



## Philippine Financial System Macrofinancial Vulnerabilities: Assessing and Forecasting Systemic Risk using LOGIT and VAR

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### Abstract:

This paper focuses on assessing and quantifying systemic risk by constructing a model employing multivariate analysis using discrete choice models (LOGIT) for determining the best indicator of systemic events (i.e., financial friction), and Vector Auto Regressions (VAR) for quantifying systemic risk. The study also attempts to forecast of expected shortfalls in the financial system and the macroeconomy during systemic periods. In fulfillment of the objectives of the study, macrofinancial indicators are accounted for as independent variables that signal financial distress. Lastly, this research also aims to conduct a forecast about the effects of systemic events through the integrated model. The researchers believe that the financial systems and the macroeconomy in general are interconnected networks that link one institution to another. Therefore it can be inferred that the effects of financial frictions are not solely borne by a single entity but rather by the system as a whole. Such shocks stemming from financial frictions follow a domino-effect mechanism wherein the impact is carried over to several units of the financial system and the macroeconomy. The 1997 Asian Financial Crisis and the 2007-2009 Global Financial Crises are alarming testaments that the financial systems are in fact interconnected. However the damage several economies had to endure was severe. Thus, the primary motivation of the researchers is to gain a deeper understanding about systemic risk, especially in the Philippine setting, to mitigate the chances of crises from happening again.

**Key Words:** Systemic Risk; Systemic Event; Financial Crisis; Vulnerability; Financial System.

### 1. INTRODUCTION

The financial system in its entirety is a complex dimension. It has a structure that extends itself further into several divisions including financial markets, financial intermediaries in the form of banks and other financial institutions. Therefore, it involves a multitude of processes and diverse product portfolios. In addition, the financial system involves a simultaneous interaction among individuals, groups of people, legal entities in the form of corporations, regulators and the

government. What make the system even more complicated are its innate vulnerabilities. It is subject to a number of risks such default risk, liquidity risk, interest rate volatility, inflation and foreign exchange fluctuation. The predicament, however, is that in most cases the idea of interconnectedness and interdependence between and among the divisions of the financial sector and the real economy is often overlooked; and that the concept of systemic risk is existent and highly probable. On the other hand, the macroeconomy encompasses a wider



perspective that also covers the financial system thus making it even more complex.

It was in 2007 to 2009 when the financial crisis erupted that led to stern ends. Like a contagion, it stemmed from one region to another forcing even the key players and the foundations to collapse. It was a domino-effect. Stock prices went volatile. Companies shut down. Unemployment was widespread. Economies suffered. Since then, the economic tumult has been a constant reminder, a catalyst to a certain extent to impart lessons and spur initiatives. Several authors including Lo Duca and Peltonen (2011), and De Niccolo and Lucchetta (2012) also believe that it is necessary to initiate renewed efforts to better understand what had happened, what caused the financial turmoil to happen, and what can be done to keep it from happening again. The 2007-2009 Financial Crisis has exemplified how financial systems are interconnected with one another. The crisis has highlighted systemic risk and its impact. This motivates further studies to explore grey areas, as well as developing more efficient models that are more reliable in measuring systemic risks and predicting systemic events.

Financial stress refers to disturbances in the financial system caused by the system's vulnerabilities to various macroeconomic and financial factors. Financial stress or financial instability can be episodic in nature. Financial stress is manifested through asset price and credit booms and busts, which may result to currency crises, sudden stops, debt crises and crises in financial intermediaries. For the purpose of this study, the focus is only on the financial instabilities that have significant impact to the macroeconomy.

For the time being, there have not yet been a lot of extensive researches conducted to explore systemic risks in the Philippines. In line with the above distresses, this study contributes to the current literature by developing a cohesive framework patterned after the study done by Lo Duca and Peltonen,

*Macro-Financial Vulnerabilities and Future Financial Stress Assessing Systemic Risk and Predicting Systemic Events* (2011). The framework has enabled the researchers to assess systemic risks present in the financial system of the Philippines stemming from macrofinancial vulnerabilities, and to forecast systemic events (i.e., financial crisis or financial instability) that pose detrimental implications on the economic wellness of the country.

### *1.1 Research Problem*

Considering the potential implications of financial crises to the economy, the researchers find it relevant to study the measure and prediction of systemic events. To recapitulate, the interconnectedness of the financial sector and the macroeconomy remains unexplored for there are only a number of studies published about the subject especially in the Philippines. Hence, the researchers firmly believe that by conducting an extensive study about systemic events they are able to provide a list of indicators that can signal future financial stress in the economy.

This paper aims to verify and answer the following questions.

- (1) Do macrofinancial indicators, namely:
  - GDP Growth;
  - Ratio Monetary Level to GDP;
  - Exchange Rate;
  - Inflation Rate;
  - Ratio of Real Estate Loans to the Outstanding Loans;
  - Composite Stock Index;
  - Price Earnings Ratio;
  - Government Debt;
  - Average Bank Lending Rates;
  - Global Indicator of Credit Conditions;
  - Global Indicator of Asset and Equity Markets Data; and
  - Global Indicator of Macroeconomic Activity signal future financial stress in the macroeconomy?



- (2) Can macrofinancial indicators effectively quantify systemic risk?
- (3) Can macrofinancial indicators forecast the expected shortfalls in the financial system and in the macroeconomy?

### *1.2 Hypothesis*

There are several assumptions that have been established to ensure a sensibility of the research. First, the instability of the financial system affecting the economic activity of a country is forecasted and signalled through various macrofinancial indicators either jointly or independently. Secondly, systemic risks are measured by the worst possible outcome or loss at a given probability (De Nicolò and Lucchetta, 2012).

*Null Hypothesis:* Macroeconomic Indicators cannot indicate financial stress or financial instability.

*Alternative Hypothesis:* Macroeconomic Indicators can indicate financial stress or financial instability.

The financial instabilities or financial stresses in the Philippines are measured and defined in the same way as how Lo Duca and Peltonen (2011) quantified them.

### *1.3 Scope and Limitation*

The focus of this study is to identify which macrofinancial indicators effectively signal future financial instabilities, to measure systemic risks associated with the financial system and the macroeconomy and to forecast the expected shortfalls. This study is based on the Philippine setting and covers a period of 15 years (1996 to 2011). The data used for the study are extracted from the economic and financial indicators of the Asia Regional Integration Center of the Asian Development Bank database, the World Bank database, the *Bangko Sentral ng Pilipinas*, and the Federal Reserve economic data. Periods with insufficient data, to serve as variables for this study, have been dropped from the

sample. The researchers are aware that there are certain limitations in the fulfilment of the study. And such limitations are attributable to the availability of data, the econometric process and the choice methodologies. The researchers understand that although the LOGIT model is able to effectively determine what can be indicators of financial frictions and likewise identify which among the said indicators best signals systemic events, the reliability of the results of the LOGIT model is but dependent on the data accounted for. In other words, the results of the model are deemed correct insofar as the variables inputted are accurate and for as long as the data sample chosen represent the same as those in real life. It is worth noting that in spite of the aforementioned constraints, the findings and the results of this study are based on historical and actual data from Q1 of 1996 to Q1 of 2011. Such limitations may only deter the correctness of forecasts that would be made on the basis past though actual data, or in relation to the findings of this research. This is because it is difficult to verify that the data inputs represent those of the real life or remain the same, if such is the fact.

The interactions of the domestic variables and financial institutions with foreign variables and financial institutions are taken into account by including variables for credit conditions, assets and equity markets. Macroeconomic activities of several countries like the United States, United Kingdom, Germany, China, Japan, Singapore, Korea, Taiwan, Hong Kong, Thailand, Malaysia, Indonesia and Saudi Arabia are also included, since these countries are the top trading partners of the Philippines. In addition, the aforementioned countries are believed to be the counties with the most induced shocks to the Philippines. Policymakers and regulators' intervention are taken into account through the inclusion of the variables such as interest rate, government expenditure and monetary liquidity.

Anything other than what has been abovementioned is beyond the scope of this study.

## 2. METHODOLOGY

In order to identify which macrofinancial indicators effectively signal future financial system stress that affect the performance of the macroeconomy, the researchers have opted to use a multivariate framework with discrete choice models, patterned after the study *Macro-Financial Vulnerabilities and Future Financial Stress: Assessing Systemic Risk and Predicting Systemic Events* by Lo Duca and Peltonen (2011), and VAR combined with quantile regressions techniques to be able to measure the systemic risk in the financial system that has potentially undesirable consequences for the real economy, as applied by De Nicolò and Lucchetta in their study *Systemic Real and Financial Risks: Measurement, Forecasting, and Stress Testing* (2012). In a sense, both studies of Lo Duca and Peltonen (2011), and De Nicolò and Lucchetta (2012) provide frameworks for the assessment of systemic risk in the financial system vis-à-vis the macroeconomy. The study of Lo Duca and Peltonen (2011) focuses on the indicators and policy makers' interventions; while the study of De Nicolò and Lucchetta (2012) focuses on measuring systemic risk.

The researchers employed the following model to determine the best indicator of systemic events.

$$\begin{aligned}
 L_{i,t} &= \ln \left( \frac{Prob_{i,t}[Dep_{i,t} = 1]}{1 - Prob_{i,t}[Dep_{i,t} = 1]} \right) \\
 &= \alpha + \beta_{1,i,t}GDPgDevMA_{i,t} \\
 &\quad + \beta_{2,i,t}Inf_{i,t} \\
 &\quad + \beta_{3,i,t}Debt\_GDP_{i,t} \\
 &\quad + \beta_{4,i,t}ER_{i,t} + \beta_{5,i,t}PSE_{i,t} \\
 &\quad + \beta_{6,i,t}ABLR_{i,t} \\
 &\quad + \beta_{7,i,t}REL\_TL_{i,t} \\
 &\quad + \beta_{8,i,t}M1\_GDP_{i,t} \\
 &\quad + \beta_{9,i,t}PER_{i,t} + \beta_{10,i,t}GME_{i,t} \\
 &\quad + \beta_{11,i,t}GCC2_{i,t} \\
 &\quad + \beta_{12,i,t}GAEM_{i,t} + u_{i,t}
 \end{aligned}$$

Additionally, the researchers used the following VAR models for quantile estimation, vector auto regressions and forecasting, using 4 lags, as determine by AIC.

$$\begin{aligned}
 GDPg_t &= \alpha_1^q + \varphi_1^M PER_t \\
 &\quad + \varphi_2^M Inf_t + \varphi_3^M d\_ABLR_t \\
 &\quad + \varphi_4^M TBL\_QG_t \\
 &\quad + \vartheta^M(L)GDPg_{t-1} + \dots \\
 &\quad + \vartheta^M(L)GDPg_{t-k} \\
 &\quad + \vartheta^Z(L)FSMAR_{t-1} \\
 &\quad + \dots + \vartheta^Z(L)FSMAR_{t-k} \\
 &\quad + u_t
 \end{aligned}$$

$$\begin{aligned}
 FSMAR_t &= \alpha_1^q + \varphi_1^M PER_t \\
 &\quad + \varphi_2^M Inf_t + \varphi_3^M d\_ABLR_t \\
 &\quad + \varphi_4^M TBL\_QG_t \\
 &\quad + \vartheta^Z(L)FSMAR_{t-1} \\
 &\quad + \dots + \vartheta^Z(L)FSMAR_{t-k} \\
 &\quad + \vartheta^M(L)GDP_{t-1} + \dots \\
 &\quad + \vartheta^M(L)GDP_{t-k} + u_t
 \end{aligned}$$

### 2.1 Corrections for problems regarding with the data



The stationarity of the variables is tested by means of unit root tests or specifically the Augmented Dickey-Fuller (ADF) tests. If the variable is otherwise non-stationary, that is, having a p-value greater than the significance level, the data must then be transformed by integrating the data to a certain degree (i.e., getting the first differences) as correction. It is worth noting, however, that in instances of cointegration or the cancelling out of the non-stationarity behavior of the two variables that have a long-run equilibrium, using the first differences may result to misspecification of the model.

It is plausible that the regression may involve a multitude of variables that may be subject to multicollinearity, and such violation may lead to the impairment of the results. Therefore, the researchers have undergone a series of tests to look into the possibility of highly correlated variables, if any, to ensure that the assumption of multicollinearity not being present is still applicable to the estimates.

Accordingly, the results show that none of the variance inflation factors (VIF) of the variables exceeded the maximum tolerable threshold of 10. Thus, it is safe to conclude that none of the variables is highly correlated.

Lastly, due to software limitations, the researchers are unable to test for the presence of heteroskedasticity in their LOGIT estimates. Thus, to ensure sound estimates and results, researchers have employed robust standard errors in all of the regressions to correct for possible violations.

### 3. RESULTS & DISCUSSION

Firstly, the indicators that are identified that are able to signal financial stress are determined in the multivariate LOGIT model. Only ABLR D1, DebtGDP D1, PSEi D1, M1GDP D1, RELTL D1, GME and GCC2 have shown significant estimates that must be taken into account in evaluating the

joint performance of the indicators. The researchers have arrived with the respective coefficients and z-score of the variables, which represent their significance. In estimating LOGIT model accounting for all the selected macrofinancial indicators for various quarters, the researchers have identified that DebtGDP D1, PSEi D1, ABLR D1, RELTL D1, M1GDP D1, GME and GCC2 are the indicators that showed significance for as many as 2 periods. The observation excludes M1GDP D1 which only showed 1 period of significance.

In summary, domestic macrofinancial variables, namely ratio of debt to GDP, market returns, average bank lending rates, ratio of real estate loans to total loans, ratio of level of money to GDP are effective in signalling future financial stresses. While global indicators of macroeconomic activity and credit conditions are significant indicators that can predict future systemic events.

After identifying the significant and effective joint indicators, the researchers are then to identify the best standalone indicator of future systemic events.

For the standalone predicting power of the indicators, the researchers measured the indicators' individual "usefulness". By and large, half of the indicators (i.e., 6 out of 12) have their respective utilities or "usefulness" that is greater than zero. This means that the neutral observer, that is, one who is equally concerned with missing alarms and false alarms, would still be better off considering the indicators rather than not because there are possible losses at stake if the indicators are ignored. The analysis of Lo Duca and Peltonen in 2011 indicates that credit cycle, equity valuations and macro-overheating are significant variables that can indicate systemic risk in the system.

Secondly, the measures for quantifying systemic risk value-at-risk and expected shortfall show the worst possible losses that may be incurred by the macroeconomy and the financial system at a



given level of probability. For this study, the researchers use 5% as the level of probability, based on the study of De Nicolo and Luccheta (2012). Given the results of the estimations, GDP-at-Risk or the worst possible value of GDP growth, and the FSMAR-at-Risk or the worst possible return from the financial sector, have their lowest values near or at the occurrence of systemic events shown in the figure.

Given the values of the GDPaR and FSMARaR for the whole period, the expected shortfalls are computed by averaging all the values of GDPg and FSMAR worse than the values of GDPaR and FSMAaR, respectively. The values computed for GDPES and FSMARES, based on actual values, are 1.06 quarterly growth and -9.76 percent, respectively.

The Value-at-Risk for GDPg for the period covered shows the worst possible realization or value of GDP growth for the period. The highlighted values show that the worst GDP realization (bottom 10%) occurred at quarters 2001 Q2, 2009 Q2, 2009 Q4 and 2011 Q3. This means that the systemic real risk, or the risk of shocks triggering a significant decline in the macroeconomic activity, is greatest in periods that coincide with the systemic event timeframe of 2008 to 2009.

The Value-at-Risk for FSQMAR for the period covered shows the worst possible realization or value of market adjusted returns for the Financial Sector for the period. The highlighted values show that the worst returns (bottom 10%) occurred in quarters 2005 Q2, 2008 Q3, 2008 Q4, and 2009 Q4. This means that the systemic financial risk, or the risk of shocks triggering a significant losses and uncertainty in the considerable portion of the financial system, are greatest in periods 2005 Q2, 2008 Q3, 2008 Q4, and 2009 Q4. It is discernible that the systemic financial risk is high but scattered in periods

2008 Q3 to 2009 Q4, when the systemic events took place.

Moving on, the expected shortfalls for GDGg and FSMAR, based on actual values, have a value of 1.06 quarterly growth and -9.76 percent sector returns, respectively. This means that expected loss for the GDP growth for the period 2000 to 2011 is a decline in its growth by 1.06 percentage points; while the expected loss for the financial sector is 9.76 index units. Furthermore, in systemic event periods alone (i.e., 2008 to 2009), GDPgES and FSQMARES have had values of 1.37 percent and -7.00 returns. This means that GDP growth and financial sector return declined by these amounts in those periods.

Lastly, after the estimation and computation of vector auto regressions, value-at-risk and expected shortfalls for both GDP growth and financial sector market adjusted returns, in-sample forecasting and one-year ahead forecasting are done by inputting the respective values of the regressors to the model. After which, the fitted values are used to arrive at the value-at-risk and expected shortfalls measures.

The expected shortfalls for the in-sample and one-year ahead forecasting are both zero for GDP growth, while 6.11 percent and 5.95 percent, respectively for financial sector returns. This means that the fitted values of GDP growth have not exceeded the value-at-risk; whereas the financial sector returns have exceeded the value-at-risk.

#### 4. CONCLUSION

Overall, the researchers have identified which macrofinancial indicators can effectively signal future financial system stress or instability that affects the performance of the real and/or the macroeconomy. Research findings show that the domestic macrofinancial variables are:

- Average Bank Lending Rates;
- Ratio of Debt to GDP;



- Market Returns;
- Ratio of Level of Money to GDP; and
- Ratio of Real Estate Loans to Total Loans are effective in signalling future financial stresses.

The average bank lending rate is the best stand alone indicator as it signifies higher default risk which may lead to higher cost of funds and liquidity impairment. This is consistent with our research from Keeton and Hakkio's study in 2009. To validate these in terms of figures, the average bank lending rate has the highest utility of 0.1250 and is significant indicator to most quarters in our study.

As per the global indicators:

- Global Indicator for Macroeconomic Activity; and
- Global Indicator for Credit Conditions are significant indicators that can predict future systemic events.

In addition to our first objective findings, joint indicators are better than stand alone indicators because of their robustness of the results which can be attributed to their predicting power and interaction to one another.

Secondly, the researchers have assessed and have quantified the systemic risk in the financial system that has potentially undesirable consequences to the real and/or to the macroeconomy. By using vector auto regressions, quantile regressions, value-at-risk and expected shortfalls, they have arrived with the respective measures of systemic risk.

Last but not the least, the researchers have predicted systemic events and forecasted their effects in the financial system that pose real consequences. By using the identified macrofinancial indicators, they have identified the chances of occurrence of systemic events. On the other hand, they have used expected shortfalls to predict the real and financial consequences of such financial stresses.

By and large, the researchers are able to achieve their objectives. Looking into the

results, it can be said that the Philippine financial system is vulnerable to numerous macrofinancial externalities and some of which are identified in this study. Meaning, the interconnectedness of the financial system and the macroeconomy exposes the system to systemic risk that may pose considerable real and financial consequences. Hence, the assessment and predicting the effects are of great significance.

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To God be the glory.

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