ESSAYS ON BANK RISKS:

THE CASE OF PHILIPPINE BANKS

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Abstract

Banking supervision has evolved from regulating individual banks to promoting the soundness and stability of the whole financial system. Meanwhile, bank risks continue to dynamically change over time. Hence, bank supervisors should be able to thoroughly understand the risk dynamics of banks and develop more risk-based prudential regulations. While there are several research on bank risks, many of them cover financial institutions in advanced economies. This dissertation contributes to the limited literature on bank risks in developing countries. Additionally, we employ quarterly bank-level data to provide more granular analysis of bank risks than previous studies did.

In the first analytical chapter (Chapter 3) of this dissertation, we examine the sensitivity of daily bank stock returns to changes in domestic interest rate, foreign interest rate, and exchange rate using generalized autoregressive conditional heteroskedasticity (GARCH) models and model averaging techniques. Our results indicate that the mean and the variance of Philippine bank daily stock returns seem to be sensitive to US interest rate risk and exchange rate risk between 2006 and 2013 (crisis period) but not between 2014 and 2018 (normal period). In addition, fluctuations in US interest rate and exchange rate seem to contribute to the high volatility of daily bank stock returns during the global financial crisis period (2007 to 2009) as illustrated by GARCH-based indicators in Section 3.6. Moreover, the different sensitivities of stock returns between sub-periods indicate that US interest rate and exchange rate risks of Philippine bank stocks are changing over time.

Furthermore, we investigate the effect of changes in US interest rate on quarterly bank income using linear panel model and find that the profitability of Philippine universal banks seems to be also sensitive to US interest rate risk. Hence, these results suggest that Philippine largest banks tend to be vulnerable to US financial markets and US interest rate risk seems to be an important risk exposure of Philippine universal banks.

In the second analytical chapter (Chapter 4) of this dissertation, we examine the microeconomic and macroeconomic determinants of non-performing loans (NPL) across six loan categories in the Philippines using instrumented dynamic panel models. Our results indicate that all NPL types tend to persist over time. In addition, bank-specific characteristics and macroeconomic conditions are likely to affect agricultural and SME NPLs (mandatory loans), while only macroeconomic factors seem to have an impact on corporate and consumption NPLs (regular loans). In particular, cost-inefficient banks tend to have higher agricultural and SME NPLs indicating that the loan quality of these two mandatory credits is associated with operational inefficiency. Additionally, rising unemployment rates seem to increase agricultural NPL. Furthermore, highly capitalized banks tend to have more agricultural NPL implying higher credit risk for agricultural loans. Meanwhile, higher SME NPL is associated with tighter credit standards. In addition, rising GDP growth rates are likely to contribute to higher SME NPL and the impact tends to last for a long period. These findings suggest a deterioration in SME loan quality and a possible credit risk build-up in SME lending segment of banks along with Philippine economic progress. Similarly, higher GDP growth rates tend to increase corporate and consumption NPLs (regular loans). However, microfinance and housing NPLs seem to be not sensitive to macroeconomic developments.

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Chapter 1

Introduction

Understanding the risk exposures of banks could play a significant role in effectively supervising the banking system and in promoting the stability of the whole financial system. In the Philippines, banks are the main financial institutions and among the main suppliers of domestic credit in the country (discussed in Section 2.2 of Chapter 2). Hence, ensuring the financial soundness of the banking system seems to be crucial for Philippine economic development.

One of key policy tools in banking supervision is the capital adequacy ratio (CAR) of banks. CAR represents the minimum amount of capital that a bank should maintain relative to its risk-weighted assets. The Basel Committee on Banking Supervision enumerates the risk exposures of banks that should have corresponding capital allocation such as credit risk, market risk, and operational risk (Bank for International Settlements [BIS], 2004). Credit risk generally refers to borrowers' inability to repay their debt oblations. Meanwhile, market risk refers to the potential losses arising from adverse movements in interest rate, foreign exchange, equities (stocks), and commodities prices (BIS, 2019). In the case of Philippine banks, loans and financial securities comprise the majority of total assets (20% and 50%, respectively). Additionally, 20% of total assets are denominated in foreign currencies. Given this asset composition, it might be possible that the main risk exposures of Philippine banks are credit risk, interest rate risk, and foreign exchange risk. Hence, this dissertation investigates the interest rate and exchange

rate risks of Philippine banks using daily bank stock returns and the factors affecting credit risk as measured by quarterly non-performing loans to total loans ratios.

The first analytical chapter (Chapter 3) of this dissertation examines the sensitivity of daily bank stock returns to changes in domestic interest rate, foreign interest rate, and exchange rate using generalized autoregressive conditional heteroskedasticity (GARCH) models and model averaging techniques. We also construct indicators of bank stock volatility based on GARCH estimates. Our results indicate that the mean and the variance of Philippine bank daily stock returns seem to be sensitive to US interest rate risk and exchange rate risk between 2006 and 2013 (crisis period) but not between 2014 and 2018 (normal period). Specifically, changes in US 3-month Treasury bill rate and PHP/USD exchange rate seem to have offsetting effects on the mean of Philippine bank stock returns with US interest rate risk dominating the impact. In addition, fluctuations in US interest rate and exchange rate seem to contribute to the high volatility of daily bank stock returns during the global financial crisis period (2007 to 2009), as illustrated by GARCH-based indicators in Section 3.6. Moreover, the different sensitivities of stock returns between sub-periods indicate that US interest rate and exchange rate risks of Philippine bank stocks are changing over time.

Furthermore, we investigate the effects of changes in interest rate and exchange rate on quarterly bank income using linear panel model and find that rising US interest rates tend to adversely affect quarterly bank income. This finding indicates that the profitability of Philippine universal banks seems to be also sensitive to US interest rate risk. Given the effects of changes in US interest rate on daily bank stock returns and on quarterly bank profits, these results suggest that Philippine largest banks tend to be

vulnerable to US financial markets. Additionally, the findings imply that US interest rate risk seems to be an important risk exposure of Philippine universal banks. Moreover, the GARCH-based indicators presented in Section 3.6 may serve as early warning signals on banks' vulnerability to shocks from external financial markets.

The third chapter of this dissertation contributes to the literature by simultaneously incorporating foreign (US) interest rate risk in a multi-index model of bank stock returns, since earlier studies analyze only domestic interest rate along with exchange rate and stock market index. In addition, we illustrate how to construct indicators for abnormal bank stock returns based on GARCH estimates which may be useful for macroprudential surveillance. Moreover, this research adds to the limited literature on bank stock returns and bank profits in developing countries and, to the best of our knowledge, is the first study on the sensitivity of Philippine bank stock returns.

One indicator of credit risk in the banking system is the ratio of non-performing loans to total loans (NPL). Although NPL in the Philippines remains low (Figure 2.14) amid the robust economic growth of the Philippines since 2010 (discussed in Chapter 2), the International Monetary Fund (2018) warns that bank credit growth is outpacing GDP growth and is reaching early warning thresholds based on their estimates. A rapid credit growth could threaten the stability of the financial system when loan growth is associated with elevated levels of non-performing loans. Higher level of NPL may constrain bank credits and other banking operations. Hence, an in-depth analysis of the factors affecting the loan quality of banks is important for policy development.

In the second analytical chapter (Chapter 4) of this dissertation, we examine the microeconomic and macroeconomic determinants of NPL across six loan categories, namely, agricultural, microfinance, small- and medium-enterprises (SME), corporate, consumption, and housing loans. We use the proprietary regulatory reports to construct a panel data set of 130 universal, commercial, and thrift banks over 40 quarters (2009Q1 to 2018Q4) and estimate the variables using instrumented dynamic panel models with fixed effects. Our results indicate that all NPL types tend to persist over time. In addition, bank-specific characteristics and macroeconomic conditions are likely to affect agricultural and SME NPLs (mandatory loans), while only macroeconomic factors seem to have an impact on corporate and consumption NPLs (regular loans).

In particular, cost-inefficient banks tend to have higher agricultural and SME NPLs indicating that the loan quality of these two mandatory credits is associated with operational inefficiency. Additionally, rising unemployment rates seem to increase agricultural NPL. Moreover, highly capitalized banks tend to have more agricultural NPL implying higher credit risk for agricultural loans.

Meanwhile, higher SME NPL is associated with tighter credit standards. In addition, rising GDP growth rates are likely to contribute to higher SME NPL and the impact tends to last for a long period. Taken together, these two findings suggest a deterioration in SME loan quality and a possible credit risk build-up in SME lending segment of banks along with Philippine economic progress. Similarly, higher GDP growth rates tend to increase corporate and consumption NPLs (regular loans). However, microfinance and housing NPLs seem to be not sensitive to macroeconomic developments.

The second analytical chapter (Chapter 4) of this dissertation contributes to the literature by providing a more granular analysis on the microeconomic and macroeconomic determinants of non-performing loans. Unlike previous research, Chapter 4 utilizes a panel data set with more bank-level information and longer period thus, providing more efficient estimates. We further contribute to NPL literature by introducing alternative measures of lending policies, namely, the ratio of real and other properties acquired to total assets (ROPA/TA) as proxy for bank's lending policies on collateral requirements and the diffusion index for credit standards as proxy for general credit standards in the banking industry. To the best of our knowledge, Chapter 4 of this dissertation is the first comprehensive study on the determinants of NPL in the Philippines using dynamic panel models.

This dissertation is organized as follows: Chapter 2 provides an overview of the Philippine economy and the Philippine banking system. Chapter 3 estimates the effects of changes in domestic interest rate, foreign interest rate, and exchange rate on daily bank stock returns as well as on quarterly bank income. Chapter 4 investigates the determinants of non-performing loans in the Philippines. Finally, Chapter 5 summarizes the main findings, provides policy implications, and identifies future research agenda.

Chapter 2

Overview

In this chapter, we provide an overview of the Philippine economy and highlight the different financial market conditions during the global financial crisis (GFC) period and after the GFC period. Note that in Chapter 3, we investigate the sensitivity of bank stock returns between two sub-periods, i.e., 2006 to 2013 and 2014 to 2018. Additionally, several empirical studies suggest that macroeconomic factors seem to affect non-performing loans, which we examine in Chapter 4. Hence, the operating environment during our observation period may help us understand the mechanism behind the results. We also discuss in this chapter the balance sheet structure of Philippine banks, since risk exposures of banks can greatly depend on the composition of their assets and liabilities.

2.1 Overview of the Philippine Economy

The Philippines is a developing country and its economy has been considered as one of the strongest performers in Asia over the past decade (International Monetary Fund, 2018). Specifically, real gross domestic product (GDP) growth has been averaging at 6.0% since 2012 (Figure 2.1). Also, unemployment rates have gradually decreased from 7.4% in 2010 to 5.3% in 2018 (Figure 2.2). Likewise, inflation rates have been relatively stable between 2010 and 2014 although increasing in 2016 to 2018 (Figure 2.3). Private consumption, which accounts for at least 70% of GDP for the past 20 years (Figure 2.4), has been steadily growing since 2010 at around 5% to 6% which is almost at the same rate as GDP growth (Figure 2.5). In addition, exports which comprise about 25% of GDP (Figure 2.4) continue to grow in double digits reaching its highest growth at 20% in 2017

(Figure 2.5), although exports are being offsetted by higher imports (Figure 2.4). Government expenditures also propel economic growth as fiscal spending are averaging an 11% growth from 2014 to 2018 (Figure 2.5). In terms of production, services sector which comprises the largest portion at 55% to 60% of GDP has been steadily growing at 6% since 2010 (Figure 2.6). In addition, the industry sector which accounts for 30% of GDP also grows at 7% on average (Figure 2.6). One important contributor to a strong domestic consumption is the continuing overseas remittances which amount to around 10% of GDP for the past two decades (Figure 2.7). External rating agencies also validate the strength of the Philippine economy as they consecutively upgrade the long-term sovereign credit rating of the Philippines from a speculative credit grade in 2006 to its first investment grade rating in 2014.[1] Rating agencies have cited sustainable growth, strong fiscal position, and low public debts as the key contributors for the rating improvements (Lucas, 2019). Overall, the Philippine economic performance is sustained by strong domestic demand particularly the growing consumer expenditure.

However, like the rest of the world, the Philippines was also affected by global financial crisis (GFC) as GDP growth slowed down from 6.5% in 2007 to 3.1% in 2008 and 1.4% in 2009 (Figure 2.1). The contraction was partly due to negative growth in exports at -9.6% in 2008 and -3.7% in 2009 (Figure 2.5) which were caused by declining world trade (Yap et al., 2009). However, the Philippine economic slowdown in 2008 and

[1] In particular, Moody's rating for the Philippines was upgraded from B1 to Baa2 between 2006 and 2014. Likewise, Standard & Poor's rating for the Philippines was upgraded from BB- to BBB+ in 2006 to 2019 that is one notch or one grade below the A- rating.

2009 was not mainly due to global economic crisis (Yap et al., 2009). Rather, shocks in international oil and food prices resulted to a spike in inflation from 3.0% in 2007 to 10.5% in 2008 (Figure 2.3) which tempered household spending (Yap et al., 2009). Thus, private consumption growth, which accounted for three-fourth of GDP, declined from 5.6% in 2007 to 2.7% in 2009 and resulted to a lower GDP growth between 2008 and 2009 (Figure 2.5). Nevertheless, empirical studies indicate that the Philippine economy did not plunge into recession during the GFC period (Balisacan et al., 2010). Unemployment rates slightly increased from 7.3% in 2007 to 7.5% in 2009 (Figure 2.2). Moreover, overseas remittances remained strong amidst the GFC and continued to grow at 5.6% in 2008 and at 8.2% in 2009 although slower than prior years (Figure 2.7). Likewise, fiscal stimulus packages helped the economic to be on track at 6.1% GDP growth in 2010 and remained to be at that range from 2012 to 2018 (Figure 2.5).

Investors' confidence and optimism in the Philippine economy is also seen in financial markets. Stock market index more than doubled from 4000 level before the GFC in 2007 to its peak at 8700 level in 2018 (Figure 2.8). Additionally, interest rates on government securities substantially decrease from 2008 to 2013 although interest rates gradually increase in 2014 to 2018 (Figure 2.9). Inflation rates are also manageable from a range of 3% to 5% between 2010 and 2014 to a range of 1% to 3% between 2015 and 2017, although they rise in 2016 to 2018 similar with domestic interest rates (Figure 2.3). While global interest rates influence the movements of domestic interest rates, strong Philippine economic fundamentals also contributed to lower domestic interest rates. Moreover, monetary policy rates are conducive for economic growth as manifested in falling bank lending rates from around 8% in 2010 to 6% in 2018 (Figure 2.10). On the

other hand, Philippine peso appreciates relative to US dollar after the GFC in 2009 until 2013, although it generally depreciates relative to US dollar between 2013 and 2018 (Figure 2.11). The impacts of changing macroeconomic conditions on stock returns and profitability of Philippine banks are investigated in Chapter 3 of this dissertation.

2.2 Philippine Banking System

The Philippine financial system is dominated by banks as they capture around 80% of total assets in the financial system since 1998 (Figure 2.12). In particular, the majority is shared among 46 universal and commercial banks which hold 75% of the total assets in the Philippine financial system as of end-2019 (Figure 2.12). Consequently, banks are also major suppliers of credit as they contribute at least two-third of the domestic credit provided by the Philippine financial sector (Figure 2.13). In addition, domestic banks play crucial roles in supporting the Philippine economic progress as bank credit to various industries grows from 30% of GDP in 2010 to 50% of GDP in 2018 (Figure 2.13). Hence, the soundness and the stability of Philippine banking system seems to be critical for a sustainable economic growth in the Philippines.

Philippine banks operate a traditional business model as their primary activities involve deposit taking and lending (Bangko Sentral ng Pilipinas, 2019b, p.18) and net interest income from these operations generate about two-third of their total operating income (Figure 2.14).[2] In particular, at least 50% of total assets are in loans followed by

[2] Net interest income is defined as the difference between interest income on loans and interest expense on deposits.

20% in financial securities and around 15% to 20% in cash and cash equivalents since 2008 (Figure 2.15). In term of funding, banking operations are mainly financed by deposits which stand at around 75% of total assets since 2008 (Figure 2.15). These deposits are mostly low cost deposits and are generally considered stable sources of funds for banks (Bangko Sentral ng Pilipinas, 2019b, p.21) since the Philippines has a broad deposit base which continue to grow and amount to 66% of GDP in 2017 (Figure 2.16).

In terms of risk exposures, credit risk remains to be the primary risk of Philippine banks, although non-performing loans to total loans ratios (NPL) are declining and remain low, at an average of 2% since 2014 (Figure 2.14). The microeconomic and macroeconomic determinants of NPL of Philippine banks are examined in Chapter 4 of this dissertation. Domestic banks are also exposed to interest rate risk as loans, which comprise the majority of bank assets, are subject to repricing risk in a falling interest rate environment. In addition, movements in interest rates can affect the market value of financial securities that account for about 20% of total assets (Figure 2.15). Philippine banks are also directly exposed to foreign exchange risk as they transact in foreign currency-denominated (FCD) lending and borrowing activities as well as foreign exchange derivatives. In particular, around 20% of bank assets are denominated in foreign currencies which are composed of FCD financial securities and FCD loans (Figure 2.17). The exposures of Philippine banks to interest rate risk and exchange rate risk are estimated in Chapter 3 of this dissertation. On the other hand, funding liquidity risk of domestic banks is fairly manageable as liquid assets, which are composed of cash and financial securities, are equivalent to around 50% of deposits (Figure 2.14). Additionally, Philippine banks have adequate capital to absorb unexpected losses as capital to risk-

weighted assets or the capital adequacy ratios (CAR) stand at around 15% since 2008 (Figure 2.14) which is above the 10% and the 8% minimum CAR set by local regulatory authority and prescribed internationally by Basel Committee on Banking Supervision, respectively.

Chapter 3

Sensitivity of Philippine Universal Bank Stock Returns to Interest Rate and Exchange Rate Risks

3.1 Introduction

The global financial crisis of 2007-2009 (GFC) highlights the importance of macroprudential regulations in promoting the stability of financial system. One aspect of macroprudential supervision is the identification of systemically important banks because financial distress arising from these institutions could potentially disrupt the country's banking industry and the whole financial system. Thus, regulatory authorities should be able to identify the vulnerabilities of these "too big to fail" banks particularly to system-wide changes in financial market conditions.

In the Philippines, the big banks are engaged in foreign currency-denominated transactions such as foreign loans and deposits as well as foreign exchange derivatives. In fact, 20% of Philippine banking assets are foreign assets that are mostly denominated in US dollars. These transactions can make the Philippine largest banks directly expose to foreign interest rate and exchange rate risks aside from domestic interest rate risk. Against this backdrop, we aim to provide empirical evidence on how US financial markets affect the ten universal banks in the Philippines. In addition, these ten banks

warrant greater supervisory attention since their size and scope of operations could have systemic importance to the Philippine economy.[3]

Several studies investigate the usefulness of bank stock prices in assessing bank financial conditions relative to bank supervisory ratings.[4] For example, Krainer and Lopez (2008) find that abnormal US bank stock returns are useful in predicting changes in supervisory ratings.[5] Likewise, Gropp et al. (2006) find that distance to default based on bank stock equity can predict changes in agency ratings (as proxy for supervisory ratings) in European banks. However, Berger et al. (2000) find that equity market indicators, such as bank stock returns, and supervisors' ratings are unrelated plausibly because these indicators may capture different perspectives, i.e., bank examiners concentrate on current condition, while market participants focus on expected future earnings.

While this chapter also utilizes bank stock returns, we do not evaluate the informational content of bank stock prices in reflecting bank's financial health or distress. Rather, we utilize bank stock returns to evaluate the risk exposures of banks to changes in macro-financial variables such as interest rate and exchange rate. Our study is more related to the works of Choi et al. (1992), Wetmore and Brick (1994), and Tai (2000) who

[3] The regulatory authority of banks in the Philippines (Bangko Sentral ng Pilipinas) does not publicly disclose the list of domestic systemically important banks.

[4] Supervisory rating provides an overall measure of bank's health and financial conditions based on the on-site inspection of bank supervisors (Krainer & Lopez, 2008).

[5] Other studies on US banks include Curry et al. (2001), Flannery (1998), and Gunther et al. (2001).

jointly examine the sensitivity of bank stock returns to stock market, interest rate, and exchange rate. In addition, we follow the growing literature on asset returns which captures the time-varying conditional variance of bank stock returns using generalized autoregressive conditional heteroskedasticity (GARCH) models. However, this chapter differs from previous research and contributes to the literature in the following ways. First, we incorporate foreign (US) interest rate risk along with domestic interest rate risk, exchange rate risk, and stock market index, as earlier studies analyze only domestic interest rate risk. The risk variables are measured by daily changes in domestic interest rate, US interest rate, and Philippine peso to US dollar (PHP/USD) exchange rate. We also include additional regressors, such as PH and US monetary policy rates as measures of policy-induced interest rate changes, and the six sectoral stock indices, instead of a single stock market index, as control for general market conditions. Second, we employ model averaging techniques to capture model uncertainties arising from covariates selection. Third, we construct indicators for abnormal bank stock returns using GARCH estimates which could serve as early warning signals of banks' vulnerability to drastic changes in financial market conditions. Fourth, we also investigate the effects of changes in interest rate and exchange rate on quarterly bank profits. Finally, to the best of our knowledge, this research is the first study on the sensitivity of Philippine bank stock returns and contributes to the limited literature on bank stock returns and bank profits in developing countries.

This chapter proceeds as follows. Section 3.2 provides the literature on sensitivity of bank stock returns. Section 3.3 specifies the empirical strategy. Section 3.4 describes the dataset. Section 3.5 presents the results of GARCH models. Section 3.6 illustrates

how to construct early warning indicators based on GARCH estimates. Section 3.7 discusses the results of panel models. Finally, Section 3.8 concludes this chapter.

3.2 Literature review

The literature on sensitivity of bank stock returns to movements in stock market index, interest rate, and exchange rate is mainly based on intertemporal capital asset pricing model (ICAPM) of Merton (1973), two-index model of Stone (1974), and arbitrage pricing theory (APT) of Ross (1976). The ICAPM provides the relationship between asset's returns and changes in investment opportunity set which can be proxied by state variables such changes in interest rates. The two-index model of Stone (1974) explicitly incorporates interest rate risk along with market risk in asset pricing model. Likewise, APT is another asset pricing model which defines the excess return (or the risk premium) of an asset as the beta-weighted sum of different risk premiums. Although empirical studies on bank stock returns employ asset pricing models, a statistically significant sensitivity coefficient does not necessarily imply that the risk is priced in the capital markets, unless the researcher further examines the pricing effect of risk premium on stock returns (Yourougou, 1990). In the literature, the risk factors that commonly affect asset prices and returns are market risk, interest rate risk, and exchange rate risk.

Interest rate risk is the most studied risk of bank stock returns and many of this literature focus on US financial institutions. Using two-index model with market risk as the other index, earlier researchers find that changes in domestic interest rates negatively affect the stock returns of US banks (Martin & Keown, 1977; Lynge & Zumwalt, 1980; Flannery & James, 1984; Booth & Officer, 1985; Scott & Peterson, 1986). Flannery and

James (1984) provide evidence that the negative impact of interest rate risk on bank stock returns is related to maturity mismatch between bank's nominal assets and liabilities. Kwan (1991) further examines Flannery and James (1984)'s maturity mismatch hypothesis by allowing interest rate estimates to vary over time using a random coefficient two-index model. The results obtained by Kwan (1991) confirm that the effect of interest rate changes on bank stock returns can be partially explained by maturity (specifically duration) mismatch between banks' assets and liabilities. Other researchers explore the differential impacts of short-term and long-term interest rates on bank stock returns and find that US bank stock returns are more sensitive to changes in long-term interest rate than in short term interest rate (Kane & Unal, 1988; Bae, 1990; Madura & Zarruk, 1995). Meanwhile, Yourougou (1990) investigates the dynamics of interest rate risk between period of relatively stable interest rate (pre-October 1979) and period of highly volatile interest rates (post-October 1979). Yourougou (1990) finds that interest rate risk has little impact during relatively stable interest rate period (pre-October 1979) but exerts a significant effect on US bank stock returns during the volatile interest rate period (post-October 1979). Continuing the observation period for US banks, Neuberger (1991) finds that the statistically significant interest rate risk in 1979 to 1987 monotonically declines and becomes insignificant between 1988 and 1990 indicating that interest rate risk of banks could change over time. Several studies also provide evidence on the declining interest rate risk sensitivity of US banks in the late 1980s (Wetmore & Brick, 1994; Allen & Jagtiani, 1997).

On the other hand, Chamberlain et al. (1997) focus on the effect of exchange rate movements on US and Japanese banks using a two-index model. They find that several

US bank stock returns are more sensitive to exchange rate risk, while only a few Japanese bank stock returns appear to be exchange rate sensitive. They further link the exchange rate coefficients of individual banks to their respective net foreign asset position, and find that accounting-based indicators of exchange rate risk provide significant, but partial measures of exchange rate risk exposures of US banks.

Succeeding researches extend the two-index model in analyzing the dynamics of bank risks. Choi et al. (1992) are the first to examine the joint sensitivity of US bank stock returns to market risk, interest rate risk, and exchange rate risk from 1975 to 1987 using a multifactor index model. They find that movements in interest rates have negative impact on bank stock returns during the post-October 1979 period similar to the results in earlier studies. More importantly, they find that exchange rate risk has a negative impact on bank stock returns prior to October 1979 but the effect becomes positively significant after October 1979. They attribute the shift in exchange rate risk to the reversal in net foreign claims of banks. Wetmore and Brick (1994) also employ Choi et al. (1992)'s multifactor model for the period of 1986 to 1991 and find that interest rate risk of US bank stock returns decreases in the late 1980s consistent with previous studies. Additionally, they find that exchange rate risk of US banks increases and empirically show that exchange rate risk is positively related to banks' unhedged foreign loans exposure. Choi and Elyasiani (1997) reexamine the period of 1987 to 1992 and find that exchange rate risk is generally more significant than interest rate risk during the period. Moreover, they provide evidence that the use of derivatives contracts influences US banks' interest rate and exchange rate risks.

Furthermore, there is a growing literature on the sensitivity of bank stock returns which incorporates the time-varying conditional variance of stock returns using autoregressive conditional heteroscedasticity (ARCH)-type modelling strategies. Song (1994) is the first to apply ARCH model on bank stock returns. He finds that the interest rate risk of US bank stock returns is relatively stable during Fed policy regime shifts in 1979 and 1982 unlike prior studies that find a higher interest rate risk. Nonetheless, the findings of Song (1994) confirm that interest rate risk of US banks also increases at the end of 1982. Using GARCH-in-mean model, Elyasiani and Mansur (1998) reexamine the period of 1970 to 1992 and likewise find a negative impact of long-term interest rate risk on US bank stock returns. Meanwhile, Tai (2000) compares the estimates of market, interest rate, and exchange rate risks on US bank stock returns from different econometric methodologies. He finds a significant exchange rate risk in US bank stock returns for the period of 1987 to 1998 using multivariate GARCH-in-mean model but an insignificant exchange rate risk using nonlinear seemingly unrelated regression via GMM approach. Some studies in other countries also utilize GARCH models such as Ryan and Worthington (2004) for Australian banks, Saporoschenko (2002) for Japanese banks, Hooy et al. (2004) for Malaysian banks, Sukcharoensin (2013) for Thai banks, and Kasman et al. (2011) for Turkish banks. These studies examine domestic interest rate along exchange rate and stock market index similar with existing literature.

3.3 Empirical Strategy

This section provides an introduction on two models of stochastic processes with time-dependent variance and a model with non-linear and non-constant variance. These

three models are combined to estimate the sensitivity of Philippine universal bank stock returns.

3.3.1 ARCH Model

Financial time series processes usually exhibit volatility clustering wherein large price changes tend to persist over an extended period of time (Mandelbrot, 1963). This phenomenon implies that the past realization of stochastic process gives information about the next period variance. One way to account for time-varying volatility is through the autoregressive conditional heteroskedasticity (ARCH) models (Engle, 1982). ARCH model assumes that the non-constant conditional variance reverts to a constant unconditional variance over time. In addition, it is a system of equations whose conditional mean, Equation (1), and conditional variance, Equation (2), are simultaneously estimated. A general form of ARCH process is specified as follows:

$$Y_t = \sum_{j=1}^{k} \beta_j X_{j,t} + \varepsilon_t \qquad (1)$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 \qquad \text{with } p > 0 \qquad (2)$$

and assumes the following properties:

$$E[\varepsilon_t] = 0\,, \qquad E[\varepsilon_t^2] = \sigma_t^2, \qquad E[\varepsilon_t \varepsilon_s] = 0 \quad for \quad t \neq s$$

where Y_t is a random variable at time t, X_t is a vector of explanatory variables which may include lagged Y_{t-1}, and ε_t is the error term of conditional mean with conditional variance σ_t^2, ε_t^2 is the squared error term, and α and β are the unknown parameters. This model requires the parameter $\alpha_o > 0$ for variance to be positive. In addition, the variance

and the fourth moment must be finite. This condition is satisfied when parameters $\alpha_1 < 1$, $\cdots$, $\alpha_p < 1$ and $3\alpha_1^2 < 1, \cdots, 3\alpha_p^2 < 1$. The stationary variance in ARCH process is defined as $\frac{\alpha_0}{1-\alpha_1-\cdots-\alpha_p}$ (Engle, 1982).

3.3.2 GARCH Model

One drawback of ARCH models is the high order of lags p needed to adequately account for the persistence of volatility. The generalized autoregressive conditional heteroskedasticity (GARCH) model is developed to provide a more parsimonious parametrization of time-varying variance (Bollerslev, 1986). It specifies that the past conditional variance affects the current conditional variance. Hence, it contains longer memory and provides a more flexible lag structure than a high-order ARCH specification. Nevertheless, GARCH model has the same properties as ARCH model. A general form of the variance equation in a GARCH (*p, q*) model is described as:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \gamma_j \sigma_{t-j}^2 \qquad (3)$$

where $p > 0$, $q > 0$. A GARCH process requires the parameters $\alpha_o > 0$, $\alpha_i \geq 0$, $\gamma_j \geq 0$, and $\sum_{i=1}^{\max(p,q)} (\alpha_i + \gamma_j) < 1$ for the variance to be finite and positive (Bollerslev, 1986).

3.3.3 Multiplicative Heteroskedasticity

Other variables can also affect the variance of a stochastic process (Judge et al., 1985, p.439). One model that incorporates exogenous variables in the variance equation is Harvey's (1976) regression model with multiplicative heteroskedasticity. This model

assumes that the variance is a nonlinear function of explanatory variables raised to a certain power. A general representation of multiplicative heteroskedasticity model is given by:

$$Y_t = X_t'\beta + \varepsilon_t \quad ; \quad \varepsilon_t \sim N(0, \sigma_t^2) \tag{4}$$

$$\sigma_t^2 = exp(Z_t'\alpha) \tag{5}$$

It has the same properties as ARCH and GARCH models wherein:

$$E[\varepsilon_t] = 0\,, \qquad E[\varepsilon_t^2] = \sigma_t^2, \qquad E[\varepsilon_t \varepsilon_s] = 0 \quad for \quad t \neq s$$

where Y_t is a (n x 1) vector of dependent variables, X_t is a (k x 1) vector of independent variables, Z_t is a (k x 1) vector of exogenous variables whose first element is assumed to be one, and α and β are the unknown parameters. These parameters are not restricted to be either zero or positive unlike in ARCH and GARCH models (Harvey, 1976).

3.3.4 Multiplicative (Logarithm) GARCH

The multiplicative heteroskedasticity model can be combined with GARCH model by adding the past squared errors (ARCH term) and lagged conditional variance (GARCH term) in the specification and is referred as multiplicative GARCH model. It is generally expressed as:

$$\sigma_t^2 = \exp(\omega_t) \prod_{i=1}^{p} (\varepsilon_{t-i}^2)^{\alpha_i} \prod_{i=1}^{q} \left(\sigma_{t-j}^2\right)^{\gamma_j} \tag{6}$$

where $\omega_t = Z_t'\alpha$. Equation (6) can be transformed to logarithms and can be written as:

$$\log(\sigma_t^2) = \omega_t + \sum_{i=1}^{p} \alpha_i \log(\varepsilon_{t-i}^2) + \sum_{j=1}^{q} \gamma_j \log(\sigma_{t-j}^2) \quad (7)$$

Thus, multiplicative GARCH is sometimes referred as logarithmic GARCH model in the literature (Bollerslev, 2008).

3.3.5 ARMA-Multiplicative GARCH model

The model used in this chapter follows the growing literature on financial asset returns which utilizes GARCH modelling strategy and assumes time-varying variance. In addition, this research extends the multifactor index model of bank stock returns (Choi et al., 1992; Wetmore & Brick, 1994; Tai, 2000). However, it differs from earlier studies as we incorporate foreign (US) interest rate risk as one of the index. We include US interest rate since the foreign assets and deposits of Philippine banks are mostly denominated in US dollars (BSP, 2019b). Likewise, we choose PHP/USD dollar exchange rate for exchange rate risk of Philippine banks, since US dollar is a major trading currency in the Philippines. Additionally, we include domestic (PH) and foreign (US) monetary policy rates as measures for policy-induced interest rate changes, since monetary policies may have time-varying effects on bank profitability (Ampudia & Van den Heuvel, 2019). Furthermore, we assume that the risk variables affect the mean of bank stock returns in a linear manner, but they influence the variance of bank stock returns in a non-linear fashion. Hence, we specify a multiplicative GARCH model in the variance equation. Our univariate ARMA (1,1) - multiplicative GARCH (1,1) model is given by:

$$R_{it} = \alpha_{i0} + \alpha_{i1} R_{it-1} + \sum_{j=1}^{6} \beta_{ij} \Delta MR_{j,t-1} + \beta_{i7} \Delta SR_{t-1} + \beta_{i8} \Delta LR_{t-1} + \beta_{i9} \Delta BSP_t$$

$$+ \beta_{i10} \Delta USR_{t-1} + \beta_{i11} \Delta FX_{t-1} + \beta_{i12} \Delta FED_t + \alpha_{i3} \varepsilon_{it-1} + \varepsilon_{it} \quad (8)$$

$$log\ \sigma_{it}^2 = \ log\gamma_{i0} + \delta_{i1} log|\Delta SR_{t-1}| + \delta_{i2} log|\Delta LR_{t-1}| + \delta_{i3} log|\Delta BSP_t|$$

$$+\ \delta_{i4} log|\Delta USR_{t-1}| + \delta_{i5} log|\Delta FX_{t-1}| + \delta_{i6} log|\Delta FED_t|$$

$$+ \gamma_{i1} log\varepsilon_{it-1}^2 + \gamma_{i2} log\sigma_{it-1}^2 \qquad (9)$$

$$\varepsilon_{it}|\Omega_{t-1} \ \sim \ student - t\ distribution\ (0,\ \sigma_{it}^2,\ v)$$

Equation (8) is the mean equation, where $R_{it} = log\left(\frac{P_{it}}{P_{it-1}}\right)$ is the log difference (% change) on daily stock prices P_{it} of bank i at time t; $\Delta MR_{j,t-1}$ is the lag of log difference (% change) on daily prices of sectoral stock index j; ΔSR_{t-1}, ΔLR_{t-1}, and ΔUSR_{t-1} are the lags of first difference ($Interest\ rate_t - \ Interest\ rate_{t-1}$) on daily PH 3-month treasury bill (T-bill) rate, PH 10-year treasury bond (T-bond) rate, and US 3-month T-bill rate, respectively; ΔFX_{t-1} is the lag of log difference (% change) on daily Philippine peso to United States dollar (PHP/USD) exchange rate. A negative ΔFX_t indicates that PHP appreciates relative to USD at time t. Meanwhile, ΔBSP_t and ΔFED_t are the first difference of current monetary policy rate and monetary policy rate before the most recent policy meeting. The Bangko Sentral ng Pilipinas (BSP) policy rate pertains to the overnight reverse repurchase rate as the main monetary policy rate in the Philippines. On the other hand, Fed funds rate refers to the federal funds rate (until 15 December 2008) and the upper bound of the federal funds target range (starting 16 December 2008) when Fed changes from a single target rate to a target range. All variables are in percentage. Furthermore, the regressors in variance equation, Equation (10), are in absolute values. The vectors of parameters are β and δ which capture the sensitivity of the mean and the variance of bank stock returns to changes in risk variables. Note that the coefficients are

bank-specific since the estimation is done for each bank. On the other hand, γ_0 pertains to time invariant or the long-run variance, γ_1 captures the effect of past squared errors (ARCH effect), and γ_2 provides the effect of lagged conditional variance (GARCH effect). The error ε_{it} is assumed to have a student-t distribution with mean zero, variance σ_{it}^2, and degrees of freedom v. Meanwhile, Ω_{t-1} contains all the available information at time $t-1$. The validity of this specification is discussed in Section 3.4 of this chapter.

3.3.6 Model Averaging

Model averaging (MA) techniques are employed when there are uncertainties on covariates inclusion, functional specifications, and theoretical framework as discussed by Steel (2019). He argues that choosing a single best model from a set of all possible models tends to disregard the information contained in alternative models. Meanwhile, MA methods incorporate model uncertainties during estimation. Since there could be uncertainties in choosing the risk variables in a multi-index model of bank stock returns, we opt to employ model averaging technique in evaluating the sensitivity of Philippine bank stock returns.

Steel (2019) explains that MA approach can be broadly classified into Bayesian model averaging (BMA) and Frequentist model averaging (FMA). The weights used in BMA are based on posterior model probabilities that require prior knowledge on the distribution of parameters. On the other hand, the weights used in FMA are based on some desirable properties of the parameters. Nevertheless, both MA methods should

define a model space or the set of models to be analyzed composed of 2^k models where k is the number of potential regressors.

Although several factors could affect bank stock returns, we confine the explanatory variables to stock market returns, interest rate, exchange rate, and monetary policy rate based on existing literature. We construct the model space in this chapter based on the following procedures: First, we use six sectoral stock indices as control variables in the mean equation. Second, we group the regressors into PH variables (i.e., PH 3-month T-bill rate, PH 10-year T-bond rate, and BSP policy rate) and US variables (i.e., PHP/USD exchange rate, US 3-month T-bill rate, and Fed policy rate).[6] Such grouping allows us to estimate the simultaneous effects of long term and short term domestic interest rates on PH bank stock returns and to capture the sensitivity of bank stock returns to yield curve dynamics. Likewise, the set of US variables will provide the joint impact of US interest rate and exchange rate on PH bank stock returns which reflects the vulnerability of Philippine banks to US financial markets. Lastly, we alternately include PH and US variables in the mean and the variance of bank stock returns. This model combination allows us to segregate the joint impact of US variables from PH variables and highlights the country-specific effects of risk variables on bank stock returns. In total, our model space has 16 models (Table 3.1) and 160 regressions for ten banks.

[6] Regressors can be grouped in model averaging techniques (Hansen, 2007).

To have a single estimate $\hat{\beta}_x$ for risk parameter x, we first weigh the estimate $\hat{\beta}_{x,i|m}$ from model m= 1, 2,…,16 of bank i using smoothened Akaike Information Criterion (SAIC). Then, we weigh each bank's SAIC estimate $\hat{\beta}_{x,i}$ using bank's market capitalization. The advantage of smoothened Akaike Information Criterion (SAIC) as a weighting function is discussed by Burnham and Anderson (2002, pp.302-305). They argue that when the true model is unknown and might not be in the model space SAIC is better than Bayesian Information Criterion (BIC), since SAIC chooses the model that minimizes the mean squared error of prediction. In particular, SAIC selects a model from a set of candidate models that adequately fits the unknown model, whereas BIC selects the model with the highest probability as if the true model is in the model space. Given that the model space in this chapter may not contain the true model, SAIC seems to be an appropriate weighing function. The SAIC estimate of a risk parameter x for bank i is defined as:

$$\hat{\beta}_{x,i} = \sum_{m=1}^{M} w_{m,i}\hat{\beta}_{x,i|m} \qquad (10)$$

where $\hat{\beta}_{x,i|m}$ is the estimated parameter x of bank i from model m and $w_{m,i}$ are weights computed as:

$$w_{m,i} = SAIC_{m,i} = \frac{exp(-\frac{1}{2}(AIC_{m,i} - AIC_{min,i}))}{\sum_{m=1}^{M} exp(-\frac{1}{2}(AIC_{m,i} - AIC_{min,i}))} \qquad (11)$$

where $AIC_{m,i}$ is the Akaike Information Criterion of model m and $AIC_{min,i}$ is the lowest AIC from a set of M models for bank i. Likewise, the market capitalization-weighted SAIC estimates $\hat{\beta}_x$ is computed as:

$$\hat{\beta}_x = \hat{\beta}_{x,i} \left(\frac{average\ of\ daily\ market\ capitalization\ of\ bank_i}{\sum_{i=1}^{N} average\ of daily\ market\ capitalization\ of\ bank_i} \right) \quad (12)$$

To determine the significance of a variable in model averaging methods, researchers utilize the posterior inclusion probability (*PIP*) or the probability of inclusion of a variable. It is defined as the sum of posterior model probabilities where variable x_t is specified in the models and is described as:

$$PIP_{x,i} = \sum_{m=1}^{M} w_{m,i}\, \mathrm{I}_{[\hat{\beta}_{x,i|m} \neq 0]} \quad (13)$$

where $\mathrm{I}_{[\hat{\beta}_{x,i|m} \neq 0]}$ is an indicator function taking a value of one when $\hat{\beta}_{x,i}$ is not equal to zero in model m. Since SAIC approximates the posterior model probabilities (Burnham & Anderson, 2002, pp.302-305), the probability that the exogenous variable affects the dependent variable can be computed using SAIC.

Similarly, the aggregate PIP_x of variable x are weighted using bank's market capitalization and is calculated as:

$$PIP_x = PIP_{x,i} \left(\frac{average\ of\ daily\ market\ capitalization\ of\ bank_i}{\sum_{i=1}^{N} average\ of daily\ market\ capitalization\ of\ bank_i} \right) \quad (14)$$

3.4 Data

3.4.1 Dependent variables

The daily gross stock returns $R_{it} = log\left(\frac{P_{it}}{P_{it-1}}\right)$ of ten universal banks traded in Philippine Stock Exchange (PSE) from June 2006 to September 2018 are used as dependent variables. Universal banks are selected because their operations (40% to 60% of Philippine banking assets) might have systemic importance to the Philippine economy.[7] However, one universal bank listed in PSE is excluded in the sample because its shares are inactively traded and its asset size is smaller compared to other universal banks. Table A3.1 in the Appendix provides the list of banks in our sample. Bank stock prices are obtained from Bloomberg.[8] All non-trading days in the Philippines such as holidays, weekends, and trade suspensions are omitted.

Meanwhile, we use daily frequencies instead of monthly data to increase the power of tests (Chamberlain et al., 1997).[9] Moreover, we estimate individual banks, unlike in earlier studies (Kane & Unal, 1988; Bae, 1990; Wetmore & Brick, 1994; Madura

[7] In addition, the ten banks represent 58% of the market capitalization of financial firms listed in PSE between 2006 and 2018.

[8] We do not adjust the bank stock prices for dividends since payments are minimal.

[9] Chamberlain et al. (1997) find that US bank holding companies are sensitive to changes in foreign exchange rate using daily data. However, the results are insignificant using monthly data. They attribute the relative strength of their findings to the use of daily frequencies.

& Zarruk, 1995) that create portfolios of banks, to allow the sensitivity coefficients to be bank-specific.[10]

We further divide the sample into two sub-periods, since they have different macroeconomic conditions. The first sub-period spans from June 2006 to December 2013 and is characterized by declining domestic interest rates environment (Figure 3.1) and relatively stronger PH peso relative to US dollar except for 2008 and 2009 (Panel B of Figure 3.2). The first sub-period also captures the full effects of global financial crisis (GFC) on financial markets. On the other hand, the second sub-period starts from January 2014 to September 2018 and has rising domestic interest rates environment (Figure 3.1) and generally depreciating PHP relative to USD (Panel B of Figure 3.2). Note that the first sub-period has only eight banks, since the shares of two universal banks started trading in the PSE only in 2012 and 2013, while the second sub-period has ten banks. We also term the first and second sub-periods as the crisis period and the normal period, respectively, in this chapter.

Additionally, the maturity mismatch (asset and liabilities management) strategies of banks may substantially differ between the crisis and the normal periods implying that the coefficients in the equations might be different in the two periods. Although the basis for dividing the sample is arbitrary, we argue that market participants will generally agree that in the second sub-period domestic interest rates are rising between 2014 and 2018 and US financial markets are operating under normal conditions.

[10] Banks are grouped together either based on assets size or common banking practices.

The descriptive statistics are shown in Table 3.2. The mean returns of bank stocks are close to zero, while the lowest and highest movements are recorded in the first sub-period (first panel of Table 3.2). Comparing the standard deviation in the first and second panels of Table 3.2, all stock returns have higher fluctuations in the first sub-period than in the second sub-period. In addition, the returns series have kurtosis in excess of three. These statistics indicate that bank stock returns are not normally distributed. Thus, we assume a student-*t* distribution.

3.4.2 Independent variables

We use several variables to proxy market risk, interest rate risk, and exchange rate risk. First, interest rate risks are measured by daily changes in PH 3-month T-bill rate and PH 10-year T-bond rate for short-term and long-term domestic interest rate risk, respectively, and US 3-month T-bill rate for short-term US interest rate risk. Second, foreign exchange risk is captured by daily changes in bilateral PHP/USD exchange rate. Finally, market risk is proxied by the return of six sectoral stock indices, namely, financials, properties (real estate), holding firms, services, commercial, and mining industries. These sectoral stock indices represent 98 firms as opposed to the main index that contains only 30 companies. Hence, they can better control for the effects of general market conditions and industry innovations on bank stock prices. All variables are in

nominal terms and obtained from Bloomberg.[11] Table A3.1 in the Appendix presents a description of all variables.

3.4.3 Diagnostic checks

All the series are covariance stationary since the null hypotheses of unit roots are rejected based on Augmented Dickey Fuller tests. The errors are not serially correlated, but the squared errors still exhibit some degree of autocorrelation based on the correlograms of predicted residuals and squared residuals, respectively. Nonetheless, we maintain a first-order GARCH specification.

Since the covariates may be correlated with each other, several researchers perform orthogonalization procedures (Kane & Unal, 1988; Flannery & James, 1984; Bae, 1990; Madura & Zarruk; 1995) by running a regression between the explanatory variables and utilizing the residuals as the new regressors. However, we use actual data in this chapter for the following reasons. First, price changes are highly unpredictable (Chamberlain et al., 1997). Second, empirical testing using raw data and their orthogonalized residuals gives qualitatively similar results (Flannery & James, 1984; Neuberger, 1991). Third, PH and US interest rates and PHP/USD exchange rate have weak collinearity with sectoral stock indices (less than $|0.3|$ in Table A3.2 in the Appendix). Moreover, the variance inflation factor of all regressors is between one and three (Table A3.3 in the Appendix). Finally, the explanatory variables are lagged by one

[11] Chamberlain et al. (1997) argue that using either nominal or real exchange rates will provide little difference in estimates as both rates are extremely and highly correlated in the short run.

period to address contemporaneous correlation of regressors similar to the approach of Elyasiani and Mansur (1998). Thus, we assume that our models satisfy the exogeneity conditions.

3.5 Results of GARCH Models

This section provides the results of GARCH models using daily bank stock returns.[12] The significance of a regressor is based on the posterior inclusion probabilities (*PIP*) and an explanatory variable is interpreted to have an impact on the dependent variable if the *PIP* > 95% following the works of Pelster and Vilsmeier (2017). It should be noted that regressors within a set (either PH variables or US variables) have the same *PIP*, since they are grouped together during estimation.[13]

Before proceeding with the results, it is important to establish that the ARMA (1,1) - multiplicative GARCH (1,1) models satisfy stability conditions of autoregressive (AR), moving average (MA), and autoregressive conditional heteroskedasticity (ARCH) processes. The absolute values of AR and MA coefficients in all regressions are less than one. In addition, eight out of ten banks have ARCH and GARCH coefficients less than one, while two banks have ARCH and GARCH coefficients greater than one. Nevertheless, the two banks are still included in the analysis. Overall, the estimation procedures are generally stable.

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[12] In the second sub-period, one bank has only 12 out of 16 models, as four models failed to converge during estimation.

[13] We also estimate GARCH-in-mean models but the variance-in-mean coefficients are mostly insignificant.

During the crisis period (2006 to 2013), both the mean and the variance of PH bank stock returns are not correlated with changes in PH 3-month T-bill rate, PH 10-year T-bond rate, and PH monetary policy rate since the *PIP* of PH variables < 95% (*PIP* = 41% in the mean and *PIP* = 68% in the variance equation, first sub-period of Table 3.3). Likewise, the mean and the variance of stock returns of at least six out of eight banks are not sensitive to changes in PH variables as the *PIP* < 95% during the crisis period (first sub-period of Table 3.4). This finding implies that domestic interest rate risk does not seem to affect bank stock returns. This result is surprising given that the core activities of Philippine banks are domestic lending and deposit taking. One plausibly explanation is our choice of variables, since we utilize actual changes in interest rates, which may substantially include anticipated changes in daily PH 3-month T-bill rate and PH 10-year T-bond rate. Stock market participants may have been correct in their expectations on domestic interest rates and already incorporate them in their pricing of bank stocks. Hence, PH bank daily stock returns do not seem to be sensitive to domestic interest rate risk possibly as a consequence of anticipated domestic interest changes. To overcome this limitation, we further examine the effects of changes in domestic interest rates on quarterly bank profits in Section 3.7 of this chapter.

On the other hand, the *PIP* of US variables in the mean equation during the crisis period is 90% (first sub-period of Table 3.3). This finding indicates that the mean of PH bank stock returns is marginally and positively correlated with changes in US 3-month T-bill rate (coefficient = 2.018, first sub-period of Table 3.5) and Fed funds rate (coefficient = 0.273, first sub-period of Table 3.5) but negatively related to changes in PHP/USD

exchange rate (coefficient = -0.305, first sub-period of Table 3.5).[14] At the bank level, the mean of five out of eight bank stock returns (*PIP* > 95%, first sub-period of Table 3.4) is also positively associated with changes in US 3-month T-bill rate and Fed funds rate and negatively correlated with PHP/USD exchange rate movements (first panel of Table 3.6). Taking into consideration the interest rate and exchange rate environment between 2006 and 2013 (crisis period), the estimates indicate that the mean of PH bank stock returns decreases along with falling US interest rates and increases along with appreciating Philippine peso relative to US dollar. Hence, macroeconomic conditions during the crisis period have offsetting effects on the mean of PH bank stock returns with co-movements dominated by US short-term interest rate, since US 3-month T-bill rate has the largest coefficient among US variables.

The positive coefficient of US interest rate on the mean of PH bank stock returns is not consistent with the negative impact of interest rates on bank stock returns found in the literature. One possible explanation is the coefficient of US 3-month T-bill rate may have captured the effect of US economic activities on PH bank stock returns, since our models do not control for US market conditions. To have a better understanding on the effects of US variables on bank profitability, we further investigate the impact of changes in US 3-month T-bill rate on quarterly bank income in Section 3.7 of this chapter.

[14] If we choose the best model based on Akaike Information Criterion, the statistically significant variables in most regressions are also US 3-month T-bill rate and PHP/USD exchange rate. In addition, these two variables have the highest posterior inclusion probabilities (*PIP*) across models.

Nevertheless, changes in US variables seem to significantly affect the variance of PH bank stock returns during the crisis period, since the *PIP* of US variables in the variance equation is 99% (first sub-period of Table 3.3). This result indicates that the variance of PH bank stock returns is positively associated with volatile (large change in absolute value) US 3-month T-bill rate (coefficient = 2.945, first sub-period of Table 3.5), Fed funds rate (coefficient = 0.515, first sub-period of Table 3.5), and PHP/USD exchange rate (coefficient = 1.368, first sub-period of Table 3.5) during the crisis period. Similarly, the variance of seven out of eight bank stock returns (*PIP* > 95%, first sub-period of Table 3.4) is positively affected by fluctuating US interest rates and exchange rates. These results imply that the mean and the variance of PH bank stock returns seem to be sensitive to US interest rate risk and exchange rate risk during the crisis period (2006 to 2013).

However, during the normal period (2014 to 2018), the mean and the variance of PH bank stock returns are no longer correlated with changes in US 3-month T-bill rate, Fed funds rate, and PHP/USD exchange rate (*PIP* = 64% in the mean and *PIP* = 39% in the variance equations, second sub-period of Table 3.3). Meanwhile, the mean and the variance of PH bank stock returns are still not associated with changes in PH 3-month T-bill rate, PH 10-year T-bond rate, and PH monetary policy rate during the normal period (*PIP* = 27% in the mean and *PIP* = 33% in the variance equations, second sub-period of Table 3.3). The insignificance of both PH and US variables is also observed at the bank-level as nine out of ten banks have *PIP* < 95% (second sub-period of Table 3.4). These results imply that the mean and the variance of PH bank stock returns do not seem to be

sensitive to domestic interest rate risk, US interest rate risk, and exchange rate risk during the normal period (2014 to 2018).

Evaluating the full period (2006 to 2018), only the variance of PH bank stock returns is positively correlated with changes in US variables (*PIP* = 95% in the variance equation, full period of Table 3.3) with US 3-month T-bill rate providing the largest coefficient among US variables (coefficient = 3.671, full period of Table 3.5). This finding is also observed at the bank level as the variance of seven out of ten banks is positively associated with changes in US variables during the full period (*PIP* > 95% in the variance equation, full period of Table 3.4). On the other hand, changes in PH variables do not significantly affect the mean nor the variance of PH bank stock returns during the full period (*PIP* = 20% in the mean and *PIP* = 51% in the variance equations, full period of Table 3.3).

Overall, the mean and the variance of Philippine bank stock returns seem to be sensitive to changes in US interest rate and exchange rate particularly during the pre- and post-global financial crisis period (2006 and 2013). These results suggest that the stock returns of Philippine universal banks tend to be vulnerable to US financial markets. Moreover, the different sensitivities of stock returns to US variables between sub-periods indicate that US interest rate and exchange rate risks of Philippine bank stocks are changing over time.

3.6 Early Warning Indicators

This section illustrates how to use GARCH estimates in constructing indicators for abnormal bank stock returns and periods of highly volatile bank stock returns. These

risk indicators may serve as early warning signals on banks' vulnerability to external financial markets and may be useful in market surveillance of bank supervisors. For example, prolonged period of volatile bank stock returns above their historical average could possibly signals that banks are exposed to higher interest rate and exchange rate risks which could merit further investigation from bank supervisors.

3.6.1 A measure of anomaly in the market

First, we select a model with the smallest AIC and compute the standardized residual r_{it} of bank i at time t as:

$$r_{it} = \frac{\hat{\varepsilon}_{it}}{\sqrt{\hat{\sigma}_{it}^2}} \tag{15}$$

where $\hat{\varepsilon}_{it}$ = predicted error and $\hat{\sigma}_{it}^2$ = conditional variance from GARCH models.[15] Then, we derive its probability p_{it} from the cumulative distribution function $\Psi_v(r_{it})$ with v degrees of freedom given by:

$$p_{it} = \Psi_v(r_{it}) \tag{16}$$

The probability of having an abnormal return in period t: $(t + h)$ is described as:

$$p_{it:(it+h)} = (p_{it}p_{it+1} \dots p_{it+h})^{\frac{1}{h+1}}$$

[15] The results are still similar when we use BIC for model selection.

$$log(p_{it:(it+h)}) = \frac{1}{h+1}\sum_{j=t}^{t+h} log(p_{ij}) \qquad (17)$$

We conclude that there seems to be an anomaly in stock returns of bank i between period t and $t+h$ whenever $log(p_{it:(it+h)})$ < log(0.01) at 1% significance level. In this chapter, we set h = seven trading days and find that the stock returns of Philippine universal banks do not exhibit any anomalies from June 2006 to September 2018.

3.6.2 A measure of turbulent times

To determine if bank stock returns are more volatile in a particular period than their historical average, we compute the average variance of bank i from period t and $t+h$ as:

$$\vartheta_{it:(it+h)} = \frac{1}{h+1}(\hat{\sigma}_{it}^2 + \hat{\sigma}_{it+1}^2 + \cdots + \hat{\sigma}_{it+h}^2) \qquad (18)$$

and the sample variance as:

$$s_i^2 = \frac{1}{T}(\hat{\sigma}_{i1}^2 + \hat{\sigma}_{i2}^2 + \cdots + \hat{\sigma}_{iT}^2) \qquad (19)$$

where T = 3004 trading days from June 2006 to September 2018.

We conclude that the stock returns of bank i tend to exhibit higher volatility during period t: $(t+h)$ whenever $\vartheta_{it:(it+h)} > 1.96\sqrt{s_i^2}$ at 5% significance level. Setting h= seven trading days, the seven-day moving volatility of PH bank stock returns is fluctuating above the historical average during 2007 to 2009(Figure 3.3). This result indicates that Philippine bank stock returns are highly volatile during the global financial

crisis period. Note that the risk indicators are derived from estimated coefficients in GARCH models which capture the effects of volatile US interest rates and exchange rates on the variance of bank stock returns. Thus, this finding implies that the high volatility of daily bank stock returns during 2007 to 2009 may be attributed to changes in US interest rate and exchange rate during the period.

3.7 Panel Analyses

Since the GARCH analysis on daily bank stock returns might fail to correctly capture the effect of domestic interest rates possibly due to the anticipation effects of changes in interest rates, we further examine the impact of changes in domestic interest rate, US interest rate and exchange rate on quarterly bank income. In addition, assessing the impact of changes in interest rate and exchange rate on bank profits may be more relevant for policy development, since operating losses could possibly erode bank capital and threaten the viability of banks. We estimate a linear panel model specified as:

$$NI_{iq} = \sum_{j=1}^{6} \beta_j \Delta MR_{jq} + \beta_7 \Delta SR_q + \beta_8 \Delta LR_q + \beta_9 \Delta BSP_q$$

$$+ \beta_{10} \Delta USR_q + \beta_{11} \Delta FX_q + \beta_{12} \Delta FED_q + \delta_q T_q + \upsilon_i + \varepsilon_{iq} \qquad (20)$$

where NI_{iq} is the net income to average equity ratio of bank i at quarter q. This data is obtained from the proprietary reports submitted by banks to the BSP. The regressors, ΔMR_{jq}, ΔSR_q, ΔLR_q, ΔBSP_q, ΔUSR_q, ΔFX_q, and ΔFED_q, are the same variables used in GARCH models but in quarterly frequencies, namely, changes in sectoral stock index j, PH 3-month T-bill rate, PH 10-year T-bond rate, BSP policy rate, US 3-month T-bill rate, PHP/USD exchange rate, and Fed policy rate, respectively.

Meanwhile, T_q is a vector of year dummies, v_i is bank fixed effect, and ε_{iq} is the idiosyncratic error term that is assumed to be uncorrelated with explanatory variables. Note that we divide the panel analysis into sub-periods similar to GARCH analysis. However, the first sub-period in panel model covers 2008Q1 to 2013Q4, instead of 2006 to 2013, as we do not have the quarterly profits for 2006 to 2007. Meanwhile, the second sub-period in panel model is the same as in the GARCH model, i.e., 2014Q1 to 2018Q3.

Controlling for domestic interest rates, changes in US 3-month T-bill rate negatively affect quarterly bank income during the crisis period (2006 to 2013) (estimate = -1.051, first sub-period of Table 3.7). One possible mechanism how US interest rates affect bank profits is through the US dollar-denominated securities holdings of banks.[16] In a decreasing interest rate environment, banks earn lower interest income on loans, but they also incur marking-to-market gains on their debt securities investments. Since Philippine banks have a considerable amount of US dollar-denominated financial securities (BSP, 2019b), falling interest rates translate to higher prices on these securities and unrealized income, thereby increasing bank income. The negative impact of US 3-month T-bill rate on bank profits is also observed during the normal period (estimate = -3.053, second sub-period of Table 3.7). These findings imply that the profitability of Philippine universal banks seems to be sensitive to US interest rate risk.

On the other hand, changes in PHP/USD exchange rate do not significantly affect bank profits (Table 3.7). One plausible explanation is the "asset cover" regulation of the

[16] Financial securities, which are mainly denominated in US dollar, comprise 50% of the total foreign currency-denominated assets of Philippine banks from 2007 to 2017 (BSP, 2019b).

BSP, wherein banks are required to match certain portion of their foreign assets and foreign liabilities in the same currency. Thus, said policy may have minimized the exchange rate risk of Philippine banks. Likewise, the use of foreign exchange derivatives may have helped banks manage their currency risk.

It is also interesting to note that changes in long-term domestic interest rate affect bank profits during the crisis period (2006 to 2018) but not during the normal period (2014 to 2018). In particular, changes in PH 10-year T-bond rate positively affect quarterly bank income during the crisis period (estimate = 1.110, first sub-period of Table 3.7). It should be noted that the main source of earnings for Philippine banks is net interest income (defined as the difference between interest income on loans and interest expense on deposits).[17] And in a falling interest rate environment, Philippine banks can remain profitable by maintaining their net interest margin.

However, prolonged period of declining interest rates between 2006 and 2013 may have put a greater downward pressure on long-term yields. This situation possibly tightens banks' net interest margin, since banks earn higher interest income on long-term loans than on short-term loans. However, when domestic interest rates increase between 2014 and 2018, changes in long-term domestic interest rates do not significantly affect bank income (second sub-period of Table 3.7). The rising domestic interest rates may have provided banks more allowance to adjust their interest rates on loans and deposits and maintain their net interest margin. Additionally, the asset and liability (maturity

[17] Net interest income from lending and deposit-taking operations of Philippine banks generate about two-third of total operating income.

mismatch) management strategies of banks may have been more effective between 2014 and 2018 (normal period).

As an additional analysis, we examine the link between bank stock returns and bank profits using a linear panel model given by:

$$R_{iq} = \alpha NI_{iq} + \delta_q T_q + \upsilon_i + \varepsilon_{iq} \quad (21)$$

where R_{iq} is the quarterly bank stock returns, NI_{iq} is the net income to average equity ratio of bank i at quarter q, T_q is a vector of year dummies, υ_i is bank fixed effect, and ε_{iq} is the idiosyncratic error term. Net income to equity ratios are statistically significant at 5% significance level indicating that bank stock prices are positively associated with bank income particularly between 2006 and 2013 (coefficient = 0.735, first sub-period of Table 3.8), although several other factors also affect bank stock prices (R-squared = 0.395, first sub-period of Table 3.8). Nevertheless, this finding implies that bank stock returns are not driven solely by market speculation, but are also related to fundamental such as bank income.

3.8 Conclusion and Policy Implications

In this chapter, we examine the sensitivity of daily bank stock returns to changes in domestic interest rate, foreign interest rate, and exchange rate using generalized autoregressive conditional heteroskedasticity (GARCH) models and model averaging techniques. We also construct indicators of bank stock volatility based on GARCH estimates. In addition, we investigate the effects of changes in interest rate and exchange rate on quarterly bank income using linear panel model.

The mean and the variance of Philippine daily bank stock returns seem to be sensitive to US interest rate risk and exchange rate risk between 2006 and 2013 (crisis period) but not between 2014 and 2018 (normal period). Specifically, changes in US 3-month Treasury bill rate and PHP/USD exchange rate seem to have offsetting effects on the mean of Philippine bank stock returns with US interest rate risk dominating the impact. In addition, fluctuations in US interest rate and exchange rate seem to contribute to the high volatility of daily bank stock returns during the global financial crisis period (2007 to 2009), as illustrated by GARCH-based indicators in Section 3.6. Moreover, the different sensitivities of stock returns between sub-periods indicate that US interest rate and exchange rate risks of Philippine bank stocks are changing over time.

Meanwhile, rising US interest rates tend to adversely affect quarterly bank income based on linear panel model. This finding indicates that the profitability of Philippine universal banks seems to be also sensitive to US interest rate risk. Given the effects of changes in US interest rate on daily bank stock returns and on quarterly bank profits, these results suggest that Philippine largest banks tend to be vulnerable to US financial markets. Hence, bank supervisors should also monitor the transmission of US financial risk to the Philippine banking industry and incorporate US financial markets in their market surveillance. Additionally, the findings imply that US interest rate risk seems to be an important risk exposure of Philippine universal banks. Thus, bank supervisors could strengthen their regulations on foreign assets and foreign currency-related transactions and thoroughly examine how banks manage their foreign assets and liabilities during on-site examination. Moreover, the GARCH-based indicators presented in Section 3.6 may

serve as early warning signals on banks' vulnerability to shocks from external financial markets.

This chapter can be extended by analyzing the sensitivity of bank capital to changes in domestic interest rate, foreign interest rate, and exchange rate and comparing the estimates with the actual capital allotted for interest rate risk and exchange rate risk to empirically assess banks' capital adequacy.

Chapter 4

Microeconomic and Macroeconomic Determinants of Non-performing Loans: The Case of Philippine Commercial and Savings Banks

4.1 Introduction

The ratio of non-performing loans to total gross loans (NPL) is one of the core financial soundness indicators used by bank supervisors.[18] It indicates the quality of bank assets, particularly loans, wherein an increasing ratio signals a deterioration in loan quality (International Monetary Fund [IMF], 2019, p.88). In the literature, NPLs have been linked with facilitating and prolonging financial crises (Ari et al., 2019). In addition, many empirical studies provide support on the cross-linkages between NPL and the growth of aggregate economy. On one hand, macroeconomic conditions affect NPL by influencing borrowers' debt-servicing capacities. On the other hand, NPL feeds back to the real economy by constraining bank credits to economic agents thus affecting outputs. Hence, understanding the nature and characteristics of NPL is crucial for policy development.

In the Philippines, NPLs have been continuously decreasing since the post-Asian financial crisis era (Figure 4.1). NPL resolution strategies, regulatory reforms, and enhancement in credit risk management policies of banks could have contributed to the decline in NPL (Baudino & Yun, 2017). In addition, favorable economic performance of

[18] Financial Soundness Indicators (FSIs) are IMF-recommended indicators on the financial health of financial institutions (IMF, 2019, p.1).

Philippine economy (discussed in Section 2.1 of Chapter 2) could have enhanced the repayment capacities of borrowers. Although the declining trends in NPL pose no imminent threat to the stability of Philippine banking system, identifying the factors affecting NPL are important aspects of macroprudential surveillance, policy development, and NPL resolution strategies should economic shocks occur.

One theoretical model that incorporates default risk in a consumption model is the life cycle model proposed by Lawrence (1995). He argues that low-income borrowers tend to have higher delinquency rates probably because low-income level signals higher risk of unemployment. While borrower's income might be an important determinant of non-performing loans, we focus on the supervisory perspective of how bank-specific characteristics and macroeconomic conditions contribute to NPL build up.

Empirical works on NPL in the Philippines remain limited particularly studies with bank-level data. For instance, Lee and Rosenkranz (2019) analyze the determinants of NPL using 165 banks in Asia including the Philippines. They find that macroeconomic factors have more quantitative impact on NPL than bank-specific characteristics. Meanwhile, a granular NPL analysis is conducted by Louzis et al. (2012) by examining NPLs of mortgages, consumer, and business loans of nine Greek banks from 2003Q1 to 2009Q3 (27 quarters). They find that declining GDP growth and rising unemployment rates strongly affect business NPL but slightly influence mortgages NPL. Our approach is similar to the strategy of Louzis et al. (2012), since we also investigate the macroeconomic and bank-specific determinants of NPL using dynamic panel models. However, our study differs from their research in several ways and contributes to the literature in the following manner. First, we employ a longer panel dataset with 130 banks

and 40 quarters from 2009Q1 to 2018Q4. Hence, we can have estimates that are more efficient than those in previous studies. In addition, our panel dataset allows us to jointly estimate several bank-specific characteristics and macroeconomic variables unlike Louzis et al. (2012) who estimate only one bank-specific variable at a time with macroeconomic variables. Second, we provide a more granular NPL analysis with regular loans (corporate, consumption, and housing loans) and specialized credits (agricultural, small- and medium-enterprises, and microfinance loans) in the Philippines which is not commonly done in the literature. Third, we employ alternative measures of lending policies, namely, the ratio of real and other properties acquired to total assets (ROPA/TA) as proxy for bank's lending policies on collateral requirements and the diffusion index for credit standards as proxy for the general credit standards in the banking industry. Finally, to the best of our knowledge, this study is the first comprehensive analysis on microeconomic and macroeconomic determinants of NPL in the Philippines using dynamic panel models.

Chapter 4 proceeds as follows: Section 4.2 provides the literature on microeconomic and macroeconomic determinants of NPL. Section 4.3 discusses the empirical strategy. Section 4.4 describes the data. Section 4.5 provides the results. Finally, Section 4.6 presents the conclusion and policy implications.

4.2 Literature review

The most common measure of loan quality in the literature is ratio of non-performing loans to total loans (NPL). Non-performing loan is a regulatory concept and is broadly defined as loan with missed payment on principal or interest for the past 90 days. Several empirical evidence suggest that macroeconomic fundamentals and banking

characteristics seem to influence NPL. They argue that macroeconomic variables are external factors that affect borrowers' repayment capacity. Meanwhile, banking characteristics are internal factors that indicate the risk-taking activities of banks. However, many of these empirical studies employ country-level and aggregate banking data. Nevertheless, there is growing strand of NPL literature that utilizes bank-level data and some of them are presented below.

4.2.1 Bank-specific factors

Berger and Deyoung (1997) and Louzis et al. (2012) examine the bank-specific factors that may affect NPL and provide the following hypotheses:

First, ‘‘moral hazard’’ hypothesis suggests that low-capitalized banks (as measure by equity to assets ratio) tend to have higher NPL. Berger and DeYoung (1997) argue that since these banks are already high risk, they have the incentive to grant riskier loans in exchange for higher profits. Several researchers also provide support to this hypothesis (Salas & Saurina, 2002; Louzis et al., 2012; Klein, 2013; Lee & Rosenkranz, 2019).

Second, “bad management” hypothesis provides that cost-inefficient banks are likely to have more NPL. Berger and DeYoung (1997) argue that low cost efficiency (as a function of operating expenses) signals poor management practices. Inadequate loan underwriting, monitoring, and control processes may lead to poor loan collection practices, thereby contributing to NPL build-up. Using another measure of efficiency (higher non-interest expenses to assets ratio), Espinoza and Prasad (2010) show that inefficient banks in Arab countries also tend to have higher NPL. Similar results are

obtained by Williams (2004) for European banks, Podpiera and Weil (2008) for Czech banks, and Louzis et al. (2012) for Greek banks.

On the contrary, the "skimping" hypothesis suggests that cost-efficient banks may have more NPL. Berger and DeYoung (1997) explain that bank managers might intentionally cut their expenses on credit evaluation and monitoring to improve current income at the expense of rising NPL in the future. Alternatively, other studies employ profitability index (higher net-income to equity) to test the "good management" hypothesis (Klein, 2013; Lee & Rosenkranz, 2019). They argue that positive profits indicate good management and properly managed banks will have better loan quality and lower NPL.

Third, "diversification" hypothesis says that banks with diversified sources of income (non-interest income from non-lending operations) tend to have fewer NPL. Although Louzis et al. (2012) are not able to confirm this hypothesis for Greek banks.

Lastly, "excess lending" hypothesis suggests that rapid credit expansion (loan growth or higher loans to assets ratio) may lead to rising NPL. Aggressive loan growth strategies can motivate bank officers to ease their credit standards to achieve their targets and widen their clientele base. Several researchers also confirm this hypothesis (Clair, 1992; Salas & Saurina, 2002; Klein, 2013; Lee & Rosenkranz, 2019).

The lending policies of banks may also influence NPL. However, it is difficult to measure for empirical validation. To test this hypothesis, Salas and Saurina (2002) utilize the change in net interest margin as proxy for credit standards. Meanwhile, Berger and Udell (1990) examine the presence of collaterals in loan contracts as indicator of lending

policies and find that pledges of collaterals on commercial loans is positively associated with riskier borrowers and higher NPL. Collaterals may lead to relaxation of credit evaluation, wherein loan officers rely more on collateral values instead on borrowers' capacity to repay the loans hence increasing NPL. In addition, collateral values may have an impact on NPL. Using Indian stock price index as proxy for collateral value, Rajan and Dhal (2003) find a positive association between stock prices and NPL. They argue that high collateral values may induce soft lending that may result to riskier loans and more NPL.

4.2.2 Macroeconomic factors

Macroeconomic factors can also affect the evolution of NPL during business cycles. Several studies provide evidence that NPL follows a countercyclical path (Salas & Saurina [2002] for Spanish banks; Rajan & Dhal [2003] for Indian banks; Quagliariello [2007] for Italian banks; Espinoza & Prasad [2010] for Arabian banks; Louzis et al. [2012] for Greek banks; Klein [2013] for European banks; Lee & Rosenkranz [2019] for Asian banks). As GDP grows, borrowers earn more income to service their debt obligations translating to lower NPL. Likewise as the economy contracts, unemployment increases and some borrowers might lose their jobs and have difficulty in repaying their loans resulting to more NPL. In addition, GDP growth and unemployment may affect the demand for loans. As the economy grows, businesses and individuals may increase their borrowing to finance higher production and consumption.

Similarly, macroeconomic environmental factors such as inflation, lending rates, and exchange rates may influence NPL. For instance, Klein (2013) argues that rising

inflation lowers the real value of debt obligations. At the same time, higher inflation decreases the real income of borrowers thus lowering borrowers' debt-servicing capacities. In a study of Asian banks, Lee and Rosenkranz (2019) find that rising inflation has a stronger impact on real income deterioration which may lead to more NPL. Moreover, Louzis et al. (2012) find that increasing lending rates may contribute to higher NPL, since borrowers with floating interest rates have to pay more interest. Furthermore, Lee & Rosenkranz (2019) argue that exchange rate depreciation may adversely affect borrowers with unhedged foreign currency-denominated loans and put an upward pressure on NPL.

4.3 Empirical Strategy

In this section, we discuss the estimation procedures and some specification test results.

We implement two-stage least squares on dynamic panel models with fixed effects to analyze the microeconomic and macroeconomic determinants of non-performing loans in the Philippines. Our model is specified as:

$$NPL_{i,t}^{j} = \alpha NPL_{i,t-1}^{j} + B_{i,t}'\beta + \rho d_{i|k,t} + M_t'\delta + I_t'\lambda + \theta t_t + \upsilon_i + \varepsilon_{i,t}$$

where $NPL_{i,t}^{j}$ pertains to the ratio of non-performing loans to total loans in loan category j of bank i at quarter t, $B_{i,t}$ are vectors of bank-specific variables that are composed of asset-side variables $B_{Ai,t}$, liability-/equity-side variables $B_{Bi,t}$, and income-related variables $B_{Ci,t}$, $d_{i|k,t}$ is a dummy variable equals one when bank i acquired or merged with bank k throughout the post-merger or post-acquisition period, M_t is a vector of

macroeconomic variables, and I_t are vectors of industry-wide lending standards I_{1t} and loan demand I_{2t}. Meanwhile, t_t pertains to the trend effect, υ_i refers to bank fixed effects or unobserved heterogeneity of bank i that may be correlated with the regressors, and $\varepsilon_{i,t}$ denotes the idiosyncratic error term that is assumed to be uncorrelated with all explanatory variables and bank fixed effects.

For dynamic panel model with short period, the inclusion of lagged dependent variable makes the estimate $\hat{\alpha}$ inconsistent, since $NPL_{i,t-1}$ is correlated with the mean error $\bar{\varepsilon}_i$ through $\hat{\varepsilon}_{i,t-1}$ as raised by Nickell (1981). Nonetheless, he points out that the demeaned lagged dependent variable ($NPL_{i,t-1} - \overline{NPL}_{i,-1}$) will not be correlated with the demeaned error ($\hat{\varepsilon}_{i,t} - \bar{\varepsilon}_i$) whenever time $T \rightarrow \infty$ since the mean error $\bar{\varepsilon}_i \rightarrow 0$. Thus, the bias in α disappears in dynamic panel model with fixed effects when T is large (Cameron & Trivedi, 2005, p.764).

Additionally, we specify two dynamic panel models for each NPL category with either asset-side variables or liability-/equity-side variables in the model (Figure 4.2 illustrates a bank balance sheet). Since total assets is always equal to total liabilities and equity in a balance sheet, alternately specifying asset ratios and liability/equity ratios in the regressions will allow us to distinguish the impact of banks' uses of funds (asset-side of balance sheet) from their sources of funds (liability-/equity-side of balance sheet) on NPL. Specifically, we estimate a model with asset-side variables given by:

$$NPL^j_{i,t} = \alpha NPL^j_{i,t-1} + \beta_1 ROPA/TA_{i,t} + \beta_2 TL^j/TA_{i,t} + \beta_3 Loangrowth_{i,t}$$

$$+ \beta_4 TAgrowth_{i,t} + B'_{Ci,t}\gamma + \rho d_{i|k,t} + M'_t\delta + I'_t\lambda + \theta t_t + \upsilon_i + \varepsilon_{i,t} \quad (1)$$

and a model with liability-/equity-side variables described as:

$$NPL_{i,t}^{j} = \alpha NPL_{i,t-1}^{j} + \beta_1 Equity/TA_{i,t} + \beta_2 Deposit/TA_{i,t} + \beta_3 Depositgrowth_{i,t}$$

$$+\beta_4 Equitygrowth_{i,t} + B'_{Ci,t}\gamma + \rho d_{i|k,t} + M'_t\delta + I'_t\lambda + \theta t_t + \upsilon_i + \varepsilon_{i,t} \quad (2)$$

The asset-side variables $B_{Ai,t}$ in Equation (1) are the following: ROPA/TA is the ratio of real and other properties acquired to total assets as proxy for bank's lending policies on collateral requirements. ROPA represents the amount of secured loans that defaulted where the collaterals are already foreclosed by banks. After the bank acquires ownership on collateral, the secured non-performing (defaulted) loan will be reclassified into ROPA at the carrying amount of the loan. Hence, from being a loan, it becomes an "acquired asset" since the bank already owns the property. It should be noted that while NPL_t can affect $ROPA_{t+1}$, NPL_t cannot influence $ROPA_t$. A bank that relies more on collateral values and not on borrower's repayment capacity will have an accumulation of ROPA in its balance sheet. In addition, Berger and Udell (1990) provide evidence that collaterals are associated with riskier borrowers. Hence, ROPA may represent bank's previous policy on collateral requirement when granting loans to probably risky borrowers.

TL^j/TA is the ratio of total loans in loan category j to total assets and captures bank's concentration in a certain lending activity. For example, agricultural NPL has

$TL^j/TA_{i,t}$ = agricultural loans to total assets ratio in the regression.[19] We include this variable because Philippine banks have different loan concentration, although they provide credits to both businesses and individuals (Figure 4.3). Loan growth is the growth rate of aggregate loan portfolios and TA growth is the total assets growth. These two variables control for the growth effects as Philippine banks continuously grow from 2009 to 2018.

On the other hand, the liability-/equity-side variables $B_{Bi,t}$ in Equation (2) are equity to total assets ratio (Equity/TA), deposits to total assets ratio (Deposit/TA), deposit growth, and equity growth. In earlier literature, Equity/TA is utilized to test moral hazard hypothesis, wherein low-capitalized banks tend to have higher NPL.[20] However, with the risk-based capital adequacy framework implemented in July 2007, wherein banks with riskier assets are required to have higher capital, there might be simultaneous causality between NPL and equity. As NPL increases, banks have to provide more loan loss allowances which may require additional equity to maintain the minimum capital ratio set by regulatory authority. Thus, we use the values of Equity/TA from the two previous quarters as instruments for the current Equity/TA to address reverse causality.

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[19] $TL^j/TA_{i,t}$ for other loan categories are the ratios of: total SME loans to total assets for SME NPL, total microfinance loans to total assets for microfinance NPL, total corporate loans to total assets for corporate NPL, and total individual loans to total assets for both consumption and housing NPLs.

[20] Studies that provide evidence in support of moral hazard hypothesis include Berger and DeYoung (1997), Salas and Saurina (2002), Louzis et al. (2012), Klein (2013), and Lee and Rosenkranz (2019).

Meanwhile, the income-related variables $B_{Ci,t}$ are the results of banks' uses and sources of funds and cannot be identified as asset-side nor liability-/equity-side item of a balance sheet. Hence, they are included in Equations (1) and (2). These regressors are the net interest income to average assets ratio as a measure of bank profitability from lending operations, non-interest income to average assets ratio as a measure of bank profitability from non-lending activities and a proxy for diversification, and non-interest expense to average assets ratio as a measure of operating expenses and a proxy for operational inefficiency. Several studies (mentioned in Section 4.2) provide evidence that bank profitability, diversification, and operational efficiency have an impact on NPL.

The bank-specific variables $B'_{i,t}$ are covariance stationary based on Fisher type-Augmented Dickey Fuller panel unit root test (Choi, 2001). However, they may have endogeneity issues with the error term $\varepsilon_{i,t}$ and reverse causality with NPL. Hence, we opt to instrument all bank-specific variables with their values from the previous two quarters.

Moreover, we introduce proxies for general lending standards in the banking industry and for loan demand using "diffusion index for credit standards" and "diffusion index for loan demand", respectively. These industry-level variables are qualitative indicators of the change in credit standards and change in loan demand from the previous quarter, which we obtain from Senior Bank Loan Officers' survey of Bankgo Sentral ng Pilipinas (BSP). On a quarterly basis, BSP conducts the survey among banks regarding changes in their policies on loan margin, size of credit lines, collateral requirements, covenants, maturity, and use of interest rate floors as well as on their perceived change in loan demand from the previous quarter (BSP, 2017a). Based on the results of the survey, diffusion index for credit standards is computed as the percentage of respondent banks

that tighten their credit standards less the percentage of respondent banks that loosen their credit standards. It can take a value between -100% and 100%. A positive (negative) diffusion index for credit standards indicates that more banks have tightened (loosened) as opposed to those that have eased (tightened) their lending standards. Similarly, diffusion index for loan demand is the percentage difference between banks that reported an increase in loan demand and banks that reported a decrease in loan demand. A positive diffusion index for loan demand means that more banks reported an increase in loan demand compared to those that stated a decrease.

The survey provides separate diffusion index for enterprises and households, namely, diffusion index for credit standards on enterprises, diffusion index for credit standards on households, diffusion index for loan demand of enterprises, and diffusion index for loan demand of households.[21] We use the four diffusion indices in our models and jointly estimate their impact on NPL. However, diffusion index for credit standards may have spontaneous causality with NPL as banks tend to tighten their lending standards when economic conditions worsen and NPL increases. Hence, we instrument credit standards with its value from the previous quarter. In addition, the credit standards for households and credit standards for enterprise seem have strong collinearity (correlation coefficients = 0.82, Table A4.1). Thus, we jointly test the credit standards for enterprises

[21] Enterprises pertain to private corporations and micro-, small-, and medium-enterprises. Meanwhile, households pertain to individuals who avail of housing and consumption loans (credit card, automobiles, and salary loans).

and households to determine the impact of lending policies on NPL. On the other hand, we assume that diffusion index for loan demand is exogenous.

Furthermore, we include GDP growth, unemployment rates, lending rates, inflation rates, and foreign exchange rates as macroeconomic determinants of NPL based on empirical findings of earlier studies.[22] For GDP growth, we also include its four quarters lags to evaluate the dynamic and long-term impact of GDP on NPL.[23] The long-run estimate of GDP with k lags is computed as:

$$\delta_{GDP}^{LR} = \frac{1}{1-\alpha}\left(\sum_{k=0}^{4} \delta_{GDP,k}\right) \quad (3)$$

where α is the coefficient of lagged NPL.

We assume that macroeconomic variables are exogenous and reserve requirement ratios on deposits follow a quadratic form to account for multiplier effect. However, macroeconomic variables are not covariance stationary based on Augmented Dickey Fuller tests. Nevertheless, trend coefficient controls for the trend effect of macroeconomic conditions. In addition, bank lending rates and loan demand seem to have strong multicollinearity with other macroeconomic variables (correlation coefficients > |0.60| in Table A4.1) which may lower the significance of estimates. Nonetheless, we choose to maintain bank lending rates and loan demand in the model as

[22] Such as studies by Louzis et al. (2012), Klein (2013), and Lee and Rosenkranz (2019).

[23] We choose four quarter lags of GDP growth because it yields the lowest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) compared with one, two, and three lags.

control variables. Table A4.2 in the Appendix provides a description of macroeconomic variables.

Lastly, we evaluate if our models are properly specified. First, we specify a model with only macroeconomic M_t' and loan demand I_{2t}' to examine the predictive power of bank-specific variables using Equation (4):

$$NPL_{i,t}^{j} = \alpha NPL_{i,t-1}^{j} + M_t'\delta + I_{2t}'\lambda + \theta t_t + \upsilon_i + \varepsilon_{i,t} \quad (4)$$

The smaller information criteria (AIC and BIC) reported in Tables 4.2 and 4.3 compared to those in Table 4.4 support the inclusion of bank-level data as explanatory variables for NPL. Second, we prefer fixed effects estimator based on Hausman (1978) test. Third, we reject the null hypothesis that asset-side variables are exogenous as the p-values of Chi-squared statistic < .05 (Models 2 and 3 of Tables 4.2). Hence, we use instruments for all bank-specific variables as well as credit standards. However, we assume that the lagged dependent variable $NPL_{i,t-1}$ is exogenous. Fourth, the instruments (IVs) are valid based on relevance and over-identification tests. We fail to reject the null hypothesis that IVs are uncorrelated with error terms $\varepsilon_{i,t}$, since the p-values of Hansen's J statistic > .05 (Models 1 to 6 of Tables 4.2 and 4.3). Additionally, all IVs are relevant, since first stage F-statistic > 10 in the joint hypothesis testing of all IV coefficients are zeros (the rule of thumb for first stage F-statistic > 10 is adopted from

Staiger and Stock, 1997).[24] Fifth, we test the assumption of no serial correlation in $\varepsilon_{i,t}$ by regressing the predicted idiosyncratic error term $\hat{\varepsilon}_{i,t}$ on its lag $\hat{\varepsilon}_{i,t-1}$. The results (available upon request from the author) suggest that our specifications do not exhibit first-order autocorrelation at 5% significance level. Finally, we do not cluster the standard errors. As raised by Abadie et al. (2017), clustering is appropriate only when both residuals and regressors are correlated within clusters. Since our models seem to have very weak endogeneity nor autocorrelation issues, we find it adequate to use heteroscedasticity-robust standard errors.

4.4 Data

We use an unbalanced panel dataset of 130 universal, commercial, and thrift banks (collectively referred as commercial and savings banks in this study) from 2009Q1 to 2018Q4.[25] In case of merger or acquisition, the surviving bank provides a consolidated financial report. Bank-level data is extracted from proprietary reports submitted by banks to BSP, while macroeconomic variables are also obtained from BSP as well as Philippine Statistics Authority.

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[24] When the number of IVs is moderate or large, the critical value is a lot larger than Staiger–Stock rule of thumb of F-statistic > 10 (Stock & Yogo, 2002). Nonetheless, first stage F-statistics in our model are way above ten.

[25] Our dataset is composed of 20 banks that were closed, 12 banks that were merged/acquired with another bank, and 17 banks that were newly opened between 2009 and 2018. In addition, the dataset excludes rural banks, which are primarily engaged in agricultural lending, due to unavailability of data.

Dependent variables are the ratios of: (a) non-performing agricultural loans to total agricultural loans (agricultural NPL), (b) non-performing microfinance loans to total microfinance loans (microfinance NPL), (c) non-performing small- and medium-enterprises (SME) loans to total SME loans (SME NPL), (d) non-performing corporate loans to total corporate loans (corporate NPL), (e) non-performing consumption loans to total consumption loans (consumption NPL), and (f) non-performing housing loans to total housing loans (housing NPL). These loan classifications are lifted from regulatory reports, hence they can be considered as reliable and consistent over the sample period.

While BSP provides several loan categories depending on the type of borrowers and purpose of loans, we select the six NPL categories due to the following reasons. First, agricultural and small- and medium-enterprise (SME) loans are mandatory credits in the Philippines. In particular, domestic banks are required to allocate portion of their loanable funds as follows: 25% on agriculture and agrarian reform credits (referred as agricultural loans), 8% on micro- and small-enterprises, and 2% medium-enterprises (reported separately as microfinance and SME loans, BSP, 2017b, p.50 & p.53). SME loans are loans to business entities with total assets below 100 million Philippine pesos (approximately two million USD). These SMEs provide the majority of employment in the Philippines (around 63% of employment in 2016) (Organization for Economic Cooperation and Development, 2018, p.374). Second, microfinance is among government policy tools for poverty alleviation and inclusive growth, hence their loans are governed by special regulations. Microfinance loans are loans to micro-enterprises with total assets below three million Philippine pesos (approximately USD 60,000) and loans to low-income households (BSP, 2017b). Third, corporate loans represent the

majority of bank loans in the Philippines (BSP, 2019b). Corporate loans are loans to enterprises that will not qualify as micro-, small-, or medium-enterprise loans. Fourth, consumption loans may play an important role in spurring Philippine economic growth, since private consumption contributes around 70% of GDP for the past 20 years (Figure 2.4). Consumption loans are loans to individuals for personal use such as credit card, automobiles, and salary loans. Lastly, housing loans are of special interest to regulatory authorities because of possible linkages between financial crisis and housing loan defaults. Housing loans are loans to individuals for residential purposes. Given the potential relevance of these loans to the Philippine economy, understanding the factors affecting their loan quality is important for banking supervision and policy development.

Table 4.1 presents the descriptive statistics. NPL of corporate loans (6.61%) is below the total NPL across loan categories (9.94%), while NPL of other loan categories are above the total NPL. Specifically, microfinance has the highest NPL at 31.20%. This statistic implies that microfinance has the lowest loan quality. In addition, this finding may provide some rational why only 67 out of 130 banks are engaged in microfinance lending and why microfinance has one of the highest borrowing rates. Meanwhile, the loan quality of mandatory credits, 15.63% agricultural NPL and 13.21% SME NPL, is comparable to that of consumption loans with 17.56% NPL. On the other hand, housing loans have better loan quality at 11.92% NPL, while corporate loans have the best loan quality at 6.61% NPL. However, corporate NPL is very volatile, since it has the highest skewness and excess kurtosis.

As shown in Figure 4.4, total NPL is generally down trending but specific NPLs follow different patterns. There could be significant variations in specific NPLs which

may be attributed to the differential impacts of bank-specific characteristics and macroeconomic conditions across NPL categories. Hence, we find it appropriate to conduct a granular analysis on the determinants of NPL.

4.5 Results

We estimate the parameters using two-stage least squares on dynamic panel models with fixed effects where we instrumented bank-specific variables with their two quarters lags and credit standards with their one quarter lag.[26] Tables 4.2 and 4.3 present the estimation results for each NPL category.

4.5.1 Bank-specific determinants

Lagged NPL positively and strongly affect current NPL across loan categories (estimates around 0.8% in Tables 4.2 and 4.3). This finding suggests that previous NPL appears to be a leading indicator of current NPL and any shock to NPL tends to persist over time.

Additionally, bank-specific characteristics tend to affect agricultural and SME NPLs but not corporate and consumption NPLs. In particular, cost-inefficient banks (higher non-interest expense to average assets ratios) tend to have more agricultural NPL (estimates around 0.4% in Model 1 of Tables 4.2 and 4.3) and SME NPL (estimates around 0.5% in Model 2 of Tables 4.2 and 4.3). These results indicate that the poor loan quality of mandatory credits (agricultural and SME loans) is associated with operational

[26] We use the Stata commands of Schaffer (2005).

inefficiency consistent with "bad management" hypothesis. Berger and DeYoung (1997) provide that low cost efficiency signals inadequate credit underwriting, monitoring, and control processes. Since we control for credit standards in our models, operational inefficiency possibly signals poor loan monitoring and collection practices which may contribute to higher agricultural and SME NPLs. On the other hand, NPLs of regular loans (corporate, consumption, and housing loans) are not associated with operational inefficiency.

Moreover, highly capitalized banks (higher equity to assets ratio) seem to have higher agricultural NPL (estimates around 0.14% in Model 1 of Table 4.3). This finding implies that agricultural loans seem to have higher credit risk than other type of loans. This result might probably explains the continuing under-compliance of Philippines banks to 25% mandatory credit allocation.

Furthermore, SME NPL is associated with tighter credit standards (estimates around 0.3% in Model 2 of Tables 4.2 and 4.3). The coefficients are still significant based on joint-test of credit standards for enterprises and households. Lown et al. (2000) provide evidence that banks tend to tighten their credit standards preceding economic recessions and slower loan growth. In addition, the respondent banks to Senior Bank Loan Officers' survey reported that they imposed stricter credit standards due to lower macroeconomic outlook and anticipated decrease in bank profits (BSP, 2011; BSP, 2017a). After controlling for GDP, loan growth, and bank income, the positive sign of credit standards suggest that tightening of credit standards probably indicate a deterioration in SME loan quality.

4.5.2 Macroeconomic determinants

Macroeconomic variables affect both the NPLs of mandatory loans (agricultural and SME NPLs) and regular loans (corporate and consumption NPLs). On the other hand, microfinance and housing NPLs seem to be not sensitive to macroeconomic factors. It should be noted that between 2009 and 2018, the Philippines has robust economic growth and relatively manageable inflation and unemployment rates (discussed in Section 2.1 of Chapter 2). Hence, these results might be relevant only during economic progress.

Nevertheless, rising unemployment rates tend to increase agricultural NPL (estimates around 2% in Model 1 of Tables 4.2 and 4.3). Although the unemployment rates in our models might substantially capture unemployment rates in the formal sector, we argue that unemployment rates in the informal labor markets also move in the same direction as those in the formal sector. In the Philippines, agricultural industry employs around 47.4% of the total informal labor force based on 2008 Informal Sector Survey (Philippine Statistics Authority, 2009). These informal workers usually have weak employment security (social security safety nets). Hence, this finding implies that when agricultural lenders lose their jobs, they will likely be unable to repay their loans resulting to higher NPL.

Moreover, rising GDP growth rates are likely to contribute to higher SME, corporate, and consumption NPLs. Specifically, 4-quarter lagged GDP growth rates tend to increase SME NPL (estimates around 0.6% in Model 2 of Tables 4.2 and 4.3). In addition, GDP growth has a marginally significant and positive long-term impact on SME NPL at 10% significance level (estimates around 7.4% in Model 2 of Tables 4.2

and 4.3). Similarly, 2-quarter lagged GDP growth rates tend to increase corporate NPL (estimates around 0.4% in Model 4 of Tables 4.2 and 4.3) and consumption NPL (estimates around 0.7% in Model 5 of Tables 4.2 and 4.3). However, GDP growth does not appear to have a long-term impact on corporate and consumption NPLs. These results indicate that the effects of GDP on NPL tend to be transmitted faster on corporate and consumption loans (six months) than on SME loans (one year). In addition, GDP growth appears to have a stronger quantitative impact of consumption NPL and a longer impact on SME NPL.

While the positive coefficient of GDP on NPL is different from the negative sign found in the literature, it should be noted that our GDP estimate is conditional on loan demand, inflation, lending rates, exchange rates, and unemployment rates unlike in previous studies.[27] In addition, the observation period in earlier studies usually include a crisis, while this chapter covers robust economic growth. There might be substantial differences in risk aversion and risk tolerance of borrowers and banks between sample periods which might possibly be related to GDP. Another plausibly explanation is that banks may become more optimistic about lending and underestimate the credit risk of borrowers during economic booms (Borio et al., 2001; Jimenéz & Saurina, 2006). Similarly, borrowers may overestimate their future earnings, avail loans above their current financial capacity, and eventually find themselves unable to repay their debt obligations. Moreover, the positive impact of GDP on NPL is aligned with the remarks

[27] These studies include the works of Salas and Saurina (2002), Rajan and Dhal (2003), Quagliariello (2007), Espinoza and Prasad (2010), Louzis et al. (2012), Klein (2013), and Lee and Rosenkranz (2019).

of IMF (2018), wherein the credit-to-GDP gap in the Philippines is nearing early warning thresholds suggesting an increasing risk in the financial system.

On the other hand, microfinance and housing NPLs do not appear to be sensitive to macroeconomic developments. The finding on housing NPL provides support on the perceived lower riskiness of residence loans over commercial loans (in our case SME loans) (Borio et al., 2001).

As a robustness check, we combine Equations (1) and (2) and estimate a model with both asset-side and liability-/equity-side variables along with macroeconomic variables. The results are consistent as bank-specific variables (i.e., higher non-interest expense to assets ratio and tighter credit standards for enterprises) will likely lead to more agricultural and SME NPLs, while macroeconomic variables (rising unemployment and higher GDP growth rates) tend to increase agricultural, SME, corporate, and consumption NPLs (Table 4.5). Furthermore, we confine the sample to banks that did not merge or acquire another bank to eliminate the merger effect, and the said variables are still significant.

Overall, agricultural and SME NPLs (mandatory credits) are susceptible to bank-specific characteristics and macroeconomic conditions. On the other hand, corporate and consumption NPLs (regular loans) are vulnerable to GDP growth but not to bank-specific factors.

4.6 Conclusion and Policy Implications

This chapter investigates the microeconomic and macroeconomic determinants of NPL in the Philippines across six loan categories (i.e., agricultural, microfinance, small- and medium- enterprises (SME), corporate, consumption, and housing loans).

Previous NPL seems to be a leading indicator of current NPL suggesting its persistence over time. Thus, bank supervisors should encourage banks to implement effective NPL resolution and early loan remedial strategies to arrest possible accumulation of NPL. In addition, bank-specific characteristics and macroeconomic conditions are likely to affect agricultural and SME NPLs (mandatory loans), while only macroeconomic factors seem to have an impact on corporate and consumption NPLs (regular loans).

In particular, cost-inefficient banks tend to have higher agricultural and SME NPLs indicating that the loan quality of these two mandatory credits is associated with operational inefficiency. Additionally, rising unemployment rates seem to increase agricultural NPL. Hence, bank supervisors should encourage banks to improve their loan monitoring and collection efforts particularly on agricultural and SME loans. Moreover, highly capitalized banks tend to have more agricultural NPL implying higher credit risk for agricultural loans. Bank regulators can consider providing regulatory incentives on agricultural lending to encourage banks' compliance with the mandatory credit allocation and to compensate for the higher risk of agricultural loans.

Meanwhile, higher SME NPL is associated with tighter credit standards. In addition, rising GDP growth rates are likely to contribute to higher SME NPL and the

impact tends to last for a long period. Taken together, these two findings suggest a deterioration in SME loan quality and a possible credit risk build-up in SME lending segment of banks along with Philippine economic progress. Similarly, higher GDP growth rates tend to increase corporate and consumption NPLs (regular loans). However, microfinance and housing NPLs seem to be not sensitive to macroeconomic developments. Thus, bank supervisors could take into consideration the vulnerability of NPLs to macroeconomic conditions when assessing banks' NPL and the appropriateness of loan loss provisions. Furthermore, bank supervisors could strengthen the credit risk management regulations particularly on establishing borrowers' financial capacity to repay their debt obligations.

An immediate extension of Chapter 4 is a research on macroprudential stress testing across different loan categories while taking into consideration the results in this chapter.

Chapter 5

Conclusions and Policy Implications

Banking supervision has evolved from regulating individual banks (microprudential) to promoting the stability of the whole financial system (macroprudential). Nevertheless, both prudential regulations utilize regulatory capital, such as the capital adequacy ratio (CAR) and the countercyclical capital buffer, to achieve these supervisory objectives. The risk-based capital adequacy ratio (CAR) refers to the minimum amount of capital that a bank should maintain relative to its credit risk, interest rate risk, and other risks arising from its operations. Meanwhile, countercyclical capital buffer pertains to the additional capital required from systemically important banks which should be accumulated during period of strong credit growth and utilized during economic downturns (Bank for International Settlements, 2015). Given these capital requirements, bank supervisors should be able to assess the adequacy of these capitals, not only based on the minimum ratios, but more importantly relative to the riskiness and activities of banks. Hence, an in-depth understanding of banks' risk profiles is necessary for effective supervision. The results of this dissertation are intended to aid bank supervisors in evaluating the risk exposures of banks and in identifying the vulnerabilities of banks in the Philippines.

This dissertation has two analytical chapters. In Chapter 3, we examine the sensitivity of Philippine banks to changes in domestic interest rate, foreign (US) interest rate, and exchange rate using their daily stock prices. We also construct indicators of bank stock volatility based on GARCH estimates. Our results indicate that the mean and the

variance of Philippine bank daily stock returns seem to be sensitive to US interest rate risk and exchange rate risk between 2006 and 2013 (crisis period) but not between 2014 and 2018 (normal period). Specifically, changes in US 3-month Treasury bill rate and PHP/USD exchange rate seem to have offsetting effects on the mean of Philippine bank stock returns with US interest rate risk dominating the impact. In addition, fluctuations in US interest rate and exchange rate seem to contribute to the high volatility of daily bank stock returns during the global financial crisis period (2007 to 2009), as illustrated by GARCH-based indicators in Section 3.6. Moreover, the different sensitivities of stock returns between sub-periods indicate that US interest rate and exchange rate risks of Philippine bank stocks are changing over time.

Furthermore, we investigate the effects of changes in interest rate and exchange rate on quarterly bank income using linear panel model and find that rising US interest rates tend to adversely affect quarterly bank income. This finding indicates that the profitability of Philippine universal banks seems to be also sensitive to US interest rate risk. Given the effects of changes in US interest rate on daily bank stock returns and on quarterly bank profits, these results suggest that Philippine largest banks tend to be vulnerable to US financial markets. Hence, bank supervisors should also monitor the transmission of US financial risk to the Philippine banking industry and incorporate US financial markets in their market surveillance. Additionally, the findings imply that US interest rate risk seems to be an important risk exposure of Philippine universal banks. Thus, bank supervisors could strengthen their regulations on foreign assets and foreign currency-related transactions and thoroughly examine how banks manage their foreign assets and liabilities during on-site examination. Moreover, the GARCH-based indicators

presented in Section 3.6 may serve as early warning signals on banks' vulnerability to shocks from external financial markets.

Chapter 3 can be extended by analyzing the sensitivity of bank capital to changes in market index, interest rate, and exchange rate and comparing the estimates with actual capital allocated for interest rate risk and exchange rate risk to empirically assess the capital adequacy of banks.

In Chapter 4, we investigate the microeconomic and macroeconomic determinants of non-performing loans (NPL) in the Philippines across six loan categories, namely, agricultural, microfinance, small- and medium-enterprises (SME), corporate, consumption, and housing loans. Our results indicate that previous NPL seems to be a leading indicator of current NPL suggesting its persistence over time. Thus, bank supervisors should encourage banks to implement effective NPL resolution and early loan remedial strategies to arrest possible accumulation of NPL. In addition, bank-specific characteristics and macroeconomic conditions are likely to affect agricultural and SME NPLs (mandatory loans) while, only macroeconomic factors seem to have an impact on corporate and consumption NPLs (regular loans). On the other hand, microfinance and housing NPLs seem to be not sensitive to macroeconomic developments.

In particular, cost-inefficient banks tend to have higher agricultural and SME NPLs indicating that the loan quality of these two mandatory credits is associated with operational inefficiency. Additionally, rising unemployment rates seem to increase agricultural NPL. Hence, bank supervisors should encourage banks to improve their loan monitoring and collection efforts particularly on agricultural and SME loans. Moreover,

highly capitalized banks tend to have more agricultural NPL implying higher credit risk for agricultural loans. Bank regulators can consider providing regulatory incentives on agricultural lending to encourage banks' compliance with the mandatory credit allocation and to compensate for the higher risk of agricultural loans.

Meanwhile, higher SME NPL is associated with tighter credit standards. In addition, rising GDP growth rates are likely to contribute to higher SME NPL and the impact tends to last for a long period. Taken together, these two findings suggest a deterioration in SME loan quality and a possible credit risk build-up in SME lending segment of banks along with Philippine economic progress. Similarly, higher GDP growth rates tend to increase corporate and consumption NPLs (regular loans). Thus, bank supervisors could take into consideration the vulnerability of NPLs to macroeconomic conditions when assessing banks' NPL and the appropriateness of loan loss provisions. Furthermore, bank supervisors could strengthen the credit risk management regulations particularly on establishing borrowers' financial capacity to repay their debt obligations.

An immediate extension of Chapter 4 is a research on macroprudential stress testing across different loan categories while taking into consideration the results in Chapter 4.

Overall, this dissertation provides that daily stock returns and quarterly bank income of Philippine banks tend to be sensitive to US interest rate risk. Hence, bank supervisors should also monitor the transmission of US financial risk to the Philippine banking industry and incorporate US financial markets in their market surveillance. In

addition, this dissertation suggests that operational inefficiency, unemployment rates, and GDP growth seem to contribute NPL build-up. Thus, bank regulators should take into consider the vulnerability of banks to macroeconomic conditions when assessing the financial soundness of individual banks and the stability of the whole banking system.

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Tables

Table 3.1 List of Models in the Model Space of Chapter 3

Model	Mean Equation			Variance equation	
	Sectoral stock indices	PH variables	US variables	PH variables	US variables
1	✓	✓	✓		
2	✓	✓	✓	✓	
3	✓	✓	✓		✓
4	✓	✓	✓	✓	✓
5	✓	✓			
6	✓	✓		✓	
7	✓	✓			✓
8	✓	✓		✓	✓
9	✓		✓		
10	✓		✓	✓	
11	✓		✓		✓
12	✓		✓	✓	✓
13	✓				
14	✓			✓	
15	✓				✓
16	✓			✓	✓

Note: The sectoral stock indices are the returns on financials, properties (real estate), holding firms, services, commercial, and mining sectoral indices in the Philippine Stock Exchange. The Philippine (PH) variables are the changes in PH 3-month Treasury bill rates, PH 10-year Treasury bond rates, and PH (BSP) monetary policy rates. While, the US variables are the changes in Philippine Peso /US dollar exchange rates, US 3-month Treasury bill rates, and US Fed funds rates.
The ✓ mark indicates that the set of variables are included in the model.

Table 3.2 Descriptive Statistics of Daily Stock Returns of Philippine Universal Banks from June 2006 to September 2018

Sub-period 1: June 2006 to December 2013							
Bank	t	mean	min	max	sd	skewness	kurtosis
A	1,852	0.040	-27.087	9.829	2.244	-1.082	17.453
B	1,852	0.036	-10.536	10.631	2.027	-0.125	5.949
C	1,852	0.035	-16.505	20.431	1.539	0.514	32.235
D	1,852	0.057	-17.387	13.505	2.374	-0.138	6.804
E	1,852	0.049	-9.909	16.038	2.534	0.501	6.152
F	1,852	0.060	-18.235	14.548	2.405	0.085	10.084
G	1,852	0.073	-11.404	11.333	1.981	0.110	7.213
H	1,852	0.052	-16.908	22.314	1.928	0.430	22.507

Sub-period 2: January 2014 to September 2018							
Bank	t	mean	min	max	sd	skewness	kurtosis
A	1,152	0.052	-5.214	7.309	1.457	0.117	4.551
B	1,152	0.002	-5.249	7.131	1.357	0.235	5.743
C	1,152	-0.029	-4.667	5.533	0.799	0.442	12.794
D	1,152	-0.004	-8.074	6.062	1.618	-0.218	4.603
E	1,152	-0.059	-14.395	10.115	1.425	-0.136	17.671
F	1,152	-0.039	-8.444	14.503	1.754	0.980	12.262
G	1,152	0.025	-13.249	8.536	1.621	-0.408	9.506
H	1,152	-0.009	-7.351	9.762	0.941	0.283	21.129
I	1,152	0.023	-9.297	5.449	0.770	-1.221	31.324
J	1,152	-0.019	-10.449	8.505	1.608	0.164	7.770

Table 3.3 Market Capitalization-weighted Posterior Inclusion Probabilities (%)

Mean Equation	Sub-period 1	Sub-period 2	Full Period
Sectoral stock indices			
Financials	100	100	100
Holding firms	100	100	100
Properties	100	100	100
Services	100	100	100
Commercial	100	100	100
Mining	100	100	100
PH variables			
BSP policy rates	41	27	20
PH 3-mo T-bill rates	41	27	20
PH 10-year T-bond rates	41	27	20
US variables			
PHP/USD forex rates	90	64	85
US 3-mo T-bill rates	90	64	85
Fed funds rates	90	64	85
Variance Equation			
PH variables			
BSP policy rates	68	33	51
PH 3-mo T-bill rates	68	33	51
PH 10-year T-bond rates	68	33	51
US variables			
PHP/USD forex rates	99	39	95
US 3-mo T-bill rates	99	39	95
Fed funds rates	99	39	95

Note: The first sub-period covers June 2006 to December 2013, while the second sub-period spans from January 2014 to September 2018.

Table 3.4 Proportion of Philippine Banks with Posterior Inclusion Probabilities > 95% or < 95%

	Sub-period 1		Sub-period 2		Full Period	
	PIP>95%	PIP<95%	PIP>95%	PIP<95%	PIP>95%	PIP<95%
Mean Equation						
Sectoral stock indices						
Financials	8/8	0/8	10/10	0/10	10/10	0/10
Holding firms	8/8	0/8	10/10	0/10	10/10	0/10
Properties	8/8	0/8	10/10	0/10	10/10	0/10
Services	8/8	0/8	10/10	0/10	10/10	0/10
Commercial	8/8	0/8	10/10	0/10	10/10	0/10
Mining	8/8	0/8	10/10	0/10	10/10	0/10
PH variables						
BSP policy rates	1/8	7/8	1/10	9/10	0/10	10/10
PH 3-mo T-bill rates	1/8	7/8	1/10	9/10	0/10	10/10
PH 10-year T-bond rat	1/8	7/8	1/10	9/10	0/10	10/10
US variables						
PHP/USD forex rates	5/8	3/8	0/10	10/10	5/10	5/10
US 3-mo T-bill rates	5/8	3/8	0/10	10/10	5/10	5/10
Fed funds rates	5/8	3/8	0/10	10/10	5/10	5/10
Variance Equation						
PH variables						
BSP policy rates	2/8	6/8	0/10	10/10	1/10	9/10
PH 3-mo T-bill rates	2/8	6/8	0/10	10/10	1/10	9/10
PH 10-year T-bond rat	2/8	6/8	0/10	10/10	1/10	9/10
US variables						
PHP/USD forex rates	7/8	1/8	1/10	9/10	7/10	3/10
US 3-mo T-bill rates	7/8	1/8	1/10	9/10	7/10	3/10
Fed funds rates	7/8	1/8	1/10	9/10	7/10	3/10

Note: This table presents the proportion of universal banks with Posterior Inclusion Probabilities > 95% or < 95% in every period. The first sub-period, which covers June 2006 to December 2013, has only eight banks. Two banks are excluded in the first sub-period because their shares started trading only in 2012 and 2013. The second sub-period, which spans from January 2014 to September 2018, has ten banks.

Table 3.5 Market Capitalization-weighted SAIC Estimates of the Ten Universal Banks

	Sub-period 1	Sub-period 2	Full Period
Mean Equation			
Sectoral stock indices			
Financials	0.123	0.106	0.109
Holding firms	0.042	-0.021	0.015
Properties	0.046	0.054	0.049
Services	0.009	-0.024	-0.009
Commercial	-0.044	-0.008	-0.027
Mining	-0.004	0.008	0.001
PH variables			
BSP policy rates	0.097	-0.054	-0.014
PH 3-mo T-bill rates	-0.068	0.016	0.006
PH 10-year T-bond rates	-0.124	0.012	0.000
US variables			
PHP/USD forex rates	-0.305	-0.184	-0.284
US 3-mo T-bill rates	2.018	1.728	1.910
Fed funds rates	0.273	-0.017	0.115
Variance Equation			
PH variables			
BSP policy rates	0.350	0.168	0.276
PH 3-mo T-bill rates	-0.492	-0.635	-0.452
PH 10-year T-bond rates	1.146	-0.787	0.405
US variables			
PHP/USD forex rates	1.368	0.414	2.271
US 3-mo T-bill rates	2.945	7.952	3.671
Fed funds rates	0.515	0.149	0.385

Note: This table presents the market capitalization-weighted and smoothened Akaike Information Criterion-weighted (SAIC) estimates for the ten universal banks listed in the Philippine Stock Exchange from June 2006 to September 2018. The first sub-period covers June 2006 to December 2013, while the second sub-period spans from January 2014 to September 2018.

Table 3.6 SAIC Estimates of Individual Banks

	Sub-period 1: June 2006 to December 2013							
	bank A	bank B	bank C	bank D	bank E	bank F	bank G	bank H
Mean Equation								
Sectoral stock indices								
Financials	0.148	0.142	0.002	0.110	0.119	0.092	0.161	0.075
Holding firms	0.007	0.058	0.024	0.084	0.107	0.054	-0.010	0.011
Properties	0.102	0.010	0.019	0.083	-0.021	0.053	-0.004	-0.005
Services	-0.009	0.053	-0.022	0.003	-0.045	0.011	0.010	-0.026
Commercial	-0.069	-0.069	-0.004	-0.031	0.014	-0.010	-0.023	0.006
Mining	0.013	-0.018	-0.001	-0.005	-0.005	-0.032	-0.010	0.009
PH variables								
BSP policy rates	0.135	0.029	0.009	0.298	-0.003	-0.021	0.002	-0.001
PH 3-mo T-bill rates	-0.119	-0.035	0.002	-0.158	-0.003	0.022	0.003	-0.001
PH 10-year T-bond rates	-0.202	-0.164	-0.025	-0.158	0.019	0.055	0.010	-0.003
US variables								
PHP/USD forex rates	-0.229	-0.397	-0.018	-0.508	-0.364	-0.051	-0.252	-0.076
US 3-mo T-bill rates	1.101	2.756	0.555	3.541	3.106	0.635	0.575	1.266
Fed funds rates	0.193	0.262	0.020	0.325	0.628	0.072	0.489	0.363
Variance Equation								
PH variables								
BSP policy rates	0.053	0.683	0.863	0.190	-0.509	1.036	-0.019	0.849
PH 3-mo T-bill rates	-0.032	-0.184	-5.695	-0.075	-0.643	0.007	-0.053	-0.407
PH 10-year T-bond rates	0.535	1.583	3.536	1.596	1.691	0.576	0.008	-0.945
US variables								
PHP/USD forex rates	1.184	1.175	-1.631	2.136	1.622	1.241	1.601	3.670
US 3-mo T-bill rates	3.042	3.931	7.915	3.930	3.013	3.025	-10.079	5.672
Fed funds rates	0.819	0.553	0.382	0.167	0.062	0.825	0.234	0.744

---------- con't Table 3.6 SAIC Estimates of Individual Banks ----

	Sub-period 2: January 2014 to September 2018									
	bank A	bank B	bank C	bank D	bank E	bank F	bank G	bank H	bank I	bank J
Mean Equation										
Sectoral stock indices										
Financials	0.159	0.114	-0.004	0.175	0.084	0.065	-0.034	0.006	0.006	0.068
Holding firms	0.021	-0.076	0.011	0.008	-0.060	-0.037	-0.029	0.008	-0.023	-0.073
Properties	0.029	0.085	-0.005	0.093	0.090	0.022	0.042	0.002	0.018	0.015
Services	-0.067	0.001	0.009	-0.060	-0.009	0.015	0.055	-0.003	-0.009	-0.047
Commercial	-0.029	-0.029	0.032	-0.003	-0.015	0.057	0.017	-0.006	0.004	0.104
Mining	0.016	-0.015	0.000	0.035	0.013	-0.006	0.034	0.002	0.001	-0.014
PH variables										
BSP policy rates	-0.016	-0.010	-0.213	-0.104	-0.027	-0.319	-0.003	-0.050	-0.006	-0.010
PH 3-mo T-bill rates	0.035	-0.001	0.078	0.019	0.024	-0.026	-0.001	-0.015	0.004	0.008
PH 10-year T-bond rates	-0.003	0.004	-0.005	0.036	-0.003	0.160	-0.003	0.003	0.002	-0.002
US variables										
PHP/USD forex rates	-0.250	-0.116	-0.014	-0.403	-0.023	-0.005	-0.267	0.000	-0.060	-0.040
US 3-mo T-bill rates	3.090	1.994	-0.066	2.912	0.271	-0.029	-0.526	-0.012	-0.278	-0.539
Fed funds rates	-0.450	0.199	0.064	0.296	0.023	0.003	-0.207	0.001	0.068	-0.006
Variance Equation										
PH variables										
BSP policy rates	0.708	0.260	0.200	-0.013	0.261	0.322	0.020	-0.663	0.761	-3.088
PH 3-mo T-bill rates	0.354	-0.483	-0.329	0.017	0.119	-15.339	0.007	-0.115	0.036	0.543
PH 10-year T-bond rates	-4.994	1.547	-0.150	0.076	-0.070	0.784	0.054	0.251	-0.124	0.163
US variables										
PHP/USD forex rates	0.730	0.018	0.170	0.247	0.015	0.066	1.542	0.884	0.087	0.644
US 3-mo T-bill rates	16.335	0.281	-1.386	12.187	0.622	-9.693	25.527	0.197	1.909	12.195
Fed funds rates	0.275	0.028	-0.495	1.456	-0.006	-0.001	-1.991	-0.416	0.023	0.369

Table 3.7 Panel Estimation Results of Quarterly Bank Profits

Fixed Effects Model	Net Income to Average Equity		
	Sub-period 1	Sub-period 2	Full period
Sectoral stock indices			
Financials	0.029	0.081	0.053***
	(0.048)	(0.045)	(0.013)
Holding firms	-0.088*	-0.059	-0.059**
	(0.044)	(0.034)	(0.023)
Properties	0.053	-0.005	0.003
	(0.051)	(0.014)	(0.015)
Services	0.010	0.014	0.005
	(0.024)	(0.010)	(0.012)
Commercial	0.036	-0.033	-0.007
	(0.037)	(0.035)	(0.021)
Mining	0.011	-0.002	0.014**
	(0.016)	(0.010)	(0.005)
PH variables			
BSP policy rates	0.105***	0.019	0.020**
	(0.027)	(0.014)	(0.008)
PH 3-mo T-bill rates	-0.090	0.189	-0.002
	(0.104)	(0.150)	(0.098)
PH 10-year T-bond rates	1.110***	0.181	0.411**
	(0.211)	(0.143)	(0.130)
US variables			
PHP/USD forex rates	-0.055	0.005	-0.009
	(0.041)	(0.081)	(0.036)
US 3-mo T-bill rates	-1.051***	-3.053**	-0.551*
	(0.280)	(1.104)	(0.285)
Fed funds rates	-0.042	0.027	0.027*
	(0.028)	(0.063)	(0.012)
Bank Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	240	190	430
Number of banks	10	10	10
Adjusted R-squared	0.282	-0.0216	0.316

Note: Bank stock returns used in this panel regression are the quarterly returns of bank stock prices. The first sub-period covers 2008Q1 to 2013Q4, while the second sub-period spans from 2014Q1 to 2018Q3.

Robust standard errors in parentheses, clustered at the bank-level.

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

Table 3.8 Panel Estimation Results of Quarterly Bank Stock Returns

Fixed Effects Models	Bank Stock Returns		
	Sub-period 1	Sub-period 2	Full period
Net Income to Average Equity	0.735**	0.879	0.781***
	(0.226)	(0.516)	(0.198)
Bank Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	202	190	392
Number of banks	10	10	10
R-squared	0.395	0.253	0.360
Adjusted R-squared	0.377	0.232	0.341

Note: Bank stock returns used in this panel regression are the quarterly returns of bank stock prices. The first sub-period covers 2008Q1 to 2013Q4, while the second sub-period spans from 2014Q1 to 2018Q3.

Robust standard errors in parentheses, clustered at the bank-level.

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

Table 4.1 Descriptive Statistics of Non-performing Loans Ratios (%) for each Loan Category

NPL	Total loans	Specialized lending			Regular lending		
		Agri-cultural	Micro-finance	SME	Corporate	Consum-ption	Housing
Mean	9.94	15.63	31.20	13.21	6.61	17.56	11.92
Standard deviation	14.59	25.01	34.75	20.09	16.97	27.13	19.81
Minimum	0	0	0	0	0	0	0
Maximum	100	100	100	100	100	100	100
Skewness	2.91	2.09	1.04	2.67	3.98	1.94	2.76
Kurtosis	12.93	6.64	2.59	10.46	19.21	5.76	10.83
# of obs	4,154	3,494	1,629	3,746	2,872	3,017	3,148
# of banks	130	117	67	118	99	105	104

Note: Agricultural and SME loans are mandatory credits since banks are required to allocate portion of their loanable funds as follows: 25% on agriculture and agrarian reform credits (referred as agricultural loans), 8% on micro- and small-enterprises (MSEs), and 2% medium-enterprises (reported separately as microfinance and SME loans) (BSP, 2017, p.50 & p.53). On the other hand, corporate loans are loans to enterprises that will not qualify as micro-, small-, or medium-enterprise loans (BSP, 2019a). Meanwhile, consumption loans are to individuals for personal use such as credit card, automobiles, and salary loans. Housing loans are loans to individuals for residential purposes. The observation period spans from 2009Q1 to 2018Q4. The data is obtained from the quarterly reports submitted to the Bangko Sentral ng Pilipinas.

Table 4.2 Estimates for Each NPL Category Using a Model with Asset-side Variables

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Agricultural NPL	SME NPL	Microfinance NPL	Corporate NPL	Consumption NPL	Housing NPL
Bank-specific variables						
Lagged dependent variable	0.781***	0.763***	0.789***	0.729***	0.766***	0.774***
	(0.027)	(0.071)	(0.037)	(0.057)	(0.034)	(0.039)
Total Loan per category/ Total Assets	-0.049	-0.027	0.053	-0.041	0.076*	0.027
	(0.036)	(0.050)	(0.111)	(0.033)	(0.040)	(0.029)
ROPA/Total Assets	0.078	0.267	-0.177	0.081	0.020	0.092
	(0.113)	(0.218)	(0.134)	(0.177)	(0.149)	(0.088)
TA growth	-5.183*	-1.254	0.464	-0.457	-1.017	-0.649
	(2.942)	(1.356)	(1.464)	(0.664)	(0.626)	(1.680)
Loan growth	1.239	0.001	-0.073	0.072	-0.001	0.003
	(1.846)	(0.007)	(0.640)	(0.343)	(0.001)	(0.834)
Net Interest Income/ Average Assets	0.120	0.258	-0.133	-0.266	-0.089	0.055
	(0.262)	(0.492)	(0.172)	(0.291)	(0.306)	(0.460)
Non-Interest Income/ Average Assets	-0.078	-0.284	-0.461**	0.147	-0.231	-0.563
	(0.258)	(0.182)	(0.185)	(0.255)	(0.445)	(0.370)
Non-Interest Expense/ Average Assets	0.479***	0.544*	0.378**	-0.056	0.139	0.528
	(0.183)	(0.286)	(0.151)	(0.379)	(0.261)	(0.444)
Credit standards for Households	0.209	-0.184	0.015	0.239	0.187	-0.055
	(0.241)	(0.191)	(0.325)	(0.187)	(0.193)	(0.175)
Credit standards for Enterprises	-0.081	0.314**	-0.152	-0.171	-0.087	0.148
	(0.197)	(0.158)	(0.241)	(0.140)	(0.170)	(0.170)
Loan demand of Enterprises	0.043	-0.000	-0.036	0.011	0.017	-0.020
	(0.032)	(0.032)	(0.050)	(0.028)	(0.032)	(0.026)
Loan demand of Households	0.014	0.019	0.061	-0.025	-0.069	-0.005
	(0.043)	(0.032)	(0.053)	(0.035)	(0.045)	(0.035)
Dummy for first merger	0.062	-0.682	-1.166	0.403	2.452	-4.527**
	(1.869)	(0.794)	(1.416)	(1.930)	(2.013)	(1.911)
Dummy for second merger	-1.096*	-0.721		-0.458	-1.758**	0.290
	(0.644)	(0.622)		(0.604)	(0.769)	(0.722)
Macroeconomic variables						
Unemployment rate	1.910**	-0.336	0.662	0.818	1.053	-0.177
	(0.940)	(0.923)	(1.178)	(0.708)	(0.859)	(0.722)
Inflation rate	-0.681	0.421	-0.108	-0.665	-0.452	0.116
	(0.800)	(0.635)	(0.979)	(0.569)	(0.635)	(0.542)
PHP/USD exchange rate	-0.124	0.172	0.032	-0.140	-0.128	0.017
	(0.125)	(0.116)	(0.156)	(0.093)	(0.117)	(0.088)
Bank lending rate	0.701	-2.382*	1.869	1.820	0.753	-1.261
	(1.706)	(1.338)	(2.117)	(1.141)	(1.394)	(1.475)
Reserves requirement ratio (RR)	0.829	29.485	-13.394	-32.898	-23.544	-2.634
	(28.597)	(25.238)	(40.939)	(23.605)	(23.373)	(23.088)
RR^2	-0.013	-0.759	0.344	0.855	0.625	0.074
	(0.738)	(0.654)	(1.059)	(0.612)	(0.604)	(0.597)

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Agricultural NPL	SME NPL	Microfinance NPL	Corporate NPL	Consumption NPL	Housing NPL
GDP growth rate	-0.437	1.046	-1.181	-0.839	-0.103	0.462
	(0.953)	(0.698)	(1.319)	(0.692)	(0.887)	(0.702)
L1.GDP growth	-0.273	0.328	0.192	-0.147	-0.438	0.160
	(0.307)	(0.252)	(0.359)	(0.188)	(0.273)	(0.254)
L2.GDP growth	0.343	-0.226	-0.208	0.489**	0.677**	0.023
	(0.329)	(0.232)	(0.372)	(0.207)	(0.272)	(0.230)
L3.GDP growth	0.020	-0.033	0.021	-0.195	-0.014	0.060
	(0.299)	(0.182)	(0.382)	(0.209)	(0.263)	(0.169)
L4.GDP growth	-0.510	0.638**	-0.588	-0.186	-0.165	0.212
	(0.381)	(0.297)	(0.615)	(0.292)	(0.360)	(0.296)
Trend	0.252	-0.206	0.145	0.185	0.120	-0.080
	(0.185)	(0.160)	(0.232)	(0.138)	(0.169)	(0.160)
Observations	2,960	3,197	1,395	2,468	2,539	2,696
Number of banks	108	113	61	91	100	99
Adjusted R2	0.655	0.636	0.631	0.496	0.571	0.613
AIC	21844	21561	10471	16461	18847	18430
BIC	22000	21719	10602	16612	18999	18584
p-value (Hansen J statistic)	0.107	0.289	0.945	0.0901	0.231	0.565
p-value (endogeneity test)	0.103	0.0516	0.0105	0.103	0.936	0.274
p-value (Joint test on RR)	0.519	0.285	0.923	0.346	0.164	0.640
p-value (Joint test on Credit Standards)	0.502	0.0437	0.480	0.441	0.523	0.373
p-value (Joint test on GDP growth)	0.422	0.364	0.588	0.167	0.115	0.780
Long-run GDP growth		7.387*		-3.247	-0.186	

Note: The results are based on the specification below:

$$NPL_{i,t}^{j} = \alpha NPL_{i,t-1}^{j} + \beta_1 ROPA/TA_{i,t} + \beta_2 TL^{j}/TA_{i,t} + \beta_3 Loangrowth_{i,t} + \beta_4 TAgrowth_{i,t}$$

$$+ B'_{Ci,t}\gamma + \rho d_{i|k,t} + M'_t\delta + I'_t\lambda + \theta t_t + v_i + \varepsilon_{i,t}$$

Heteroskedasticity-robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4.3 Estimates for Each NPL Category Using a Model with Liability-/Equity-side Variables

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Agricultural NPL	SME NPL	Microfinance NPL	Corporate NPL	Consumption NPL	Housing NPL
Bank-specific variables						
Lagged dependent variable	0.785***	0.778***	0.788***	0.737***	0.761***	0.764***
	(0.027)	(0.040)	(0.036)	(0.056)	(0.034)	(0.040)
Deposits/ Total Assets	0.024	0.042	-0.014	-0.068	-0.079	-0.147***
	(0.053)	(0.055)	(0.097)	(0.064)	(0.094)	(0.056)
Equity/Total Assets	0.140**	0.076	-0.060	-0.103*	0.047	-0.073
	(0.057)	(0.052)	(0.086)	(0.060)	(0.100)	(0.103)
Deposit growth	-0.004***	0.003	0.000	-0.000	-0.002	-0.002
	(0.001)	(0.005)	(0.002)	(0.001)	(0.002)	(0.002)
Equity growth	-0.739	0.042	-0.015	0.136	0.312	-0.722
	(0.895)	(0.076)	(0.032)	(0.432)	(0.907)	(0.778)
Net Interest Income/ Average Assets	0.119	-0.117	0.074	-0.248	0.124	0.053
	(0.330)	(0.336)	(0.134)	(0.354)	(0.277)	(0.456)
Non-Interest Income/ Average Assets	-0.135	-0.464**	-0.407*	0.177	-0.208	-0.474
	(0.260)	(0.215)	(0.228)	(0.250)	(0.475)	(0.328)
Non-Interest Expense/ Average Assets	0.645***	0.810***	0.265	0.055	0.156	0.620
	(0.207)	(0.314)	(0.176)	(0.388)	(0.265)	(0.430)
Credit standards for Households	0.247	-0.257	-0.042	0.190	0.261	0.070
	(0.238)	(0.166)	(0.291)	(0.173)	(0.199)	(0.156)
Credit standards for Enterprises	-0.115	0.348**	-0.102	-0.130	-0.166	0.052
	(0.186)	(0.152)	(0.226)	(0.130)	(0.178)	(0.146)
Loan demand of Enterprises	0.048	-0.004	-0.041	0.006	0.022	-0.003
	(0.033)	(0.023)	(0.046)	(0.027)	(0.032)	(0.023)
Loan demand of Households	0.001	0.025	0.067	-0.021	-0.084*	-0.029
	(0.043)	(0.034)	(0.051)	(0.032)	(0.046)	(0.034)
Dummy for first merger	-0.049	-0.865	-0.992	-0.537	2.477	-3.699**
	(1.689)	(0.625)	(1.474)	(1.503)	(2.068)	(1.690)
Dummy for second merger	-1.328*	-0.573		-0.485	-1.572*	0.339
	(0.705)	(0.719)		(0.533)	(0.900)	(0.702)
Macroeconomic variables						
Unemployment rate	2.063**	-0.405	0.392	0.670	1.380	0.337
	(0.890)	(0.635)	(1.133)	(0.681)	(0.889)	(0.652)
Inflation rate	-0.814	0.583	0.132	-0.531	-0.649	-0.314
	(0.790)	(0.459)	(0.843)	(0.532)	(0.663)	(0.494)
PHP/USD exchange rate	-0.179	0.214*	0.039	-0.118	-0.148	-0.047
	(0.139)	(0.110)	(0.152)	(0.090)	(0.128)	(0.100)
Bank lending rate	1.005	-2.650**	1.337	1.528	1.449	-0.368
	(1.576)	(1.137)	(1.951)	(1.052)	(1.461)	(1.253)
Reserves requirement ratio (RR)	-1.660	39.600*	-8.113	-24.982	-32.100	-13.178
	(27.734)	(20.653)	(36.516)	(22.580)	(25.133)	(20.927)
RR^2	0.051	-1.023*	0.210	0.652	0.846	0.347
	(0.717)	(0.534)	(0.945)	(0.585)	(0.649)	(0.541)

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Agricultural NPL	SME NPL	Microfinance NPL	Corporate NPL	Consumption NPL	Housing NPL
GDP growth rate	-0.712	1.168*	-0.839	-0.685	-0.524	-0.091
	(0.923)	(0.646)	(1.184)	(0.637)	(0.896)	(0.629)
L1.GDP growth	-0.337	0.357*	0.210	-0.093	-0.465	0.053
	(0.315)	(0.216)	(0.359)	(0.189)	(0.293)	(0.237)
L2.GDP growth	0.362	-0.342	-0.218	0.440**	0.723**	0.100
	(0.327)	(0.242)	(0.385)	(0.204)	(0.283)	(0.210)
L3.GDP growth	-0.007	0.038	0.094	-0.183	-0.026	0.000
	(0.305)	(0.186)	(0.392)	(0.212)	(0.261)	(0.164)
L4.GDP growth	-0.583	0.636**	-0.548	-0.120	-0.316	0.059
	(0.368)	(0.270)	(0.565)	(0.276)	(0.364)	(0.272)
Trend	0.314*	-0.246*	0.096	0.156	0.229	0.054
	(0.178)	(0.137)	(0.213)	(0.126)	(0.171)	(0.139)
Observations	2,960	3,200	1,398	2,470	2,538	2,696
Number of banks	108	113	61	91	100	99
Adjusted R2	0.653	0.575	0.628	0.503	0.572	0.608
AIC	21854	22041	10524	16441	18815	18468
BIC	22010	22199	10655	16592	18966	18621
p-value (Hansen J statistic)	0.748	0.513	0.608	0.167	0.229	0.399
p-value (endogeneity test)	0.535	0.539	0.127	0.288	0.896	0.130
p-value (Joint test on RR)	0.443	0.158	0.976	0.418	0.131	0.444
p-value (Joint test on Credit Standards)	0.502	0.0507	0.569	0.549	0.403	0.310
p-value (Joint test on GDP growth)	0.461	0.291	0.639	0.209	0.107	0.843
Long-run GDP growth		8.357*		-2.440	-2.545	

Note: The results are based on the specification below:

$$NPL_{i,t}^{j} = \alpha NPL_{i,t-1}^{j} + \beta_1 Equity/TA_{i,t} + \beta_2 Deposit/TA_{i,t} + \beta_3 Depositgrowth_{i,t} +$$

$$\beta_4 Equitygrowth_{i,t} + B'_{Ci,t}\gamma + \rho d_{i|k,t} + M'_t\delta + I'_t\lambda + \theta t_t + \upsilon_i + \varepsilon_{i,t}$$

Heteroskedasticity-robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4.4 Estimates for Each NPL Category Using a Model with Macroeconomic Variables

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Agricultural NPL	SME NPL	Microfinance NPL	Corporate NPL	Consumption NPL	Housing NPL
Lagged dependent variable	0.799***	0.816***	0.812***	0.735***	0.763***	0.763***
	(0.025)	(0.030)	(0.035)	(0.054)	(0.032)	(0.043)
Loan demand of Enterprises	0.020	0.017	-0.031	-0.013	-0.012	-0.020
	(0.021)	(0.014)	(0.032)	(0.016)	(0.024)	(0.015)
Loan demand of Households	0.019	-0.022	0.089*	-0.002	-0.032	-0.022
	(0.029)	(0.026)	(0.046)	(0.022)	(0.035)	(0.022)
Unemployment rate	1.534***	0.930**	0.210	0.155	0.410	0.282
	(0.507)	(0.374)	(0.804)	(0.411)	(0.588)	(0.437)
Inflation rate	-0.054	-0.179	-0.056	0.063	0.183	-0.002
	(0.208)	(0.135)	(0.330)	(0.132)	(0.208)	(0.163)
PHP/USD exchange rate	-0.061	0.117*	0.064	-0.039	-0.051	-0.019
	(0.066)	(0.060)	(0.100)	(0.042)	(0.070)	(0.060)
Bank lending rate	-0.175	-0.041	0.401	0.376	-0.177	-0.407
	(0.473)	(0.345)	(0.834)	(0.301)	(0.559)	(0.422)
Reserves requirement ratio (RR)	21.714*	4.823	-6.888	-4.840	0.156	-6.563
	(11.257)	(7.719)	(17.474)	(7.519)	(12.967)	(8.490)
RR^2	-0.554*	-0.124	0.178	0.130	0.014	0.175
	(0.293)	(0.202)	(0.455)	(0.197)	(0.340)	(0.222)
GDP growth rate	0.081	-0.081	-0.695*	0.036	0.501	0.008
	(0.268)	(0.190)	(0.419)	(0.182)	(0.337)	(0.274)
L1.GDP growth	-0.162	0.038	0.226	0.006	-0.341	0.024
	(0.250)	(0.133)	(0.303)	(0.149)	(0.225)	(0.189)
L2.GDP growth	0.139	-0.085	-0.139	0.303	0.518**	0.020
	(0.263)	(0.144)	(0.283)	(0.206)	(0.261)	(0.157)
L3.GDP growth	0.108	-0.038	-0.026	-0.089	0.069	0.107
	(0.270)	(0.149)	(0.359)	(0.220)	(0.253)	(0.161)
L4.GDP growth	-0.455**	0.042	-0.326	0.089	-0.056	-0.128
	(0.199)	(0.111)	(0.325)	(0.154)	(0.198)	(0.145)
Trend	0.196***	0.056	0.020	0.020	0.041	0.042
	(0.061)	(0.043)	(0.084)	(0.043)	(0.064)	(0.048)
Observations	3,001	3,251	1,423	2,502	2,580	2,724
Number of banks	108	113	62	91	100	100
Adjusted R2	0.646	0.652	0.640	0.515	0.582	0.597
AIC	22258	21832	10672	16554	19139	18731
BIC	22348	21923	10751	16641	19227	18820
p-value (Joint test on RR)	0.0291	0.737	0.920	0.626	0.127	0.620
p-value (Joint test on GDP)	0.146	0.948	0.591	0.259	0.218	0.917

Note: The results are based on the specification below:

$$NPL_{i,t}^{j} = \alpha NPL_{i,t-1}^{j} + M_t'\delta + I_{2t}'\lambda + \theta t_t + \upsilon_i + \varepsilon_{i,t}$$

Heteroskedasticity-robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4.5 Estimates for Each NPL Category Using a Model with Asset-side and Liability-/Equity-side Variables

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	Agricultural NPL	SME NPL	Microfinance NPL	Corporate NPL	Consumption NPL	Housing NPL
Bank-specific variables						
Lagged dependent variable	0.781***	0.768***	0.785***	0.732***	0.755***	0.767***
	(0.028)	(0.042)	(0.037)	(0.057)	(0.034)	(0.040)
Total Loan per category/ Total Assets	-0.052	-0.023	0.059	-0.027	0.039	0.042
	(0.034)	(0.040)	(0.124)	(0.033)	(0.041)	(0.028)
ROPA/ Total Assets	0.086	0.233*	-0.167	0.092	0.038	0.105
	(0.112)	(0.123)	(0.137)	(0.178)	(0.145)	(0.086)
TA growth	-3.589	0.328	0.924	-0.499	0.164	-0.515
	(2.366)	(3.232)	(1.101)	(0.692)	(0.598)	(1.441)
Loan growth	1.660	-0.618	-0.174	0.263	-1.341*	0.511
	(1.566)	(2.296)	(0.670)	(0.416)	(0.771)	(1.125)
Deposit growth	-0.003	0.001	-0.001	-0.000	-0.000	-0.002
	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)
Equity growth	-0.017	0.013	-0.011	-0.044	0.585	0.104
	(0.854)	(0.044)	(0.027)	(0.493)	(0.898)	(0.732)
Deposits/Total Assets	0.018	0.044	-0.011	-0.064	-0.077	-0.155***
	(0.052)	(0.071)	(0.096)	(0.064)	(0.094)	(0.056)
Equity/Total Assets	0.112**	0.064	-0.045	-0.098	0.006	-0.098
	(0.056)	(0.051)	(0.090)	(0.063)	(0.098)	(0.110)
Net Interest Income/ Average Assets	0.065	0.156	-0.079	-0.191	0.244	0.036
	(0.248)	(0.382)	(0.181)	(0.316)	(0.320)	(0.487)
Non-Interest Income/ Average Assets	-0.188	-0.351**	-0.397	0.177	-0.110	-0.498
	(0.275)	(0.171)	(0.250)	(0.256)	(0.498)	(0.352)
Non-Interest Expense/ Average Assets	0.505***	0.665***	0.307*	-0.049	0.394	0.599
	(0.190)	(0.251)	(0.173)	(0.353)	(0.296)	(0.439)
Credit standards for Households	0.203	-0.209	-0.111	0.212	0.237	-0.037
	(0.229)	(0.161)	(0.302)	(0.180)	(0.191)	(0.163)
Credit standards for Enterprises	-0.088	0.315**	-0.070	-0.145	-0.142	0.128
	(0.184)	(0.145)	(0.227)	(0.135)	(0.172)	(0.158)
Loan demand of Enterprises	0.040	-0.001	-0.051	0.008	0.022	-0.018
	(0.031)	(0.030)	(0.048)	(0.028)	(0.032)	(0.026)
Loan demand of Households	0.017	0.019	0.073	-0.021	-0.082*	-0.007
	(0.041)	(0.043)	(0.050)	(0.034)	(0.043)	(0.036)
Dummy for first merger	0.374	-1.022	-1.057	-0.072	2.373	-3.986**
	(1.715)	(0.670)	(1.563)	(1.529)	(2.043)	(1.926)
Dummy for second merger	-1.193*	-0.822		-0.448	-1.608*	0.536
	(0.652)	(0.664)		(0.564)	(0.892)	(0.715)
Macroeconomic variables						
Unemployment rate	1.915**	-0.336	0.275	0.730	1.263	0.001
	(0.893)	(0.831)	(1.146)	(0.698)	(0.867)	(0.690)

Model: Dependent Variable:	(1) Agricultural NPL	(2) SME NPL	(3) Microfinance NPL	(4) Corporate NPL	(5) Consumption NPL	(6) Housing NPL
Inflation rate	-0.670	0.484	0.297	-0.605	-0.549	0.038
	(0.769)	(0.502)	(0.873)	(0.548)	(0.639)	(0.512)
PHP/USD exchange rate	-0.125	0.177*	0.066	-0.129	-0.123	0.030
	(0.128)	(0.107)	(0.149)	(0.094)	(0.121)	(0.093)
Bank lending rate	0.806	-2.375**	1.170	1.661	1.230	-0.977
	(1.588)	(1.194)	(1.969)	(1.085)	(1.393)	(1.371)
Reserves requirement ratio (RR)	1.504	31.862*	0.728	-27.795	-30.355	-1.422
	(26.947)	(18.398)	(37.370)	(23.431)	(23.847)	(21.733)
RR^2	-0.031	-0.821*	-0.020	0.724	0.802	0.043
	(0.696)	(0.476)	(0.968)	(0.607)	(0.616)	(0.562)
GDP growth rate	-0.505	1.069	-0.721	-0.756	-0.360	0.327
	(0.899)	(0.669)	(1.184)	(0.668)	(0.882)	(0.654)
L1.GDP growth	-0.301	0.321*	0.254	-0.116	-0.427	0.159
	(0.301)	(0.193)	(0.356)	(0.189)	(0.286)	(0.249)
L2.GDP growth	0.349	-0.262	-0.275	0.464**	0.691**	0.018
	(0.327)	(0.186)	(0.381)	(0.205)	(0.278)	(0.223)
L3.GDP growth	0.011	-0.000	0.054	-0.194	0.003	0.049
	(0.300)	(0.165)	(0.397)	(0.210)	(0.264)	(0.168)
L4.GDP growth	-0.532	0.612**	-0.433	-0.144	-0.277	0.173
	(0.359)	(0.301)	(0.567)	(0.284)	(0.363)	(0.282)
Trend	0.260	-0.202	0.061	0.175	0.202	-0.034
	(0.173)	(0.162)	(0.220)	(0.131)	(0.167)	(0.149)
Observations	2,960	3,196	1,395	2,468	2,538	2,696
Number of banks	108	113	61	91	100	99
Adjusted R2	0.661	0.624	0.626	0.500	0.577	0.608
AIC	21793	21633	10495	16448	18786	18467
BIC	21973	21815	10647	16622	18962	18644
p-value (Hansen J statistic)	0.183	0.429	0.976	0.189	0.491	0.460
p-value (endogeneity test)	0.0928	0.153	0.0291	0.246	0.890	0.0309
p-value (Joint test on RR)	0.573	0.178	0.995	0.390	0.0897	0.552
p-value (Joint test on Credit Standards)	0.568	0.0454	0.505	0.500	0.429	0.402
p-value (Joint test on GDP growth)	0.426	0.359	0.645	0.184	0.100	0.854
Long-run GDP growth		7.490		-2.774	-1.507	

Note: The results are based on the specification below:

$$NPL^{j}_{i,t} = \alpha NPL^{j}_{i,t-1} + \beta_1 ROPA/TA_{i,t} + \beta_2 TL^{j}/TA_{i,t} + \beta_3 Loangrowth_{i,t} + \beta_4 TAgrowth_{i,t} + \beta_1 Equity/TA_{i,t} + \beta_2 Deposit/TA_{i,t} + \beta_3 Depositgrowth_{i,t} + \beta_4 Equitygrowth_{i,t} + B'_{Ci,t}\gamma + \rho d_{i|k,t} + M'_t\delta + I'_t\lambda + \theta t_t + \upsilon_i + \varepsilon_{i,t}$$

Heteroskedasticity-robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Figures

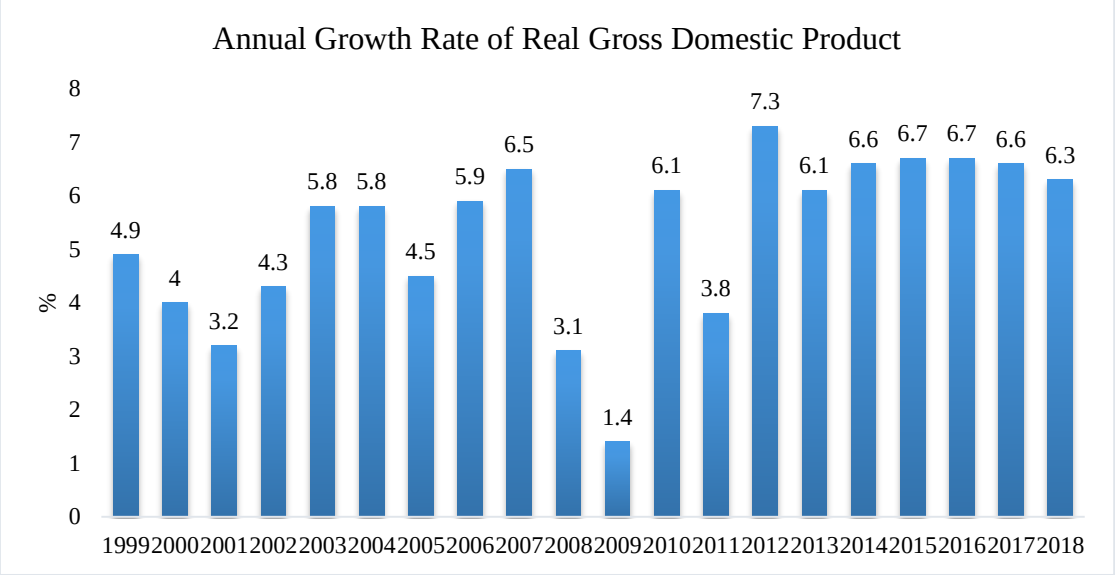


Figure 2.1 Annual Growth Rate of Real Gross Domestic Product in the Philippines from 1999 to 2018
Note: Based on 2000 prices. This figure is drawn using data from Philippine Statistics Authority.

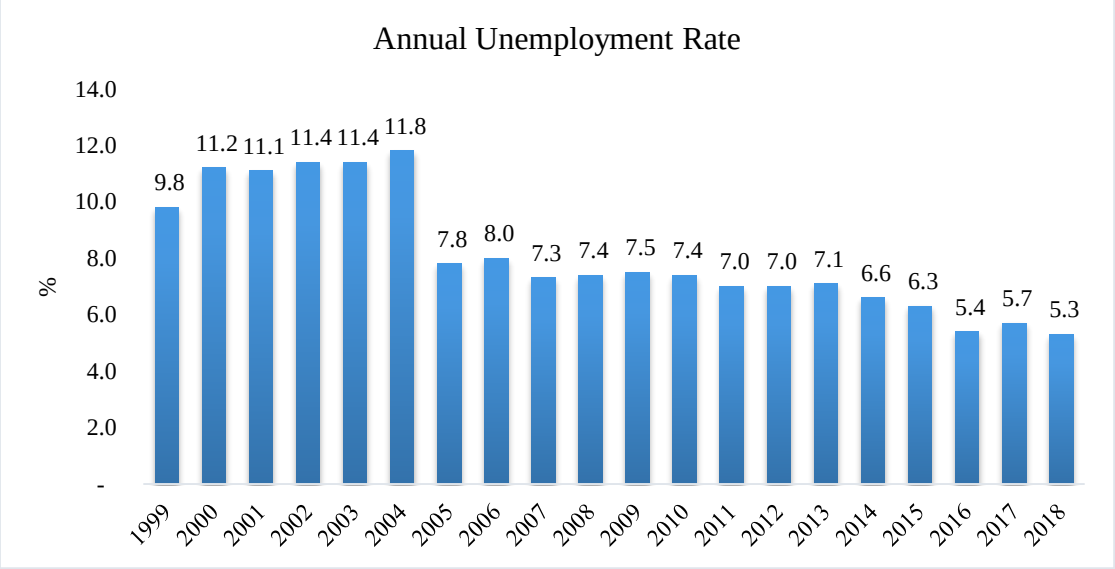


Figure 2.2 Annual Unemployment Rate in the Philippines from 1999 to 2018
Note: This figure is drawn using data from Philippine Statistics Authority.

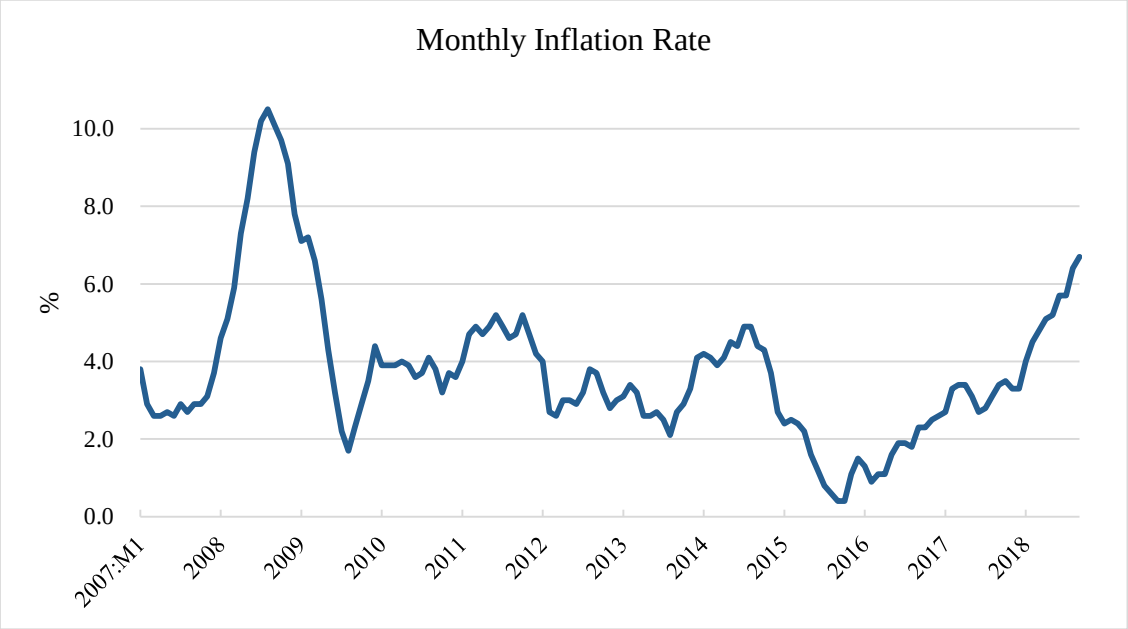
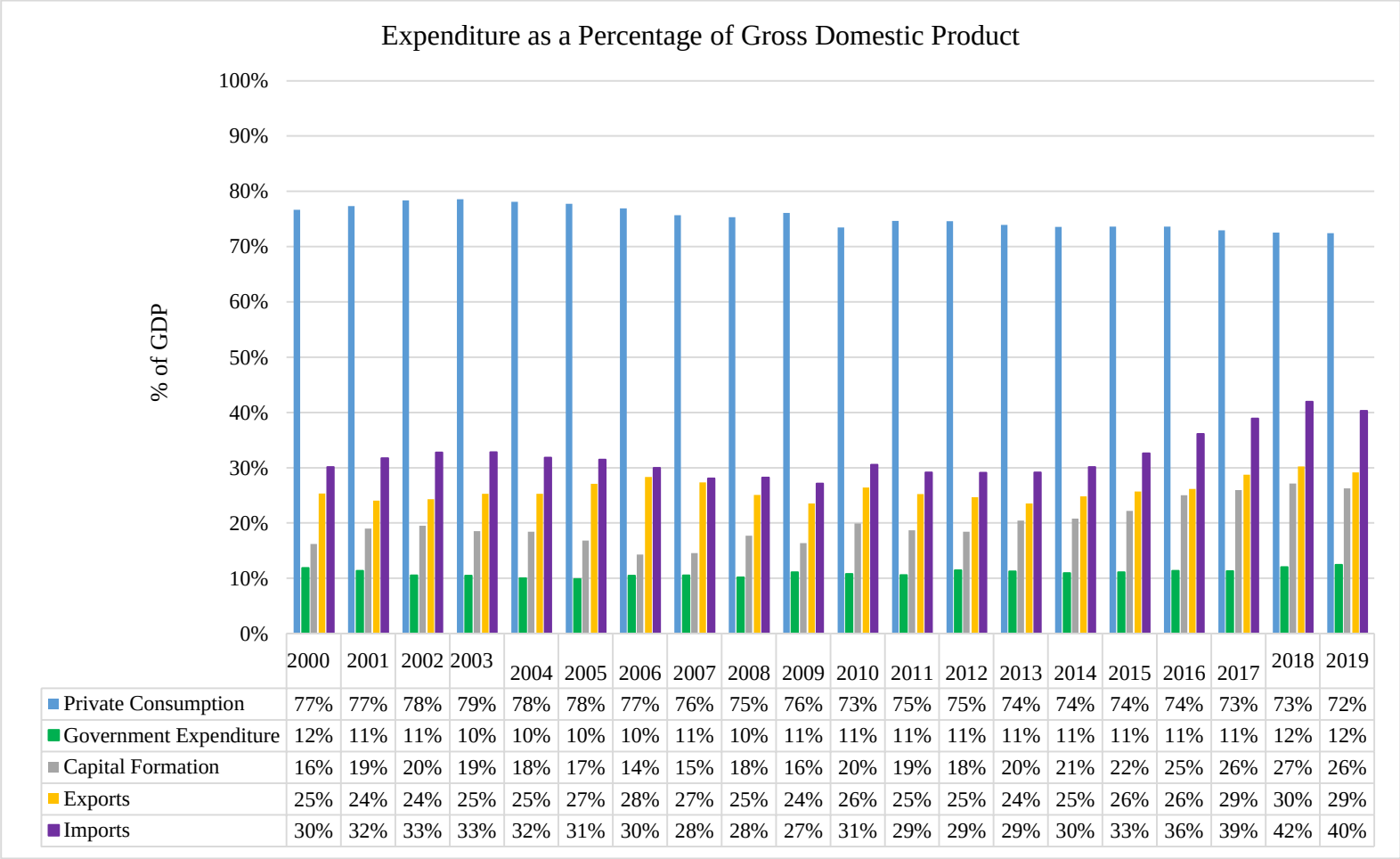
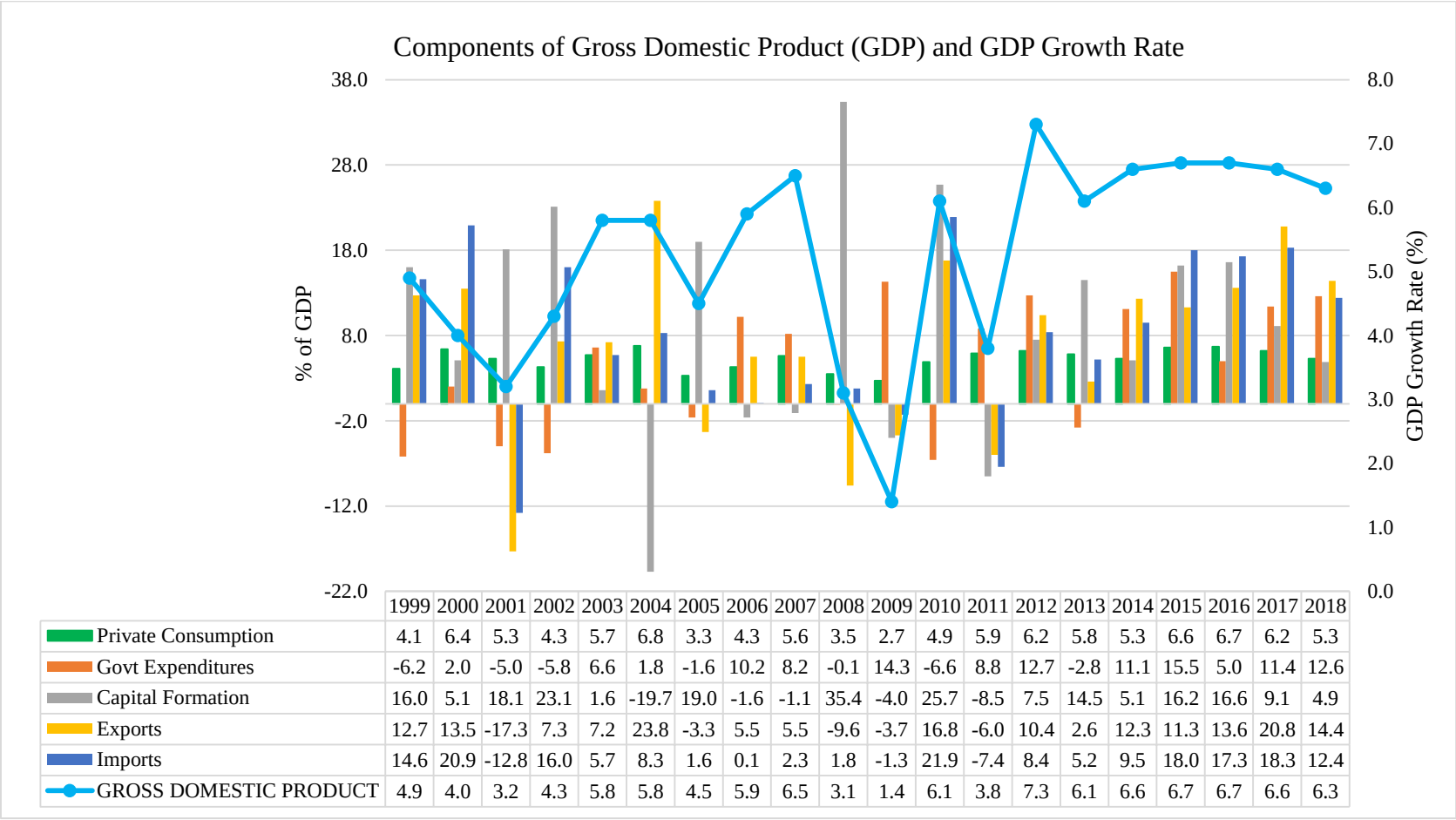


Figure 2.3 Monthly Inflation Rate in the Philippines from 2007 to 2018
Note: Based on 2006 prices. This figure is drawn using data from Bangko Sentral ng Pilipinas.



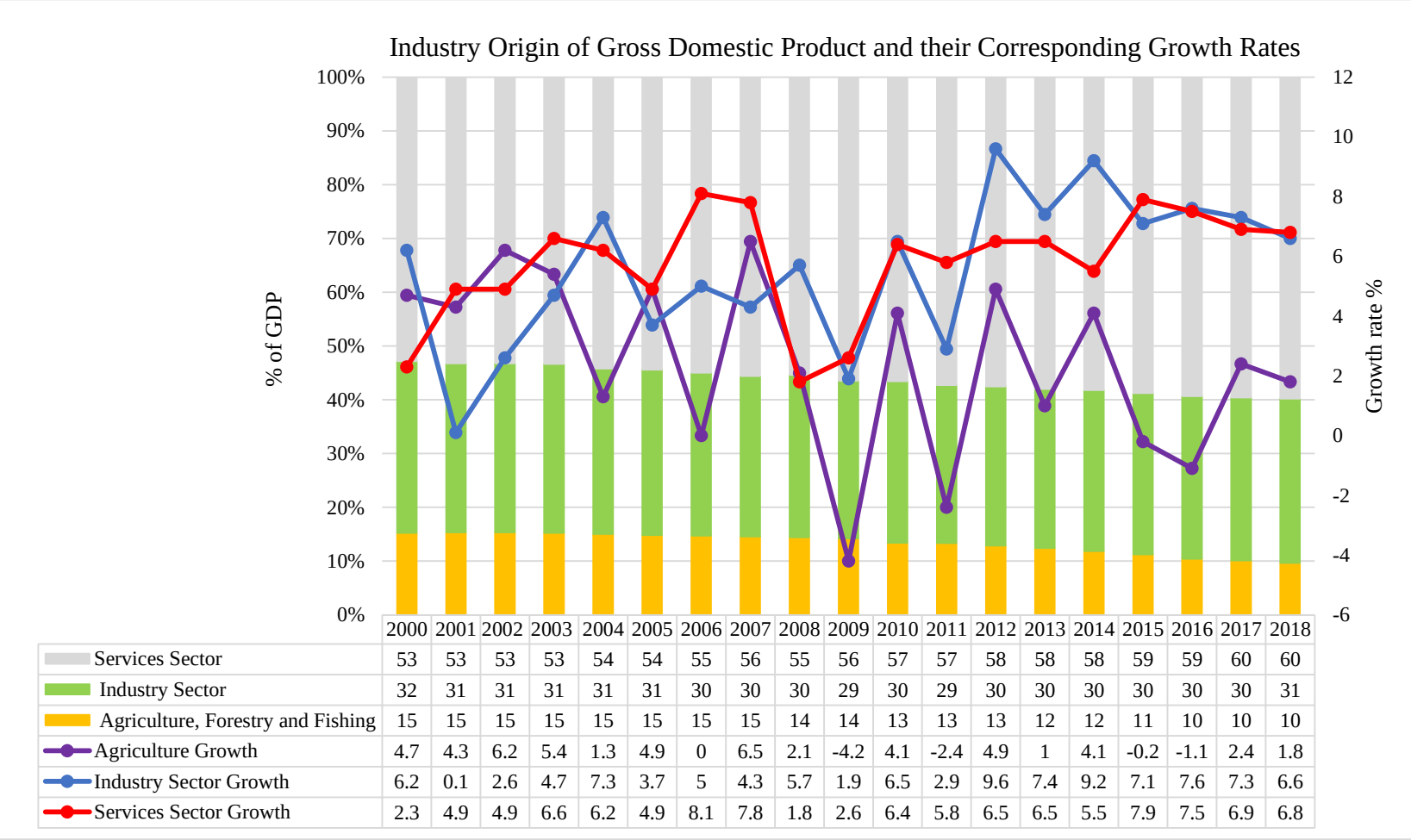
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Private Consumption	77%	77%	78%	79%	78%	78%	77%	76%	75%	76%	73%	75%	75%	74%	74%	74%	74%	73%	73%	72%
Government Expenditure	12%	11%	11%	10%	10%	10%	10%	11%	10%	11%	11%	11%	11%	11%	11%	11%	11%	11%	12%	12%
Capital Formation	16%	19%	20%	19%	18%	17%	14%	15%	18%	16%	20%	19%	18%	20%	21%	22%	25%	26%	27%	26%
Exports	25%	24%	24%	25%	25%	27%	28%	27%	25%	24%	26%	25%	25%	24%	25%	26%	26%	29%	30%	29%
Imports	30%	32%	33%	33%	32%	31%	30%	28%	28%	27%	31%	29%	29%	29%	30%	33%	36%	39%	42%	40%

Figure 2.4 Expenditure as a Percentage of Gross Domestic Product in the Philippines from 2000 to 2019
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Private Consumption	4.1	6.4	5.3	4.3	5.7	6.8	3.3	4.3	5.6	3.5	2.7	4.9	5.9	6.2	5.8	5.3	6.6	6.7	6.2	5.3
Govt Expenditures	-6.2	2.0	-5.0	-5.8	6.6	1.8	-1.6	10.2	8.2	-0.1	14.3	-6.6	8.8	12.7	-2.8	11.1	15.5	5.0	11.4	12.6
Capital Formation	16.0	5.1	18.1	23.1	1.6	-19.7	19.0	-1.6	-1.1	35.4	-4.0	25.7	-8.5	7.5	14.5	5.1	16.2	16.6	9.1	4.9
Exports	12.7	13.5	-17.3	7.3	7.2	23.8	-3.3	5.5	5.5	-9.6	-3.7	16.8	-6.0	10.4	2.6	12.3	11.3	13.6	20.8	14.4
Imports	14.6	20.9	-12.8	16.0	5.7	8.3	1.6	0.1	2.3	1.8	-1.3	21.9	-7.4	8.4	5.2	9.5	18.0	17.3	18.3	12.4
GROSS DOMESTIC PRODUCT	4.9	4.0	3.2	4.3	5.8	5.8	4.5	5.9	6.5	3.1	1.4	6.1	3.8	7.3	6.1	6.6	6.7	6.7	6.6	6.3

Figure 2.5 Components of Gross Domestic Product (GDP) and GDP Growth Rate from 1999 to 201
Note: This figure is drawn using data from Philippine Statistics Authority.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Services Sector	53	53	53	53	54	54	55	56	55	56	57	57	58	58	58	59	59	60	60
Industry Sector	32	31	31	31	31	31	30	30	30	29	30	29	30	30	30	30	30	30	31
Agriculture, Forestry and Fishing	15	15	15	15	15	15	15	15	14	14	13	13	13	12	12	11	10	10	10
Agriculture Growth	4.7	4.3	6.2	5.4	1.3	4.9	0	6.5	2.1	-4.2	4.1	-2.4	4.9	1	4.1	-0.2	-1.1	2.4	1.8
Industry Sector Growth	6.2	0.1	2.6	4.7	7.3	3.7	5	4.3	5.7	1.9	6.5	2.9	9.6	7.4	9.2	7.1	7.6	7.3	6.6
Services Sector Growth	2.3	4.9	4.9	6.6	6.2	4.9	8.1	7.8	1.8	2.6	6.4	5.8	6.5	6.5	5.5	7.9	7.5	6.9	6.8

Figure 2.6 Industry Origin of Gross Domestic Product and their Corresponding Growth Rates from 1999 to 2018
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas and Philippine Statistics Authority.

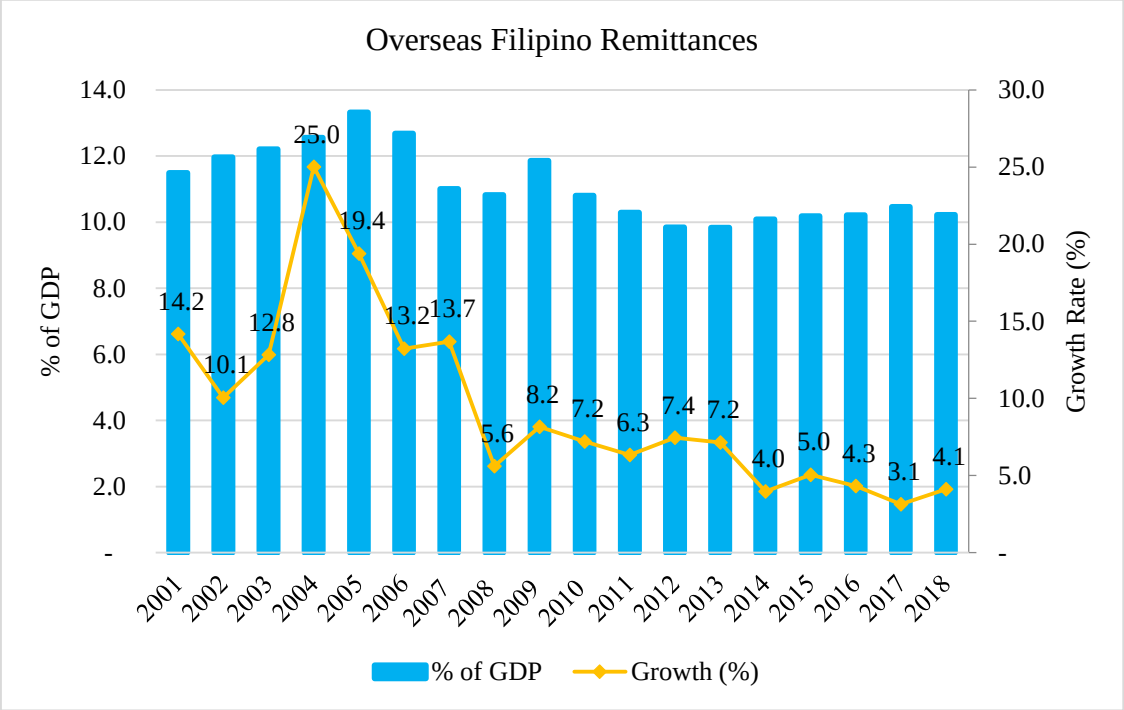


Figure 2.7 Overseas Filipino Remittances as a Percentage of Gross Domestic Product and Growth Rate of Remittances
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas and World Bank.

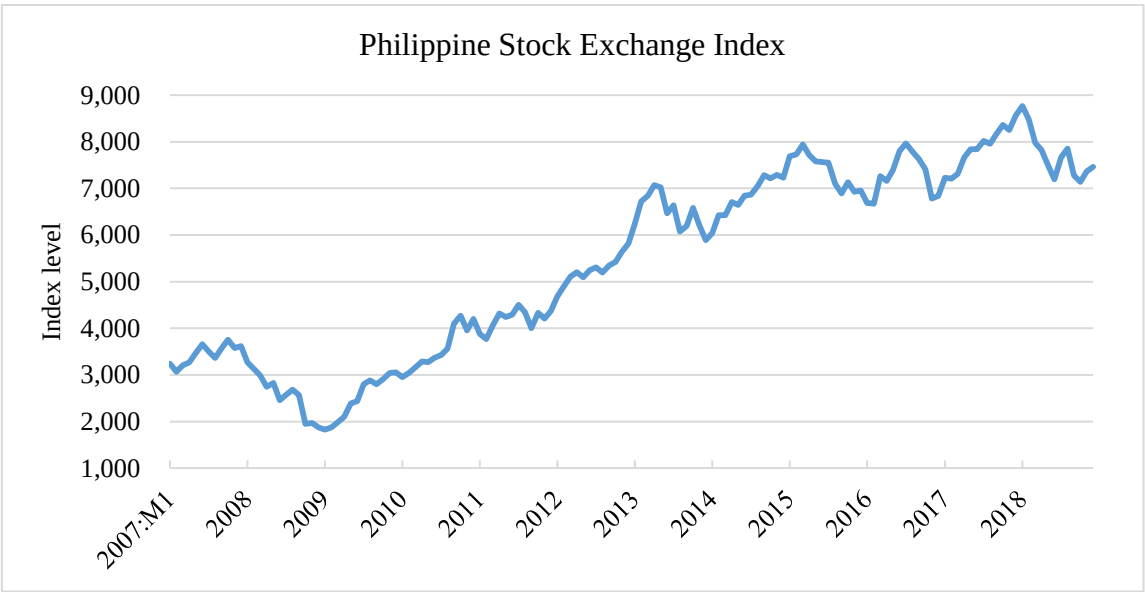


Figure 2.8 Philippine Stock Exchange Index from 2007 to 2018
Note: This figure is drawn using monthly data from Bangko Sentral ng Pilipinas.

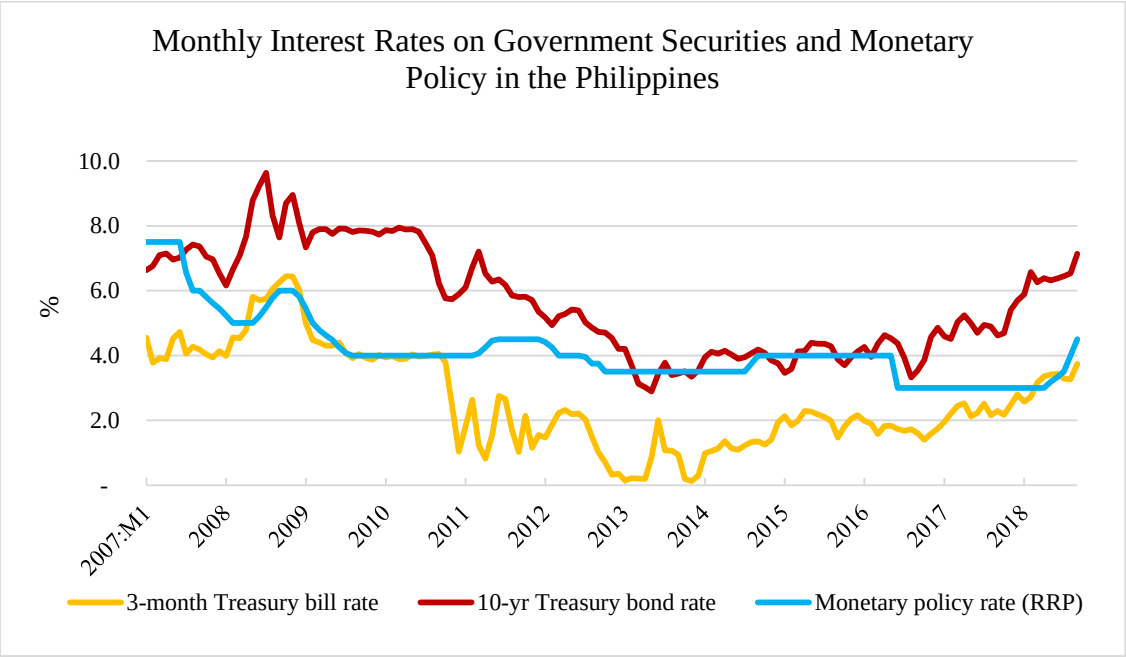


Figure 2.9 Monthly Interest Rates on Government Securities and Monetary Policy Rates in the Philippines from 2007 to 2018
Note: This figure is drawn using monthly data from Bangko Sentral ng Pilipinas and Bloomberg.

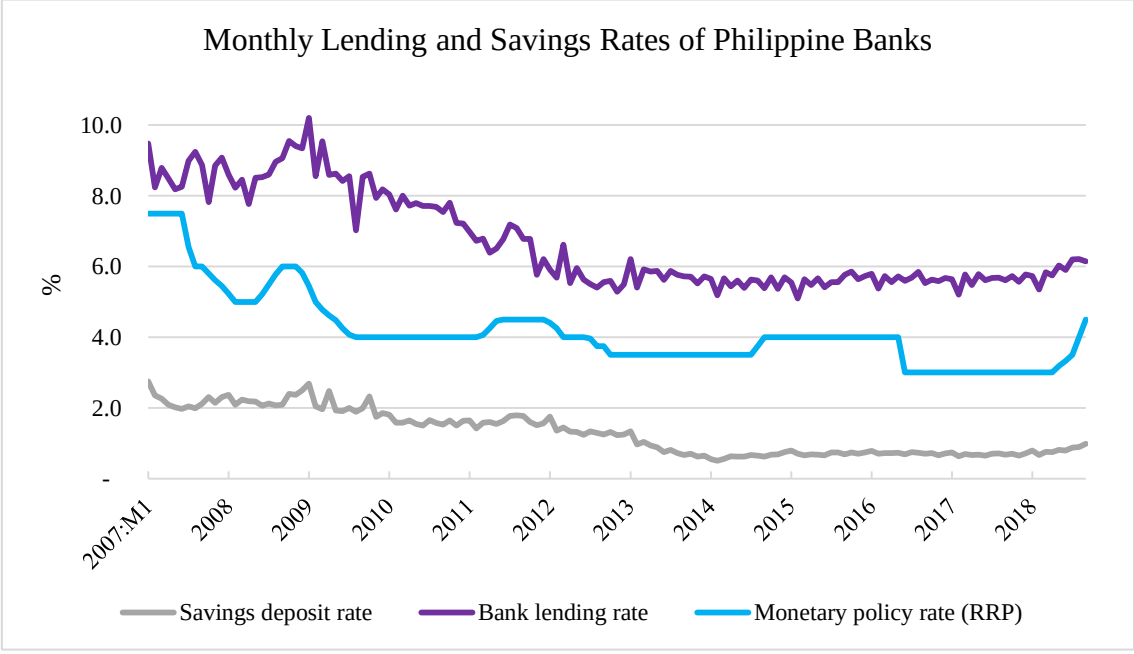


Figure 2.10 Monthly Lending and Savings Rates of Philippine Banks from 2007 to 2018
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas.

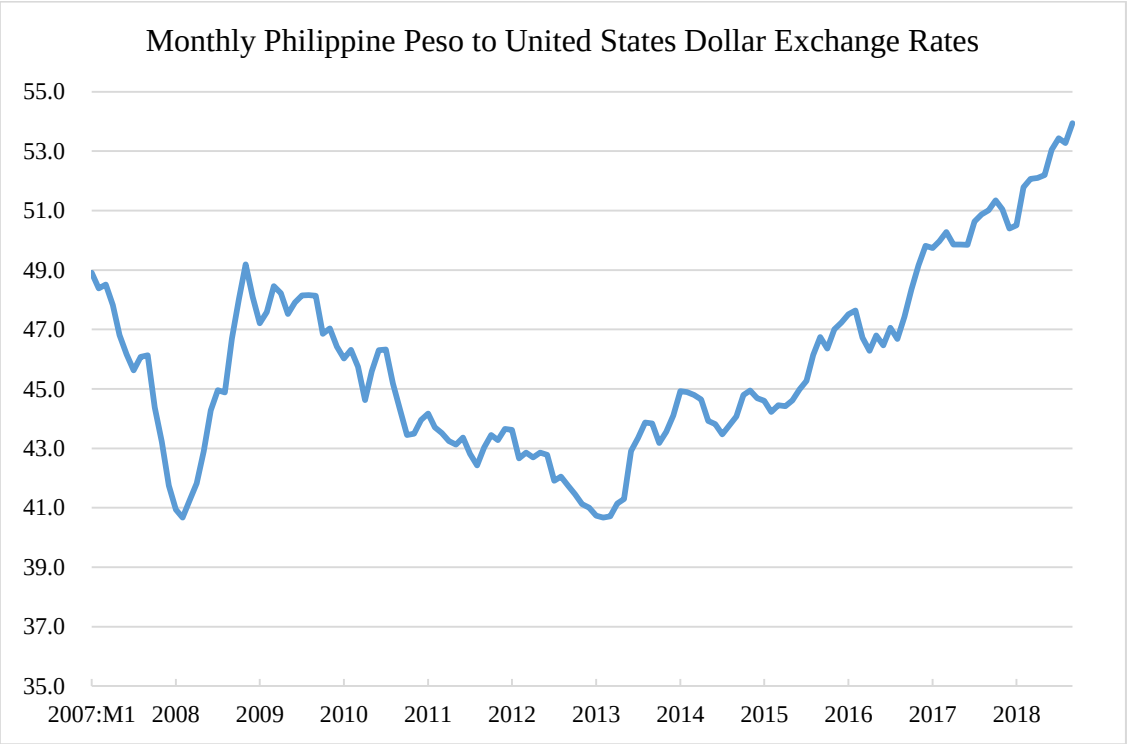


Figure 2.11 Monthly Philippine Peso to United States Dollar Exchange Rates from 2007 to 2018
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas.

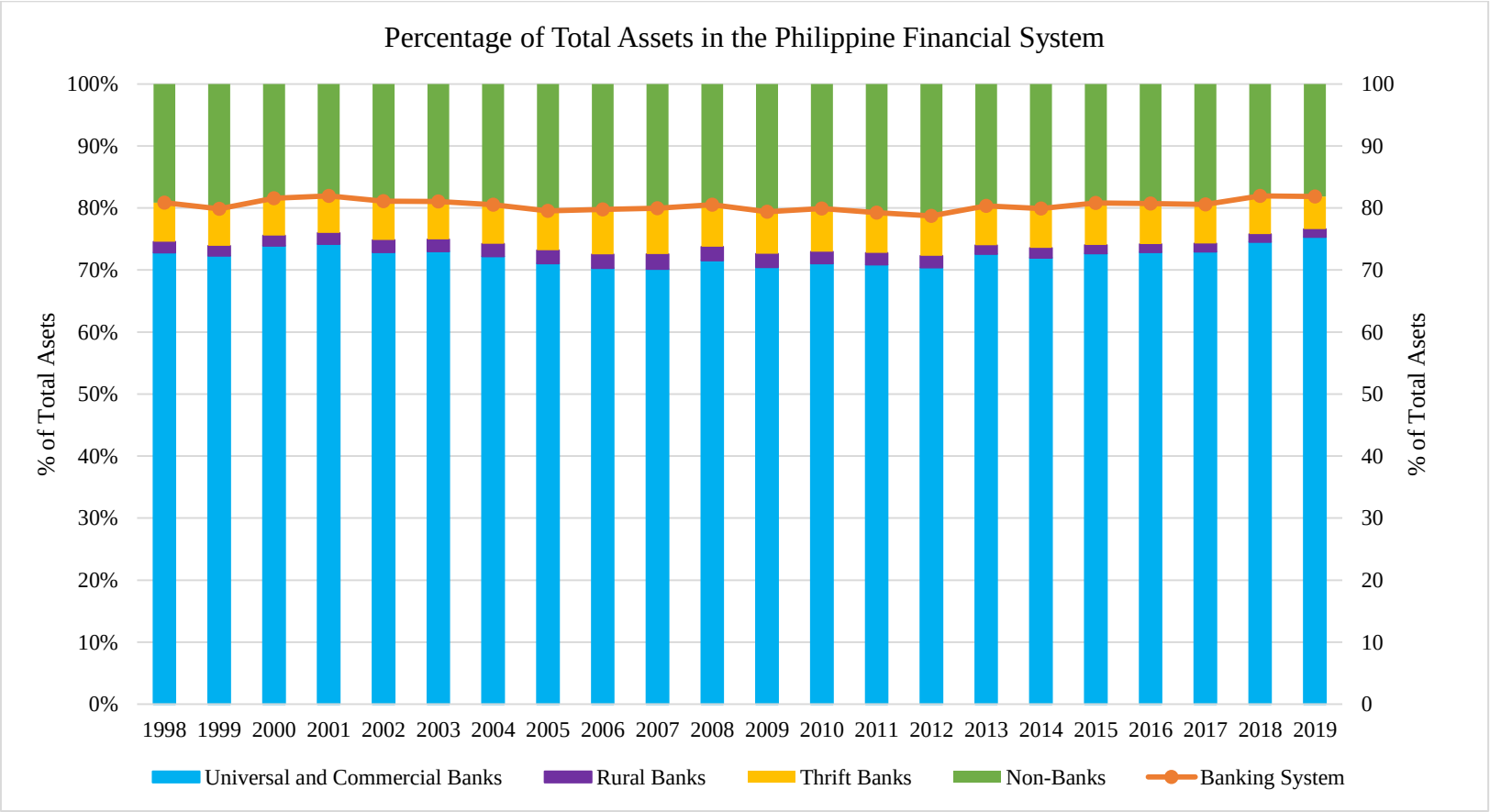


Figure 2.12 Percentage of Total Assets in the Philippine Financial System from 1998 to 2019
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas.

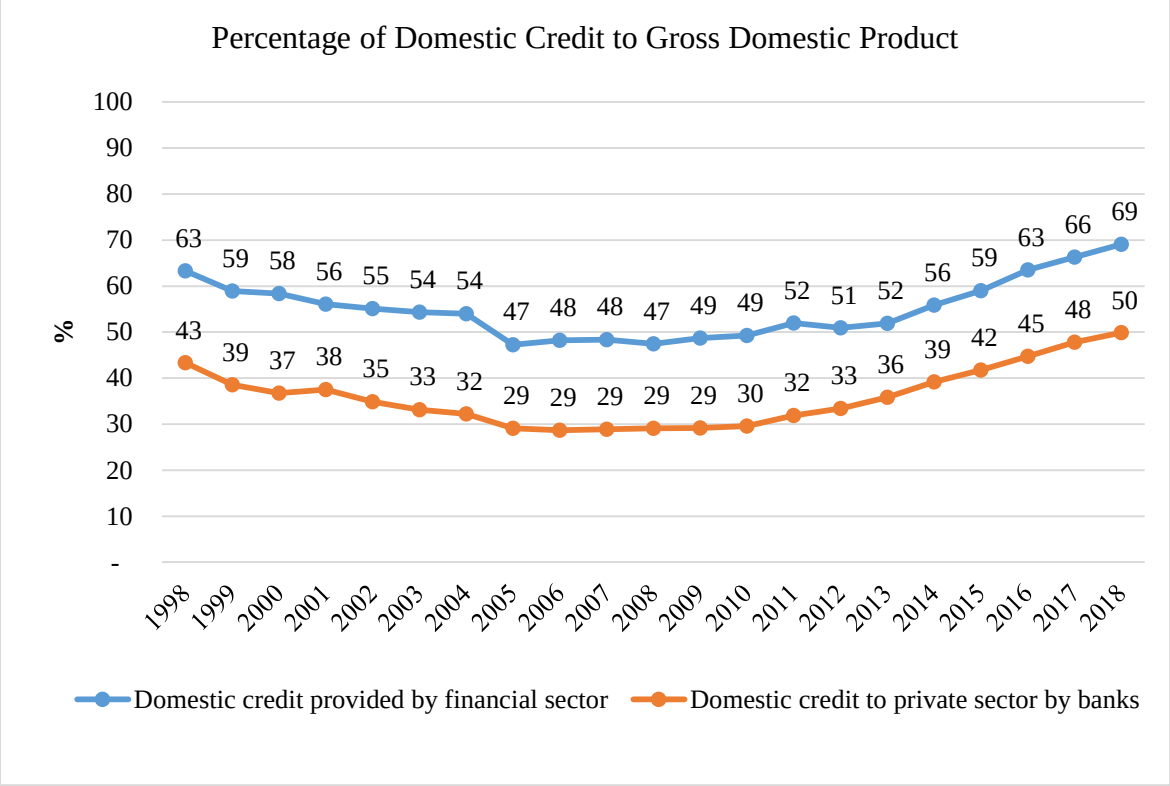


Figure 2.13 Percentage of Domestic Credit to Gross Domestic Product in the Philippines from 1998 to 2018
Note: This figure is drawn using data from World Bank.

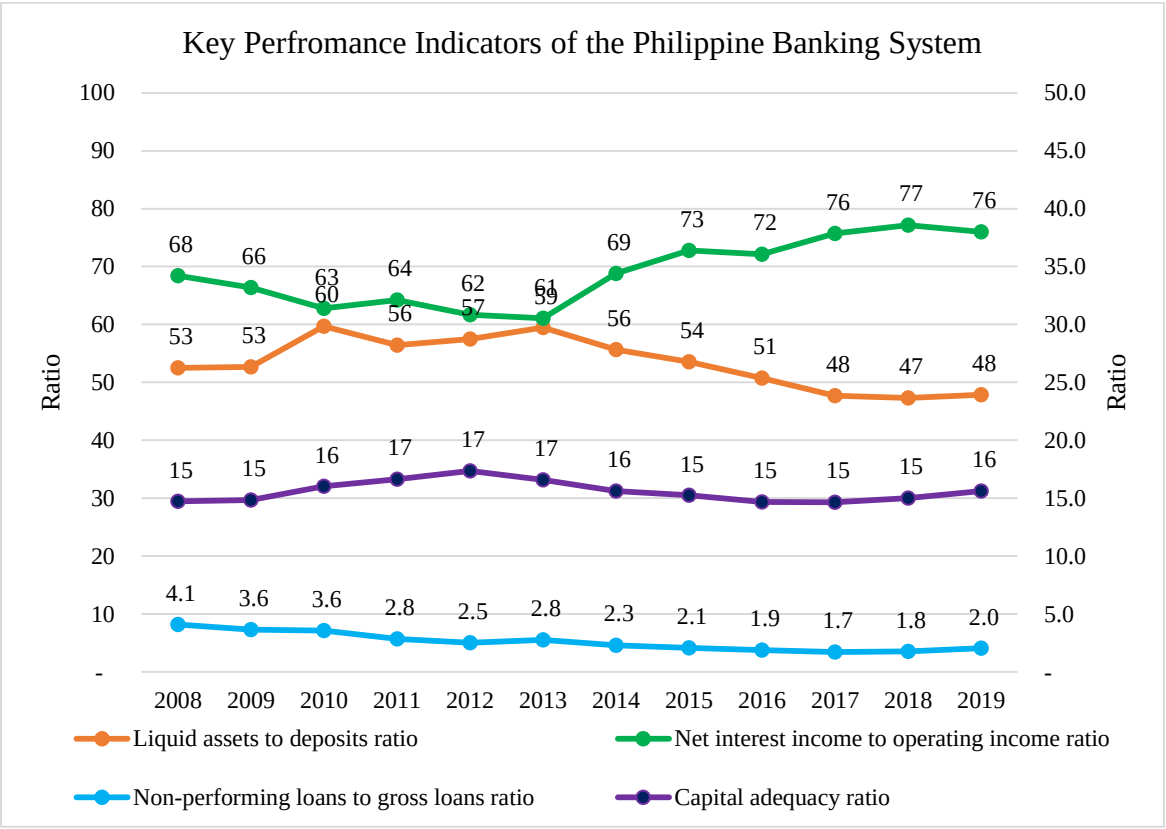
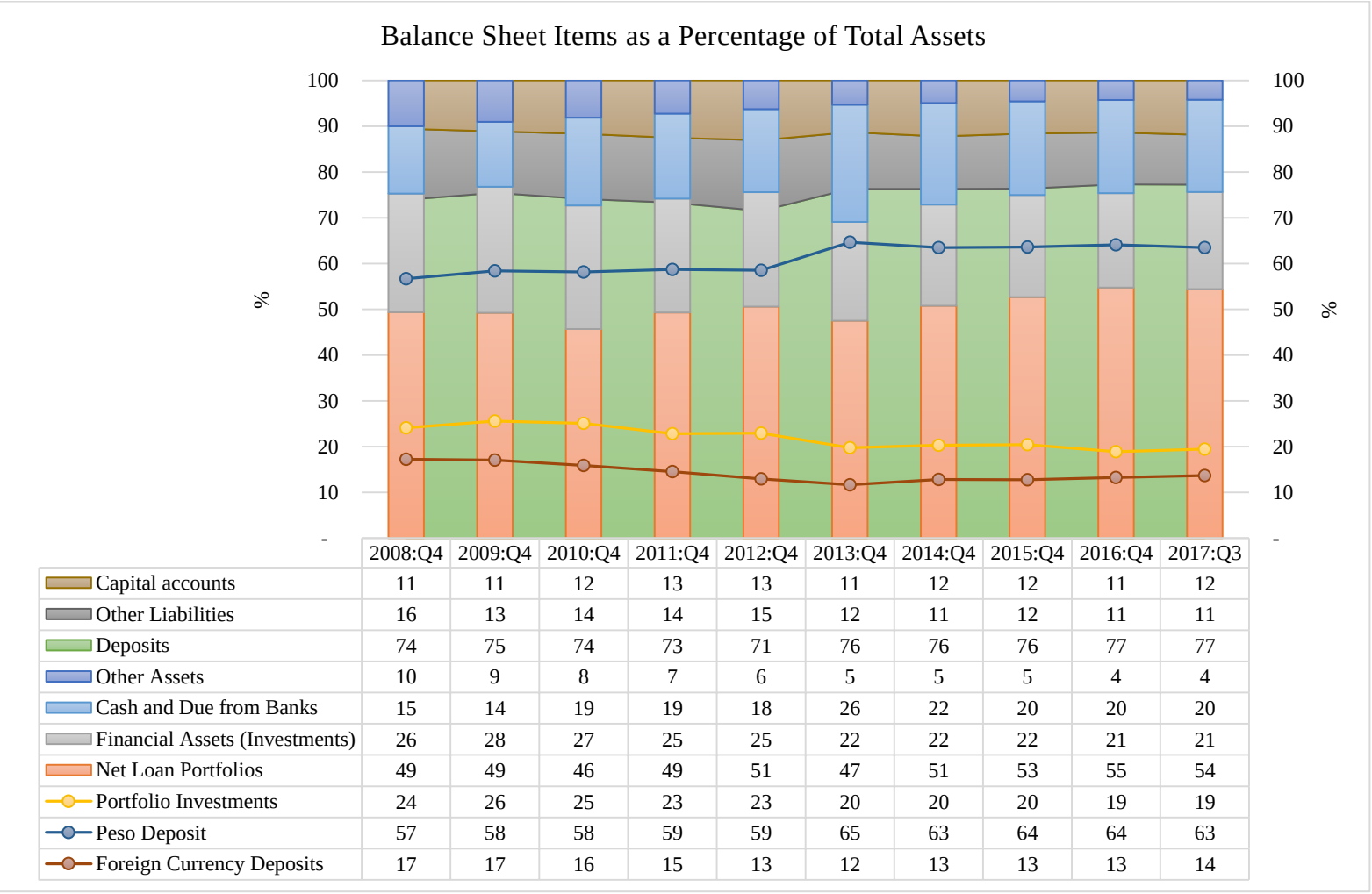


Figure 2.14 Key Indicators of the Philippine Banking System from 2008 to 2019
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas. This publicly available data represents only universal banks and commercial banks and does not include thrift banks.



	2008:Q4	2009:Q4	2010:Q4	2011:Q4	2012:Q4	2013:Q4	2014:Q4	2015:Q4	2016:Q4	2017:Q3
Capital accounts	11	11	12	13	13	11	12	12	11	12
Other Liabilities	16	13	14	14	15	12	11	12	11	11
Deposits	74	75	74	73	71	76	76	76	77	77
Other Assets	10	9	8	7	6	5	5	5	4	4
Cash and Due from Banks	15	14	19	19	18	26	22	20	20	20
Financial Assets (Investments)	26	28	27	25	25	22	22	22	21	21
Net Loan Portfolios	49	49	46	49	51	47	51	53	55	54
Portfolio Investments	24	26	25	23	23	20	20	20	19	19
Peso Deposit	57	58	58	59	59	65	63	64	64	63
Foreign Currency Deposits	17	17	16	15	13	12	13	13	13	14

Figure 2.15 Balance Sheet Items as a Percentage of Total Assets in the Philippine Banking System from 2008 to 2017
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas.

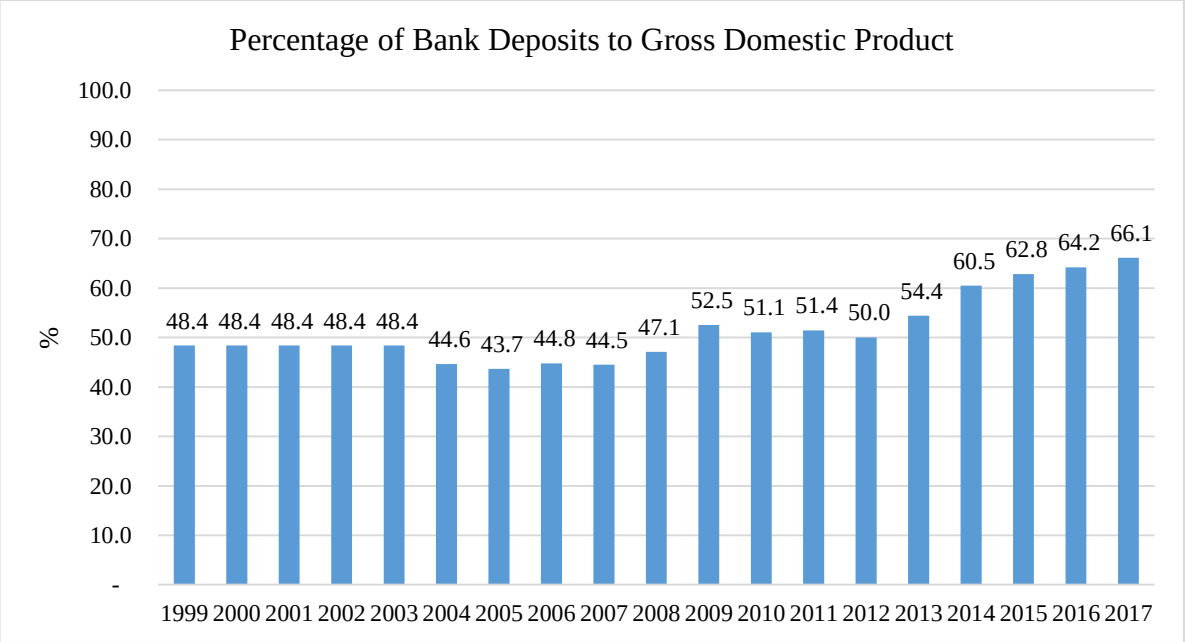


Figure 2.16 Percentage of Bank Deposits to Gross Domestic Product in the Philippines from 1999 to 2017
Note: This figure is drawn using data from World Bank as retrieved from the Federal Reserve Bank of St. Louis website.

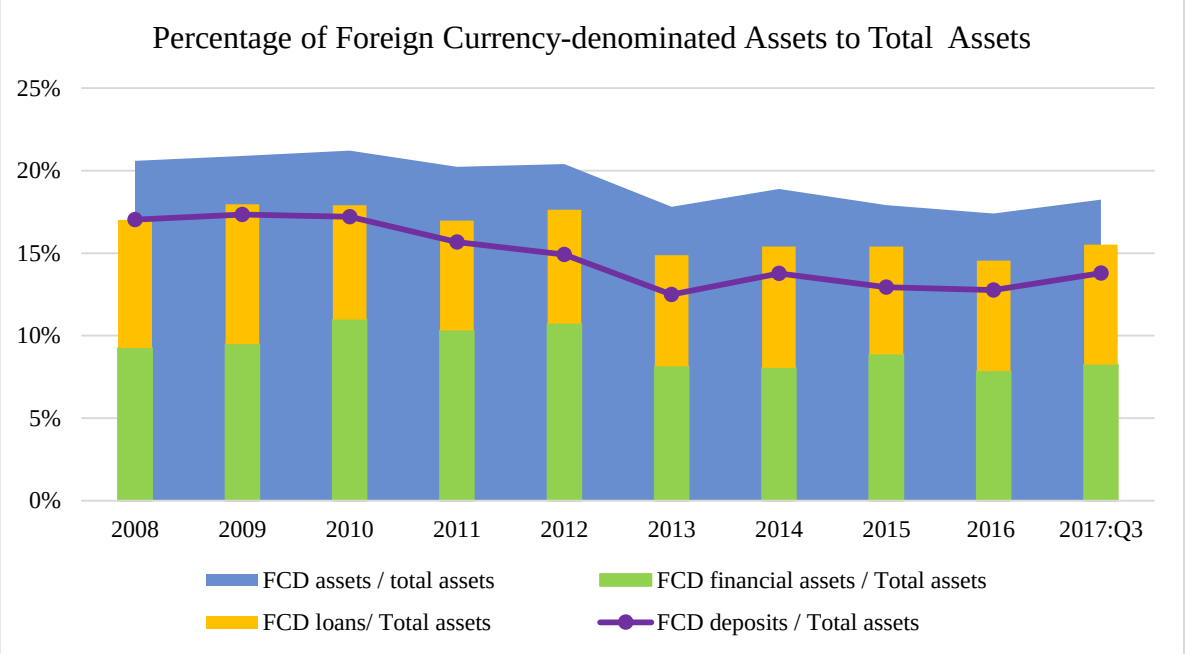
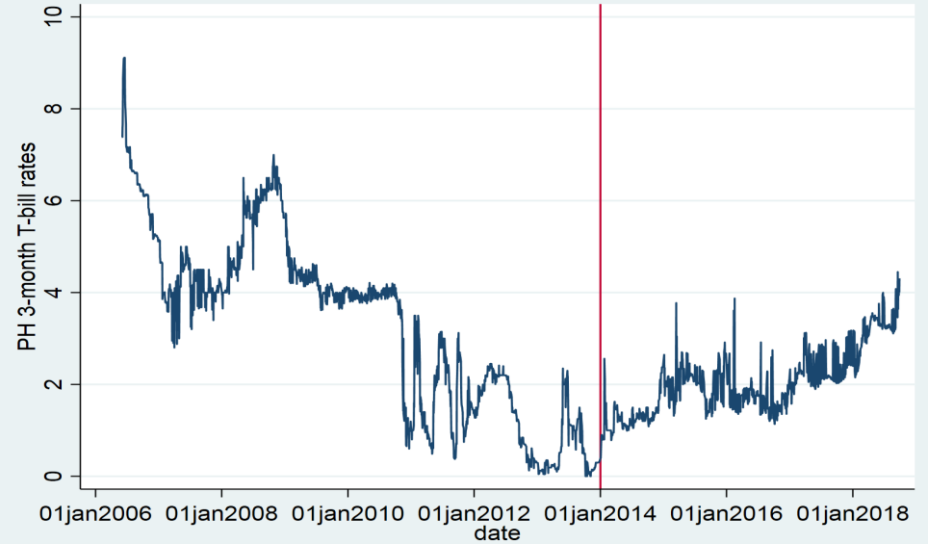


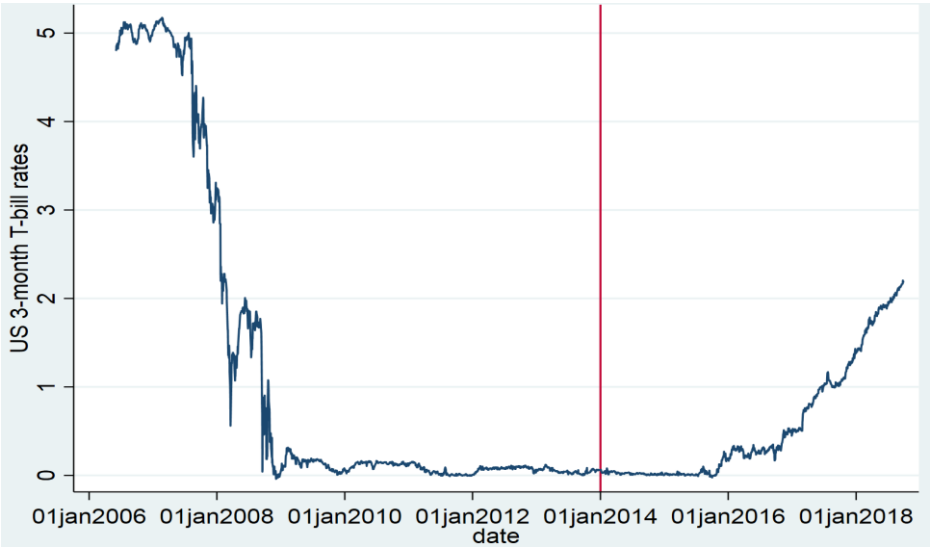
Figure 2.17 Percentage of Foreign Currency-denominated Assets to Total Assets in the Philippine Banking System from 2008 to 2017
Note: This figure is drawn using data from Bangko Sentral ng Pilipinas



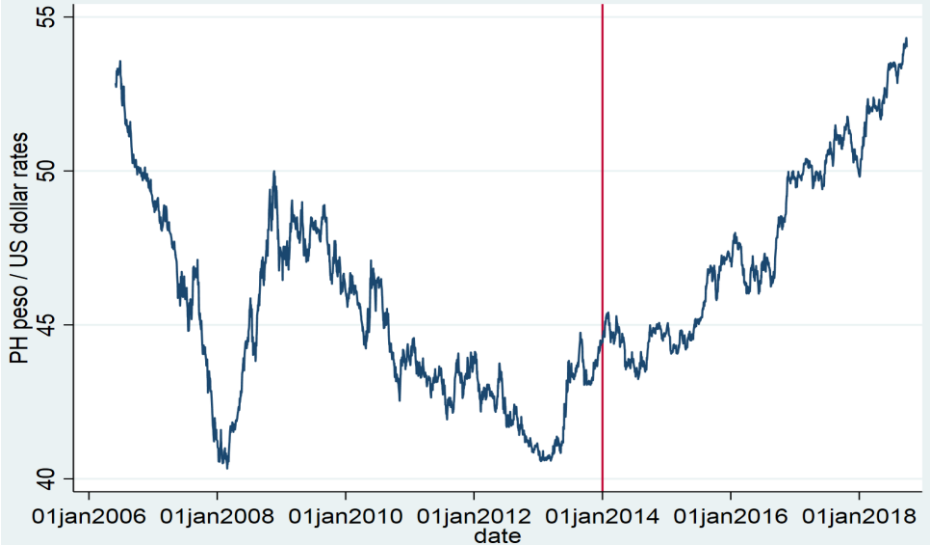
(a) Philippine daily 3-month Treasury bill rates

(b) Philippine daily 10-year Treasury bond rates

Figure 3.1 Daily Interest Rates on Philippine Government Securities from June 2006 to September 2018.
Note: The red straight line divides the period into the first sub-period on the left side and the second sub-period on the right side of the red line. The first sub-period (June 2006 to December 2013) is characterized with declining and low domestic interest rates. The second sub-period (January 2014 to September 2018) is generally described as a period of increasing domestic interest rates. These figures are drawn using daily data from Bloomberg.



(a) US 3-month Treasury bill rates



(b) Philippine Peso to US Dollar Exchange Rates

Figure 3.2 Daily US 3-month Treasury Bill Rates and Philippine Peso/US Dollar Exchange Rates from June 2006 to September 2018.
Note: The red straight line divides the period into the first sub-period on the left side and the second sub-period on the right side of the red line. The first sub-period (June 2006 to December 2013) generally has appreciating Philippine peso relative to US dollar except during the global financial crisis period. The second sub-period (January 2014 to September 2018) is characterized with depreciating Philippine peso relative to US dollar. These figures are drawn using daily data from Bloomberg.

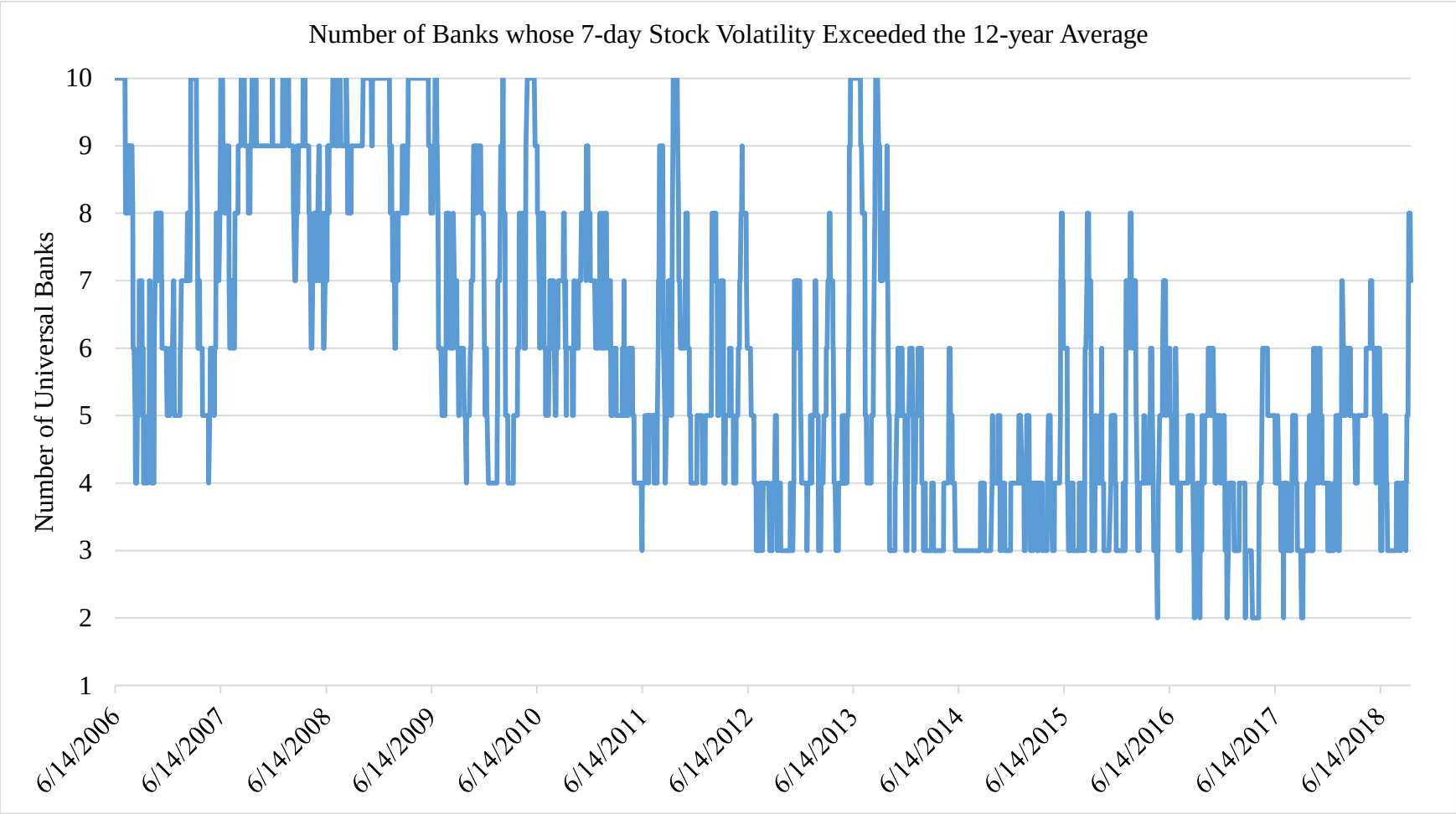


Figure 3.3 Number of Bank Stock Returns whose Seven-day Volatility Exceeded the 12-year Average
Note: This figure is drawn using author's calculation.

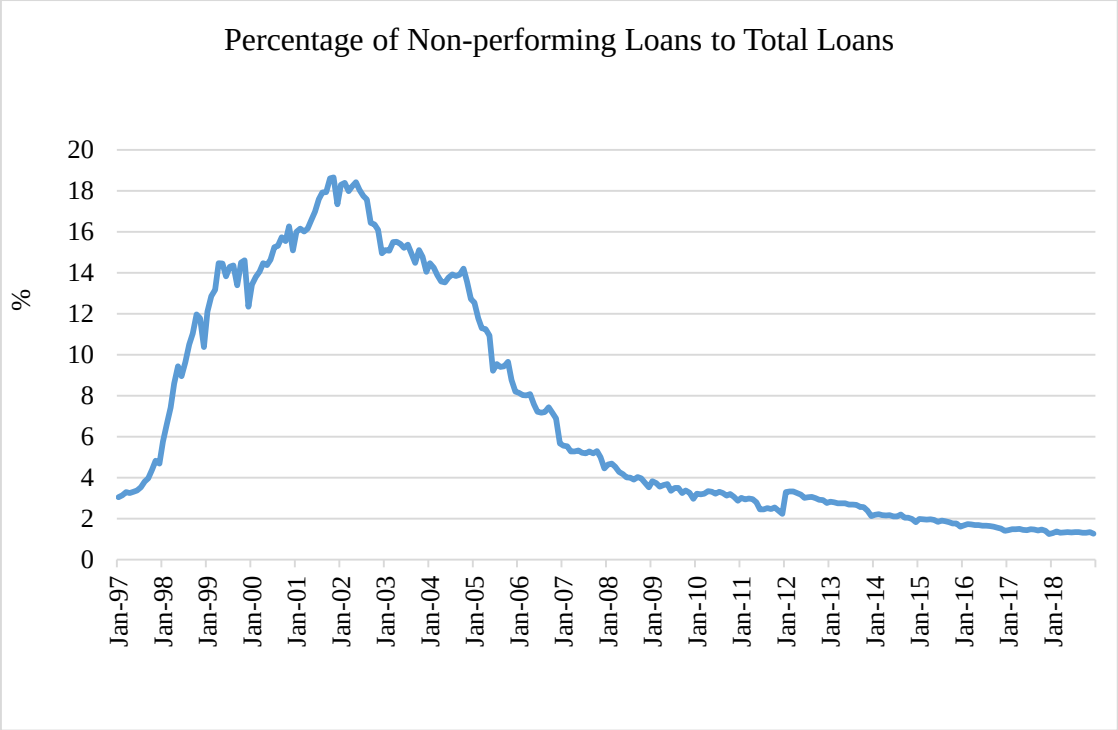


Figure 4.1 Percentage of Non-performing Loans to Total Loans of Philippine Universal and Commercial Banks from 1997 to 2018

Note: This figure is drawn from the publicly available NPL data from the Bangko Sentral ng Pilipinas which do not include the NPL of thrift banks. This series reflect the revised NPL definition starting 2012 without adjusting the previous years' data hence, a sudden spike in NPL ratio is observed in January 2012. However, the dataset in Chapter 4 utilizes the same NPL definition throughout the sample period and includes thrift banks.

Cash		Deposits
Securities		Bills payable
		Total Liabilities
Loans		
		Capital stock
Fixed assets		Retained earnings
Properties acquired		*Total Equity*
Total Assets	=	**Total Liabilities and Equity**

Figure 4.2 Simplified Balance Sheet of a Bank

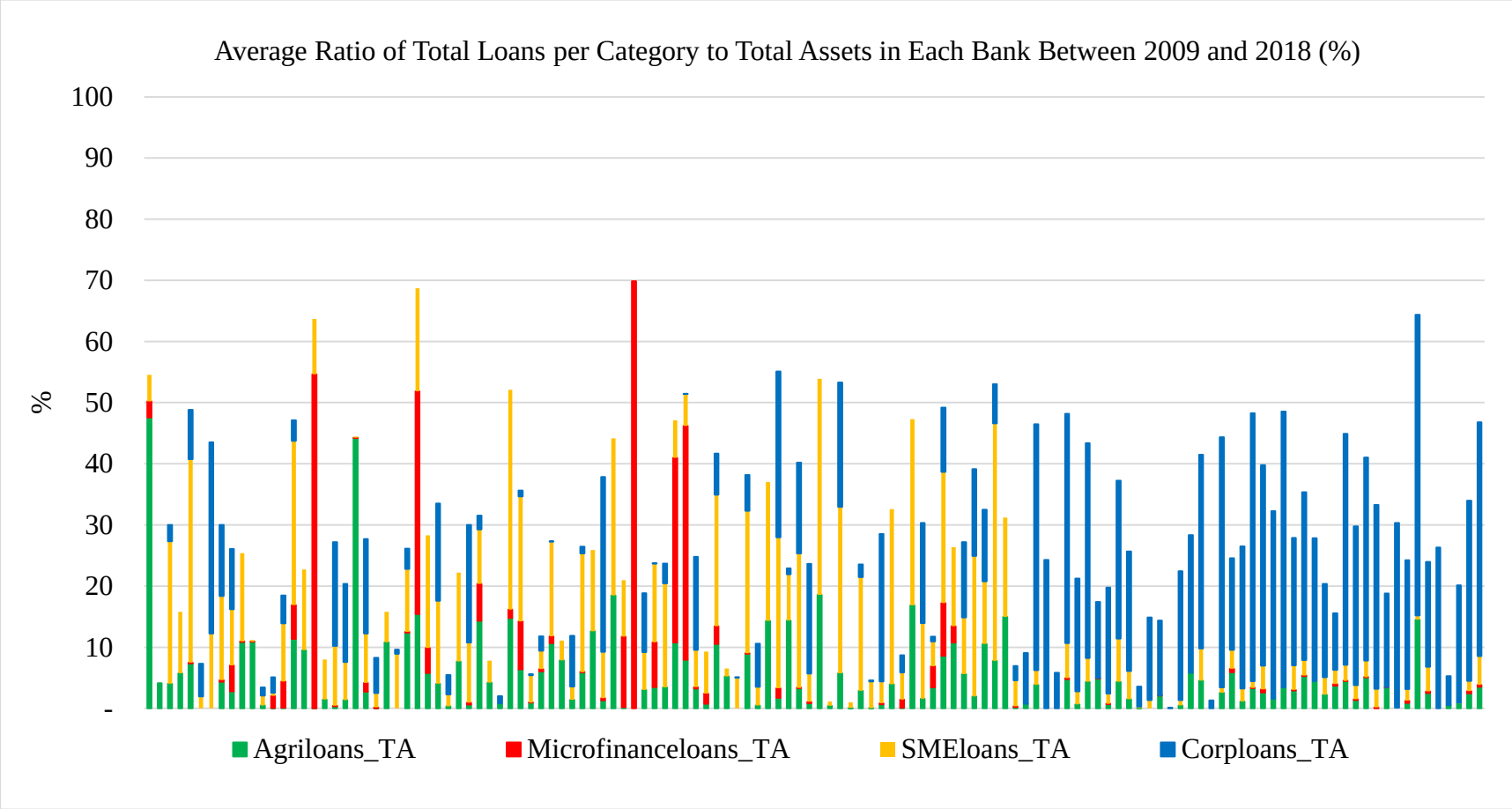


Figure 4.3 Average Ratio of Total Loans per Category to Total Assets in Each Bank between 2009 and 2018 (%)
Note: Each column corresponds to a bank and the colors represent its loan concentration across categories. This figure is drawn from the quarterly regulatory reports from the Bangko Sentral ng Pilipinas..

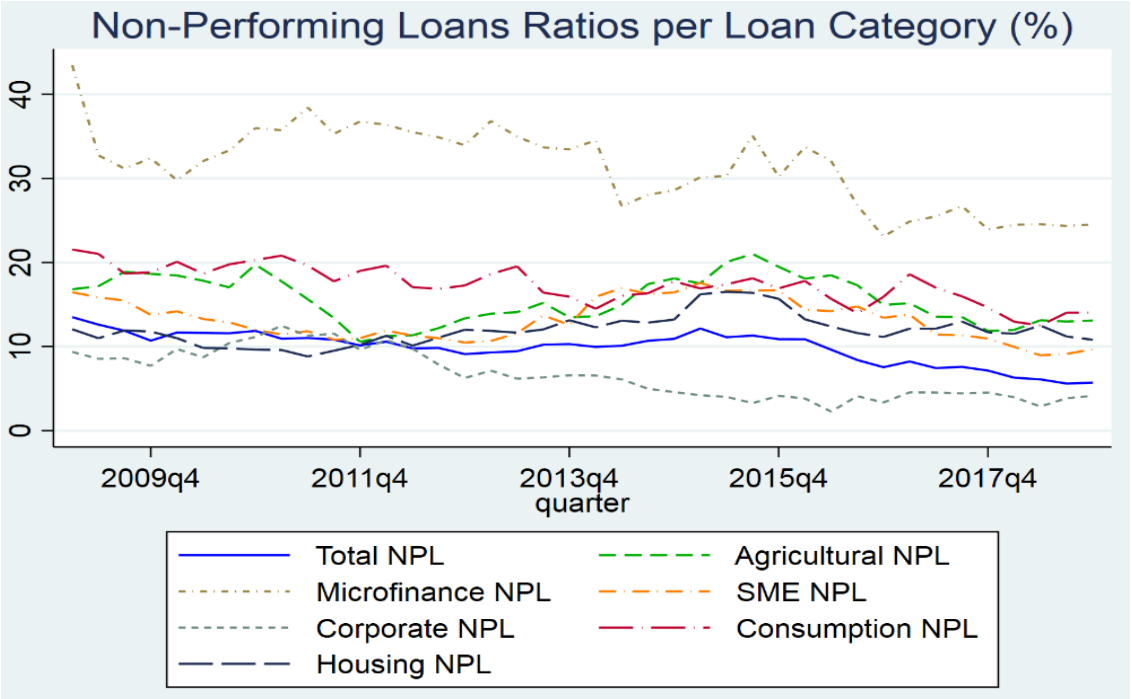


Figure 4.4 Non-performing Loans Ratios of Philippine Universal, Commercial, and Thrift Banks for Each Loan Category

Note: Total NPL refers to total non-performing loans to total loans ratio across loan categories. Meanwhile, agricultural NPL = non-performing agricultural loans to total agricultural loans ratio, microfinance NPL = non-performing microfinance loans to total microfinance loans ratio, SME NPL = non-performing small- and medium-enterprises (SME) loans to total SME loans ratio, corporate NPL = non-performing corporate loans to total corporate loans ratio, consumption NPL = non-performing consumption loans to total consumption loans ratio, and housing NPL = non-performing housing loans to total housing loans ratio.This figure is drawn using data from the Bangko Sentral ng Pilipinas.

Appendices

Table A3.1 List of Banks and Description of Explanatory Variables

Variables	Bloomberg Ticker	Description
Bank stock prices	AUB PM Equity	Daily closing prices of each bank based on last done deal.
	BDO PM Equity	
	BPI PM Equity	
	CHIB PM Equity	
	EWB PM Equity	
	MBT PM Equity	
	PNB PM Equity	
	RCB PM Equity	
	SECB PM Equity	
	UBP PM Equity	
Sectoral stock indices	PFINC Index	Daily closing prices of six sectoral stock indices of the Philippine Stock Exchange (PSE).
	PHLDG Index	
	PPROP Index	
	PSERV Index	
	PCOMM Index	
	PMINI Index	
Philippine 3-month Treasury bill rate	PDSF3MO Index pdss3MO Index	Daily average of secondary market rates. ➢ From 1 June 2006 to 13 March 2007, rates were based on PDSF series until 14 March 2007 when PDSSR2 series became available. The latter series was used by banks in pricing/marking-to-market their end-of-day fixed income securities. ➢ Data from 14 March 2007 to 30 September 2018 were based on PDSSR2 series. ➢ PDSSR2, however, was replaced by BVAL on 27 October 2018.
Philippine 10-year Treasury bond rate	PDSF10YR Index pdss10YR Index	
Philippine Peso to US dollar exchange rate	PPDONE Index	Daily closing exchange rate based on last done deal.
Philippine (BSP) policy rate	PPCBON Index	The overnight reverse repurchase (RRP) rate of the Bankgo Sentral ng Pilipinas (BSP) is the policy rate (borrowing rate) set by the central bank to influence short-term interest rates. ➢ This RRP represents the lower bound of the policy (target) interest rates range. ➢ Changes in RRP rates were recorded on the day the new rate was announced and not on its effectivity date.

Variables	Bloomberg Ticker	Description
US 3-month treasury bill rate	USGG3M Index	Daily average of secondary market rates.
US Federal Reserve Bank (Fed) policy rate	FDTR Index	The federal funds rate is the short-term target rate set by the Federal Reserve's Federal Open Market Committee (FOMC) as part of its monetary policy. ➢ From 1 June 2006 to 15 December 2008, fed rate referred to the single fed funds rate. ➢ On 16 December 2008, the target fed funds rate was replaced by a range of target rates. ➢ Data from 16 December 2008 to 30 September 2018 were based on the upper bound of the target range to eliminate zero interest rates.

Table A3.2 Collinearity of Explanatory Variables

	Financials	Holding firms	Properties	Services	Commercial	Mining	3-mo PH T-bill	10-year PH T-bond	3-mo US T-bill	PHP/USD forex rate	BSP policy rate	Fed funds rate
In log difference:												
Financials	1											
Holding firms	0.742	1										
Properties	0.699	0.749	1									
Services	0.556	0.604	0.583	1								
Commercial	0.656	0.721	0.671	0.579	1							
Mining	0.472	0.497	0.483	0.432	0.492	1						
In first difference:												
3-mo T-bill	-0.037	-0.026	-0.044	-0.03	-0.027	-0.026	1					
10-year T-bond	-0.079	-0.086	-0.104	-0.099	-0.095	-0.098	0.072	1				
3-mo US T-bill	0.092	0.051	0.071	0.077	0.085	0.047	-0.012	-0.026	1			
PHP/USD forex ra	-0.295	-0.299	-0.299	-0.224	-0.271	-0.187	0.043	0.081	-0.051	1		
BSP policy rate	0.011	0.025	0.022	0.006	0.018	0.021	0.007	-0.005	0.068	0.026	1	
Fed funds rate	0.029	0.035	0.028	0.027	0.034	0.02	0.004	-0.011	0.051	0.023	0.167	1

Table A3.3 Collinearity Diagnostics of Explanatory Variables

Variable	VIF	SQRT VIF	Tolerance	R-Squared
Financials	2.64	1.62	0.3788	0.6212
Holding firms	3.39	1.84	0.295	0.705
Properties	2.78	1.67	0.36	0.64
Services	1.79	1.34	0.5578	0.4422
Commercial	2.49	1.58	0.4022	0.5978
Mining	1.46	1.21	0.6861	0.3139
3-mo T-bill	1.01	1	0.9921	0.0079
10-year T-bond	1.02	1.01	0.9774	0.0226
3-mo US T-bill	1.02	1.01	0.9802	0.0198
PHP/USD forex ra	1.13	1.06	0.8849	0.1151
BSP policy rate	1.03	1.02	0.9664	0.0336
Fed funds rate	1.03	1.02	0.9684	0.0316
Mean VIF	1.73			

Table A4.1 Collinearity of Macroeconomic Variables

	Credit standards for Households	Credit standards for Enterprises	Loan demand of Enterprises	Loan demand of Households	Unemployment rate	Inflation rate	PHP/USD exchange rate	Bank lending rate	Reserves requirement ratio	GDP growth rate
Credit standards for Households	1									
Credit standards for Enterprises	0.82	1								
Loan demand of Enterprises	-0.58	-0.61	1							
Loan demand of Households	-0.67	-0.65	0.51	1						
Unemployment rate	0.21	0.16	-0.32	-0.08	1					
Inflation rate	0.49	0.49	-0.32	-0.36	0.21	1				
PHP/USD exchange rate	0.46	0.45	-0.28	-0.35	-0.28	0	1			
Bank lending rate	0.64	0.73	-0.64	-0.46	0.51	0.51	0.01	1		
Reserves requirement ratio	-0.14	-0.05	0.03	0.01	-0.2	-0.25	0	-0.1	1	
GDP growth rate	-0.47	-0.57	0.49	0.29	-0.31	-0.35	-0.26	-0.58	-0.14	1

Table A4.2 List of Macroeconomic Variables

Variables (%)	Description	Data Source
Data with quarterly frequency		
Unemployment rate	▪ Total unemployed as a percentage share of total labor force	http://openstat.psa.gov.ph
GDP growth	▪ Year-on-year % change in Gross Domestic Product at Constant 2000 Prices	http://openstat.psa.gov.ph
For the following variables, we average the monthly data to get the quarterly data.		
Bank lending rate	▪ Annual percentage equivalent of all commercial banks' actual monthly interest income on peso-denominated loans to the total peso-denominated loans and other debt obligations.	http://www.bsp.gov.ph/statistics/efs_fsa1.asp
Inflation rate	▪ Year-on-year % change in the Consumer Price Index (2012=100)	http://openstat.psa.gov.ph
PHP/USD exchange rate	▪ Average quarterly returns on the daily Philippine peso to United States dollar exchange rates	http://www.bsp.gov.ph/statistics/efs_ext3.asp
For the reserve requirement ratio, we use the current rate as of quarter-end.		
Reserve requirement ratio	▪ Regulatory reserves on deposits imposed by the central bank (Bangko Sentral ng Pilipinas)	http://www.bsp.gov.ph/statistics/efs_fsa1.asp