneity problem between the cost of capital and diversification. The findings remain robust when a three stage least squares model are applied to estimate a system of equations. Finally, international diversification is found to be associated with

[16] On Russell Investment Group website:
http://www.russell.com/indexes/characteristics_fact_sheets/US/Russell_3000_Index.asp

lower operating cash flows while industrial diversification is unassociated with change of cash flow when compared to domestic single industry firms.

The contributions of this study are the following. First, this is the first study to examine the association between diversification and firm-specific cost of capital (both debt and equity) and thereby between diversification and total firm value. The results show that the external capital market views industrial (international) diversification positively (negatively) and, hence, requires a lower (higher) cost of capital in response to it. Coupled with the findings on the association between diversification and firms' operating cash flow, these results can provide a more complete picture of the diversification effect on firm value from perspectives of both cash flow and expected return. Second, this study shows that because industrial and international diversification of firms have dissimilar effects on firm's cost of capital, failure to control either dimension would produce misleading conclusions concerning the other dimension.

Third, tests on a sub-sample of all-equity firms yield similar results. All-equity firms also benefit from (hurt by) industrial (international) diversification in terms of cost of capital change. Therefore, the benefits of industrial diversification are not confined to the debt side (Mansi and Reeb, 2002). The patterns how industrial and international diversification affect cost of equity for all-equity firms are similar to how they affect cost of capital for leveraged firms. Fourth, cross-sectional analysis employed here eliminates the potential bias associated with matching the segments of diversified firms to the single-segment firms.[17] In addition, comparing cost of capital avoids the bias generated

[17] See Campa and Kedia (2002), Graham et al. (2002), and Villalonga (2004a).

by employing Tobin's Q, which uses book value instead of market value of debt.[18] Overall, this study shows that industrial (international) diversification is beneficial (harmful) to firm total value by explicitly revealing how the two dimensions of diversification alters firms cost of capital and cash flow, which are the two basic factors determining firm value.

The rest of the paper is organized as follows. Section 2.2 reviews the related literature and develops the hypothesis. Section 2.3 describes the data measurements and the sample selection process. Section 2.4 reports the empirical results on the relationship between cost of capital and industrial and international diversification. It also shows how the two dimensions of diversification change firm cash flow and discusses how our findings fit in the literature. Section 2.5 concludes.

2.2 Literature Review and Hypothesis Development

The 1960s witnessed the great wave of takeovers with a dominant trend toward business diversification and conglomeration. The abnormal returns earned by bidding firms in response to acquisition announcements suggest that by and large the market rewarded diversification.[19] However, diversification was not associated with profitability improvement in the years following the merger and/or acquisition (M&As). Indeed, in the years subsequent to M&As, a large percentage of acquisitions were reversed through

[18] See Mansi and Reeb (2002).

[19] Schipper and Thompson (1983) find significant positive abnormal performance associated with the announcement of diversifying acquisition programs. Elgers and Clark (1980) conclude that diversifying mergers earn higher monthly returns than related mergers. Matsusaka (1993) reports that diversified merger bidders earned positive abnormal returns.

divestitures.[20] Shleifer and Vishny (1991) describe the conglomerate mergers in the 1960s as a mistake and consider the reversal trend towards specialization in the 1980s as a process which restored the efficiency of the U.S. corporations. An important fact, however, is that diversified firms continue to account for a significant percentage of the U.S. corporations. Moreover, Hyland and Diltz (2002) find evidence that even refocused firms did subsequently diversify again. Academic research has offered arguments for both the benefits and the costs of diversification. However, the question whether diversification increases or decreases firm value remains in dispute.

2.2.1 Studies on Diversification

2.2.1.1 Diversification and Firm Value

To study the value effect of industrial diversification, financial studies generally compare the value of a conglomerate to the value of a portfolio of stand-alone firms operating in the same industries as the conglomerate's divisions and/or segments. Assuming the segments of conglomerates have the industry average Tobin's Q, Lang and Stulz (1994) find that diversified firms have lower Q's than comparable portfolios of single-segment firms. Berger and Ofek (1995) compare the sum of the imputed stand-alone values for segments of conglomerates to the actual firm value and find that, in their sample, conglomerates are valued at a discount of 13%-15%. Following this method, Servaes (1996) also finds a firm value discount for conglomerates during the merger wave of the 1960s. Lins and Servaes (1999) find similar results in Japan and United Kingdom. These results are generally cited as evidence that diversification destroys firm value.

[20] See, among others, Porter (1987), Ravenscraft and Scherer (1987), and Kaplan and Weisbach (1992).

Recently, several studies have challenged the previous research from many perspectives. One argument is that neither the imputed value nor Tobin's Q takes into account the effect of diversification on debt because calculation of these measures is based on the book value, rather than the market value, of debt. Therefore, the previous results can only be interpreted as diversification being associated with lower *equity* value but not *firm* value. If, as described in Mansi and Reeb (2002), diversification decreases firm risk and, consequently, increases the debt value of the firm, the overall effect on firm value can go in either direction. Mansi and Reeb find that diversification's value effect relates to firm leverage and, in particular, the all-equity firms do not show a value discount in response to diversification, confirming that the so called diversification discount is only equity value discount. Moreover, using a small sub-sample of firms for which data on market values of bonds are available, they find no significant effect from diversification on firm value.

The second potential bias comes from ignoring international diversification. Most of the aforementioned studies fail to control for the international diversification effect. Similarly, the literature on international diversification generally ignores industrial diversification. Denis et al. (2002) find that international diversification is more pervasive than industrial diversification for the U.S. firms and that the two dimensions of diversification are complementary to one another in the sense that conglomerates generally diversify in both dimensions. They also find that at the firm level, the two dimensions of diversification result in approximately the same magnitude of firm value discounts. Contrary to their finding, Bodnar et al. (2000) find that when compared to

single-activity firms, firms with international operations are valued at a premium, while firm with multi-industry operations are valued at a discount.

Empirical results on the firm value effect of international diversification alone are also mixed. Errunza and Senbet (1984) document that internationalization is positively related to excess firm value. Morck and Yeung (1991) find, however, that this positive effect applies only to firms with firm-specific intangible assets. Christophe (1997) reports that multinational firms have a lower Tobin's Q than domestic firms indicating a diversification discount. Christophe and Pfeiffer (2002) and Click and Harrison (2000) both find that multinational firms are traded at a discount relative to domestic firms. Although the direction of the value effect is an unsettled issue, it is clear that failure to control for international diversification will bias the measurement of the industrial diversification effect on firm value and vice versa.

Third, a steam of literature argues that since conglomerates and single-segment firms have systematically different characteristics, those firm characteristics may drive both firms' diversification decision and firms' value resulting in endogeneity problems. Campa and Kedia (2002) find that diversified firms were traded at a discount even prior to their diversification, indicating that the discount is not due to diversification. Similarly, Graham et al. (2002), find that the reduction of excess value comes from firms' acquisition of already discounted business units, also indicating that diversification per se does not reduce firm value. After controlling for the endogeneity problem, these two studies find no evidence that diversification destroys firm value.

Villalonga (2004a) matches diversified firms and single-segment firms based on firms' propensity to diversify. She finds that, on average, there is no value discount effect

from diversification. Villalonga (2004b) uses establishment level data to compare diversified and single-segment firms. The results show a diversification premium, rather than a diversification discount, to be in effect. Fluck and Lynch (1999) present a theoretical model in which low-value firms diversify but still trade at a discount relative to single-segment firms, even though the diversification creates value.

Based on the discussion, the issue whether diversification increase or decrease firm value remains as an open question. To obtain convincing results, direct comparison between single-segment firms and conglomerates should be performed in order to avoid matching conglomerates to portfolios of single-segment firms. Moreover, empirical tests should take into account both equity and debt value and control for international diversification effect. This paper is a step in this direction by examining the firm's cost of capital. Cost of capital data not only satisfy the requirement of considering both debt and equity, but also reveal how the external capital market views the efficiency of fund allocation by the firm. In other words, the cost of capital data offers an alternative method to measure the efficiency of conglomerates' internal capital market, as explained in the following sections.

2.2.1.2 Efficiency of Internal Capital Market

What makes conglomerates different from single-segment firms, in terms of financing activities, is the existence of an internal capital market. Conglomerates allocate internal funds among their segments so that their segments do not face the restrictions from the external capital markets. It follows that the efficiency of the internal capital market is a key factor in determining whether conglomerate arrangements are enhancing or destroying firm value, compared to single-segment firms.

Some authors have argued that internal capital markets are inefficient and the misallocation of funds to segments with poor investment opportunities decreases firm value. Berger and Ofek (1995) find that the diversification discount increases with larger investment in segments operating in industries with low Tobin's Q (as a proxy of poor investment opportunity), confirming that the efficiency of internal capital market drives firm value. Lamont (1997) finds that during the 1986 oil price decrease, oil companies significantly reduced investment in their non-oil segments when compared to those segments' median industry investment, even if investment opportunities in those industries did not change. This result shows that internal capital market failed to efficiently allocate the investment funds. Shin and Stulz (1998) find that investments in segments with the best and the less valuable investment opportunities have similar sensitivities to cash flows of other segments, also indicating inefficient resource allocation. Rajan et al. (2000) argue that because of internal power struggles among division managers, when diversity in resources and opportunities increases, resources flow toward the most inefficient divisions leading to more inefficient investments and less valuable firms. Scharfstein and Stein (2000) offer a model showing that rent-seeking behavior of segment managers may lead to a kind of "socialism" in internal capital allocation, whereby weaker divisions get subsidized by stronger ones.

Studies arguing for inefficiency of internal capital markets are subject to several criticisms. Chevalier (2004) looks at the investment behavior of firms prior to the mergers that combined them into diversified conglomerates. Her main finding is that the investment behavior of the conglomerates studied in the literature occurs in the individual firms *before* they undertake a diversifying merger. Therefore, some of the cross-

subsidization results in the literature may be attributable to sample selection bias. Whited (2001) argues that the measurement error in Tobin's Q leads to biased estimates of investment opportunities and, thereby, contributes to the finding in the literature of inefficient allocation of investments.

On the other hand, a number of authors argue that internal capital markets can enhance firm value if firms face external financing constraints and can direct the internal funds to business segments with good, rather than poor, investment opportunities. Weston (1970) and Williamson (1975) consider the effective internal capital market as the main benefit of diversification. Stein (1997) argues that by "winner-picking", head-quarters with control rights can create value even without relaxing the overall firm-wide credit constraints. Maksimovic and Phillips (2002) also show that the majority of conglomerate firms exhibit growth across industry segments that is consistent with optimal behavior, indicating efficient internal capital markets.

However, few empirical studies directly measure the efficiency of internal capital markets due to data limitations. Among them, Billett and Mauer (2000) find that the announcement effect of a tracking stock[21] equity restructuring offers a proxy for the market's assessment of the value of a firm's internal capital market. Hadlock et al. (2001) examine the announcement effect of corporate equity-issue process for the same purpose. The latter study finds that security issues by diversified firms are viewed less negatively by the market than those of the focused firms. They conclude that there is no evidence that market anticipates the funds raised by diversified firms to be invested in particularly poor projects.

[21] Tracking stock is common stock issued by a parent company that tracks the performance of a particular division without having claim on the assets of the division or the parent company. Also known as "designer stock".

2.2.2 Cost of Capital and Diversification

The required return on external capital acquired by firms is the firm's cost of capital. The firms' overall cost of capital (both debt and equity) reflects the required return on the firms' assets and it is determined by the usage of the funds acquired. Diversification may have differential effects on equity and debt holders (Mansi and Reeb, 2002; Deng et al., 2007). Hence, it is important to consider the effects on both debt and equity components of capital. The cost of capital data allows this objective to be achieved as it shows the overall effect of diversification from the investors' perspective. Moreover, the cost of capital data can provide indirect evidence on whether diversification destroys firm value because firm value and cost of capital move in opposite directions. Comparing cost of capital between diversified and single-segment firms offers an alternative avenue to compare the values of these entities. This study is the first to test the overall effect of the two dimensions of diversification, industrial and international, on firm's overall cost of capital.

Firm value is determined by the discounted value of the expected future cash flows.

$$Value\ of\ \ Firm = \sum_{t=1}^{\infty} \frac{Cashflow\ to\ Firm_t}{(1+WACC)^t} \qquad (2\text{-}1)$$

Accordingly, there are two channels through which cost of capital can affect firm value. First, cost of capital determines what projects a firm can accept and, therefore, it influences the level and uncertainty of the firm's cash flows. Ceteris paribus, firms with lower cost of capital enjoy a broader investment opportunity set and, therefore, larger potential cash flows. Suppose a project is offering a return of 8%. If a diversified firm

has a cost of capital of 7% and a single-segment firm has a cost of capital of 9%, then only the diversified firm can accept the project. If investment behavior of single-segment firms is used as the benchmark for project choice, without taking into account the differences in the cost of capital between single-segment and diversified firms, one would mistakenly conclude that the latter firms are investing in negative NPV projects and wasting resources. In this perspective, the results of this paper will contribute to understanding the dissimilar investment behavior between diversified and single-segment firms.

Second, the firm's cost of capital determines the return rate at which the firm's cash flows are discounted. With similar cash flows, firms with lower cost of capital will have higher values. Almost all of the previously mentioned studies focus on the differences in cash flows between diversified and single-segment firms with the assumption that their discount rates are identical. The only exception is Lamont and Polk (2001). They point out that value differences between diversified and single-segment firms are due to differences in both cash flows and discount rates. However, Lamont and Polk's measure of discount rate does not consider the dissimilarity of costs of debt between diversified firms and single-segment firms. Instead, they use the Lehman Brothers Corporate Bond Index return as the cost of debt for all firms. Since diversified firms have significantly lower cost of debt, Lamont and Polk's study overestimates the required return for diversified firms and underestimates it for the single-segment firms.[22] In this perspective, the current study is the first to examine the relationship between firm-specific cost of capital and international and industrial diversification.

[22] See Mansi and Reeb (2002) and Deng et al. (2007).

2.2.3 Hypothesis Development

Empirical studies offer some evidence on the association between industrial and international diversification and cost of equity and debt capital. For example, Mansi and Reeb (2002) and Reeb et al. (2001) find, respectively, that industrial and international diversifications are associated with a lower cost of debt. Contrary to this, Reeb et al. (1998) and Lamont and Polk (2001) report that international and industrial diversification are both associated with a higher cost of equity. However, no existing study examines the influence of the two dimensions of diversification on firms' cost of capital (equity and debt) jointly. Failing to take both debt and equity into consideration may yield inaccurate cost of capital and therefore lead to wrong decisions for both manages who evaluate investment projects for capital budgeting purpose and investors who valuate firms' overall risk. The only study considering the cost of capital as a whole (both debt and equity) is Singh and Nejadmalayeri (2004). These authors examine 90 French firms and find that international diversification is associated with a lower cost of capital. Their finding may be biased, however, because they do not control for industrial diversification and they have a limited sample.

To study the effect of diversification on the firm's cost of capital, influences from other factors should be controlled for. The existing literature shows that risk, information asymmetry, and firm leverage affect the firm's cost of capital. According to the Capital Asset Pricing Model (CAPM), beta risk is the most important risk factor determining equity returns. For debt capital, credit risk is the primary factor determining returns. Firms with higher risk will have a higher cost of capital. Easley and O'Hara (2004) show that differences in the composition of information between public and private

information, i.e., information asymmetry between insiders and outsiders, affect the cost of capital, with investors demanding a higher return to hold stocks with greater private information. Firms facing more severe information asymmetry will have a higher cost of capital.

Backed by capital structure literature, leverage also affects cost of capital because of the tax benefit and costs of financial distress due to debt (Modigliani and Miller, 1958 and 1963). At a low leverage level, debt capital will be cheaper than equity because of the interest tax shield. When a firm increases its leverage, its cost of capital will decrease. However, at a high leverage level, the firm's probability of being in financial distress will be high and, therefore, debt capital will be more expensive than equity capital. At this stage an increase in leverage will be associated with a higher cost of capital. Based on these arguments, the association between firm leverage and cost of capital may be approximated by a U-shaped curve.

Diversification can change firm risk and information asymmetry as well. If risk and information asymmetry fully incorporate the information on firm diversification, cost of capital change will be captured in those two factors and empirical tests should not reveal any additional association between firm diversifications and cost of capital. Hence, if the current study unveils an association between cost of capital and diversification after controlling risk and information factors, the results will provide a test for the efficiency of internal capital mark.

If internal capital markets are inefficient because of agency problem and/or cross-subsidization, industrial diversification should be associated with higher cost of capital. On the other hand, if internal capital markets are efficient because of headquarters'

winner-picking activity, industrial diversification should be associated with lower cost of capital. Only empirical tests can reveal which effect dominates. Similar hypotheses can be developed for international diversification.

H_{2A} - H_{2B}: Industrial diversification is positively (negatively) associated with firm cost of capital.

H_{3A} – H_{3B}: International diversification is positively (negatively) associated with firm cost of capital.

Based on the argument of Mansi and Reeb (2002), industrial diversification may decrease shareholder value but at the same time increase debt holder value. Consequently, the effect of industrial diversification on firm value depends on firm leverage. Doukas and Kan (2006) find similar results for international diversification. Li and Li (1996) also state that firms need to utilize debt in order for diversification to be efficient because debt serves as a bonding device on the managers' self-interest behavior. Jensen (1986) refers this benefit of debt in reducing agency cost of free cash flows as the "control hypothesis". According to these arguments, if diversification benefits the firm only with the presence of debt capital, then diversification would have no effect on, or would increase the cost of equity for the all-equity firms (firms fully financed by equity). Mansi and Reeb find no diversification discount for their all-equity firms. Agrawal and Nagarajan (1990) point out that all-equity firms exhibit greater levels of managerial stockholdings than leveraged firms. Consequently, we would expect the managers of the all-equity firms to choose the best strategy for shareholders and also for their own benefit. Whether all-equity firms benefit from, or are hurt by, industrial and international

diversification is again an empirical question. The following two hypotheses are used to test the association between diversification and cost of equity for all-equity firms:

H_{4A} – H_{4B}: Industrial diversification is positively (negatively) associated with firm's cost of equity.

H_{5A} – H_{5B}: International diversification is positively (negatively) associated with firm's cost of equity.

Finally, to complete the picture on firm valuation, one needs to test whether international and industrial diversification change firms' cash flow in addition to altering the discount rate. Diversification makes cash flows of conglomerates different from portfolio of single-segment firms through two channels. First, as previously mentioned, diversified firms may have different costs of capital than single-segment firms. The cost of capital advantage or disadvantage of conglomerates would make them choose dissimilar projects to those of the single-segment firms. Second, the efficiency or inefficiency of internal capital markets in project picking may also result in taking different projects when compared to single-segment firms. The question whether conglomerates generate more or less cash flows compared to single-segment firms will need to be answered empirically.

H_{6A} – H_{6B}: Industrial diversification is positively (negatively) associated with firm cash flow.

H_{7A} – H_{7B}: International diversification is positively (negatively) associated with firm cash flow.

In Section 2.4, univariate and multivariate analyses will be used to test these hypotheses in different model specifications.

2.3 Model, Data and Methodology

2.3.1 Data Sources

The cost of capital data are acquired from Russell 3000 EVA/MVA Annual Ranking Database compiled by Stern Stewart & Co.[23] The dataset includes historical data for cost of capital as well as industry classification and ticker for each company in the Russell 3000 index. The Russell 3000 index is a market-capitalization-weighted benchmark made up of the 3000 largest US stocks, the market value of which represents about 98% of the US equity market. The time period covered in this study runs from year 1998 to 2004 to make sure that the segment data are consistent with SFAS No.131, discussed in next section. More than 80 corporations in U.S. (e.g., Coca-Cola Co., Sprint and Whirlpool) and about 50 corporations around the world are using Economic Value Added (EVA) criteria in their performance evaluation. Academic studies also use EVA as a proxy for firm performance (e.g., Anderson and Reeb, 2003; and Abate et al., 2004).

Each firm-year covered in the Stern Stewart database are matched with Compustat industrial annual data, Compustat segment data, I/B/E/S and CRSP databases either through the same identifier or hand-match. To be included in the sample, the firm year must have data available in all four databases. Moreover, firms with total sales below $50 million are eliminated to exclude the influence of small firms. Compustat industrial annual data offers firm characteristic data.[24] Compustat segment data record

[23] Based on the description on Stern Stewart & Co. website "Economic Value Added is the financial performance measure that comes closer than any other to capturing the true economic profit of an enterprise" Cost of capital data is part of their dataset in their Russell 3000 EVA/MVA Annual Ranking Database.

[24] Following the literature, missing R&D expenses are manually set to zero.

sales, book values of assets, and other variables for each industrial and international (including domestic) segment. The I/B/E/S database offers detailed analyst forecasts of firm earning-per-share. Information from this database is commonly used to proxy for firm information asymmetry. CRSP indices--Year-end decile assignment database offers year end beta value based on current year computed using the methods developed by Scholes and Williams (1977). Following Denis et al. (2002), this study eliminates utility and financial firms (SIC codes 4900-4999 and 6000-6999, respectively) and firms incorporated outside of the United States. After excluding missing values, I have an initial sample of 7,688 firm-year observations.

2.3.2 Variable Constructions

The following model is used to investigate the association between cost of capital (WACC) and diversification whose measures will be described below. The control variables chosen are the factors identified in literature.

Cost of Capital = f (Diversification, Risk, Leverage, Information Asymmetry) (2-2)

2.3.2.1 Measure of Cost of Capital

Borrowed from asset pricing literatures, the dependent variable used in this study is the risk premium (Premium), defined as the difference between the firm's cost of capital and the risk-free rate. Cost of capital data are obtained directly from EVA/MVA database. The annual risk-free rate is the market yield on U.S. treasury securities at 1-year constant maturity, quoted on investment basis from the H.15 release of the Federal Reserve System[25]. Since both cost of capital and risk-free rate are quoted in percentage term, the unit of Premium is also in percentage term. This study focuses on the cross-

[25] obtained from Federal Reserve Statistical Release website at: http://www.federalreserve.gov/releases/h15/data/Annual/H15_TCMNOM_Y1.txt

sectional differences in cost of capital between diversified firms and single-segment firms, the maturity of risk-free rate would not make a difference to empirical tests as long as the same rate is used to calculate Premium for all firms.

2.3.2.2 Measure of Diversification

Statement of accounting Standards (SFAS) No.14, issued by the Financial Accounting Standard Board (FASB) in 1976, requires U.S. firms to disclose financial information for individual industrial and foreign segments that account for more than 10 percent of consolidated sales, profits, or assets. Prior to 1997, enterprises were required to classify line-of-business segment information using the *industry approach*. According to Ernst and Young (1998), the discretion in the definition of "industry" allowed many enterprises to report much less segments to external users than what was reported internally. In 1997, FASB issued SFAS No.131, which requires enterprises using the *management approach* to present disaggregated information based on how management internally evaluates the operating performance of its business units. Consequently, the problem mentioned in Denis, et al. (2002) that only a limited number of segments are reported in Compustat segment data alters in nature after 1998. Since the changing of reporting approach offers more accurate segment data, the beginning of the sample is chosen to be 1998.

The existing literature offers three different measures of diversifications: i) a dummy variable for reporting more than one business or international (including domestic) segments, ii) the number of reported segments, and iii) a segment-sale-based Herfindahl index. The first two measures are used by Mansi and Reeb (2002), and the third by Doukas and Lang (2003). In this study, all three measures of diversification will

be calculated. Industrial and international segments with non-positive net sales are eliminated to ensure that the sum of segment sales is properly allocated to each individual segment. The dummy variables for diversification and the number of segments are used primarily as diversification measures. The Herfindahl indices are also applied later to check for the robustness of the results.

The Business diversification index (BUS-HHI) and the international diversification index (INT-HHI) are described below. In these calculations, segments with negative net sales are deleted to avoid the potential confusion in calculating the sum of all segment sales.

$$BUS - HHI = 1 - \sum_j \left(\frac{Sales_j}{\sum_j Sales_j} \right)^2, j = 1, 2, ..., m \quad (2\text{-}3)$$

$$INT - HHI = 1 - \sum_j \left(\frac{Sales_j}{\sum_j Sales_j} \right)^2, j = 1, 2, ..., n \quad (2\text{-}4)$$

2.3.2.3 Measure of Cash Flow

An important issue about studying the magnitude of firm cash flow is that firm size has to be controlled for because large firms are generating more cash flows than small firms by nature. Therefore, the variable used in this study is size adjusted firm cash flow variables. Borrowed from accounting literature, e.g., Subramanyam and Venkatachalam (2007), operating cash flow (CF) is defined as net cash flow from operating activities (Compustat data item 308[26]) obtained from the cash flow statement

[26] Net cash flow from operating activities represents the change in cash from all items classified in the Operating Activities section on a Statement of Cash Flows including changes in operating assets and liabilities.

adjusted for extraordinary items and discontinued operations (Compustat data item 124)[27] and scaled by firms' book value of total assets.

2.3.2.4 Control Variables

To examine the effect of diversification on firm cost of capital, it is necessary to control for other factors that affect the firm's cost of equity and debt. Three control variables are used for this purpose; beta risk (based on CAPM), size, and book-to-market (BTM) based on Fama and French (1993). Beta is the year-end Scholes-Williams beta value, based on current year. The necessary data is obtained from CRSP Indices--Year-end decile assignment data. Firm size (Size) is measured as the natural log of the total assets. Market to book ratio (MTB) is measured as the ratio of market and book values of total assets, where the market value is measured as the product of the year-end close price and number of common shares outstanding plus total assets minus shareholder's equity.

In the cost of debt model, following Reeb et al. (2001), firm size and default risk are used as the control variables. Default risk of a firm is measured by three variables: leverage, firm credit rating, and tangible assets. Leverage (Leverage) is the sum of total long-term debt and debt in current liability divided by total assets. Since this study is looking from the firm's perspective, individual bond rating cannot be used to measure firm default risk. Therefore, a firm credit rating (Rating), the S&P long-term domestic issuer credit rating, obtained from Compustat, is used. Borrowed from Compustat database manual, Appendix C provides the table based on which firm credit rating symbols are converted into the corresponding numbers. Based on the table, the better the

[27] This item represents Extraordinary Items/Discontinued Operations, net of the portion not affecting cash (for Source & Use Statements and Cash Flow Statements) or working capital (for Working Capital Statements).

rating is, the smaller the assigned number. For the initial sample of 7,688 firm-year observations, Rating data are available for only 3,124 of firms. To limit the loss of observations due to missing firm credit rating, an alternative measure is used; tangible assets (Tangible), measured as the value of net property, plant and equipment scaled by total assets.

Asset pricing literature indicates that beta and default risk proxies may not be able to fully capture the firm risk profile. International finance literature also indicates that international risk may not be embedded in beta and default risks. Therefore, this study employs an alternative risk proxy to control for total firm risk. The proxy is coefficient of variation of firm annual sales (CV Sales), defined as the standard deviation of sales divided by its mean in the previous five years.[28] Sales data are chosen over net income because sales are less likely to be subject to managerial manipulation than ROA or net income. The argument here is that even if risk factor was not fully captured by beta and credit rating risks, it would be better embedded in the firm total risk. The additional benefit of using total firm risk is to avoid deleting a large number of observations with missing credit rating data.

Another factor that may affect both the cost of equity and the cost of debt is information asymmetry. According to Myers and Majluf (1984), firms prefer internal to external funds and prefer debt to equity if external financing is necessary because of information asymmetry. Easley et al. (2002) and Easley and O'Hara (2004) show that shareholders require higher premium on firms with severe information asymmetry problem. Mansi et al. (2006) point out that information risk increases corporate bond

[28] Similar variable construction is used in Minton and Schrand (1999).

yields. Following Bailey et al. (2003), two measures are constructed as proxies for firm information asymmetry. First, the absolute consensus forecast error (Error), which is calculated as the absolute value of the difference between actual earnings and consensus forecasts scaled by stock price at the end of the year. Second, the forecast dispersion (Dispersion), calculated as the standard deviation of the most recent individual forecasts scaled by the stock price at the end of the year. Error will be used in primary analysis and Dispersion will be used in robustness test.

2.3.3 Descriptive Statistics and Univariate Analysis

Table 2-1 reports descriptive statistics for the sample. Panels A and B present the sample distribution in each one-digit SIC coded industry and the distribution over time, respectively. In Panel C, the sample is classified into four sub-samples, according to the number of their industrial and international segments: domestic single-industry (DS), domestic multi-industry (DM), multinational single-industry (MS), and multinational multi-industry (MM). A firm is classified as domestic if it only has domestic segment, and as multinational otherwise. A firm is classified as a single-industry if it only has one industrial segment and as multi-industry, otherwise. Out of the 7,688 firm-year observations in the sample, the MM group is the largest with 2,944 firm-year observation, MS and DS groups account for 2,122 and 1,618 observations, respectively, and the DM group has the fewest observations of 1,004.

Panel D offers the summary statistics on the variables employed. Firms in the sample have an average risk Premium of 5.371%. The average book value of total assets is $2,862.58 million, indicating that our sample contains mostly large firms. The average Rating score is 12.16, equivalent to a rating of BBB (see Appendix C). For the

Table 2-1: Summary statistics (7,688 firm-year observations, 1998-2004)

Premium is the difference between firm cost of capital and the risk-free rate in the corresponding year. Risk-free rate is the Market yield on U.S. Treasury securities at 1-year constant maturity. **Size** is the natural logarithm of the book value of total assets. **Beta** is year end Beta value obtained from CRSP, based on current year. **Rating** is the S&P Long-term Domestic Issuer Credit Rating data in the Compustat database. Rating of AAA is coded as value 2 and Rating of D as 27 (See Appendix C). **CV-Sales** is the coefficient of variation of sales, defined as the ratio of standard deviation and mean of sales for the previous five years. **MTB** is market/book ratio, defined as the market value of total assets (sum of book value of debt and market value of equity) divided by the book of value of equity. **Tangible** is net property, plant and equipment scaled by the book of value of equity. **ROA** is net income scaled by the book value of total assets. Capital expenditure is capital expenditures scaled by total assets. Capital expenditure **(Capex) and R&D** are scaled by the book value of total assets. **Leverag**e is measured as the book value of total debt (long-term debt plus debt in current liabilities) divided by the book value of total assets. Number of business segments and number of international segments are from Compustat segment database. **BUS-HHI** and **INT-HHI** are segment-sales-based Herfindahl index-like measures of firm industrial and international diversification, respectively. **Error** is the absolute consensus forecast error, which is calculated as the absolute value of the difference between actual earnings and consensus forecasts scaled by stock price at the end of the year. **Dispersion** is the forecast dispersion calculated as the standard deviation of the most recent individual forecasts scaled by the stock price at the end of the year. **CF** is defined as net cash flow from operating activities adjusted for extraordinary items and discontinued operations and scaled by total assets.

Panel A. Sample distribution in each one-digit SIC coded industry

One-digit SIC code	Industry	NOBS
0	Agriculture, Forestry, and Fishing	18
1	Mining and Construction	434
2	Light Manufacturing	1165
3	Heavy Manufacturing	2873
4	Transportation, Communications, and Sanitary Services	518
5	Whole Sale Trade And Retail Trade	1075
7	Services	1230
8	Public Administration And Non-classifiable Establishments	375

Panel B. Sample distribution over time

Year	NOBS
1998	778
1999	806
2000	969
2001	1116
2002	1237
2003	1290
2004	1492

Panel C. Diversification type

Type	Sub-group name	NOBS
Domestic Single-industry	DS	1618
Domestic Multi-industry	DM	1004
Multinational Single-industry	MS	2122
Multinational Multi-industry	MM	2944

Panel D. Descriptive statistics

Variable	NOBS	Mean	Median	St.d.	Min	Max
Premium (%)	7688	5.372	5.2	2.573	0.22	11.99
Total Assets ($million)	7688	2862.58	662.9	8121.78	18.404	257,389
Beta	7688	0.965	0.901	0.592	-0.551	4.001
Rating	3124	12.156	12	3.431	2	23
CV Sales	7664	0.309	0.239	0.252	0.004	2.626
MTB	7688	2.178	1.646	1.617	0.638	14.064
Tangible	7688	0.272	0.218	0.213	0	0.954
ROA	7624	0.029	0.046	0.115	-0.802	0.309
Capex	7688	0.059	0.041	0.064	0	1.134
Leverage	7688	0.215	0.195	0.195	0	0.927
R&D	7688	0.039	0.006	0.065	0	0.938
Error	7688	0.024	0.002	0.310	0	17.328
Dispersion	7688	0.012	0.002	0.070	0	3.037
# of Business Segments	7688	2.035	2	1.299	1	9
# of International Segments	7688	2.639	2	1.827	1	18
BUS-HHI	7688	0.228	0.038	0.263	0	0.862
INT-HHI	7688	0.282	0.278	0.258	0	0.874

diversification measures, firms in the sample have an average of 2.0 business segments and 2.6 international segments. The Herfindahl indexes BUS-HHI and INT-HHI have average scores of 0.23 and 0.28 over the range of zero to one, respectively.

Correlations among the variables are reported in Table 2-2. Some initial evidence can be found by looking at the correlation between risk Premium and diversifications measures. Industrial (international) diversification is significantly and negatively (positively) correlated with Premium, suggesting that firms with greater degrees of industrial (international) diversification have a lower (higher) cost of capital. This result supports hypothesis H_{1B} (H_{2A}). To account for the influence of the control variables, in the next section, multiple regression analysis will be used to further explore the hypotheses,.

Univariate statistics, means of variables, and test results for the equality of means across the four groups of firms are reported in Table 2-3. Out of the four groups, multinational single-industry firms (MS) and multinational multi-industry firms (MM) have the highest and the second highest cost of capital, indicating that international diversification is associated with higher cost of capital. Domestic-multi-industry (DM) and domestic-single-industry firms have the lowest and second lowest cost of capital among all the firms, suggesting that industrial diversification is associated with lower cost of capital for both domestic and multinational firms. As to the firm size, multinational multi-industry firms (MM) are the largest as expected. It is also notable that multi-industry firms (MM and DM) are larger than single-industry firms (MS and DS).

Multinational single-industry (MS) firms have the highest beta risk and multi-national-multi-industry firms (MM) rank the second. The result on international

Table 2-2: Pearson simple correlation coefficients among variables

	Premium	Size	Beta	Rating	CV Sales	MTB	Tangible	ROA	Leverage	Error	R&D	#BUSEG	#GESEG	BUS-HHI
Size	-0.165													
	<0.001													
Beta	0.464	0.149												
	<0.001	*<0.001*												
Rating	0.130	-0.595	0.180											
	<0.001	*<0.001*	*<0.001*											
CV Sales	0.212	-0.168	0.163	0.365										
	<0.001	*<0.001*	*<0.001*	*<0.001*										
MTB	0.195	-0.104	0.109	-0.325	0.157									
	<0.001	*<0.001*	*<0.001*	*<0.001*	*<0.001*									
Tangible	-0.349	0.176	-0.176	0.024	-0.136	-0.181								
	<0.001	*<0.001*	*<0.001*	*0.184*	*<0.001*	*<0.001*								
ROA	-0.188	0.077	-0.181	-0.430	-0.230	0.250	0.039							
	<0.001	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*							
Leverage	-0.376	-0.332	-0.060	0.459	-0.033	-0.276	0.322	-0.154						
	<0.001	*<0.001*	*<0.001*	*<0.001*	*0.004*	*<0.001*	*<0.001*	*<0.001*						
Error	0.019	-0.022	0.023	0.106	0.065	-0.038	0.040	-0.158	0.081					
	0.089	*0.054*	*0.041*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*					
R&D	0.477	-0.248	0.241	-0.053	0.234	0.294	-0.314	-0.308	-0.286	0.012				
	<0.001	*<0.001*	*<0.001*	*0.003*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.294*				
#BUSEG	-0.112	0.342	-0.016	-0.289	-0.197	-0.137	-0.019	-0.004	0.101	-0.015	-0.099			
	<0.001	*<0.001*	*0.167*	*<0.001*	*<0.001*	*<0.001*	*0.093*	*0.736*	*<0.001*	*0176*	*<0.001*			
#GESEG	0.210	0.147	0.203	-0.180	-0.043	0.057	-0.160	-0.070	-0.089	-0.007	0.219	0.193		
	<0.001	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.567*	*<0.001*	*<0.001*		
BUS-HHI	-0.120	0.278	-0.023	-0.263	-0.203	-0.156	-0.030	-0.015	0.091	-0.023	-0.092	0.866	0.219	
	<0.001	*<0.001*	*0.042*	*<0.001*	*<0.001*	*<0.001*	*0.008*	*0.195*	*<0.001*	*0.043*	*<0.001*	*<0.001*	*<0.001*	
INT-HHI	0.273	0.161	0.238	-0.209	-0.067	0.076	-0.219	-0.082	-0.105	-0.010	0.314	0.144	0.757	0.176
	<0.001	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.380*	*<0.001*	*<0.001*	*<0.001*	*<0.001*

Note: This table reports simple correlation between every two variables used in this study. Below each correlation coefficient, the significance of the correlation coefficient estimation is reported. All the variable definitions are the same as in Table 2-1.

Table 2-3: Univariate statistics and group mean comparison tests

	Domestic Firms		Multinational Firms		Tests of Group Difference					
	Single Industry (DS)	Multi-Industry (DM)	Single Industry (MS)	Multi-Industry (MM)	(DS) vs. (DM)	(DS) vs. (MS)	(DS) vs. (MM)	(DM) vs. (MS)	(DM) vs. (MM)	(MS) vs. (MM)
No. of Firms	1618	1004	2122	2944	p-value					
Premium	4.818	4.599	6.398	5.200	0.012	0.001	0.001	0.001	0.001	0.001
Size	6.273	6.548	6.340	7.163	0.001	0.135	0.001	0.001	0.001	0.001
Beta	0.836	0.801	1.094	1.001	0.112	0.001	0.001	0.001	0.001	0.001
Rating	13.796	12.893	12.403	11.259	0.001	0.001	0.001	0.018	0.001	0.001
CV Sales	0.345	0.309	0.368	0.247	0.001	0.010	0.001	0.001	0.001	0.001
MTB	2.189	1.758	2.620	1.996	0.001	0.001	0.001	0.001	0.001	0.001
Tangible	0.361	0.310	0.221	0.248	0.001	0.001	0.001	0.001	0.001	0.001
ROA	0.041	0.035	0.021	0.025	0.132	0.001	0.001	0.001	0.003	0.272
Capex	0.084	0.063	0.056	0.047	0.001	0.001	0.001	0.010	0.001	0.001
Leverage	0.240	0.251	0.164	0.226	0.193	0.001	0.039	0.001	0.001	0.001
R&D	0.022	0.011	0.066	0.038	0.001	0.001	0.001	0.001	0.001	0.001
Error	0.031	0.020	0.034	0.014	0.260	0.800	0.039	0.237	0.315	0.065
# of Business Segments	1	2.788	1	3.093						
# of Intl. Segments	1	1	3.338	3.595						
BUS-HHI	0	0.367	0	0.470						
INT-HHI	0	0	0.4444	0.417						
CF	0.111	0.093	0.087	0.088	0.001	0.001	0.001	0.182	0.115	0.794

Note: The sample is sorted into four sub-samples based on firm diversification status. Numbers in the first four columns are the group mean of each variables. The last six columns report the p-value of t-test of group mean differences between each two of the four groups. All the variable definitions are the same as in Table 1.

diversification is consistent with Reeb et al. (1998), who find that multinational corporations have higher systematic risk than domestic firms. Industrial diversification is associated with a lower beta risk for both domestic and multinational firms. As for credit rating, the four groups are ranked as multinational multi-industry (MM), multinational single-industry (MS), domestic-multi-industry (DM), and domestic single-industry (DS) from the best to the worst. Internationally-diversified and industrially- diversified firms have lower credit risk than their single-industry counterparts. This result is consistent with Reeb et al. (2001) and Mansi and Reeb (2002), respectively. Statistics for firm total risk, Coefficients of variation of Sales show that MS firms are the riskiest while MM firms are the safest.

Domestic single-industry firms have the largest tangible assets, ROA, and capital expenditure as scaled by total assets. These results show that firms with larger portions of tangible assets, are more profitable, have better investment opportunities, and are less likely to diversify. These firms are more likely to stay domestic and in the current industry. As to the firm leverage ratio, DM firms have the highest score and MS firms have the lowest. One important point to notice is that MS firms have the highest R&D to total assets ratios and these ratios are much larger than even those for the second highest MM firms. Accordingly, multinational firms are subject to more agency problems. Absolute consensus analyst forecast error is rather similar across the groups. Overall, the group-mean comparisons show that the four sub-groups are dissimilar in key firm characteristics.

The last row of Table 2-3 describes the firm cash flow characteristics and it will be explained in detail in Section 2.4.4. To further explore the effect of diversification on

firm cost of capital, the following section will apply regression models to analyze this issue.

2.4 Regression Analysis

2.4.1 Pooled Full Sample Regression

The model describing the Premium variable can be presented as:

$$Premium = \alpha_1 + \alpha_2(Size) + \alpha_3(Beta) + \alpha_4(Rating) + \alpha_5(MTB) + \alpha_6(Tangible) + \alpha_7(Leverage) + \alpha_8(LeverageSquare) + \alpha_9(Error) + \alpha_{10}(Industrial\ Div) + \alpha_{11}(International\ Div) + \alpha_{12}(Industry\ DV) + \alpha_{13}(Year\ DV) + \varepsilon \quad (2\text{-}5)$$

The model includes a set of two-digit SIC code dummy variables to control for the industry effect and a set of year-dummy variables to control for the time effect. The parameters of major interest are the coefficients of industrial and international diversification (α_{10} and α_{11}). Industrial Div and International Div either take values of a dummy variable for diversification or the number of segments. An alternative model, will substitute the coefficient of variation of sales (CV Sales) for Beta and Rating variables as control for firm total risk. Herfindahl indices will also substitute dummy variables for diversification measures in later model specification.

Table 2-4 presents the multivariate regression results on the association between firm cost of capital and diversification based on the entire (pooled) sample. As shown in data section, less than half of the observations have firm credit rating data available. Therefore, in models (1) and (2) the risk factor is proxied by the coefficient of variation of sales (CV Sales) in order to be able to utilize more (7,664) observations. In models (3) and (4) beta risk and credit rating are used as proxies for equity and debt risk,

Table 2-4: Determinants of cost of capital premium: OLS regressions of the pooled sample

Premium = $\alpha_1 + \alpha_2$*(Size)* + α_3*(Beta)* + α_4 *(Rating)* + α_5*(MTB)* + α_6*(Tangible)* + α_7*(Leverage)* + α_8 *(LeverageSquare)* + α_9*(Error)* + α_{10}*(Industrial Div)* + α_{11}*(International Div)* + α_{12}*(Industry DV)* + α_{13}*(Year DV)* + ε

	Total Risk		Beta and Rating Risk	
Models	1	2	3	4
Intercept	1.486***	1.218***	-0.742	-0.586
	(3.72)	(3.03)	(-1.04)	(-0.82)
Size	0.011	0.014	0.105***	0.108***
	(0.85)	(1.10)	(4.21)	(4.45)
Beta			0.551***	0.576***
			(12.24)	(12.88)
Rating			0.094***	0.087***
			(9.03)	(8.32)
CV-Sales	1.345***	1.328***		
	(19.62)	(19.28)		
MTB	0.118***	0.117***	0.302***	0.286***
	(10.93)	(10.81)	(15.03)	(14.19)
Tangible	-0.816***	-0.788***	-0.477***	-0.489***
	(-6.93)	(-6.64)	(-3.23)	(-3.31)
Leverage	-4.425***	-4.350***	-4.251***	-4.197***
	(-18.52)	(-18.13)	(-10.52)	(-10.42)
LeverageSquare	2.678***	2.578***	2.129***	2.055***
	(7.81)	(7.48)	(4.60)	(4.45)
Error	0.151***	0.142***	-0.141	-0.146
	(3.00)	(2.80)	(-1.39)	(-1.45)
DV-BUS		-0.123**		-0.272***
		(-2.15)		(-3.40)
DV-INT		0.509***		0.142*
		(9.72)		(1.80)
DV-BUSINT		0.007		-0.270***
		(0.13)		(-3.52)
# of Business Segments	-0.128***		-0.058***	
	(-9.44)		(-3.49)	
# of Intl. Segments	0.131***		0.062***	
	(13.28)		(4.74)	
Year DV	Yes	Yes	Yes	Yes
Industry DV	Yes	Yes	Yes	Yes
No. of obs	7664	7664	3124	3124
Adjusted R^2	0.728	0.726	0.754	0.756

Note: This table presents the OLS results of the models in which the dependent variable is Premium. Independent variables include Size, Beta, Rating, CV-Sales, MTB, Tangible, Leverage, R&D, number of business and international segments. The definitions of these variables are the same as in Table 1. LeverageSquare is the square of the leverage. DV-BUS, DV- INT and DV-BUSINT are dummy variables for industrial diversification only, international diversification only, and both industrial and international diversifications, respectively. To control for time effect and industry effect, dummy variables are also included for each calendar year (Year DV) and each industry based on two-digit SIC code (Industry DV). t-statistics are reported in parentheses below each coefficient estimate. *, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

respectively. A total of 3,124 observations are available for this sub-sample. Industrial and international diversifications are measured by the number of segments in models (1) and (3). In model (2) and (4), dummy variables for business diversification only, international diversification only, and both business and international diversification (DV-BUS, DV-INT, and DV BUSINT, respectively) are used to sort the observations into the four sub-groups considered. Differential patterns of behavior in cost of capital across the groups are then contrasted.

2.4.1.1 Main Results

Estimation results based the four models in Table 2-4 show several interesting results. First, in Models (2) and (4) the coefficient of industrial (international) diversification dummy is negative (positive) indicating that compared to domestic single-industry firms, domestic multi-industry (multinational single-industry) firms have significantly lower (higher) costs of capital. Moreover, multinational multi-industry firms have a lower cost of capital compared to domestic single-industry firms in model (4) but not in model (2). This latter result indicates that when firms are involved in both international and industrial diversification, the effect of diversification on cost of capital is unclear.

In model (1) and (3), the number of industrial (international) segments is used as the proxy for industrial (international) diversification. The dissimilarity between the two models is that model (1) controls for total risk, while model (3) controls for systematic risk (beta) and credit rating risk. The estimation results show that the number of business (international) segments is negatively (positively) associated with firm cost of capital.

These results are consistent with hypotheses H_{1B} and H_{2A} and the arguments presented in the hypotheses section.

Results for model (1) in this table suggest that for an average firm in the sample, one standard deviation increase in industrial diversification (measured by the number of business segments) would result in an approximately 16.6 basis point lower cost of capital. This is computed by multiplying the standard deviation of number of business segments (1.299) in the sample by the coefficient estimate in the regression (-0.128). The economic impact for the average firm in sample (with total assets $2862.58 million) is estimated to be a $4.76 million saving per year. Similarly, one standard deviation increase in international diversification will cost a firm approximated $6.85 million per year additional cost. Given the fact that multinational multi-industry firms consist of significant portion of our sample, these results clearly show the importance of jointly considering industrial diversification and international diversification when studying valuation change associated with diversifications. As to the average firm in our sample, if it increases international and industrial diversification both by one standard deviation of our sample, the combined effect would be an additional cost of $2.09 million per year. This adverse effect would have been mistakenly attributed to industrial diversification if the international diversification was not taken into consideration.

2.4.1.2 Results on Control Variables

Models (1) and (2) use CV-sales to proxy for firm total risk. In these models, Premium is found to be unrelated to firm size, possibly because CV-sales, as a measure of total risk, captures the risk effects embodied in the firm size (the dimension of risk identified in Fama and French (1992) as size). In Models (3) and (4) firm risk is

controlled for by using market Beta and credit risk (Rating). In these two models, size is positively related to Premium. The reason may partly due to the fact that Beta and Rating did a poor job in fully capturing all the risk factors contained in the firms and some risk factors had been captured by the size variable. Considering that the sample consists of the largest firms on the U.S. equity market, the positive association between Premium and size may not be surprising because larger firms have a bigger tolerance for risk and their management is often more prone to risk taking.

The signs for the coefficient estimates for risk factors are as expected. CV-sales, Beta and Rating are all positively related to Premium, indicating that higher risk is associated with higher cost of capital. Market-to-book ratio (MTB) is found to be positively related to Premium in all four model specifications, indicating that firms with more growth opportunities are having higher cost of capitals, partly due to the unrealized nature of future growth opportunity and the associated riskiness. This may also due to the fact that the dividend growth rate, also known as the capital gain yield, is a major part of cost of equity. Tangible assets are negatively associated with Premium, indicating that providers of funds require a lower premium from firms holding higher levels of tangible assets possibly because tangible assets can serve as collateral. Leverage has a non-linear effect on firm cost of capital. When firms increase leverage starting from the all-equity capital structure, cost of capital decreases because of the tax-benefits and the lower cost of debt. However, as firms gradually accumulate a large amount of debt, the probability of financial distress increases and, thus, the cost of capital will increase in an increasing manner. The result is consistent with the capital structure literature on this perspective (Modigliani and Miller, 1958 and 1963). Absolute consensus forecast error, defined as

the absolute value of the difference between actual earnings and consensus forecasts scaled by stock price at the end of the year, is positively associated with cost of capital in model (1) and (2), consistent with information asymmetry theory. This association is not significant in model (3) and (4), where Beta and Rating are used to proxy for firm risk, instead of using CV-sales.

Overall, all the four model specifications in Table 2-4 show that industrial (international) diversification is associated with a lower (higher) firm cost of capital. As for multinational multi-industry firms, the direction and the strength of the association between cost of capital and diversification are determined by the joint force of the two dimensions of diversification. However, it is unclear whether in multinational multi-industry firms, industry and international diversification still have the same effects on cost of capital as they do in firms involved in only one dimension of diversification. To find the answer to this question, tests should be performed to compare multinational multi-industry firms to firms involved in only one dimension of diversification and the difference of cost of capital can be attributed to the other dimension of diversification. In the next section, the effect of each diversification type will be tested separately using sub-sample regressions.

2.4.2 Sub-sample Regression

As described in the data section, credit rating data are available only for a small potion of the sample observations. Therefore, in this section, coefficient of variation of sales (CV-Sales) will be used, rather than Beta and Rating, as the proxy for risk in order increasing the number of observations. The model is specified as follows:

$$Premium = \alpha_1 + \alpha_2(Size) + \alpha_3(CV\text{-}Sales) + \alpha_4(MTB) + \alpha_5(Tangible) + \alpha_6(Leverage) + \alpha_7(LeverageSquare) + \alpha_8(Error) + \alpha_9(Div) + \alpha_{10}(Industry\ DV) + \alpha_{11}(Year\ DV) + \varepsilon \quad (2\text{-}6)$$

The association between the cost of capital and industrial and international diversification will be examined one at a time using different sub-samples of observations. By separating the entire sample into sub-samples, the effect of one type of diversification is controlled while the other type is tested. The same analysis is conducted using both beta and credit rating to control for risk instead of using CV-sales and the estimation results (not reported) are similar to those reported below.

2.4.2.1 Cost of Capital and Industrial Diversification

Panel A in Table 2-5 reports the results for the sub-sample of observations based on domestic firms only (domestic single-industry and multi-industry firms). The model specification uses both dummy variable and the number of business segments as measures of industrial diversification. Estimated coefficients for both of these two proxies are negative, indicating that industrial diversification is associated with lower cost of capital.

In Panel B, a similar model is estimated using sub-sample of multinational single-industry and multinational multi-industry firms (MS and MM groups). Because the sample contains multinational firms only, the results in Panel B reveal the effect of industrial diversification, after controlling for international diversification. The results show that industrial diversification is associated with a lower cost of capital and the more business segments a firm has, the lower the cost of capital will be. All the control variables have the expected signs as discussed in the previous section.

Table 2-5: Determinants of cost of capital premium by diversification type: OLS regressions of the four sub-samples

Premium = α_1 + α_2*(Size)* + α_3*(CV-Sales)* + α_4*(MTB)* + α_5*(Tangible)* + α_6*(Leverage)* + α_7*(LeverageSquare)* + α_8*(Error)* + α_9*(Div)* + α_{10}*(Industry DV)* + α_{11}*(Year DV)* + ε

	Industrial Diversification				International Diversification			
	Panel A: Domestic Firms		Panel B: Multinational Firms		Panel C: Single-industry Firms		Panel D: Multi-industry Firms	
Intercept	1.336*	1.401*	1.709***	1.715***	1.059**	1.194**	1.390*	1.406*
	(1.72)	(1.80)	(3.57)	(3.57)	(2.19)	(2.52)	(1.86)	(1.89)
Size	0.006	0.008	0.029*	0.039**	0.048**	0.013	-0.005	-0.009
	(0.28)	(0.38)	(1.78)	(2.30)	(2.33)	(0.62)	(-0.34)	(-0.55)
CV-Sales	1.094***	1.080***	1.471***	1.528***	1.201***	1.215***	1.506***	1.474***
	(11.74)	(11.56)	(15.49)	(15.96)	(13.04)	(13.45)	(14.36)	(14.15)
MTB	0.141***	0.141***	0.105***	0.109***	0.086***	0.081***	0.193***	0.192***
	(8.00)	(8.02)	(7.71)	(8.00)	(6.04)	(5.79)	(11.34)	(11.32)
Tangible	-0.092	-0.087	-1.300***	-1.336***	-1.103***	-0.977***	-0.529***	-0.591***
	(-0.64)	(-0.61)	(-7.28)	(-7.44)	(-6.11)	(-5.52)	(-3.30)	(-3.73)
Leverage	-2.657***	-2.656***	-5.353***	-5.507***	-3.637***	-3.606***	-4.842***	-4.841***
	(-8.21)	(-8.21)	(-15.87)	(-16.29)	(-10.69)	(-10.81)	(-14.41)	(-14.46)
LeverageSquare	0.570	0.572	3.901***	4.055***	2.053***	2.021***	2.943***	2.999***
	(1.34)	(1.35)	(7.59)	(7.86)	(4.26)	(4.28)	(6.01)	(6.15)
Error	0.181**	0.189**	0.144**	0.153**	0.151***	0.144***	0.104	0.104
	(2.32)	(2.41)	(2.23)	(2.39)	(2.79)	(2.70)	(0.54)	(0.55)
DV-BUS	-0.150***		-0.474***					
	(-3.13)		(-10.16)					
DV-INT					0.394***		0.235***	
					(6.50)		(4.11)	
# of Business Segments		-0.073***		-0.129***				
		(-3.32)		(-7.43)				
# of Intl. Segments						0.244***		0.078***
						(13.65)		(6.90)
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	2607	2607	5057	5057	3721	3721	3943	3943
Adjusted R^2	0.758	0.758	0.708	0.705	0.733	0.743	0.726	0.728

Note: This table reports results of OLS regression on four sub-samples explaining Premium. The definitions of variables are the same as in Table 1. t-statistics are reported in parentheses below each coefficient estimate. *, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

Put together, Panels A and B show that industrial diversification is associated with lower cost of capital for both domestic and multinational firms.

2.4.2.2 Cost of Capital and International Diversification

The association between cost of capital and international diversification is tested in single-industry and multi-industry firms and reported in Panel C and D of Table 2-5, respectively. In Panel C, a model based on Equation (2-6) is run on the sub-sample of domestic single-industry firms and multinational single-industry firms (DS and MS groups). Both the dummy variable for international diversification and the number of international segments are used as proxies for international diversification. The results show that for single-industry firms, international diversification is associated with a higher cost of capital.

In Panel D, the same model is estimated using the sub-sample consisting of domestic multi-industry and multinational multi-industry firms (DM and MM groups). The coefficient estimates on both the dummy variable for international diversification and the number of international segments show that international diversification is associated with a significantly higher cost of capital. All the control variables have similar signs to those discussed in the previous section. Based on these findings, we can conclude that, after separating the individual effects of industrial and international diversification, international diversification remains associated with a higher cost of capital for both single-industry and multi-industry firms and the results reported in Section 2.4.1 remain robust. In brief, industrial diversification is associated with a lower firm cost of capital while international diversification is associated with a higher cost of capital.

2.4.3 All Equity Sample Regression

In this section, we investigate whether the industrial and international effects we found so far are sensitive to the sources of funds used to finance the firm, namely, debt and equity. If efficiency of internal capital market is the reason why diversification is associated with the cost of capital, it would not matter whether funds come from debt or equity because both of these sources would be affected by diversification in a similar manner. The reason is that when investors (in equity or debt) believe firms are investing their funds inefficiently, they would require a higher return. Since separate data on the cost of equity and debt are not available, we can only carry out an indirect test of this issue based on the all-equity firms.

In the existing literature the findings on the effect of diversification on equity returns are mixed while that on debt is unanimously negative (Reeb et al., 2001; Mansi and Reeb, 2002; Deng et al., 2007). If the reduction in the cost of capital due to diversification comes solely from debt side, then the all-equity firms will not be able to capture this benefit and the association between the two variables will be insignificant for this sub-sample of firms.

The all-equity firms, however, have some unique characteristics that may affect their choice of diversification. These firms are more liquid, have a higher manager ownership, and a greater family involvement (Agrawal and Nagarajan, 1990). Consequently, compared to the leveraged firms, the managers in all-equity firms are unlikely to be involved in value-destruction diversification. To investigate this issue, we will carry out some empirical tests to determine whether all-equity firms exhibit behavioral patterns similar to those found for the pooled sample.

An all-equity firm is defined as a firm with leverage ratio of zero. Out of the 7,688 firm-year observations in the sample, 1,102 are classified as all-equity. The basic model (Equation (2-5), excluding variable Rating) is estimated for the all equity firms and the results are reported in Table 2-6. First of all, the entire pooled sample is used to estimate a model similar to equation (2-5) in Section 2.4.1 using number of segments as measure of diversification but adding a dummy variable. The regression result in model 1 shows that all-equity firms as a group have a higher cost of capital (equity) than the leveraged firms. This effect can be attributed to the fact that debt has lower cost than equity because of its interest tax shield. This finding is also consistent with the leverage effect obtained in Table 2-4, where it is shown that cost of capital will decrease when firm increase leverage from low debt level. Secondly, in model 2, we test the effect of diversification and the interaction of all-equity classification and diversification. The results show that industrial diversification effects are statistically identical between all-equity and leveraged firms since the coefficient estimation on the interaction between all-equity dummy and number of business segments are insignificant. The same can not be said about international diversification. In this case, international diversification increases the cost of capital for all-equity firms more severely than for leveraged firms, as shown by the positive sign on the interaction term between all-equity dummy and number of international segments. The reason may be attributed to the lack of counter-balancing effect of a lower cost of debt identified in Mansi and Reeb (2002).

The basic model is estimated also for the all-equity firm sub-sample, except that leverage and leverage square are excluded from the model because leverage is always zero for these firms. Model 3 and model 4, respectively, use CV-Sales and Beta as

Table 2-6: Determinants of cost of capital premium for all-equity firms: OLS regressions

	Entire Sample		All Equity Sub-Sample	
Models	1	2	3	4
Intercept	1.417***	1.462***	1.629***	1.641***
	(3.55)	(3.68)	(4.50)	(4.89)
Size	0.013	0.017	0.313***	0.239***
	(1.00)	(1.33)	(7.04)	(5.57)
Beta				0.980***
				(11.67)
CV Sales	1.348***	1.341***	0.962***	
	(19.69)	(19.69)	(5.31)	
MTB	0.116***	0.116***	0.004	-0.012
	(10.72)	(10.79)	(0.17)	(-0.58)
Tangible	-0.773***	-0.766***	-2.417***	-2.366***
	(-6.54)	(-6.53)	(-4.91)	(-5.09)
Leverage	-3.909***	-3.936***		
	(-14.79)	(-14.97)		
LeverageSquare	2.106***	2.114***		
	(5.77)	(5.82)		
Error	0.153***	0.152***	-0.184	-0.130
	(3.04)	(3.03)	(-0.63)	(-0.47)
# of Business Segments	-0.126***	-0.119***	-0.275***	-0.223***
	(9.29)	(-8.45)	(-5.90)	(-5.00)
# of Intl. Segments	0.132***	0.098***	0.276***	0.225***
	(13.38)	(9.35)	(9.87)	(8.38)
DV- All Eq.	0.251***	-0.304***		
	(4.54)	(-2.93)		
# Bus. Seg. * DV-All Eq.		-0.050		
		(-1.18)		
# Intl. Seg. * DV-All Eq.		0.241***		
		(9.44)		
Year Dummy	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes
No. of obs	7664	7664	1098	1102
Adjusted R2	0.727	0.728	0.667	0.702

Note: This table presents results of OLS regressions explaining cost of equity premium based on all-equity sub-sample. All equity firms are defined as firms with leverage equals to zero. DV-All Eq is a dummy variable which equals one is the firm is all-equity firm (leverage equals zero), and zero otherwise. The definitions of other variables are the same as in Table 1. t-statistics are reported in parentheses below each coefficient estimate. *, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

control variables for total risk and beta risk. The coefficient estimates on diversification measures in model 3 and 4 show that all-equity firms with more industrial (international) segments have a lower (higher) cost of equity. These findings suggest that the cost of capital of all-equity firms is affected by diversification in a similar manner as leveraged firms. Whether investors require a premium or discount in their investment of diversified firms is determined by the efficiency of firms' internal capital markets. This effect is valid for both debt and equity capital. In other words, all-equity firms will still benefit from (hurt by) industrial diversification (international diversification) without relying on debt capital if their internal capital markets are efficient (inefficient). These tests show that for all-equity firms, industrial (international) diversification is associated with a lower (higher) firm cost of equity.

2.4.4 Results on Firm Cash Flow

Firm value is determined by the discounted value of expected future cash flows. After examining the association between cost of capital and diversification, it is also important to examine the association between cash flow and diversification in order to draw a more complete picture of the diversification effect. This section is an attempt to that end. The results presented here are tentative because firm cash flows are affected by so many factors, including firm characteristics, firms' investing and financing policies, which make it impossible to control for all the influence from those factors. This study will only look at firm operating cash flow and control for general firm characteristics. Cash flow from operation activities (CF) is defined as net cash flow from operating activities adjusted for extraordinary items and discontinued operations and scaled by total assets, as described in Section 2.3.2.3.

The group means comparison tests in Table 2-3 is a good point to start. The figures in Table 2-3 show that domestic single industry (DS) firms have significantly higher CF than all the other three groups: domestic multi-industry (DM), multinational single industry (MS), and multinational multi-industry (MM) firms. The differences in CF among the other three groups are not significant at 10% confidence level. These findings suggest that operating cash flow may be reduced when a domestic single industry firm diversifies across industry or internationally. As to the firms already diversified, the effect of diversification on cash flow is unclear.

Since cash flows may be influenced by other firm characteristics than diversification variables, regression analysis is needed to derive more reliable evidence on the relationship between cash flow and diversification. Two alternative measures are used as proxy for firm cash flow: current period CF and the mean value of the next three years CFs. Regression models can be presented as follows: the dependent variables are, respectively, the current period CF in model 1 and 2, and the mean of CFs for next three years in model 3 and 4. Control variables include Size, MTB and Leverage. Both the number of segments (business and international) and dummy variables for each dimension of diversification are used as measures of the two diversifications.

$$CF = \alpha_1 + \alpha_2 (Size) + \alpha_3 (MTB) + \alpha_4 (Leverage) + \alpha_5 (Industrial\ Div) + \alpha_6 (International\ Div) + \varepsilon \quad (2\text{-}7)$$

Regression results are shown in Table 2-7. Operating cash flows of domestic multi-industry firms are similar in pattern to those of domestic single-industry firms because the coefficients of the dummy variable for industrial diversification dummy variable in models 2 and 4 are insignificant. Similarly, the coefficients on the number of

Table 2-7: Determinants of cash flows (CF): OLS regressions of the pooled sample

$CF = \alpha_1 + \alpha_2(Size) + \alpha_3(MTB) + \alpha_4(Leverage) + \alpha_5(Industrial\ Div) + \alpha_6(International\ Div) + \varepsilon$

	Current year CF		Average CF for next 3 years	
Models	1	2	3	4
Intercept	0.006	0.013	0.109**	0.115***
	(0.22)	(0.46)	(4.12)	(4.29)
Size	0.010***	0.010***	0.001	0.001
	(11.35)	(11.10)	(1.48)	(1.06)
MTB	0.018***	0.018***	0.011***	0.011***
	(24.66)	(24.71)	(15.35)	(15.45)
Leverage	-0.063***	-0.062***	0.006	0.007
	(-9.20)	(-9.16)	(0.93)	(0.96)
DV BUS		-0.002		-0.003
		(-0.50)		(-0.78)
DV INT		-0.016***		-0.011***
		(-4.46)		(-2.99)
DV BUSINT		-0.011***		-0.008**
		(-2.93)		(-2.18)
# of Business Segments	-0.0001		-0.001	
	(-0.06)		(-0.79)	
# of Intl. Segments	-0.004***		-0.002***	
	(-5.62)		(-3.10)	
Year DV	Yes	Yes	Yes	Yes
Industry DV	Yes	Yes	Yes	Yes
No. of obs	7643	7643	5272	5272
Adjusted R2	0.179	0.178	0.111	0.110

Note: This table presents results of OLS regressions explaining firm cash flows. In model 1 and 2, the dependent variable is current period CF, which is defined as net cash flow from operating activities adjusted for extraordinary items and discontinued operations and scaled by total assets. In model 3 and 4, the dependent variable is the mean of CF for next three years. Independent variables include Size, MTB, Leverage, number of business and international segments. The definitions of these variables are the same as in Table 1. DV BUS, DV INT and DV BUSINT are dummy variables for industrial diversification only, international diversification only, and both industrial and international diversifications, respectively. To control for time effect and industry effect, I also include in dummy variables for each calendar year (Year DV) and each industry based on two-digit SIC code (Industry DV). t-statistics are reported in parentheses below each coefficient estimate. *, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

business segments in models 1 and 3 are also insignificant, indicating that industrial diversification is unassociated with change of firm cash flow. As for international diversification, the coefficients for the number of international segments in models 1 and 3 and those of the dummy variable for international diversification in models 2 and 4 are negative and significant indicating that multinational single-industry firms are generating relatively less operating cash flow than domestic single-industry firms. Lastly, when firms are involved in both international and industrial diversifications, their cash flows are significantly lower than single-industry domestic firms. In brief, international diversification is negatively associated with firm net operating cash flow while industrial diversification is unassociated with it.

The analysis on the cash flow effect is not the focus of this study and it may needs refinement. However, the basic result provides some evidence that industrial and international diversifications are dissimilar in affecting both firm cash flow and cost of capital. Industrial diversification per se does not change firm cash flow but decrease cost of capital. These results suggest that firm would benefit from diversifying across multiple industries. International diversification is associated with both reduced cash flow and increased cost of capital. Hence, it would be harmful to firm value. When conglomerates diversify in both dimensions, the overall effect of diversification is reduced cash flow and increased cost of capital, also indicating a reduced firm value. This result may partly due to the relatively stronger negative effect from international diversification and relatively weaker positively effect from industrial diversification. For those studies who failed to include international diversification while studying industrial diversification, they would easily commit the sin of attributing the value decrease to industrial diversification.

2.4.5 Endogeneity of Diversification

A question remains to be examined is the endogeneity of firms' diversification choice (Campa and Kedia, 2002). If international and industrial diversification are endogenously decided by the firm, the associations found between cost of capital and diversification may be due a third set of variables, e.g. firm characteristics, affecting both, rather a direct relationship between diversification and cost of capital. In this case, the exclusion of these variables from the model may have strengthened the association between these two variables by diversification capturing also the latter variables' effect.

To address this issue, a simultaneous equation model, described below, will be employed in which cost of capital and number of business and international segments are all treated as endogenous and the three stage least squares (3SLS) procedure similar to Bhojraj and Sengupta (2003) is used to jointly estimate them.

$$\begin{cases} Premium = \alpha_1 + \alpha_2(Size) + \alpha_3(CV\ Sales) + \alpha_4(MTB) + \alpha_5(Tangible) + \alpha_6(Leverage) \\ \qquad + \alpha_7(LeverageSquare) + \alpha_8(R\&D) + \alpha_9(Bus.\ Seg.\ \#) + \alpha_{10}(Intl.\ Seg.\ \#) \\ \qquad + \alpha_{11}(YearDV) \qquad (2\text{-}8) \\ Bus.\ Seg.\ \# = \beta_1 + \beta_2(Size) + \beta_3(ROA) + \beta_4(CapEx) + \beta_5(MTB) + \beta_6(R\&D) + \beta_7(Premium) \\ \qquad + \beta_8(IndustryDV) \qquad (2\text{-}9) \\ Intl.\ Seg.\ \# = \gamma_1 + \gamma_2(Size) + \gamma_3(ROA) + \gamma_4(CapEx) + \gamma_5(MTB) + \gamma_6(R\&D) + \gamma_7(Premium) \\ \qquad + \gamma_8(IndustryDV) \qquad (2\text{-}10) \end{cases}$$

Following Villalonga (2004) and Campa and Kedia (2002), I include firm size (Size), profitability (ROA), firm risk (CV-Sales), capital expenditure (CapEx), and growth opportunities (MTB) as control variables in the equations for business and international diversification. Industry and year effects are also controlled for by dummy variables. The estimation results are reported in Table 2-8. Coefficient estimates for

Table 2-8: A simultaneous equation model of cost of capital and cash flow (Equations 2-8 to 2-10)

Dependent Variable:	Premium Eq. (8)	# Business Segments Eq. (9)	# International Segments Eq. (10)
Intercept	3.658***	0.444	-0.777**
	(26.82)	(1.35)	(-1.94)
Size	-0.041*	0.279***	0.317***
	(-1.73)	(28.45)	(23.89)
CV-Sales	1.665***	-0.531***	-0.714***
	(15.87)	(-8.93)	(-8.89)
MTB	0.090***	-0.049***	-0.019
	(5.44)	(-4.98)	(-1.41)
Tangible	-1.464***		
	(-13.04)		
Leverage	-5.162***		
	(-18.02)		
LeverageSquare	4.050***		
	(9.88)		
Error	0.164**		
	2.09		
R&D		-2.397***	6.165***
		(-8.70)	(18.48)
Capex		-0.927***	-0.471
		(-3.71)	(-1.54)
ROA		-0.436***	-0.869***
		(-3.25)	(-5.33)
Premium		-0.0001	0.027**
		(-0.01)	(2.33)
#Business Segments	-0.571***		
	(-7.84)		
#Intl. Segments	0.749***		
	(22.74)		
Year Dummy	Yes		
Industry Dummy		Yes	Yes
No. of obs	7600	7600	7600
System-weighted R2	0.4527	0.4527	0.4527

Note: This table presents results of three-stage least square regressions (3SLS) of a system of equations jointly explaining cost of equity premium and firm diversification choices using the pooled sample with 7600 observations. The first column is the regression explaining cost of capital premium. The second and third columns are regressions explaining the number of business and international segments. The definitions of variables are the same as in Table 1. t-statistics are reported in parentheses below each coefficient estimate. *, **, and *** indicates statistical significance at the 10%, 5%, and 1% level, respectively.

equation (2-8) show that Premium is still significantly and negatively (positively) associated with the number of business (international) segments, even after the number of business and international segments are treated as endogenous. This confirms our earlier findings that industrial (international) diversification is associated with lower (higher) firm's cost of capital.

Results for equation (2-9) and (2-10) explain firms' diversification choices. Some firm characteristics have similar effects on industrial and international diversification. Firm size is significantly and positively associated with the number of business and international segments, indicating that larger firms are more likely to diversify across businesses and countries. ROA is significantly and negatively associated with the number of business and international segments, indicating that profitable firms are less likely to be involved in either type of diversification. The explanation may be that firms with lower profitability move into other areas of business activity and other geographic markets in search of new sources of revenue. In addition, CV-sales is negatively associated with the number of business and international segments, indicating that firms with less total risk (more stable revenue) are more likely to diversify both across industry and internationally. Such firms with low risk can afford to do so because at low risk level their tolerance for incremental risk is higher.

Other firm characteristics have dissimilar effects on industrial and international diversification. Market to book ratio is negatively associated with the number of firm's business segments but unassociated with the number of international segments, indicating that firms with better growth opportunities are less likely to get involved in industrial diversification. This result shows that whenever growth opportunities are satisfactory,

firms do not find the need or the urge to seek other alternatives or explore other markets. Capital expenditure and R&D expenses are negatively associated with the number of business segments. These results may be an indication that firms with more investment opportunities in existing areas of activity or those which have recently increased capital spending would be less likely to diversify into new business activities. Market to book ratio is negatively associated with the number of business segments, also indicating that firms with more growth opportunities in their existing business activities would be less likely to expand into more industries.

Cost of capital has a differential association with the number of business and international segments; it is unassociated with the number of business segments but positively associated with the number of international segments. This result shows that high cost of capital may drive firms or forces them to seek alternative markets, especially foreign markets, in the hope that they will find projects with higher return rate or gain access to cheaper capital in foreign capital market. However, the goal of lowering cost of capital by diversifying internationally may not be achieved since the process of diversification may bring in extra risk factors including but not limited to exchange risk and politic risk. The overall effect of international diversification is higher cost of capital, as identified in equation (2-8). In addition, the number of international segments is shown to be positively related with R&D expenses, indicating that firms actively seeking for new product and technologies are also more likely to seek alternative foreign market. Given the result that diversification did not lower cost of capital, one reason why firms still diversify internationally could be attributed to agency problems. Managers may put their personal benefit, e.g., empire building, in front of shareholders benefits. Building

and managing an international conglomerate may benefit the managers but hurt investors (Morck et al., 1990). This explanation that agency problems are responsible for firms value-reducing diversification is consistent with Denis et al. (1997). In brief, the empirical results found about the effect of diversification on cost of capital in previous sections remain valid even after controlling the endogenous choice of firm diversifications.

2.4.6 Additional Robustness Tests

An important assumption for empirical analysis is whether the chosen proxies adequately capture the effects they were meant to control for. This section shows that the results found earlier are robust to various specifications. First, we use Herfindahl index measures as alternative proxies for industrial and international diversifications. Results (not reported) confirm and strengthen the previous findings. Second, following Reeb et al. (2001), several risk measures are used as alternatives for firm credit rating. These include a dummy variable distinguishing firms with A- or better rating versus the rest of the sample, dummy variables for each of the rating categories, and the square of the converted number of ratings. All tests yield results very similar to those reported earlier. It may be argued that international diversification may bring in additional risk to the firm not captured by beta risk and credit rating risk. If this is true, the additional international risk is captured in the total firm risk measure. Therefore, the association between diversifications and cost of capital found in our basic models are free from the influence of risk factors.

Third, in addition to examining the relation between the level of firm diversification and cost of capital, we also perform the test on the relation between

changes in firm diversification and changes in cost of capital (i.e., first difference for each variable) with the same control variables, also specified in changes. Again, the models yield similar results for diversification effects on firm cost of capital (not reported). Overall, our empirical findings are robust to alternative specifications.

2.5 Conclusion

Industrial and international diversification may be complements to one another in the sense that conglomerates are involved in both dimensions of diversification. Multinational multi-industry firms constitute 38% of total firm-year observations in our sample of the largest firms in the U.S. Therefore, empirical studies on diversification should examine the effects of the two dimensions of diversification jointly. In addition, diversification may have different effects on firm debt and equity value. These effects should also be considered simultaneously and within the same framework of analysis. This study offers the first empirical study on the association between industrial and international diversification and the firm's cost of capital including both debt and equity. The finding is that industrial (international) diversification is associated with a lower (higher) cost of capital. These results are robust to alternative measures of diversification and risk and different model specifications. The results also hold true for a sub-sample of all-equity firms, i.e., firms with full equity financing. Finally, empirical results also show that industrial diversification is unassociated with firm's cash flow change while international diversification is associated with lower cash flow.

These results offer several implications. First, as to the total firm value, industrial diversification may be beneficial because it reduces the firm's cost of capital while has no significant effect on its cash flows. This finding is consistent with Villalonga (2004a and 2004b) who finds firm value premium for industrial diversification. Previous studies finding firm value discount in response to diversification are subject to the potential bias that they ignore debt value effect and/or international diversification effect. Second, this study shows a higher cost of capital and a lower cash flow associated with international diversification. Hence, international diversification can be said to be harmful to firm value. The internal capital market of multinational firms may be inefficient due to agency problems and/or other conflicts in cross-country fund allocation. Third, all-equity firms can benefit from industrial diversification but are harmed by international diversification. Firms financed entirely by equity and firms financed by a mix of debt and equity are subject to similar effects on their cost of capital by diversifications. This is consistent with the hypothesis that efficiency of internal capital market determines diversification's effect on cost of capital, no matter how the external funds are financed. These findings also have implication for legislators with intention of protecting investors' interests. The two dimensions of diversification have dissimilar effects on the firm's cost of capital and international diversification is potentially harmful to the firm value and therefore should be more closely monitored. These results offer deeper understandings to our knowledge about firm diversification.

CHAPTER 3

BANK HOLDING COMPANY DIVERSIFICATION AND PRODUCTION EFFICIENCY

3.1 Introduction

The Gramm-Leach-Bliley Act (GLBA), enacted in 1999, changed the regulatory structure governing the U.S. financial industry considerably. It removed the legal barriers constraining the affiliation and competition among banking organizations, security firms, and insurance companies, with the goal of fostering competition and improving production efficiency of these firms. To this end, a new type of financial firms called financial holding companies (FHCs) was authorized to engage in a wide range of financial activities.[29]

According to the Federal Reserve Board, the number of FHCs grew from 477 in 2000 to 660 in 2007. More interestingly, although the number of FHCs constitutes a relatively small ratio of all BHCs,[30] they held about 86% of the aggregate consolidated assets of all BHCs, as of December, 2004. Moreover, the number of FHCs engaged in

[29] GLBA is also known as the Financial Services Modernization Act. In this paper, FHCs refer to holding companies that elected to become FHCs (including FHCs that are formed by insurance companies through acquiring commercial banks). BHCs include FHCs and other BHCs that did not obtain the FHC status. According to Yeager et al. (2007), FHCs are allowed to engage in financial activities including, but not limited to, lending, deposit taking, insurance underwriting and other insurance activities, merchant banking, investment banking, brokerage services, and other securities activities.

[30] The total number of BHCs was 5,284 as of 3/31/2003 according to the "Report to the Congress of Financial Holding Companies under the Gramm-Leach-Bliley Act", obtained from: http://www.federalreserve.gov/boarddocs/rptcongress/glbarptcongress.pdf

securities, insurance and merchant banking and their share in the total BHC assets continue to rise at a prominent pace.[31]

Whether diversification in financial services is beneficial to BHCs is a major topic of debate by both the practitioners and the academia. The literature has examined this issue from several perspectives such as the effect of diversification on equity value, debt value, and risk-return trade-off. The findings are mixed (e.g. Laeven and Levine, 2007; Baele et al., 2007; Deng et al., 2007; Stiroh and Rumble, 2006). An area overlooked in the literature is the association between BHC diversification and production efficiency. This issue is important especially in the post-GLBA period because joint production of multiple products allows input reutilization, joint monitoring, account maintenance, and advertisement and the possibility of scope economies (diseconomies).[32] This study explores whether the trend of diversification of BHC activities is associated with improvement in productive efficiency of the banking subsidiaries and the BHC entity as a whole. The findings here can shed light on the debate on whether activity diversification within financial conglomerates is cost reducing and value-enhancing or cost increasing and value-reducing. Additionally, the evidence offered by this study complements our understanding of the costs and benefits of activity diversification in general.

BHCs achieve diversification by extending their lines of activities through the existing subsidiaries or by establishing new subsidiaries. If diversification is associated with improved efficiency, the efficiency measures for the subsidiaries of the BHC and/or the efficiency of the entire BHC should improve. Measurement of the production efficiency at the BHC level is difficult and the results are hard to interpret especially

[31] According to the same report as in footnote 3.
[32] There are numerous efficiency studies in banking. Berger and Humphrey (1997) survey this literature.

because of the heterogeneous product mix at the holding company level and differential regulatory constraints across the subsidiaries. To make meaningful comparison of efficiency across different BHCs, this study examines the association between BHC diversification and efficiency of the lead (the largest) subsidiary commercial bank. The advantage of this approach is that it focuses on the relatively homogenous production units of commercial banks to derive the efficiency improvement. Estimation of efficiency within a set of banks with similar inputs and outputs, especially outputs, produces more reliable results than measurement of efficiency indexes across BHCs with dissimilar and aggregated outputs. In other words, this approach unmasks the detailed information which may be concealed in the aggregate measures at the BHC level. It is true that there exists a tradeoff between revealing information and obtaining a more comprehensive measure of gain in efficiency. However, given the important status of the lead commercial banks (consisting of 87% total assets of the ultimate holding companies in our sample), the benefit of this approach outweighs the potential cost. To my best knowledge, this study is the first empirical research linking the diversification of BHCs to the production efficiency of their subsidiary commercial banks.

Production efficiency is estimated by applying the Malmquist index derived from Data Envelopment Analysis (DEA), a non-parametric technique that has been widely applied in finance and economics (Cooper et al., 2000) on a sample of BHCs over the period 1997-2007. The Malmquist index shows both cross-sectional and time-series changes in production efficiency relative to the best practice frontier. By way of preview, the empirical analysis of this study shows that the activity diversification is on average associated with relatively lower production efficiency. Comparing the input and output

combination of BHCs to that of the best practice frontier in the concurrent year reveals that diversification is negatively associated with technical efficiency, and the effect is primarily driven by BHCs that did not have diversification experiences through Section 20 subsidiaries before the GLBA. In addition, the degree of change in diversification over time does not affect the total factor productivity change but it is negatively associated with technical efficiency change over time, as shown in Malmquist indices, indicating that these diversified firms are left behind relative to their peers in the trend of productivity growth. The latter effect is also primarily shown on BHCs that did not have Section 20 subsidiaries before GLBA. Therefore, BHC diversification is on average associated with reduced production efficiency of the BHC subsidiaries. This finding is conceptually consistent with the diversification discount argument in Laeven and Levine (2007). The current study also calls for attention of both legislators and practitioners about the diversification trend in the financial industry in that diversification is not a one-size-fit-all strategy of improving performance, especially for BHCs without any experience in investment banking and insurance activities.

The paper proceeds as follows. Section 3.2 summarizes the trends toward deregulation and product diversification in the banking industry. Section 3.3 reviews the existing literature and develops a set of hypotheses. Section 3.4 describes the research methodology, the sample selection procedure, and variable construction. Section 3.5 reports the empirical results on the relationship between BHC activity diversification and efficiency and Section 3.6 concludes.

3.2 Deregulation and Diversification in the Banking Industry

After the Great Depression of 1929-1933 banking activities were strictly separated from other financial and non-financial activities by legislation. For example, the Glass-Steagall Act of 1933 prohibited commercial banks form being affiliated with firms "engaged principally" in investment banking activities such as the issuing, floatation, underwriting, public sale, or distribution of securities (Fein, 1997). Similarly, the Bank Holding Company Act of 1956 prohibited BHCs from engaging in most non-banking activities or acquiring voting securities of certain companies that are not banks (Barth et al., 2000). Accordingly, banks and BHCs were seriously limited in their ability to enter the securities and insurance activities. The barriers between banking and other financial activities started to crumble in 1980s. In 1987, the Federal Reserve authorized BHCs to establish securities subsidiaries (the so called Section 20 Subsidiaries) to engage in limited securities activities under Section 20 of the Glass-Steagall Act. In addition, BHCs also engaged in very limited insurance and other non-bank activities through other loopholes and interpretative freedom of the regulation, such as "operating subsidiaries" (Barth et al., 2000; Reichert and Wall, 2000).

In 1999, the Gramm-Leach-Bliley Act (GLBA) repealed the separation among banking, securities, and insurance activities by authorizing the establishment of FHCs. A BHC can elect to become a FHC and by doing so it is authorized to engage in a variety of activities including securities underwriting and dealing; insurance underwriting;

insurance agency activities; and merchant banking.[33] The Federal Reserve, with the approval of the Secretary of the Treasury, may also expand this list of activities to include other "financial" or "incidental" activities. The GLBA has been referred to as "the most important banking bill in 60 years" because it "opens up new competition" and "will literally bring to every city and town in America the financial services supermarket".[34] It is notable that the broad scope of activities proposed under GLBA is still more restrictive than the "universal banking" practiced in Europe, where banks have the freedom to own and be owned by nonfinancial companies.

The financial service industry reacted favorably to the GLBA. According to the list of FHCs obtained from the Federal Reserve Board, 660 BHCs had elected to become FHCs as of the end of year 2007 and the assets attributable to these expanded activities continued to grow between 2000 and 2007.[35] For example, the assets of the securities underwriting and dealing subsidiaries of FHCs grew by two-thirds, and the insurance underwriting assets of FHCs tripled between 2000 and 2003.[36] Similarly, Yeager et al. (2007) report that 16% of FHCs total revenue in year 2004 came from the newly permissible activities. However, they also point out that some FHCs (27% in their sample) continue to operate as traditional commercial banks, despite the fact that they are authorized to conduct the new activities.

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[33] The subsidiary banks and thrifts must meet several criteria: they must be well capitalized and well managed and must have at least a satisfactory Community Reinvestment Act rating. See the Conference Report and Text of Gramm-Leach-Bliley Bill. http://banking.senate.gov/conf/confrpt.htm

[34] Quote from former Senator Phil Gramm, chairman of the Senate Committee on Banking, Housing and Urban Affairs. News from the Senate Banking Committee Thursday, November 4, 1999. http://banking.senate.gov/prel99/1104grm.htm

[35] Federal Reserve Board website http://www.federalreserve.gov/generalinfo/fhc/ accessed on February 2008.

[36] See the "Report to the congress on Financial Holding Companies under the Gramm-Leach-Bliley Act (2003)" http://www.federalreserve.gov/boarddocs/rptcongress/glbarptcongress.pdf

The activity diversification of BHCs is also contributed to by dramatic technological improvements which can not be separated from the change in deregulation. Innovations in information processing, telecommunications, and related technologies have significantly changed the way financial institutions operate and have created opportunities to improve efficiency (see Berger et al., 1999 and Berger, 2003 for detail). New technology creates new tools of financial engineering and new financial products, which have also blurred the line separating different financial activities. These effects all contributed to the passing of GLBA.

3.3 Literature Review and Hypothesis Development

3.3.1 Review of Studies on Bank Diversification

The greater diversification of FHCs' in business activities, compared to the BHCs prior to the passage of the GLBA, has raised questions whether diversification is indeed beneficial to these institutions. The literature has examined this issue from several perspectives. Some studies explore whether the stock market appreciates the diversification phenomenon. For example, Deng et al. (2007) find an inverse association between bank activity diversification and the cost of debt issued by the bank, offering an indication that diversification does engender benefits for the firm. Examining a sample of banks from 17 European countries, Baele et al. (2007) also find a strongly positive relationship between franchise value and the degree of functional diversification. Some other studies attribute an adverse effect to diversification. Laeven and Levine (2007) show that market values of financial firms that engage in multiple activities

(unfortunately, they only separate lending and non-lending financial services) are lower when these products are produced within a conglomerate structure than if each product is produced by a separate financial intermediary. Similarly, Stiroh and Rumble (2006) report that increased reliance on non-interest income activities is associated with increased risk as well as lower return for FHCs. This double adversarial effect casts a shadow of doubt on the benefits of diversification.

Given the inconclusive findings on the benefits of diversification, this study looks into the so called "black box" of financial conglomerates (Berger and Mester, 1997) and tests the effects of diversification in term of production efficiency of the diversified firms. This approach is similar to Schoar (2002), who employs a Longitudinal Research Database (LRD), a plant level database for firms in manufacturing sector, to show that the total factor productivity of plants in diversified firms is greater than those in comparable single-segment firms. However, the latter study is subject to the shortcoming that it estimates production efficiency based on a log-linear Cobb-Douglas production function with three inputs and a single output. The availability of more detailed data on the banking industry allows a more thorough analysis of efficiency based on the state-of-the-art estimation methodology.

3.3.2 Review of Efficiency Studies of the Financial Industry

Efficiency measurement is a way to "benchmark" the production performance of firms relative to the best practice of the firms in the sample. Berger et al. (1993), Berger and Mester (1997), and Berger and Humphrey (1997) offer excellent surveys of the efficiency studies in the banking industry. Specifically, Berger and Humphrey (1997) documents 130 studies on efficiency of financial institutions, using data from 21

countries, at different time periods, and at different organizational levels such as individual banks, and bank branches. The existing efficiency studies differ primarily in terms of the assumptions made about the functional form of the production or cost frontier and the distributional properties of the random error terms.

Efficiency estimation methodology can be classified into parametric and non-parametric techniques based upon the specification of production function. The advantage of the *nonparametric approach* is that it does not require the explicit specification of the production relationship, providing flexibility and allowing the data to delineate the shape of the frontier. The most commonly applied nonparametric approach is the Data Envelopment Analysis (DEA), where a linear programming technique is used to find the set of best-practice units spanning the frontier. These units are defined as the units that generate the largest level of outputs for given levels of inputs, or the units that utilize the least inputs for given levels of outputs. Accordingly, the best practice frontier is formed by connecting the set of best-practice units, yielding a production possibilities set. Banker (1996) offers a summary for work that provides the theoretical foundation for statistical hypothesis testing in a DEA environment. Examples of studies using DEA include Elyasiani and Mehdian (1990), Mukherjee et al. (2001), Isik and Hassan (2003), and Cummins and Xie (2008), among others. The free disposal hull approach (FDH) is a special case of the DEA. In this approach, the production frontier only consists of the observed DEA vertices but not the points that are on the hypothetical lines connecting those vertices. Studies applying FDH includes Fried et al. (1993) and Fried and Lovell (1994). The disadvantage of the non-parametric approach is that it assumes away the random error term in the production or cost structure, disallowing for the random error

and inefficiency to be separated, and, hence, producing distorted efficiency measures (Canhoto and Dermine, 2003).

The *parametric approaches* to efficiency measurement are threefold; the stochastic frontier approach (SFA, e.g. Berger and DeYoung, 1997; Bauer et al., 1993), the distribution-free approach (DFA, e.g., Berger, 1993 and 1995), and the thick frontier approach (TFA, e.g., Berger and Humphrey, 1991 and 1992). These techniques all impose a particular functional form that presupposes the shape of the frontier but differ from one another by the assumptions they make about the distributions of inefficiency and the random error term, and the way they separate these two factors. A main drawback of the parametric approaches is that they impose a particular functional form (and associated behavioral assumptions) that presupposes the shape of the frontier. If the functional form is mistakenly specified, measured efficiency may be confounded due to the specification errors.

There is no consensus among scholars about the best approach in efficiency studies. Berger and Humphrey (1997) state that "the lack of agreement… boils down to a difference of opinion regarding the lesser of evils." The current study employs the DEA approach because of the following reasons: First, DEA does not require the explicit specification of the form of the underlying production relationship, which is unknown. Second, DEA does not require price data on outputs. The proxies for output prices are not accurately defined for the financial industry. Third, the Malmquist productivity index takes into consideration both cross-sectional and time-series effects of efficiency change. Fourth, decomposition of the Malmquist index reveals detailed information about the nature of the efficiency changes. Section 3.5.1 offers detailed information on this subject.

3.3.3 Sources of Efficiency Improvement through Diversification

Although a rationale behind the passage of GLBA was to improve the efficiency of financial institutions by capturing additional scale and scope economies, the question whether diversification of BHC activities actually improves efficiency is in dispute. In theory, activity diversification through entering into new lines of business activity can improve the production efficiency of BHCs because of several reasons. First, product diversification may improve efficiency through increased competition. Before GLBA, banks, securities firms, and insurance companies were not allowed to be affiliated with one another and could compete with each other only to a very limited extent. With proliferation of FHCs and their huge sizes competition has only strengthened. It is noteworthy that prohibition of ownership of commercial banks by non-financial firms has limited the possibility of banks being acquired in the takeover market. Prowse (1997) and Mester (1989) note that this prohibition has reduced the disciplinary role played by takeovers, which are primarily focusing on improving efficiency.

The legislation of GLBA, knocked down the walls that divided the American financial system, leveled the playground in the financial industry and opened up the way for competition from a broader group of firms. The increasing level of competition led to development of new financial products across the industry lines and fostered multimarket competition among the FHCs. A good example is the annuity product offered by insurance companies in direct competition to the certificates of deposit offered by banks. The GLBA also permitted bank, security firms, and insurance company to acquire one another. Recent examples include Charles Schwab & Co. and Metlife Inc.'s acquisitions of commercial banks before they became FHCs. The potential of being taken over may

give the managements of commercial banks extra incentives to improve efficiency from the corporate governance perspective. Over all, the higher level of competitive pressure in the post-GLBA period can be a source of improved efficiency (Jayaratne and Strahan, 1998)

Second, diversification may also improve production efficiency because of the potential economies of scale and scope which were not achievable before. Scale and scope economies have long been recognized in the banking literature. Berger et al. (1999) offer a comprehensive review of this subject. GLBA enabled FHCs to exploit the scale and scope economies that were unavailable before the deregulation. FHCs can engage in cross-selling business products such as commercial loans, securities underwriting, and insurance protection increasing their revenues, curtailing their costs and achieving a competitive advantage over financial institutions with narrower product sets. Input reutilization and shared monitoring, advertising and account maintenance among different products also lower costs and contribute to improved efficiency. In addition, scale and scope economies may be achieved through consolidation of back-office functions such as information technology, settlement activity, record keeping, and spreading fixed costs and managerial overhead over an expanded product mix. Hughes et al. (2001) show that deeper diversification of the U.S. BHCs is associated with larger scale economies. A similar result is offered by Stiroh (2000).

Third, efficiency improvement may come from the sharing of information on the customers. The financial industry is highly information intensive as distinct from any other industry and information is a considerably costly input in production of financial services products (Diamond, 1984; Denis and Mihov, 2003). The information cost can be

viewed as a fixed cost of establishing a "relationship" with customers. Saunders and Walter (1994) and Kashyap et al. (2002) argue that banks gather extensive and costly information about their clients during their long-term contractual relationships. Such information can be utilized as an input by other subsidiaries of the same FHC to produce other products for the same clients without additional costs. Similarly, non-interest income activities, e.g., securities underwriting and insurance services, in turn produce information that can facilitate loan making. Referring to this benefit, Michael Patterson, the vice chairman of J.P. Morgan, stated "…financial services providers are better able to access information about a customer's total account relationship in order to offer products best suited to the customer's needs (Patterson, 1999).

3.3.4 How Can Diversification Hinder Efficiency?

Some studies have argued that the diversification trend of FHCs will have a minor positive or even a negative effect on production efficiency. Their arguments can be classified into the followings streams. First, some have argued that potential efficiency improvements through scope and scale economies had already been exploited before the passage of GLBA, by exploiting the loopholes in the prevailing legislations (Reichert and Wall, 2000; Yeager et al., 2007). According to this view, further diversification by financial institutions may actually decrease efficiency because it may lead to scope and scale diseconomies. Consistent with this view, Wheelock and Wilson (2001) show that potential savings from scale and scope economies appear to diminish with the increasing size of financial institutions. Specifically, they show that scale economies may be exhausted at assets level of $300-500 million.

In 1987, the Federal Reserve allowed BHCs to establish securities subsidiaries,

commonly referred to as "Section 20 subsidiaries", in order to engage in limited underwriting and security dealing.[37] Similarly, in 1996, the Office of the Comptroller of the Currency permitted operating subsidiaries of national banks to engage in bond and equity underwriting and other certain security and insurance activities (Barth et al., 2000 describe in detail these loopholes generated from regulators' interpretative freedom). These developments blurred the lines that separated banking, securities, and insurance sectors of the financial markets even before the passage of the GLBA. It is argued that to the extent that diversification can bring about efficiency gains, most BHCs would have been pursuing these activities up to the regulation limit prior to the GLBA. This position can be challenged on the ground that, according to Federal Reserve Board of Governors, only 45 domestic and international BHCs had Section 20 subsidiaries as of December 31, 1999.[38] This evidence shows that a large number of BHCs did not consider activity diversification through Section 20 subsidiaries as the best strategy for diversification.

Second, diversification may reduce production efficiency because it increases the complexity of BHCs' structure and governance and consequently makes the monitoring process by both the capital market and regulators less effective. The monitoring mechanism of the capital market over large diversified BHCs may be less effective because diversification into multiple activities is generally associated with more severe information asymmetry problems (Elyasiani and Wang, 2008). Under more complex organizational structure but without more effective monitoring, managers of diversified BHCs would be more likely to be entrenched. Consequently, it is more likely for

[37] The Federal Reserve Board increased the ratio of revenue that a section 20 subsidiary may derive from underwriting and dealing in securities in 1996 but still limited the ratio to 25 percent of its total revenue.
[38] See Appendix D. Source: Federal Reserve Board of Governors and also Yeager et al. (2007).

manages to achieve empire building objectives (Hughes et al., 2003). These agency and empire building problems have the potential to harm the production efficiency of the diversified FHCs. As to the regulatory structure, the GLBA adheres to the "functional regulation" principle in the sense that banking, securities, and insurance company regulators at the federal and state levels will each regulate the activities corresponding to their sphere. Barth et al. (2000) have argued that differing goals of different regulatory agencies with jurisdiction over various functions of FHCs may result in contention between these regulators. This effect may also adversely affect the efficiency of the regulated institutions.

Third, diversification through mergers and acquisitions may generate more financial conglomerates with inefficient "too big to fail" status. The largest and most powerful banks are generally considered to be "too big to (let) fail". This status ultimately means that these banks have fewer incentives to practice thrift and sound business procedures, since they would expect to be bailed out in the event of failure. Similarly, the explicit and implicit insurance reduces the incentive of debt-holders to monitor bank performance. In recent years, the number of commercial banks in the U.S. has decreased significantly and banking assets have been redistributed from smaller banks to larger banks (Mester, 2007). As a result, more banks have become too big to be liquidated because of the fear of contagion and systemic runs. Mergers and acquisitions for the purpose of establishing FHCs have strengthened this phenomenon. In addition, FHCs have an advantage over smaller and non-bank competitors in terms of access to the federal banking safety net (Barth et al., 2000). The status and the advantage of the largest

entities' can block competition from smaller institutions and protect the less efficient FHCs.

Last by not least, diversification may reduce the operational efficiency of BHCs because of the dilution or loss of "core competence" of BHCs. Prahalad and Hamel (1990) discuss "an area of specialized expertise that is the result of harmonizing complex streams of technology and work activity." For decades, BHCs' focused on commercial banking while investment banking and insurance activities were separated away by legislation. The post GLBA diversification into the latter activities has forced the BHCs to inevitably redistribute resources across a range of products in which BHCs do not have expertise or core competence. This is likely to result in lower operational efficiency. Capon et al. (1988) and Markides and Williamson (1994) have both identified this effect for cases of unrelated diversification. Palich et al. (2000) have also shown that performance declines as firms change from related diversification to unrelated diversification.

3.3.5 Hypothesis

Based on the preceding arguments, whether diversification of financial activities improves or diminishes the production efficiency of BHCs remains an empirical question. This study explores the relationship between diversification at the BHC level and the production efficiency at the commercial bank subsidiary level. The rationale is that while activity diversification occurs at the overall BHC level, productivity improvement will be primarily manifested in the subsidiary production units, especially in commercial banks because of their status in the holding company.

Although it is intuitively appealing to construct the production efficiency of the overall BHCs, the numerous and heterogeneous inputs and outputs make the efficiency comparison among BHCs meaningless. The simultaneous consideration and/or the aggregation of these outputs are likely to contaminate the efficiency measures and render interpretation of these measures suspect, especially for production efficiency. Specifically, measurement of efficiency at the bank level is superior to that at the holding company level because of the following reasons. First, the product set and the product mix across different BHCs is quite diverse and heterogeneous. According to Yeager et al. (2007), 158 out of the 582 distinct FHCs derived no income from, nor held any assets in, insurance underwriting, merchant banking, and investment banking at the end of year 2004. These activities are primarily conducted only by the largest FHCs. For example, they observe that as of the end of 2004, Citigroup, Bank of America, and JPMorgan Chase accounted for 72% of all FHCs' assets in investment banking. Similarly, MetLife and Citigroup accounted for 96% of all FHCs' insurance assets. Therefore, there exists significant cross-sectional difference in BHCs' product mix. Comparison of the production efficiency of BHCs with significantly different output mix may yield biased results (Colwell and Davis 1992).

Second, the differential regulatory constraints across the subsidiaries are very likely to result in dissimilar production frontiers, distorting efficiency measurements within a common frontier. Different subsidiaries have dissimilar capital requirements, dissimilar leverage, and differential risk exposures. Overlooking these similarities may distort the efficiency and productivity measures. Additionally, the overall production efficiency of the BHCs is subject to the influence of merger and acquisition and the

changing of governance. As noted in Mester (2007), there is an average of about 440 mergers per year in the banking industry from 1980 to 2005. Consequently, this study looks at the production efficiency of commercial banks whose ultimate (highest-tier) BHCs remain unchanged during the sample year.

Commercial banks make up the largest group of depository institutions measured by asset size (Saunders and Cornett, 2006). As the keystone and common entity across different BHCs, commercial banks produce a set of relatively homogeneous products of deposits and loans. The input and output mixes are also relatively homogenous across different commercial banks compared to the product mixes across different BHCs. In addition, commercial banks are usually the largest entity in the entire BHC in terms of asset size (e.g. 87% in our sample). Therefore, measuring the production efficiency of commercial banks and using their efficiency as an indicator of their ultimate parent BHC's efficiency makes sense both statistically and economically. For these reasons, the majority of efficiency studies in banking are conducted at the commercial bank level, rather than the BHC level. In brief, banks and banking products are unique and operate under unique environments necessitating the specification of a banking-specific frontier.

This study parallels Schoar (2002) in terms of methodology but it has several advantages over the latter. These include the use of much more detailed data available on commercial banks (compared to the LRD), employment of the nonparametric approach which avoids the imposition of a specific functional form (Cobb-Douglas in Schoar's case) and the stronger theoretical justification of the input and output specifications for commercial banks.

Based on the above arguments, the following hypothesis is proposed:

H_8: *Activity diversification of the BHCs improves the productive efficiency of their largest subsidiary commercial bank.*

As stated in Section 3.2, even before the passing of GLBA, BHCs did manage to find loopholes in legislation to bypass the separation between commercial banking and investment banking and insurance activities. The most common practice was establishing Section 20 subsidiaries to engage in limited underwriting and dealing in municipal revenue bonds, mortgage related securities, consumer-receivable related securities, and commercial paper. By doing so, the BHCs with Section 20 subsidiaries may have enjoyed the First-Mover Advantages specified in Lieberman and Montgomery (1998) including technological leadership, preemption of scarce assets, and the switching costs and buyer choice uncertainty. In this scenario, the Section 20 subsidiaries entering new product market quickly use up the existing resources, including clients, and, therefore, create comparative advantages relative to late comers. If this is indeed the case, BHCs that had already some experience in dealing with investment banking through Section 20 subsidiaries are likely to benefit more from the GLBA and further diversification. Supporting this argument, Mamun et al. (2005) find a stronger positive stock market reaction to GLBA for banks with Section 20 subsidiaries.

Some counter arguments do exist. First-movers may suffer because of free-rider effects, resolution of technological or market uncertainty over time, shifts in technology or customer needs, and incumbent inertia (Lieberman and Montgomery, 1998).[39] In addition, Yeager et al. (2007) and Barth et al. (2000) argue that GLBA only ratified what

[39] Late comers may learn lessons and experience from the first-movers, avoid early hurdles, and enjoy the improved environments at no cost. In addition, the sunk costs incurred by first movers put them at a disadvantage, especially when facing uncertain market and economic environment.

BHCs had been doing, rather than being a revolutionary environmental change for the banking industry. Consequently, the benefits obtained through post-GLBA diversification may be negligible or totally exhausted already. Thus, the following hypothesis is proposed:

H_9: *BHCs that had Section 20 subsidiaries benefited more from (or hurt less by) activity diversification than BHCs that did not have such subsidiaries.*

The following section explains how this study constructs the sample and how it measures the diversification of BHCs and the production efficiency of commercial banks.

3.4 Research Methodology and Sample Construction

3.4.1 Research Methodology

This study employs Data Envelopment Analysis (DEA) to construct the efficiency frontier. In DEA, the set of best-practice decision making units (DMUs) includes those units for which no other DMUs or linear combination of DMUs produces as much or more of every output given the inputs, or uses as little or less of every input given the outputs (Berger and Humphrey, 1997). The production frontier is formed as a piecewise linear combination that connects the set of those best practice DMUs, yielding a convex production possibilities set. The DEA estimation used in this study is input oriented, addressing the issue of reducing input quantities proportionally while keeping output quantities unchanged. The method is conceptually consistent with cost minimization model in economic theory (Cummins and Xie, 2008).

Varian (1984) specifies the following inner approximation to the production possibility set *S* for an industry consisting of *N* firms as DMUs:[40]

$$S = \left[(x, y) : x \geq \sum_{i=1}^{N} \lambda_i x_i, y \leq \sum_{i=1}^{N} \lambda_i y_i, \sum_{i=1}^{N} \lambda_i = 1, \lambda_i \geq 0, i = 1, 2, ..., N \right] \quad (3\text{-}1)$$

The input-oriented *technical efficiency* (TE) of the *i*th firm can then be measured by the proportional reduction in inputs that is possible to still allow the given bundle of outputs to be produced. Farrell (1957) specifies the TE as described by equation (3-2)

$$TE = \min\{\alpha: (\alpha x_i, y_i) \in S\} \quad (3\text{-}2)$$

where TE indicates the production efficiency of the observed DMU relative to the best practice frontier[41]. A value of 1 will indicate a technically efficient DMU with its inputs-outputs combination point on the efficiency frontier. A firm whose inputs-outputs combination lies in the interior of the feasible production set is technically inefficient, since it would be possible for the firm to reduce its inputs while holding outputs constant. Therefore, any points in the interior of the frontier will yield a TE score of less than 1, with the value indicating the ratio of the inputs of an efficient DMU to the inputs of an inefficient DMU when they produce the same outputs. The next section of this paper will construct TE scores for each of the commercial banks based on DEA frontier of each sample year.[42] Alternatively, Shephard (1953, 1970) defines the input distance function

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[40] Assume a convex production possibility set with freely disposable inputs and outputs. The industry consists of *N* DMUs. These *N* DMUs together will use *p* inputs $x=(x_1, x_2,\ldots, x_p)$ to produce *q* outputs $y=(y_1, y_2,\ldots, y_q)$. Each one of the N DMUs use the input vector x_i to produce the vector y_i. λ_i is the weight of the *i*th DMU.

[41] α is a ratio less than or equal to one. It measures the possible reduction of inputs to produce the exact same amount of outputs.

[42] Coelli (1996) expresses the relevant linear programming as: $\min_{\theta,\lambda} \theta,\ s.t.\ -y_i + Y\lambda \geq 0;\ \theta x_i - X\lambda \geq 0;$ and $\lambda \geq 0$. For an industry with K inputs and M outputs and consisting of N DMUs. The ith DMU has vectors xi and yi as inputs and outputs, and the industry has a K×N matrix X and an M×N matrix Y as inputs and outputs, respectively. θ is a scalar, λ is an N×1 vector of constants. If an additional restriction $I'\lambda=1$ is added to

$D(x_i, y_i)$ of any DMU as equation (3-3), which is simply the inverse of the technical efficiency described in (2). $D(x_i, y_i)$ measures the ratio of the inputs of an inefficient DMU to the inputs of an efficient DMU when they produce the same outputs.

$$D(x_i, y_i) = \max\left[\gamma : (\frac{x_i}{\gamma}, y_i) \in S\right] \tag{3-3}$$

The Malmquist (1953) Productivity Index is a chained index which is generated by constructing a production efficiency frontier for every time period (year in this study) and then measuring the changes in productivity relative to the previous year. The ratio of the two distance functions corresponding to two consecutive years as defined in (3) reveals the information about the change in total factor productivity (TFP). Caves et al. (1982) extend the model developed by Malmquist (1953) into a productivity index and use the Shephard input distance as the proportional scaling. Specifically, for two input-output pairs (x^t, y^t) at time t and (x^{t+1}, y^{t+1}) at time $t+1$, the Malmquist productivity index with respect to the production possibility set of time t can be defined as equation (3-4):

$$M^t(x^t, x^{t+1}, y^t, y^{t+1}) = \frac{AP^{t+1}}{AP^t} = \frac{y^{t+1}/x^{t+1}}{y^t/x^t} = \frac{D_c^t(x^t, y^t)}{D_c^t(x^{t+1}, y^{t+1})} \tag{3-4}$$

where the subscript c under the distance function denotes that the distance function is measured with reference to constant returns to scale (CRS) technology. AP is average productivity, defined as the ratio of outputs to inputs. Intuitively, M^t measures productivity growth from t to t+1, as shown in equation (3-4) the ratio of average productivities in t+1 and t respectively, using the period t reference technology.

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equation (3-1), then the program is designed to solve a constant returns to scale (CRS) production, where I is an N×1 vectors of ones. The value of θ obtained through this procedure is the efficiency score for the ith DMU.

Similarly, the productivity growth from t to t+1 with respect to the production possibility set of time *t+1*can be defined as a Malmquist index M^{t+1}, where

$$M^{t+1}(x^t, x^{t+1}, y^t, y^{t+1}) = \frac{D_c^{t+1}(x^t, y^t)}{D_c^{t+1}(x^{t+1}, y^{t+1})} \tag{3-5}$$

Instead of arbitrarily choosing the technology of period t or t+1 as the benchmark, Färe et al. (1992) calculate the Malmquist index as the geometric mean of M^t and M^{t+1} as follows:

$$M(x^t, x^{t+1}, y^t, y^{t+1}) = \left[\frac{D_c^t(x^t, y^t)}{D_c^t(x^{t+1}, y^{t+1})} \frac{D_c^{t+1}(x^t, y^t)}{D_c^{t+1}(x^{t+1}, y^{t+1})} \right]^{1/2} \tag{3-6}$$

Ray and Desli (1997) and Mukherjee et al. (2001) show that even if the constant return to scale (CRS) assumption was relaxed (removing the constraint $\sum_{i=1}^{N} \lambda_i = 1$), this Malmquist index definition would be still valid under variable return to scale (VRS). Therefore, this index specified in (6), also known as total factor productivity change (TFPCH), is widely applied in the empirical studies of economics and finance as a measure of change in production efficiency. TFPCH can attain a value greater than, equal to, or less than 1 depending on whether the DMU experiences productivity growth, stagnation, or decline, respectively. This variable reveals how the total productivity grows over time from a particular year to next year.

TFPCH can be decomposed into detailed components as suggested by Ray and Desli (1997) and Fare et al. (1994) into factors measuring technical change, pure efficiency change, and scale change under VRS specification. However, they do not agree with each other on either the way TFPCH is decomposed or the rationale behind it.

Empirical studies have followed both of these methods and they name those decomposed factors differently.[43] Fortunately, both of the two studies agree on one particular factor: the pure efficiency change factor (PEFFCH), of which the interpretation is the most intuitively clear among the three components. It is defined identically by both studies as:

$$PEFFCH = \left[\frac{D_v^t(x^t, y^t)}{D_v^{t+1}(x^{t+1}, y^{t+1})} \right] \tag{3-7}$$

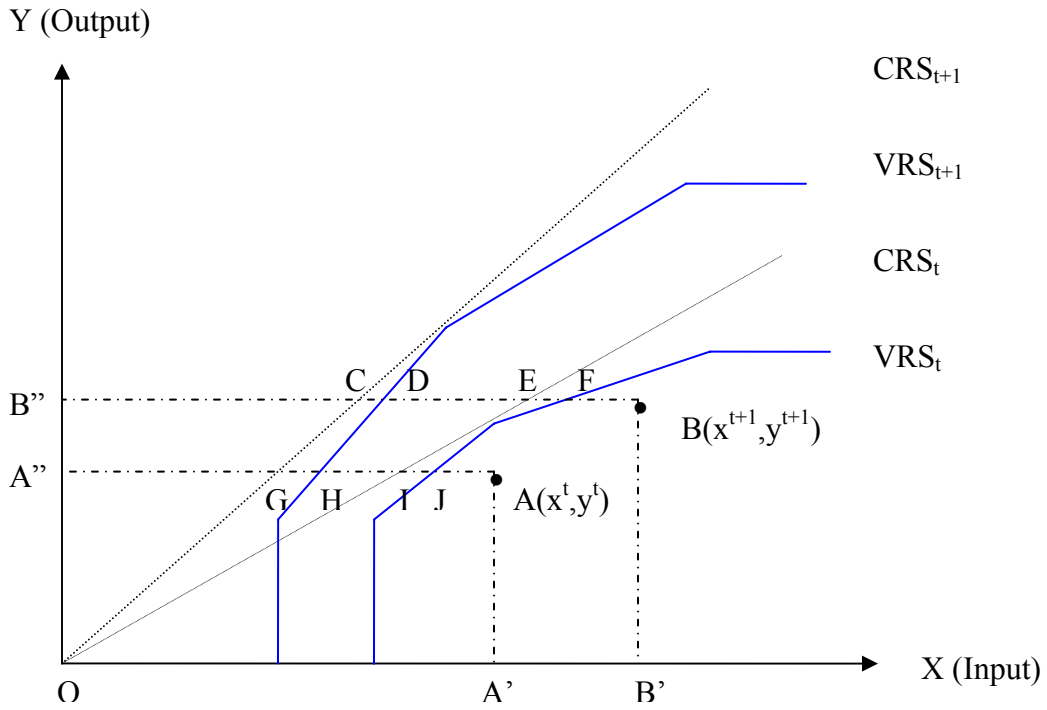
where the subscript v under the distance function denotes that the distance function is measured with reference to VRS technology. PEFFCH compares the DMU's distance function from the VRS production frontier in period t to its new distance from the VRS frontier in period t+1. This variable shows how a DMUs' relative efficiency to its peers changes over time. If a DMU becomes relatively more efficient (i.e. its inputs-outputs combination moves closer to the efficiency frontier, and/or its technical efficiency score becomes larger, and/or its distance function becomes smaller, from t to t+1), then the DMU will obtain a PEFFCH score greater than 1 during time t~t+1. If a DMU becomes relatively less efficient from t to t+1, the PEFFCH will yield a value less than 1. In the next section, the TFPCH and PEFFCH will be the primary focus in measuring commercial banks' efficiency change over time.

Figure 3-1 illustrates the production function and the Malmquist methodology using a single-input (X), single-output (Y) industry. CRS_t and CRS_{t+1} represent the constant returns to scale production frontier for period *t* and *t+1*, while VRS_t the VRS_{t+1}

[43] Mukherjee et al. (2001) and Cummins and Xie (2008), among others, follow Ray and Desli (1997). In their setting, the Malmquist Index can be decomposed into technical change, pure efficiency change, and scale change. Isik and Hassan (2003) and Alam (2001), among others, follow Fare et al. (1994). In their setting, the Malmquist Index can be decomposed into pure efficiency change, technological change, and scale efficiency change. All these decomposed factors except pure efficiency change are hypothetical efficiency change assuming some other factors stay the same.

represent the corresponding variable returns to scale production frontiers. A and B are the observed input-output combinations of a firm in the *t* and *t+1* periods, respectively.

Figure 3-1: Efficiency and Productivity Change: Single-Input-Single-Output Model



Based on this specification, TEs and input distance functions can be expressed as:

$$TE_c^t = \frac{1}{D_c^t(x^t, y^t)} = \frac{A"I}{A"A},\ TE_c^{t+1} = \frac{1}{D_c^{t+1}(x^{t+1}, y^{t+1})} = \frac{B"C}{B"B},\ \text{and}$$
$$TE_v^t = \frac{1}{D_v^t(x^t, y^t)} = \frac{A"J}{A"A},\ TE_v^{t+1} = \frac{1}{D_v^{t+1}(x^{t+1}, y^{t+1})} = \frac{B"D}{B"B} \qquad (3\text{-}8)$$

The Malmquist index TFPCH measuring the ratio of average productivity in the two years can be expressed as:

$$M = \left[\frac{D_c^t(x^t, y^t)}{D_c^t(x^{t+1}, y^{t+1})} \times \frac{D_c^{t+1}(x^t, y^t)}{D_c^{t+1}(x^{t+1}, y^{t+1})}\right]^{1/2} = \left[\frac{A"A}{A"I} \times \frac{B"E}{B"B} \times \frac{A"A}{A"G} \times \frac{B"C}{B"B}\right]^{1/2} \qquad (3\text{-}9)$$

and lastly the PEFFCH measuring the change of DMU's distance from VRS frontier is:

$$PEFFCH = \left[\frac{D_v^t(x^t, y^t)}{D_v^{t+1}(x^{t+1}, y^{t+1})} \right] = \frac{A"A}{A"J} \times \frac{B"D}{B"B} \tag{3-10}$$

3.4.2 Sample Selection

The data set used in this study is primarily drawn from Bank Holding Company and Commercial Bank Data sets available from the Federal Reserve Bank of Chicago website. The Bank Holding Company data contain quarterly information on all domestic BHCs on a consolidated basis. The Commercial Bank Data include financial information of all banks regulated by the Federal Reserve System, Federal Deposit Insurance Corporation, and the Comptroller of the Currency. This study obtains the year-end data of both BHCs and commercial banks for a time period covering 1997-2007.[44]

Small and large banks may operate under different technologies as found in Humphrey (1985 and 1990). Accordingly, to compare production efficiency of a similar group of banks, this study only considers large banks with total assets greater than $500 million (similar thresholds are commonly used in the literature, e.g., Mukherjee (2001)). To be qualified, a commercial bank must have data available for each year of the time period (1997-2007) and must have been the largest entity of the BHC for at least one year[45]. Using the identifier provided in the Commercial Bank Data set, each qualified commercial bank is then linked to its ultimate (highest-tier) parent BHC. Commercial banks for which the ultimate BHC changed during the sample period are deleted from the

[44] The starting time is set to 1997 because of the reporting format change of FR-Y9C. In order to construct compatible time-series data, observations prior to 1997 are not considered.

[45] If more than one commercial banks have been the largest entity of the same BHC (FHC), the commercial bank with the largest number of years being the largest entity will be selected and the other commercial banks will be eliminated.

sample to eliminate any potential effect on change of production efficiency resulted from merger and acquisition. In addition, this study requires the BHCs to have data available for every year of the time period. The result of this procedure is a balanced panel data covering 164 different commercial banks with 164 different ultimate BHCs for 11 years. After carefully examining the BHCs not included in the sample, the small sample size is primarily due to merger and acquisition and missing data, we do acknowledge the potential effect generated by the survivor bias.

3.4.3 Variable Construction

Two main approaches have been employed in literature to describe the production structure of financial institutions; the intermediation approach and the production approach. This study adopts the *intermediation approach* which treats banks as intermediaries of financial services, rather than producers of loan and deposit account services as done in the *production approach*. Specifically, similar to Hughes and Mester (1993) and Elyasiani and Mehdian (1990), among others, deposits are treated as an input rather than an output.

Four inputs are specified: (i) labor; (ii) fixed assets; (iii) deposits; and (iv) other non-interest expenses excluding expenses on (i). Labor is measured as full-time equivalent employees. Fixed assets measures the physical inputs coming from premises and fixed assets, including capitalized leases. Deposits include interest-bearing and noninterest-bearing deposits (includes total demand deposits and noninterest-bearing time and savings deposits) in both domestic and foreign offices. Other non-interest expenses are defined as the total of non-interest expenses excluding salaries and employee benefits. Two alternative specifications are followed in the choice of outputs in the literature. The

first specification considers (i) loans (total loans and leases, net of unearned income), (ii) securities (held-to-maturity securities and available-for-sale securities), and (iii) non-interest income (total non-interest income) as the three outputs of commercial banks, following Sealey and Lindley (1977) and Casu et al. (2004). Non-interest income is included to cover the off balance sheet products, which are sometimes overlooked in efficiency studies. The second specification adds trading assets as an additional output. Trading assets is constructed by separating the available-for-sale securities under securities category of the first specification and combining it with trading assets. Therefore, the four outputs are loans, securities (hold-to-maturity), trading assets, and non-interest income. Elyasiani and Mehdian (1990) also separate the securities held in trading accounts from other security assets.

The production efficiency of commercial banks is estimated based on the DEA and the Malmquist Index methodoloy. For a particular year in our sample period, production frontiers are constructed under both constant returns to scale (CRS) and variable returns to scale (VRS) specifictions (the results shown in this study are primarly based on VRS because CRS is just a special case for VRS). The technical efficiency score (TE) for each commercial bank is then calculated relative to the current year VRS frontier. In addition, production frontiers of two consecutive years are paired together as references and consequently the total factor productivity change (TFPCH) and pure efficiency change (PEFFCH) are calculted relative to the pair of frontiers. These two variables reveal informaton about productivity change over time and change in the distance of a DMU from productoin frontier over time, respectively.

The change in the reporting format by banks during the sample period creates a problem in construction of a compatible time series of BHC diversification measure. During 1996-2000, according to the BHCs' reporting form (FR Y-9C), the non-interest income was divided into three components, which are income from i) fiduciary activities; ii) service charges, commissions, and fees; and iii) trading revenue. Any other sources of non-interest income were reported in the residual category of "other non-interest income". Rapid growth of activity diversification led to change in the format of Y-9C. According to the FDIC, the new report format, introduced in the first quarter of 2001, included the previously classified categories, and broke out the "other non-interest income" item into various new categories.[46] Specifically, under the new format of FR Y-9C report, there are 13 different items reported as non-interest income. They are: a) income from fiduciary activities; b) service charges on deposit accounts in domestic offices; c) trading revenue; d) investment banking, advisory, brokerage, and underwriting fees and commissions; e) venture capital revenue; f) net servicing fee; g) net securitization income; h) insurance commissions and fees; i) net gains (losses) on sales of loans and leases; j) net gains (losses) on sales of other real estate owned; k) net gains (losses) on sales of other assets (excluding securities); and l) other non-interest income. Starting from the first quarter of 2003, item h) was further broken down into h1) insurance and reinsurance underwriting income and h2) income from other insurance and reinsurance activities. In year 2007, item h) was grouped into item d) and the new item d) included five sub-items.[47] To make the reported items compatible across different time

[46] See "New Reporting Offers Insight Into Bank Activities" from FDIC, Internet access: http://www.fdic.gov/bank/analytical/fyi/2002/041802fyi.html

[47] See Appendix A for detailed information on the format change of FR Y-9C Report.

periods, this study follows the advice about constructing consistent variables obtained on the Federal Reserve Bank of Chicago website and categories the income of the BHCs by two methods. First, for the entire sample period, this study separates BHCs' income into five categories as interest income; income from fiduciary activities; service charges, commissions, and fees; trading revenue; and other non-interest income. Second, for sub-sample of data starting in year 2001, BHCs' income is grouped into 14 categories including interest income and 13 non-interest income items.

Following Hughes et al. (1999) and Deng et al. (2007), a Hirschman- Herfindahl Index like diversification measure (DIV) is constructed for each of the different items of BHCs' income. These measures are computed as one minus the sum of the squares of each item's proportion of the total, where a higher score on DIV means a BHC is more diversified among income activities.

$$. \quad DIV = 1 - \sum_i \left(\frac{Income_i}{\sum_i Income_i} \right)^2 , i = 1, 2, \ldots \text{ for each income item} \qquad (3\text{-}11)$$

The characteristics of BHCs may also have potential effects on the production efficiency of the commercial banks. To control for such effects, this study constructs the following control variables. To measure a BHC's reliance on non-interest income, a variable RATIO is constructed as the ratio of non-interest income to the sum of interest income and non-interest income.[48] Ratio is capturing different information from DIV because it looks at non-interest income as a whole and examines the weight of it to BHCs' income stream rather than how many different activities those BHCs do.

[48] Note that the FR Y-9C report does not offer the sum of interest income and non-interest income. Net income is calculated as interest income minus interest expense, plus non-interest income minus non-interest expense.

The size of the BHCs is accounted for by introducing the variable SIZE, which is the natural log of the BHC assets. Larger size may yield advantages in terms of productivity growth because advanced technologies require huge initial investments, which makes it impossible for smaller BHCs to acquire. On the other hand, a larger size may convey disadvantages due to higher organizational complexity, coordination costs and agency problems. Berger and Mester (1997) show that efficiency estimates do not vary much across different size classes.

Regulators consider capital adequacy as an important indicator when evaluating bank performance. The effects of leverage on production efficiency are two fold. Higher leverage may benefit BHCs with interest tax shield and increased profitability but at the same time may also increase the concern of debt-holder and regulator about the possibility of bankruptcy and therefore reduce the independency of BHCs' decision and disturb their operating strategy (Berger, 1995). This study constructs LEVERAGE, the ratio of total liability to total asset, to control for the potential effect of this factor on efficiency. In addition, the profitability of the BHC may also have positive influence on the productivity. This effect is controlled by return on assets (ROA), defined as the ratio of net income to total assets. More profitable BHCs would be more capable and likely to employ new technologies and management strategies. In addition, internal capitals such as profits will be much easier to obtain than external capital and this benefit gives the profitable BHCs more flexibility than less profitable BHCs. Therefore the profitability is expected to be positively associated with production efficiency. Lastly, to take into consideration the effect of the intangible assets of BHCs, such as reputation and trademarks, on commercial banks productivity, the ratio of intangible assets (sum of good

will and other intangible assets) to total assets (INTANGIBLE) is also included as a control variable. BHCs with better reputation may obtain stronger market power and therefore generate more outputs given the same inputs. On the other hand, the production efficiency may actually rely more on physical inputs rather than intangible assets. Therefore, INTANGIBLE may be either positively or negatively correlated with production efficiency.

To test whether BHCs with Section 20 subsidiaries would enjoy special advantages over others in terms of production efficiency, a Section 20 dummy is constructed that separates BHCs used to have Section 20 subsidiaries (Section20=1 if they did and 0 if they didn't). Appendix D lists all the BHCs with Section 20 subsidiaries as of December 31, 1999, right before the effective date of GLBA. This study examines domestic BHCs due to data availability. Our sample includes 15 BHCs with Sectoin20=1, also partly due to mergers and acquisitions in the last decade.

It would be beneficial to include similar control variables based on the characteristics of commercial banks. However, due to the dominant status of our sample banks in their ultimate BHCs (87% of total assets), similar variables at commercial bank level and at BHC level are highly correlated. Adding similar control variables to the same regression results in collinearity problem. Therefore, this study does not repeat those variables at commercial bank level. The only exception is WEIGHT, which is defined as the total assets of commercial banks divided by the total assets of their ultimate BHCs'. Commercial banks having a larger weight of total assets in their BHCs may have controlling power over the resources of production and managers of their BHCs may put more focus on improving their efficiency. At the same time, those commercial banks may

also be less likely to benefit from other relatively smaller subsidiaries in different product lines if complimentary and synergy exists in production of those products. The over all effect of WEIGHT on efficiency is an empirical issue.

3.4.4 Model Specification

To test the hypotheses developed in Section 3.3.5, this study examines the effect of BHCs' diversification on commercial banks' production efficiency from the following two perspectives. First, the current year technical efficiency (TE) scores are used as the dependent variable to test how the level of diversification and other control variables influence it. Since TE's values range from 0 to 1, a Tobit regression is used on the pooled sample. The regression considers both the direct effect of Section20 and the interaction between DIV and Section20.

$$TE = \alpha + \beta_1 DIV + \beta_2 Section20 + \beta_3 DIV \times Section20 + \gamma Contral\ \ Variables + \varepsilon \qquad (3\text{-}12)$$

Next, using the TFPCH and PEFFCH obtained from Malmquist Index analysis, this study examines the relationship between change of diversification and change of production efficiency. The value of TFPCH and PEFFCH can be greater, or equal to, or less than 1 and therefore an OLS regression will be applied. Correspondingly, the control variables will also be the changes from the previous year.

$$TFPCH = \alpha + \beta_1 \Delta DIV + \beta_2 Section20 + \beta_3 \Delta DIV \times Section20 + \gamma \Delta Contral\ \ Variables + \varepsilon \qquad (3\text{-}13)$$

$$PEFFCH = \alpha + \beta_1 \Delta DIV + \beta_2 Section20 + \beta_3 \Delta DIV \times Section20 + \gamma \Delta Contral\ \ Variables + \varepsilon \qquad (3\text{-}14)$$

The next section will describe the characteristic of the sample and report the results of these regressions.

3.5 Empirical Analysis

3.5.1 Description of Sample

Table 3-1 offers some key statistic describing the sample. BHCs in our sample have total assets varying from $0.5 billion to $1720 billion with a mean of $23 billion. BHCs' reliance on non-interest income, measured by RATIO, ranges from 1.2% to 89%. This pattern clearly shows the heterogeneous production characteristics across different BHCs. The average BHC derives 20% of its income form non-interest activities. BHCs are highly leveraged, with the smallest value of LEVERAGE being 0.8. The average BHC also has net income and intangible assets as 1.1% and 1.3% of its total assets, respectively. As to activity diversification, there exist huge differences among the BHCs in the sample. The diversification measure (DIV) varies from 0.112 for focused BHCs to 0.732 for highly diversified BHCs. The commercial banks in our sample hold about 87% of total assets of the entire holding company. The efficiency of the banking subsidiaries, hence, serves as a good indicator for the efficiency of their ultimate BHCs. The technical efficiency scores have an average value of 0.728 and 0.796 under CRS and VRS, respectively. The least efficient commercial banks have a TE score of 0.37 and 0.45 in each specification.

Next, this study separates the sample into BHCs that did and did not have Section 20 subsidiaries before GLBA and calculate group means for each group. Table 3-2 shows data on the characteristics of the two groups. BHCs that used to have Section 20 subsidiaries are relatively more efficient than others under both CRS and VRS. These BHCs are also significantly larger in total assets, higher in leverage, and rely more

Table 3-1: Descriptive statistics of the sample

This table describes the sample of 161 commercial banks for time periods 1998-2007. The variables are defined as follows: TE is technical efficiency score obtained through DEA analysis based on three outputs four inputs production model. TA is the amount of total assets of the BHCs. SIZE is the natural log of book value of total assets at the end of each year. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. LEVERAGE is defined as the ratio of total liabilities to total assets. ROA is a profitability measure defined as the ratio of net income to book value of total assets. INTANGIBLE is defined as the ratio of intangible assets to book value of total assets. DIV is the Hirschman- Herfindahl Index like measure for the dispersion among income activities. WEIGHT is the ratio of book value of total assts of the commercial bank to book value of total assts of its ultimate BHC. Due to reporting delay and/or errors, very few commercial banks have larger total assets than their BHCs. In these cases, WEIGHT is set to 1.

Variable	Description	NOBS	Mean	Median	St.d.	Max	Min
TE (CRS)	Technical efficiency under CRS	1610	0.728	0.701	0.141	1	0.370
TE (VRS)	Technical efficiency under CRS	1610	0.796	0.782	0.144	1	0.453
TA	Total assets ($billion)	1610	23.132	2.460	117.655	1720.688	0.540
SIZE	Natural log of total assets (in thousands)	1610	15.087	14.716	1.406	21.266	13.199
RATIO	Ratio of non-interest income	1610	0.196	0.177	0.105	0.892	0.012
LEVG	Leverage	1610	0.908	0.909	0.020	0.966	0.803
ROA	Net income/Total assets	1610	0.011	0.011	0.004	0.029	-0.023
INT	Intangible Assets/Total assets	1610	0.013	0.009	0.015	0.092	0
DIV	Bank income diversification (HHI)	1610	0.285	0.279	0.140	0.732	0.112
WEIGHT	Total assets bank/total assets BHC	1610	0.871	0.926	0.197	1	0.156

Table 3-2: Group means comparison of sample characteristics

This table compares the group means between commercial banks that are subsidiaries of BHC with Section 20 subsidiaries before GLBA and those that are not. The variables are defined as follows: TE is technical efficiency score obtained through DEA analysis based on three outputs four inputs production model. SIZE is the natural log of book value of total assets at the end of each year. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. LEVERAGE is defined as the ratio of total liabilities to total assets. ROA is a profitability measure defined as the ratio of net income to book value of total assets. INTANGIBLE is defined as the ratio of intangible assets to book value of total assets. DIV is the Hirschman- Herfindahl Index like measure for the dispersion among income activities. WEIGHT is the ratio of book value of total assts of the commercial bank to book value of total assts of its ultimate BHC. *, **, and *** denote the significance of 10%, 5%, and 1% in t-test of group means, respectively.

Variable	Description	Section20=1	Section20=0	Difference
TE (CRS)	Technical efficiency under CRS	0.815	0.712	0.094***
TE (VRS)	Technical efficiency under CRS	0.941	0.784	0.157***
SIZE	Natural log of total assets	18.030	14.784	3.245***
RATIO	Ratio of non-interest income to…	0.311	0.184	0.126***
LEVG	Leverage define	0.913	0.908	0.005***
ROA	Net income/Total assets	0.012	0.011	0.001
INT	Intangible Assets/Total assets	0.023	0.012	0.011***
DIV	Bank income diversification	0.419	0.272	0.147***
WEIGHT	Total assets bank/total assets BHC	0.790	0.888	-0.098***

heavily on non-interest incomes in their total income. They are also more diversified in their activities in comparison to BHCs that did not have Section 20 subsidiaries. However, the two groups are not much different in terms of profitability, as indicated by their return on assets (ROA). The assets of commercial bank subsidiaries constitute a much smaller share of the total assets for BHCs with Section 20 experiences, largely due to the larger size of their subsidiaries other than commercial banks.

3.5.2 Inputs, Outputs, and Technical Efficiency

Results of efficiency estimation are sensitive to the choice of inputs and outputs (Berger et al., 1993). Therefore, the current study considers two alternative production models as specified in Section 3.4.3. Inputs are identical in the two models and they include labor, fixed assets, deposits, and other non-interest expenses. As to outputs, Model 1 specifies three outputs of loans, securities, and non-interest income, while Model 2 specifies four outputss as loans, securities, trading, and non-interest income. Details about the definition of these inputs and outputs have been described in Section 3.4.3. Table 3-3 contains a summary for the input and output variables from 1997-2007. All values are in million of dollars, except the number of full-time equivalent employees.

It is easy to see from the table that every input is steadily increasing over time. Labor, fixed assets, and non-interest expenses all more than doubled during the sample period.[49] The most striking increase in input, however, occurred in the level of deposits, which quadrupled between 1997 and 2007. As to outputs in Model 1, securities and non-interest income grew steadily, while loan growth faced a set-back in year 2001, largely

[49] Dollar amount may be affected by inflation factor. However, using price index to deflate these variables may not help in improving the accuracy of production efficiency, because as long as both inputs and outputs are adjusted by the same factor the production efficiency would not change.

Table 3-3: Average outputs and inputs by year 1997-2007

All variables except labor are measured in millions of dollars. Labor is measured in full-time equivalent employees. The sample includes balanced panel data for 161 commercial banks for time periods 1997-2007. This study specifies two set of input-output combination. The first specification is a three outputs four inputs model with loan, securities, and non-interest income as outputs. The alternative specification is a four outputs four inputs model. In this specification, the available-for-sale securities under securities category are combined with trading output because of their similarity. Inputs include labor, fixed assets, deposits and non-interest expenses.

Variable	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Outputs											
Loan	4277	5432	6864	7787	7610	8227	8715	10745	13185	14950	17038
Securities	1419	1823	2091	2205	2418	2876	3145	4009	4279	4466	4542
Non-interest income	134	188	250	272	296	330	364	381	488	584	580
Security (Alternative)	175	154	145	142	120	119	125	180	227	227	215
Trading (Alternative)	1751	2176	2581	2826	3608	4604	4925	6017	6273	6970	7760
Input											
Labor (# employees)	2033	2645	3023	3188	3328	3480	3535	3896	4341	4597	4702
Fixed Assets	97	120	142	157	169	180	186	203	228	238	261
Deposits	4792	6013	7495	8618	9184	10048	11024	13657	16106	18142	20403
Non-interest expenses	121	167	188	214	239	247	256	303	347	368	421

due to the slowdown in the economy caused by the burst of the internet bubble and terrorist attacks of 911. Outputs specified in model 2 also grew steadily, except that securities output declined until 2002 and increased thereafter.

Based on Model 1 and 2, the input-oriented DEA analysis is performed for the sample of 161 commercial banks under the assumption of both constant returns to scale (CRS) and variable returns to scale (VRS). For each year from 1998 to 2007, an efficient production frontier is constructed based on the DEA linear programming method and then each commercial bank is compared to the frontier in that year to determine its efficiency score. The efficiency score of a DMU is the ratio of inputs used by the most efficient DMUs to the inputs of the DMU of interest when they both produce the same levels of outputs (Farrell, 1957). For example, an input efficiency score of 0.8 indicates that the commercial bank could have reduced its inputs by approximately 25% ((1-0.8)/0.8)) without changing its output levels if they were as efficient as their best practice peers.

DEA efficiency scores under both CRS and VRS specification are shown in Table 3-4, with Panel A and B listing scores for Model 1 and 2, respectively. Under Model 1, Average efficiency for the whole sample ranges from 0.704 (1998 and 2000) to 0.769 (2002) for CRS, and from 0.776 (1998, 1999, and 2006) to 0.825 (2002) for VRS. Under both return to scale specifications, average efficiency peaked in 2002 and then declined gradually until 2007. Panel B shows the average efficiency under Model 2. The average efficiency for the sample ranges from 0.723 (2006) to 0.794 (2002) for CRS, and from 0.790 (2006) to 0.840 (2002) for VRS. These efficiency summary statistics also show a peak of productivity in 2002 and then a decline to year 2006. These average efficiency

Table 3-4: Average DEA technical efficiency scores across years

Input oriented DEA analysis is performed based upon the 161 commercial banks for time periods 1998-2007. Efficient production frontiers are constructed for observations in each year. The efficiency score is defined as the ratio of inputs used by the most efficiency DMUs to the inputs of the observed DMU in production of the same level of outputs, as defined in Farrell (1957). Difference is the mean of section 20 group minus the mean of others group. *, **, and *** denote the significance of 10%, 5%, and 1% in t-test of group means, respectively.

Variable	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Panel A Model 1 (4 inputs 3 outputs)										
CRS										
All BHCs	0.704	0.708	0.704	0.766	0.769	0.745	0.742	0.718	0.709	0.719
Section 20 group	0.801	0.810	0.778	0.782	0.852	0.831	0.826	0.826	0.840	0.802
Other BHCs	0.696	0.699	0.698	0.764	0.762	0.738	0.735	0.709	0.699	0.713
Mean Difference	0.105**	0.111**	0.080*	0.018	0.090**	0.093**	0.091**	0.117**	0.141***	0.089**
VRS										
All BHCs	0.776	0.776	0.792	0.809	0.825	0.820	0.816	0.790	0.776	0.784
Section 20 group	0.944	0.942	0.950	0.930	0.952	0.927	0.961	0.946	0.950	0.964
Other BHCs	0.763	0.762	0.779	0.799	0.815	0.812	0.805	0.777	0.762	0.770
Mean Difference	0.181***	0.180***	0.171***	0.131***	0.137***	0.115***	0.156***	0.169***	0.188***	0.194***
Panel B Model 2 (4 inputs 4 outputs)										
CRS										
All BHCs	0.742	0.739	0.732	0.782	0.794	0.767	0.763	0.734	0.723	0.739
Section 20 group	0.817	0.819	0.786	0.807	0.865	0.835	0.857	0.839	0.851	0.812
Other BHCs	0.736	0.732	0.728	0.780	0.788	0.761	0.755	0.725	0.713	0.733
Mean Difference	0.081*	0.087*	0.058	0.027	0.077*	0.074*	0.102**	0.114***	0.138***	0.079*
VRS										
All BHCs	0.813	0.801	0.818	0.825	0.840	0.834	0.831	0.804	0.790	0.798
Section 20 group	0.967	0.950	0.969	0.963	0.948	0.930	0.960	0.945	0.949	0.962
Other BHcs	0.801	0.789	0.806	0.816	0.832	0.826	0.821	0.793	0.777	0.7850
Mean Difference	0.166***	0.161***	0.163***	0.117***	0.116***	0.104***	0.139***	0.152***	0.172***	0.177***

values show each year how efficient the BHCs are as a group comparing to the most efficient BHCs. They are similar in magnitude to Mukherjee et al. (2001).

Efficiency scores under variable returns to scale (VRS) are higher than those under constant returns to scale (CRS). The reason is that under VRS we are comparing the observed DMUs to best practice frontier, the points on which would be considered as inefficient under CRS. For example, as to the observed production point A in Figure 1, the technical efficiency under CRS and VRS are $TE_c^t(x^t, y^t) = \frac{1}{D_c^t(x^t, y^t)} = \frac{A"I}{A"A}$ and $TE_v^t(x^t, y^t) = \frac{1}{D_v^t(x^t, y^t)} = \frac{A"J}{A"A}$, respectively. Since *A"I*<*A"J*, $TE_c^t(x^t, y^t) < TE_v^t(x^t, y^t)$.[50]

The other notable finding from Table 3-4 is that the average technical efficiency score under Model 2 is slightly higher than that under Model 1 under both CRS and VRS specification. The implication is that if we identify more outputs for the production function, more DMUs will be relatively efficient. The reason is that the DMUs are more likely to have expertise in some dimensions when a greater number of products are defined than when fewer products are considered. Such a phenomenon is identified in Berger et al. (1993). Given this potential problem, this study avoids the calculation of BHC efficiency measures because BHCs have a much broader and more heterogeneous set of products than the commercial banks.

Lastly, Table 3-4 also contrasts the production efficiency between the lead banks in BHCs with Section20 subsidiaries and the others based on a test of means. The results

[50] The difference between these two scores is actually the scale efficiency as specified in Coelli (1996).

clearly show that the commercial banks in Section20 groups are more efficient in both models and under both CRS and VRS. In Model 1 and VRS specification, the banks with Section20 are significantly more efficient than other commercial banks in every year with a difference in efficiency score at least 0.115. The difference in efficiency is also significant under CRS except for the year 2001. Similar results are shown for Model 2, except that the difference is not significant for year 2001 and 2002 under CRS. Based on the group mean comparsion statistics in Table 3-4, BHCs with Section20 are more efficient than other banks.

3.5.3 Regressions Explaining Technical Efficiency

Since the dependent variable, technical efficiency (TE) ranges from 0 to 1, Tobit regressions are applied to the sample of 161 observations from 1998-2007 in order to examine the association between efficiency and activity diversification. Table 3-5 reports the regression results under different specifications using the technical efficiency (TE) obtained from the three-outputs, four inputs VRS production model (Model 1) as dependent variable. In regression Model A based on the entire sample, the principal finding is that technical efficiency is negatively associated with activity diversification, indicating that under current-year technology, more diversified BHCs are relatively less efficient in comparison to their less diversified peers. The finding is consistent with the diversification discount arguments in the financial industry as in Laeven and Levine (2007). The harmful factors associated with diversification may outweigh the benefits (as described in Section 3.3.3) and, therefore, the overall effect is a reduction in production efficiency.

Table 3-5: Tobit regression results on determinants of technical efficiency

$$TE = \alpha + \beta_1 DIV + \beta_2 Section20 + \beta_3 DIV \times Section20 + \gamma Contral\ Variables + \varepsilon$$

This table reports the results of a series of Tobit regressions based on the sample of 161 commercial banks for time periods 1998-2007. The dependent variable is TE, which is technical efficiency score obtained through DEA analysis based on three outputs four inputs production model under VRS specification. SIZE is the natural log of book value of total assets at the end of each year. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. LEVERAGE is defined as the ratio of total liabilities to total assets. ROA is a profitability measure defined as the ratio of net income to book value of total assets. INTANGIBLE is defined as the ratio of intangible assets to book value of total assets. DIV is the Hirschman- Herfindahl Index like measure for the dispersion among income activities. WEIGHT is the ratio of book value of total assts of the commercial bank to book value of total assts of its ultimate BHC. Due to reporting delay and/or errors, very few commercial banks have larger total assets than their BHCs. In these cases, WEIGHT is set to 1. *, **, and *** denote the significance of 10%, 5%, and 1%, respectively.

Data	Entire Sample			Sub-Sample	
Models	A Basic Model	B Section 20 DV	C Model with Interaction	D BHCs w/out Section20	E BHCs with Section20
Constant	-0.185	-0.043	-0.040	0.107	1.267
	(-0.90)	(-0.21)	(-0.19)	(0.51)	(1.21)
SIZE	0.057***	0.042***	0.041***	0.024***	0.192***
	(13.6)	(8.72)	(8.33)	(4.64)	(8.08)
RATIO	0.286***	0.245***	0.251***	0.210***	0.721**
	(4.30)	(3.69)	(3.79)	(3.12)	(2.04)
INTANGIBLE	-1.757***	-1.544***	-1.568***	-1.297***	-6.330***
	(-5.09)	(-4.47)	(-4.55)	(-3.72)	(-3.31)
LEVERAGE	0.150	0.226	0.253	0.361	-3.383***
	(0.65)	(0.98)	(1.10)	(1.56)	(-2.68)
ROA	5.071***	5.146***	5.224***	6.142***	-11.96**
	(4.86)	(4.96)	(5.04)	(5.86)	(-2.02)
WEIGHT	-0.038*	-0.044**	-0.048**	-0.066***	-0.220**
	(-1.77)	(-2.05)	(-2.21)	(-2.98)	(-2.16)
DIV	-0.157***	-0.145***	-0.153***	-0.108**	-0.128
	(-3.14)	(-2.92)	(-3.09)	(-2.15)	(-1.22)
SECTION20		0.111***	0.052*		
		(5.47)	(1.75)		
DIV×SECTION20			0.204***		
			(2.70)		
No. of obs	1610	1610	1610	1460	150
Pseudo R^2	0.160	0.167	0.171	0.151	0.122

The positive coefficient on the SIZE implies that larger BHCs experience significantly higher technical efficiency. This suggests that a large total asset (production scale) result in comparative advantages in terms of improving productivity. The underlying explanations include large firms' ability to maintain favorable access to resource markets and the threshold of investment needed to utilize up-to-date technology. Larger ratios of non-interest income to total income are positively associated with improved production efficiency. This result shows that the non-interest income activities are complementary to traditional intermediation activities (interest income) in terms of improving efficiency. The possible reasons include the scope economies, input reutilization and cost spreading between interest income and non-interest income generating activities. Specifically, particular non-interest income production such as trading and derivative activities have strong synergy with interest generating activity but do not involve much physical production. Combining these activities together under one roof improves production efficiency. However, the important difference between RATIO and DIV is that the former measure consolidates all non-interest income categories together and fails to differentiate among them. Therefore, although generating more non-interest income is associated with higher efficiency, diversifying into too many different activities is associated with lower efficiency. The explanation lies in the fact that distributing BHCs' resource into many subsidiaries generating different products will dilute the core competence and generate additional complexity in BHCs governance process, and therefore lower the efficiency of production.

BHCs that have higher ratio of intangible assets (such as value of reputation and trademark) to total assets are less efficient, partly due to the fact that even though

intangible assets contribute to product market power and profitability, they may not contribute in physical production process. Leverage does not have significant effect on efficiency. The positive effect from interest tax shield and negative effect from bankruptcy cost may cancel out each other. More profitable BHCs are associated with higher efficiency, partly due to the fact that they have more resources available to invest in either technology or improvement of management in order to improve production efficiency. Plus, these BHCs do not have to worry about liquidity or capital adequacy as much as less profitable BHCs. Lastly, commercial banks having a larger share in the total assets of their BHCs are likely to be less efficient, partly because of the disincentive provided by the "too-big-to-fail" status of their commercial banking entity.

In Model B of Table 3-5, the dummy variable Section20 is added to the Tobit regression. All control variables in Model B have signs and significances similar to those in Model A. In addition, the coefficient on Sectoin20 dummy variable is positive and significant. The result indicates that BHCs that had Section 20 subsidiaries before GLBA have significantly higher technical efficiency than BHCs that did not. This is consistent with the first mover advantage argument. Those BHCs obtain first hand experience in securities and insurance activities and enjoy the benefit of integrating whole line of financial services under one roof, if there is any. Such a status gives those BHCs a comparative advantage relative to others.

To control for the possible differential effects of diversification on production efficiency for BHCs with and without Section 20 subsidiaries, Model C includes an interaction term between DIV and Section20. The Tobit regression result shows similar signs and significances for the control variables. Dummy variable Section20 has same

sign but smaller significance than in Model B. The interaction term between DIV and Section20 has positive and significant contribution to the efficiency, indicating that diversification has indeed differential effects on production efficiency of BHCs with and without Section 20 subsidiaries in the sample. For those BHCs that were involved in other financial activities by forming Section 20 subsidiaries before GLBA, the overall effect of diversification on efficiency is unclear because of the negative sign on DIV and the positive sign on the interaction term.

This differential effect is tested using additional regressions based on separate samples. Model D in Table 3-5 reports the Tobit regression results on sub-sample of BHCs without Section 20 subsidiaries. Control variables in Model D have signs and significances similar to those in Model A. Activity diversification is negatively associated with production efficiency for BHCs without Section 20 experience. Model E reports the results of similar regression analysis for BHCs that had Section 20 subsidiaries before GLBA. The most important finding here is that activity diversification does not have a significant effect on technical efficiency. Therefore, whether activity diversification has a negative effect on BHCs' production efficiency depends on whether the BHCs have diversification experience through Section 20 subsidiaries before GLBA. Those BHCs with the so called "first mover advantages" do not suffer deterioration of production efficiency through further diversification.

Taken together, the regression results based on both the entire sample and on different sub-samples show that diversification is negatively associated with technical efficiency for BHCs without Section 20 subsidiary experiences, while such effect is not

significant for BHCs that had been involved in new financial activities through Section 20 subsidiaries before GLBA.

3.5.4 Description of Productivity and Efficiency Change Over Time

As described in the research methodology section, DEA analysis allows one to construct Malmquist Indices as measures of average production efficiency change over time. In Figure 1, total factor productivity change (TFPCH) is the ratio of average efficiency in year t+1 to average efficiency in year t. Therefore, this variable offers information about the improvement of average productivity comparing to the previous year. The important feature of this variable is that TFPCH is generated by comparison to the same DMU over time, rather than to other DMUs.

By decomposing the TFPCH into three contributing factors, either following Ray and Desli (1997) or Fare et al. (1994), another variable pure efficiency change (PEFFCH) can be constructed to measure the change of technical efficiency over time. In other words, the TE score under VRS in both year t+1 and year t are compared to each other and the ratio reveals the improvement or deterioration of technical efficiency over time. PEFFCH contains different information from TFPCH in that the former measures the change of the DMU's relative efficiency comparing to the best practice frontiers in t+1 and t, while the later compares the same DMU's productivity to its own productivity in the previous year.

Table 3-6 describes the distribution of TFPCH and PEFFCH in each sample year. As to TFPCH, average annual productivity increased by 2.17% (mean of the entire sample, calculated as the geometric mean of those annual means) from 1997 to 2007. This number masks a decrease in productivity in year 2000-2001, however. This

Table 3-6: Distribution of the total factor productivity change (TFPCH) and pure efficiency change (PEFFCH)

Commercial banks total to 161 in each column. TFPCH is obtained from DEA and Malmquist Index analysis based on the three outputs four inputs production model specification. Mean is the arithmetic average across all banks.

Variable	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
Panel A: TFPCH										
<0.8	1	0	5	5	2	1	4	4	2	5
0.8⟨⟨0.9	8	7	10	15	5	10	13	8	6	8
0.9⟨⟨1.0	37	41	60	62	46	40	52	63	61	53
1.0⟨⟨1.1	81	86	69	57	79	80	74	70	70	80
1.1⟨⟨1.2	25	20	14	20	20	21	12	13	15	12
1.2⟨⟨1.3	5	6	2	1	6	5	5	1	7	3
>1.3	4	1	1	1	3	4	1	2	0	0
Mean across banks	1.048	1.037	1.009	0.999	1.039	1.041	1.009	1.008	1.021	1.006
Coef. of Variation (%)	8.720	12.617	8.876	9.560	10.508	10.40	10.709	10.085	12.135	10.771
Panel B: PEFFCH										
<0.8	3	3	0	5	2	2	3	1	1	2
0.8⟨⟨0.9	14	6	9	13	7	16	7	23	14	6
0.9⟨⟨1.0	74	85	72	54	73	78	94	97	96	77
1.0⟨⟨1.1	50	54	58	51	49	52	42	38	45	57
1.1⟨⟨1.2	14	10	15	29	20	12	11	1	4	13
1.2⟨⟨1.3	3	3	5	7	7	1	3	0	1	4
>1.3	3	0	2	2	3	0	1	1	0	2
Mean across banks	1.003	1.001	1.025	1.031	1.028	0.997	0.998	0.969	0.983	1.015
Coef. of Variation (%)	9.607	12.089	12.164	9.414	9.781	12.943	11.445	14.244	14.66	11.400

deterioration of productivity may be associated with the burst of internet bubbles. The magnitude of the average productivity increase here is similar to that shown in Mukherjee et al. (2001) for 1984-1990. The majority of BHCs enjoyed a productivity improvement in the range of 0-10% in each year during the sample period. Among those years, 1997-1998 possesses the highest annual productivity improvement of 4.8%. Panel A also reveals the wide variation in productivity change across BHCs. 1998-1999 witnesses the highest dispersion of productivity indexed across BHCs while 1997-1998 possesses the lowest.

Panel B reports similar distributions of variable PEFFCH. Average annual technical efficiency improves by 0.53% in the sample period (mean of the entire sample, calculated as the geometric mean of those annual means). From 1997 to 2007, there are four consecutive years when the average technical efficiency deteriorated from the previous years, with the largest decrease of 3.1% in 2004-2005. Therefore, although the trend is a "catch-up" of commercial banks' technical efficiency to the best practice frontier, there are years when set-back happened. The best improvement happened in 2000-2001 with an increase of 3.1%. This happens because the bad economic condition may hurt the best practice frontier most and, therefore, flattens the production efficiency of the entire universe of BHCs. The pure efficiency change also has wide variation in each year. The highest dispersion happened in 2005-2006 while the lowest happened in 2000-2001 (this low variation also supports the leveling up effect of bad economic conditions).

In Figure 3-2, the cumulative total factor productivity change (TFPCH) is drawn across sample years. BHCs with Section 20 subsidiaries seem to enjoy higher cumulative

Figure 3-2: Cumulative Total Factor Productivity Change Over Time

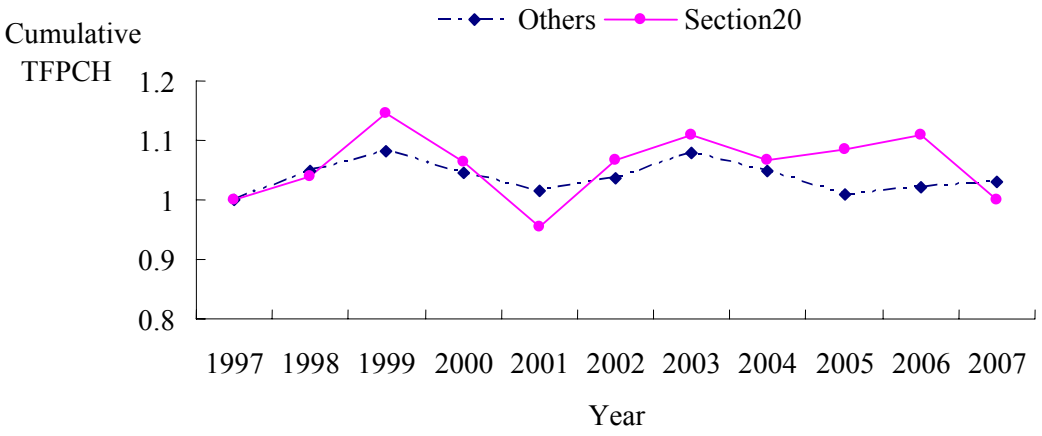
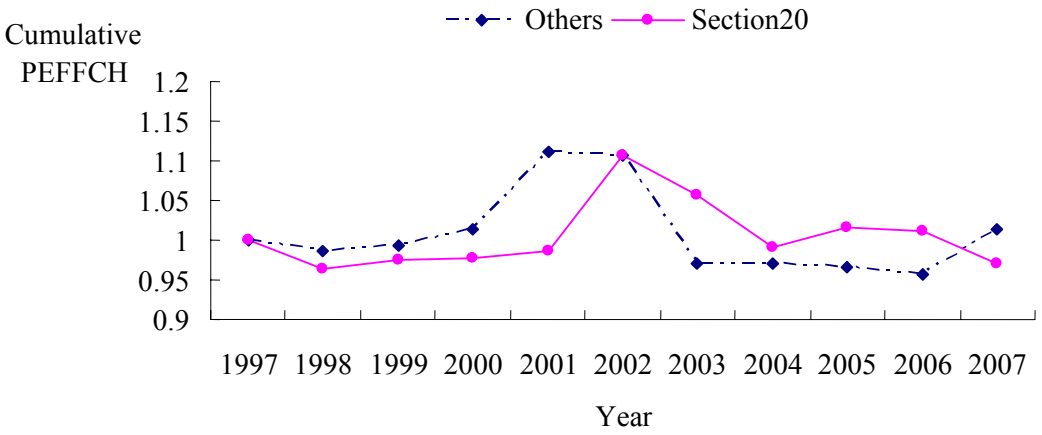


Figure 3-3: Cumulative Pure Efficiency Change Over Time



total factor productivity growth than BHCs without such subsidiaries, except in 1997-98 (where the two groups have very similar TFPCH), 2000-01, and 2006-07. The total productivity change of Section 20 group seems to be more volatile, especially when there is an economy-wide shock like the recession and terrorist attack in year 2000-2001. This result is consistent with the argument that non-interest income activities actually increase the risks of BHCs (Stiroh, 2006).

Figure 3-3 shows the cumulative pure efficiency change (PEFFCH) over time. PEFFCH measures the change of BHCs' relative efficiency comparing to best practice frontier of the current year. Table 3-4 showed that BHCs without Section 20 subsidiaries were relatively less efficient than their peers with such subsidiaries, but they were catch up at a higher speed before 2002 as shown in Figure 3. After 2003, they were left-behind further with a PEFFCH score less than 1 for each year except 2006-07. The largest catching up effect happened in 2000-01, when the entire group of BHCs is suffering efficiency loss due to recession. On the other hand, BHCs with Section 20 subsidiaries were shown to be more efficient in Table 3-4. Their technical efficiency deteriorated a little bit from 1997 to 2001 but quickly improved after that.

3.5.5 Regressions Explaining Productivity and Efficiency Changes

Finally, this study examines the determinants of the changes in productivity and efficiency over time. The value of TFPCH and PEFFCH can be greater, equal to, or less than one. Therefore, OLS, rather than a regression method designed for dependent variable with censored values, can be applied. In addition, because the dependent variables are changes over consecutive years, the control variables are also correspondingly adjusted as changes over time, calculated by taking the difference

between values of current year and the previous year. The estimates of coefficients are reported in Table 3-7.

The first regression uses the entire sample to examine the effect of diversification on TFPCH. Most of the control variables yield similar signs and significances as in Table 3-5. Increases of asset size, ratio of non-interest income to total income, and profitability are all associated with total factor productivity improvement. Increased leverage is also positively associated with TFPCH in this model specification. Changes in diversification do not have a significant effect on TFPCH. Therefore, for sample BHCs, the degree of change in activity diversification does not have significant effect on their own average productivity improvement.

The second regression employs a similar model specification to test PEFFCH. Estimations of coefficients show similar effect for control variables as in the first regression. The most important finding is that changes in diversification over time are negatively associated with those of technical efficiency. Therefore, for an average BHC, increased diversification over time is associated with a negative improvement, or deterioration on its technical efficiency change. In other words, the further diversification is associated with the BHC's inputs-outputs combination further from the best practice frontier. This is contrary to the "catch-up" effect and can be thought of as a "left-behind" effect. To examine the question whether the "Section 20 subsidiary experience" plays a role in this effect, two additional regressions are performed based on sub-samples of BHCs that did and did not have Section 20 subsidiaries before GLBA. The results of these two regressions reveal that, indeed, the "left-behind" effect is only present in the group of BHCs without Section 20 experiences, as shown in the third regression. BHCs

Table 3-7: OLS regressions explaining TFPCH and PEFFCH

$$TFPCH = \alpha + \beta_1 \Delta DIV + \beta_2 Section20 + \beta_3 \Delta DIV \times Section20 + \gamma \Delta Contral\ Variables + \varepsilon$$

$$PEFFCH = \alpha + \beta_1 \Delta DIV + \beta_2 Section20 + \beta_3 \Delta DIV \times Section20 + \gamma \Delta Contral\ Variables + \varepsilon$$

This table reports the results of OLS regressions based on the sample of 161 commercial banks for time periods 1998-2007. The dependent variable is TFPCH and PEFFCH, which are the total factor productivity change and pure efficiency change factors obtained form Malmquist Index analysis based on three outputs four inputs production model. Independent variables are the change from previous year value. SIZE is the natural log of book value of total assets at the end of each year. RATIO is the ratio of BHC's non-interest income to the sum of interest income and non-interest income. LEVERAGE is defined as the ratio of total liabilities to total assets. ROA is a profitability measure defined as the ratio of net income to book value of total assets. INTANGIBLE is defined as the ratio of intangible assets to book value of total assets. DIV is the Hirschman- Herfindahl Index like measure for the dispersion among income activities. WEIGHT is the ratio of book value of total assts of the commercial bank to book value of total assts of its ultimate BHC. *, **, and *** denote the significance of 10%, 5%, and 1%, respectively.

Dependent Variable	TFPCH	PEFFCH	PEFFCH	PEFFCH
Sample	Entire Sample	Entire Sample	BHCs w/out Section20	BHCs with Section20
Constant	1.008***	0.995***	0.993***	1.007***
	(111)	(207)	(289)	(100)
ΔSIZE	0.167***	0.085***	0.108***	-0.032
	(7.03)	(3.57)	(4.15)	(-0.56)
ΔRATIO	0.426***	0.026	-0.028	0.448**
	(5.59)	(0.34)	(-0.33)	(2.32)
ΔINTANGIBLE	-1.023***	-1.627***	-1.755***	-1.426
	(-2.64)	(-4.20)	(-4.16)	(-1.34)
ΔLEVERAGE	0.865***	0.419*	0.419*	0.121
	(3.64)	(1.77)	(1.70)	(0.13)
ΔROA	7.730***	4.800***	5.064***	1.846
	(9.59)	(5.96)	(5.80)	(0.83)
ΔWEIGHT	-0.020	0.002	-0.012	0.045
	(-0.94)	(0.081)	(-0.52)	(0.93)
ΔDIV	0.007	-0.397**	-0.439***	0.121
	(0.15)	(2.01)	(3.61)	(1.01)
No. of obs	1610	1610	1460	150
Adjusted R^2	0.108	0.095	0.098	0.111

that had Section 20 subsidiaries before GLBA did not suffer from the same effect. Changes in diversification do not have any significant effect on technical efficiency change for this latter group of BHCs. The same separated sub-sample regressions were applied to explain TFPCH but no significant findings were obtained for variable ΔDIV in either regression, indicating that change in diversification do not have significant effect on total factor productivity change for both BHCs with and without Section 20 experience.

To summarize, changes in the degree of diversification over time are found not to have a significant effect on the average productivity change of BHCs. On the other hand, changes in diversification are negatively associated with changes in BHCs' technical efficiency over time, with this effect being primarily driven by the sub-group of BHCs that did not have Section 20 subsidiaries before GLBA. This finding is also consistent with the results shown in the preceding section.

3.5.6 Robustness of Model Specification

In this section we examine the robustness of the results to alternative model specifications other than specified earlier and. we find the following results. First, TE scores are different under CRS and VRS specification, similar to results shown in Table 3-4. As shown in both Ray and Desli (1997) and Fare et al. (1994), CRS is only a special case of VRS and the TE scores for the same DMU under both specifications will be highly correlated with each other. This study also runs similar regression as in equation (3-12) using TE under CRS specification as the dependent variable. The estimations of coefficients are statistically similar in sign and significance. Second, total factor productivity change (TFPCH) and pure efficiency change (PEFFCH) variables are

identical by definition under both CRS and VRS because of their definition (please refer to Section 3.4.1). Therefore, there is no need to repeat regressions similar to those in Table 3-6 under CRS specification. Third, this study also performed identical analysis based on TE, TFPCH, and PEFFCH calculated from the four-output four-input production function described in the inputs and outputs specification section (Section 3.4.3). The empirical results are identical to what was shown above (Table 3-5 and Table 3-7) except some differences in the magnitudes of the coefficients. Therefore, the preceding findings are robust to these alternative model specifications.

3.6 Conclusion

Depression era regulations like Glass-Steagall Act of 1993 and Bank Holding Company Act of 1956 separated commercial banking from securities and insurance activities. However, BHCs gradually expanded into these businesses through loopholes and interpretive freedom of legislations. GLBA (1999) removed the barriers that separated different financial activities. Thereafter, diversification of BHCs has been a predominant trend. Legislators, practitioners, and academia cannot agree on whether diversification is beneficial to financial institutions. This study examines this issue from the perspective of the production efficiency of BHCs and examines the association between activity diversification and efficiency.

By applying data envelopment analysis (DEA) and Malmquist Index analysis on a sample of BHCs over the period 1997-2007, this paper obtains the following results. First, this study constructs best practice frontiers in each year and generates technical

efficiency by comparing the performance of BHCs to the current frontier. Activity diversification is shown to be negatively associated with technical efficiency, with this effect being primarily driven by BHCs that did not have diversification experiences through Section 20 subsidiaries before GLBA. Second, Malmquist Indices are constructed to examine changes in production efficiency over time. The degree of change in diversification over time is found not to affect the total factor productivity change but to be negatively associated with technical efficiency change over time. This latter effect is also primarily shown on BHCs that did not have Section 20 subsidiaries before GLBA. Therefore, diversification on average harms production efficiency of BHCs, especially those without first-mover advantage.

The results shown here indicate that for diversification to improve production efficiency, or at least not harm it, BHCs need experience and/or other first-mover advantages. This argument is consistent with the one stated by Yeager et al. (2007), where they show that even if diversification generates synergies, such effect are likely to be captured by BHCs with Section 20 affiliates. Mamun et al. (2005) show that BHCs with Section 20 subsidiaries benefited more than other BHCs after GLBA, which offers additional supporting evidence for the current study.

This study has lessons for legislators as well as practitioners. Diversification may not be a remedy for improving production efficiency, especially it is not a one-size-fit-all solution. Although GLBA opens up a new playground and levels the field of competition for financial institutions, constructing financial conglomerates in the spirit of universal banking may not be an efficiency improving strategy. Hence, those decisions must be based on a comprehensive set of criteria including profitability, risk, and consumer

convenience (demand side effects) as well as production efficiency. This approach also overlooks the revenue side scope economies. Incorporation of this additional dimension would benefit further research on this topic.

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APPENDIX A

FORMAT CHANGE OF CONSOLIDATED INCOME STATEMENT (FR Y-9C REPORT) ABOUT NONINTEREST INCOME (SCHEDULE HI)

June 1996-December 1996

5. Noninterest income:
    a. Income from fiduciary activities
    b. Service charges, commissions, and fees
        (1) Services charges on deposit accounts
        (2) Other service charges, commissions, and fees
    c. Trading revenue
    d. Other foreign transaction gains (losses)
    e. Other noninterest income
    f. Total noninterest income

January 1997-December 2000

5. Noninterest income:
    a. Income from fiduciary activities
    b. Service charges, commissions, and fees
        (1) Services charges on deposit accounts
        (2) Other service charges, commissions, and fees
    c. Trading revenue
    d. Not applicable
    e. Other noninterest income
    f. Total noninterest income

March 2001-December 2002

5. Noninterest income:
    a. Income from fiduciary activities
    b. Service charges on deposit accounts in domestic offices
    c. Trading revenue
    d. Investment banking, advisory, brokerage, and underwriting fees and commissions
    e. Venture capital revenue
    f. Net servicing fee
    g. Net securitization income
    h. Insurance commissions and fees
    i. Net gains (losses) on sales of loans and leases
    j. Net gains (losses) on sales of other real estate owned
    k. Net gains (losses) on sales of other assets (excluding securities)
    l. Other noninterest income
    m. Total noninterest income

March 2003-December 2006

5. Noninterest income:
    a. Income from fiduciary activities
    b. Service charges on deposit accounts in domestic offices
    c. Trading revenue
    d. Investment banking, advisory, brokerage, and underwriting fees and commissions
    e. Venture capital revenue
    f. Net servicing fee
    g. Net securitization income

h. (1) Insurance and reinsurance underwriting income
(2) Income from other insurance and reinsurance activities
i. Net gains (losses) on sales of loans and leases
j. Net gains (losses) on sales of other real estate owned
k. Net gains (losses) on sales of other assets (excluding securities)
l. Other noninterest income
m. Total noninterest income

March 2007-December 2007

5. Noninterest income:
a. Income from fiduciary activities
b. Service charges on deposit accounts in domestic offices
c. Trading revenue
d. (1) Fees and commissions from securities brokerage
(2) Investment banking, advisory, and underwriting fees and commissions
(3) Fees and commissions from annuity sales
(4) Underwriting income form insurance and reinsurance activities
(5) Income from other insurance activities
e. Venture capital revenue
f. Net servicing fees
g. Net securitization income
h. Not applicable
i. Net gains (losses) on sales of loans and leases
j. Net gains (losses) on sales of other real estate owned
k. Net gains (losses) on sales of other assets (excluding securities)
l. Other noninterest income
m. Total noninterest income

Appendix B

ADJUSTMENT IN CUMULATIVE ABNORMAL RETURNS

One important issue whether the magnitude of cumulative abnormal return is an appropriate proxy for the amount of information revealed across ***different*** BHCs**.** Suppose BHC A has a substantial amount of firm-specific information and the information is constantly released to the market. As a result, when a one factor market model is estimated, stock returns of A would constantly have an "abnormal" part, say 4% in magnitude. One the other hand, if BHC B does not have much firm-specific information and it releases very little of that information across time, then stock return of B would have an "abnormal" part of 1% in magnitude based on the market model. Assume that when BHC A and B make quarterly earning announcements, the absolute value of cumulative abnormal returns around announcement date are 4% and 3%, for A and B, respectively. By just looking at the raw $|CAR|$, one may conclude that the earning announcement of A had released more information than announcement of B did. However, this is actually not the case because BHC A does not release much information in earning announcement compared to its normal level of information leakage. One the other hand, BHC B has actually revealed three times as much information when compared to its normal information leakage level. The relative magnitude of information released by earning announcements tells us that BHC B is suffering from more severe information asymmetry problem than A is.

This problem is an important issue in event studies, especially when firm characteristics influence the magnitude of market model residuals, which is used as the abnormal return around event date. Without controlling for the differences among firms

in terms of information leakage before the events, the abnormal returns may be a biased proxy for the information content. There exists an additional reason why the magnitude of cumulated abnormal returns needs to be adjusted. When regression models using $|CAR|$ as dependent variable are tried, White (1980) tests reveal heteroskedasticity. This requires adjustment of $|CAR|$ to avoid it.

APPENDIX C

S&P LONG-TERM DOMESTIC ISSUER CREDIT RATING (COMPUSTAT DATA 280)

Code	Rating	Note
1	Unassigned	Unassigned
2	AAA	
3	Unassigned	Unassigned
4	AA+	
5	AA	
6	AA-	
7	A+	
8	A	
9	A-	
10	BBB+	
11	BBB	
12	BBB-	
13	BB+	
14	BB	
15	BB-	
16	B+	
17	B	
18	B-	
19	CCC+	
20	CCC	
21	CCC-	
22	Unassigned	Unassigned
23	CC	
24	C	
25	Unassigned	Unassigned
26	CI	Reserved for income bonds on which no interest is being paid
27	D	
28	Not Meaningful	Not Meaningful
29	SD	Selective default on a specific issue or class of obligations in a timely manner
90	Suspended	S&P suspended the bond rating on a class of debt

Source: Compustat North America User's Guide page 248-249.

APPENDIX D

BHCS WITH SECTION 20 SUBSIDIARIES AS OF DECEMBER 31, 1999

ABN AMRO Bank, NV	HSBC Holdings PLC
Banco Bilbao Vizcaya, SA	Huntington Bancshares, Inc.
Banco Santander Central Hispano	J.P. Morgan & Co.
Bank of America	KeyCorp
Bank of Montreal	Mellon Bank Corporation
Bank of New York Company, Inc.	National City Corporation
Bank of Nova Scotia	Natoinal Westminster Bank PLC
Bank One Corporation	PNC Financial Services Group
Banque Nationale de Paris	Royal Bank of Canada
Barclays Bank PLC	SABAN/Republic New York Corp.
BB&T Corporation	San Paolo-IMI SpA
BOK Financial Corporation	Sanwa Bank Ltd.
Canadian Imperial Bank of Com	Societe Generale
Chase Manhattan	Southtrust Corporation
Citigroup	State Street Corporation
Commerce Bancorp	Suntrust Banks, Inc.
Cullen/Frost Bankers, Inc.	Toronto-Dominion Bank
Deutsche Banks AG	U.S. Bancorp
Dresdner Bank AG	Umpqua Holdings Corporation
Fifth Third Bancorp	Union Bank of Switzerland
First Security Corporation	Wachovia Corporation
First Union Corporation	Wells Fargo & Company
Fleetboston Financial Corporation	

This table lists the 45 domestic and international BHCs that had Section 20 subsidiaries as of December 31, 1999, which is the effective date of the GLBA. Our analysis will focus on domestic BHCs because data on the commercial banks as subsidiaries of international BHCs are not available. Source: Federal Reserve Board of Governors.