Understanding Credit Crunch of 2018: A System Dynamics Study of Nepalese Banking Sector

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Thesis submitted in partial fulfilment of the requirements of
Master of Philosophy in System Dynamics
(Universitetet I Bergen)

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July, 2020

Acknowledgements

I owe my gratitude to all those people who have made this thesis possible and have made my journey for graduation a remarkable one. Most importantly, I would like to extend my deepest gratitude to my thesis supervisor, ***Professor Pål I. Davidsen****. I have been incredibly fortunate to be supervised by Pål whose expertise in system dynamics is of paramount pre-eminence. His insightful comments and constructive criticisms at different stages of my study were thought-provoking and helped me improve my work.*

I am grateful to all the respondent who gave their valuable time which ensured my confidence in my work. I am also thankful to all those who bridged my communication to get access to such occupied professionals (respondents) amid of crisis.

I greatly value the motivation and support my faculty and friends at M.Phil program in System Dynamics at UIB have shown during my entire study period. Without those incredible people my system dynamics journey would have definitely been less interesting. I warmly appreciate their generosity and effort for helping me to get over my confusions and always improved me in my endeavor.

Lastly, none of this would have been possible without the support and patience of my family who has been a constant source of motivation, concern, support and strength all the times.

July 22, 2020

Abstract

This thesis idea originates from the observation of Ashish Shrestha, the author of this thesis, during his employment in one of the banks of Nepal where the entire banking industry moved from a normal business operation to a severe credit crunch. Then executives in the banking industry all discussed about the recurrent nature of such crises. That idea was then presented as proposal which was accepted as possible thesis work by Prof. Pål Davidsen, who also supervised the thesis.

There are several evidences found in literature that advocate the necessity to strengthen financial system through capital increments to develop banking sector as resilient to economic shock. Nepal Rastra Bank (NRB), regulator, imposed capital increment hopeful to strengthen Nepalese banking sector. But with such imposition banking sector had to face new challenge of credit crunch. Such outcome of credit crunch, completely opposite of expected, resembles a complex feedback system. Thus, it was identified that use of SD methodology would help understand the dynamics of such recurrent crises.

To study the problem, a system dynamics model of integrated financial system covering banking and GDP sector has been constructed. The key feedback structure that exist and govern the interaction of this sector in explicit behind the development of the model. This model reveals that the interaction of theses feedback mechanism, both reinforcing and balancing, explains the behavior and helped identify leverage point for scenario analysis, after establishing confidence through testing.

The thesis follows a structure starting with Chapter 1 which defines the context, problem, research objective and research question followed by description of structure and feedback perspective in Chapter 2. Chapter 3 describes tests performed for structure and behavior validation to establish confidence in the model. In Chapter 4 behavior produced by model under different runs and scenario are presented. Finally, the conclusion, limitation and further works are summarized at the end.

List of Acronyms

CCD: Credit to core capital and deposit

CRR: Cash Reserve Ratio

DMNL: Dimensionless

GNDI: Gross National Disposable Income

GNI: Gross National Income

GNS: Gross National Saving

GOVT: Government

NRB: Nepal Rastra Bank

PVT: Private

RGNI: Real Gross National Income

RGNDI: Real Gross National Disposable Income

SLR: Statutory Liquidity Ratio

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Chapter 1: Introduction

1.1 Background

Banks play an invaluable role in the economy. Banks provide both liquid and relatively low savings facilities and credit in flexible amounts to households, business concerns, and governments and promote the payments system both by providing a major form of exchange, such as demand deposits, and by operating clearing systems for paper and electronic financial transfers. It is quite known that well-functioning banking systems accelerate long-run economic growth, but poorly functioning banking systems can impede economic progress, exacerbate poverty and destabilize economies (J. Barth, Caprio, & Levine, 2001).

Nepal marked the beginning of an era of formal banking in the year 1937 with the establishment of Nepal Bank Ltd, first commercial bank. After decades, in 1984, financial liberalization commenced, and several sweeping changes and reforms were made in the Nepalese financial system. While Nepal was moving towards financial liberalization, world economies were already concerned about the stability of banks and financial institution and the risk exposed due to the evidences of financial crisis.

The spectacular increase in bank and thrift failures in the 1980s and during the financial crisis of 2008 raised concerns about depository institution risk (Berger & Udell, 1994). While in Nepal, financial liberalization was formalizing which introduced several prudential norms such that Banking system was well defined and shaped after the norms were put into practice. Subsequently, Nepal Rastra Bank (NRB), the central bank, also set up certain requirements such as capital adequacy requirement, loan loss provisioning, interest income recognition, loan classification, and income disclosure requirement in order to develop the financial sector, mainly banking system, as transparent and credible to a large extent. Consequently, the number of Nepalese commercial banks were increasing during that period which had increased to 33 till year 2015 while as of 2019 there are 28 commercial banks in Nepal. With such development, banking industry in Nepal became (and still is) one of the strongly regulated industry. Despite such regulation, there are several instances where many development banks

have been directly managed by central bank itself to maintain the trust of general public in banking system, commercial banks are no exceptions.

Commercial banks and development banks go through several ups and down depending upon the economic growth of the nation which eases out gradually (Bernauer & Koubi, 2004). But Nepalese banks had to face severe financial crises during 2011 and 2018. In 2011, Vibor Bikas Bank, one of the leading development banks as that time, had to face bank run and was not able to even pay back depositor money. Vibor Bikas Bank was not the only bank that came into verge of collapse due to liquidity crunch. There were other financial institutions- Nepal Development Bank, Samjhana Finance, United Development Bank, Gorkha Development Bank- that faced such disaster leading to liquidation of some of these banks. No only development banks, Nepal Bangladesh Bank, a joint venture commercial banks, also faced bank run resulting to direct management take over by NRB to maintain public confidence in financial system.

On March 14, 2018, The Himalayan Times, leading Nepalese newspaper, published a news entitled- "NRB to inject Rs 20 billion as liquidity crunch looms large over market" (Himalayan News Service, 2018). Though no banks had to supported by Nepal Rastra Bank (NRB), central bank of Nepal, during 2018 liquidity crunch, but banks did appeal NRB to ease core capital and credit to deposit ratio (CCD) so that banks could continue lending fund at least to fulfil this agreed debt commitment, while completely restricting any new debt commitment. Such liquidity crunch hiked the lending rate on mortgages as high as 18 percent which severely affected the repayment capacity of many borrowers on one hand and on the other hand business were unable to utilize their short-term credit facilities that effected this operation cashflow.

These instances of liquidity crisis and/or credit crunch have severely affected the financial system. The cause of such liquidity crisis for the different time horizon can be different from each other; thus, this research aims to focus on the credit crunch that effected the lending ability of commercial banks of Nepal during 2018.

1.2 Problem Definition

Well-functioning banking systems accelerate long-run economic growth, but poorly functioning banking systems can impede economic progress, exacerbate poverty and

destabilize economies (J. Barth et al., 2001). On contrary, deterioration in aggregate economic conditions can undermine the viability of some banks, especially those with a small capital base and even lead to the insolvency of banks (Bernauer & Koubi, 2004). Thus, efficient bank operation and stability should be a major macro-economic concern of a nation. To ensure that the banking system is efficient and operationally effective, the government of every country does exert some regulatory controls. One of such control is the regulation of bank capital base through capital requirement policy (Agbeja, 2013). Furthermore, the history of financial crisis raises fundamental issues about the role of bank equity capital, particularly from the standpoint of bank survival. Not surprisingly, public outcries for more bank capital tend to be greater after financial crises, and post-crisis reform proposals tend to focus on how capital regulation should adapt to prevent future crises (Berger & Bouwman, 2013).

In this context, Nepalese commercial banks were directed to adhere with the Capital Adequacy Framework (CAF) developed based on the risk weighted capital requirement stated by Basel II since 2007, after the regulatory requirement imposed by NRB (Accord Implementation Group, 2007). Such regulatory capital requirement would normally strengthen bank capital and, thus, improve the resilience of banks to negative shocks (Chiuri, Ferri, & Majnoni, 2002) . CAF defined banks' capital consisting of Tier 1(core) capital and Tier 2(supplementary) capital elements. Such core capital includes paid-up (equity) capital and disclosed reserves (Accord Implementation Group, 2007).

In the same period, Nepalese commercial banks were also directed to maintain a minimum paid-up capital requirement of Nepalese Rupees (NPR) 2 billion effective from Mid-July 2007 (Bank and Financial Institution Regulation Department, 2007). This Tier 1 capital should be maintained at not less than 6 percent of total risk weighted exposure along with other disclosed reserves (Accord Implementation Group, 2007). During that period, maximum permissible credit to capital and deposit ratio was 95 percent which was reduced to 80 percent and continued since January 14, 2012 through an NRB circular published on December 17, 2009 (Bank and Financial Institution Regulation Department, 2009) .

Recently, monetary policy of NRB published in 2015 increased the paid-up capital requirement for commercial banks from existing NPR 2 billion to NPR 8 billion by

the end of the fiscal year 2017/18 (Nepal Rastra Bank, 2015). Such regulation was imposed to promote the financial stability and mobilize the resources needed for the long-term development (Nepal Rastra Bank, 2015). Whereas, NRB regulation allowed commercial banks to create credits up to the level where banks credit to core capital and deposit (CCD) ratio does not exceed 80%, remained unchanged. With the increase in paid-up capital banks' ability to lend also increases. However, despite of increased lending capacity with increased paid-up capital, commercial banks reported a severe shortage of loanable funds during 2018 (Cosic, Dahal, Bajracharya, & Rana, 2017) (Bhatta, 2017) (Sharma & Pande, 2018). The historical development of CCD ratio for the commercial banks of Nepal is best portrayed by Figure 1.

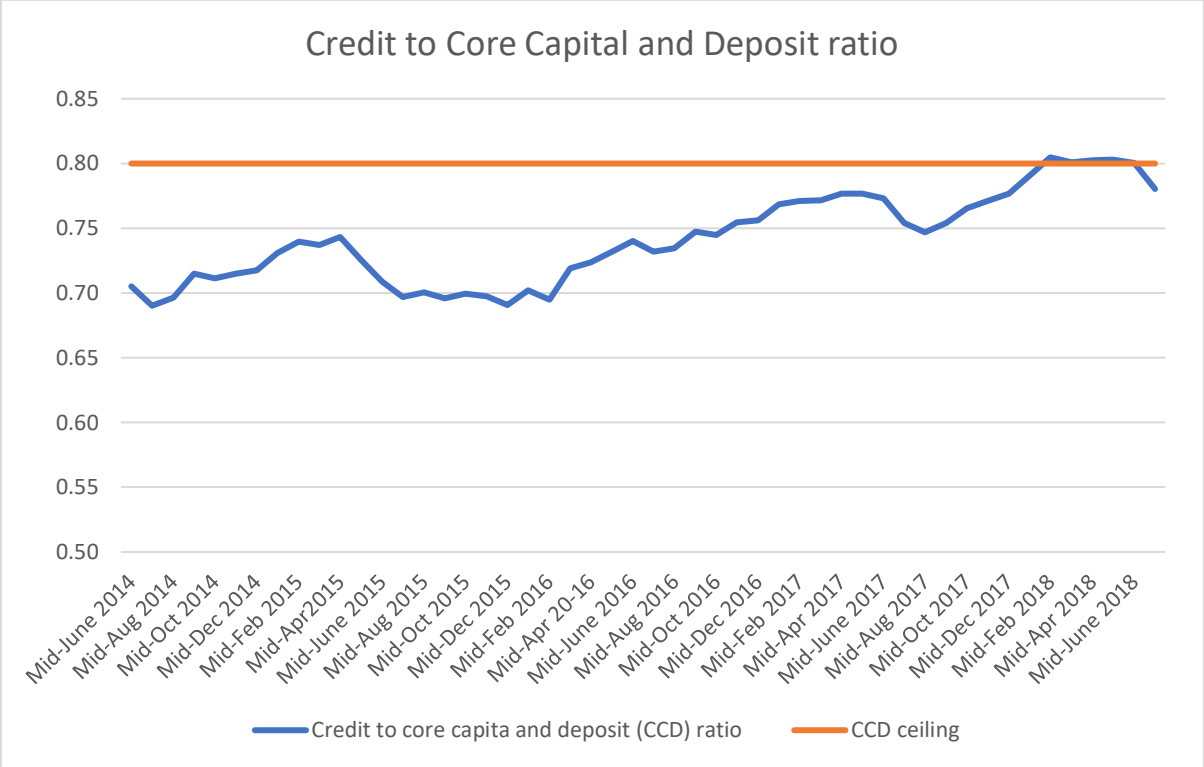


Figure 1. Credit to Core Capital and Deposit ratio (Mid-June 2014 to Mid-June 2018)

Source: Compiled from Bank and Financial Statistics report published by Nepal Rastra Bank from Mid-June 2014 to Mid-June 2018 https://www.nrb.org.np/category/banking-and-financial-statistics/?department=bfr

The above CCD ratio information generated from the compilation of monthly report for 50 months show an increasing growth in banks' CCD ratio over the period of 50 months. Specifically, after Mid-June 2015 when NRB imposed new regulatory requirement to increase the core capital requirement of commercial banks, above CCD

ratio showed a higher increase. This clearly demonstrate the major problem the Nepalese commercial banks were facing at that time: lending ability of commercial banks were decreasing due to tighter CCD ratio to its stated ceiling of 0.8 or 80 percent shown by orange line in the above figure. The determining factor that result in the above depicted CCD ratio are banks' loan, paid-up capital and deposit. The pattern of these three balance sheet components of banks are shown in Figure 2:

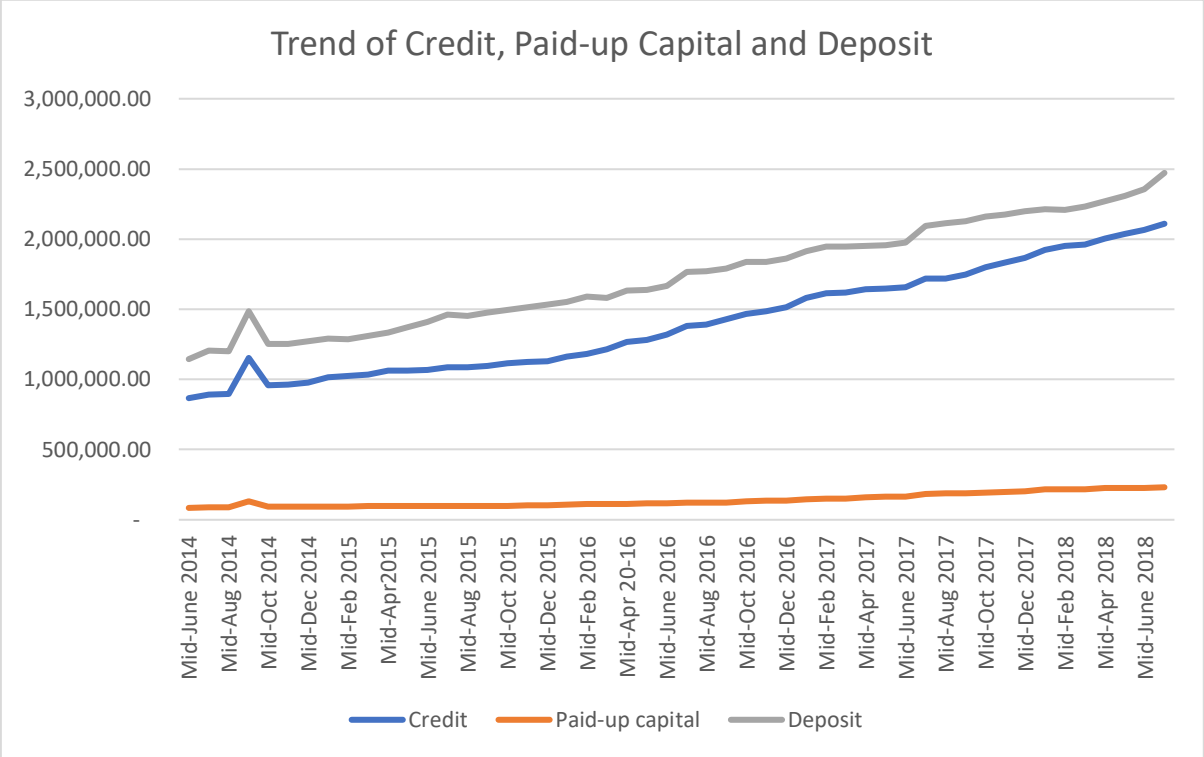


Figure 2. Trend of Credit, Paid-up Capital and Deposit

Source: Compiled from Bank and Financial Statistics report published by Nepal Rastra Bank from Mid-June 2014 to Mid-June 2018 https://www.nrb.org.np/category/banking-and-financial-statistics/?department=bfr

Figure 2 shows the trend of three balance sheet components which effect the banks' lending capacity and its CCD ratio. The trend of these three components show a gradual increase but noticeably the growth rate since Mid-June 2015 can be observed as higher for both deposits and credit while paid-up capital is also increasing gradually. With the increase in paid-up capital and deposit, banks' lending capacity (credit) also increases but despite of such increases CCD ratio, as shown in Figure 1, is reaching its limits.

Thus, based on the above description of key regulatory changes and trends of different balance sheet components, the problem, which this project is supposed to

address, can be formulated as following: Nepalese commercial banks are facing challenges to provide adequate credit facilities to their borrowers limited by regulatory imposed CCD limit despite of increase in their paid-up capital; while increase in paid-up capital should supply additional lending buffer to such banks.

The puzzling question following this problem definition is what caused the shortage of loanable fund even after a four-fold increase in paid-up capital while the lending limit remained unchanged.

1.3 Research Objectives and Research Questions

In accordance with the problem definition in the previous section, the research objective and corresponding research question were formulated. To address the defined problem, the research project was designed to accomplish the following objective:

a. To investigate the credit crunch in Nepalese banking sector between 2015 to 2018 through the understanding of economics behind the creation of loanable funds through deposit and paid-up capital and disbursement of loans to the final borrower by way of a model and simulation-based analysis. The fulfilment of this objective will allow us to construct a model that will incorporate a comprehensive casual representation of fundamental nature of banks' credit creation through deposit. Deposit, a supply for credit creation for banks, come from the savings deposit, salary deposit and repayment of loans. This model is also supposed to explain the contribution of banking sector in creating private and government capital investment that supplies fund for productive/priority sector investment which contributes to Gross Domestic Product (GDP) of Nepal.
b. Based on the model, a scenario analysis to observe that wholistic consideration of regulator will be tested to see its impact on GDP growth and banks' lending ability , which is the second objective of the project.

To fulfill the stated research objectives, the following research questions were formulated for the project to answer:

a. What are the underlying causes of credit crunch in Nepalese Commercial Banks during 2018 after regulatory requirement for increases in paid up capital while risk weighted capital requirement was unchanged?

b. What is the macro-economic impact of such credit crunch and its feedback effect on the financial system?
c. What are the leverage points that are critical to maintain a balance in financial system stability and profitability?

1.4 Research Methodology and Strategy

In order to fulfill the research objective a quantitative system dynamic modeling and simulation-based analysis approach is adopted. This modelling approach allows us to represent, explicitly, coherently and consistently, relevant interactions between different causes and their effects. In that way, it is possible to facilitate a variety of formal analyses that enhance our understanding of interaction between regulatory requirement and balance sheet components of commercial banks, commercial banks' functioning in terms of deposit collection and loan mobilization and the feedback of commercial banks' activities on GDP and their effects due to regulatory changes. The process of deposit collection, mobilization and credit creation takes place in a highly dynamic environment, characterized by massive feedback, interaction between a variety of subsystems, significant time delays and uncertainty. System dynamics has been developed specifically to facilitate the analysis of the relationship between the structure and behavior in such complex feedback systems under uncertainty (Sterman, 2000).

Research Strategy adopted here is a combination of grounded theory and experiment. The grounded theory is effective to address the first research objective of the study. The extensive analysis of various bank reports, regulatory circular and directives, national account data and as well as the mental models, highly influenced by regulatory obligation, governing the banks' decisions constitute the majority of the qualitative and quantitative data used for this project. Then the analysis of banks' monthly statements and national accounts reports was enhanced with the interviews and conversations with bank's personnel (practitioner) to make sure that our understanding of the system correspond to the system in practice. Based on these secondary data analysis and conversation with the insider added with the researcher's experience an understanding of what determines deposit collection and loan/credit

mobilization, its effect on GDP and consequently a feedback to the banking system is constructed and represented in a quantitative system dynamics model.

Moreover, a computer aided experimentation strategy is employed to address the second research objective. This approach allows conducting an evaluation of different regulatory scenario aimed at stimulating different results for key balance sheet indicator which could help in recommending key leverage points both for regulators and the banks.

1.5 Literature Overview

Quantitative and qualitative information are critical for development of any system dynamics model. From the formulation of problem through model development and validation, extensive analysis of documents, reports and literature done which is provided in this section of the report. It is notable that such sources of literature were also consider the sources of data for model initialization and parameter estimation. Broadly, the literature can be grouped into two blocks: literature that backed the existence of problem and literature that back formation of model structure.

The starting section of this chapter provides the background about banking industry, its importance and some information about banking sector of Nepal. Basel III has set its objectives to improve the shock absorbing capacity of each and every individual bank as the first order of defense (Bank and Financial Institution Regulation Department, 2013) . A study conducted by Bank and Financial Institution Regulation Department for the implantation of Basel III (Bank and Financial Institution Regulation Department, 2013) identified need of additional capital for buffers like capital conservation buffer and countercyclical buffer which might have resulted in regulatory requirement for increased capital. Such increased capital ensures stable banking system which is important component of well-functioning financial systems (J. R. Barth, Caprio, & Levine, 2005) (Agbeja, 2013). On contrary, banks, especially those with a small capital base, can lead to the insolvency of banks under volatile economic situation (Bernauer & Koubi, 2004). But Nepalese sector even after increases in capital reported credit crunch which different than what literature suggested resulting in the formulation of problematic behavior.

Secondly, the major literature that back the development of model structure and subsequent sector was derived from the work of (Yamaguchi, 2019). Yamaguchi (2019) in his book has used system dynamics to model the accounting system that represents the functioning of an individual bank and GDP as a whole. The structure for individual bank was conceptualized and adopted to develop the banking sector used in the model. Furthermore, GDP sector was conceptualized as a broader system based on the works of (Yamaguchi, 2019) and (Wheat, Oliskevych, & Novik, n.d.). whereas, the base rate sector was model completely based on the regulatory guideline of NRB (Bank and Financial Institution Regulation Department, 2012a). Moreover, the literature referred for model calibration are well documented in Appendix A.

1.6 Research Ethics

Major source of data for this thesis was secondary data. Thus, research ethics for the use of secondary data was adhered properly with no misrepresentation or misinterpretation of such data. Data sources, information from different literature review and any assumption for the any parameter has been clearly explained, cited and works of other author were acknowledge through referencing. Moreover, primary data were collected in the due course of research and confidentiality of interviewee and respondent is and will be maintained at all time. Respondents consent was obtained voluntary after communicating the purpose and information need for this study. Anonymity of the respondents is maintained at all time to ensure no harm is caused to those who participate as respondent or interviewee. Data, analysis, and results will be made available upon request, but within the limits of confidentiality.

Chapter 2. Model Description

2.1 Model Overview

The previous chapter described the problem definition and a number of issues related to the research design aimed at addressing the stated problem. In accordance with the research objectives and research questions, the scope and timing of the model were specified. This section describes what the model does (namely, the dynamics of which variables is generated, or, a scope of the model), and for which time period. Based on this description, the purpose of the model is explained.

All these elements provide an overview of the model so that the reader can understand what the model is about without referring to exact specifications used in the model. The next section discusses how the chosen scope, and timing of the model translate into the model's assumptions. Then the discussion shifts to a more detailed description of the structure of the model's sectors in terms of stocks and flows and major formulations. After that, a less detailed perspective structure is presented, whereby the major feedback loops and their interactions is presented.

As discussed in problem definition, the model focuses on dynamics of deposit collection, mobilization and loan creation by Nepalese commercial banks. As such the model generates the dynamics of following key variables at national level for all commercial banks:

- CUMULATIVE DEPOSIT
- CUMULATIVE LOAN
- PAID-UP CAPITAL
- PRIVATE CAPITAL INVESTMENT
- GOVERNMENT CAPITAL EXPENDITURE
- REAL GDP

The model is then used to test different scenario of regulatory constraints on loan creation for priority sector. The effect of such regulatory constraints on banks' lending and CCD ratio is described and supported by relevant implication in Chapter 4.

The time frame of the model simulation is 49 months from the starting point, which is Mid-June 2014. The choice of 49 months is based on following reasons:

The main objection of this model is to determine the cause of credit crunch after the implementation of increased regulatory paid-up capital requirement. The regulation to increase the paid-up capital was published in the Monetary Policy 2015/16 (Nepal Rastra Bank, 2015). Thus, the model start time is taken as Mid-June 2014, thirteen months before the regulatory requirement was impose. The regulator mandated the commercial banks to achieve the increase in paid-up capital within 24 months after the regulation was imposed. Then, twelve months additional period is taken to see the impact of the capital enhancement on the deposit and lending creation.

For the scenario analysis, different regulatory requirement for lending restriction are tested within the last 36 months of model simulation time, precisely within the time when increased capital requirement was imposed to see how CCD ratio of banks would have behaved under different combination of lending restriction.

Scoping of the model is determined based on the implication of increased regulatory capital requirement for commercial banks. As such, the scope of the model is characterized by following key features:

- Credit/loans is at the center of this model which is clearly identified as a main component in banks' balance sheet and its effect on GDP is at the core of the model.
- Paid-up capital is another key element in this model which is affected by the changed regulatory requirement and consequently effects Credit/loan creation, center variable in the model.
- The model incorporates an important feedback mechanism between supply of deposit through GDP, mobilization of deposit and paid-up capital for loan creation. There is a general understanding, among banker and regulators, that deposit and paid-up capital enhances lending capacity of banks is elementary (open loop perspective); however, the consequences of loan creation and mobilization on GDP and consequently on further deposit collection (closed loop perspective) seems to be ignored, more accurately undermined, by bankers. Yet,

this closed feedback mechanism was identified as a central driver of the system under study using the SD modelling.

- Another crucial variable that establishes a link between banking sector and GDP is the lending requirement for priority sector. This lending requirement is key variable that drives the subsequent deposit collection. As such, this establishes the supply of capital investment for GDP and refuels economy's performance which again supplies deposits for banking sectors; hence, strengthens the banks financial stability and profitability.

2.2 Model Assumptions

The scope of the model described along two key dimensions (variables and time) is exhibited in a set of assumptions made throughout the modeling process. This section provides an elaborate discussion of those assumptions, their justification and consequences of their utilization in the model.

2.2.1 Assumption 1: system boundaries

Three key variables, namely, SHARE OF EMPLOYEE COMPENSATION OF GNDI, REMITTANCE GROWTH RATE, DESIRED RETURN ON CAPITAL and loan mobilization represented by sectoral lending (REAL ESTATE LOANS, PERSONAL LOANS, and PRIORITY SECTOR LOANS) are taken as exogeneous in the model.

- SHARE OF EMPLOYEE CONPENSATION OF GNDI is treated as exogenous. This variable is the key determinant for banks' deposit which contributes in the deposit accumulation and consequently loan creation. Yet, it is generated by the demographic composition of population in term of employment and pay scale. Modeling the employability of working age population and their remuneration is determined by demand and supply for work force in a larger macro-economic perspective which stands beyond the scope of the modeling effort. Thus, the average estimated value of this variable based on 16 years of national account data is used.
- REMITTANCE GROWTH RATE is also assumed as exogenous. Nepal's GDP is significantly dependent on the remittance inflow in the country from majority of migrants working in oil-exporting gulf countries (Cosic et al., 2017) (Ojha, 2019).

But REMITTANCE GROWTH RATE is dependent on foreign migration of Nepalese worker for employment which is a complex system in itself. This remittance is not only dependent on unemployment situation of Nepal but also the demand for workforce in different oil-exporting gulf countries which is again beyond the scope of this model. Hence, average annual growth rate of remittance from 2013 to 2018 is used for this modelling purpose.

- DESIRED RETURN OF CAPITAL is exogenous to the model. It effects the loan creation by banks. Since desired return is a management decision exact figures are often hard to estimate. Thus, for this model its value is calibrated in such a way that the lending volume of bank can follow that trend shown by real data.
- Sectoral lending as REAL ESTATE LOANS, PERSONAL LOANS and PRIORITY SECTOR LOANS is also exogenous to this model. Loans are mobilized based on the demand for such loan in the market, but the demand for loans for different sector requires a comprehensive understanding and modeling of functioning of these sector of economy with is an overwhelming complex non-linear system that incorporate a micro and macro level aggregation of sectoral economic outlook which is definitely beyond the current modeling scope. Therefore, only supply-side assumption, based on banks' lending fraction in different sector, is used through average sectoral lending calculated from banks data for the period of 2013 to 2018.

2.2.2 Assumption 2: calculation of GDP

GDP is the used as a macro-economic measure of total income of the country. There are there methods for calculation of nation's GDP: expenditure method, income method and production method (Mankiw, 2012). For this modeling purpose, a simplified version of expenditure method is used to calculate GDP. Expenditure method uses consumption, investment, government spending and net exports for the calculation of GDP (Mankiw, 2012) represented by following equation:

GDP= Consumption + Investment + Government Spending + Net exports

However, for modeling purpose we have only considered the contribution of Investment and Government spending on GPD by using the elasticity of these factors on

Nepal's GDP. The main objective of this model is focused on banking sector thus, such simplification is made for calculation of GDP. Moreover, GDP calculation, itself, is a dynamic process interrelated to different macro-economic factor which is beyond the scope of this model.

2.2.3 Assumption 3: calculation of elasticities

Elasticity represent the effect of change in one variable to another variable. This model uses elasticities for GOVT EXPENDITURE ON GDP GROWTH, PRIVATE CAPITAL EXPENDITURE ON GDP GROWTH, REAL GDP ON CONSUMPTION EXPENDITURE and GDP ON GNI. These elasticities are critical for calculation of different variable in the model. Hence, all these elasticities value were determined based on the average elasticity for each variable for the period of 16 years calculated using the national accounts data from 2002/2003 published by Central Bureau of Statistics Nepal.

2.2.4 Assumption 4: effect of interest on deposit and loan

Interest paid and charged by banks on deposit and loan, respectively, effects the volume of deposit collected and loan disbursed by banks. But this model does not account for such effect. The model scope is mainly targeted toward the impact of capital increment on CCD ratio. Thus, it is assumed that both deposit and loan are demand and supply dependent, respectively, and pricing/interest is assumed to have not impact. This is coherent with the assumption that demand side for loan and supply side of deposit are beyond the scope of this model.

2.3 Model Structure

This chapter describes the model structure. Several section in this chaper is organized in the following way. First, the overall mechanism of the model is presented. Then, each of the sectors are described in detail. The main idea of the section is to refrain from giving exact formulations of model equations. Only when such formulations are crucial to understanding the functioning of the model those details are explained. The documentation of the model, which includes all the equations, units for the variables and reference to the sources for estimated values and formulations, is described in Appendix A.

2.3.1 Overall model

As portrayed in Figure 3, the system dynamic model of the study consists of three sectors:

1. Banking sector,
2. GDP sector, and
3. Base rate calculation sector.

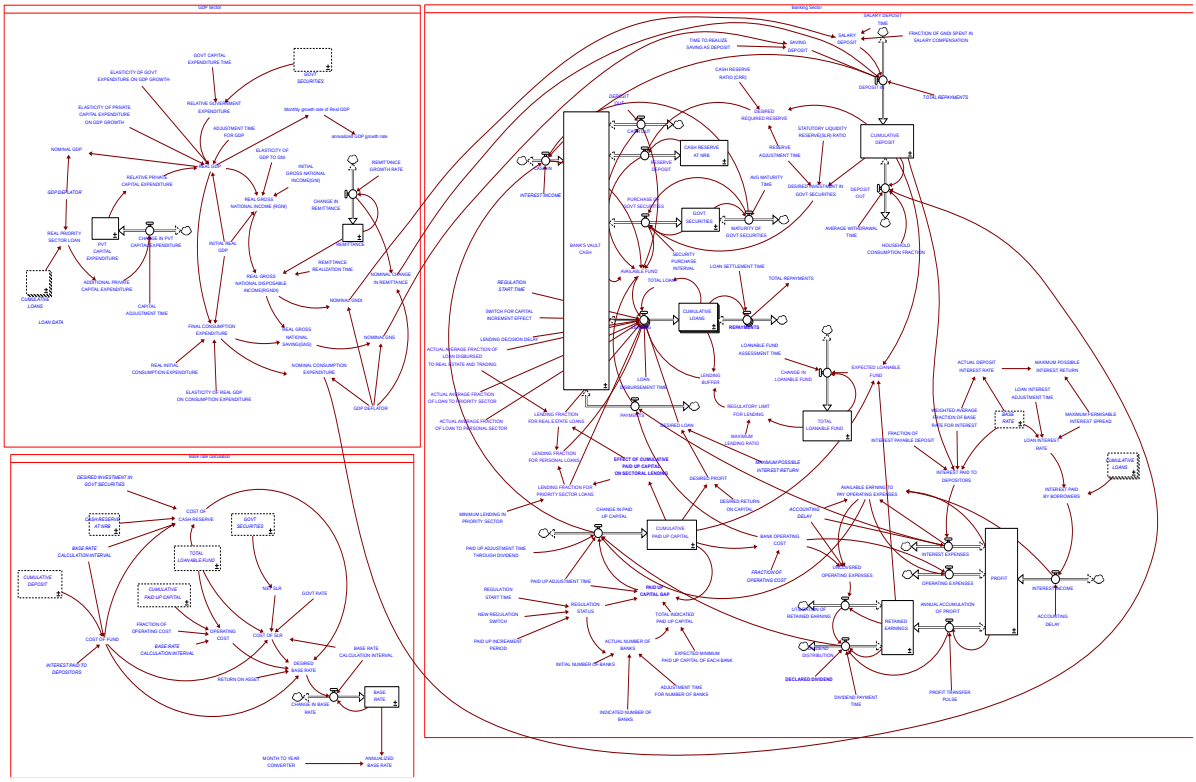


Figure 3. Model Overview

The overall mechanics of how the model works is detailed below. The variable and name of loops used in the model are capitalized wherever used in this document.

<u>Sector 1 'Banking Sector'</u> begins from the CUMULATIVE DEPOSIT stock, a liability side of bank's balance sheet, which determines the BANKS VAULT CASH after regulatory reduction maintained as CASH RESERVE AT NRB, GOVT SECURITIES and banking lending function captured by CUMMULATIVE LOANS. BANKS VAULT CASH, CASH RESERVE AT NRB, GOVT SECURITIES AND CUMMULATIVE LOANS form the assets side of bank's balance sheet. CUMULATIVE PAID-UP CAPITAL, another component of banks liability and key variable in the model, capture the equity contribution of shareholders. CUMULATIVE DEPOSIT and CUMULATIVE PAID-UP CAPITAL determines the EXPECTED

LOANABLE FUND which bank mobilizes within the given regulatory restriction to facilitate LENDING. Bank's CUMULATIVE DEPOSIT and CUMULATIVE LOANS generates income for the bank measured by PROFIT stock which transfers as RETAINED EARNING, considering accounting adjustment, to flows as CHANGE IN PAID UP CAPTIAL to cover the PAID UP CAPITAL GAP generated through increase in paid-up capital requirement represented by EXPECTED MINIMUM PAID UP CAPITAL OF EACH BANK. Banking sector provides input to GDP sector thorough CUMULATIVE LOAN IN PRORITY SECTOR, represented as one dimension in the arrayed stock initiating a feedback loop to the GDP sector. Furthermore, all key stock except BANKS VAULT CASH and CUMULATIVE LOAN generate inputs for Base rate sector establishing a feedback link to that sector. While, Banking sector takes input from both GDP and Base rate sector in the form of DEPOSIT IN and BASE RATE which closes the feedback loop.

Sector 2 'GDP Sector' intervenes the model dynamics through the CUMULATIVE LOANS and GOVT SECURITIES, inputs from Banking Sector. These two variables interplay under different elasticities to generate REAL GDP. REAL GDP is affected by different elasticities and provides NOMINAL GNDI, NOMINAL CONSUMPTION EXPENDITURE and NOMINAL GNS after it is adjusted for GDP DEFLATOR. NOMINAL GNDI gets its value from REAL GROSS NATIONAL DISPOSABLE INCOME (RGNDI) which includes REAL GROSS NATIONAL INCOME (RGNI) and REMITTANCE. REMITTANCE GROWTH RATE, exogenous input to the model, is an important contributor to REMITTANCE and then REAL GROSS NATIONAL DISPOSABLE INCOME. NOMINAL GNDI, NOMINAL CHANGE IN REMITTANCE and NOMINAL GNS feedbacks to the CUMULATIVE DEPOSIT through DEPOSIT IN flow and NOMINAL CONSUMPTION EXPENDITURE feedbacks to CUMULATIVE DEPOSIT through DEPOSIT OUT flow completing the feedback loop.

Sector 3 'Base Rate Sector' supplements the structure of overall Banking sector contributing only one key component, i.e., BASE RATE. This sector takes input from five out of seven stocks, representing the balance sheet component of bank, from Banking Sector. While feeding bank only one input to Banking Sector. Although, it is only one variable but is the key variable that drives the entire Income-statement component of Banking sector influencing PROFIT through INTEREST EXPENSES and INTEREST INCOME flows.

2.3.2 Sector 1: Banking Sector

Banking Sector captures the overall dynamics of the key model variable that are at core of this modeling project. It generates input to other sectors which accelerates/decelerates the different components in other sectors which then strengthens or weakens the feedback loop that ends back in the Banking sector. The structure of the sector is conceptualized form the work of Professor Kaoru Yamaguchi in the book Money and Macroeconomic Dynamics (Yamaguchi, 2019) and is exhibited in Figure 4.

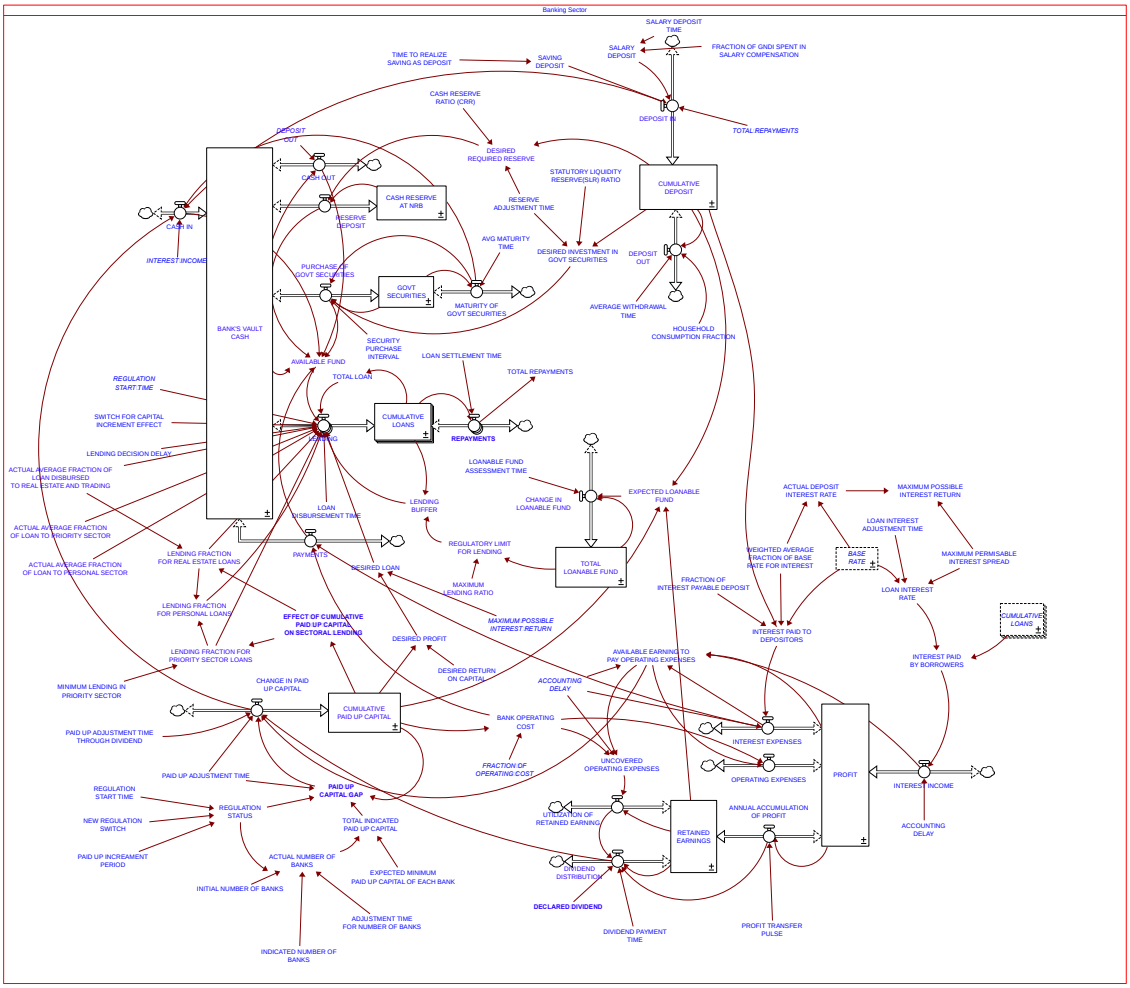


Figure 4. Banking Sector

Banking sector inhibits the key feedback components of this model as mentioned in 2.3.1 which determines the behavior of other sector and is controlled by the consequent inputs from other sectors. This sector is the modelling representation of a commercial bank's balance sheet and income statement.

Balance sheet components are grouped broadly into two categories assets side- BANKS VAULT CASH, CASH RESERVE AT NRB, GOVT SECURITIES and CUMULATIVE LOANS- and liability side- CUMULATIVE DEPOSIT, RETAINED EARNINGS and CUMULATIVE PAID UP CAPTIAL. Similarly, income statement component is represented by PROFIT stock. This sector mimics the functioning of a bank following regulatory norms, in modeling terms.

Commercial Banks collects deposits from fund suppliers and lend these funds to ultimate users such as individuals, private and government institutions. They also play a key role is transmission of monetary policy from central bank to the rest of the economy (Saunders & Cornett, 2015). As defined, this sector captures the function of commercial banks and how it operates in Nepal. The mechanism of this sector starts from the DEPOSIT IN flow that accumulates CUMULATIVE DEPOSIT. Based on the CUMULATIVE DEPOSIT accumulated by banks, banks set aside certain liquid money, cash, to maintain certain reserves like CASH RESERVE RATIO and STATUTORY LIQUIDITY RESERVE (SLR) RATIO (Bank and Financial Institution Regulation Department, 2015)in the form of CASH RESERVE AT NRB and GOVT SECURITES respectively. These reserves are adjusted periodically which the change is CUMULATIVE DEPOSIT through DEPOSIT IN, money deposited in the bank through saving and income, and DEPOSIT OUT, which represents withdrawal of money by depositor to meet their consumption expenditure.

DEPOSIT IN increases BANKS VAULT CASH while CASH OUT and PAYMENTS decreases BANKS VAULT CASH. AVAILABLE FUND accounts for the balance cash available with bank to create CUMULATIVE LOANS through LENDING. Although, banks can lend from their AVAILABLE FUND but such LENDING is constrained by TOTAL LOANABLE FUND. TOTAL LOANABLE FUND, formulated as first order information delay, adjusts to the level of EXPECTED LOANABLE FUND which represents the sum of CUMULATIVE DEPOSIT, CUMULATIVE PAID UP CAPITAL and RETAINED EARNINGS.

RETAINED EARNING come from ANNUAL ACCUMULATION OF PROFIT FLOW that resembles an accounting record keeping of profits controlled by PROFIT TRANSFER PULSE. PROFIT stock captures the balance of INTEREST INCOME after deducting INTEREST EXPENSES and OPERATING EXPENSES until it is transferred to RETAINED

EARNING. RETAINED EARNING is a major source of fund for banks to meet new regulatory capital requirement.

INITIAL MINIMUM PAID UP CAPITAL PER BANK and EXPECTED MINIMUM PAID UP CAPITAL OF EACH BANK represents two different level of paid up capital requirement before and after regulatory changes respectively. REGULATION STATUS controls the operation of model with/without incremental capital requirement. Change in REGULATION STATUS also effect the ACTUAL NUMBER OF BANKS, because after the formalization of regulation number of banks in Nepal decreases with is represented by INDICATED NUMBER OF BANKS. ACUTAL NUMBER OF BANK is formulated as third order material delay with ADJUSTMENT TIME FOR NUMBER OF BANKS. PAID UP CAPTIAL GAP accounts for the gap in paid up capital after regulatory implication and adjusts the CUMULATIVE PAID UP CAPITAL to TOTAL INDICATED PAID UP CAPTIAL.

With the changing CUMULATIVE PAID UP CAPITAL, banks engage in aggressive lending to maintain returns for their shareholder through larger loan in quick disbursement and high return sector like REAL ESTATE LOAN and PERSONAL LOAN while reducing their lending in PRIORITY SECTOR LOANS. PRIOTIY SECTOR LOAN is the input to GDP sector that accelerate/decelerates GDP growth which feedbacks to this Banking sector through DEPOSIT IN and DEPOSIT OUT.

2.3.3 Sector 2: GDP Sector

GDP sector generate the savings and income that are key driver which determines the banks' lending capacity. It attempts to model the process of conversion of private capital investment, CUMULATIVE LOANs to priority sector, and government capital expenditure, GOVT SECURITIES, into national output, REAL GDP. The structure of this sector is shown in Figure 5.

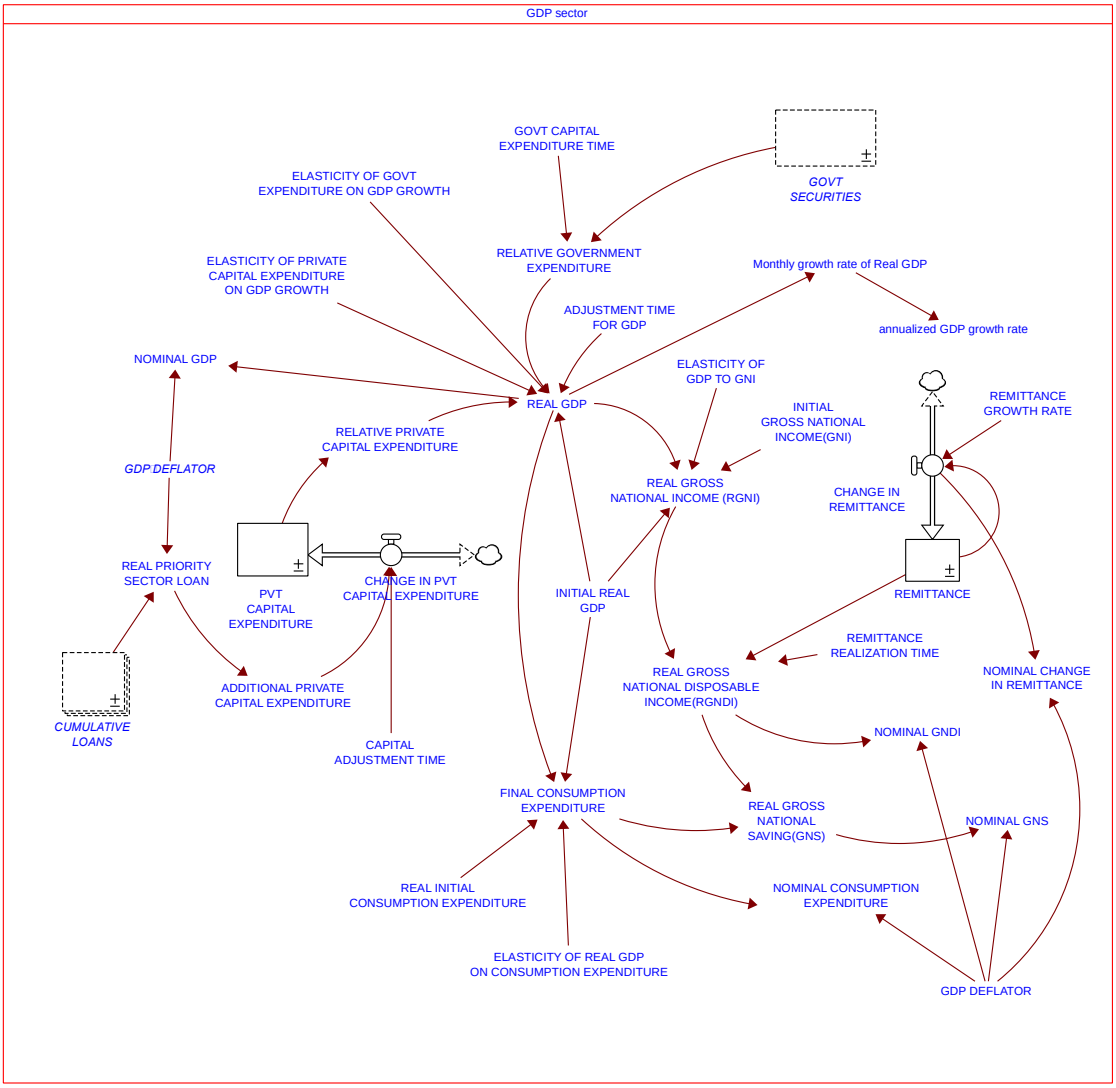


Figure 5. GDP Sector

The dynamics in this sector is created by the CUMULATIVE LOANS from banking sector which sets the goal for PVT CAPITAL EXPENDITURE, i.e., DESIRED PRIVATE CAPTIAL EXPENDITURE. Over the CAPTIAL ADJUSTMENT TIME, actual capital expenditure attains the desired goal. As capital expenditure from private and government sector changes, measured by RELATIVE PRIVATE CAPTIAL EXPENDITURE and RELATIVE GOVERNMENT EXPENDITURE respectively, REAL GDP also changes with certain degree of elasticity. Changes in capital expenditure reinforces REAL GDP, however, the goal for private capital expenditure drives the direction of GDP growth meaning higher goal increases GDP and vice-versa.

REAL GDP, again, directly reinforces REAL GROSS NATIONAL INCOME and FINAL CONSUMPTION EXPENDITURE with varying elasticities which then determines the REAL

GROSS NATIONAL SAVINGS. REAL GROSS NATIONAL DISPOSABLE INCOME (RGNDI) is also reinforced by REMITTANCE, which is exogenous to the model. For the modelling period, REMITTANCE is always increasing with reinforces RGNDI.

All REAL values are adjusted with GDP DEFLATOR to determines the NOMINAL values which are the key outputs from this sector to the Banking sector. NOMINAL GNDI and NOMINAL SAVING increases the CUMULATIVE DEPOSIT in Banking sector while NOMINAL CONSUMPTION EXPENDITURE decreases CUMULATIVE DEPOSIT. Outputs from this sector strengthens or weakens the LENDING through TOTAL LOANABLE FUNDS and AVAILABE FUND in banking sector resulting in shift in loop dominance determined by the action of banks to mobilize their lending in different sectors of economy- consumption (REAL ESTATE and PERSONAL LOANs) or investment (PRIORITY SECTOR).

2.3.4 Sector 3: Base Rate Sector

This sector mainly intervenes with the banking sector effecting- first, the profitability of banks and second, the available fund with the banks. The key objective of this sector is the determination of the BASE RATE. Base rate is the minimum rate of interest on which bank can collect deposits or lend credit (Bank and Financial Institution Regulation Department, 2012b). This rate is calculated using a specified equation dictated by Nepal Rastra Bank. BASE RATE has multiple feedback effect on other two sectors. The most substantial effect of BASE RATE is on CUMULATIVE LENDING through RETAINED EARNING and AVAILABE FUND. BASE RATE reinforces banks PAYMENTS resulting lower AVAILABLE FUND and lesser CUMULATIVE LOAN, lesser GDP and Lesser CUMULATIVE DEPOSIT collection. This again effect the key balance sheet components contributing to shift in loop dominance. The structure of this sector is shown in Figure 6.

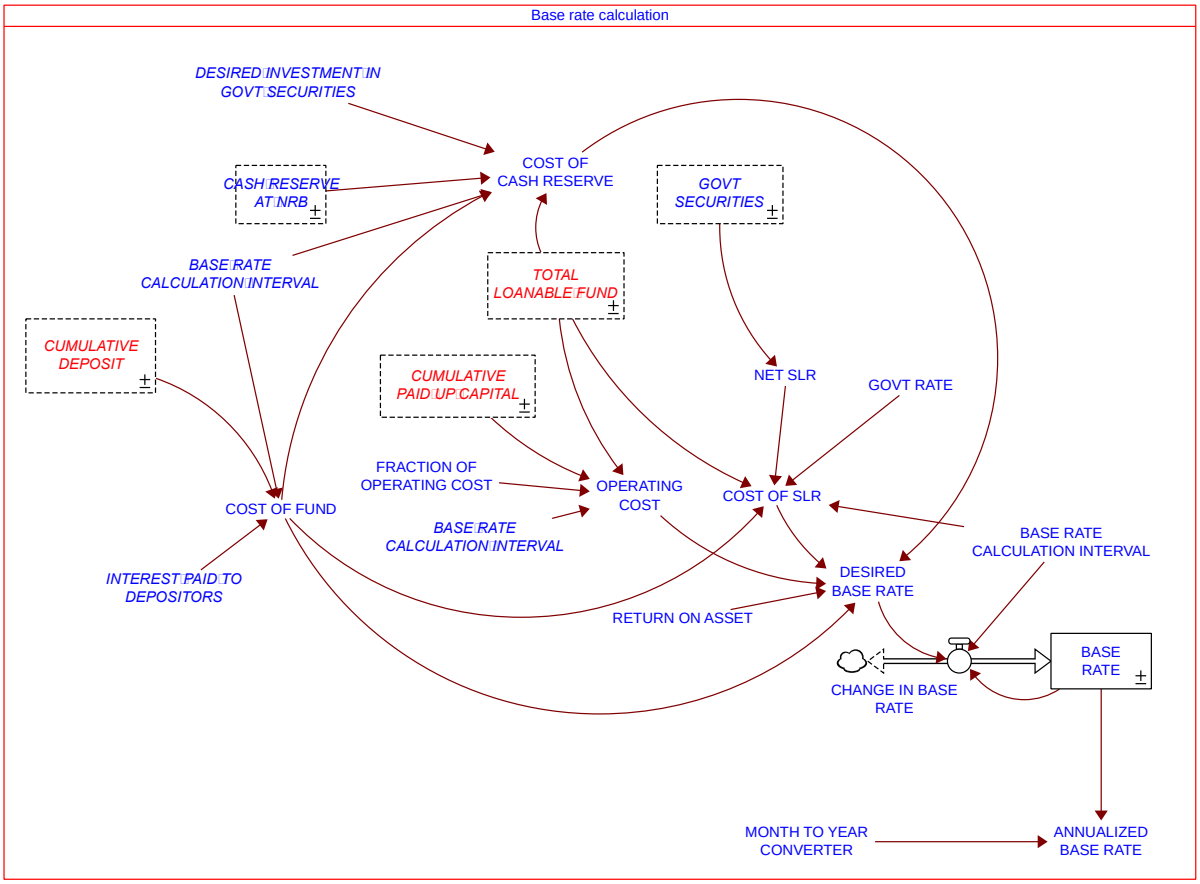


Figure 6. Base Rate Sector.

This sector mainly determines the BASE RATE using a classic information delay formulation where BASE RATE adjusts to its goal, DESIRED BASE RATE, after an adjustment time of BASE RATE CALCULATION INTERVAL. This interval of one month is specified by NRB(Bank and Financial Institution Regulation Department, 2012a). DESIRED BASE RATE is determined by in this model from COST OF FUND, COST OF SLR, OPERATING COST, COST OF CASH RESERVE and RETURN ON ASSET which is in line with the formulation dictated by NRB(Bank and Financial Institution Regulation Department, 2012a). All stocks, except BASE RATE, in this sector come as inputs from Banking Sector and BASE RATE is the output from this sector to Banking Sector completing a feedback. RETRUN ON ASSET, FRACTION OF OPERATING COST and GOVT RATE are exogenous to this sector which values are either taken as per NRB regulation or derived from actual average, detail of these exogenous inputs is documented with references in Appendix A.

2.4 Causal Loop Diagram

Figure 6 exhibit the feedback perspective of the system model for this project. Feedback perspective allows us to observe the endogeneity of the system and interconnection among thee variables. By endogeneity, we mean, here, the explanation of behavioral patterns under concern by the presence and interaction of feedback loops constituting and governing the system. The following section focuses on the description of feedback loops and how they produce the behavior that model exhibits.

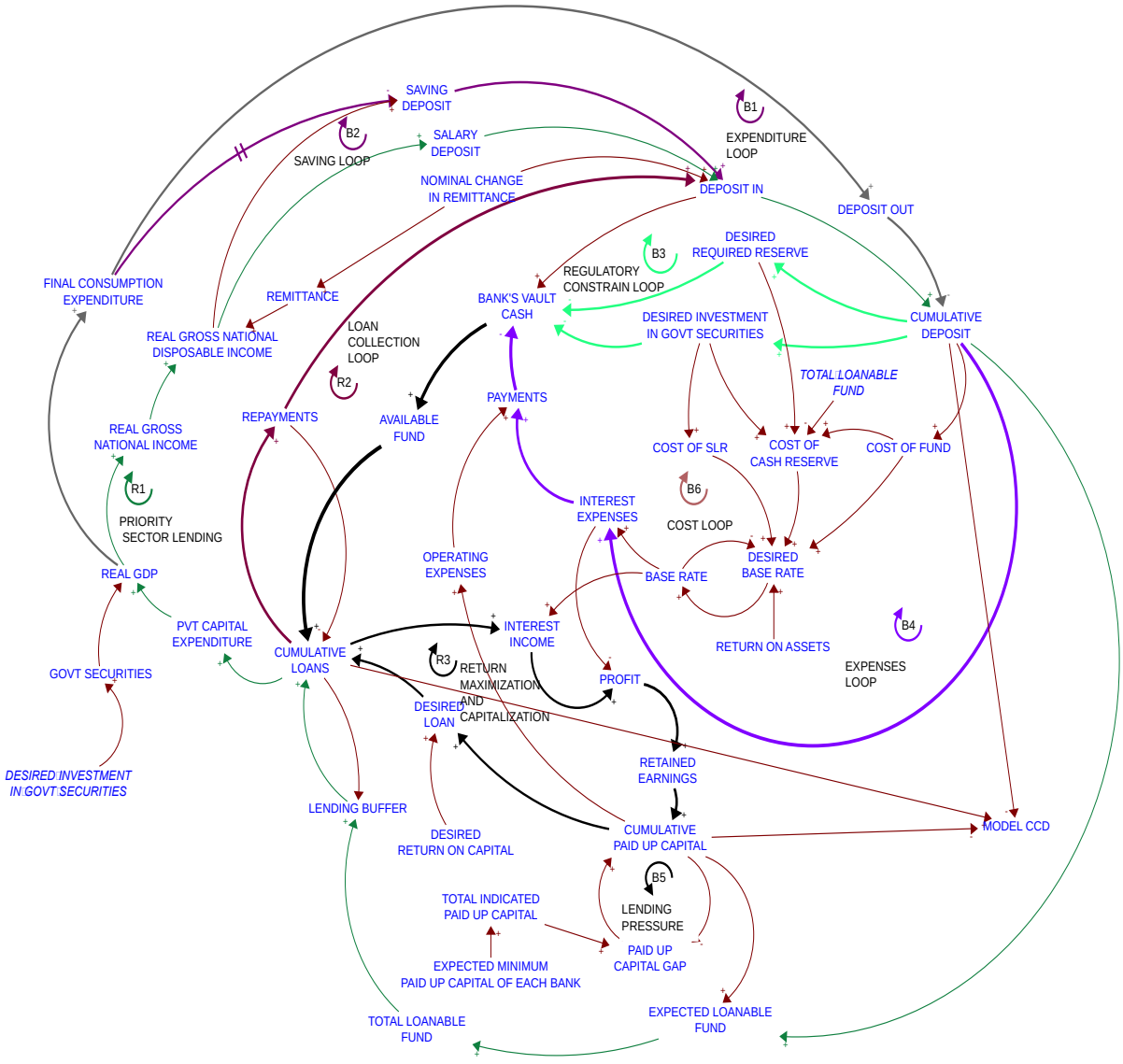


Figure 7. Causal Loop Diagram

R1-PRIRORITY SECTOR LENDING LOOP	The banking operation is mainly about collection of deposit and creation of loan. As CUMULATIVE DEPOSIT increases EXPECTED LOANABLE FUND increases which increases the TOTAL LOANABLE FUND. With the increase in TOTAL LOANABLE FUND, LENDING BUFFER available with the bank increases and bank can create more CUMULATIVE LOANS. Such loans are disbursed to several sector-personal and real estate, trading and priority sector. Priority sector loans, here, is used as PVT CAPITAL EXPENDITURE. Such PVT CAPITAL EXPENDITURE contribute in REAL GDP with also increase REAL GROSS NATIONAL INCOME. Increase in REAL GROSS NATIONAL INCOME along with REMITTANCE, exogenous to the model, collectively increase the REAL GROSS NATIONAL DISPOSABLE INCOME. More REAL GROSS NATIONAL DISPOSABLE INCOME increase SALARY DEPOSIT and SAVING DEPOSIT which increases DEPOSIT IN, an inflow to CUMULATIVE DEPOSIT and completes the first major reinforcing loop that drive one major component of the system. CUMULATIVE DEPOSIT is one of the three contributors to MODEL CCD. MODEL CCD is not a part of any feedback loop of the whole system but instead is driven by three components CUMULATIVE DEPOSIT, CUMULATIVE LOAN and CUMULATIVE PAID UP CAPITAL.
B1 EXPENDITURE LOOP	Unlike the R1 loop with strengthen the CUMULATIVE DEPOSIT, B1 EXPENDITURE LOOP weakens the CUMULATIVE DEPOSIT as it effects DEPOSIT OUT, outflow to CUMULATIVE DEPOSIT. This loop can be followed, again, through increase in CUMULATIVE DEPOSIT which increases CUMULATIVE LOANS through EXPECTED LOANBALE FUND, TOTAL LOANABLE FUND and LENDING BUFFER. With the increase in CUMULATIVE LOAN, similar to R1, REAL GDP increases. As expenditure side of the economy comes to play, increase in REAL GDP increases FINAL CONSUMPTION EXPENDITURE which increases withdrawal of deposit shown by DEPOSIT OUT finally depleting the CUMULATIVE DEPOSIT and completing this feedback.

R2 LOAN COLLECTION LOOP	Major source of DEPOSIT IN, in the model, is generated from REAL GDP. However, loan collection by bank also contribute to the overall of deposit of the bank. This reinforcing loop can, again, be trace back from CUMULATIVE DEPOSIT stock which increases CUMULATIVE LOANS. As CUMULATIVE LOAN increases REPAYMENTS from such loan also increase as these loans matures. With the increase in REPAYMENTS, CUMULATIVE DEPOSIT again increases.
B2 SAVING LOOP	Balancing loop B2 follows same path as that of the R1 and B1. However, it effects another key component in the GDP sector that feedback to the banking sector. The path of B2 is same starting from CUMULATIVE DEPOSIT till REAL GROSS NATIONAL DISPOSABLE INCOME as that of R1 loop. Similarly, B1 contributes to B2 till we derive FINAL CONSUMPTION EXPENDITURE. SAVING DEPOSIT gets inputs from FINAL CONSUPTION EXPENDITURE and REAL GROSS NATIONAL DISPOSABLE INCOME. As FINAL CONSUMTION EXPENDITURE increase SAVING DEPOSIT decreases and consequently DEPOSIT IN also decrease, slowing the accumulation of CUMUALTIVE DEPOSIT.
R3 RETRUN MAXIMIZATION AND CAPTIALIZATION LOOP	R3, like other loops, starts with increase in CUMULATIVE DEPOSIT which increases DESIRED REQUIRED RESERVE and DESIRE INVESTMENT IN GOVT SECURITIES which now decreases the BANK'S VAULT CASH. As BANK'S VAULT CASH decreases AVAILABLE FUND decreases CUMULATIVE LOAN decreases with consequently decreases INTEREST INCOME, PROFIT, RETAINED EARNING, CUMULATIVE PAID UP CAPITAL, DESIRED LOAN and CUMULATIVE LOAN. Banks, as profit-oriented business, attempts to increases its profit for decreases level of CUMULATIVE LOAN by investing in loans in non-priority high return credit which cuts the strength of R1 to strengthen R2. As R1 weakens DEPOSIT IN decreases where as R2 keeps DEPOSIT IN increasing but in a relatively smaller volume which also increases CUMULATIVE DEPOSIT but very slowly.
B3	B3 gets strength with the increase in CUMULATIVE DEPOSIT, which decreases REAL GROSS NATIONAL

REGULATORY CONSTRAIN LOOP	DISPOSABLE INCOME as R3 takes over resulting in decreases in DEPOSIT IN and consequently decreases accumulation of CUMULATIVE DEPOSIT.
B4 EXPENSES LOOP	Increase in CUMULATIVE DEPOSIT increases the INTEREST EXPENSES of banks resulting to decrease in BANK'S VAULT CASH and AVAILABLE FUND. As AVAILABLE FUND decreases R3 come to play and slows down the effect of R1 consequently decreasing CUMULATIVE DEPOSIT.
B5 LENDING PRESSURE	All the loops explained above mainly depicts the operating mechanism of banks. The key loop that generate the problematic behavior in this model is B5. Although B5 is a minor balancing loop but it interplays with other loops and strengthens R3 while weakens R1 resulting in the problematic behavior. This loop takes account of the regulatory restriction to increase paid up capital through higher EXPECTED MIMINUM PAID UP CAPTIAL OF EACH BANK which increases the TOTAL INDICATED PAIDUP CAPITAL. With the increase in TOTAL INDICATED PAID UP CAPITAL, PAID UP CAPITAL GAP increases and B5 kicks in. As banks try to reduce the gap, they increase the CUMULATIVE PAID UP CAPITAL, which increases DESIRED LOAN. To maintain DESIRED RETURN ON CAPITAL, lending shifts from priority sector to return maximizing sectors that reinforces R3 and slows down R1 resulting in slower CUMULATIVE DEPOSIT GROWTH and tighter MODEL CCD.
B6 COST LOOP	B6 loops gains its strength from R1. As CUMULATIVE DEPOSIT increases COST OF FUND, COST OF CASH RESERVE and COST OF SLR increases which also increase the DESIRED BASE RATE. BASE RATE, adjusts to DESIRED BASE RATE, increase INTEREST EXPENSES and decreases BANK'S VAULT CASH after which R3 gets its further strength and weakens R1 resulting to slow accumulation of CUMULATIVE DEPOSIT

Table 1. Explanation of feedback loops

Although above feedback perspective is critical for explaining the behavior through structure, such interaction of loops is characterized by several non-linearities where some of the loops are inactive or have varied strength through different time.

Thus, it is not counterintuitive to predict the behavior of system solely based on interaction of loops.

System dynamics methodology, thus, requires simulation technique to understand the effect of interaction of feedback loops. The following chapters explains the validity of the model structure that resulted in the feedback perspective explained in this section followed by behavior analysis generated by the model tracing back its causes to the several loops explained in this chapter. Hence, this section builds the basis for understanding the simulation runs and serves as focal point for explanation of the Chapter 4.

Chapter 3. Validation

3.1 Model Validation

Model validation constitutes a critical step in system dynamics methodology (Barlas, 2002). Such validation adds value to the modelling work and allows confirming the model to demonstrate real world system. This chapter is targeted to exhibit the confidence in the model described in the previous chapters. Based on the confidence assured, users of this model can then relate to the model and can confirm to the discussion forwarded based on model analysis with some credibility. Absence so credible simulations results, depicted by the valid system dynamics model, scenario analysis and policy suggestion would lack creditworthiness. Thus, this section of thesis is dedicated to performing several tests to unveil the validity of the model.

The following section, in this chapter, emphasizes on defining the validating test used in this thesis. As this thesis work was developed with several assumption which is suitable to Nepalese banking for a limited time scope, sensitivity testing is crucial in concluding the model behavior depending on specification of number of parameters.

System dynamics literature, as far as the researcher is aware of, does not provide any formal definition of the validation concept. Having said that, there is some degree of consensus that acknowledge validation as a process to determine the soundness of the model to accurately predict, examine and explain the causes of important problem under consideration and provide basis for designing policies that can improve the future behavior (Forrester & Senge, 1980). According to (Barlas, 2002), the primary reason for checking validity of any model is to build the soundness of the model with respect to its purpose. Thus, validation in this thesis work is driven by essence of this definition.

The model developed for this thesis work is validated using some of the test suggested in (Barlas, 2002). The focus of validation procedures is primarily on validating the structure of the model and then, to some extent, validating the behavior of the model within the assumption of the model. As suggested in (Barlas, 2002), this chapter includes explanation of following test used for validation the modeling work:

- Direct structure tests,

- Structure-oriented behavior tests, and
- Behavior test.

Importantly, this chapter exhibits only the validation testing with regard to the explanatory part of the model.

3.2 Direct Structure tests

Direct structure test assesses the validity of the model structure by direct comparison with knowledge about real system structure (Barlas, 2002). It comprises of empirical and theoretical test. Empirical test included structure verification, parameter confirmation whereas theoretical test includes dimensional consistency.

Structure-confirmation test

Structure confirmation test is conducted to ensure that the model does not contradict with real system. Structure confirmation test applied as an empirical one, means comparing the form of the equations of the model with relationships that exist in the real system (Forrester & Senge, 1980). For this modelling work, structure-confirmation test was performed simultaneously with the development of every structure within each sector. Moreover, the entire conceptual foundation of the model is grounded in extensive literature review. Also, whenever possible, the model was critically analyzed by the modeler based on work experience in a banking sector, as well as cross examination with two banking sector personnel currently working for two different commercial banks in Nepal. Specifically, the application of these test procedures can be characterized as a mix of empirical and theoretical approaches. On the one hand, modeler first utilized own experience (empirical approach), then based on the literature and similar previous modelling work (Yamaguchi, 2019) the model sector were constructed (theoretical approach) which was again confirmed with banking sector personnel, real world practitioners (empirical approach).

As an example, for structure confirmation test performed during the modelling of banking sector where CUMULATIVE DEPOSIT stock accumulates SAVING DEPOSIT, SALARY DEPOSIT, NOMINAL CHANGE IN REMITTANCE and REPAYMENTS as shown in Figure 8. However, driven by theoretical approach, initially the CUMULATIVE DEPOSIT

stock was model to accumulate all previously mention input expect REPAYMENTS. But, upon model discussion with practitioners it was identified that REPAYMENTS also account for good size of bank's deposit which was important to be captured.

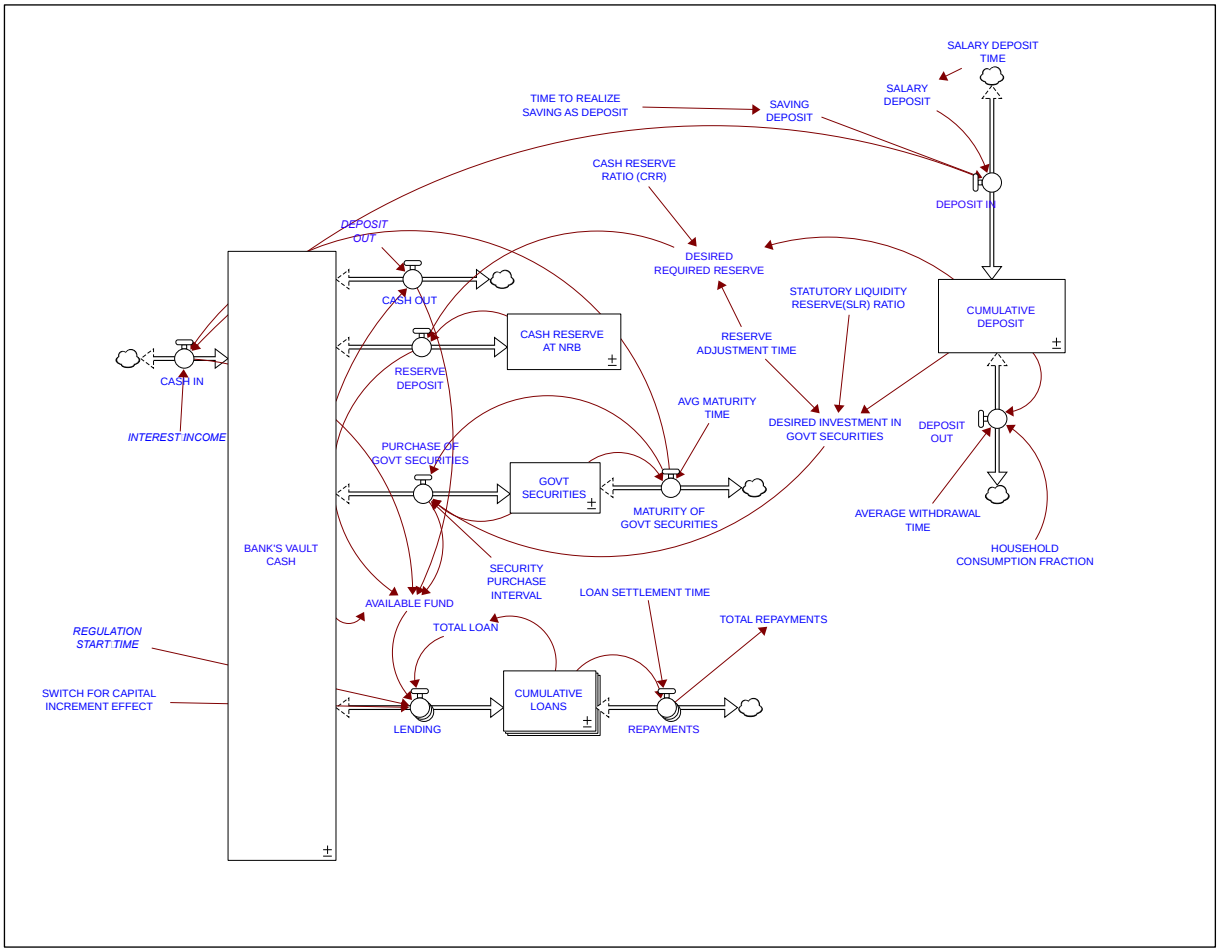


Figure 8. Section of Banking Sector

Parameter-confirmation test

Parameter confirmation test means evaluating the constant parameters against knowledge of the real system both conceptual and numerical (Forrester & Senge, 1980). Parameter confirmation test makes a check that all the parameters used in the model has real life values. Parameter-confirmation test was carried out through-out the modelling process in two way. At first, majority of the parameters used in this model has been based on literature review such as STATUTORY LIQUIDITY RATIO, GDP DEFLATOR, COST OF SLR etc. Secondly, some key parameters namely LENDING BUFFER, PROFIT TRANSFER PULSE, ACCOUNTING DELAY etc. were identified based real practice

to identify such undocumented internal banking terminology incorporating some relevant the modelling practices used of system dynamics modelling. All the parameters are supported by the relevant sources in documentation to the model (Appendix A).

Direct extreme-condition test

This test helps to evaluate the validity of model equation under extreme condition by assessing the reliability of resulting value compared against the knowledge/anticipation of probable result under similar condition in real conditions (Barlas, 2002). CUMULATIVE PAID UP CAPITAL is an important stock in this model. We demonstration the use of this test performed in this model using, here, one example for the flow formulation of the said stock in Banking sector. The flow is formulated by the following equation:

CHANGE_IN_PAID_UP_CAPITAL=MAX(0,DELAY3(PAID_UP_CAPITAL_GAP,PAID_UP_ADJUSTMENT_TIME)+DELAY3(DIVIDEND_DISTRIBUTION,PAID_UP_ADJUSTMENT_TIME_THROUGH_DIVIDEND))

In the real-life practice, banks are restricted to reduce their paid-up capital once it is created unless the banks go for liquidation. Considering our model time-horizon, there were no liquidation of bank. Thus, MAX function is used to regulate the flow of CUMULATIVE PAID UP CAPITAL in such a way that the flow does not take a negative value and depletes the existing paid up capital even when the profitability is negative.

Dimensional consistency test

Dimensional consistency checks the consistency of units used with model equations. Dimensional consistency test entails checking the right-hand side and left-hand side of each equation for dimensional consistency(Barlas, 2002).

Stella, system dynamics software used for this project, was used to automatically perform the dimensional consistency test. The software using checks unit error and notifies on screen at lower right-hand corner. Figure 9 has not error notification on the designation lower right-hand corner which prove that all the units in the model appear to be consistent.

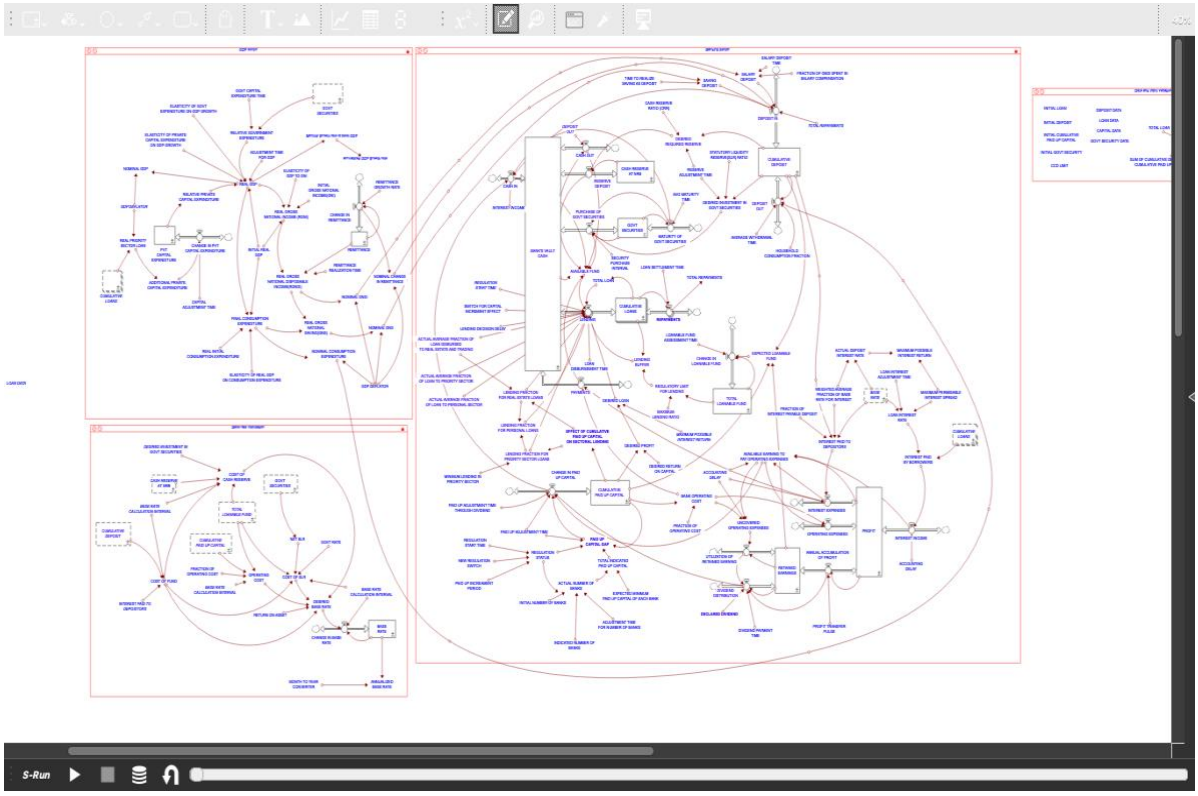


Figure 9. Unit Consistency Test

While the software confirmed that there were no unit errors in the model, it should be mention that such unit consistency must also be accompanied by parameter-consistency test. Some parameter used in this model may look like dummy variable but as mention in parameter consistency section those parameters were incorporated to meet the modelling requirement through insights from practitioners backed by empirical uses of variables in system dynamics modelling.

3.2 Structure-oriented behavior tests

Second test conducted to test the validity is structure-oriented behavior test. Structure-oriented behavior test assess the validity of the structure indirectly by applying certain behavior test on the model- generated behavior pattern (Forrester & Senge, 1980). As suggested in (Barlas, 2002), these tests involve simulation, applicable to entire model as well as to isolated sub-model, and are considered to facilitate the modeler uncover potential structural flaws.

Extreme-condition test

Extreme-condition test checks the robustness of the model. Robustness under extreme conditions means that model should behave in realistic manner, no matter how extreme the input or policies imposed on it be (Sterman, 2000) . Extreme condition test involves assigning extreme values to selected parameters and comparing observed (or anticipated) behavior of the real system under the same extreme condition (Barlas, 2002).

Although extreme-condition test was performed for several parameter in the model, MAXIMUM LENDING RATIO, one of the parameters, is used, here, to demonstrate the robustness of the model for extreme condition. MAXIMUM LENDING RATIO is exogenous in the model and plays important role in determining the potential for growth in CUMULATIVE LOAN: smaller ratio would mean decrease in LENDING and CUMULATIVE LOAN.

Ideally for extreme condition test we would change the parameter both upwards and downwards. However, as the model is already set at regulatory maximum, a downwards extreme condition test is performed for validation. Figure 10 shows the model response to the extreme condition. As the figure portrays, the TOTAL LENDING, sum of arrayed LENDING flow, indeed remains at zero value when the MAXIMUM LENDING RATIO is set at zero suggesting that banks could not lend even if they had AVAILABLE FUND. TOTAL LENDING of zero gradually depletes the TOTAL LOAN, sum of arrayed CUMULATIVE LOANS.

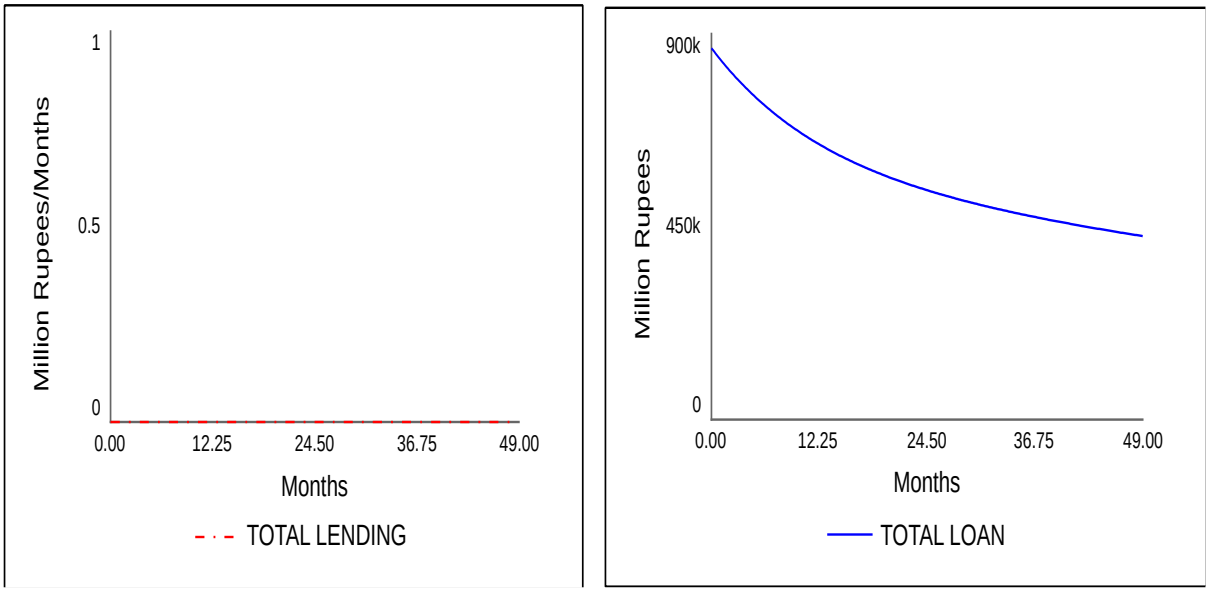


Figure 10. Extreme condition test: MAXIMUM LENDING RATIO

Behaviour sensitivity test

Behavior sensitivity test consist of determining the parameters to which the model is highly sensitive and asking if the real system would exhibit similar high sensitivity to the corresponding parameter (Barlas, 2002).

In the overall model, discussed in Chapter 2, sensitivity analysis identified four key sensitive parameters:

- FRACTION OF GNDI SPENT IN SALARY COMPENSATION and HOUSEHOLD CONSUMPTION FRACTION, are exogenous variable that increases and decreases CUMULATIVE DEPOST respectively.
- DESIRED RETURN ON CAPITAL, is another exogenous variable that governs the LENDING flow.
- EFFECT OF CUMULATIVE PAID UP CAPTIAL ON SECTORAL LENDING, is a graphical function use to depict banks sectoral lending decision based on the regulatory increases in paid up capital.

All other parameters were also tested for sensitivity but those parameter in the system exhibited relatively higher degree of confidence for the chosen level of aggregation. For the identified sensitive parameters, brief explanation in covered in the following sections.

FRACTION OF GNDI SPENT IN SALARY COMPENSATION

Using Stella, sensitivity analysis for this variable was performed by changing the value for this parameter. Figure 11 demonstrate the response of incremental fraction on the MODEL CCD: run 1 is the base run at the identified fractional value of 0.32, run 2-10 shows progress from 0.32 to 1. Value below 0.32 was not tested because the historical trend for 16 years of real data suggested an average fraction of 0.32.

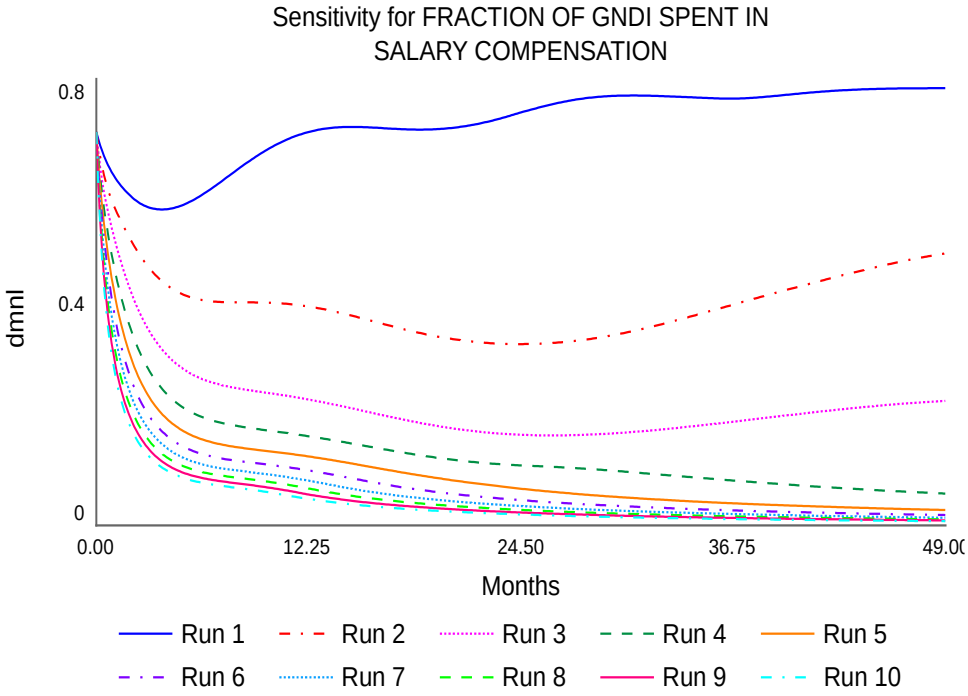


Figure 11. Sensitivity test: FRACTION OF GNDI SPENT IN SALARY COMPENSATION

The results indicate an expected sensitivity of this parameter. It is important to mention why it was expected. Higher fraction of salary contribution would result in higher deposit accumulation and consequently higher loanable funds resulting in lower credit to core capital and deposit ratio.

While FRACTION OF GNDI SPENT IN SALARY COMPENSATION effects positively in deposit accumulation, aggressive HOUSEHOLD CONSUMPTION FRACTION depletes deposit resulting in higher CCD ratio. Runs in Figure 12 show the sensitivity of the parameter. Run 10 shows simulation result for HOUSEHOLD CONSUMPTION FRACTION at 0.8, derived from the same data set used for entire model parameter, and Run 9-1 show a decreasing value for the parameter going to the minimum of zero.

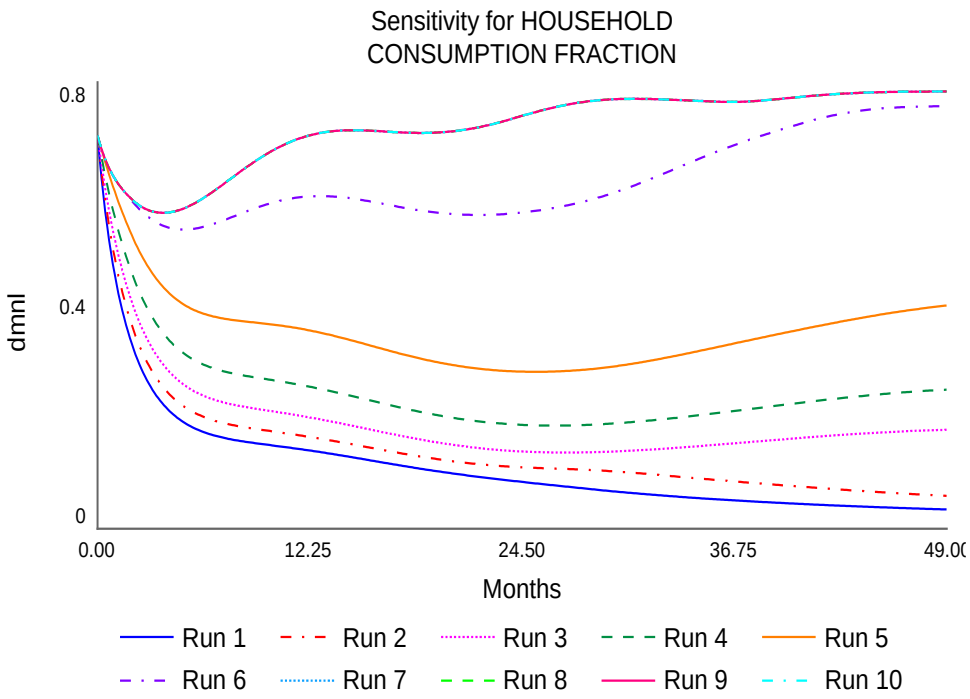


Figure 12. Sensitivity test: HOUSEHOLD CONSUMPTION FRACTION

DESRIED RETURN ON CAPITAL

This parameter is exogenous to the model and captures the desired profitability expected by banks' management for their investors. Figure 13 show several sensitivities run for the parameter ranging from 0.0035 to 0.014. During model calibration a value 0.07 was identified as the optimal value that tends to provide adequate match to the reference mode, thus sensitivity was performed the said range.

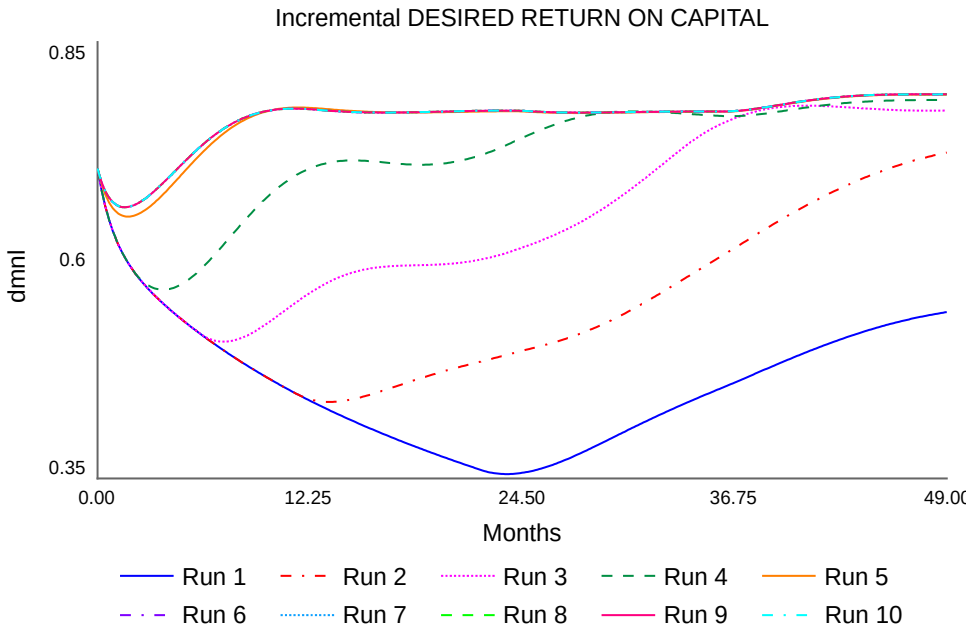


Figure 13.Sensitivity test: DESIRED RETURN ON CAPTIAL

SHAPE OF EFFECT OF CUMULATIVE PAID UP (RELATIVE) CAPITAL ON SECTORAL LENDING

This is the only graphical function used in the entire model. This effect exhibits the decision rule of bank's management in their lending behavior in several sectors. The value the y-axis of the graphical function has been normalized based on the actual data meaning, lower limit was set to represent the minimum regulatory requirement while upper limit was identified based on the highest value of sector lending reported after normalization. The result of sensitivity test performed for the shape of the graphical function with changing the value in shown in Figure 14. Run 1, 2 and 3 represent S-shaped growth, linear and concave shapes respectively. As observed in the runs, it can be concluded that some level of sensitivity exists for the concave shape while other shapes were not sensitive.

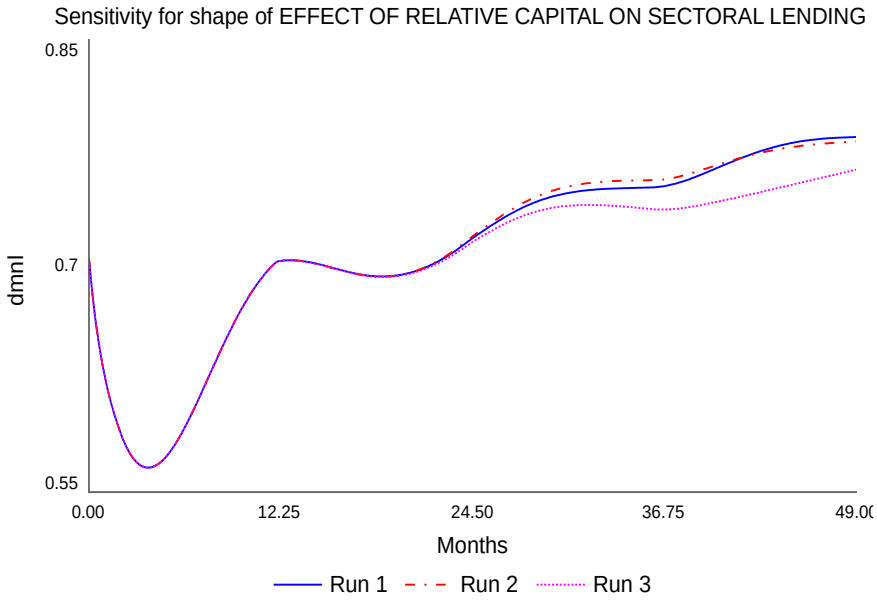


Figure 14.Sensitivity test: Shape of EFFECT OF CUMULATIVE PAID UP CAPITAL ON SECTORAL LENDING

Partial model testing

Partial model testing was effectively performed during the development of each sector. For partial model testing, each sector was first constructed and reviewed with the practitioner then using the exogenous input connected to each sector were feed-in and simulation was carried out. Individual behavior of key stock in each sector were cross matched with their reference mode data. The model generated behavior followed the trend shown by the data for different sector separately. Thus, partial model testing confirmed the functioning of sector separately as intended.

3.4 Behavior pattern test

These procedures basically assess whether the behavior pattern generated by the model structure corresponds to the real system under observation. For the behavior pattern test, initialization of stock and value assumption for parameters is critical. All the stock and parameter value used were identified for the data and necessary calculation which can be found in model documentation (Appendix A). As exogenous parameters are numerical value calculated based on data sensitivity analysis is crucial for the model, discussed previously.

For behavior pattern test, run comparison between three variables is shown in Figure 15. These variables were chosen because they, altogether, represent the problematic behavior the model attempts to identify as stated in research objective.

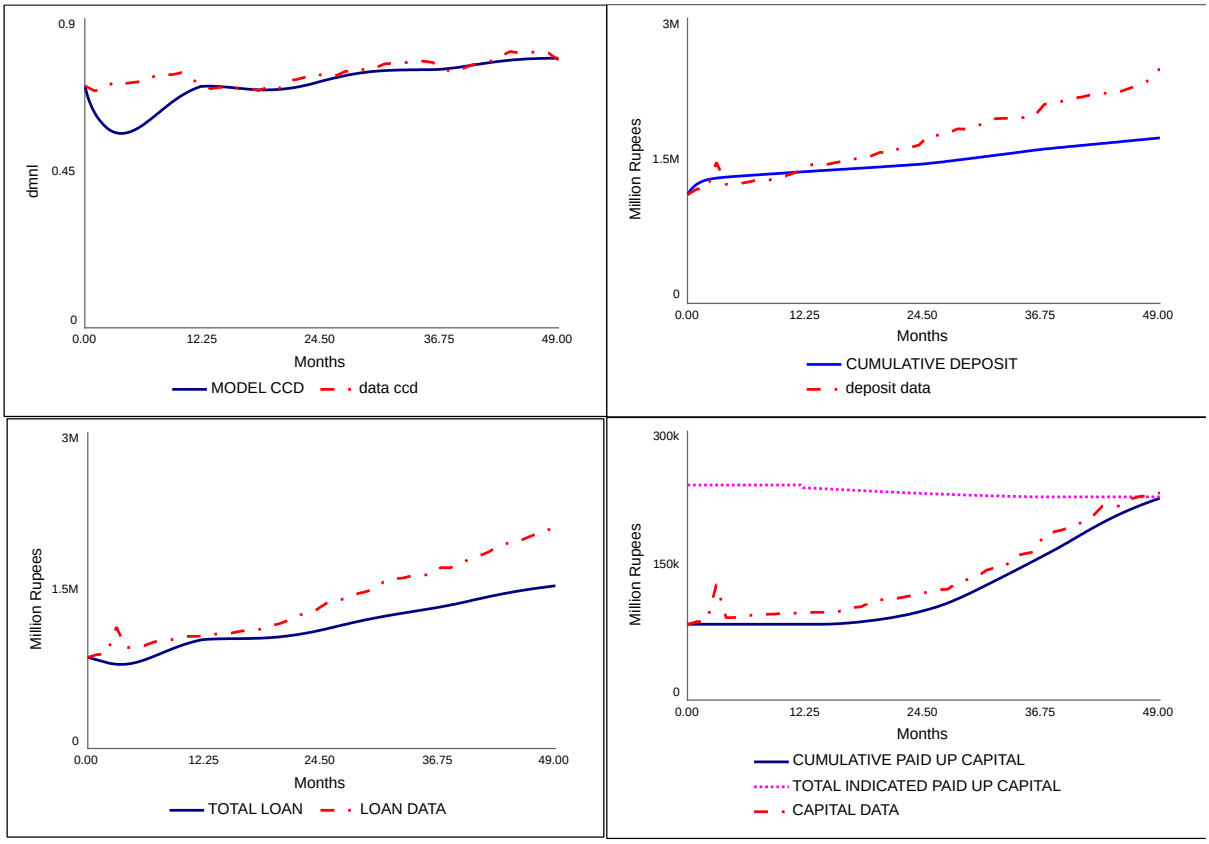


Figure 15.Behavior pattern test

Dashed red lines in Figure 15 represent behavior of actual data, whereas, dotted and dashed line represent model generated behavior. Overall, the behavior generated by the model tends to replicate the trend of deposit and loan data however, the behavior undershoots actual data at the later time horizon. The main reason for that

can be assigned to one of the assumptions made for the model, i.e. Assumption 4. Moreover, a mismatch of behavior in MODEL CCD and DATA CCD can be observed in the initial simulation time. This is because we have not captured the GDP variation two year prior to the model start time as the effect of GDP on CUMULATIVE DEPOSIT is delayed in our model resulting in undershooting of TOTAL LOAN and marginal overshoot of CUMULATIVE DEPOSIT. Importantly, the delays assumed for the model was calibrated in a way to represent the behavior patter after the regulatory requirement of paid up capital. Such delays take account for easier government regulation for lending and quicker capital expenditure by government immediately after Nepal suffered from earthquake and unofficial blockade imposed by India which in general would be relatively slower.

Summarizing this chapter, the validation test carried out for this model relies mainly on structure and structure-oriented behavior tests. The structure validation was backed by literature review and practitioners' insights whereas, behavior validation was mainly supported by the data generated reference mode. Model sensitivity analysis disclosed some sensitive parameter that exhibit uncertainty. Notably, considering the model purpose and scope, this sensitivity is tolerable.

Chapter 4. Model Behavior & Scenario Analysis

Previous chapters explained the structural components, feedback perspective and validation of the model structure. The validation test carried out in Chapter 3 assures confidence in the model structure. Thus, this chapter first presents behavior generated by the model structure followed by possible changes in the behavior through the introduction of some scenario.

4.1 Model behavior

This section of the chapter presents the behavior of model in two segments: base run and ideal run. Base run depicts the behavior generated by the model under assumption that banks were operating as they would without the necessity to increase the capital requirement. Modeler felt it necessary to present this behavior to draw attention to the fact why the problem under consideration emerge as increase capital is generally assumed to be good for both the business and the economy.

4.1.1 Base Run

Base run in the model simulation can be interpreted as 'as-it-was' condition, meaning no regulatory intervention to increase the minimum paid up capital requirement. These refers to the simulation of model with initial value. The initial condition definitely describes the banking operation which existed till 2014 and assumes same was continued. The key variable we look at for baseline simulation runs are CUMULATIVE DEPOSIT, TOTAL LOAN, and CUMULATIVE PAID UP CAPITAL. MODEL CCD is the resulting variable derived from the interaction of these three variables and is important for the assessing the liquidity position of the banks which also represent the lending potential of banks.

Both CUMULATIVE DEPOSIT and TOTAL LOAN (representing sum of arrayed CUMULATIVE LOAN stock) are shown in Figure 16.

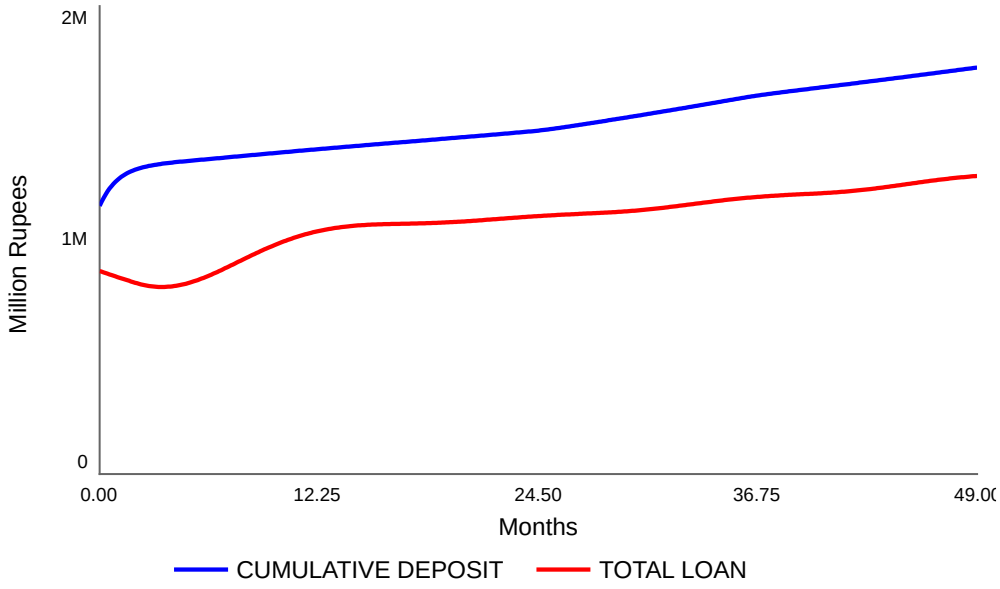


Figure 16.Base Run: CUMULATIVE DEPOSIT and TOTAL LOAN.

As seen in the above figure, both the CUMULATIVE DEPOSIT and TOTAL LOAN is increasing. Interestingly, we have not introduced any increment in paid up capital. Such increment can be traced back to the source of CUMULATIVE DEPOSIT and TOTAL LOAN. A part of the reinforcing loop R1 established increase in CUMULATIVE LOAN as the source of increase in TOTAL LOAN.

Indeed, TOTAL LOAN increases as a result of increase in CUMULATIVE DEPOSIT. Now, we trace back the reason for increase in CUMULATIVE DEPOSIT. DEPOSIT IN is the only inflow to CUMULATIVE DEPOSIT. DEPOSIT IN sums up money coming into the bank under different head. Figure 17 portrays the behavior of DEPOSIT IN and different variables that are input to DEPOSIT IN.

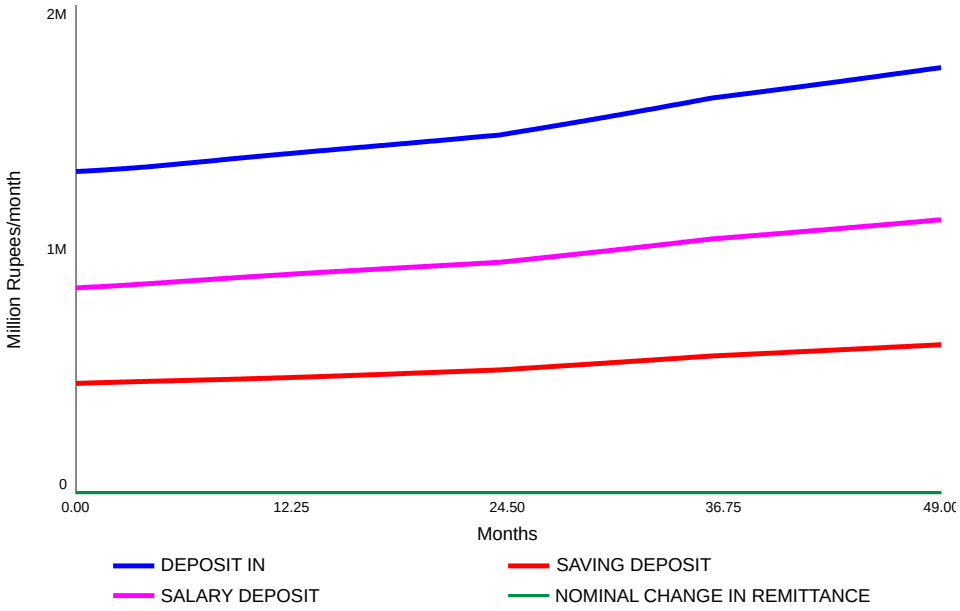


Figure 17.Base Run: Inputs to CUMULATIVE DEPOSIT

All the inputs to CUMULATIVE DEPOSIT are increasing collectively shown by DEPOSIT IN in Figure 17. To understand deeper the dynamics behind the increase in such deposit sources and how become the part of a feedback look we now look into GDP sector. Figure 18 summarizes key variable from GDP sector.

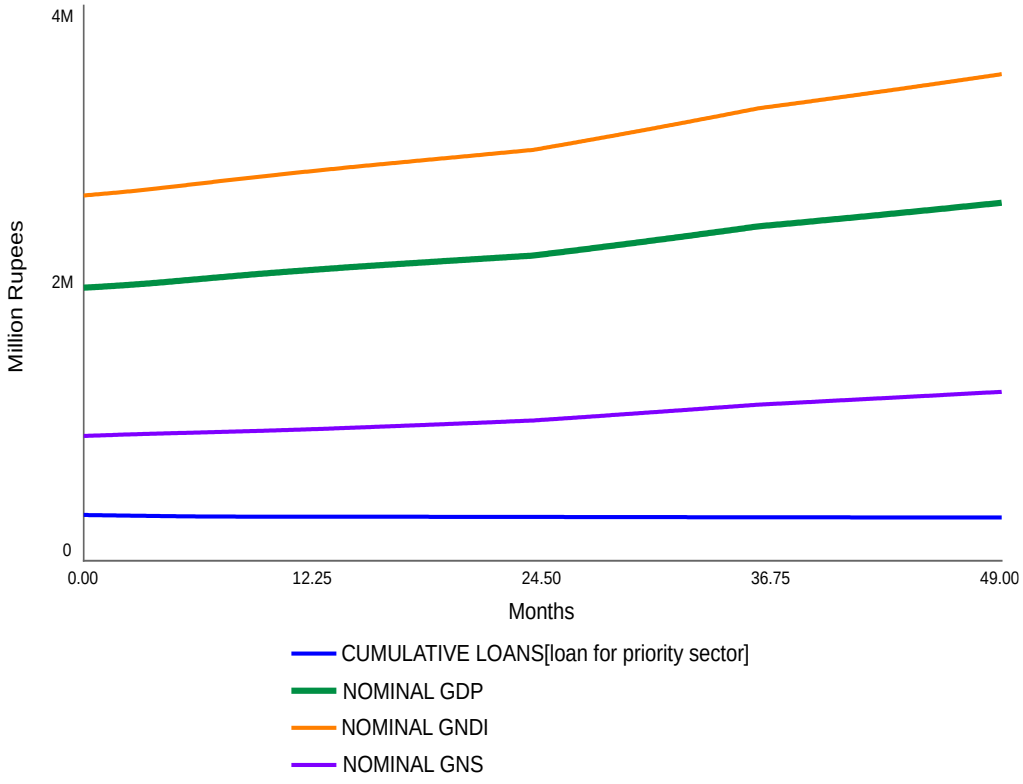
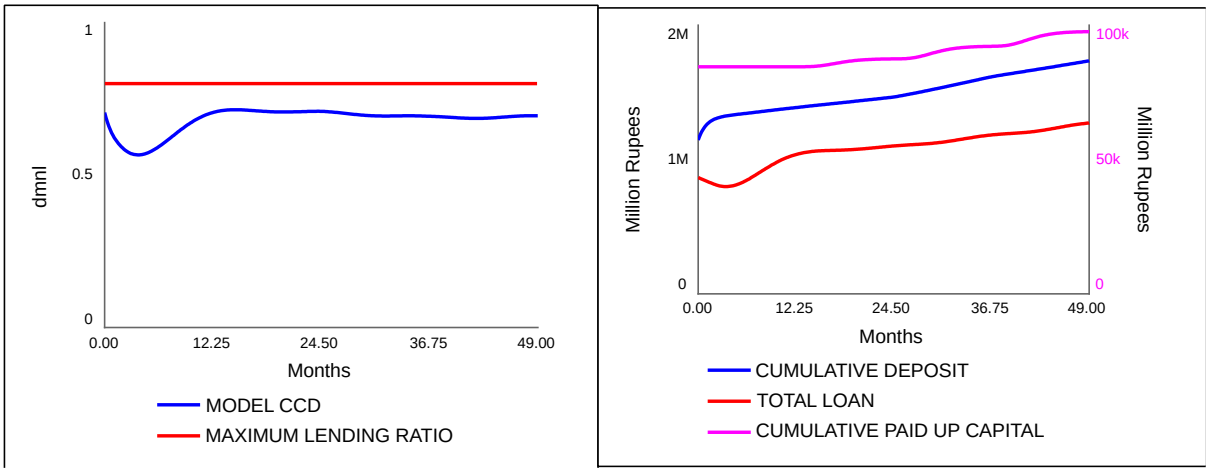


Figure 18.Base Run: Input from GDP Sector

In the beginning of this section, we showed how TOTAL LOAN originates from CUMULATIVE DEPOSIT. CUMULATIVE LOANS (loan for priority sector) is one of the components of TOTAL LOAN. As it can be observed from the above graph although there is a marginal decrease in CUMULATIVE LOAN due to the elasticity of PVT CAPITAL EXPENDITURE, represented by loans to priority sector, REAL GDP increases. NOMINAL GDP is the GDP DEFLATOR adjustment of REAL GDP has been used here to maintain homogeneity of variable represented in one graph. Nevertheless, as GDP DEFLATOR is a constant adjustment based on price conversion, we can see how R1 loop is active here to reinforce CUMULATIVE DEPOSIT resulting in gradual increase in TOTAL LOAN as well.

After tracing back the loop, we now see the behavior of the problem variable under baseline simulation run shown in Figure 19.



(a) (b)

Figure 19.Base Run: MODEL CCD and MAXIMUM LENDING RATIO

MODEL CCD shows an initial fall for 12 months and stabilizes after that. Such initial fall is triggered by the initialization. This is because we have not captured the GDP variation two year prior to the model start time as the effect of GDP on CUMULATIVE DEPOSIT is delayed in our model resulting in undershooting of TOTAL LOAN and marginal overshoot of CUMULATIVE DEPOSIT. Simultaneous, R3 is active but very negligibly resulting in marginal increase in CUMULATIVE PAID UP CAPITAL represented in right Y-axis of Figure 19(b). Importantly, the delays assumed for the model was calibrated in a way to represent the behavior patter after the regulatory requirement of paid up capital. Such delays take account for easier government regulation for lending and quicker

capital expenditure by government immediately after Nepal suffered from earthquake and unofficial blockade imposed by India which in general would be relatively slower.

Based on above discussion, as it can be seen from the base run, the increase CUMULATIVE DEPOSIT strengthens the R1 loop resulting increased lending. However, MODEL CCD remained relatively stable after an initial decline.

4.1.2 Ideal Run

Ideal run is to be considered as the actual representation of the existing banking situation after the regulatory intervention through enhancement in minimum paid up capital requirement. With this intervention three major loop, dormant during Base run, are activated resulting in interesting dynamics that resulted in the problematic behavior.

As shown in the base run, we start with the same key variables and trace back the effect of now active loop- mainly, B3 (REGULATORY CONSTRAIN LOOP), B4 (EXPENSES LOOP) and B5 (LENDING PRESSURE LOOP)- on previously dominant loop R1 (PRIORITY SECTOR LEDNING LOOP). Figure 20 show the behavior of key variables under examination.

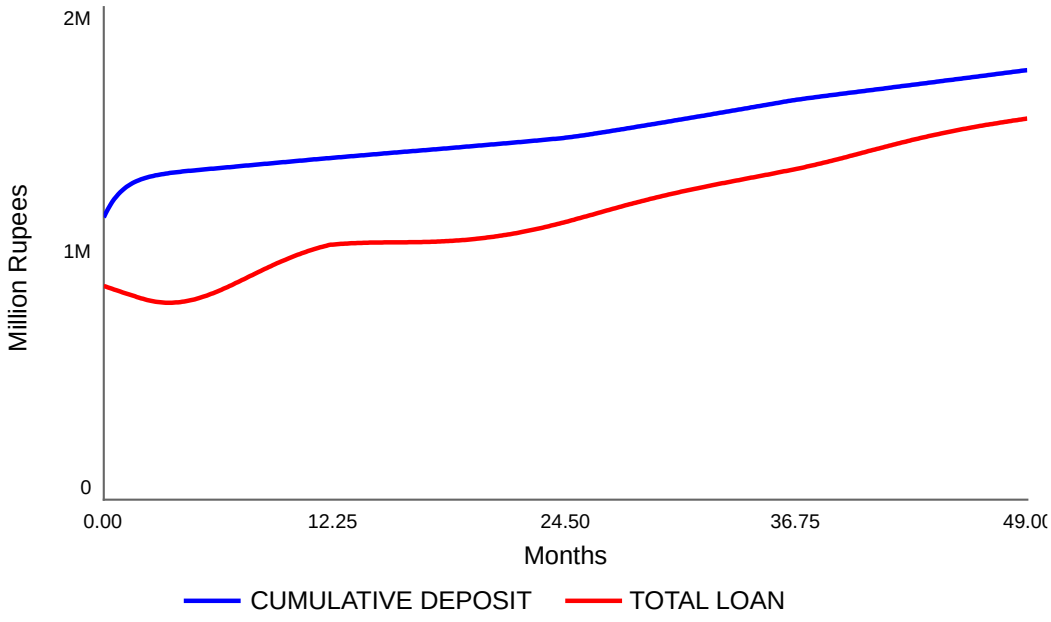
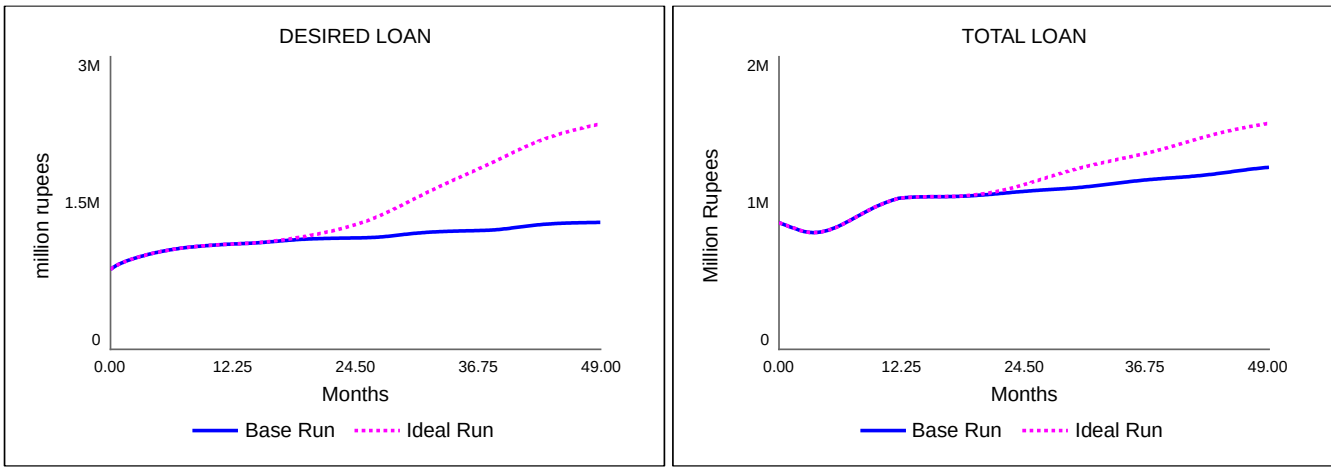


Figure 20.Ideal Run: CUMULATIVE DEPOSIT and TOTAL LOAN

As seen in the above figure, similar to Base run both the CUMULATIVE DEPOSIT and TOTAL LOAN is increasing. Interestingly, we have introduced increment in paid up capital the increase in TOTAL LOAN is relatively steeper after 24 months of simulation

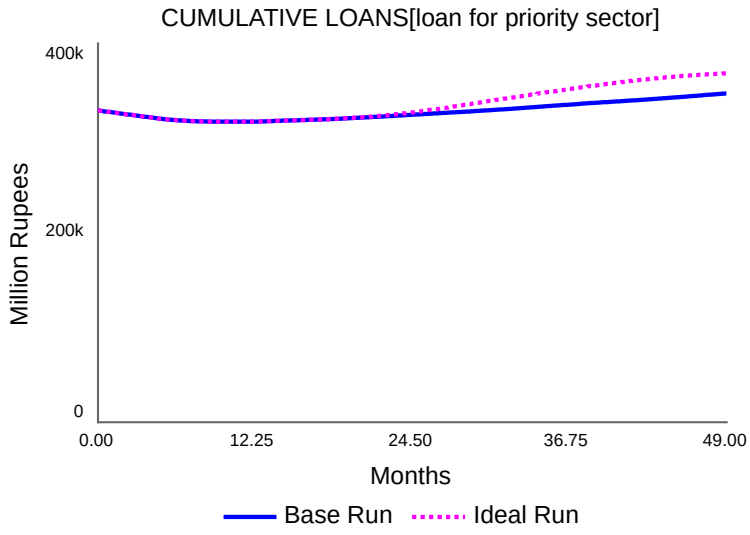
run. As in base run, increment in CUMULATIVE DEPOSIT can be traced back to its source and increment in TOTAL LOAN now should also be traced back with the help of CUMULATIVE PAID UP CAPITAL, including pre-existing source from Base run. As previously mentioned, a part of the reinforcing loop R1 established increase in CUMULATIVE LOAN as the source of increase in TOTAL LOAN. While, after regulatory intervention increase in EXPECTED MINIUMUM PAID UP CAPITAL OF EACH BANK increases TOTAL INDICATED PAID UP CAPITAL widening the PAID UP CAPITAL GAP. This increase in PAID UP CAPTIAL GAP activates B5 resulting in higher DESIRED LOAN for constant DESIRED RETURN ON CAPITAL as shown in Figure 21.



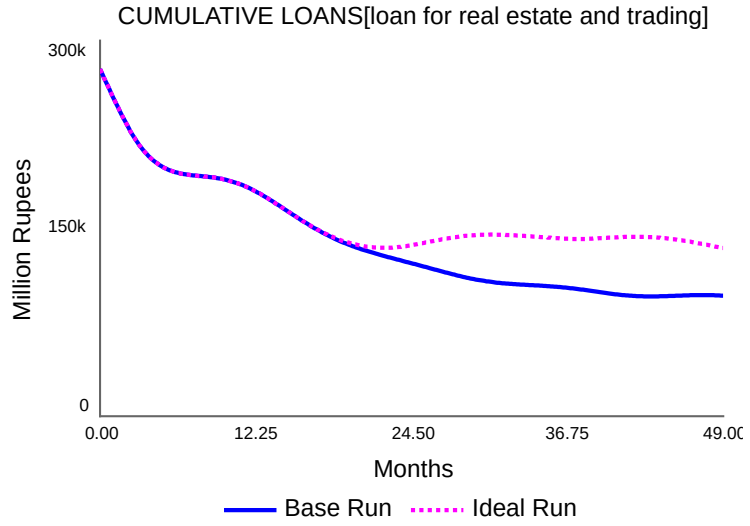
(a) (b)

Figure 21.Ideal Run: DESIRED LOAN

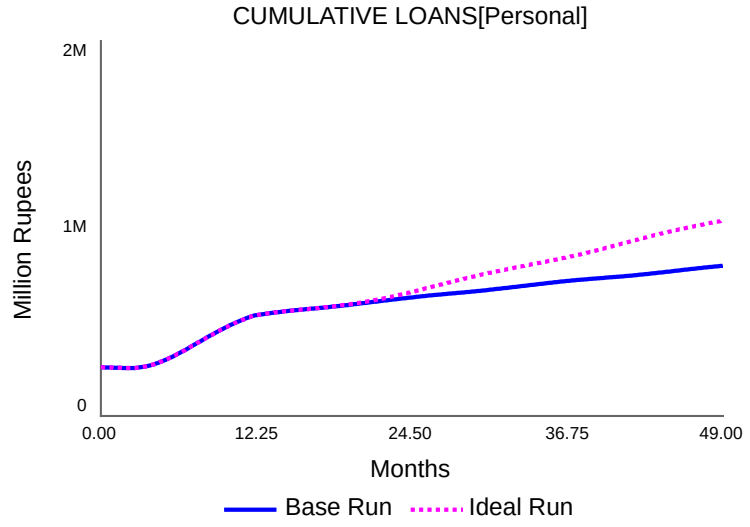
With increase in DESIRED LOAN, SWITCH FOR CAPITAL INCREMENT EFFECT should be activated as banks would like to maintain their DESIRED RETURN ON CAPITAL. This increase in DESIRED LOAN increasing the overall lending of bank but, noticeably, increase in loan for non-priority sector, more correctly high return sector increases significantly compared to priority sector as depicted in Figure 22.



(a)



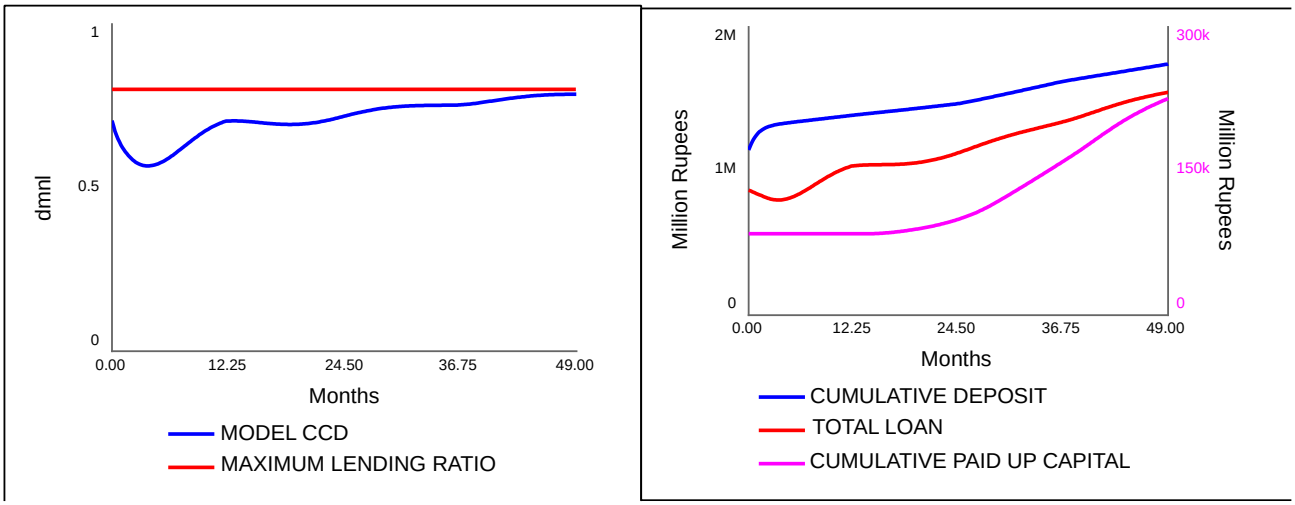
(b)



(c)

Figure 22.Ideal Run: Comparative loans in Different sectors

As lending shifts to non-priority sector, reinforcing loop R1 which is critical for increase in CUMULATIVE DEPOSIT loses its strength and thus, CUMULATIVE DEPOSIT growth becomes stagnant. Moreover, increase in CUMULATIVE DEPOSIT increases the cost, both regulatory and expenses cost, shown by activeness of two balancing loops B3 and B4 respectively. These loops were active even during the base run, but its effect was not significant and LENDING PRESSURE loop B5 was not active. With increase in the strength of LENDING PRESSURE loop R3 (RETURN MAXIMIZATION AND CAPITALIZATION) loop further strengthens resulting in the problematic behavior shown by Figure 23.



(a) (b)

Figure 23.Ideal Run: MODEL CCD and MAXIMUM LENDING RATIO

Based on the explanation, the reason for such significant increase in MODEL CCL is the higher increase in TOTAL LOAN compared to that of CUMULATIVE DEPOSIT. In base run, increase in both TOTAL LOAN and CUMULATIVE DEPOSIT were triggered by reinforcing loop R1 alone with mild impact from reinforcing loop R3.

On the contrary, the growth depicted in ideal runs characterize the impact created by regulatory intervention for capital increment with strengthens reinforcing loop R3 and three balancing loops B3, B4 and B5. B5 kick in first and changes the dynamics of the model behavior. It is noteworthy to mention that the DESIRED RETURN ON CAPITAL is kept constant for both the runs

As from two above run, we have identified the cause of the problematic behavior through the interaction of different feedback loop. As mention previously, the intervention was only targeted to increase the paid-up capital and bank also adhered to

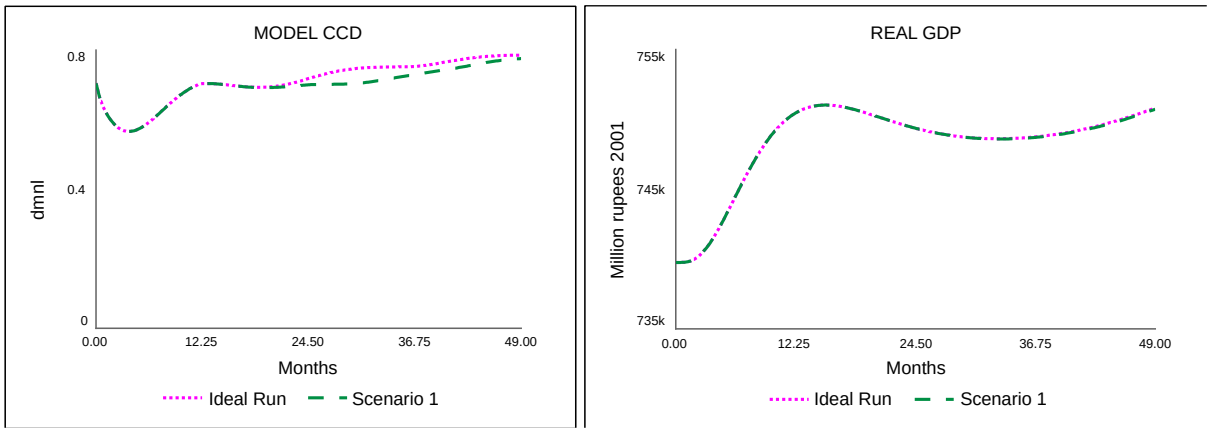
the regulatory requirement; however, such regulatory requirement created an irrational, more correctly selfish, lending practice which supported short term benefits for bank but constrained their long run business operation. On the other side, specific regulatory requirement targeted for the betterment of financial system did strengthen the financial system but at the cost of overall economic growth. Thus, in the following section, we will observe the need for a wholistic approach of a regulator while intervening in the existing system.

4.2 Scenario Analysis

The research objective for this thesis work stated in Chapter 1 determined the model scope and time horizon. Based on such model scope, we have not developed any policy structure to improve the problematic behavior. Furthermore, the model was developed to identify the impact of regulatory intervention, an exogenous parameter to the model, on banks' lending capacity. Our main focus was to understand the dynamics created by such intervention without modeling the reason for such regulatory intervention. Thus, we have not extended the modelling work by incorporating policy structure. However, to reinstate the importance of wholistic approach by a regulator for any intervention we have performed scenario analysis for three different scenario: capital increment of two times increase in paid-up capital instead of four times, capital increment along with increase in minimum lending in priority sector and finally constraining the return on capital of bank with the increase in paid up capital.

Scenario 1: Capital increment of two times instead of four time

This scenario represents the behavior, as show in Figure 24, of two key variable MODEL CCD and NOMINAL GDP from banking sector and GDP sector to assess the impact of less aggressive capital increment regulation from the regulator, importantly are value for kept constant.



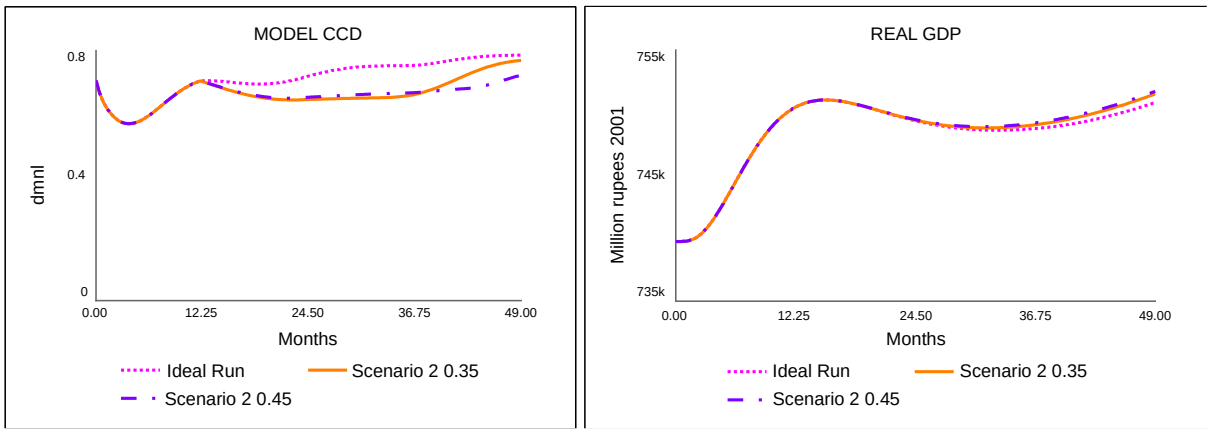
(a) (b)

Figure 24.Scenario 1: Less aggressive capital increment

The above figure depicts that even a less aggressive capital increment by the regulator would not facilitate a substantial reduction in MODEL CCD and more importantly, this does not have any positive impact on GDP as well.

Scenario 2: Capital increment along with increase in minimum lending in priority sector

This scenario was tested to observe the impact of regulatory requirement of increased capital coupled with increase minimum lending in priority sector. Priority sector represent agricultural, infrastructure, education and tourism sector in context of Nepal which are the key drivers for the growth of economy. Again, we use same variable to assess the impact of this scenario shown in Figure 25.



(a) (b)

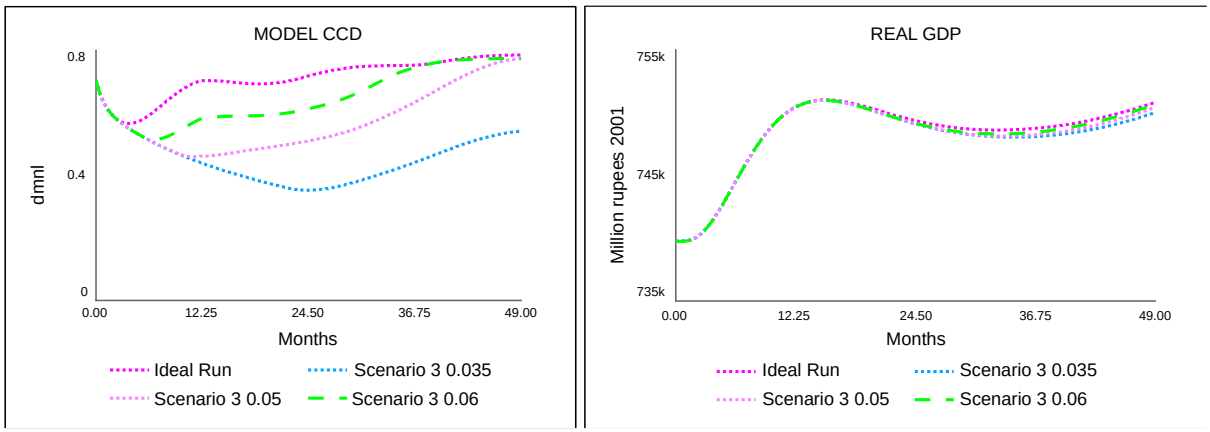
Figure 25.Scenario 2: Prioritizing lending in Priority(productive) sector

For this scenario analysis, MINIMUM LENDING IN PRIORITY SECTOR were assigned two value 0.35 and 0.45 as seen in the x-axis of the graphs. It can be observed

that by prioritizing lending in productive sector not only financial system is beneficial but also economy as a whole show some positive to outcomes. This scenario shows a marginal positive impact on economy (REAL GDP) but it would be referred to the fact that this model has only considered private sector investment and existing elasticity to generate REAL GDP, limited by the scope of model. Moreover, it is noteworthy to mention that with additional lending buffer show by decreased MODEL CCD banks' lending practices will facilitate credit for consumer which will be spent in the economy resulting in better economic outcomes.

Scenario 3: Constraining the return on capital of bank

Although banks in Nepal operate in free competition, regulator does hold right to impose ceiling on return on capital generated by banks (based on discussion with practitioners). Scenario 3 was tested, upon curiosity, to see how such ceiling effect bank CCD and overall economic growth. Figure 26 uses the same variable to show the change in behavior under scenario 3, ceteris paribus.



(a) (b)

Figure 26.Scenario 3: Constraining banks' return on capital

Three different ceiling for return on capital was tested for this scenario analysis. Figure 26 demonstrates that with the ceiling imposed for return on capital MODEL CCD does improves but without a significant development in GDP it reaches bank to Ideal Scenario. Under Scenario 3 0.035, MODEL CCD seems to be very low compared to other, but the growth trend will eventually push it back to the Ideal run.

In conclusion, based on different scenario tests it was observed that Scenario 2 would benefit both the financial system as well as the economy. This scenario analysis clearly

helps us to identify MINIMUM LENDING IN PRIORITY sector as a leverage point which regulator could have accompanied along with capital increment intervention to strengthen financial system and consequently improve overall economic development.

Conclusion & Limitation

Conclusion

The background of this thesis work comes for the experience of the modeler during his employment in one of the banks of Nepal where not only the bank he was employed in, but the entire banking industry move from a normal business operation to a severe credit crunch. Senior bank managers and Chief Executive Officer (CEO) all discussed about the recurrent nature of such crises, sometime named as liquidity crunch but at that time it was phrased as credit crunch. Evidences of repetitive nature of such crises are described and supported by newspaper coverages in Chapter 1.

With that premise accompanied with knowledge from System Dynamics studies, it was identified that use of SD methodology would help understand the dynamics of such recurrent crises. As modelling all those past crises would expand the model boundary to a large scale, 'credit crunch' of 2018 faced by Nepalese commercial banks was sorted. This selection of specific credit crunch was interesting as it was resulted by the action of banking operation and specifically regulatory intervention through capital increment. Based on that, research objective and research questions were identified. The simplest reformulation of research question will be why a regulated banking system went into a credit crunch even though the regulatory intervention was targeted to strengthen the banking sector?

In Chapter 2, a detailed description of model structure is given to summarize the functioning of banking operation and its rippling effect on the economy. Further the feedback perspective established through CLD explains how PRIORITY SECTOR LENDING LOOP reinforces the deposit collection of bank and how other balancing loop namely LENDING PRESSURE LOOP, REGULATORY CONSTRAIN LOOP, COST LOOP AND EXPENSES LOOP shift the dominance from PRIORITY SECTOR LENDING LOOP to RETURN MAXIMIZATION LOOP triggered by exogenous increases capital required even at constant DESIRED RETURN ON CAPITAL resulting in the problematic behavior.

This model created based on the less counterintuitive feedback perspective was tested under several validation test to establish confidence in the model. Direct

structure test, structure-oriented behavior test and behavior test were performed which validated the structure and behavior generated by the model. The sensitivity analysis conducted helped identify key sensitive parameters in the model and possible uncertainty that such parameter would result. However, in accordance with model's purpose, the sensitivity of such parameters was identified as tolerable.

Chapter 4 presents model simulation for base run and ideal run condition where the interaction of different feedback loops and their resulting behavior were analyzed. The reason for such significant increase in MODEL CCL, under ideal run, is higher increase in TOTAL LOAN compared to that of CUMULATIVE DEPOSIT. The growth depicted in ideal runs characterize the impact created by regulatory intervention for capital increment with strengthens reinforcing loop R3 and three balancing loops B3, B4 and B5. B5 kick in first and changes the dynamics of the model behavior. Similarly, different scenario tests were performed, and it was observed that Scenario 2 would benefit both the financial system as well as the economy. This scenario analysis clearly helps us to identify MINIMUM LENDING IN PRIORITY sector as a leverage point which regulator could have accompanied along with capital increment intervention to strengthen financial system and consequently improve overall economic development.

Limitation and Further work

This thesis work and model developed for it had many assumptions. The following section lists the considerable limitation of the current study and suggest the direction for further work:

a. The current model assumes several exogenous parameters which was calculated for the specific time period of model simulation. Such assumption of parameters is only suitable for the current scope of the model. Further, these parameters represent key components of a much larger extended system thus, interpretation and value assigned to those parameters are limited for the use in this model structure.
b. Although the model attempts to capture the economic impact of banking operation through GPD sector, the development of GDP sector is a higher-level aggregation in connection to one element of banking system's contribution. GDP

is an extensive concept with coverage to different sectors. Thus, GDP sector is a major limitation of this model because of it higher level simplification.

c. This model does not capture the impact of interest rate fluctuation on deposit collection and loan creation which limit the applicability of the model for a much broader and in-depth analysis of operation of banking system under such regulatory intervention.
d. The effect of capital increment of lending behavior is derived from reports available. However, such lending decision are management driven which might differ based on the experience and knowledge of bank's management along with the promoters' risk taking and compliance preferences.
e. The delays used in this model are calibration based on experience of modeler and consultation with few practitioners. Thus, such delay might not represent the delay perceived by the industry as a whole which again limits the applicability of the model as it is.
f. Lastly, the model was developed to address the research objective largely informed based on the limited knowledge of modeler during in business studies and experience working with bank, with possible literature review and consultation. Thus, industry expert, professional and academicians can observe this model as a very aggregated representation of different sectors which might not capture the functioning mechanism of different sectors in real terms.

As mentioned above there are several exogenous parameters to the model which are part of larger system. Further iteration of the model should target to study the development of these parameter, taking into consideration the complex system driving those parameters. Specifically, the modeler himself identifies the oversimplification of GDP sector which is definitely a next important step which modeler is curious to expand and ready to collaborate with interested researchers.

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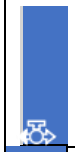
Appendix A

	Variable name	Equation	Properties	Documentation	Units
	ACTUAL_AVERAGE_FRACTION_OF_LOAN_DISBURSED_TO_REAL_ESTATE_AND_TRADING	0.32		ACTUAL AVERAGE FRACTION OF LOAN DISBURSED TO REAL ESTATE AND TRADING represent the amount of loan provided by Nepalese bank to real estate sector. This fraction is calculated as the average based on the trend of historical data for lending form year Mid-June 2014 to Mid-June 2018.(based on Monthly Financial Statements of banks published by NRB)	dmnl
	ACTUAL_AVERAGE_FRACTION_OF_LOAN_TO_PRIORITY_SECTOR	0.38		ACTUAL AVERAGE FRACTION OF LOAN TO PRIORITY SECTOR represent the amount of loan provided by Nepalese bank to priority sector enlisted by NRB. This fraction is calculated as the average based on the trend of historical data for lending form year Mid-June 2014 to Mid-June 2018. (based on Monthly Financial Statements of banks published by NRB)	dmnl
	Banking_Sector:				
	ACCOUNTING_DELAY	3		ACCOUNTING DELAY, here, depict the reporting time allowed by NRB to banks to report their un-audited financial statement. Its value is 3 month because banks are required to report their un-audited financial statement on quarterly basis to NRB.	months

	ACTUAL_AVERAGE_FRACTION_OF_LOAN_TO_PERSONAL_SECTOR	0.3		FRACTION OF TOTAL LOAN TO PRIORITY SECTOR represent the amount of loan provided by Nepalese bank to priority sector enlisted by NRB. This fraction is calculated as the average based on the trend of historical data for lending form year Mid-June 2014 to Mid-June 2018. (based on Monthly Financial Statements of banks published by NRB)	dmnl
	ACTUAL_DEPOSIT_INTEREST_RATE	WEIGHTED_AVERAGE_FRACTION_OF_BASE_RATE_FOR_INTEREST*BASE_RATE		It represent the actual interest rate of deposit anchored on based rate.	dmnl/month
	ACTUAL_NUMBER_OF_BANKS	IF REGULATION_STATUS=1 THEN DELAY3(INDICATED_NUMBER_OF_BANKS, ADJUSTMENT_TIME_FOR_NUMBER_OF_BANKS, INITIAL_NUMBER_OF_BANKS) ELSE PREVIOUS(SELF, INITIAL_NUMBER_OF_BANKS)		ACTUAL NUMBER OF BANK represents the total number of banks that existed by the end of 2017. It is a goal gap adjustment formulation that tends to adjust the total number of banks in 2015 to 2017. This is a conditional formulation to show the fact the banks consolidated and merged together to increases their paid up capital only after the time when regulation was imposed. This formulation also uses a third order delay to incorporate a complex procedure of bank mergers the requires several financial due-diligence and regulatory approvals. Its unit is bank.	bank

	ADJUSTMENT_TIME_FOR_NUMBER_OF_BANKS	24		ADJUSTMENT TIME FOR NUMBER OF BANK represents the time required to adjust the number of bank from its initial value to indicated value. It is taken as 24 in line with the time allowed by NRB to increases the paid up capital of the bank considering the fact that banks opted to merge due to the paid up enhancement regulation and thus targeted their merger to accomplish when regulation was applicable for monitoring. Its unit is month.	month
	ANNUAL_ACCUMULATION_OF_PROFIT	PROFIT*PROFIT_TRANSFER_PULSE		ANNUAL ACCUMULATION OF PROFIT keep account of the annual transfer of profit to retained earning which is a general accounting practice in every company. It is formulated in such a way that it transfer all the profit to RETAINED EARNINGS every 12 months.	Million Rupees/ month
	AVAILABLE_EARNING_TO_PAY_OPERATING_EXPENSES	PROFIT/ACCOUNTING_DELAY+INTEREST_INCOME-INTEREST_EXPENSES		It keep account of net income of the bank with it can utilize to cover operating expenses.	Million Rupees/ month
	AVAILABLE_FUND	BANK'S_VAULT_CASH/DT-PURCHASE_OF_GOVT_SECURITIES-RESERVE_DEPOSIT-PAYMENTS+CASH_IN-CASH_OUT		AVAILABLE FUND check the availability of money with bank all fulfilling compliance requirement and covering expenses that bank can use to create loans.	Million Rupees/ month

	AVERAGE_WITHDRAWAL_TIME	1		Average withdrawal delay represents the average time customer take to decide the withdrawal of the deposit for consumption expenditure. This time is kept at 1 month. 1 month delay is assumed based on the assumption that every depositor only withdrawal from their saving when their regular monthly income is not sufficient to fulfill their requirement for the month. Its unit is Month.	month
	AVG_MATURITY_TIME	6		Average maturity time is the time required to sell the security held by banks and convert it back to cash. Average maturity time for this model is taken as 6 months. Public Debt department of NRB issues government security with varying maturity ranging from 90 days to several years. Bank's primary purpose of holding government security is to maintain SLR. Thus, banks usually invest in T-Bills with maturity range from 90 days to 365 days. Based on the maturity range of T-Bills issue by NRB an average of 6 months (180 days) was used for this model.	months
	BANK_OPERATING_COST	CUMULATIVE_PAID_UP_CAPITAL*FRACTION_OF_OPERATING_COST		BANK OPERATION COST refers to the monetary value of operational expenses incurred by banks. It is the multiplication of CUMULATIVE PAID UP CAPITAL and FRACTION OF OPERATING COST. Since, FRACITONA OF OPERATING COST is anchored to CUMULATIVE PAID UP CAPITAL such multiplication is used. Its unit is Million Rupees/month	Million Rupees/ month

	BANK'S_VAULT_CASH(t)	BANK'S_VAULT_CASH(t - dt) + (CASH_IN - RESERVE_DEPOSIT - PURCHASE_OF_GOVT_SECURITIES - LENDING[loan_for_real_estate_and_trading] - LENDING[loan_for_priority_sector] - LENDING[Personal] - PAYMENTS - CASH_OUT) * dt	INIT BANK'S_VAULT_CASH = INITIAL_DEPOSIT	BANK'S VAULT CASH refers to the total stock of cash maintained at different commercial banks in Nepal. CASH IN is an inflow that increases this stock. While, RESERVE DEPOSIT, PURCHASE OF GOVT SECURITES, LENDING AND PAYMENTS decreases this stock. Its unit is Million Rupees.	Million Rupees
	CASH_IN	DEPOSIT_IN+CHANGE_IN_PAID_UP_CAPITAL+MATURITY_OF_GOVT_SECURITIES+INTEREST_INCOME		CASH IN represents the actual cash inflow to BANKS' VAULT. Bank can receive cash in the form of DEPOSIT IN and INTEREST INCOME. Its unit if Million Rupees/month	Million Rupees/ month
	CASH_OUT	MIN(BANK'S_VAULT_CASH/DT, DEPOSIT_OUT)		CASH OUT represent the amount of money, physical cash, actually withdrawn by the depositor for consumption.	Million Rupees/ month
	CASH_RESERVE_AT_NRB(t)	CASH_RESERVE_AT_NRB(t - dt) + (RESERVE_DEPOSIT) * dt	INIT CASH_RESERVE_AT_NRB = CUMULATIVE_DEPOSIT*"CASH_RESERVE_RATIO_(CRR)"	CASH RESERVE AT NRB represents the mandatory cash reserve maintained by all commercial banks at Nepal Rastra Bank(NRB, central bank of Nepal) to maintain their CRR in line with the guideline mentioned in Unified Directive 2072 issued by NRB. This reserve changes with the change in flow, RESERVE DEPOSIT, that takes out the liquid asset (cash) from BANK'S VAULT CASH AND LIQUID ASSETS to maintain the stock at the level of DESIRED REQUIRED RESERVE. Its unit is Million Rupees.	Million Rupees

	"CASH_RESERVE_RATIO_(CRR)"	0.06		CASH RESERVE RATIO (CRR) refers to the fraction of total deposits that financial institutions must maintain at central bank as deposit. CRR is maintain to meet the day to day liquidity need of banks. CRR is set at 6% based on the requirement set by NRB in its Unified Directive 2072(2015/16) page 216. Its unit is dimensionless.	Dmnl
	CHANGE_IN_LOANABLE_FUND	(EXPECTED_LOANABLE_FUND-TOTAL_LOANABLE_FUND)/LOANABLE_FUND_ASSESSMENT_TIME		CHANGE IN LOANABLE FUND represents the adjustment of TOTAL LOANABLE FUND to EXPECTED LOANABLE FUND. It is formulated as classic goal gap formulation used in SD models.	Million Rupees/ month
	CHANGE_IN_PAID_UP_CAPITAL	IF AVAILABLE_EARNING_TO_PAY_OPERATING_EXPENSES>0 THEN MAX(0, DELAY3(PAID_UP_CAPITAL_GAP, PAID_UP_ADJUSTMENT_TIME)+DELAY3(DIVIDEND_DISTRIBUTION, PAID_UP_ADJUSTMENT_TIME_THROUGH_DIVIDEND)) ELSE AVAILABLE_EARNING_TO_PAY_OPERATING_EXPENSES		CHANGE IN PAID UP CAPITAL is the inflow to CUMULATIVE PAID UP CAPITAL. It is a goal-gap formulation that adjusts CUMULATIVE PAID UP CAPTIAL to its desired goal adjusted by PAID UP ADJUSTMENT TIME. MAX function is used to avoid the stock from going negative. MAX function is also applicable here because CUMULATIVE PAID UP CAPITAL of banks in Nepal cannot decrease. This formulation also uses a third order material delay to deficit that fact the paid up increment process involves activities like profit finalization and approval through Annual General Meeting, then NRB's approval to issue stock dividend or right share, followed by actual call to claim stock dividend or right share and finally the settlement of such dividend to banks actual paid up capital. Its unit is Million Rupees/month	Million Rupees/ Months

CUMULATIVE_DEPOSIT(t)	CUMULATIVE_DEPOSIT(t - dt) + (DEPOSIT_IN - DEPOSIT_OUT) * dt	INIT CUMULATIVE_DEPOSIT = INITIAL_DEPOSIT	CUMULATIVE DEPOSIT is a stock that represents the total amount of deposit collected by all commercial banks of Nepal. It is increased by the amount of saving deposited by customers of the bank while it is decreased by the withdrawal of deposits by the customer to meet their consumption needs. Its unit in Million Rupees. Rupees is the currency of Nepal.	Million Rupees
CUMULATIVE_LOANS[loan_for_real_estate_and_trading](t)	CUMULATIVE_LOANS[loan_for_real_estate_and_trading](t - dt) + (LENDING[loan_for_real_estate_and_trading] - REPAYMENTS[loan_for_real_estate_and_trading]) * dt	INIT CUMULATIVE_LOANS[loan_for_real_estate_and_trading] = INITIAL_LOAN*ACTUAL_AVERAGE_FRACTION_OF_LOAN_DISBURSED_TO_REAL_ESTATE_AND_TRADING	CUMULATIVE LOAN refers to the sum of total loans provided by different commercial bank of Nepal. This is a stock which increases through LENDING and decreases through REPAYMENTS. This stock is arrayed for different types of loan- real estate loan, personal loan and priority sector loan. Its unit is Million Rupees.	Million Rupees
CUMULATIVE_LOANS[loan_for_priority_sector](t)	CUMULATIVE_LOANS[loan_for_priority_sector](t - dt) + (LENDING[loan_for_priority_sector] - REPAYMENTS[loan_for_priority_sector]) * dt	INIT CUMULATIVE_LOANS[loan_for_priority_sector] = INITIAL_LOAN*ACTUAL_AVERAGE_FRACTION_OF_LOAN_TO_PRIORITY_SECTOR		

	CUMULATIVE_LOANS[Personal](t)	CUMULATIVE_LOANS[Personal](t - dt) + (LENDING[Personal] - REPAYMENTS[Personal]) * dt	INIT CUMULATIVE_LOANS[Personal] = INITIAL_LOAN*ACTUAL_AVERAGE_FRACTION_OF_LOAN_TO_PERSONAL_SECTOR		
	CUMULATIVE_PAID_UP_CAPITAL(t)	CUMULATIVE_PAID_UP_CAPITAL(t - dt) + (CHANGE_IN_PAID_UP_CAPITAL) * dt	INIT CUMULATIVE_PAID_UP_CAPITAL = 84542	Capital means the authorized capital, issued capital and paid up capital of a bank or financial institution. CUMULATIVE PAID UP CAPITAL means the portion of the capital paid up on behalf of shareholders out of the issued capital of a bank or financial institution (Bank and Financial Institution Act, 2017-BAFIA). It increases from the inflow CHANGE IN PAID UP CAPITAL. It includes initial paid up capital raised by banks by issuing equity share in the primary market and regular stock dividend/bonus share distributed by bank to its equity share holders from its annual profit. Stock dividend represents a distribution of shares in lieu of or in addition to the cash dividend to the existing shareholders. In this model, CUMULATIVE PAID UP CAPITAL is the actual which tends to reach the goal of TOTAL INDICATED PAID UP CAPITAL after the regulation was imposed by NRB to increase the minimum paid up capital requirement of banks. Its value is initialized in line with the data available from the monthly financial statement published by each bank and cumulatively reported by NRB. Its unit is Million Rupees	Million Rupees

	DECLARED_DIVIDEND	0.19		DECLARED DIVIDEND is the fraction of stock dividend provided by commercial banks of Nepal. This fraction of stock dividend is proposed by Board of DIrectors of Bank and approved through Annual General Meeting of Shareholder. Dividend declared vary based on bank's profitability and BOD decision. Since, this model attempts to depict the commercial banking industry as a whole average dividend declared by different bank each year is used. Again, average of dividend declared by different bank is averaged for the period of 2014/15 to 2017/18 to arrive at the value of 0.19. Information about dividend declared is collected from https://www.sharesansar.com/proposed-dividend for fiscal year 2014/15 to 2017/18. Fiscal year are reported as per Nepalese calendar which start from Mid July every year. Its unit is dimensionless.	Dmnl
	DEPOSIT_IN	(SALARY_DEPOSIT+SAVING_DEPOSIT+NOMINAL_CHANGE_IN_REMITTANCE/1+TOTAL_REPAYMENTS)		Deposit in is the inflow to the stock Deposit. It is dependent on the SAVING DEPOSIT, SALARY DEPOSIT, NOMINAL CHANGE IN REMITTANCE AND REPAYMENTS . Its unit is Million Rupees/month.	Million Rupees/ month
	DEPOSIT_OUT	MIN(CUMULATIVE_DEPOSIT/AVERAGE_WITHDRAWAL_TIME, (((NOMINAL_CONSUMPTION_EXPENDITURE*HOUSEHOLD_CONSUMPTION_F		DEPOSIT OUT is the outflow to the CUMULATIVE DEPOSIT STOCK. Its value is determined as the sum of NOMINAL CONSUMPTION EXPENDITURE and LENDING.	Million Rupees/ month

		RACTION)/AVERAGE_WITHDRAWAL_TIME)))		CONSUMPTION EXPENDITURE is take as deposit out to address that fact that people withdraw money from their savings deposited in bank to meet their consumption expenditure. Here, it is assumed that all compensation to employees are directly deposited into bank account of employees and no cash reimbursement takes place. It is adjusted for AVERAGE WITHDRAWAL TIME, representing that on average people hold cash to cover expenses for 22 days in a month. Moreover, LENDING is incorporated in this outflow because here LENDING capture the amount of money that borrowers actually take out of the bank to utilized for different purposes. Loan creation and actual LENDING should be treated separately in banking transaction. For simplicity, this model does not incorporate the loan creation process. If Loan creation was model it would first be incorporated as deposit and when actually loan were disbursed it will be taken out from deposit. It is in line with the definition/function of fractional reserve banking. For instance, when a loan in created bank opens a loan account for that customer and deposit that amount for customer's use. This would at first increase the deposit as a creation of new loan account . Now, when the customer withdrawals money from its loan account, it would reduce the deposit. Since, loan creation is not model and LENDING, here, represents the actual withdrawal of cash from bank it is incorporated directly as DEPOSIT OUT.	

				DEPOSIT OUT is formulated using combination of MAX and MIN function to regulate the stock from going negative and control the monthly withdrawal in line with the available CUMULATIVE DEPOSIT after each withdrawal adjustment time. Its unit is Million Rupees/month	
	DESIRED_INVESTMENT_IN_GOVT_SECURITIES	SMTH1(CUMULATIVE_DEPOSIT*"STATUTORY_LIQUIDITY_RESERVE(SLR)_RATIO", RESERVE_ADJUSTMENT_TIME)		DESIRED INVESTMENT IN GOVT SECURITIES is a sum of amount maintained by commercial banks in liquid form (cash, government bonds and other convertible assets) . At present, NRB has provisioned 12% SLR for commercial banks. Although, cash reserve can also be included to accomplish SLR requirement, commercial banks usually maintain their SLR requirement mainly by holding government security. This tendency of holding 12% SLR through investment in government security was informed by one of the interviewee. Moreover, annual bank supervision report published by Nepal Rastra Bank reports that the average SLR maintained by commercial banks of Nepal is between 18 to 22 percent. Since, SLR maintained by Nepalese commercial bank is always above 12% for this model sum allocated to cash reserve is not considered in SLR while SLR has been kept at minimum requirement imposed by NRB.	Million Rupees
	DESIRED_LOAN	DESIRED_PROFIT/MAXIMUM_POSSIBLE_INTEREST_RETURN			million rupees
	DESIRED_PROFIT	(DESIRED_RETURN_ON_CAPITAL*CUMULATIVE_PAID_UP_CAPITAL)			Million Rupees/ month

	DESIRED_REQUIRED_RESERVE	SMTH1(CUMULATIVE_DEPOSIT*"CASH_RESERVE_RATIO_(CRR)",RESERVE_ADJUSTMENT_TIME)		DESIRED REQUIRED RESERVE represents the monetary value of CRR that needs to be maintained at NRB. It is the multiplication of CUMULATIVE DEPOSIT and CRR. Simply, it can be understood as the goal to CASH RESERVE AT NRB. The general idea behind this formulation is that as CUMULATIVE DEPOSIT stock changes, banks must adjust their CASH RESERVE AT NRB. When deposit increases banks must increase their cash balance at NRB to maintain regulatory requirement; while when deposit decreases bank can withdraw from the NRB and use the excess amount for LENDING or PAYEMNTS as holding deposit in NRB yields minimum return compared to LENDING. It is formulated as a first order smooth adjusted for RESERVE ADJUSTMENT TIME. Since, the information about CUMULATIVE DEPOSIT and CASH RESERVE AT NRB is always available with bank a first order smooth is used. Its unit is Million Rupees.	Million Rupees
	DESIRED_RETURN_ON_CAPITAL	0.05			DMNL/MONTH

	DIVIDEND_DISTRIBUTION	IF RETAINED_EARNINGS>0 THEN MAX(0, MIN(RETAINED_EARNINGS/DT-UTILIZATION_OF_RETAINED_EARNING, SMTH3(DECLARED_DIVIDEND*ANNUAL_ACCUMULATION_OF_PROFIT, DIVIDEND_PAYMENT_TIME))) ELSE 0		DIVIDEND DISTRIBUTION refers to the amount paid to the shareholder of bank for their investment. Dividends are distributed based on the annul profit made by a bank is the outflow that decreases RETAINED EARNING. Since, profits are transferred to retained earning every year, DIVIDEND DISTRIBUTION decreases RETAINED EARNING. Its unit is Million Rupees	Million Rupees/ month
	DIVIDEND_PAYMENT_TIME			DIVIDEND PAYMENT TIME is the time required to finalize dividend through AGM. It usually takes 3 months to conduct AGM for different banks in Nepal, thus dividend payment time is set at 3 months.	month
	EFFECT_OF_CUMULATIVE_PAID_UP_CAPITAL_ON_SECTORAL_LENDING[loan_for_real_estate_and_trading]	GRAPH(CUMULATIVE_PAID_UP_CAPITAL/INIT(CUMULATIVE_PAID_UP_CAPITAL)) Points: (1.000, 1.00200785528), (1.200, 1.00539586299), (1.400, 1.01422776195), (1.600, 1.03576087661), (1.800, 1.08068242641), (2.000, 1.1500), (2.200, 1.21931757359), (2.400, 1.26423912339), (2.600, 1.28577223805), (2.800, 1.29460413701), (3.000, 1.29799214472)		EFFECT OF CUMULATIVE CAPITAL ON SECTORAL LENDING represent the decision of bank management to mobilize their limited loanable funds in different sector. Lending behavior of bank management changes as banks increases paid up capital due to promoter pressure to maintain desire profitability. This lower and upper limit of graphical function was determined by normalizing the actual sectoral lending fraction over the model simulation time based on real data. While the share of the curve was first expected by modeler and then validated by two practitioner.	dmnl

	EFFECT_OF_CUMULATIVE_PAID_UP_CAPITAL_ON_SECTORAL_LENDING[loan_for_priority_sector]	GRAPH(CUMULATIVE_PAID_UP_CAPITAL/INIT(CUMULATIVE_PAID_UP_CAPITAL)) Points: (1.000, 1.99330714908), (1.200, 1.98201379004), (1.400, 1.95257412682), (1.600, 1.88079707798), (1.800, 1.73105857863), (2.000, 1.500), (2.200, 1.26894142137), (2.400, 1.11920292202), (2.600, 1.04742587318), (2.800, 1.01798620996), (3.000, 1.00669285092)			
	EFFECT_OF_CUMULATIVE_PAID_UP_CAPITAL_ON_SECTORAL_LENDING[Personal]	GRAPH(CUMULATIVE_PAID_UP_CAPITAL/INIT(CUMULATIVE_PAID_UP_CAPITAL)) Points: (1.000, 1.00267714037), (1.200, 1.00719448398), (1.400, 1.01897034927), (1.600, 1.04768116881), (1.800, 1.10757656855), (2.000, 1.2000), (2.200, 1.29242343145), (2.400, 1.35231883119), (2.600, 1.38102965073), (2.800, 1.39280551602), (3.000, 1.39732285963)			
	EXPECTED_LOANABLE_FUND	CUMULATIVE_DEPOSIT+CUMULATIVE_PAID_UP_CAPITAL+RETAINED_EARNINGS		EXPECTED LOANABLE FUND is the sum of CUMULATIVE DEPOSIT and CUMULATIVE PAID UP CAPITAL of banks in Nepal. It represents the total fund that bank can utilize to operate its business of creating loans to generate its earning through interest. Its unit is Million Rupees.	million rupees

	EXPECTED_MINIMUM_PAID_UP_CAPITAL_OF_EACH_BANK	8000		It represents the minimum paid up capital of each banks after the regulatory intervention to increase the paid up capital.	Million Rupees/ bank
	FRACTION_OF_GNDI_SPENT_IN_SALARY_COMPENSATION	0.32		SHARE OF EMPLOYEE COMPENSATION OF GNDI refers to the fraction of GNDI that goes for employee compensation. It value is determined based on the average compensation paid to employees over the period of 16 year.	dmnl
	FRACTION_OF_INTEREST_PAYABLE_DEPOSIT	0.7		FRACTION OF INTEREST PAYABLE DEPOSIT represent the collective some of time and saving deposit on which banks pay interest. It does not include call and current account deposit that are held in bank for transaction purpose, thus banks do not pay interest on them. This value is determined based on the average fraction of time and saving deposit held by Nepalese commercial bank from Mid June 2014 to Mid June 2018. (based on compiled monthly financial statement of banks published by NRB)	dmnl

	GOVT_SECURITIES(t)	GOVT_SECURITIES(t - dt) + (PURCHASE_OF_GOVT_SECURITIES - MATURITY_OF_GOVT_SECURITIES) * dt	INIT GOVT_SECURITIES = INITIAL_GOVT_SECURITY	Government security refers to a wide range of investment products offered by a governmental body through Nepal Rastra Bank(NRB) to raise capital from public to meet its budget deficit. In Nepal, treasury bills, development bonds, national saving bonds, special bonds and citizen saving certificates are the major types of Govt Securities issued by NRB. In this model, GOVT SECURITIES refers to a stock of investment made by Nepalese commercial banks in government security instruments (mainly treasury bills) to meet the mandatory SLR requirement imposed by NRB. GOVT SECURITIES increases through the purchases of new T-bills, represented by PURCHASE OF GOVT SECURITIES, of varying maturities and decreases when these instruments matures after their definite maturity period represented by MATURITY OF GOVT SECURITES, an outflow. Its unit is Million Rupees.	Million Rupees
	HOUSEHOLD_CONSUMPTION_FRACTION	0.8			DMNL
	INDICATED_NUMBER_OF_BANKS	28		INDICATED NUMBER OF BANK represents the total number of commercial banks that existed in Nepal at the start of Mid-July 2017. Its value is taken as 28 based on the information available in Bank Supervision Report of 2017 published by NRB.	bank
	INITIAL_NUMBER_OF_BANKS	30			bank

	INTEREST_EXPENSES	DELAY(INTEREST_PAID_TO_DEPOSITORS, ACCOUNTING_DELAY)		INTEREST EXPENSES refers to the amount of interest paid by banks to its depositor. This flow is model as a discrete delay with delay time of 3 months because Nepalese commercial banks must report their quarterly profit in line with NRB regulation. Its unit is Million rupees/month.	Million Rupees/ month
	INTEREST_INCOME	DELAY(INTEREST_PAID_BY_BORROWERS, ACCOUNTING_DELAY)		INTEREST INCOME refers to the income earned by banks through lending money at different rates. This flow is model as a discrete delay with delay time of 3 months because Nepalese commercial banks must report their quarterly profit in line with NRB regulation. Its unit is Million rupees/month.	Million Rupees/ month
	INTEREST_PAID_BY_BORROWERS	LOAN_INTEREST_RATE*SUM(CUMULATIVE_LOANS)		It represent the interest paid to bank by the borrowers for utilization of credit facilities.	Million Rupees/ month
	INTEREST_PAID_TO_DEPOSITORS	BASE_RATE*WEIGHTED_AVERAGE_FRACTION_OF_BASE_RATE_FOR_INTEREST*CUMULATIVE_DEPOSIT*FRACTION_OF_INTEREST_PAYABLE_DEPOSIT		It represent the actual amount paid to depositor as interest on their deposit.	Million Rupees/ month
	LENDING[loan_for_real_estate_and_trading]	IF SWITCH_FOR_CAPITAL_INCREMENT_EFFECT=1 AND REGULATION_START_TIME<=TIME THEN MAX(0, DELAY1(MIN(LENDING_FRACTION_FOR_REAL_ESTATE_LOANS*(MIN(LENDING_BUFFER, (DESIRED_LOAN-TOTAL_LOAN))/LOAN_DISBURSEMENT_TIME), AVAILABLE_FUND), LENDING_DECISION_DEL		LENDING is an outflow to BANKS' VAULT CASH and inflow to CUMULATIVE LOANS. It is arrayed for the type of loan to capture loans provided by banks to different sector of economy. LENDING is formulated as a MAX and MIN function to incorporate the idea that it cannot be negative and cannot exceed the maximum loanable limit. Its unit is Million Rupees/month. For instance:	Million Rupees/ month

		AY[loan_for_real_estate_and_trading])) ELSE MAX(0, DELAY1(MIN(ACTUAL_AVERAGE_FRACTION_OF_LOAN_DISBURSED_TO_REAL_ESTATE_AND_TRADING*(MIN(LENDING_BUFFER, (DESIRED_LOAN-TOTAL_LOAN))/LOAN_DISBURSEMENT_TIME), AVAILABLE_FUND), LENDING_DECISION_DELAY[loan_for_real_estate_and_trading]))	MAX(0, MIN(AVAILABLE_FUND, ((LENDING_BUFFER*Fractional_of_total_loan_to_Priority_Sector*effect_of_relative_capital_on_different_types_of_loan[loan_for_priority_sector])/LOAN_DISBURSEMENT_TIME[loan_for_priority_sector]))) This equation for priority sector loan calculates as under: 1. It determines the amount of loan that banks are willing to give to priority sector determined by: LENDING_BUFFER*Fractional_of_total_loan_to_Priority_Sector*effect_of_relative_capital_on_different_types_of_loan[loan_for_priority_sector] 2. The calculated maximum loanable fund available for priority sector is adjusted by LOAN DISBURSEMENT TIME. This formulation give the value of loan that can be disbursed by banks, if and only if banks have enough cash in their vault. 3. MIN function compares the minimum value between the AVAILABLE FUND and Maximum loanable fund available for priority sector calculated in step 2. MIN function is used here to implement the fact that banks can only lend the minimum of what is available or what is required. 4. Finally, MAX function is used to control the negative value of lending under circumstances when banks have already reached their maximum lending capacity.	

	LENDING[loan_for_priority_sector]	IF SWITCH_FOR_CAPITAL_INCREMENT_EFFECT=1 AND REGULATION_START_TIME<=TIME THEN MAX(0, DELAY1(MIN(LENDING_FRACTION_FOR_PRIORITY_SECTOR_LOANS*(MIN(LENDING_BUFFER, (DESIRED_LOAN-TOTAL_LOAN))/LOAN_DISBURSEMENT_TIME), AVAILABLE_FUND), LENDING_DECISION_DELAY[loan_for_priority_sector])) ELSE MAX(0, DELAY1(MIN(ACTUAL_AVERAGE_FRACTION_OF_LOAN_TO_PRIORITY_SECTOR*(MIN(LENDING_BUFFER, (DESIRED_LOAN-TOTAL_LOAN))/LOAN_DISBURSEMENT_TIME), AVAILABLE_FUND), LENDING_DECISION_DELAY[loan_for_priority_sector]))			

	LENDING[Personal]	IF SWITCH_FOR_CAPITAL_INCREMENT_EFFECT=1 AND REGULATION_START_TIME<=TIME THEN MAX(0, DELAY1(MIN(LENDING_FRACTION_FOR_PERSONAL_LOANS*(MIN(LENDING_BUFFER, (DESIRED_LOAN-TOTAL_LOAN))/LOAN_DISBURSEMENT_TIME), AVAILABLE_FUND), LENDING_DECISION_DELAY[Personal])) ELSE MAX(0, DELAY1(MIN(ACTUAL_AVERAGE_FRACTION_OF_LOAN_TO_PERSONAL_SECTOR*(MIN(LENDING_BUFFER, (DESIRED_LOAN-TOTAL_LOAN))/LOAN_DISBURSEMENT_TIME), AVAILABLE_FUND), LENDING_DECISION_DELAY[Personal]))			
	LENDING_BUFFER	REGULATORY_LIMIT_FOR_LENDING-SUM(CUMULATIVE_LOANS)		LENDING BUFFER is the difference of TOTAL LOANABLE FUND and CUMULATIVE LOANS. It shows maximum fund that banks can lend in addition to its existing loans. In other words, it represents the gap between maximum loan and actual loan that banks can lend. Its unit is Million Rupees.	Million Rupees
	LENDING_DECISION_DELAY[loan_for_real_estate_and_trading]	3			MONTH

	LENDING_DECISION_DELAY[loan_for_priority_sector]	12			
	LENDING_DECISION_DELAY[Personal]	3			
	LENDING_FRACTION_FOR_PERSONAL_LOANS	1-LENDING_FRACTION_FOR_PRIORITY_SECTOR_LOANS-LENDING_FRACTION_FOR_REAL_ESTATE_LOANS		It represents the model generate lending fraction on personal lending sector based on the lending decision due to increased paid up capital requirement.	dmnl
	LENDING_FRACTION_FOR_PRIORITY_SECTOR_LOANS	MINIMUM_LENDING_IN_PRIORITY_SECTOR*EFFECT_OF_CUMULATIVE_PAID_UP_CAPITAL_ON_SECTORAL_LENDING[loan_for_priority_sector]		It represents the model generate lending fraction on priority sector loan based on the lending decision due to increased paid up capital requirement.	dmnl
	LENDING_FRACTION_FOR_REAL_ESTATE_LOANS	ACTUAL_AVERAGE_FRACTION_OF_LOAN_DISBURSED_TO_REAL_ESTATE_AND_TRADING*EFFECT_OF_CUMULATIVE_PAID_UP_CAPITAL_ON_SECTORAL_LENDING[loan_for_real_estate_and_trading]		It represents the model generate lending fraction on real estate sector loan based on the lending decision due to increased paid up capital requirement.	dmnl
	LOAN_DISBURSEMENT_TIME[loan_for_real_estate_and_trading]	3		LOAN DISBURSEMENT TIME refers to the time interval between the sanction of loan and actual outflow of money from the bank. The value of disbursement time is derived from modelers experience working for bank with confirmation from two practitioners.	month
	LOAN_DISBURSEMENT_TIME[loan_for_priority_sector]	12			
	LOAN_DISBURSEMENT_TIME[Personal]	1			

	LOAN_INTEREST_ADJUSTMENT_TIME	1		Loans realize interest income thus banks usually delay the revision of interest rate on loan which is captured by this variable. This insight was provided by practitioners which is relevant for the model scope as during that period base rate tend to increases most of the times.	month
	LOAN_INTEREST_RATE	SMTH1(BASE_RATE, LOAN_INTEREST_ADJUSTMENT_TIME)+MAXIMUM_PERMISABLE_INTEREST_SPREAD			dmnl/month
	LOAN_SETTLEMENT_TIME[loan_for_real_estate_and_trading]	12		LOAN SETTLEMENT TIME refers to the time allowed to borrowers to settle their loan. It differs for different types of loan. The value of settlement time is derived from modelers experience working for bank with confirmation from two practitioners.	month
	LOAN_SETTLEMENT_TIME[loan_for_priority_sector]	180			
	LOAN_SETTLEMENT_TIME[Personal]	120			
	LOANABLE_FUND_ASSESSMENT_TIME	1			month
	MATURITY_OF_GOVT_SECURITIES	MAX(0, GOVT_SECURITIES/AVG_MATURITY_TIME)		MATURITY OF GOVT SECURITIES is a outflow from GOVT SECURITIES. It represents the amount recollected by Nepalese commercial bank when their investment in government security instruments matures. Thus, it is also an inflow to the BANKS' VAULT CASH. Its unit is Million Rupees/month	Million Rupees/month

	MAXIMUM_LENDING_RATIO	0.8		MAXIMUM LENDING RATIO refer to the maximum permissible fraction of TOTAL LOANABLE FUND that can be disbursed by commercial banks of Nepal. This ratio is fixed at 80% by NRB under Unified Directive published every year. For the purpose of this model Unified Directive of 2072 (2015/16) is used. Its unit is dimensionless.	dmnl
	MAXIMUM_PERMISABLE_INTEREST_SPREAD	0.0032		It represent the maximum spread allowed by regulator to charge on loan over the bank's base rate. It value is 0.0032 dmnl/month which is the monthly conversion of 4% annual spread allowed by NRB.	dmnl/month
	MAXIMUM_POSSIBLE_INTEREST_RETURN	MAXIMUM_PERMISABLE_INTEREST_SPREAD+ACTUAL_DEPOSIT_INTEREST_RATE		It represent the sum of MAXIMUM PERMISABLE INTEREST SPREAD and ACTUAL DEPOSIT INTEREST RATE. It helps to determine the fractional value of return that bank can generate.	dmnl/month
	MINIMUM_LENDING_IN_PRIORITY_SECTOR	0.25		MINIMUM LENDING IN PRIORITY SECTOR represent the floor limit for banks to lend in priority sector. It is dictated by NRB through its circular and unified directives. This value is set at 0.25 as per the report of NRB.	DMNL
	NEW_REGULATION_SWITCH	1		REGULATION SWITCH indicates where the new capital requirement is considered or not. New capital requirement is active when the value of this switch is 1. Its unit is dimensionless.	dmnl

	OPERATING_EXPENSES	MIN(AVAILABLE_EARNING_TO_PAY_OPERATING_EXPENSES, BANK_OPERATING_COST)		OPERATING EXPENSES refers to the expenses incurred by bank to meet its operational expenditure such as staff salary, rents, maintenance and etc. This flow is model as a discrete delay with delay time of 3 months because Nepalese commercial banks must report their quarterly profit in line with NRB regulation. Its unit is Million rupees/month.	Million Rupees/ month
	PAID_UP_ADJUSTMENT_TIME	18		PAID UP ADJUSTMENT TIME is the time required to actually credit banks paid up capital in its books of account. Books of account are finalized on annual basis after publishing Audited Financial Report with takes place every 12 months. Further, after the book of account are published banks need to conduct Annual general meeting to approve the book of accounts and decided on the amount of right and bonus share to be distributed to share holder. There is a provision stated by NRB to conduct the AGM within 6 months after the finalizing the Audited Financial Report. Thus, PAID UP ADJUSTMENT TIME is assumed at 18 months. Its unit is month.	month
	PAID_UP_ADJUSTMENT_TIME_THROUGH_DIVIDEND	3		PAID UP ADJUSTMENT TIME THROUGH DIVIDEND is the time required to actually credit banks paid up capital after dividends are distributed. Its value is set as 3 months because adjustment of books of account which takes 12 months are already considered by PROFIT TRANSFER PULSE, while DIVIDEND PAYMENT TIME take account of time required to finalize dividend through AGM. Its unit is month.	Month

	PAID_UP_CAPITAL_GAP	IF REGULATION_STATUS=0 THEN 0 ELSE (TOTAL_INDICATED_PAID_UP_CAPITAL-CUMULATIVE_PAID_UP_CAPITAL)/PAID_UP_ADJUSTMENT_TIME		PAID UP CAPITAL GAP is the difference between the actual CUMULATIVE PAID UP CAPITAL and TOTAL INDICATED PAID UP CAPITAL. Monetary Policy 2015/16 published by NRB increased the EXPECTED MINIMUM PAID UP CAPITAL OF EACH BANK to 8 billion rupees to be met by mid July 2017. Thus, PAID UP CAPITAL GAP determines the gap the exist between banks' actual paid up capital and the desired paid up capital.	Million Rupees/ month
	PAID_UP_INCREAMENT_PERIOD	24		PAID UP INCREMENT PERIOD refer to the time allocated by NRB to increase the paid up capital of banks. Its value is set at 24 months in line with the Monetary Policy 2015/16, where banks are mandated to increases their paid up capital by Mid July 2017. Its unit is month.	months
	PAYMENTS	MAX(0, (INTEREST_EXPENSES+BANK_OPERATING_COST))		PAYMENTS is an outflow from BANKS' VAULT CASH which represents the cash out of the bank for operation and interest expenditure.	Million Rupees/ month
	PROFIT(t)	PROFIT(t - dt) + (INTEREST_INCOME - INTEREST_EXPENSES - OPERATING_EXPENSES - ANNUAL_ACCUMULATION_OF_PROFIT) * dt	INIT PROFIT = 0	PROFIT refer to the net gain made by banks from operation. Profit, in general, is the difference between the sales revenue minus all expenses. For bank, sales revenue comes from the INTEREST INCOME, inflow, they earn by lending money to different borrower whereas, banks' expenses are outflow from PROFIT that incorporates INTEREST EXPENSES and OPERATING EXPENSES. For accounting purpose, PROFIT are transferred to RETAINED EARNING annually with is depicted by ANNUAL ACCUMULATION OF PROFIT outflow. ANNUAL ACCUMULATION OF PROFIT is formulated in such a way that it transfer all the profit to retained earning every 12 months.	Million Rupees

				It is initialized at 0 because profit at beginning of each year is always 0. Its unit is Million Rupees.	
	PROFIT_TRANSFER_PULSE	PULSE(1, 12, 12)			dmnl/month
	PURCHASE_OF_GOVT_SECURITIES	MAX(0, (DESIRED_INVESTMENT_IN_GOVT_SECURITIES-GOVT_SECURITIES)/SECURITY_PURCHASE_INTERVAL+MATURITY_OF_GOVT_SECURITIES)		PURCHASE OF GOVT SECURITIES is a outflow from Vault cash and an inflow to Govt. Securities. It represents the amount invested by Nepalese commercial bank in government security instruments to maintain their SLR. Moreover, it also incorporate MATURITY OF GOVT SECURITIES to keep account the outflow from the GOVT SECURITIES stock to avoid steady state error where reaching the desired goal. Its unit is Million Rupees/month	Million Rupees/ month
	REGULATION_START_TIME	12		REGULATION START TIME indicates the time from when new capital requirement regulation was imposed. This time is set as 12 because the model start from Mid June 2014 while the new capital requirement was imposed from Mid July 2015. Its unit in month.	months
	REGULATION_STATUS	IF NEW_REGULATION_SWITCH=1 AND REGULATION_START_TIME<=TIME AND TIME<(PAID_UP_INCREAMENT_PERIOD+REGULATION_START_TIME) THEN 1 ELSE 0		REGULATION STATUS variable is used to control the enhancement of paid up capital within the 24 months allowed by NRB. This is a conditional formulation which is elaborate as under: IF NEW_REGULATION_SWITCH=1 AND REGULATION_START_TIME<=TIME AND TIME<(PAID_UP_INCREAMENT_PERIOD+REGULATION_START_TIME) THEN 1 ELSE 0	dmnl

				For this formulation to be effective, first NEW REGULATION SWITCH should be active. As the regulation is only effective after Mid July 2015, REGULATION START TIME<= TIME is used as start condition. Similarly, the requirement to increase the capital by Mid July 2017 is regulated by another conditional argument TIME<(PAID_UP_INCREAMENT_PERIOD+REGULATION_START_TIME) which is used as a stop condition.	
	REGULATORY_LIMIT_FOR_LENDING	TOTAL_LOANABLE_FUND*MAXIMUM_LENDING_RATIO		REGULATORY LIMIT FOR LENDING is the maximum amount that can be lend by Nepalese commercial banks. It is the multiplication of TOTAL LOANABLE FUND and MAXIMUM LENDING RATIO. This variable keeps track of change in lending capacity of banks based on the change in the TOTAL LOANABLE FUND. Its unit is Million Rupees.	Million Rupees
	REPAYMENTS[loan_type]	CUMULATIVE_LOANS/LOAN_SETTLEMENT_TIME		REPAYMENTS captures the amount of loan that has been settled after their maturity period. In other words, it can be understood as the amount that has been paid back by the borrower to the bank. It is also arrayed for different type of loan to capture different settlement time of such loans. It is also an inflow to BANKS' VAULT CASH because it also represents the cash paid by borrowers which come back to banks' vault.	Million Rupees/ month

	RESERVE_ADJUSTMENT_TIME	0.5		RESERVE ADJUSTMENT TIME is the time allowed by central bank to commercial banks to maintain the mandatory reserve requirement. Commercial banks are required to report their reserve holding on a daily basis but reserve adjustment is done on the amount of deposit held by banks in the balance sheet 15 days before the reporting time. 15 days is taken based on information provided by a Senior Officer Staff of one of the commercial bank of Nepal working in Treasury Department through a online interview. Treasury Department is responsible to maintain the liquidity requirement of the commercial bank.	months
	RESERVE_DEPOSIT	MAX(0, (DESIRED_REQUIRED_RESERVE-CASH_RESERVE_AT_NRB)/DT)		RESERVE DEPOSIT is a flow that adjusts the CASH RESERVE AT NRB to its goal, DESRIED REQUIRED RESERVE. It is a bi-flow that take out from BANKS' VAULT CASH when goal is greater than actual and sends back to BANKS' VAULT CASH when actual is greater than goal. It is a classic goal gap formulation which is commonly used in such system dynamics model. Its unit is Million Rupees/month.	Million Rupees/ month

	RETAINED_EARNINGS(t)	RETAINED_EARNINGS(t - dt) + (ANNUAL_ACCUMULATION_OF_PROFIT - DIVIDEND_DISTRIBUTION - UTILIZATION_OF_RETAINED_EARNING) * dt	INIT RETAINED_EARNINGS = 3036.03	RETAINED EARNINGS are the profits that a company has earned to date, less any dividends or other distributions paid to investors. This amount is adjusted whenever there is an entry to the accounting records which is generally a annual process. Thus, RETAINED EARNING increase through ANNUAL ACCUMULATION OF PROFIT and decrease through DIVIDEND DISTRIBUTION. It is initialized at 3036.02 Million Rupees as per the compiled monthly financial report of commercial banks of Nepal published by NRB for the month of Mid July 2014.	Million Rupees
	SALARY_DEPOSIT	(FRACTION_OF_GNDI_SPENT_IN_SALARY_COMPENSATION*NOMINAL_GNDI)/SALARY_DEPOSIT_TIME			Million Rupees/ month
	SALARY_DEPOSIT_TIME	1		SALARY DEPOSIT TIME accounts for the time required to credit the salary account of the employees. Its value is set as 1 months on the assumption that employees compensation are paid on monthly basis. Its unit is month.	month
	SAVING_DEPOSIT	(NOMINAL_GNS/TIME_TO_REALIZE_SAVING_AS_DEPOSIT)		SAVING DEPOSIT refers amount of saving that is deposited in bank. In this model, SAVING DEPOSIT is generated from the NOMINAL GROSS NATIONAL SAVING adjusted for TIME TO REALIZE SAVING AS DEPOSIT.	Million Rupees/ month

	SECURITY_PURCHASE_INTERVAL	3		Security Purchase time represent the average time when a government security is available for purchase to commercial banks and other financial institution. Based on the data reported by Public debt department of NRB and their auction data an average time period is taken at 3 months. Public debt department issues all types of government security- treasury bills, development bonds, national saving bonds and citizen saving bonds. Commercial bank's purpose for holding government security is to maintain SLR and fulfill their immediate liquidity requirements by selling government security. Thus, even though security issue by government takes place as frequent as every month for treasury bills while bonds are issues every six month or a year. An average of 3 months was take for this model which was also confirmed through the interview.	months
	"STATUTORY_LIQUIDITY_RESERVE(SLR)_RATIO"	0.12		Statutory Liquidity Ratio (SLR) is a provision of reserve requirement set by the central bank to its bank and financial institutions for maintaining some liquidity in the form of cash, government bonds or other convertible assets. SLR is set at 12% based on the regulation imposed by Nepal Rastra bank (NRB) in its Unified directive 2072(2015/16) page 218.	dmnl
	SWITCH_FOR_CAPITAL_INCREMENT_EFFECT	1			DMNL

	TIME_TO_REALIZE_SAVING_AS_DEPOSIT	2		TIME TO REALIZE SAVING AS DEPOSIT accounts for the time required to estimate the GNS on national level by central bank and then these deposit become the part of saving held by individuals, private companies and government bodies in banks. Its value is set as 1 months on the assumption that government concludes its national accounts transaction on monthly basis.	month
	TOTAL_INDICATED_PAID_UP_CAPITAL	ACTUAL_NUMBER_OF_BANKS*EXPECTED_MINIMUM_PAID_UP_CAPITAL_OF_EACH_BANK		TOTAL INDICATED PAID UP CAPITAL represent the total desired level of paid up capital that must be maintained by all banks in Nepal. It is determined as the multiplication of EXPECTED MINIMUM PAID UP CAPITAL OF EACH BANK and ACTUAL NUMBER OF BANK. It shows the goal for CUMULATIVE PAID UP CAPITAL stock after the change in regulatory requirement to increase paid up capital. Its unit is Million Rupees	Million Rupees
	TOTAL_LOAN	SUM(CUMULATIVE_LOANS)		TOTAL LOAN represent the sum of different sectoral loans.	Million Rupees
	TOTAL_LOANABLE_FUND(t)	TOTAL_LOANABLE_FUND(t - dt) + (CHANGE_IN_LOANABLE_FUND) * dt	INIT TOTAL_LOANABLE_FUND = INITIAL_DEPOSIT+ INITIAL_CUMULATIVE_PAID_UP_CAPITAL	TOTAL LOANABLE FUND refers to the total fund available with all banks for providing loans to private sector. This stock increases/decreases with the flow, CHANGE IN LOANABLE FUND, to settle at the level of its goal, DESIRED LOANABLE FUND. It is initialized as the sum of INITIAL DEPOSIT and INITIAL CUMULATIVE PAID UP CAPITAL. Such initialization is done to reflect the concept that banks' can use their deposit and capital to provide loans to private sectors.	Million Rupees

TOTAL_REPAYMENTS	SUM(REPAYMENTS)		TOTAL REPAYMENTS refer the amount of loan settled by the borrowers.	Million Rupees/ Month
UNCOVERED_OPERATING_EXPENSES	DELAY(BANK_OPERATING_COST, ACCOUNTING_DELAY)-AVAILABLE_EARNING_TO_PAY_OPERATING_EXPENSES		It is there to take account of situation when banks do not make enough profit to cover their operating expenses which is a rare phenomenon.	Million Rupees/ month
UTILIZATION_OF_RETAINED_EARNING	IF UNCOVERED_OPERATING_EXPENSES>0 THEN MIN(RETAINED_EARNINGS/DT, UNCOVERED_OPERATING_EXPENSES) ELSE 0		It represent the amount of uncovered operating expenses that needs to be covered by utilizing retained earnings.	Million Rupees/ month
WEIGHTED_AVERAGE_FRACTION_OF_BASE_RATE_FOR_INTEREST	0.6		It represent the weighted average fraction of base rate that banks usually pay as interest rate on deposit. Deposit rate for different types of deposit are different thus for simplicity weighted average anchored to base rate is use for determining the interest rate on deposit. Such weighted average is calculated based on the actual interest rate data published in monthly financial statement of banks from 2014 to 2018.	DMNL
Base_rate_calculation:				
ANNUALIZED_BASE_RATE	BASE_RATE*MONTH_TO_YEAR_CONVERTER*100			Per Year
BASE_RATE(t)	BASE_RATE(t - dt) + (CHANGE_IN_BASE_RATE) * dt	INIT BASE_RATE = 0.0067	Base rate is the minimum rate used by the bank to determine the interest rate of loan created by it. It adjust to the desired base rate.	dmnl/month
BASE_RATE_CALCULATION_INTERVAL	1			month
CHANGE_IN_BASE_RATE	(DESIRED_BASE_RATE-BASE_RATE)/BASE_RATE_CALCULATION_INTERVAL			1/Months^2

	COST_OF_CASH_RESERVE	SMTH1((CASH_RESERVE_AT_NRB*COST_OF_FUND)/(TOTAL_LOANABLE_FUND-DESIRED_INVESTMENT_IN_GOVT_SECURITIES), BASE_RATE_CALCULATION_INTERVAL)		It represent the cost for holding cash reserved in NRB. It is calculate based on the equation dictated by NRB in circular 08-Attachment for base rate calculation. (source:Bank and Financial Institution Regulation Department. (2012a). Circular 08_Attachment for Base Rate_2069-70. Retrieved from https://archive.nrb.org.np/bfr/circular/2069-70/2069_70--Circular_08- Attachment- Base rate.pdf)	Dmnl/month
	COST_OF_FUND	SMTH1(INTEREST_PAID_TO_DEPOSITORS/CUMULATIVE_DEPOSIT, BASE_RATE_CALCULATION_INTERVAL)		COST OF FUND refers to the actual cost incurred by bank to collect deposit. It is determined based on standard formula give by NRB to different bank for the calulation of base rate. (source:Bank and Financial Institution Regulation Department. (2012a). Circular 08_Attachment for Base Rate_2069-70. Retrieved from https://archive.nrb.org.np/bfr/circular/2069-70/2069_70--Circular_08- Attachment- Base rate.pdf)	Dmnl/month
	COST_OF_SLR	SMTH1(((COST_OF_FUND-GOVT_RATE)*NET_SLR)/TOTAL_LOANABLE_FUND, BASE_RATE_CALCULATION_INTERVAL)		It represent the cost of maintaining SLR. It is calculate based on the formulation given by NRB. (source:Bank and Financial Institution Regulation Department. (2012a). Circular 08_Attachment for Base Rate_2069-70. Retrieved from https://archive.nrb.org.np/bfr/circular/2069-70/2069_70--Circular_08- Attachment- Base rate.pdf)	dmnl/month
	DESIRED_BASE_RATE	OPERATING_COST+RETURN_ON_ASSET+COST_OF_SLR+COST_OF_CASH_RESERVE+COST_OF_FUND		Desired base rate is the rate calculated based on different cost as prescribed NRB. (source:Bank and Financial Institution Regulation Department. (2012a). Circular 08_Attachment for Base Rate_2069-70. Retrieved from https://archive.nrb.org.np/bfr/circular/2069-70/2069_70--Circular_08- Attachment- Base rate.pdf)	dmnl/month

	FRACTION_OF_OPERATING_COST	0.03		FRACTION OF OPERATION COST refers to the fraction of Paid up capital that bank require to fulfill its operational expenses. Increase in paid up capital requires banks to increases its operational activities in terms of branch expansion, new recruitment, marketing expenditure to expand its loan and deposit portfolio to generate return for its investor. Thus, operating cost is anchored to paid up capital. FRACTION OF OPERATING COST is set at 2% based on the 48 months average operating cost reported in different monthly financial statement published by NRB from FY 2014/15 to 2017/18.	dmnl/month
	GOVT_RATE	0.002		It represent the average t-bill rate over the period of 49 months calculated using the data published by NRB.	dmnl/month
	MONTH_TO_YEAR_CONVERTER	12			month/year
	NET_SLR	GOVT_SECURITIES			Million Rupees
	OPERATING_COST	SMTH1((CUMULATIVE_PAID_UP_CAPITAL*FRACTION_OF_OPERATING_COST*.85)/TOTAL_LOANABLE_FUND, BASE_RATE_CALCULATION_INTERVAL)			dmnl/month
	RETURN_ON_ASSET	0.0006		It represent the return on assets dictated by NRB. (source:Bank and Financial Institution Regulation Department. (2012a). Circular 08_Attachment for Base Rate_2069-70. Retrieved from https://archive.nrb.org.np/bfr/circular/2069-70/2069_70--Circular_08- Attachment- Base rate.pdf)	dmnl/month
	Data_and_Input_variables:				

	BASE_RATE_DATA	GRAPH(TIME) Points: (0.00, 8.34), (1.00, 8.36), (2.00, 7.68), (3.00, 7.90), (4.00, 7.73), (5.00, 7.46), (6.00, 7.44), (7.00, 6.82), (8.00, 7.51), (9.00, 7.52), (10.00, 7.68), (11.00, 7.76), (12.00, 7.69), (13.00, 7.88), (14.00, 7.18), (15.00, 7.21), (16.00, 7.22), (17.00, 7.04), (18.00, 6.91), (19.00, 6.82), (20.00, 6.58), (21.00, 6.46), (22.00, 6.32), (23.00, 6.29), (24.00, 6.27), (25.00, 6.54), (26.00, 6.10), (27.00, 6.23), (28.00, 6.43), (29.00, 6.55), (30.00, 6.78), (31.00, 7.10), (32.00, 7.80), (33.00, 8.30), (34.00, 8.60), (35.00, 9.00), (36.00, 9.40), (37.00, 9.89), (38.00, 9.67), (39.00, 10.13), (40.00, 10.08), (41.00, 10.11), (42.00, 9.87), (43.00, 9.94), (44.00, 10.19), (45.00, 10.36), (46.00, 10.40), (47.00, 10.32), (48.00, 10.41), (49.00, 10.47)			DMNL

	CAPITAL_DATA	GRAPH(TIME) Points: (0.00, 84542.51), (1.00, 87454.02), (2.00, 87654.01), (3.00, 129137.03), (4.00, 91932.78), (5.00, 92152.57), (6.00, 93162.33), (7.00, 95569.55), (8.00, 95621.7), (9.00, 95968.43), (10.00, 96756.95), (11.00, 96931.78), (12.00, 96931.78), (13.00, 97921.41), (14.00, 97938.04), (15.00, 98470.76), (16.00, 99150.27), (17.00, 102989.38), (18.00, 104142.05), (19.00, 109377.84), (20.00, 111770.55), (21.00, 112480.85), (22.00, 114031.45), (23.00, 116058.92), (24.00, 117700.46), (25.00, 121090.62), (26.00, 123169.66), (27.00, 123677.05), (28.00, 131225.66), (29.00, 134507.43), (30.00, 137445.07), (31.00, 144848.62), (32.00, 148182.62), (33.00, 149867.62), (34.00, 160722.31), (35.00, 163470.57), (36.00, 165441.97), (37.00, 185010.73), (38.00, 187763.31), (39.00, 190233.64), (40.00, 195314.7), (41.00, 198269.11), (42.00, 204817.16), (43.00, 216200.25), (44.00, 216200.25), (45.00,			Million Rupees

		216588.3), (46.00, 224558.08), (47.00, 227490.22), (48.00, 227891.08), (49.00, 231457.62)			

	CCD_LIMIT	GRAPH(TIME) Points: (0.00, 0 0.8), (2.04166666667, 0.8), (3.0 (4.08333333333, 0.8), (5.10416 0.8), (7.14583333333, 0.8), (8.1 (9.1875, 0.8), (10.2083333333, 0.8), (12.25, 0.8), (13.27083333 (14.2916666667, 0.8), (15.3125 (16.3333333333, 0.8), (17.3541 0.8), (19.3958333333, 0.8), (20. (21.4375, 0.8), (22.4583333333 (23.4791666667, 0.8), (24.50, 0 0.8), (26.5416666667, 0.8), (27. (28.5833333333, 0.8), (29.6041 0.8), (31.6458333333, 0.8), (32. (33.6875, 0.8), (34.7083333333 (35.7291666667, 0.8), (36.75, 0 0.8), (38.7916666667, 0.8), (39. (40.8333333333, 0.8), (41.8541 0.8), (43.8958333333, 0.8), (44. (45.9375, 0.8), (46.9583333333 (47.9791666667, 0.8), (49.00, 0			dmnl
	DATA_CCD	LOAN_DATA/DATA_SUM _OF_CORE_CAPITAL_AN D_DEPOSIT			dmnl
	DATA_SUM_OF_CORE_C APITAL_AND_DEPOSIT	CAPITAL_DATA + DEPOSIT_DATA			Million Rupees

	DEPOSIT_DATA	GRAPH(TIME) Points: (0.00, 1 1204463.0), (2.00, 1202009.0), (4.00, 1253478.0), (5.00, 12535 1271327.0), (7.00, 1291660.0), (9.00, 1310165.0), (10.00, 1335 1370748.0), (12.00, 1408820.0) (14.00, 1451508.0), (15.00, 147 1493546.0), (17.00, 1512390.0) (19.00, 1550151.0), (20.00, 159 1579594.0), (22.00, 1633818.0) (24.00, 1666080.0), (25.00, 176 1770950.0), (27.00, 1791256.0) (29.00, 1835001.0), (30.00, 186 1913326.0), (32.00, 1945040.0) (34.00, 1952784.0), (35.00, 195 1975083.0), (37.00, 2093255.0) (39.00, 2129110.0), (40.00, 215 2174751.0), (42.00, 2197313.0) (44.00, 2206811.0), (45.00, 223 2269500.0), (47.00, 2309325.0) (49.00, 2471514.0), (50.00, 0.0)			Million Rupees

	GOVT_SECURITY_DATA	GRAPH(TIME) Points: (0.00, 153310.35), (1.00, 155190.33), (2.00, 153592.44), (3.00, 164997.58), (4.00, 165959.23), (5.00, 173661.19), (6.00, 158900.97), (7.00, 159227.29), (8.00, 154057.01), (9.00, 142287.42), (10.00, 129134.55), (11.00, 128245.72), (12.00, 130192.32), (13.00, 176214.77), (14.00, 195982.22), (15.00, 197109.91), (16.00, 174294.83), (17.00, 192874.43), (18.00, 205054.34), (19.00, 240668.26), (20.00, 188079.42), (21.00, 194474.87), (22.00, 198937.45), (23.00, 206316.2), (24.00, 198549.03), (25.00, 187275.77), (26.00, 200808.65), (27.00, 200284.95), (28.00, 190943.84), (29.00, 189673.91), (30.00, 183779.27), (31.00, 184926.13), (32.00, 172319.5), (33.00, 160726.87), (34.00, 155166.81), (35.00, 184066.19), (36.00, 189995.08), (37.00, 208699.8), (38.00, 246474.95), (39.00,			Million Rupees

		262970.43), (40.00, 269435.43), (41.00, 304509.19), (42.00, 307957.42), (43.00, 261796.05), (44.00, 252493.68), (45.00, 249827.34), (46.00, 271796.83), (47.00, 264980.64), (48.00, 273783.73), (49.00, 285849.84)			
	INITIAL_CUMULATIVE_PAID_UP_CAPITAL	84542		INITIAL CUMULATIVE PAID UP CAPITAL is the total capital of all commercial banks in the year 2013/14, the stating year of the model simulation. Its value is take from the Monthly financial statement of Mid June 2014 published NRB.	Million Rupees

	INITIAL_DEPOSIT	1144500		INITIAL DEPOSIT is the total deposit of all commercial banks in the year 2013/14, the stating year of the model simulation. Its value is take from the Monthly financial statement of Mid June 2014 published NRB.	Million Rupees
	INITIAL_GOVT_SECURITY	153310.35		INITIAL GOVT SECURITIES is the total investment of of all commercial banks in govt security instrument in the year 2013/14, the stating year of the model simulation. Its value is take from the Monthly financial statement of Mid June 2014 published NRB.	Million Rupees
	INITIAL_LOAN	866484.32		INITIAL LOAN is the total loan portfolio of all commercial banks in the year 2013/14, the stating year of the model simulation. Its value is take from the Monthly financial statement of Mid June 2014 published NRB.	Million Rupees

	LOAN_DATA	GRAPH(TIME) Points: (0.00, 866484.32), (1.00, 891629.91), (2.00, 898027.86), (3.00, 1152963.71), (4.00, 956867.01), (5.00, 961816.18), (6.00, 979122.8), (7.00, 1013720.22), (8.00, 1022477.17), (9.00, 1036450.11), (10.00, 1064241.87), (11.00, 1064534.31), (12.00, 1067505.23), (13.00, 1087486.69), (14.00, 1085346.43), (15.00, 1095095.45), (16.00, 1114024.86), (17.00, 1126820.83), (18.00, 1131595.75), (19.00, 1164772.0), (20.00, 1182750.23), (21.00, 1216790.15), (22.00, 1265200.1), (23.00, 1283033.63), (24.00, 1319986.85), (25.00, 1380358.68), (26.00, 1391616.99), (27.00, 1430928.23), (28.00, 1465349.69), (29.00, 1486321.52), (30.00, 1513094.11), (31.00, 1581702.65), (32.00, 1613599.01), (33.00, 1618719.62), (34.00, 1641457.26), (35.00, 1646360.83), (36.00, 1654818.23), (37.00, 1718131.88), (38.00, 1717629.25), (39.00, 1748490.67), (40.00,			Million Rupees

		1801567.33), (41.00, 1830197.32), (42.00, 1866030.95), (43.00, 1921446.79), (44.00, 1949973.68), (45.00, 1962073.79), (46.00, 2001609.23), (47.00, 2037616.67), (48.00, 2066045.42), (49.00, 2109245.99)			
	MODEL_CCD	(TOTAL_LOAN)/SUM_OF_CUMULATIVE_DEPOSIT_AND_CUMULATIVE_PAID_UP_CAPITAL			dmnl
	SUM_OF_CUMULATIVE_DEPOSIT_AND_CUMULATIVE_PAID_UP_CAPITAL	CUMULATIVE_DEPOSIT + CUMULATIVE_PAID_UP_CAPITAL			Million Rupees
	GDP_sector:				

	ADDITIONAL_PRIVATE_CAPITAL_EXPENDITURE	REAL_PRIORITY_SECTOR_LOAN		ADDITIONAL PRIVATE CAPITAL EXPENDITURE represents the monthly addition of bank's lending in priority sector. It take the value from REAL PRIORITY SECTOR LOANS	Million rupees 2001
	ADJUSTMENT_TIME_FOR_GDP	12		ADJUSTMENT TIME FOR GDP represent the time take to convert investment into product and services that results in GDP of a country.	month
	annualized_GDP_growth_rate	Monthly_growth_rate_of_Real_GDP^12-1			dmnl
	CAPITAL_ADJUSTMENT_TIME	3		CAPITAL ADJUSTMENT TIME refers to the time taken for the loans to be invested as capital expenditure.	months
	CHANGE_IN_PVT_CAPITAL_EXPENDITURE	MAX(0, ADDITIONAL_PRIVATE_CAPITAL_EXPENDITURE/CAPITAL_ADJUSTMENT_TIME)			Million rupees 2001/month
	CHANGE_IN_REMITTANCE	REMITTANCE*REMITTANCE_GROWTH_RATE			Million rupees 2001/month
	ELASTICITY_OF_GDP_TO_GNI	1.01		ELASTICITY OF GDP on GNI capture the change in RGNI resulted from the change in REAL GDP. Its value is determined as 1.01 based on the calculation of elasticity from the real data over the period of 16 years from 2002/03 to 2018/19. Its unit is dimensionless.	dmnl

	ELASTICITY_OF_GOVT_EXPENDITURE_ON_GDP_GROWTH	0.07		ELASTICITY OF GOVT EXPENDITURE ON GDP GROWTH captures the change in REAL GDP resulted from the change in GOVT SECURITIES, representing fund available for government expenditure. RELATIVE GOVERNMENT EXPENDITURE determines the change in government expenditure fund from initial available fund. Its value is determined as 0.07 based on the calculation of elasticity from the real data over the period of 16 years from 2002/03 to 2018/19. Its unit is dimensionless.	dmnl
	ELASTICITY_OF_PRIVATE_CAPITAL_EXPENDITURE_ON_GDP_GROWTH	0.17		ELASTICITY OF PRIVATE CAPITAL EXPENDITURE ON GDP GROWTH captures the change in REAL GDP resulted from the change in PRIVATE CAPITAL EXPENDITURE from the initial year represented by RELATIVE PRIVATE CAPITAL EXPENDITURE. Its value is determined as 0.17 based on the calculation of elasticity from the real data over the period of 16 years from 2002/03 to 2018/19. Its unit is dimensionless.	dmnl
	ELASTICITY_OF_REAL_GDP_ON_CONSUMPTION_EXPENDITURE	1.52		ELASTICITY OF REAL GDP ON CONSUMPTION EXPENDITURE capture the change in consumption expenditure resulted from the change in REAL GDP. Its value is determined as 1.5 based on the calculation of elasticity from the real data over the period of 16 years from 2002/03 to 2018/19. Its unit is dimensionless.	dmnl

	FINAL_CONSUMPTION_EXPENDITURE	REAL_INITIAL_CONSUMPTION_EXPENDITURE*((REAL_GDP/INITIAL_REAL_GDP)^ELASTICITY_OF_REAL_GDP_ON_CONSUMPTION_EXPENDITURE)		FINAL CONSUMPTION EXPENDITURE consists of all expenditure incurred by the households and residential institutional units including both government and private institution incorporated within the territory of Nepal for the satisfaction of individual/institutional needs. In this model, FINAL CONSUMPTION EXPENDITURE is calculated based on the REAL GDP and ELASTICITY OF REAL GDP ON CONSUMPTION EXPENDITURE. It is based on the assumption that consumption expenditure are elastic with respect to the GDP of the country. Since, FINAL CONSUMPTION EXPENDITURE is calculate with reference to the constant price level of 2001, its unit is Million Rupees 2001.	Million rupees 2001

	GDP_DEFLATOR	GRAPH(TIME) Points: (0.00, 2.6557), (1.00, 2.6664), (2.00, 2.6771), (3.00, 2.6879), (4.00, 2.6987), (5.00, 2.7096), (6.00, 2.7205), (7.00, 2.7315), (8.00, 2.7425), (9.00, 2.7535), (10.00, 2.7646), (11.00, 2.7757), (12.00, 2.7869), (13.00, 2.7986), (14.00, 2.8104), (15.00, 2.8222), (16.00, 2.834), (17.00, 2.8459), (18.00, 2.8579), (19.00, 2.8699), (20.00, 2.8819), (21.00, 2.894), (22.00, 2.9062), (23.00, 2.9184), (24.00, 2.9306), (25.00, 2.9533), (26.00, 2.9761), (27.00, 2.9991), (28.00, 3.0223), (29.00, 3.0456), (30.00, 3.0692), (31.00, 3.0929), (32.00, 3.1168), (33.00, 3.1409), (34.00, 3.1652), (35.00, 3.1896), (36.00, 3.2143), (37.00, 3.2306), (38.00, 3.247), (39.00, 3.2634), (40.00, 3.28), (41.00, 3.2966), (42.00, 3.3133), (43.00, 3.3301), (44.00, 3.347), (45.00, 3.364), (46.00, 3.381), (47.00, 3.3982), (48.00, 3.4154), (49.00, 3.4327)		GDP DEFLATOR is the ratio nominal GDP to real GDP. This is use to convert the nominal value to real value or vice versa. Its value is calculated from actual data.	Million Rupees/ million rupees 2001

	GOVT_CAPITAL_EXPENDITURE_TIME	9		GOVT CAPITAL EXPENDITURE TIME represents the time taken by Nepalese government to mobilize its capital expenditure budget in economy for infrastructural and development activities. Its value is estimated as 9 months based on the spending pattern of the government in different sector of economy based on government spending reported Monthly macro economic report published by Nepal Rastra Bank and Ministry of Finance. Its unit is month.	month
	"INITIAL_GROSS_NATIONAL_INCOME(GNI)"	752087		INITIAL GROSS NATIONAL INCOME is the real gross national income of Nepal in the year 2013/14, the stating year of the model simulation. Its value of 752087 Million Rupees 2001 is obtained from national accounts data published by Central Bureau of Statistics Nepal.	Million rupees 2001
	INITIAL_REAL_GDP	739754		INITIAL REAL GDP is the real GDP of Nepal in the year 2013/14, the stating year of the model simulation. Its value of 739754 Million Rupees 2001 is obtained from national accounts data published by Central Bureau of Statistics Nepal.	Million rupees 2001
	Monthly_growth_rate_of_Real_GDP	REAL_GDP/INIT(REAL_GDP)			dmnl
	NOMINAL_CHANGE_IN_REMITTANCE	GDP_DEFLATOR*CHANGE_IN_REMITTANCE		NOMINAL CHANGE IN REMITTANCE shows the value of real REMITTANCE GROWTH RATE in nominal term meaning at the current price level adjusted for inflation.	Million Rupees/ month
	NOMINAL_CONSUMPTION_EXPENDITURE	FINAL_CONSUMPTION_EXPENDITURE*GDP_DEFLATOR		NOMINAL CONSUMPTION EXPENDITURE shows the value of FINAL CONSUMPTION EXPENDITURE in nominal term meaning at the current price level adjusted for inflation.	Million Rupees
	NOMINAL_GDP	REAL_GDP*GDP_DEFLATOR			Million Rupees

	NOMINAL_GNDI	"REAL_GROSS_NATIONAL_DISPOSABLE_INCOME(RGNDI)"*GDP_DEFLATOR			Million Rupees
	NOMINAL_GNS	"REAL_GROSS_NATIONAL_SAVING(GNS)"*GDP_DEFLATOR		NOMINAL GNS shows the value of REAL GROSS NATIONAL SAVING in nominal term meaning at the current price level adjusted for inflation.	Million Rupees
	PVT_CAPITAL_EXPENDITURE(t)	PVT_CAPITAL_EXPENDITURE(t - dt) + (CHANGE_IN_PVT_CAPITAL_EXPENDITURE) * dt	INIT PVT_CAPITAL_EXPENDITURE = 123382	PVT CAPITAL EXPENDITURE represents the investment made by private sector in the economy through the utilization of priority sector loans disbursed by banks.	Million Rupees 2001
	REAL_GDP	DELAY3(INITIAL_REAL_GDP*((RELATIVE_PRIVATE_CAPITAL_EXPENDITURE^ELASTICITY_OF_PRIVATE_CAPITAL_EXPENDITURE_ON_GDP_GROWTH)*(RELATIVE_GOVERNMENT_EXPENDITURE^ELASTICITY_OF_GOVT_EXPENDITURE_ON_GDP_GROWTH)), ADJUSTMENT_TIME_FOR_GDP)		REAL GDP represent the GROSS DOMESTIC PRODUCT of NEPAL at constant price level of 2001.	Million rupees 2001
	"REAL_GROSS_NATIONAL_DISPOSABLE_INCOME(RGNDI)"	SMTH1(REMITTANCE, REMITTANCE_REALIZATION_TIME)+"REAL_GROSS_NATIONAL_INCOME_(RGNI)"		REAL GROSS NATIONAL DISPOSABLE INCOME (RGNDI) is the sum of the gross net disposable incomes of all the sectors in the economy. RGNDI equals to REAL GROSS NATIONAL INCOME (at constant prices) minus current transfers payable to non-resident units, plus current transfers (REMITTANCE) receivable by resident units from the rest of the world. It is the sum of RGNI and REMITTANCE for this model. REMITTANCE information is updated by bank on a fortnightly basis which is capture by the use of SMTH1 with a delay time of 0.5 months. Its unit is Million Rupees 2001	Million rupees 2001

	"REAL_GROSS_NATIONAL_INCOME_(RGNI)"	"INITIAL_GROSS_NATIONAL_INCOME(GNI)"*((REAL_GDP/INITIAL_REAL_GDP)^ELASTICITY_OF_GDP_TO_GNI)		REAL GROSS NATIONAL INCOME represents the total income claimed by residents of a country.	Million rupees 2001
	"REAL_GROSS_NATIONAL_SAVING(GNS)"	"REAL_GROSS_NATIONAL_DISPOSABLE_INCOME(RGNDI)"-FINAL_CONSUMPTION_EXPENDITURE		REAL GROSS NATIONAL SAVING (GNS) is derived by deducting FINAL CONSUMPTION EXPENDITURE from RGNDI, and consists of personal saving, plus business saving, plus government saving, but excludes foreign saving. It is determined on the basis of constant price level of 2001 thus it is termed as REAL GNS. Its unit is Million Rupees 2001.	Million rupees 2001
	REAL_INITIAL_CONSUMPTION_EXPENDITURE	651555		REAL INITIAL CONSUMPTION EXPENDITURE is the real consumption expenditure in the year 2013/14, the stating year of the model simulation. Its value of 651555 Million Rupees 2001 is obtained from national accounts data published by Central Bureau of Statistics Nepal.	Million rupees 2001
	REAL_PRIORITY_SECTOR_LOAN	CUMULATIVE_LOANS[loan_for_priority_sector]/GDP_DEFLATOR		REAL PRIORITY SECTOR LOAN refer to the amount of loan banks have provided in priority sector. The categorization of priority sector is given by NRB which includes agriculture, fishery, tourism, infrastructure, energy. (Bank Supervision Report 2017, NRB) https://www.nrb.org.np/contents/uploads/2019/12/Annual_Reports-Annual_Bank_Supervision_Report_2017.pdf	Million rupees 2001

	RELATIVE_GOVERNMENT_EXPENDITURE	DELAY3(GOVT_SECURITIES/INIT(GOVT_SECURITIES), GOVT_CAPITAL_EXPENDITURE_TIME)		RELATIVE GOVERNMENT EXPENDITURE is the ratio of GOVT SECURITIES and INITIAL GOVT SECURITIES. It keep record of the change in government expenditure from its initial value. A third order delay with a GOVT CAPITAL EXPENDITURE TIME is used to capture the transfer of government funds, available as securities, to actual expenditure mobilized by government. Since, it is a ratio its unit is dimensionless.	Dmnl
	RELATIVE_PRIVATE_CAPITAL_EXPENDITURE	PVT_CAPITAL_EXPENDITURE/HISTORY(PVT_CAPITAL_EXPENDITURE, TIME-1)		RELATIVE PRIVATE CAPITAL EXPENDITURE is the ratio of PVT CAPITAL EXPENDITURE and INITIAL PRIVATE CAPITAL EXPENDITURE. It keep record of the change in private capital expenditure from its initial value. Since, it is a ratio its unit is dimensionless.	dmnl
	REMITTANCE(t)	REMITTANCE(t - dt) + (CHANGE_IN_REMITTANCE) * dt	INIT REMITTANCE = 237794	REMITTANCE refers to the amount of money that is transferred by workers working in other countries to their family members in Nepal. It is a stock that increases due to the CHANGE IN REMITTANCE flow. The amount of remittance is represented in real/constant price thus tts unit is Million Rupees 2001	Million rupees 2001
	REMITTANCE_GROWTH_RATE	0.0016		REMITTANCE GROWTH RATE is the rate at with remittance inflow of Nepal has increased over the period from 2013 to 2018. REMITTANCE GROWTH RATE in the model is obtained by through net current transfer posted in the national account data for the year 2019 published by Central Bureau of Statistics Nepal. During the reference period, remittance growth rate was 2 percent per year which is converted to monthly growth rate of 0.16 percent or 0.0016. Its unit is dimensionless.	dmnl/month

	REMITTANCE_REALIZATION_TIME	0.5		REMITTANCE REALIZATION TIME refers to the time required to realize the REMITTANCE received by the bank before it is transferred to actual consumer account for final consumption which is then updated by banking channel to the central bank. It is assumed as 0.5 months for the determination of REAL GROSS NATIONAL DISPOSABLE INCOME (GNDI) under the assumption that the transfer of money from foreign nation to Nepalese bank and then to the final receiver takes times. Banks updates such information to central banks based on the changes in their balance of foreign currency. Such reporting is done twice a month. Its unit is month.	month