Chapter 6

A MACRO-PRUDENTIAL ASSESSMENT FOR NEPAL

By

Suman Neupane¹

1. Introduction

In the history of modern capitalism, crises are the norm, not exception. That is not to say that all crises are the same. Far from it, the particulars can change from disaster to disaster, and crisis can trace their origins to different problems in different sectors of the economy. Sometimes a crisis originates in the excesses of overleveraged households; at other times financial firms or corporations or even governments are to blame. Moreover, the collateral damage that crisis cause varies greatly; much depends on the scale and appropriateness of government intervention. However, contrary to conventional wisdom, crises are not ‘black swan’² but ‘white swan’: the elements of boom and bust are remarkably predictable. (Roubini and Mihm, 2010)

The crises are the accumulated outcome of the sequence of past events as well as their connectedness. Therefore, they can be forecasted if appropriate measures are applied for their calculation. After the global financial crisis of 2008, there is agreement that the conventional models and analytical tools used by central banks and supervisory institutions are not sufficient for identifying the systemic risks of the economy. As there had been a focus mainly on the micro-

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² The “black-swan” is a metaphor that encapsulates the concept that the event is a surprise (to the observer) and has a major impact. After the occurrence of the event, the theories are developed and its causes are identified. It is introduced by Nassim Nicholas Taleb in his book, The Black Swan.
Financial stability tends to be a common responsibility, reflecting the far-reaching consequences of financial crises. It is imperative for coordination across all policies to ensure that systemic risks should be comprehensively addressed. In addition to the monetary policy and micro-prudential policy, the issues of systemic risk can be addressed by macro-prudential policy. Therefore, how to define and develop the macro-prudential element of financial stability policy has attracted particular attention of the policymakers and academia. Policymakers broadly agree that the purpose of macro-prudential policy is to reduce systemic risk, strengthen the financial system against shocks and help it to continue functioning stably without emergency support on the scale that was extended in the crisis. Macro-prudential policy is the measure to prevent the crisis instead of its cure. Therefore, preventative in its orientation, macro-prudential policy is distinct from financial crisis management policy.

The aim of this study is to develop a framework for identifying systemic risk and stress testing of the financial sector and economy of Nepal. The systemic risk is measured as default probabilities of banks. This study uses two consecutive steps: (i) contingent claims analysis (CCA) to evaluate the default probabilities of commercial banks; and (ii) panel vector autoregression (panel-VAR) as macroeconomic model. The CCA approach is used to calculate the time series of default risks. The unrestricted panel-VAR methodology is applied to analyse the impact of macroeconomic shock to default risks.

The CCA is commonly called the Merton Model. The basic analytical tool is the risk-adjusted balance sheet, which shows the sensitivity of the enterprise’s assets and liabilities to external “shocks.” The CCA framework provides a forward-looking market-based set of indicators to measure the vulnerability of various sectors of the economy and is well-suited to capturing “non-linearities” and to quantifying the effects of asset-liability mismatches within and across institutions. This study uses a new approach to improve the way in which the central bank of Nepal can conduct analysis for the management of the financial

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risks of a national economy. In addition, it explores the methodology which is useful for simulations and stress testing to evaluate the potential impact of policies to manage systemic risk of any shocks to the Nepalese economy.

2. Objectives of the Study

The broad objectives of the study are as follows:

- To determine the interrelationships among the macroeconomic and financial stability variables of Nepal;
- To analyse the impact of the shocks on the macroeconomic variables to the financial stability variables of Nepal; and
- To recommend policies regarding financial sector stability of Nepal.

3. Significance of the Study

Nepal Rastra Bank (NRB), the central bank of Nepal, has a major responsibility to maintain confidence in the financial sector in pursuant to the NRB Act, 2002. The objectives of NRB Act, 2002, are the achievement of price, balance of payments (BOP) and securing of financial sector stability. However, its main focus was on inflation. After the global financial crisis in 2008, the NRB, like the other central banks, is focusing increasingly on the financial stability.

Globally, there have been more banking crises in the last two decades than ever before and their consequences have been far-reaching. The NRB, the supervisor of the banks and financial institutions, is also facing the challenges of maintaining financial stability in the country. Effective implementation of New Capital Adequacy Framework and the adoption of more sophisticated approaches are some of the prime concerns of the NRB. The strengthening of supervisory capacity commensurate with increasing number of bank and financial institutions (BFIs) and the movement towards risk-based supervision in the context of increasing risks and tight supervisory resources are the other big challenges to the NRB.

Similarly, the growth of consumer credit, personal loans and multiple banking issues, and difficulty in defining big borrowers are some of the challenges that are hindering prudent lending practices in Nepal. Again, the lack of co-ordination
among various economic sectors, absence of rating agency and the fostering of strong corporate governance in the banking sector are some of the issues to be resolved for the facilitation of sustained development of Nepal’s financial sector. In this context, the NRB has the responsibility to ensure financial stability in the country. Therefore, the NRB is encouraging banks for self-regulation and making them sensitive toward risks.

4. **Elements of Macro-prudential Policy Framework**

The financial crisis revealed critical gaps and weaknesses in the world’s financial system and the financial regulatory framework. The explicit incorporation of macro-prudential considerations in the nation’s framework for financial oversight represents a major innovation in the literature of financial regulation, which is taking place abroad as well as in Nepal. The new approach to regulation should be constructive and necessary to avoid the likelihood of systemic risk. However, it also poses considerable conceptual and operational challenges in its implementation.

Macro-prudential policy should seek to avoid systemic, or system-wide, financial risk. It must complement the micro-prudential policy and coordinate with other types of public policy that have an impact on systemic financial stability.

**Macro-prudential Policy Objectives**: The analysis of risks from a systemic perspective, not just from the perspective of an individual firm, is the hallmark of macro-prudential regulation and supervision. The objective of macro-prudential supervision and regulation is to lessen the risks of financial disruption that are sufficiently severe to cause significant damage on the entire economy. The systemic orientation of the macro-prudential approach may be contrasted with that of the traditional, or “micro-prudential,” approach to regulation and supervision, which is concerned primarily with the safety and soundness of individual institutions, markets, or infrastructures.
More importantly, defining elements of macro-prudential policy are its **objective**, its **scope of analysis** of the financial system as a whole and its interactions with the real sector; its **set of powers and instruments**, and their **governance as** prudential tools which are assigned to macro-prudential regulatory authorities.

NRB has given both responsibilities of effective implementation of monetary policy and assurance of financial stability in Nepal. Therefore, these two policies should be clearly distinguished. The distinctions between monetary and macro-prudential policies are shown in Table 1.
Macro-prudential regulators must be concerned with at least two types of risks. The first type encompasses aspects of the structure of the financial system - such as gaps in regulatory coverage or the evolution of shadow banking - that pose ongoing risks to financial stability. Secondly, the risks that vary over time with financial or economic circumstances, such as widespread buildups of leverage in good times that could ultimately unwind in destabilising ways.

4.1 Macro-prudential Supervision and Regulation

The regulation and supervision executing a macro-prudential approach to oversight can involve heavier informational requirements and more complex analytic frameworks. In particular, because of the highly interconnected nature of the modern financial system, macro-prudential oversight must be concerned with all major segments of the economy. It must cover financial sector, including financial institutions, markets, and infrastructures. It should emphasise on understanding the complex linkages and interdependencies among institutions and markets, as these linkages determine how any shocks propagate throughout the system.

However, macro-prudential approach should not ignore the need for careful micro-prudential regulation and supervision. The oversight of individual institutions serves many purposes beyond the enhancement of systemic stability, including the protection of the deposit insurance fund, the detection of money laundering and other forms of financial crime, and the prevention of unlawful discrimination or abusive lending practices. Equally important, however, is that micro-prudential oversight also provides the knowledge base on which a more systemic approach must be built; we cannot understand what is going on in the system as a whole without a clear view of developments within key firms and markets. Without a strong micro-prudential framework to underpin them, macro-prudential policies would be ineffective.

The Financial Stability Board, the Basel Committee on Banking Supervision, and other international groups also have undertaken substantial work to coordinate macro-prudential policies in the world. Consistent with the macro-prudential approach, the Basel III framework requires the largest, most globally active banks to hold more, higher-quality capital, reflecting the greater systemic risk associated with financial distress at the largest institutions.
4.2 Macro-prudential Regulation in Nepal

NRB has, continuously, directed its efforts and is making progress in implementing prudential regulations including new capital adequacy norms, strengthening supervisory capacity, making provisions for liquidity support to banks, and introducing Prompt Corrective Actions (PCA), Early Warning Signals (EWS), and Stress Testing of banks. NRB has developed and issued various guidelines on the basis of Basel Core Principles to set the minimum standard for risk management in commercial banks.

The Nepalese banking sector gained momentum after the liberalisation process started in mid-eighties. Rapid growth in terms of the number as well as transactions of the banks and financial institutions has been creating new challenges every year. The number of commercial banks as at the end of 2011 reached to 31 from 5 in 1990. The total assets of the commercial banks increased to Rs 787.11 billion in mid-July 2010 from Rs 26.68 billion in mid-July 1990. In the last decade, a huge change had been observed in the banking practices, banking regulation and supervision. (Bank Supervision Report, 2010)

The NRB has also realised that a stable and reliable financial system is a prerequisite for price stability and stable economic growth. Therefore, the NRB has a responsibility to identify and minimise in advance any major risks that may endanger financial stability. The NRB seeks to maintain confidence in the financial system. In addition to the institution-level micro-prudential analysis, macro-prudential analysis has also become the primary responsibility of the NRB. The aim of macro-prudential analysis is to identify, at a sufficiently early stage, systemic risks threatening the stability of the financial system as a whole.

The financial sector regulation in Nepal, as carried out in the past, also had some macro-prudential aspects, and the recent financial crisis has significantly boarder line implications in “micro” and “macro” prudential theory, however, it is conceptually difficult to demarcate the two in practice. NRB supervises the payment and settlement system infrastructure as a whole by regularly monitoring the liquidity, regularly communicating about the risks and providing guidelines to mitigate risks, and control institutions with strong directives as well. The main elements of macro-prudential regulation of the NRB, though still in the initial stage, are briefly explained below.

**Capital Requirements:** The Basel Committees on Banking Supervision’s (BCBS) recommendations on capital accord are important guiding framework for the regulatory capital requirement to the banking industry of the world.
Realising the significance of capital for ensuring the safety and soundness of the banks and the banking system, at large, the NRB has developed and enforced capital adequacy requirement based on international practices with appropriate level of customisation based on the domestic state of market developments. The simplified Basel II framework that the NRB is using provides capital measurements and capital standards. It is built around three mutually reinforcing pillars, viz. minimum capital requirements, supervisory review process and disclosure requirements.

The NRB has prescribed to commercial banks in Nepal capital adequacy requirements that are to be maintained. The minimum core capital of 6% and the capital fund of 10% of risk-weighted assets are to be maintained by the commercial banks. These capital requirement frameworks are higher than the BASEL-II recommendation and international practice.

**Table 2**

<table>
<thead>
<tr>
<th>Core capital</th>
<th>Capital fund</th>
</tr>
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<tr>
<td>6.0</td>
<td>10.0</td>
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</tbody>
</table>

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**Risk Management Guidelines to Banks:** The NRB (2010) in July issued guidelines to all commercial banks on risk management systems that are required to be in place. This document sets out the minimum standards that shall be expected of a risk management framework. Overall risk management is of utmost importance to banks, and as such, policies and procedures should be endorsed and strictly enforced by the senior management and the board of the bank.4

The guideline is a focal point of reference for all requirements of the NRB for overall risk policy formulation and management. The guideline applies to the commercial banks in Nepal. It provides the minimum standard for the risk management practice to be exercised in the banks. A bank may establish a more comprehensive and sophisticated framework than that outlined in the guideline. This is entirely acceptable as long as all the essential elements of the guideline are fully taken into account. This guideline covers the most common risks of Nepalese commercial banks, mainly, Credit Risk, Market Risk, Operational Risk and Liquidity Risk.

**Stress Testing Guidelines:** The NRB has issued guidelines to Nepali banks for the conduct of stress testing. These guidelines cover simple sensitivity tests in different areas of risk management. There are simple shocks, which provide the minimum standards for stress testing in Nepalese banking. As a minimum, all the commercial banks are required to conduct stress testing at corporate level on a regular basis. The stress test should be conducted in the area of credit, market, operational and liquidity risk. The impact of these should be analysed in the risks of the banks’ financial performance.

**Liquidity Monitoring and Forecasting Framework:** The NRB also monitors the liquidity of individual financial institutions as well as the liquidity of the system. The reporting system is based on the systematic framework issued for all financial institutions. The reporting schedule ranges from weekly to monthly reporting requirement. The liquidity monitoring position requirements for Nepalese banks and financial institutions liquid assets is the sum of cash, bank balance, money at calls at short notice, investment in government securities and reverse repo and the placement up to 30 days. Liquid assets should include unencumbered liquid assets only. Unencumbered assets are those assets which are free from any debt obligation and can be easily sold or mortgaged. The report should cover the assets and liability portion as stated in the given format of NRB.

**Policy in Real Estates Market:** The NRB observed that the main reason behind the rapid growth in real estate sector was due to the massive investment facility provided by the financial institutions. With the view of the bubble in the realty market, the NRB imposed a cap on the exposure of banks and financial institutions to housing and real estate loans, asking them to limit such exposure to 25% of their total investment portfolio. As for the real estate sector, except the housing sector, the NRB has directed the lending banks to reduce exposure to 15% of total loan portfolio by the end of 2011/12 and to 10% by the end of fiscal year 2012/13. Meanwhile, the NRB’s directive has been able to control stagnation in the realty business and might have controlled a systemic failure of the financial system.

**Deposit Insurance and Others:** Developing a financial safety net for banks has been an important issue for the sustainable development of the financial system. The NRB has an objective of promoting stability and credibility of the general public in banking system. Deposit guarantee schemes are recently initiated in the Nepalese financial sector up to Rs. 200,000. In spite of the provision of deposit guarantee, the establishment of the Asset Management Company (AMC),
strengthening of the capacity of the Debt Recovery Tribunal and establishment of Credit Rating Agencies are required in Nepal to maintain and promote financial safety and soundness.

5. Macroeconomic and Financial Indicators of Nepal

**Growth and Inflation:** Nepalese economy is experiencing a weak performance as indicated by the overall macroeconomic variables. The growth rate of GDP remained at low level at 3.8% over the period 2008 to 2010. However, for the year 2011/12 the Ministry of Finance, Government of Nepal projected the growth rate to remain at 5% as there is a good monsoon which increased the agricultural production. Agriculture is the largest contributor to GDP, making out 35% of the national output. The low level of GDP growth rate is attributed to the low level of gross fixed capital formation.\(^5\)

\[\text{Figure 1} \quad \text{Economic Growth}\]

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\(^5\) Pandit (2010)
The annual inflation rate, measured as a percentage change in consumer price index (CPI), has averaged 11% over the last three years. It registered the highest rate of 13.2% during the fiscal year 2008/09.

**Figure 2**
**Inflation Rate**

Low economic growth, high inflation, unfavourable balance of payments, high proportion of consumption in GDP, low rate of saving, lack of an investment-friendly environment, energy crisis and weak industrial relationship are some of the challenges facing the Nepalese economy. In this context, the overall business environment signals symptoms of reduced business confidence and weakened investment climate in the economy. Due to these reasons, the various sectors of the economy like agriculture, industry and services are achieving low levels of growth.

It seems that the growth of the banking sector has not yet made a significant impact on the growth of the overall economy. Thus, there is a challenge to channel resources towards productive economic activities for the sustainability of the banking sector and economy as a whole.
As depicted in Table 3, the other variables like export is relatively low in comparison to imports. Remittance, pension and foreign grant are the main contributing factors behind its favourable balance of payments. However, in 2009/10 and 2010/11 the balance of payments remained negative. Due to the negative balance of payment situation, the level of foreign exchange reserve also declined. Similarly, the budget deficit stood less than 5% over the years and the outstanding debt to GDP is 32% in the recent years.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>2008/09</th>
<th>2009/10</th>
<th>2010/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Growth</td>
<td>3.8</td>
<td>4.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Inflation Rate</td>
<td>13.2</td>
<td>10.5</td>
<td>9.6</td>
</tr>
<tr>
<td>Per Capita GNI (US$)</td>
<td>471</td>
<td>561</td>
<td>645</td>
</tr>
<tr>
<td>Export/GDP (in %)</td>
<td>6.9</td>
<td>5.2</td>
<td>4.9</td>
</tr>
<tr>
<td>Import/GDP (in %)</td>
<td>28.8</td>
<td>32.3</td>
<td>28.9</td>
</tr>
<tr>
<td>Remittance/GDP (in %)</td>
<td>21.2</td>
<td>19.8</td>
<td>19.3</td>
</tr>
<tr>
<td>BoP (in Billion Rs.)</td>
<td>41.28</td>
<td>-3.63</td>
<td>-8.8*</td>
</tr>
<tr>
<td>Budget Deficit/GDP (in %)</td>
<td>5.0</td>
<td>3.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Outstanding Debt/GDP (in %)</td>
<td>40.3</td>
<td>34.5</td>
<td>32.0</td>
</tr>
</tbody>
</table>

*However, the balance of payments has been in surplus in the first quarter of 2011/12. Source: Government of Nepal, MoF, Economic Survey, 2010/11.

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**Stock Market**: After liberalisation, the Nepali financial system underwent rapid structural changes in the last two and half decades. However, the financial system is basically bank-dominated. Capital markets and stock markets are in the process of development and have not attained full scale operations. The banking institutions, particularly the commercial banks, are the major financial intermediaries in satisfying the financing need of the productive units of the economy.

The overall condition of the securities market has not been satisfactory in the review period of the current fiscal year. As compared to the previous year, the securities market indicators, like the NEPSE indicator, stocks transactions amount, and market capitalisation, have slid down. The NEPSE indicator, which stood at 444.8 points by mid-April 2010, further fell to 373.20 points in the
corresponding period of the current fiscal year. Similarly, the value of capitalised market which stood at Rs. 344.45 billion in mid-April 2010 fell to Rs.331.14 billion by mid-April of 2011. Also, the volume of securities transactions dropped by almost 50% over the review period.

Figure 3
NEPSE Index

The Nepalese stock market is relatively small, illiquid and thinly traded. Despite the size and illiquid nature of the stock markets, their continued existence and development can have important implications for economic activity (G.C. and Neupane, 2006). Changes in the economy also affect the stock market performance. As the stock market is bank-dominated, the performance indicators of the banks are reflected in the stock markets as well. The Nepali stock market is isolated from the rest of the world. The global economic slowdown has little direct impact on the Nepali stock market. However, as we can see in the above figure, there might have been some psychological effect on the investors.

Non-performing Loan (NPL): The ratio of non-performing loans (NPLs) to total loans declined since 2003/04 to 2.4% from 5.8% for private commercial banks, and from 55.1% to 10.5% for the state banks (IMF, 2010). However, the favourable NPL ratios may be masked by the ever greening of loans and rapid growth of the loan portfolio. The non-performing loan of commercial banks declined to 2.39% in mid-July 2010 from 3.53% in the mid-July 2009. The total amount of NPA remained at Rs. 11,223.34 million from Rs. 13,574.6 million in the mid-July 2009.
**Financial Institutions:** The Nepalese financial sector is composed of the banking sector and non-banking sector. The banking sector comprises NRB and commercial banks. The non-banking sector includes the financial institutions licenced by NRB, namely, the development banks, finance companies, micro-finance development banks, co-operative financial institutions, and non-governmental organisations (NGOs) performing limited banking activities; and the financial institutions other than licenced by NRB, namely, the insurance companies, Employee’s Provident Fund, Citizen Investment Trust, Postal Saving Offices and Nepal Stock Exchange.

**Deposit and Credit:** The financial sector has expanded in terms of number of institutions. In addition, deposits have also grown significantly. The deposit-GDP ratio which stood at 41.2% in 2003, reached 55.5% in 2009, and it was estimated to remain at 50.8% in 2011. The trend of deposit-GDP ratio is shown in Figure 4.

![Figure 4 Deposit/GDP (In Percent)](image-url)
In similar manner, credit advances have also grown significantly in the recent period. The credit-GDP ratio which recorded 45.5% in 2003, reached 56.1% in 2009 and it is estimated to remain at 55.2% in 2011. The trend of credit-GDP ratio is shown in Figure 5.

![Credit/GDP Ratio](image)


There are various methods for examining the systemic risks of the financial system. For a given confidence interval and time span, Value at Risk (VAR), a market risk measure, indicates the maximum expected portfolio loss under normal market conditions (Benninga and Weiner, 1998). Basle sets a 99% confidence interval and a 10-day horizon, based on at least 12 months historic data. Banks must hold at least three times this VAR amount in capital. Stress tests quantify portfolio movements for unlikely but feasible events (see BIS, 2000 and 2001 for more detail). Early Warning Systems (EWS) generate out-of-sample probabilities of crisis using historic data. Demirguc-Kunt and Detragiache (1997) developed a parametric EWS for banking crises using a multinomial logit model with macroeconomic, financial and structural variables as inputs. Logistic models are appropriate for explaining binary banking crisis observations in panel data.
The CCA is a method that uses Black-Scholes option-pricing techniques to calculate the likelihood of corporate default. It is an extension of the Merton (1974) model based on the insight that a shareholder has an implicit call option on the value of the assets of the firm. The CCA uses both historical balance sheet data (leverage ratio) and timely and forward-looking equity market information (volatility of returns) to calculate a measure called “distance to default”. This method measures credit risk by expressing a firm’s net worth as a proportion of asset price volatility; the higher this ratio, the lower the likelihood of default. Any asset with a liquid secondary market can be used because, assuming market efficiency, prices should incorporate markets’ forward looking expectations of firm default (Chan-Lau, 2006).

This study uses CCA and panel-VAR methodology. In the absence of a robust single measure, a pragmatic approach may be applied to monitor a set of selected indicators, depending on each country’s circumstances. According to Brockmeijer, J., Moretti M., et al (2011), the best tools in this regard may be country specific, depending on the level of development, the structure of financial system, the type of monetary and exchange rate policy regime, the openness of economy to capital flows, etc. For each dimension, it proposes to rely on one or two specific analytical tools that are identified as the most robust and useful from an early warning perspective. Importantly, such a system needs to be tailored to individual countries’ circumstances—reflecting aspects such as the degree of market development and data availability—and should be revisited and updated over time.

6.1 Theoretical Concept

The study uses a panel data set that includes 12 listed commercial banks and macroeconomic data and follows a two-step procedure to analyse systemic risk of financial stability of Nepal. As a first step, the default risks of banks are calculated using Black and Scholes (1973) option pricing theory. Then, unrestricted panel-VAR methodology is applied for the analysis, which allows the examination of the underlying relationships between efficiency and risk without applying any a-priori restrictions. Finally, the effect of a one standard deviation shock for macroeconomic variables to default risks is analysed. The VAR model and CCA method are briefly explained below.

**Vector Autoregression (VAR) Model:** Sims (1980) proposed a new method of identifying and interpreting economic shocks in historical data and of analysing how such shocks are gradually transmitted to different macroeconomic variables.
His approach has had an enormous impact on research. It has also been used extensively as a basis for decision-making in economic policy.6

VAR analysis can be described in simple terms as a method of extracting structural macroeconomic shocks, such as unexpected exogenous shocks to the central bank’s main policy instrument (e.g., the federal funds rate in the U.S.) or unexpected exogenous changes in productivity, from historical data and then analysing their impact on the economy. Thus, this analysis is a tool for: (i) estimation of a forecasting model, by separating unexpected movements in macroeconomic variables from expected movements; (ii) identification, by breaking down these unexpected movements into structural shocks, i.e., shocks that can be viewed as fundamental causes of macroeconomic fluctuations; and (iii) impulse-response analysis, by tracing out the dynamic impact of these shocks on subsequent movements in all of the macroeconomic variables.

Sims proposed that the empirical study of macroeconomic variables could be built around a statistical tool, the vector autoregression (VAR). Technically, a VAR is a straightforward N-equation, N-variable (typically linear) system that describes how each variable in a set of macroeconomic variables depends on its own past values, the past values of the remaining N-1 variables, and on some exogenous shocks.

**Contingent Claims Approach:** The details of the framework for assessing macro-financial risk to financial institutions are explained in the Appendix 1.

### 6.2 Data

The study includes financial statements and time series data of the 12 commercial banks of Nepal. The total deposits, total liabilities to total capital ratios, non-performing loans, and total capital are collected and calculated from the regular issues of quarterly financial highlights of commercial banks published in the website of NRB since 2005 to 2010 and from the Quarterly Economic Bulletin. The stock price of individual banks and stock market index data are collected from the Nepal Stock Exchange office, Kathmandu. GDP growth rate is collected from the Economic Survey, 2010/11, published by the Ministry of

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Finance, Government of Nepal. As GDP data is published on annual basis in Nepal, it is transformed into quarterly basis using Goldstein and Khan (2010) method\(^7\). Inflation data are collected from the NRB.

7. Empirical Results: Assessment of Systemic Risk

The study includes eight variables for panel VAR analysis. The variables used are GDP growth rate (\(Y_G\)), inflation rate (\(INF\)), total deposit (TD), non-performing loans in percentage of total loans (NPL), total liabilities to total capital ratios (TL\(_TC\)), stock market index (SMI), total capital (TC), and default probabilities of financial institutions (DEFPROB). The variables NPL and DEFPROB are used as panel data of 12 commercial banks of Nepal and remaining variables are in aggregate.

Most of the sampled banks’ probabilities to default are found to be positively correlated with non-performing loans. As depicted in Table 4 below, the correlation coefficients of banks’ default probabilities to their non-performing loans are presented for the 12 commercial banks. Out of the 12 correlation coefficients, 10 have positive correlation between the banks’ NPL and their probabilities to default. When there are high default probabilities, their NPLs are also high. This indicates that default probabilities could be the indicator to reflect financial stability.

<table>
<thead>
<tr>
<th></th>
<th>BANK1</th>
<th>0.82</th>
<th>BANK7</th>
<th>0.71</th>
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<tr>
<td>BANK2</td>
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<td></td>
<td>BANK8</td>
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<td>BANK3</td>
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<td>BANK6</td>
<td>-0.40</td>
<td></td>
<td>BANK12</td>
<td>0.56</td>
</tr>
</tbody>
</table>

\(^7\) For details, see Al-Turki S.M. (1995).
The unrestricted panel-VAR model has been used as a macroeconomic model to analyse the impact of shocks. The study has not tested unit root to check stationarity of the data. It is because “Sims (1980) and Sims, Stock, and Watson (1990) recommend against the differencing even if the variable contain a unit root. They argue that the goal of a VAR analysis is to determine the interrelationships among the variables, not to determine the parameter estimates. The main argument against the differencing is that it “throws away” information of concerning the co-movements in the data such as possibility of cointegrating relationships. Similarly, it is argued that the data need not be detrended.”

After estimation of panel-VAR model, three experiments – impact of positive inflation shock, positive GDP shock, bank run shock (10% decrease in deposit) – are conducted to generate the impulse response functions.

Figure 1 in Appendix III depicts the impulse responses of other variables to one standard deviation shocks to GDP growth. The initial impact of shocks has been presented in Table 5. As the GDP growth rate increases, inflation increases, total deposits increases, and total capital increases. However, non-performing loans decreases and ratio of total liabilities to total capital decreases. As a consequence, the default probability of banks also increases. It can be concluded that boom in the economy would increase the default probabilities of banks.

**Table 5**

<table>
<thead>
<tr>
<th>Shocks to Variables</th>
<th>INF</th>
<th>TD</th>
<th>NPL</th>
<th>TL_TC</th>
<th>SMI</th>
<th>TC</th>
<th>DP</th>
<th>YG</th>
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<tbody>
<tr>
<td>YG ↑ One SD</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
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<tr>
<td>INF ↑ One SD</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
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</tr>
<tr>
<td>TD ↓ (10 PC)</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
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</tr>
</tbody>
</table>

*PC = Percentage, SD = Standard Deviation and arrows show the direction*

Similarly, the Figure 2 in Appendix III shows the impact of one standard deviation inflation shock to other variables. As shown in the Table 5, increase in inflation increases total deposits, total liabilities to total capital ratio and total capital as well. On the other hand, it decreases GDP growth, stock market activities and non-performing loans as well. As a result, default probabilities increase. The simulation result shows that increase in inflation decreases GDP growth. The negative association between inflation and economic growth is against the Phillips curve relationship. It might be due to the reason that when inflation increases the aggregate supply curve shifts to the left decreasing output.

Figure 3 in Appendix III shows the impact of bank-run shock measured as a fall in deposit by 10% to innovations. The initial impact of the shock is also summarised in Table 5. If there is a fall in deposit by 10%, it decreases GDP growth rate, total capital, inflation and total liabilities to total capital ratio. On the other hand, a fall in deposit increases NPL and default probabilities reflecting financial sector instability in the economy. Therefore, a fall in aggregate deposit increases non-performing loans and is the cause of systemic risks in the Nepali financial sector.

All shocks significantly increased the default probabilities of the banks, i.e., they increase credit risks or the probabilities of default. In the both cases, the increase in economic growth and fall in deposits, default probabilities or risks to financial stability have been increased. It indicates that the agents have strong collective tendency of overexposing themselves to risk in the upswing of a business cycle, i.e., increase in economic growth raises default probabilities. On the other hand, the agents become overly risk-averse, i.e., when there is a downswing (fall in deposits) there is an increase in default probabilities. The study shows that change in economic growth, inflation and bank-run also affect the probability of bank defaults. NRB should closely monitor these variables while formulating its policies.
8. Conclusion

The financial crisis demonstrated that a stable and reliable financial system is a prerequisite for price stability and stable economic growth. The supervisory and regulatory authorities must consider overall financial stability as well as the safety and soundness of individual institutions. Therefore, the NRB has to work so as to better understand the sources of systemic risk, to develop improved monitoring tools, and to evaluate and implement policy instruments to reduce risks to the economy. As the study shows that change in economic growth, inflation and bank-run also affect the probability of bank defaults, the NRB should closely monitor these variables while analysing the systemic risks to the financial institutions. Therefore, macro-prudential policy is crucial in Nepal in addressing these sources of systemic risks. Moreover, macro-prudential, monetary and micro-prudential policies should be implemented in such a way that they can reinforce one other to stabilise financial system and the economy as a whole.
References


Appendix 1

Framework for Macro-Prudential Policies for Emerging Economies in a Globalised Environment

I. Methodology: Framework for Assessing Systemic Risk of Major Financial Institutions

1. Theoretical Concept

   The Contingent Claims Approach is a structural model based on the Black-Scholes and Merton model. Consider a case of a firm with assets, \( V \), which are financed by debt obligation, \( F \), and Equity, \( E \). The value of the firm’s assets is simply the sum of the firm’s debt and equity:

   \[
   V_t = F_t + E_t
   \]

   (1)

   The value of the firm’s debt obligation is also known as the default barrier, \( DB \). The probability of default \( (V_{t+1} < F_{t+1} \text{ or } DB) \) exists as long as it is greater than zero. This implies that at time \( t+1 \), the market value of assets, \( B_t \), is lower than the yield to maturity of the debt, \( F e^{-rT} \). In this simplified firm structure, the risk is a function of the leverage ratio,

   \[
   LR = \frac{F e^{-rT}}{B_t}
   \]

   , the volatility of the rate of return of the firm’s assets, \( \sigma_r \), and the time to maturity of the debt, \( T \). Thus, a creditor who extended a loan to this firm must purchase a put option to eliminate the risk on the loan. The value of the put option, \( P_n \), on the market value of the firm assets, \( B_t \), for the term of the debt must have a strike price, \( S \), equal to the face value of the loan. The creditor can completely eliminate the credit risk and convert the risky loan into a riskless loan. If the riskless interest rate is \( r \), then in equilibrium it should be that:

   \[
   B_t + P_n = F e^{-rT}
   \]

   (2)

   9. A put option is a contract between two parties to exchange assets for an agreed amount (strike price) at a specified future date. The buyer of the put, has the right but not the obligation to sell the asset at the strike price. The seller has the obligation to buy the asset once the buyer exercises his right.
In applying the Black-Scholes and Merton model, the value of the put can be written as:

\[ P_0 = -N(d_1)B_t + Fe^{-rT} N(-d_2) \]  

(3)

Where \( P_0 \), is the current value of the put, \( N(.) \) is the cumulative standard normal distribution, \( \mu \) is the expected return on the assets, and \( \sigma_v \) is the standard deviation of the rate of return of the firm’s assets.

\[
d_1 = \frac{\ln \left( \frac{F_t}{P_t + \sigma_v \sqrt{T}} \right) + \left( \mu + \frac{1}{2} \sigma_v^2 \right)T}{\sigma_v \sqrt{T}}
\]

(4)

\[
d_2 = d_1 - \sigma_v \sqrt{T}
\]

(5)

The numerator measures the distance between the expected one-year ahead market value of the firm’s assets and the distress barrier. The denominator is used to scale the numerator with respect to units of standard deviations. Thus, the probability of default, \( (V_{t+1} < F_{t+1} \sigma_r DB) \) is as follows:

\[
\text{Probability of default} = N\left(- \left( LN \frac{V_{t+1}}{(DB)} + \left( \mu - (\sigma_v \sqrt{2}/2)^T \right) / (\sigma_v \sqrt{T}) \right) \right)
\]

(6)

Using Equation (5), the expected return on assets, \( \mu \), can be computed as follows:

\[
\mu = \max \left[ \frac{V_{A,t}(t) - V_{A,t+1}(t)}{V_{A,t+1}(t)}, r \right]
\]

(7)

where \( r \), is the one year Treasury Bill rate and \( T \), is set to one year so that the probability emerging out of the assessment is the one year ahead probability of default on an ex ante basis.
Moreover, the equity of the firm, $E_t$, is itself a contingent claim on the firm’s assets. Since equity holders have a junior claim on the residual value of the assets, the value of the equity can be viewed as a call option. This means that equity holders receive the maximum of market value assets minus the default barrier or nothing in case of default. Given that the firm’s equity behaves like a European call option on the firm’s assets, the Black-Scholes and Merton model can be used to compute the equity value. The equation for valuing equity as a European call option is:

$$E_t(t) = V_t(t)N(d_1) - F e^{-rT}N(d_2)$$  \hspace{1cm} (8)

1. **Estimating Financial Institution Risk Using the Contingent Claims Approach**

In the theoretical concept, it is shown that the Black-Scholes and Merton model can be applied to calculate risks in the financial system by showing the distance of institutions from the default barrier and estimating the probability the default. In cases where the debt and equity are both traded, the market value of assets, $V$, can be reconstructed by adding the market values of both debt and equity as stated in Equation (1). However, practical problem arises in cases where the firm debt is not traded and only equity is traded or vice versa. For this project, the data of the top big banks are limited only to institutions where there are available equity prices. Since most of the participating economies are constrained by market data availability of debt, the default barrier ($K_F \alpha 1(\tau_T)$) is determined as a function of the short-term debt and long-term liabilities of the firm.\(^{10}\)

---

According to the Vasicek and Kealhofer empirical model, firms default when the asset value reaches a level that is somewhere between the value of the total liabilities and the value of the short-term debt. Therefore, the tail of the distribution of asset values below the total debt may not be as accurate as a measure of actual probability of default. The loss of accuracy may result from the non-normality of the asset return distribution or the firm is able to draw on lines of credit (unobservable). Thus, the default barrier is computed as the sum of short-term debt plus half of the long-term debt.

For the market value of equity, it is equal to the number of outstanding stocks multiplied by the closing stock price as of the balance sheet date. To calculate a single systemic risk indicator, an aggregation technique based on the weighted average market value of assets is used.

11. The most popular commercial model is the Kealhofer, McQuown and Vasicek (KMV) model.
Appendix 2

Construction of Quarterly GDP Series

Interpolation method is used to derive the quarterly GDP growth rate from annual data, as outlined by Goldstein and Khan (1976). The method has been explained in this section. The task is to approximate the graph of \( Y = f(x) \) between the points at which the values of \( Y \) are known. That is, we want to approximate the graph of \( Y \) between any two annual points. If we represent \( f(x) \) by the quadratic function on the form \( Y_G = ar^2 + br + c \), then for any three consecutive annual observations (at years 0, 1 and 2) of \( Y_G \), the approximation of \( Y_G \) takes the form\(^{12}\):

\[
\int_0^1 (ar^2 + br + c)\,dr = Y_{G_{t-1}} \quad \text{(i)}
\]
\[
\int_1^2 (ar^2 + br + c)\,dr = Y_{G_t} \quad \text{(ii)}
\]
\[
\int_2^3 (ar^2 + br + c)\,dr = Y_{G_{t+1}} \quad \text{(iii)}
\]

Now, integrating, substituting and solving equations for \( a, b \) and \( c \) gives:

\[
a = 0.5Y_{G_{t-1}} - Y_{G_t} + 0.5Y_{G_{t+1}} \quad \text{(iv)}
\]
\[
b = -2Y_{G_{t-1}} + 3Y_{G_t} - Y_{G_{t+1}} \quad \text{(v)}
\]
\[
c = 1.8333Y_{G_{t-1}} - 1.1666Y_{G_t} + 0.3333Y_{G_{t+1}} \quad \text{(vi)}
\]

Then the four quarterly data within a given year can be interpolated respectively, by using:

\[
Q_1 = \int_0^{\frac{1}{4}} (ar^2 + br + c)\,dr = 0.05468Y_{G_{t-1}} + 0.23438Y_{G_t} - 0.039067Y_{G_{t+1}} \quad \text{(vii)}
\]
\[
Q_2 = \int_{\frac{1}{4}}^{\frac{1}{2}} (ar^2 + br + c)\,dr = 0.00781Y_{G_{t-1}} + 0.26563Y_{G_t} - 0.02344Y_{G_{t+1}} \quad \text{(viii)}
\]
\[
Q_3 = \int_{\frac{1}{2}}^{\frac{3}{4}} (ar^2 + br + c)\,dr = -0.02344Y_{G_{t-1}} + 0.26562Y_{G_t} + 0.00781Y_{G_{t+1}} \quad \text{(ix)}
\]
\[
Q_4 = \int_{\frac{3}{4}}^1 (ar^2 + br + c)\,dr = -0.0391Y_{G_{t-1}} + 0.23437Y_{G_t} + 0.05469Y_{G_{t+1}} \quad \text{(x)}
\]

The above equations can be used to derive quarterly data series.

---

### Appendix 3

**Output of the Study**

#### Vector Autoregression Estimates

<table>
<thead>
<tr>
<th>Vector Autoregression Estimates</th>
<th>Y_G (1)</th>
<th>INF</th>
<th>TD</th>
<th>NPL</th>
<th>TL TC</th>
<th>SMI</th>
<th>TC</th>
<th>DEFFPROB</th>
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Figure 3.1
Graphical Presentation of Data
B: Impulse Response Functions of VAR Analysis

Fig. 3.2
Response to One Standard Deviation GDP Shock
Fig. 3.3
Response to One Standard Deviation Inflation Shock
Fig. 3.4
Response to 10% Fall in Deposit
Appendix 4.1
Default Probabilities of Banks

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<th>FISCAL YEAR</th>
<th>QUARTER</th>
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<th>BANK2</th>
<th>BANK3</th>
<th>BANK4</th>
<th>BANK5</th>
<th>BANK6</th>
<th>BANK7</th>
<th>BANK8</th>
<th>BANK9</th>
<th>BANK10</th>
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<td></td>
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<tr>
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Note: The default probabilities of sampled banks are calculated using Contingent Claims Approach (CCA). The name of banks is not disclosed because of such information might be the sensitive.
## Appendix 4.2

### Time Series Data

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