

Diversification in banking: is non-interest income the answer? The case of Taiwan banking industry

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As Taiwan has undergone a recent series of financial reforms, the commercial banks have faced a huge challenge. This research is aimed at investigating how non-interest income, which includes commission earned, trustee fee, and exchange gains, affects the mean and variation of bank profits in Taiwan's banking industry. We select the aggregate and individual bank data over the period 1992 - 2009 and follow Stiroh's (2004) method to measure the potential return and bank risk. At the aggregate level, although there may be diversification benefits from declining covariance between net interest income and non-interest income, non-interest income has much more variation than net interest income. At the bank level, there is positive significance to explain how diversification benefits will decline as non-interest income enlarges. By analyzing the econometric model, the continued expansion in the component of non-interest income will lower risk-adjusted returns. From these overall results, we can conclude that inflation, along with nontraditional activities, may not have diversification benefits in Taiwan banking industry.

JEL Codes:

1. Introduction

1.1 Research Motivation

In the past few years, traditional interest income has been the main source of revenue in banking industry. This interest income refers to the bank offering different interest rates between clients' loan (mortgage, private loan and corporate loan) and deposit services. In 1991, Taiwan faced financial reforms, which caused the removal of some restrictions on the banking industry. Simultaneously, it also led the commercial banks to face a huge challenge from 16 newcomers, although some of these have since merged.

Because of Taiwan's asset bubbles in 1993, the foreign institutional trader entered the country supposedly seeking short-term profits, which has become the influx of hot money. Therefore, financial magnates such as mortgagers or large landlords would be in danger of being impacted. Although Taiwan was not seriously hurt in the 1997 Asian financial crisis, the Taiwanese financial crisis occurred immediately after, in the following year, and the financial magnates have since suffered badly. The 'Challenge 2008: National Development Plan' determined Taiwanese financial

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reforms in the areas of politics, banking, and public finance to push the revolution in July 2002. There were four goals: (1) maintaining stable finance, (2) continuing financial reforms, (3) assisting in developing industry, and (4) protecting investors and consumers from harm. The first financial reforms planned to reduce the bad debt ratio to 5% in financial institutions and raise the capital adequacy ratio to 8% within two years.

According to researchers' analyses, these financial reforms expended 1.4 trillion dollars, and furthermore, they used a trillion dollars in their earnings to reduce the bad debts. Of this, the general public would bear 400 billion dollars, 150 billion dollars of which would come from the banking business tax and reserve requirement. Although this money is considered public property, people would allow this reform to avoid an occurrence similar to the Japanese financial black hole and a slump in economic growth.

President Chen Shui-bian had confidence in executing the second round of financial reforms after he presided at the economic advisory meeting on October 20, 2004. The goals of these reforms were coordinating the over-scattered domestic financial market structure, aligning the financial environment and legal law with international standards, and pushing Taiwan into the regional financial services center. In other words, magnification and internationalization would increase the competition in Taiwan financial industry. There were four goals of the second round of financial reforms. First, at least three financial holding corporations would hold over 10% of the market share before the end of the next year. Second, the public shares of financial institutions would reduce from 12 to 6 by the end of this year. Third, the financial holding corporations would reduce from 14 to 7 before the end of next year. Fourth, at least one financial holding corporation would have the Foreign Depository Receipts or would have attracted foreign investment Taiwan Depository Receipts. Because of the many problems in politics, culture, society and co-ordination, this second financial reform failed. Additionally, mergers and acquisitions among banks have violated the logic of normal business operations. The government should pay more attention and let the invisible hand freely operate in the market mechanisms.

After the liberalization of the financial market, Taiwan's banking industry became more and more competitive, leading to the overbanking phenomenon. Because of the rise in the number of banks, they often attract customers by loosening conditions, such as lower rates and fees. In general, the banking structures have significant changes and declining profits. Thus, not only new and old banks but also foreign banks must pay more attention to improve the efficiency and quality in financial services to survive after deregulation. If the commercial banks want to stably increase revenue, they must develop a new source of profit. Currently, non-interest income has been an important factor in Taiwan. The rising share of non-interest income in net operating revenue (defined as net interest income plus non-interest income) and the change of non-interest income. It can be seen that the non-interest income share had increased from 11.19% (1992: Q1) to 24.24% (1999: Q2) but decreased to 8.02% (2000: Q3). This decrease was due to the Internet bubble in 2000. Then, it increased to 34.66% in 2003: Q3 and fell to 11.23% in 2008: Q3. In China, the non-interest income share also decreased to 20.76% in 2008. Because of the Financial Tsunami in 2008, all global industries were impacted, especially the banking industry. Then, the non-interest income share increased to 32.18% in 2009: Q4. Furthermore, the average share of non-interest income during

2002-2009 (24.96%) was higher than during 1992-2001 (17.45%), which indicates that the trend of non-interest income has increased in Taiwan's banking industry.

1.2 Research Objectives

The Taiwan banking industry transfers gradually from traditional single source of return to multiple return packages with both net interest income and non-interest income. Non-interest income refers to revenue from other services such as business income, consultation and investment output, or helping clients to negotiable securities, derivatives, and insurance. A bank's non-interest income comes mainly from the following: (1) account service charges for insufficient funds fees (when depositors fail to meet the minimum deposit requirement), check and deposit slip fees, check storage fees; (2) other service and transaction charges (stock broker commission, custodial fees, consulting fee, credit card fee, underwriting of treasury bills, debentures, bonds); (3) other operating revenue (trust revenue, leveraged rental income, non-operating revenue). Because the bankers emphasize non-interest income's speed and future power, the local banks have started to expand the non-interest business, a more stable, safe and profitable source of revenue.

Considering whether the increase of non-interest income could reduce risk is an important topic for individual banks and their managers. The answer will influence the bank's operating strategy. For example, if non-interest income can decrease risk, supervisors will lower the capital requirements and reallocate their diversified revenue portfolio. However, adopting nontraditional activities can increase and diversify banks' income sources, although those activities might also lead to more risks and inputs. Thus, getting involved in those non-traditional activities might affect the bank's operating efficiency. This study is expected to contribute by investigating the relationship between bank risk and return as non-interest income increased from 1992 to 2009 in Taiwan. Comparing to the previous studies related to Taiwan banking industry, we employ Stiroh's method (2004) to estimate the diversification effect of non-interest income instead of DEA method. Besides, we use aggregate and individual bank data to examine how non-interest income influences the mean and variation of bank revenue. The results showed that neither aggregate nor individual part can generate benefits through increasing non-interest income. In other words, increasing non-interest income in Taiwan banking industry may raise their risk and lower the return.

The rest of this paper is organized as follows: Section 2 presents the literature review on the relationship between risk and return effects in increasing non-interest income. Section 3 discusses the meaning of bank data and its statistical analysis. Section 4 examines the aggregate volatility and cyclicity, calculates the correlation between the growth rate of net interest income and non-interest income, and tests the model of non-interest income on bank risk and return. Section 5 concludes and summarizes what we have found. This research hopes to determine the characteristics of the Taiwanese banking industry and the great contributions to various stakeholders, such as investors, bank shareholders, and bank managers. Further, this study will fill the literature gap related to banking diversification, especially in the Asian-Pacific Basin countries.

2. Literature Review

Much of the literature in this area analyzes the commercial banks' operating revenue to evaluate the banking industry's risk and efficiency, especially in the U.S. Compared to many American studies, researchers start to notice the emerging world market in places such as China, Taiwan, Korea and so on. In these Asian-Pacific Basin countries, the Taiwanese banking industry changes dramatically due to regulations from the Taiwanese government. In the 1990s, Taiwanese government deregulates the restriction on setting up commercial banks and on lending and borrowing interest rates. Taiwan's banking industry became more competitive as the newcomers shared the whole market. Banks began to adjust their lending and borrowing interest rates to attract customers.

As a result, the Taiwan central bank data shows that the interest spread between lending and borrowing becomes smaller (from 2.55% in 2004 to 1.31% in 2009). Based on this environment, non-interest oriented activities become a new type of revenue in Taiwan's banking industry. We also found that after the first and second financial reforms in Taiwan, there was a shift from traditional revenue to a multiple revenue structure with both interest income and non-interest income.

2.1 Positive Side

Most bankers believe that increasing the percentage of non-interest income to operating income will be a good way to improve bank profitability. When Templeton and Severiens (1992) examined market data for 54 bank holding companies (BHCs) from 1979 to 1986, they found that this diversification can lower the variance of shareholder returns. Santomero and Chung (1992) used option pricing techniques to simulate the volatility of asset returns from combinations of 123 bank holding companies and 62 non-bank financial firms and concluded that bank expansion into nonbanking businesses reduces risk. Mester (1992) found that there were some economies of scale when mixing traditional banking activities of originating and monitoring loans with non-traditional activities of loan selling and buying products. Canals (1993) analyzed an overall assessment of the outlook for banking in terms of profitability and found that in recent years, the increased revenues from new business units can improve bank performance. Boyd and Graham (1988) and Boyd, Graham and Hewitt (1993) used simulated mergers between bank holding companies and nonbank financial firms to reduce the risk of bankruptcy. Wall, Reichert and

Mohanty (1993) constructed synthetic portfolios based on the accounting rates of return earned by banks and non-bank financial firms. Their results suggested that had banks been able to diversify into small amounts of insurance, mutual fund, securities brokerage, or real estate activities, they could have experienced higher returns and lower risk from 1981 to 1989. Saunders and Walters (1994) found that diversification in nonbanking businesses can diminish risk, with massive shifts in financial innovation's products and processes and intense competition among institutions and between them and many of their clients.

DeYoung (1994) and Rogers (1998) showed that large amounts of non-traditional products or services improved bank efficiency in the 1980s and 1990s and indicated similar results for commercial banks and bank holding companies. Nonetheless, because of the low return correlation between securities and bank subsidiaries, he

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concluded that some diversification benefits do exist for commercial banks. Radecki (1999) analyzed the data in bank holding company's annual reports on sources of non-interest income and found that the increasing share of banks' revenue from fee services is important to the banking industry.

Hillon et al. (2002) reported that an increase in non-interest activities is associated with an increased return on assets, but there was no change in firm risk in the establishment of Section 20 Subsidiaries. When they examined the variability of interest and non-interest income from 1994-1998, Smith et al. (2003) found that the increasing importance of non-interest income can stabilize profits in the European banking industry.

Lepetit et al. (2008) found a negative correlation between interest margin and non-interest income in the 602 European banks during the period from 1996 to 2002. Chiorazzo et al. (2008) found that income diversification increases the risk-adjusted returns, when using annual data from Italian banks to analyze the link between non-interest revenues and profitability. Reichert, Wall, and Liang (2008) examined the combined value with bank holding companies and commercial firms and found that there were potential gains and risk reduction when diversification into the non-bank commercial and industrial sector is permitted.

2.2 Negative Side

Although there is a growth phenomenon regarding the percentage of non-interest income to operating income, bank profitability as affected by the non-interest income has been a controversial topic in empirical studies.

Pilloff and Rhoades (2000) showed that geographically diversified banks do not have a net competitive advantage. Demsetz and Strahan (1995) found that the risk-reducing potential of diversification at large BHCs is offset by their lower capital ratios, industrial loan portfolios, and greater use of derivatives. Although BHCs tend to become more diversified as they grow, this diversification does not necessarily translate into risk reduction because these firms also tend to shift into riskier activities and hold less equity. Roland (1997) found that high returns from fee-based activities were less persistent than those from lending and deposit-taking.

DeYoung and Roland (2001) constructed a framework to examine the link between earnings volatility and revenue volatility, expense fixity, and product mix for 472 U.S. commercial banks from 1988 to 1995. It showed that there were no diversification benefits, but there were higher volatility of bank revenue and higher total leverage. When they analyzed the trade-offs between specialization and diversification on the return and the risk for 105 Italian banks from 1993 to 1999, Acharya et al. (2002) found that the diversification of bank assets is not guaranteed to improve banks' performance or safety. When they examined geographic diversification, Morgan and Samolyk (2003) reported that a broader presence is not associated with greater returns or reduced risk.

Stiroh (2004) found that the declining volatility of net operating revenue reflects reduced volatility of net interest income rather than diversification benefits from non-interest income, which also implies that non-interest income will lead to higher risks and less diversification benefits. DeYoung and Rice (2004) indicated that non-interest income was generated by traditional and non-traditional activities,

leading to higher bank profitability and risk associated with the increase in earnings volatility.

Baele et al. (2006) examined European banks over the period 1989-2004 and used market-based measures of return potential and bank risk to find that diversification will increase banks' expected returns and systematic risk. Stiroh (2006) further showed that an increase of non-interest revenue did not lead to higher share of market returns but did cause increased market risk. Mercieca et al. (2007) concluded that banks' financial stability is negatively affected by a reliance on non-interest income, but shifting into non-interest income creates an inefficient trade-off between risk and return.

Ramona and Thomas (2009) analyzed the impact of non-interest income on financial performance and the risk profile of German banks between 1995 and 2007, and the results showed that a strong engagement in fee-generating activities correlates with higher risk for commercial banks and higher risk-adjusted returns on equity and total assets.

2.3 Hypothesis

Because previous studies used different methods over time to analyze banks' efficiency, their results are therefore different. There are also fewer studies analyzing the operating revenue in Taiwanese banking. However, they employ the DEA approach to evaluate performance and efficiency (Ho and Zhu 2004, Huang and Chen 2006). Considering this research, this study follows the analysis of Stiroh (2004) and compares the results of the banking industries in the U.S. (Stiroh, 2004), China (,2011) and Taiwan. We assume that there are diversification benefits in Taiwan's banking industry by increasing non-interest income. Therefore, we employ the same method as Stiroh (2004) to estimate our hypothesis as follows:

H1: The increase of non-interest income brings diversification benefits to Taiwan banking industry.

3. Sample Selection

Because of the 1991 financial reforms, some restrictions on the banking industry were removed by Taiwan's government. After the liberalization of the financial market, there was an overbanking phenomenon in Taiwan due to the influx of 16 newcomers. This rise in the number of banks prompted fierce competition. Thus, banks were forced to use non-traditional methods to increase their profit.

This study selected all available Taiwan commercial banks on an annual basis from 1992 to 2009. All banks are listed companies (see Table 1) except IBTAIPEI (International Bank TAIPEI), CTB (Chiao Tung Bank), Grand Com. Bank, Dah An Bank, Cathay Bank, Fubon Bank, Lucky Bank, E. Sun Bills, CTBF (China trust Bills Finance), SKB (Shin Kong Bank), and Hua Nan Bills because they had merged after the liberalization of the financial market. We select the large banks with assets are greater than 1.5 billion, and the remaining are small banks. In addition, in following Stiroh (2004), this study selects the aggregate and individual bank data from 1992 to 2009 to examine how non-interest income affects the mean, variation of bank profits, and revenues in Taiwan's banking industry. We also compare the

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results among the U.S., China and Taiwan. All data are from the Taiwan Economic Journal Co., Ltd.

Table 1: The Sample Banks

	Bank's Name	2009 Assets (billions)
Large Banks	Bank of Taiwan	3.89
	Mega Bank	2.20
	First Bank	1.92
	Hua Nan Bank	1.78
	China trust Commercial Bank	1.64
	Cathay United Bank	1.51
	Chang Hwa Bank	1.48
Small Banks	Taipei Fubon Bank	1.36
	Bank SinoPac	1.00
	E. Sun Bank	0.93
	Taishin Bank	0.83
	Shin Kong Bank (Macoto Bank)	0.42
	Yuanta Bank	0.37
	China Development Industrial Bank	0.24
	Mega Bills	0.20
	Jih Sun Bank	0.19
	International Bills	0.16
	Yuanta Securities Finance	0.07
Taishin Bills	0.03	

Source: Taiwan Economic Journal Co., Ltd.

Because of the indistinct agreement regarding the concepts and scopes of non-interest income, there are different disclosures for these commercial banks. Excluding the traditional interest income, all the remaining income can be classified as non-interest income. The data is separated into two types to be consistent with Stiroh's study. First, the aggregate Taiwanese banking industry data are on a quarterly frequency from 1992:Q1 to 2009:Q4. Second, the bank-level data are sourced on an annual basis from 1992 to 2009. These data include balance sheets and income statement items. We also break non-interest income into four components: fees and commission income, exchange gains, investment revenue, and other income. These components of non-interest income and independent variables in the regression model differ from Stiroh's paper.

Fees and commission income include Commission Earned, Trustee Fee, Brokerage Commission, Credit Cards Revenue, and Reversal of Reserve. Exchange gains include revaluation of interest rate, foreign exchange, equity derivative, commodity and other markings to market changes in the carrying value of assets and liabilities. Investment revenue includes Interest Revenue Short-Term Investment, Gain on Trade of Short-Term Investments, Gain-Disposal Investment, and Reverse-Loss on Investment. Any non-interest income not listed above belongs to other income.

When we examine Table 2, we find the non-interest income share of net operating revenue for all banks increased from 14.61% in 1992 to 23.16% in 2002 to 32.20% in 2009. The fee and commission income and investment revenue are the main sources of non-interest income in commercial banks and the biggest increase in non-interest income.

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Table 2: Commercial Bank Net Operating Revenue Structure and Bank Size in All Banks

	Taiwan			U.S.			China		
	1992	2002	2009	1980	1990	2000	1986	1996	2008
Percent of Net Operating Revenue (%)									
Net	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Net Interest	85.39	76.84	67.80	79.6	67.5	56.6	85.03	69.77	79.24
Noninterest	14.61	23.16	32.20	20.4	32.5	43.4	4.97	30.23	20.76
Fee and	4.83	8.78	22.99				14.88	5.48	13.43
Exchange	1.22	2.03	0.12				0.00	2.17	3.23
Investment	7.93	12.60	17.56				0.00	16.63	3.15
Other	0.64	-0.25	-8.46				0.08	5.95	0.95
Billions of Dollars									
Net Income	0.005	-0.004	0.020	24.4	18.4	66.0	34.01	28.13	311.91
Net	0.054	0.124	0.107	123.4	196.9	333.7	54.89	214.12	1038.5
Total Assets	2	11	20	3243	3899	5789	2652	9764	30730
Number of	19	19	19	14523	12370	8388	15	15	15

Notes: Net operating revenue is net interest income plus noninterest income.
Source: Stiroh, K.J., 2004, "Diversification in banking: is noninterest income the answer?" Table 1 & "Are There Diversification Benefits from Increasing Noninterest Income in the China Banking Industry?" Working Paper, Table 1

According to Tables 3 and 4, the same case is true for the large and small banks. For large banks, it rises from 11.87% in 1992 to 19.76% in 2002 to 30.52% in 2009, and in small banks, it rises from 21.34% to 28.69% to 34.71%. In China and the U.S., there is also arise in the non-interest income share of net operating revenue.

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Table 3: Commercial Bank Net Operating Revenue Structure and Bank Size in Large Banks

	Taiwan			U.S.			China		
	1992	2002	2009	1980	1990	2000	1986	1996	2008
Percent of Net Operating Revenue (%)									
Net	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Net Interest	88.13	80.24	69.48	73.5	58.6	52.2	85.03	70.44	77.67
Noninterest	11.87	19.76	30.52	26.5	41.4	47.8	14.97	29.56	22.33
Fiduciary	4.85	8.39	24.95				14.88	5.38	14.11
Service	1.24	2.58	1.65				0.00	2.20	3.71
Trading	5.01	8.76	19.31				0.00	16.82	3.48
Fees and	0.77	0.04	-15.38				0.08	5.17	1.03
Billions of Dollars									
Net Income	0.003	0.003	0.010	7.6	6.3	44.9	34.01	21.87	250.04
Net	0.038	0.077	0.064	41.0	86.0	233.1	54.90	20.31	840.33
Total Assets	2	7	13	1375	1720	4027	2652	9277	24350
Number of	6	6	6	31	66	79	5	5	5

Notes: (1) Larger banks with assets greater than 10 billion in U.S. and greater than 3 trillion in China.
Source: Stiroh, K.J., 2004, "Diversification in banking: is noninterest income the answer?" Table 1 & "Are There Diversification Benefits from Increasing Noninterest Income in the China Banking Industry?" Working Paper, Table 1

Table 4: Commercial Bank Net Operating Revenue Structure and Bank Size in Small Banks

	Taiwan			U.S.			China		
	1992	2002	2009	1980	1990	2000	1986	1996	2008
Percent of Net Operating Revenue (%)									
Net	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Net Interest	78.66	71.31	65.29	82.6	74.3	69	84.79	51.61	85.87
Noninterest	21.34	28.69	34.71	17.4	25.7	33.1	15.21	48.39	14.13
Fee and	4.76	9.41	20.07				3.30	5.91	10.53
Exchange	1.17	1.13	-2.17				0.00	2.50	1.17
Investment	15.09	18.88	14.95				0.01	21.69	1.79
Other	0.32	-0.73	1.86				11.89	18.29	0.64
Billions of Dollars									
Net Income	0.002	-0.007	0.009	16.8	12.2	21.1	1.90	7.25	61.87
Net	0.016	0.047	0.043	82.4	110.8	100.6	2.08	16.24	198.17
Total Assets	1	4	7	1868	2179	1762	139	601	6381
Number of	13	13	13	14492	12304	8309	10	10	10

Notes: Small Banks with assets below 10 billion in U.S. and below 3 trillion in China.
Source: Stiroh, K.J., 2004, "Diversification in banking: is noninterest income the answer?" Table 1 & "Are There Diversification Benefits from Increasing Noninterest Income in the China Banking Industry?" Working Paper, Table 1

4. Research Method

Previous studies (Stiroh, 2004; ,2011) focus the diversification effect in U.S. and China banking industry. In fact, U.S. banking industry possesses a strong system with long history. Moreover, China banking industry is an emerging market. Comparing to these two countries, although Taiwan banking industry was not developed for long time as U.S., Taiwan has become an important financial market in Asia. Therefore, we employ similar method like Stiroh (2004) to estimate the effect of non-interest income in Taiwan banking industry.

In the following section, firstly, we exploited equation (1) as Stiroh (2004) to analyze how net interest income and non-interest income contribute to the volatility of bank revenue. Secondly, we employed equation (2) to describe the cyclical properties of the different types of bank revenue. Thirdly, we describe the degree of variation between net interest income and non-interest income across banks in a particular year by using equation (3). Fourthly, we use equation (4) to describe the degree of correlation between net interest income and non-interest income moving together over time. Fifthly, we use non-interest income share to examine the historical relationship between revenue correlations and nontraditional activity via equation (5). Lastly, we set up an econometric regression to examine the non-interest income's impact on bank risk and return as equation (6).

4.1 Aggregate Volatility and Cyclicity of Bank Revenue

This section examines the aggregate volatility and cyclicity of bank profits in Taiwan over the period 1992 to 2009. Figure 1 shows the quarterly variations of net interest income and non-interest income growth rates. The same conclusion for China and the U.S. stands that the non-interest income appears much more volatile than net interest income in past years, particularly from 2003 to 2009 in Taiwan.

Figure 1: Growth Rates of Net Interest Income and Noninterest Income (1992:Q2-2009:Q4)

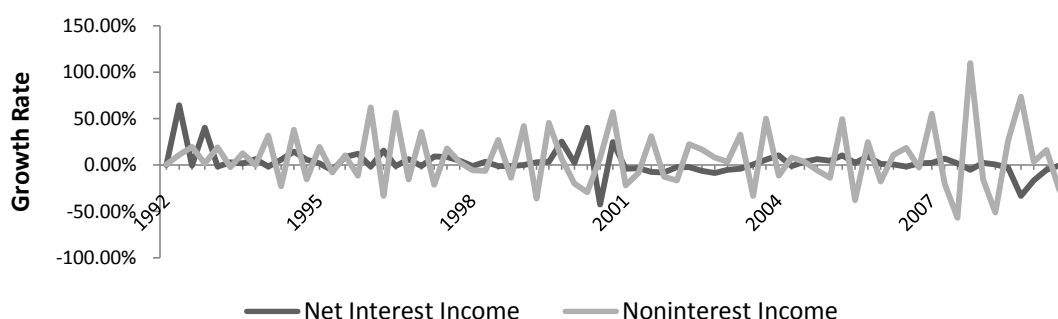


Figure 1 also indicates the standard deviation of non-interest income and net interest income is 30.36% and 13.71% for all periods, 25.28% and 15.89% in 1992-2002, and 37.46% and 8.86% in 2003-2009, respectively. We use the F-test to compare the volatility of net interest income to non-interest income and reject the null hypothesis of equal standard deviations for all periods (p-value = 0.00), the period 1992:Q2 to 2002:Q4 (p-value = 0.0033), and the period 2003:Q1 to 2009:Q4 (p-value = 0.00). Non-interest income also has a higher mean growth rate than net interest income (6.75% vs. 2.75% in all periods, 6.65% vs. 4.91% in 1992-2002, and 8.17% vs. -0.56% in 2003-2009, respectively). This result confirms that

non-interest income appears to become more volatile, while net interest income becomes less volatile after financial reforms. However, the coefficients of variation (the ratio of the standard deviation to the mean) for non-interest income and net interest income growth are 4.49 and 4.98 for all periods, 3.80 and 3.23 in 1992-2002, and 4.58 and -15.90 in 2003-2009, respectively. Because of the financial tsunami, net interest income dramatically decreased not only in Taiwan but also in the global banking industry.

Figure 2: Growth Rates of the Four Components of Noninterest Income (1992:Q2-2009:Q4)

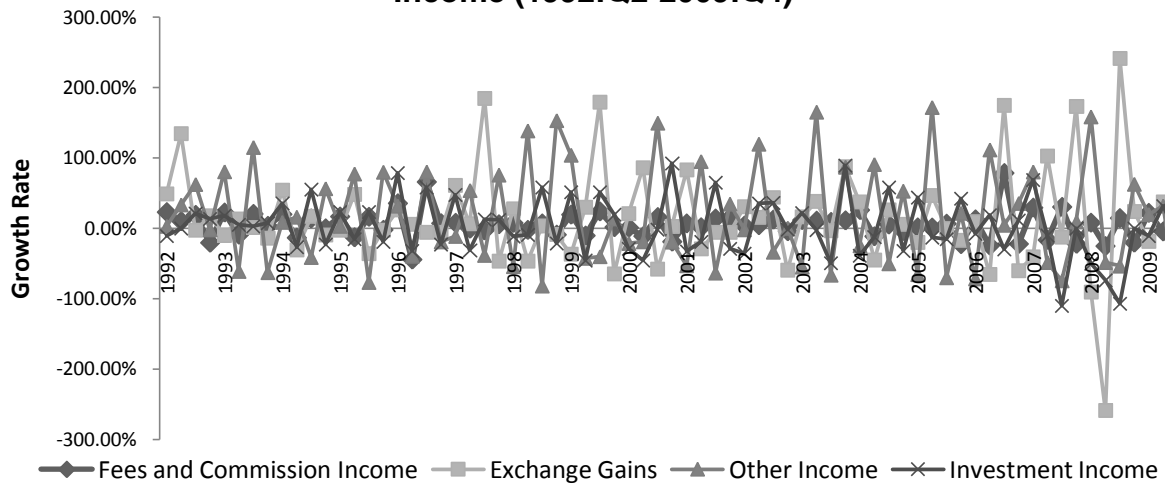


Figure 2 shows the growth rates of the four components of non-interest income, which includes fee and commission income, exchange gains, investment revenue and other income from 1992:Q2 to 2009:Q4. In this period, the standard deviation of the four-quarter growth rate of exchange gains is 72.47%, compared to 70.91% for other income, 40.82% for investment revenue, and 20.26% for fee and commission. As shown in figure 2, the exchange gains peaked in 2008 because of the extreme volatility from the financial tsunami. We also use the F-test to examine the quarterly growth rate for the four components of non-interest income and reject the null hypothesis of equal standard deviations for the pair wise combinations (p-value = 0.00). Obviously, exchange gains and other income are the most volatile components, while fee and commission are the least volatile.

4.1.1 Aggregate Volatility

Now we attempt to further accurately calculate the volatility of bank revenue. Because the specific assets in each income class are very difficult to identify and use to calculate a rate of return, we correct the standard decomposition of portfolio return volatility into a decomposition of portfolio growth volatility. Additionally, net operating revenue used to be considered as a simple portfolio of assets including net interest income and non-interest income. To analyze how net interest income and non-interest income contribute to the volatility of bank revenue, Stiroh (2004) defines net operating revenue (OPREV) as the sum of net interest income (NET) and non-interest income (NON).

The equation is:

$$\sigma_{d\ln OPREV}^2 = \alpha^2 \sigma_{d\ln NON}^2 + (1-\alpha)^2 \sigma_{d\ln NET}^2 + 2\alpha(1-\alpha)Cov(d\ln NON, d\ln NET) \quad (1)$$

Where $\alpha = \frac{NON}{NET+NON}$ is the proportion of the non-interest income in net operating revenue, $(1-\alpha)$ is the proportion of the net interest income in net operating revenue, $d\ln X$ is the growth rate of X , $\alpha^2 \sigma_{d\ln NON}^2$ is the share-weighted variance of non-interest income to overall revenue volatility, and $(1-\alpha)^2 \sigma_{d\ln NET}^2$ is the contribution of net interest income to overall revenue volatility.

$$Cov(d\ln NON, d\ln NET) = Cor(d\ln NON, d\ln NET) \times \sigma_{d\ln NON} \times \sigma_{d\ln NET}$$

In standard portfolio theory, if the noninterest income is more volatile than the net interest income, the overall variance of net operating revenue will rise as the non-interest income share grows. As we know, the coefficient of correlation between net interest income growth and non-interest income growth is between negative one and positive one. When the covariance is a negative value, it will directly lower the overall variance. That is, if the net interest income and non-interest income are negatively or weakly correlated, they will have diversification benefits for bank portfolios with growing non-interest income. If the coefficient of correlation is a positive value, the standard deviations of net operating revenue will be lower than the sum of the weighted average of net interest income growth and non-interest income growth as long as the coefficient of correlation is not exactly one. Because the average growth is the weighted average of the growth rates of the components, the trade-off between the growth of net operating revenue and volatility can improve.

Table 5: Decomposition of Variance of Net Operating Revenue

	Average Share	Variance/ Covariance	Contribution to Variance
1992:Q2 to 2002:Q4 in Taiwan			
Net operating revenue		1.74	
Net interest income	81.99	2.53	1.70
Noninterest income	18.01	6.39	0.21
Net interest/Noninterest		-0.33	-0.10
2003:Q1 to 2009:Q4 in Taiwan			
Net operating revenue		0.82	
Net interest income	74.77	0.76	0.42
Noninterest income	25.23	14.49	0.92
Net interest/Noninterest		-1.09	-0.41
1984:Q1-1989:Q4 in U.S.			
Net operating revenue		50.38	
Net interest income	72.00	100.18	51.90
Noninterest income	28.00	228.89	18.20
Net interest/Noninterest		-28.95	-11.7
1990:Q1-2001:Q3 in U.S.			
Net operating revenue		46.16	
Net interest income	63.10	14.24	5.7
Noninterest income	36.90	259.14	35.8
Net interest/Noninterest		5.61	2.6
Source: Stiroh, K.J., 2004, "Diversification in banking: is noninterest income the answer?"			
1987-1999 in China			
Net operating revenue		3.83	
Net interest income	79.50	4.82	3.05
Noninterest income	20.50	4.66	0.20
Net interest/Noninterest		1.36	0.22
2000-2008 in China			
Net operating revenue		0.91	
Net interest income	77.70	0.71	0.43
Noninterest income	22.30	3.84	0.19
Net interest/Noninterest		0.77	0.13
Source: "Are There Diversification Benefits from Increasing Noninterest Income in the China Banking Industry?" Working Paper, Table 2			

Table 5 shows estimates for the two time periods-1992:Q2 to 2002:Q4 and 2003:Q1 to 2009:Q4. The first column gives the average shares of non-interest income α and net interest income $(1 - \alpha)$. The second column gives the sample variance or covariance of the variables $(\sigma_{d\ln OPREV}^2, \sigma_{d\ln NON}^2, \sigma_{d\ln NET}^2, Cov(d\ln NON, d\ln NET))$. The third column gives the contributions (share-weighted variances), as on the right-hand side of Equation (1).

These estimates indicate that the operating revenue has become less volatile because the variance of net operating revenue growth fell from 1.74 for 1992:Q2-2002:Q4 to 0.82 for 2003:Q1-2009:Q4, and the covariance between net interest income growth and non-interest income growth fell from -0.33 to -1.09. In these two time periods, non-interest income became more volatile (variance

increased from 6.39 to 14.49) and grew in relative size (share increased from 18.01% to 25.23%). The entire decline in overall bank revenue volatility is due to net interest income, which became much less volatile (variance fell from 2.53 to 0.76) and relatively less important (share fell from 81.99% to 74.77%). Moreover, the contribution of non-interest income to overall revenue volatility increased from 0.21 in the first period to 0.92 in the second, a much larger gain than that of net interest income to overall revenue volatility (1.70 to 0.42). That is, diversification benefits associated with the shift toward non-interest income do not seem to have played an important role. We use the F-test to individually examine the three parts across the two periods and reject the null hypothesis of equal standard deviations (p-value = 0.04 for net operating revenue, 0.00 for net interest income, and 0.02 for non-interest income).

On the other hand, the results show that net interest income and non-interest income contribute to the volatility of bank revenue in the U.S. and China. They indicate the same phenomenon with Taiwan in the decreasing variance of net operating revenue growth. They fell from 50.4 for 1984:Q1-1989:Q4 to 46.2 for 1990:Q1-2001:Q3 in the U.S. and fell from 3.83 for 1987-1999 to 0.91 for 2000-2008 in China. In the U.S., the net interest income became much less volatile (100.2 to 14.2) as did the contribution to overall revenue (51.9 to 5.7). However, the non-interest income became more volatile (from 228.9 to 259) and increased the contribution to overall revenue (18.2 to 35.8). Moreover, the covariance between the net interest income and non-interest income became larger (-29.0 to 5.6). In China, the net interest income became much less volatile (4.82 to 0.71) as did the contribution to overall revenue (3.05 to 0.43). Non-interest income became much less volatile (4.66 to 3.84) as did the contribution to overall revenue (0.20 to 0.19). Besides, the covariance between the net interest income and non-interest income became much less volatile (1.36 to 0.77). It implies that non-interest income may replace net interest income to be the main source of overall revenue volatility with decreasing net interest income volatility.

4.1.2 Aggregate Cyclicity

Stiroh (2004) uses a regression equation to describe the cyclical properties of the different types of bank revenue. He estimates this regression to determine the correlations between income growth and lags of GDP growth.

$$d \ln X_t = \alpha + \sum_{\tau=1}^n \beta_{t-\tau} d \ln X_{t-\tau} - \sum_{\tau=0}^n \delta_{t-\tau} d \ln GDP_{t-\tau} + \varepsilon_t \quad (2)$$

Where X_t is some measure of bank income, which includes net income, net income plus provisions, net interest income, net interest income less provision, non-interest income, and non-interest income less exchange gains in period t . GDP is real GDP.

Net income and net income plus provisions are measures of bank profits. Because there is some evidence that banks use loan loss provisions to smooth earnings over the cycle, and adding back provisions may help to better understand the cyclicity of bank earnings, we include net income plus provisions. Net interest income and net interest income less provisions are part of traditional banking activities. We use the standard measure and then adjust for provisions because the subtracting provisions may provide a more accurate measure of the return to traditional lending

activities. Non-interest income and non-interest income less exchange gains are measures of the nontraditional activities in the form of non-interest income. If we subtract an exchange gain that is very volatile in the cyclicity of non-interest income, then we can obtain a better estimation.

Table 6: Link Between Aggregate Bank Income Growth and GDP Growth in Taiwan
Dependent Variables (X_t)

	Bank Profits		Traditional Revenue		Non-traditional Revenue	
	Net Income	Net Income plus Provisions	Net Interest Income	Net Interest Income less	Noninterest income	Noninterest Income less Exchange
Constant	-4.130 (-0.92)	0.032 (0.53)	-0.048** (-2.27)	-4.989*** (-2.85)	0.062 (1.35)	0.069 (1.51)
X _{t-1}	-0.770*** (-5.56)	-0.005 (-0.96)	-0.263** (-2.06)	-0.439*** (-3.37)	-0.717*** (-5.10)	-0.623*** (-4.54)
X _{t-2}	-0.226 (-1.54)	-0.006 (-0.96)	0.048 (0.37)	-0.346*** (-2.67)	-0.422** (-2.29)	-0.319* (-1.79)
X _{t-3}	0.064 (0.78)	-0.005 (-0.88)	-0.100 (-0.84)	-0.427*** (-3.25)	-0.159 (-0.76)	-0.060 (-0.30)
X _{t-4}	-0.076 (-0.66)	0.002 (0.33)	-0.060 (-0.47)	-0.110 (-0.81)	0.083 (0.48)	0.263 (1.55)
GDP _t	15.888 (0.32)	-0.635 (-0.39)	0.219 (0.39)	-35.461 (-0.74)	1.012 (0.63)	-0.723 (-0.46)
GDP _{t-1}	45.124 (1.04)	1.507 (1.18)	1.272*** (2.81)	95.268*** (2.77)	-0.885 (-0.85)	-1.287 (-1.30)
GDP _{t-2}	7.890 (0.17)	-0.919 (-0.72)	1.176** (2.51)	63.832* (1.78)	0.820 (0.81)	0.034 (0.03)
GDP _{t-3}	126.72*** (2.85)	1.272 (1.03)	1.576*** (3.38)	99.659*** (2.84)	-0.078 (-0.08)	-0.104 (-0.11)
GDP _{t-4}	-39.069 (-0.74)	-0.048 (-0.03)	0.985 (1.65)	99.723* (1.96)	-1.318 (-0.97)	0.119 (0.09)
Jt. Sig of Lagged	0.000	0.158	0.226	0.016	0.000	0.000
Jt. Sig of GDP & Lagged GDP in	0.001	0.203	0.050	0.307	0.459	0.679
Jt. Sig of GDP & Lagged GDP in	0.080	0.192	0.272	0.853	0.117	0.026
Jt. Sig of GDP & Lagged GDP in China	0.039	0.247	0.816	0.535	0.057	0.087

Notes: All variables are quarterly growth rates and t-value in parentheses. Jt Sig reports p-values associated with the null hypothesis for the set of independent variables that are jointly insignificant. ***, **, * indicate statistical at the 99%, 95%, and 90% level.

Table 6 reports the regression with bank profits as the dependent variable in Column 1. A significant linear relationship exists between net income growth and GDP growth because the contemporaneous and lagged GDP coefficients are jointly significant at the 1% level (p-value=0.001). Adding back provisions in column 2 weakens the significance of the GDP variable slightly (p-value=0.203), implying that income smoothing does not exist in Taiwan's banking industry. The significant

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positive coefficients on the lagged dependent variable indicate the positive autocorrelation of the series. For example, rapid growth in provision in one quarter is typically followed by positive growth in the next quarter as provisions return to normal levels. We further examine the two components of net operating revenue, which are net interest income in column 3 and non-interest income in column 5.

Column 3 shows that the contemporaneous and lagged GDP coefficients are jointly significant (p -value=0.050), and column 5 shows that they are not jointly significant (p -value=0.459). Column 4 shows an increasing p -value (p -value=0.307). Removing exchange gains from non-interest income in column 6 weakens the link between contemporaneous and lagged GDP (p -value=0.679), which means that exchange gains are more highly correlated with GDP than the other three components of non-interest income. As a result, non-interest income is more clearly cyclical than net interest income. It means a shifting towards nontraditional banking activities will extend the impact of fluctuations in the macroeconomic on bank revenue.

On the other hand, the results show that the estimates of this regression in the U.S. and China have the same results as in Taiwan. There appears to be a significant linear relationship between net income growth and GDP growth but a non-significant linear relationship for net income after adding back provisions. The relationship shows the same phenomenon with Taiwan, namely, that income smoothing does not appear to tell the story.

According to the research, an increase in non-interest income cannot smooth the impact of fluctuations in the macroeconomic on bank revenue. Despite removing the provisions from net interest income, it shows a more stable fluctuation than non-interest income. We use a second method, simple Vector Autoregressive Model (VAR), to examine trends in long-levels for real GDP, real net interest income and real non-interest income.

Figure 3: Impulse Response Function of Net Interest Income and Noninterest Income to an Innovation in Real GDP

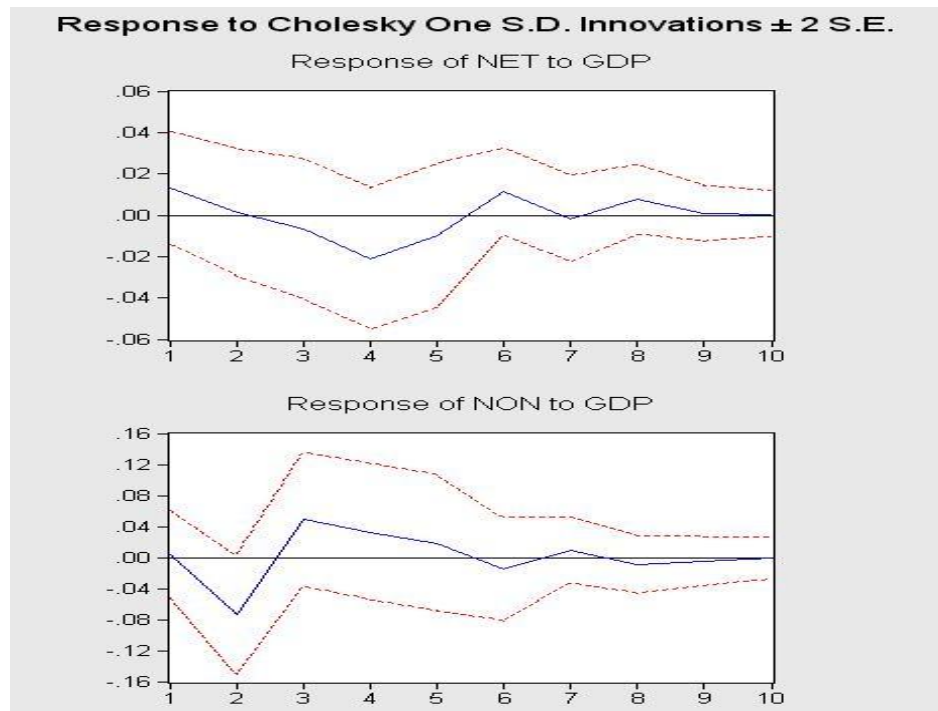


Figure 3 shows the impulse response figure that uses days as the horizontal axis and response function as the vertical axis. The impulse response analysis shows how a shock to GDP expands through the net interest income and noninterest income. The analysis shows a weakly positive response in non-interest income for shocks to GDP in only the third quarter and for net interest income in only the sixth quarter. After that, the results appear to non-significantly respond to macroeconomic fluctuations. These results indicate net interest income and non-interest income respond only weakly to changes in real output.

4.2 Bank-Level Correlation and Variability

This section examines the aggregate data, or the role of non-interest income in determining the profitability and risk of individual banks. There are two ways to help us determine the correlation of each asset in the portfolio and examine the diversification effect of an asset portfolio. We set up the “cross-sectional correlation” and the “bank-specific correlation” to examine the correlation between net interest income and non-interest income. First, the “cross-sectional correlation” measures the correlation between net interest income growth and non-interest income growth across banks at a point in time. Second, the “bank-specific correlation” measures the correlation between net interest income growth and non-interest income growth across time for each bank. The cross-sectional correlation has one observation for each year, and the bank-specific correlation has one observation for each bank.

4.2.1 Cross-Sectional Correlation

According to Stiroh (2004), the cross-sectional correlation across banks in each year t is defined as:

$$\begin{aligned} \rho_t &= \text{Corr}(d \ln NET_{i,t}, d \ln NON_{i,t}) \forall_i \\ &= \frac{\sum_{i=1}^I \left[\left(d \ln NET_{i,t} - \overline{d \ln NET_t} \right) \left(d \ln NON_{i,t} - \overline{d \ln NON_t} \right) \right]}{\left(\sum_{i=1}^I \left(d \ln NET_{i,t} - \overline{d \ln NET_t} \right)^2 \right)^{1/2} \left(\sum_{i=1}^I \left(d \ln NON_{i,t} - \overline{d \ln NON_t} \right)^2 \right)^{1/2}} \end{aligned} \quad (3)$$

where $NET_{i,t}$ is net interest income and $NON_{i,t}$ is non-interest income for bank i in year t . $\overline{d \ln NET_t}$ and $\overline{d \ln NON_t}$ are the average growth rates across all i banks in year t .

The cross-sectional correlation describes the degree of variation between net interest income and non-interest income across banks in a particular year. There is contrary variation when positive shocks to one revenue source are offset by negative shocks to the other. When non-interest income has high diversification benefits on bank revenue, the correlation is expected to be negative. On the other hand, a higher correlation means lower diversification benefits from the non-interest income of bank revenue.

Figure 4 plots the time series of cross-sectional correlations for the total, as well as large (assets greater than 1.5 billion) and small banks (assets below 1.5 billion). For all banks, the number of the negative correlation's year is 11, and the number of the positive correlation's year is 6. The ρ_t gradually decrease from 0.592 in 2000 to 0.148 in 2009. The average ρ_t across all years is -0.058. The mean of ρ_t is -0.013 between 1993 and 2002 and -0.122 between 2003 and 2009. These results imply that non-interest income has evident diversification benefits in Taiwan's banking industry. For large banks, the number of the negative correlation's year is 8, and the number of the positive correlation's year is 9. The average ρ_t across all years is 0.016; the mean of ρ_t is -0.178 between 1993 and 2002 and is 0.294 between 2003 and 2009. For small banks, the number of the negative correlation's year is 12, and the number of the positive correlation's year is 5. The average ρ_t across all years is -0.171. The mean of ρ_t is -0.099 between 1993 and 2002 and -0.2274 between 2003 and 2009. We find that the estimate for small banks is much more volatile; furthermore, large banks had intensely reduced the correlation in the 2000 Internet bubble. Interestingly, the correlation for large banks falls during recessions, but for small and all banks, the correlation rises.

Figure 4: Cross-Sectional Correlation between Noninterest Income Growth and Net Interest Income Growth

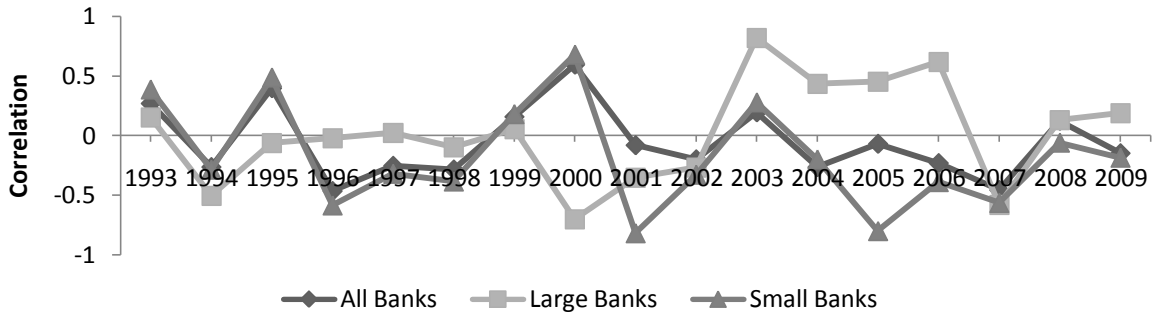
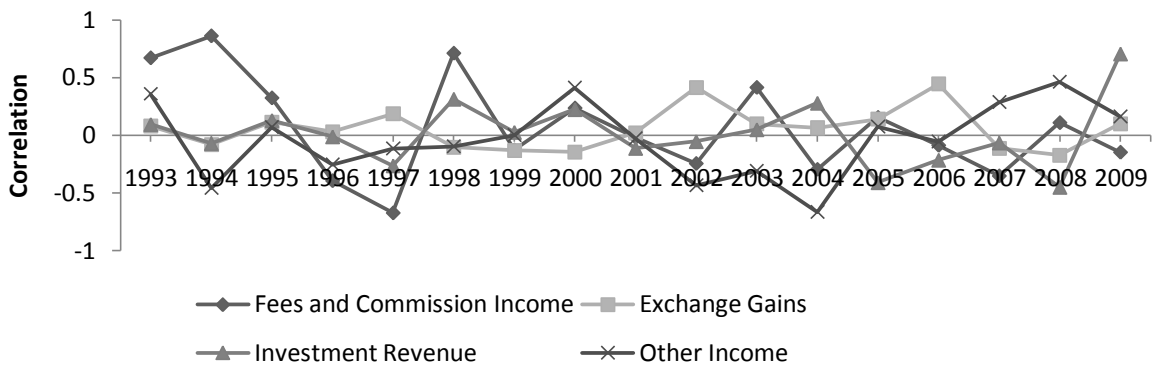


Figure 5: Cross-Sectional Correlation between Net Interest Income Growth and Growth in the Components of Noninterest Income



In addition, we calculate the correlation between the components of non-interest income and net interest income. Figure 5 shows that the correlation is an irregular fluctuation. The mean of ρ_t is 0.0677 between net interest income and fee and commission income, 0.0565 between net interest income and exchange gains, 0.0099 between net interest income and investment revenue, and -0.0339 between net interest income and other income. As a result, we would suggest that there are little diversification benefits for the expansion of the non-interest income of bank revenue in large banks.

4.2.2 Bank-Specific Correlation

The bank-specific correlation across time for each bank is defined as

$$\rho_i = \text{Corr}(d \ln NET_{i,t}, d \ln NON_{i,t}) \forall_i$$

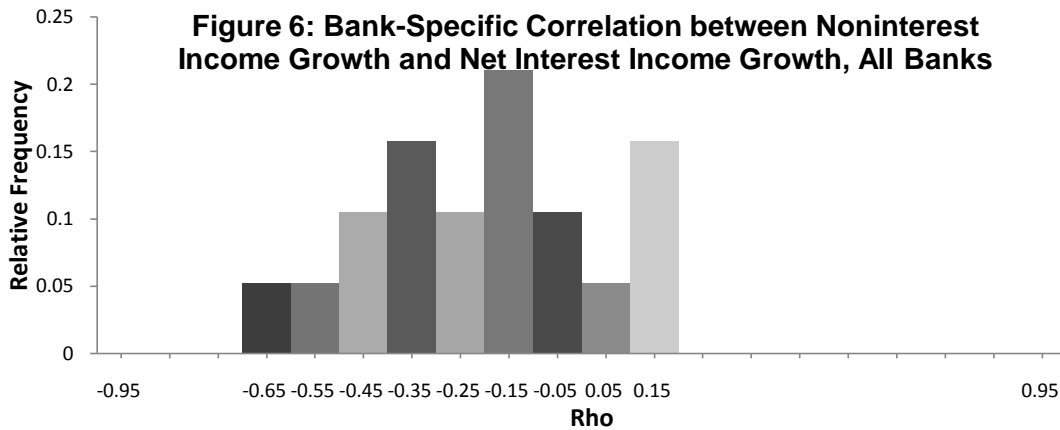
$$= \frac{\sum_{t=1}^T [(d \ln NET_{i,t} - \overline{d \ln NET_i})(d \ln NON_{i,t} - \overline{d \ln NON_i})]}{\left(\sum_{t=1}^T (d \ln NET_{i,t} - \overline{d \ln NET_i})^2 \right)^{1/2} \left(\sum_{t=1}^T (d \ln NON_{i,t} - \overline{d \ln NON_i})^2 \right)^{1/2}} \quad (4)$$

Where $\overline{d \ln NET_i}$ and $\overline{d \ln NON_i}$ are the average growth rates for bank i across all T years of its years of operations.

The bank-specific correlation describes the degree of correlation between net interest income and non-interest income moving together over time. Besides, it is a traditional method to measure the correlation, which has directly indicated whether the non-interest income has diversification benefits. When there is a negative correlation, it implies strong potential diversification benefits on bank revenue. Similarly, when there is a positive correlation, it implies a weak potential diversification benefits on bank revenue.

We analyze ρ_t with annual data for all banks with growth rates of both net interest income and non-interest income from 1993 to 2009. For all banks, the average ρ_t is -0.200, with a median of -0.184 and a standard deviation of 0.227. For large banks, the average ρ_t is -0.234, with a median of -0.216 and a standard deviation of 0.171. For small banks, the average ρ_t is -0.181, with a median of -0.182 and a standard deviation of 0.259. According to these calculations, these data indicate that non-interest income has significant diversification benefits in Taiwan's banking industry.

Figure 6 shows that the range of ρ_t for all banks is distributed between -0.602 and 0.181. The mass in the left-hand tail with low correlations primarily reflects banks with a potentially diversified benefit. Additionally, the highest relative frequency is 0.21, which is distributed over the period from -0.1 to -0.2. For all banks, the number of negative correlation banks is 15, and the number of positive correlation banks is 4. Although there is little diversification from the expansion of the non-interest income of bank revenue in small banks, the bit of the right-hand tail is nearly 0.



We further examine the factors associated with the correlation between growths of bank revenue with the estimate of ρ_t as the dependent variable in the following regression:

$$\rho_i = \alpha + \beta_1 \ln(\overline{A_i}) + \beta_2 \left(\frac{\overline{E}}{\overline{A}}\right)_i + \beta_3 \overline{d \ln(A_i)} + \beta_4 \overline{NONSH_i} + \beta_5 \overline{FEESHR_i} + \beta_6 \overline{EXCSHR_i} + \beta_7 \overline{INVSHR_i} + \varepsilon_i \quad (5)$$

where A is assets, (E/A) is the equity capital to assets ratio, $d \ln(A)$ is annual asset growth, $NONSH$ is non-interest income's share of net operating revenue, $FEESHR$ is fees and commission income's share of non-interest income, $EXCSHR$ is exchange gain's share of non-interest income, and $INVSHR$ is investment revenue's share of non-interest income.

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We can use non-interest income share to examine the historical relationship between revenue correlations and nontraditional activity, which can reflect a bank's strategy and business opportunity. Additionally, we include the (E/A) ratio and asset growth because it may have different operating strategies in high- or low-risk banks so that it forces them to focus on revenue generation in different ways. To avoiding perfect collinearity, one of the four components of non-interest income must be eliminated from this model. It can help us find the historical relationship regardless of whether a bank is full of its net operating revenue as either net interest income or as non-interest income.

Table 7 reports results for all of the banks in Taiwan, China and U.S.. Because there are only 7 large banks, we could not use the scarce sample to estimate regression. For all banks, we found that the non-interest income's share is not significant. However, the coefficients between the components of non-interest income and correlation are positively significant. It implies that as individual components of non-interest income increase, the correlation will increase, and the diversification benefits will decrease. Lower concentrations of other income are associated with a higher correlation between net interest income growth and non-interest income growth. They may have some diversification benefits as banks shift their non-interest income away from fee and commission income, exchange gains, or investment revenue, into other income sources. Furthermore, the coefficients between growth in assets and correlation are negatively significant. This means as growth in assets increases, the correlation will decrease, and the diversification benefits will increase.

In China, the coefficients between the components of non-interest income and correlation are not significant. This indicates that the individual component of non-interest income does not have a significant impact on the correlation between net interest income and non-interest income. However, there is a negative significance, which means that there may be some diversification benefits while banks shift their non-interest income away from service charges and toward fiduciary, trading, or fees and other non-interest income. The results also show that the coefficients between non-interest income and correlation are positively significant both in the U.S. and for all banks. There appears to be little diversification benefit from an increase in non-interest income as the correlation between net interest income and non-interest income increases. Furthermore, U.S. banks with high equity ratios (China banks with low equity ratios) and growth in assets tend to show higher correlations between net interest income growth and non-interest income growth.

Table 7: Determinants of the Correlation between Net Interest Income Growth and Noninterest Income Growth in All Banks

	Taiwan		China		U.S.			
β_1	0.061 (1.07)	-0.004 (-0.06)	β_1	0.287*** (3.344)	0.310** (2.534)	β_1	0.166 (0.346)	1.186*** (0.428)
β_2	0.297 (0.35)	-0.042 (-0.04)	β_2	-17.536* (-2.991)	-22.736** (-3.171)	β_2	0.451** (0.230)	0.540** (0.214)
β_3	-1.284 (-1.30)	-2.761** (-2.52)	β_3	3.051*** (3.374)	3.663** (3.698)	β_3	2.258*** (0.075)	2.196*** (0.076)
β_4	-0.423 (-0.55)	0.0363 (0.05)	β_4	1.743** (2.912)	1.855** (2.897)	β_4	89.143** (36.381)	86.335** (33.952)
β_5		0.694* (1.82)	β_5		-0.254 (-0.441)	β_5	-124.06* (57.552)	-112.092** (54.053)
β_6		2.126** (2.19)	β_6		2.371 (1.743)	β_6		-18.524** (4.607)
β_7		0.369* (2.10)	β_7		-0.168 (-0.476)	β_7		-12.577 (11.514)
α	-1.197 (-1.02)	-0.492 (-0.34)	β_8	0.194 (0.852)	0.416 (1.551)	β_8		-18.058* (4.673)
			α	-2.859** (-3.470)	-3.104* (-2.785)	β_9	-0.487*** (0.064)	-0.513*** (0.065)
						β_{10}	1.753** (0.873)	1.584* (0.871)
						α	0.033 (5.527)	3.942 (5.740)
Adjusted -R ²	0.135	0.316	Adjusted -R ²	0.604	0.618	Adjusted -R ²	0.19	0.19
No. Obs.	19	19	No. Obs.	15	15	No. Obs.	14,503	14,503

Notes: ***, **, * indicate statistical at the 99%, 95%, and 90% level.

Source: Stiroh, K.J., 2004, "Diversification in banking: is noninterest income the answer?", Table 4 & "Are There Diversification Benefits from Increasing Noninterest Income in the China Banking Industry?" Working Paper, Table 4

$$\rho_i = \alpha + \beta_1 \ln(\bar{A}_i) + \beta_2 \left(\frac{E}{A}\right)_i + \beta_3 \overline{d\ln(A_i)} + \beta_4 \overline{NONSH} + \beta_5 \overline{FEESHRR}_i + \beta_6 \overline{EXCSHRR}_i + \beta_7 \overline{INVSHRR}_i + \varepsilon_i \dots \text{Taiwan}$$

$$\rho_i = \alpha + \beta_1 \ln(\bar{A}_i) + \beta_2 \left(\frac{E}{A}\right)_i + \beta_3 \overline{d\ln(A_i)} + \beta_4 \overline{NONSH}^2 + \beta_5 \overline{FEESHRR}_i + \beta_6 \overline{EXCSHRR}_i + \beta_7 \overline{OTHERSH}_i + \beta_8 \overline{MULTI}_i + \varepsilon_i \dots \text{China}$$

$$\rho_i = \alpha + \beta_1 \ln(\bar{A}_i) + \beta_2 \left(\frac{E}{A}\right)_i + \beta_3 \overline{d\ln(A_i)} + \beta_4 \overline{NONSH} + \beta_5 \overline{NONSH}^2 + \beta_6 \overline{FIDSHRR}_i + \beta_7 \overline{TRDSHRR}_i + \beta_8 \overline{FEESHRR}_i + \beta_9 \overline{BANYRS}_i + \beta_{10} \overline{MULTI}_i + \varepsilon_i \dots \text{U.S.}$$

4.3 Non-interest Income Share Impact on Bank Risk and Return

After analyzing the bank diversification benefits through correlation, we want to know how non-interest income shares are correlated with other variables in this final section. When we examine the link between non-interest income shares and bank revenue and risk, it will help us to discover how a shift towards non-interest income impacts efficiency and stability. Therefore, we use the Sharpe Ratio and Z-score to analyze the relationship between non-interest income shares and standard measures of performance and risk. The Sharpe Ratio (average return on equity (ROE) divided by the standard deviation of ROE) measures the bank performance; in fact, it has to subtract out the risk-free rate of return. Because we analyze across all banks in constant, it would not affect the result. The Z-score (average return on assets (ROA) plus average equity to assets, divided by the standard deviation of

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ROA) measures how many standard deviation profits must fall below to bankrupt the firm. The lower value in both Sharpe Ratio and Z-score correlates with higher risk and worse bank performance.

We further set up an econometric regression to examine the non-interest income's impact on bank risk and return:

$$Y_i = \alpha + \beta_1 \ln(\overline{A_i}) + \beta_2 \left(\frac{\overline{E}}{\overline{A}}\right)_i + \beta_3 \overline{d \ln(A_i)} + \beta_4 \overline{NONSH_i} + \beta_5 \overline{FEESHR_i} + \beta_6 \overline{EXCSHR_i} + \beta_7 \overline{INVSHR_i} + \varepsilon_i \quad (6)$$

where i is bank i , and the estimation results are shown in Tables 8, 9 and 10. We use the mean and standard deviation of net income growth as the dependent variables to analyze how it alters the composition of the revenue stream in Table 9. We also estimate the mean and volatility of return on equity (ROE) as the dependent variables in Table 9. Moreover, Table 10 uses the average Sharpe Ratio and Z-score to examine the relationship with non-interest income shares and bank revenue and risk.

From Table 8, we can see that, with the mean growth rate of net income as the dependent variable, the non-interest income and its component share are not significant. However, there is a positive relationship between non-interest income and the mean of net income growth, but there is a negative relationship between non-interest income and the standard deviation of net income growth. Therefore, enlarging non-interest income shares will increase net income growth and decrease volatility. In the U.S., increasing growth in assets will enlarge the mean of net income, but increasing non-interest income will expand its volatility.

Table 8: Noninterest Income Shares as Determinants of Bank Risk and Return Net Income Growth

	Taiwan			China			U.S.	
	Mean	Std. Dev		Mean	Std. Dev		Mean	Std. Dev
β_1	-0.753 (-0.80)	-2.864 (-1.32)	β_1	-0.017 (-0.226)	-0.045 (-0.249)	β_1	0.162 (0.120)	-4.255*** (0.401)
β_2	-10.68 6 (-0.88)	-18.86 1 (-0.67)	β_2	2.094 (0.475)	-12.49 6 (-1.174)	β_2	0.126** (0.054)	-0.307* (0.163)
β_3	12.791 (0.89)	6.781 (0.21)	β_3	1.902* (3.122)	1.315 (0.894)	β_3	1.053*** (0.034)	0.316*** (0.086)
β_4	4.267 (0.46)	-4.955 (-0.23)	β_4	0.053 (0.133)	0.627 (0.660)	β_4	19.140** (3.831)	129.273* (16.782)
β_5	-7.553 (-1.52)	-1.979 (-0.17)	β_5	0.040 (0.113)	-0.165 (-0.193)	β_5	-17.057* (6.925)	-96.423** (25.590)
β_6	0.368 (0.03)	2.436 (0.08)	β_6	-0.297 (-0.355)	-0.304 (-0.150)	β_6	-2.489** (1.163)	-19.602** (4.333)
β_7	-0.740 (-0.32)	1.379 (0.26)	β_7	-0.221 (-1.017)	0.107 (0.205)	β_7	3.523 (2.616)	19.674* (11.539)
α	17.857 (0.94)	66.280 (1.51)	β_8	0.223 (1.349)	0.760 (1.909)	β_8	-0.856 (0.595)	8.974*** (3.371)
			α	-0.190 (-0.277)	0.810 (0.489)	β_9	-0.161** (0.023)	-1.283*** (0.071)
						β_{10}	-0.003 (0.308)	-1.768* (1.009)
						α	0.190 (1.034)	72.626*** (3.626)
Adjusted- R ²	0.00	0.00	Adjusted- R ²	0.45	0.06	Adjusted- R ²	0.34	0.10

Notes: Dependent variables are mean net interest income growth and standard deviation of net interest income growth.

Independent variables ($\beta_1, \beta_2, \dots, \beta_7$) indicate Log assets, Equity/Assets, Asset growth, Non-interest income's share of net operating revenue, Fees and commission income's share of non-interest income, Exchange gain's share of non-interest income, and Investment revenue's share of non-interest income, respectively.

***, **, * indicate statistical significance at the 99%, 95%, and 90% level.

Source: Stiroh, K.J., 2004, "Diversification in banking: is noninterest income the answer?", Table 4 & "Are There Diversification Benefits from Increasing Noninterest Income in the China Banking Industry?" Working Paper, Table 4

Table 9 demonstrates stronger explanatory power in these regressions. The coefficient on the component of non-interest income suggests that the relationship between fee and commission income share and the mean of ROE is negative, but the relationship between fee and commission income share and the standard deviation of ROE is positive. This implies that increasing fee and commission income shares will diminish ROE and expand its volatility. On the other hand, investment revenue share shows the same results with fee and commission income

share. However, the relationship between growth in assets and the mean of ROE is positive and significant. In the U.S., there is a strong negative relationship. That is, increasing the non-interest income will enlarge its volatility.

Table 9: Noninterest Income Shares as Determinants of Bank Risk and Return

	ROE							
	Taiwan		China		U.S.			
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev		
β_1	1.475*** (4.08)	-0.834 (-0.92)	β_1	-0.080 (-0.559)	0.231 (0.365)	β_1	0.217 (2.252)	-2.809 (6.270)
β_2	5.092 (1.09)	-3.281 (-0.28)	β_2	14.641 (1.734)	-62.481 (-1.680)	β_2	0.386 (0.279)	-3.124*** (0.814)
β_3	10.304* (1.87)	-11.016 (-0.80)	β_3	-1.505 (-1.290)	7.342 (1.428)	β_3	-0.104 (0.104)	-0.067 (0.306)
β_4	0.909 (0.25)	1.807 (0.20)	β_4	-0.770 (-1.022)	2.457 (0.740)	β_4	-21.508 (20.109)	117.23*** (57.311)
β_5	-14.332* ** (-7.50)	18.640* ** (3.91)	β_5	-0.983 (-1.449)	4.313 (1.443)	β_5	36.743 (33.937)	-8.158 (90.564)
β_6	-4.796 (-0.98)	7.286 (0.60)	β_6	0.456 (0.285)	-0.385 (-0.055)	β_6	17.598 (16.297)	-71.679 (45.705)
β_7	-5.028** * (-5.70)	4.550* (2.06)	β_7	-1.062 ** (-2.557)	4.075* (2.227)	β_7	4.793 (14.637)	11.717 (36.957)
α	-21.207* * (-2.90)	10.292 (0.56)	β_8	0.011 (0.036)	0.098 (0.071)	β_8	-22.079 (19.176)	72.205 (52.396)
			α	1.158 (0.882)	-3.409 (-0.590)	β_9	1.535** (0.642)	-5.243*** (1.708)
						β_{10}	3.293 (3.728)	-11.239 (11.049)
						α	-18.450 (10.727)	131.15** * (32.476)
Adjusted-R ²	0.85	0.51	Adjusted-R ²	0.17	0.10	Adjusted-R ²	0.00	0.00

Notes: Dependent variables are mean net interest income growth and standard deviation of net interest income growth. Independent variables ($\beta_1, \beta_2, \dots, \beta_7$) indicate Log assets, Equity/Assets, Asset growth, Non-interest income's share of net operating revenue, Fees and commission income's share of non-interest income, Exchange gain's share of non-interest income, and Investment revenue's share of non-interest income, respectively.

***, **, * indicate statistical significance at the 99%, 95%, and 90% level.

Source: Stiroh, K.J., 2004, "Diversification in banking: is noninterest income the answer?", Table 4 & "Are There Diversification Benefits from Increasing Noninterest Income in the China Banking Industry?" Working Paper, Table 4

**Table 10: Noninterest Income Shares as Determinants of Bank Risk and Return
Sharpe Ratio & Z-Score**

	Taiwan		China		U.S.			
	S-ratio	Z-score	S-ratio	Z-score	S-ratio	Z-score		
β_1	0.775*** (4.00)	0.611** (2.86)	β_1	-0.119 (-0.249)	1.556 (0.384)	β_1	0.440*** (0.023)	2.786*** (0.168)
β_2	9.054*** (3.60)	4.255 (1.54)	β_2	100.3** (3.576)	349.6 (1.473)	β_2	0.059*** (0.012)	0.940*** (0.083)
β_3	3.018 (1.03)	4.212 (1.30)	β_3	-3.943 (-1.017)	-40.47 (-1.234)	β_3	-0.023** (0.002)	-0.169*** (0.022)
β_4	-4.261** (-2.22)	-2.112 (-1.00)	β_4	-3.280 (-1.309)	24.567 (1.159)	β_4	-8.402** (2.120)	-74.588* (12.244)
β_5	-4.106*** (-4.01)	-4.045* (-3.59)	β_5	-2.227 (-0.987)	-2.633 (-0.138)	β_5	3.453 (3.375)	2.276 (19.677)
β_6	-3.597 (-1.38)	-0.948 (-0.33)	β_6	-1.280 (-0.240)	-36.73 (-0.815)	β_6	1.851*** (0.285)	17.402** (2.069)
β_7	-2.451*** (-5.19)	-0.950* (-1.82)	β_7	-3.518* (-2.550)	-8.326 (-0.713)	β_7	-2.084* (1.089)	-6.401 (5.171)
α	-11.921** (-3.04)	-9.081* (-2.10)	β_8	-2.015 (-1.920)	-6.841 (-0.770)	β_8	-0.466** (0.122)	-3.197*** (0.865)
			α	2.543 (0.583)	-7.699 (-0.209)	β_9	0.050*** (0.004)	0.456*** (0.028)
						β_{10}	0.394*** (0.043)	0.554 (0.389)
						α	0.114 (0.339)	7.153*** (2.066)
Adjusted -R ²	0.71	0.67	Adjusted- R ²	0.56	0.06	Adjusted- R ²	0.15	0.18

Notes: Dependent variables are mean net interest income growth and standard deviation of net interest income growth.

Independent variables ($\beta_1, \beta_2, \dots, \beta_7$) indicate Log assets, Equity/Assets, Asset growth, Non-interest income's share of net operating revenue, Fees and commission income's share of non-interest income, Exchange gain's share of non-interest income, and Investment revenue's share of non-interest income, respectively.

***, **, * indicate statistical significance at the 99%, 95%, and 90% level.

Source: Stiroh, K.J., 2004, "Diversification in banking: is noninterest income the answer?", Table 4& "Are There Diversification Benefits from Increasing Noninterest Income in the China Banking Industry?" Working Paper, Table 4

Table 10 shows a negative and significant coefficient on the non-interest income share, fee and commission share and investment share when the Sharpe Ratio is the dependent variable. That is, the bank with high shares of non-interest income and its components has low profitability per unit of risk. Furthermore, the equity capital to assets ratio has a positive and significant coefficient, which indicates that it can offer the most risk-adjusted return. On the other hand, the consequences with the Z-score as the dependent variable are alike. There is sufficient evidence that as fee and commission income shares rise, the Z-score falls and the risk increases. In

the U.S., there is significant evidence to prove that increasing non-interest income will lower the Sharpe Ratio and Z-score.

Following this result, the increasing non-interest income has been associated with higher risk of bank income but not with higher returns. That is, they may have worsened the risk-adjust return in trade-off when banks change their focus from traditional interest income to non-interest income. We find that the result in the U.S. and China is the same as Taiwan. As the non-interest income increased, the volatility of net income growth and ROE increased. With the Sharpe Ratio as the dependent variable, it also shows a low risk-adjusted return. Moreover, there is the reverse direction in the Z-score and non-interest income shares.

Therefore, we found that the increasing non-interest income could not help Taiwan banks getting diversification benefits. In other words, we can't find strong evidence to support our hypothesis in this paper.

5. Conclusion

This paper researches the link between the non-interest income growth and the volatility of bank revenue in Taiwan from 1992 to 2009. Firstly, we analyze the aggregate volatility and cyclical. Secondly, we analyze the cross-sectional correlation and bank-specific correlation. Finally, we set up an econometric model to analyze the impact on bank risk and return from increasing non-interest income.

At the aggregate level, Taiwan banking industry shows that non-interest income appears much more volatile than net interest income, especially after 2002. Exchange gains and other income are the most volatile components. However, the net operating revenue has become less volatile because net interest income became much less volatile than non-interest income. According to these analyses of aggregate volatility and cyclical, we conclude that banks in Taiwan changes their operating toward nontraditional banking activities will not smooth the impact of fluctuations in the macroeconomic on bank revenue. Furthermore, the covariance between net interest income and non-interest income has changed from positive to negative in Taiwan. This indicates that increasing non-interest income may bring diversification benefits in Taiwan banking industry.

At the bank level, this study explores how there are diversification benefits from increasing non-interest income, but not in large banks. Other income is weakly correlated with net interest income, while fee and commission income is highly correlated. Furthermore, sufficient evidence exists to prove that the correlation will increase as non-interest income enlarges. In terms of bank risk and return, rising fee and commission income share and investment revenue share will diminish ROE and enlarge its volatility. That is, the continued expansion in the banks may lower profitability per unit of risk, even after standardizing the dependent variables.

These results deny the belief that increasing non-interest income shares will improve profitability and diminish risk. However, it does not mean that no banks are able to successfully manage their nontraditional activity for this effect. Compared to the extant literature, our contribution shows that there is a negative proof for stakeholders to conduct their investing opinion in Taiwan's banking industry. That is, if you want to have diversification benefits, shifting toward non-interest income does not seem to play an important role.

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