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Nepal

THE BANK OF KOREA

Development of a Macroeconomic Model for Economic Forecasting

THE BANK OF KOREA

YONSEI UNIVERSITY

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2017 BOK Knowledge Partnership Program Nepal

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Executive Summary

In the 21st century, Nepal has steadily built a stable political system, while achieving 4% annual GDP growth. The country also presents several opportunities, particularly with its geographical suitability for hydroelectric power. Yet, it has only been less than 20 years since its political stabilization, and its economic growth has not come at a stable pace recently, due to natural disasters such as the 2015 earthquake.

The Nepalese economy has several features of note. Chief among them is (i) the dependence on foreign remittances from laborers working abroad, which occupy up to 30% of GDP, (ii) having India as its largest and dominant trading partner, and (iii) a nominal exchange rate peg between the Nepalese Rupee and the Indian Rupee.

This study produces a tractable theory-based macroeconometric model of the Nepalese economy for policy analysis and forecasting. Two tiers of models are presented that can be adopted depending on specific needs: a small-scale macroeconomic model and a medium-scale macroeconomic model. The models take an explicit account of features specific to the Nepalese economy, such as a massive inflow of remittances from abroad, rainfalls during the monsoon season, relations with India, earthquakes and political unrest, all of which can affect the stability and performance of the economy in a critical way.

The serious lack of data has made it implausible to develop a more comprehensive and segmented model. Nevertheless, the current models are shown to provide a reasonable description of the Nepalese economy. It is also able to produce comparable predictions on the future path of economic growth and inflation. The models should be useful for understanding interactions among major sectors of the economy, evaluating the effects of policies and their implications, and generating short- and long-term projections under alternative economic environments.

This report also provides all the methodological and technical information necessary for implementing and managing the model included are a detailed explanation of the model structure, an extensive coverage of econometric Eviews programs and a step-by-step guide on how to run them. We also plan to provide a series of tutorial sessions for hand-on experience. These would help the staff at the National Rastra Bank to manage the models and update them on their own when needed. It is our hope that the models can serve the roles of assessing the economy more accurately and providing a useful guidance for the making of monetary policy in Nepal.

Ⅰ. Introduction

Nepal experienced civil war until the early 2000s followed by democratization in 2008. In 2015, a large earthquake destroyed a large portion of the industrial infrastructure, causing many deaths and casualties, and leaving much to be reconstructed. GDP per capita (in 2015) was $730, and the country's economic growth is still slower than its neighbors. Nepal also relies heavily on other economies, especially that of its geographical neighbor, India. A good example of this reliance on India's economy is the fixed exchange rate and currency pegging of the Nepalese rupee to the Indian rupee. Currently, the pegging of the Nepalese currency to the Indian one is seen as a positive influence on the Nepalese economy, but this in turn constrains independent monetary policy. Another example of reliance on foreign economies is remittances sent by Nepalese laborers working overseas, composing up to 30% of national GDP.

Nepal is regarded as having an advanced financial system relative to other economies with similar income per capita. Although there are considerable restrictions on entry into its financial services market, compared to other similar economies, Nepal has a high ratio of bank deposits to GDP. Starting from 2016, Nepal has introduced an interest rate corridor in order to improve the efficiency of its monetary policy and to stabilize financial markets. Through fiscal spending for reconstruction projects, the country is expected to reach higher growth rates than before. Given this situation, the Nepal Rastra Bank (NRB) has recognized the need for a maroeconomic model that can be used in determining economic policy, and the research group (the Yonsei University Economics Department faculty and research assistants) has taken the task of designing a macroeconomic model that incorporates the characteristics of the Nepalese economy.

The Ministry of Finance, the NRB and the National Planning Commission are the main governmental departments and agencies dealing with the Nepalese macroeconomy. Among these, the NRB is in charge of monetary policy and collects macroeconomic data. However, data is collected on an annual basis as opposed to a quarterly basis, and data systems are not as advanced as those of international organizations such as the International Monetary Fund (IMF), Asia Development Bank (ADB) and World Bank. Although several international organizations have already designed macroeconomic models for Nepal, these models have not been used widely due to their overwhelming scale and complexity.

Our first goal is to improve the efficiency of economic policy by creating an economic model of Nepal that enables predictions of macroeconomic trends. The second goal is to help the NRB's researchers to use the model by themselves and to improve the model as needed. Our third goal is to enhance the economic partnership between the Republic of Korea and Nepal through this project.

This project is composed of two components, focused on institution building and on capacity building. For institution building, we analyze the characteristics of the Nepalese economy and each institution's demands through discussions with NRB personnel and field surveys. With this foundation, we develop a model that maximizes the ability to make economic forecasts that reflect structural changes in the economy. For capacity building, we hold several educational sessions for NRB staffs on Eviews software in order to understand the model. An important goal of this project is for the NRB to forecast and improve the model on its own even after the termination of this project.

Ⅱ. Nepalese Economy and Current Issues

1. Real Sector

A. Economic Growth

The growth performance of Nepal remained subdued historically. During the last five and a half decades, the growth rate fluctuated from -1.6 percent in 1967 to 9.5 percent in 1981. The economy grew by 3.6 percent on average over the period.

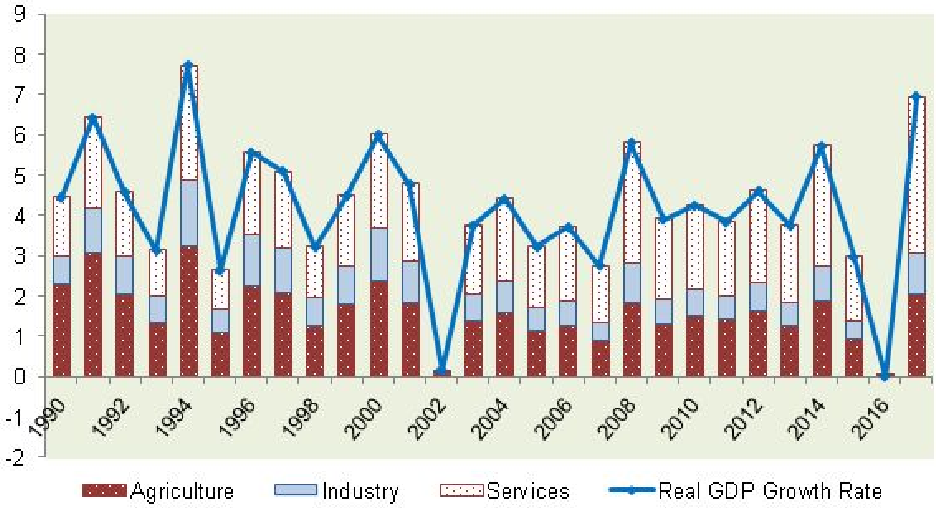
The performance of the economy was satisfactory during the 1980s as it grew by 5.2 percent on average. Likewise, the economy performed relatively better during the first half of the 1990s thanks to improved performance of manufacturing and trade along with the expansion in transport and other services following the economic liberalization policies adopted by the government. The average growth rate stood at 4.9 percent during the 1990s.

The political uncertainty following the decade-long conflict and prolonged transition reduced the productive capacity of the economy and, consequently, the growth performance did not improve further. During the last 15 years (2003 - 2017), the growth rate has been consistently below five percent except for the years 2008, 2014 and 2017.

In 2016, the growth performance of the economy was very poor due to the devastating earthquake of April 2015 and supply disruptions. However, in 2017, the economy bounced back; it has been estimated to grow by 6.9 percent underpinned by a favorable monsoon, improvements in energy supply and the ongoing post-earthquake reconstruction works (<Figure 2-1>).

<Figure 2-1>

Economic Growth Rate and Sectoral Contribution



Source: Central Bureau of Statistics

B. Sectoral Growth Performance

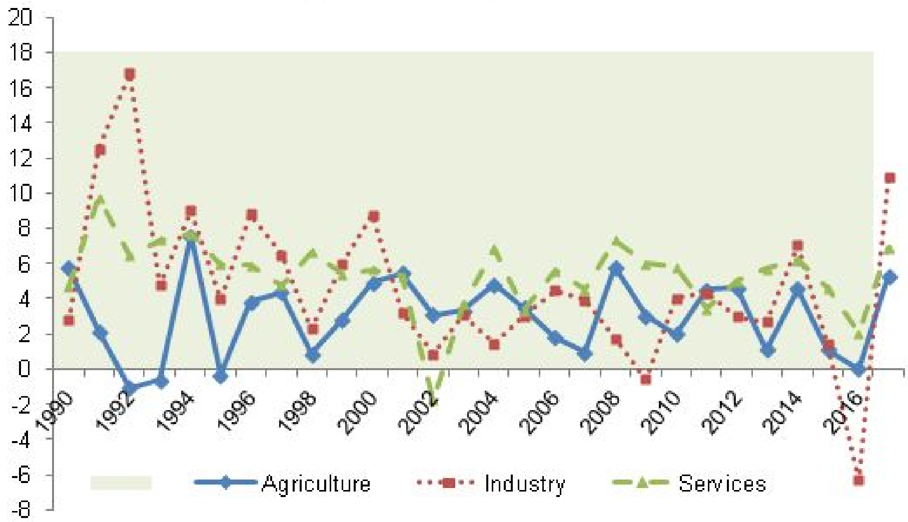
The agricultural sector was the primary driver of economic growth until 2000. Since then, the service sector has been the main contributor to growth. The contribution of the industrial sector to growth has been historically low due to its small size and weak performance. Agriculture and industrial output growth rates remained quite volatile due to the high dependency of agriculture on the monsoon, internal conflict and industrial relation problems. From 1975 to 2017, the growth rate of agricultural output has been negative in seven years, whereas the industrial output growth was negative in three years. The service sector performed relatively better, except for the years 1983 and 2002 as <Figure 2-2> illustrates.

(1) Agriculture

The agricultural sector plays a key role in economic growth and employment generation. About one-third of the gross value added comes from this sector, while it provides employment opportunities to nearly two-thirds of the labor force. However, the output growth is relatively volatile due to the high dependency on the monsoon and the adoption of subsistence farming practices. Consequently, agricultural productivity is low causing a deceleration in the expansion of aggregate output and a falling share in the gross value added of this sector.

<Figure 2-2>

Sectoral Growth Performances



Source: Central Bureau of Statistics.

Over 27 years from 1990 to 2017, agricultural output grew by 2.9 percent on average. The growth of this sector remained volatile. For instance, the average growth rate of this sector in the last decade was 3.2 percent, 4.5 percent in 2014 and 1.1 percent in 2015. In 2016, the devastating earthquake and the supply disruption affected this sector severely, resulting in almost no growth. However, agricultural output is estimated to increase by 5.3 percent in 2017 thanks to a favorable monsoon and increased forest- related output from the on-going reconstruction works. Cereal crops contribute about two-fifths of agricultural output in which more than half comes from paddy production alone.

(2) Industry

The growth of the industrial sector in Nepal has not been so promising over the past one and a half decades. The performance of industrial output was better in the late 1980s and 1990s following the economic liberalization policy. However, as the internal conflict heightened, the industrial sector deteriorated in performance due to the security and labor related problems. As a result, the contribution of industrial output in the gross value added has continuously fallen from 22.3 percent in 1997 to 14.6 percent to 2017.

Manufacturing and construction activities are the main drivers of industrial output. More than 85 percent of industrial output comes from these activities. The electricity sector, though having a huge potential for expansion, contributes only eight percent of industrial output and less than two percent of the gross value added of the economy.

Over the past 27 years, industrial output grew by 4.7 percent on average. During the 1990s, industrial output grew by 7.9 percent but was limited to 2.5 percent in the 2000s and 3.3 percent on average after 2010. In 2016, industrial output contracted by a historical record of 6.3 percent due to the disruptions caused by the earthquake. In 2017, output rebounded and grew by 10.9 percent underpinned by the reconstruction activities taking place in the economy.

(3) Services

The service sector has been the primary driver of growth in recent years. After the country adopted economic liberalization policies in the early 1990s, the relative size of this sector increased substantially. Its share in the gross value added stands at 56 percent in 2017. Wholesale and retail trade, transport and communication, real estate and education are the major drivers of services sector output. More than two-thirds of the services sector output comes from these activities.

Over the past 27 years, service sector output grew by 5.4 percent on average. During the 1990s, output grew by 6.6 percent, while the services growth rate dropped to 4.7 percent in the 2000s and increased marginally to 4.9 percent on average after 2010. The growth of the service sector decelerated in 2016 due to the adverse impact on trade and tourism activities from the earthquake. However, in 2017, trade, tourism and social sector activities have expanded and the overall services sector is estimated to grow by 6.9 percent.

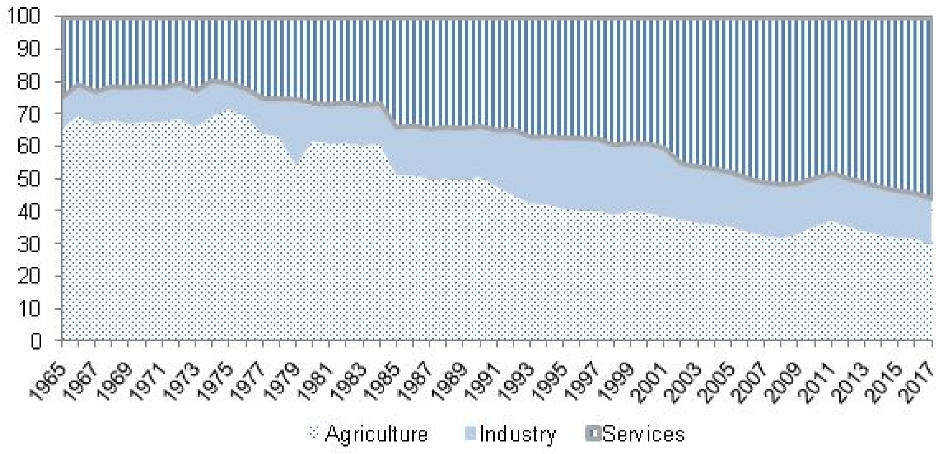
C. Pattern of Structural Change

There has been a gradual shift of economic activities from agriculture to service sector over the past five decades. The relative contribution of agriculture sector in gross value added (GVA) has been falling over time and that of the services sector is rising, while the industrial sector has not increased significantly in terms of GVA. In 1965, the share of the agriculture sector in gross value added was 65.2 percent, which increased to 71.6 percent in 1975. This share has gradually fallen over time and reached 29.4 percent in 2017 (<Figure 2-3>).

On the other hand, the share of the non-agricultural sector has increased from 34.8 percent in 1965 to 70.6 percent in 2017. Within the non-agricultural sector, the service sector has grown a lot in terms of its contribution to gross value added. The share of this sector in GVA was 24.5 percent in 1965 gradually increasing to 56.0 percent in 2017. The relative contribution of the industrial sector, however, has been relatively stagnant. Its share in GVA was 10.3 percent in 1965 which gradually increased to 22.3 percent in 1996, and has fallen persistently thereafter to 14.6 percent in 2017.

<Figure 2-3>

Sectoral Composition of GDP



Source: Central Bureau of Statistics.

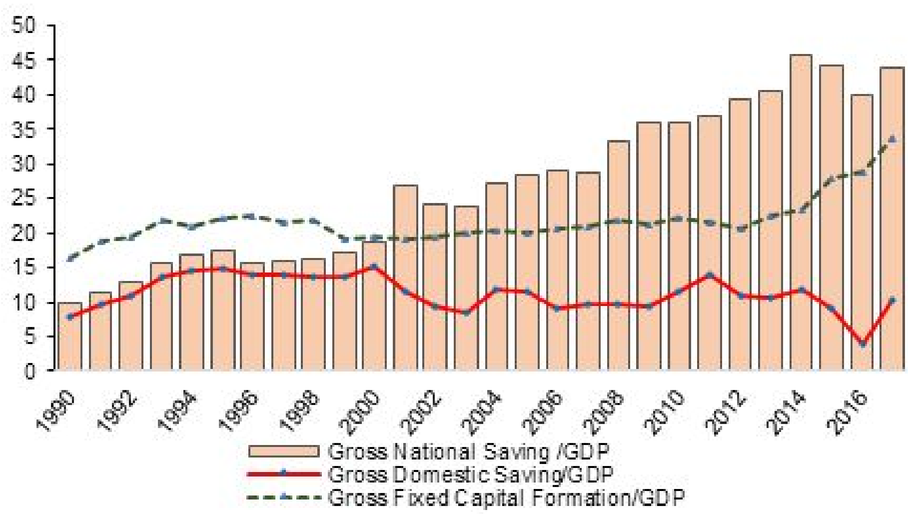
D. Consumption, Saving and Capital Formation

The consumption expenditure of the economy relative to the output produced indicates the availability of resources that can be leveraged for capital formation so as to increase the productive capacity of the economy. A high consumption ratio implies that there remains a dearth of resources for enhancing the productive capacity through investment in capital goods.

In Nepal, consumption expenditure compared to domestic production is very high: the consumption to gross domestic product ratio is around 90 percent, which leaves some room for utilizing the resources for capital formation. During the past four decades, the consumption expenditure to GDP ratio was 88.8 percent on average, fluctuating between 84.8 percent and 96.2 percent. The ratio was 89.6 percent in the 1980s, and fell to 86.6 percent in the 1990s. The ratio again increased to 89.7 percent in the 2000s and 89.9 percent during 2011-2017. In 2016, the ratio reached a historical high of 96.2 percent, and is estimated to fall to 89.7 percent in 2017 as can be seen in <Figure 2-4>.

<Figure 2-4>

Saving and Investment, as Percent of GDP



Source: Central Bureau of Statistics.

As a consequence of high consumption expenditure coupled with the slow increase in productive capacity, the domestic saving ratio has been persistently low for the past four decades (11.2 percent on average). This ratio increased to 13.4 percent during the 1990s, from 10.4 percent in the 1980s, but declined to 10.3 percent in the 2000s. During 2014 to 2016, the ratio declined sharply from 11.9 percent to 3.8 percent, the lowest level in the past four decades. In 2017, the domestic saving ratio has been estimated to rise to 10.3 percent. On the other hand, the gross national saving ratio of the economy is higher than the domestic saving due to remittance inflows and transfer earnings. This ratio reached a historical high of 45.7 percent in 2014.

The gross fixed capital formation (GFCF) to GDP ratio averaged 20 percent during 1975-2017. This ratio is low in comparison to other low income countries in South Asia. During the late 1970s the GFCF ratio was only 14.9 percent, which reached 17.8 percent during 1980s and further increased to 20.8 percent during 1990s. There was no further improvement in fixed capital formation, and the GFCF to GDP ratio has remained at around 20 percent until 2013. Recently, the GFCF ratio has been gradually increasing from 23.5 percent in 2014 to 33.8 percent in 2017.

The private sector has been playing a dominant role in fixed capital formation of the economy. During the past four decades, the share of the private sector in capital formation was 70.3 percent on average. The contribution of the private sector in capital formation decreased during the late 1970s and 1980s and reached a historical low of 51.8 percent in 1989. During the 1990s, the contribution of the private sector averaged 66.2 percent, while remaining at 75 percent after 2001.

E. Issues and Challenges

The major issues and challenges of the real sector are as follows:

- Achieving the targets as set in the annual budget, periodic plans and long-term development goals has been a challenge.
- Timely completion of reconstruction works by providing adequate resources for the reconstruction of private residences, schools, health post and public buildings, cultural heritages and, physical and social infrastructures has been

a challenge.

- Even though local level elections have been held in an attempt to implement federalism in government, in practice, developing infrastructure at federal, provincial and local levels as per the federal structure is a daunting task under the existing institutional framework.
- The increasing dependency of the country on foreign employment has made the economy vulnerable to external shocks. Creating employment opportunities at home and reaping a demographic dividend by developing human resources as per the national priority and demand has been a challenge. In addition, slowing down remittances growth, along with the low spending capacity of the government could put a limit on the deposit growth and flow of new credit.

F. Growth Outlook

Nepal's growth prospects seem promising. Due to the improved supply of electricity, increased provision of physical infrastructure, expected pick-up of the reconstruction activities and increasing expenditure at the local level through newly elected local bodies, a positive outlook of economic growth is warranted in the short to medium-term.

The poor capital budget spending capacity of government is expected to improve as the continuous economic reform process for government budgetary operation is underway. Furthermore, the investment environment for domestic and foreign investors is being enhanced and made conducive. Thus, a higher investment flow in sectors like agriculture, construction, hydropower, and tourism is expected to take off.

It is expected that programs and policies targeted to achieve Nepal's long-term economic goals of graduating from least developing country (LDC) status by 2022 and upgrading to middle income country status by 2030 will enhance the growth performance of the economy in the years to come.

2. External Sector

A. Historical Background

Comprehensive recordings of external sector activity started in Nepal from 1956. However, much evidence points to the prevalence of foreign trade with India and Tibet long ago. Nepal's trade relations took on momentum with the dawn of democracy in 1950. Since then, an unfavorable trade balance has been experienced continuously, as exports grew by only 765 times, whereas imports grew by 5828 times from 1956 to 2017. However, foreign exchange reserves have often been increasing since mid-July 1957 as a result of surplus in the balance of payments. The terms of trade (ToT) and International Investment Position (IIP) statistics also indicate that Nepal's external sector has been remaining stable despite a huge trade deficit.

There was a control regime in place for the external sector until the end of 1980s. Merchandise exports and imports increased by 54 times and 107.9 times respectively during 1957 to 1990. In 1957, the shares of merchandise exports and imports in total trade were 36 percent and 64 percent respectively. Such ratios changed to 22 percent and 78 percent respectively in 1990. The average annual growth rate of merchandise exports and imports remained at 15.6 percent and 16.9 percent respectively during that period. The current account remained in deficit throughout the period except in the years 1976, 1977 and 1978. Despite the unfavorable trend of foreign trade, the size of foreign exchange reserves increased by 381.9 times during that period due to surplus balance of payments in all years except in 1966 and 1983-1985.

B. External Sector After 1990

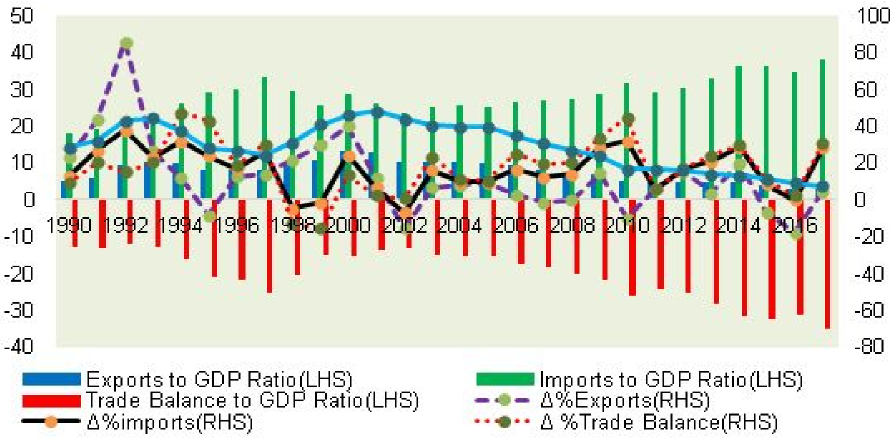
Following the restoration of multi-party democracy in 1990, the country adopted economic liberalization policies. This brought changes in economic dimensions, as the Nepalese currency was made convertible for current account transactions. The peg to the Indian currency was revised and fixed at NPR 1.60 per Indian rupee, widespread inflows of foreign direct investment were allowed, and the open general license system for imports was adopted. Foreign employment has also gained momentum since then. In 2004, the country became a member of the World Trade Organization (WTO), Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), and South Asian Free Trade Area (SAFTA).

During 1990-2017, as a result of several policy reforms, trade facilitation initiatives, and trade and treaty agreements which occurred along with energy shortages, internal conflicts and political transition, the external sector showed mixed performance. The average shares of exports and imports in total trade remained 21.7 percent and 78.3 percent respectively during that period. The average ratio of exports to imports remained at 28.9 percent. However, this ratio has been falling over the period owing to the increasing size of imports. Moreover, the average growth rate of merchandise exports and imports remained 12.4 percent and 16.4 percent, respectively, resulting into a widening trade deficit by 17.7 percentage points on an average. The performance of the exports sector, in terms of its share in total trade, was relatively better until 2002. On the other hand, imports grew significantly during the first half of the 1990s and the second half of 2000s and beyond. Exports declined and imports slowed down in 2016 due to the earthquake of April 2015, and obstructions in major southern custom points in 2016.

External sector performance changed in 1990-2017. The current account remained in deficit during the 1990s except 1990. After 2000, it recorded surpluses throughout the period except in the years 2007, 2010 and 2011. The overall balance of payments remained in surplus for almost all years except in 1995, 1996, 2002, and 2010. The current account and overall balance of payments remained in surplus in the later period mainly due to a massive inflow of remittances from abroad. However, the current account slipped into deficits by USD 93.5 million, and consequently balance of payments surplus narrowed down to USD 0.7 billion in 2017 on account of significant growth in imports, and a decelerating growth of remittances. <Figure 2-6> shows that the foreign exchange reserves, which reflects the overall balance and exchange rate movement, grew by 20.2 percent on average, and its ratio to GDP remained 24.6 percent on average during the period.

<Figure 2-5>

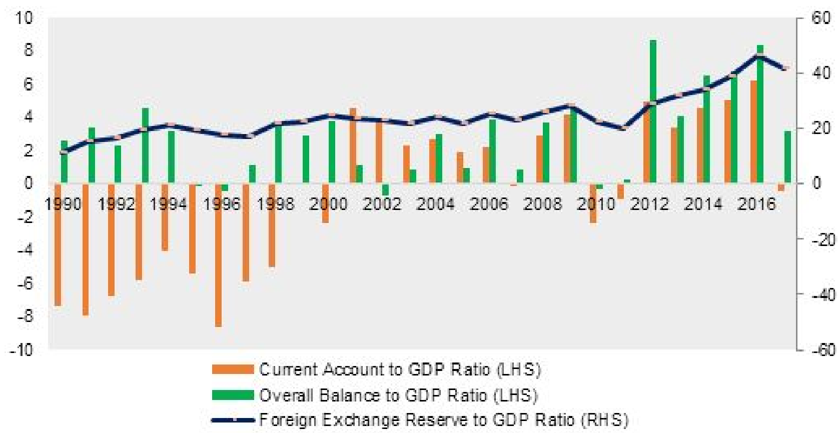
Foreign Trade Position



Source: Nepal Rastra Bank

<Figure 2-6>

Current Account, Balance of Payments and Forx Reserves

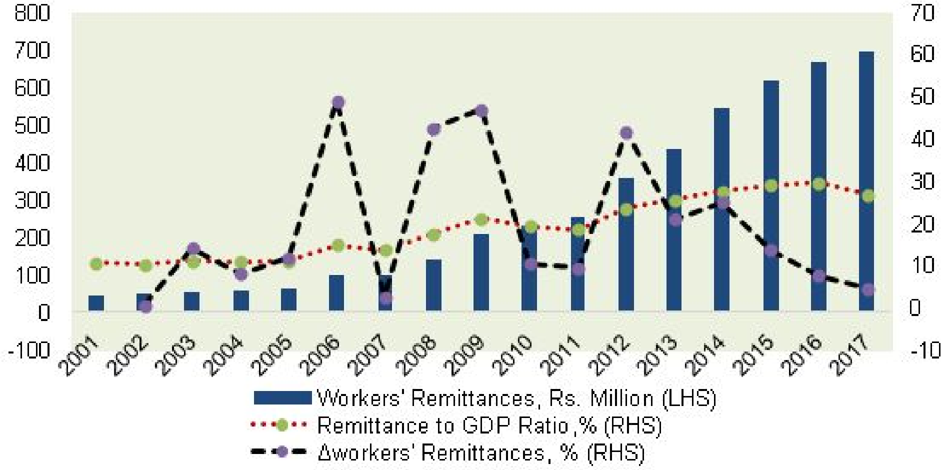


Source: Nepal Rastra Bank

As foreign employment took on momentum after the liberalization policy adopted in the early 1990s, workers' remittances became one of the main sources of external sector stability in Nepal. Remittances grew by 19.3 percent on average during 2001-2017 as <Figure 2-7> depicts. The ratio of remittances to GDP, which was 10.7 percent in 2001, increased to 13.8 percent in 2007 and 26.8 percent in 2017.

<Figure 2-7>

Worker's Remittances



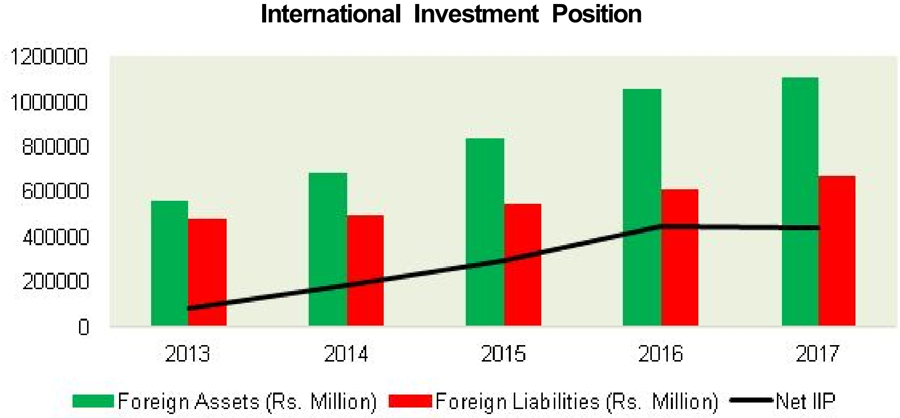
Source: Nepal Rastra Bank

C. International Investment Position and Terms of Trade

The net IIP has remained in surplus since its compilation was initiated in 2013, as can be seen clearly in <Figure 2-8>. Likewise, ToT, also available since 2013, shows that export prices have been increasing, while import prices remained largely stable over the period. As a result, the ratio of export to import price index (ToT) has been improving. Despite the improvement in ToT, Nepal has been unable to exploit the benefits of this due to stagnant exports (See <Figure 2-9>).

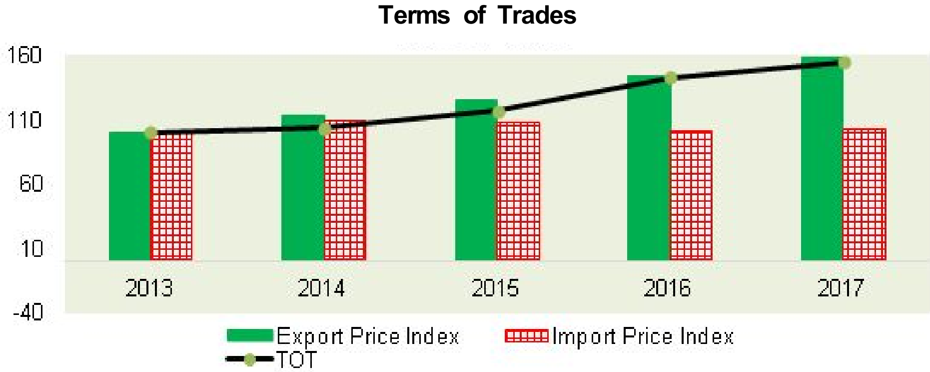
Following the global financial crisis, there was a decline in the number of Nepalese migrating workers abroad resulting into a slowdown in remittance inflows. Consequently, the growth rate of remittances stood only at 10.5 percent in 2010 and 9.5 percent in 2011. Remittances alone contributed more than 50 percent in total foreign exchange receipts of the country. However, the growth of workers' remittances has been decelerating since 2014 due to the fall in number of workers going abroad. There is a concentration risk on workers' remittances from four destination countries: namely, Malaysia, Qatar, Saudi Arabia and UAE, which account for about 90 percent of total workers abroad in 2017.

<Figure 2-8>



Source: Nepal Rastra Bank

<Figure 2-9>



Source: Nepal Rastra Bank

Despite the increasing trade deficits, the overall external sector of Nepal remained stable in recent years due to the inflows of transfer receipts. As a result, there have been adequate foreign exchange reserves for import and debt financing. However, broadening and heightening imports, stagnant exports, concentrated foreign employment, declining growth of workers' remittances, and absence of reliable alternatives to workers remittance as a source of foreign exchange earnings, are warning for the sustainability of the sector.

D. Issues and Challenges

The major concerns facing the external sector of the Nepalese economy are smaller size and stagnant merchandise exports and galloping merchandise imports, resulting into the ever increasing trade deficits. Though these worries are somehow shaded out by the solid inflows of workers' remittances in recent years, this may not be sustainable in the long run on account of the fall in number of workers going abroad. The main issues pertaining to the external sector are as follows.

- The size of merchandise exports remained almost stagnant and the basket has not expanded in the last decade. The export basket consists of major products either of unprocessed agricultural goods or products produced using imported raw materials. Additionally, Nepal's external trade is also constrained by its landlocked geography. Thus, producing high value products and increasing its export base along with easing the access to international market remains a challenging task.
- The size of merchandise imports increased continuously throughout the period. In recent years, merchandise imports are comprised of a significant volume of basic goods like rice, vegetables, medicine, edible oils, and live animals among others. Thus, the management of galloping imports and widening trade deficits is another challenge.
- The size of merchandise exports was almost half of service exports in the past couple of years. Foreign direct investment companies are also focused on service related industries than manufacturing. The reasons may be geography, access to markets, availability of raw materials, potential of manufacturing and service industries, and so on. Hence, enlarging the manufacturing export base has remained a challenge.
- There are multiple roles of workers' remittances in Nepal. Empirical evidence shows that it has reduced the poverty level, managed unemployment and narrowed income inequalities. In addition, it has also helped enhance the socio-economic status of the people and expanded the banking system. However, the Gulf and Malaysia comprise around 95 percent of total outbound workers and around 70 percent of total remittances inflows. The risk is that any economic downturn in these countries can be easily

transmitted into Nepal. Thus, the challenge is to diversify the destination countries of workers going abroad.

- Galloping merchandise imports has been supported by the inflows of workers' remittances. The remittances to import ratio was around 71 percent in 2017, and it contributed for more than 50 percent in total foreign exchange receipts. Workers remittances have been playing a key role for external sector stability. Any downturn in remittances may bring about a gap in external sector balance. It is a challenge of the economy to develop alternative sustainable sources of foreign exchange earnings on account of the declining growth of remittances.

E. External Sector Outlook

The manufacturing sector performance is determined by the political environment, labor relations, and availability of infrastructure. There have been some improvements in these aspects which are expected to continue. Hence, merchandise exports are expected to take on momentum in both the short and medium term.

The ongoing reconstruction of damage from the earthquake and start of constructing several mega projects requires a huge amount of construction materials and machineries. Even if Nepal has been producing significant volumes of cement and metal related products recently, this may not be sufficient for fulfilling the total demand. Thus, the size of imports is expected grow in the short run, but may be moderated in the long run after completion of reconstruction works and national pride mega projects.

The size of workers' remittance depends upon the number of workers going abroad, stock of workers abroad, their wages and salaries, economic activities of the destination country, tendency to shift from low to high paying jobs, job opportunities available in the home country, prevailing exchange rate, medium of remitting money, and so on. The workers' remittance is expected to increase in the short run, but it may remain stagnant in the medium run.

There is a huge prospect of foreign direct investment in Nepal. It has been indicated by the foreign direct investment (FDI) commitment of USD 13.74 billion by investors from different countries at the Investment Summit held in

March 2017. Gradual improvements in legal, institutional and business environment are essential for materializing this.

3. Prices and Monetary Developments

A. Inflation

(1) Consumer Price Inflation

Maintaining price stability is the primary goal of the central banks worldwide. The Nepal Rastra Bank Act of 2002 has given the mandate of price stability as one of the three objectives assigned to the NRB. The NRB gets the target from the government and works to contain inflation within the given target. The structure of inflation and its current status is discussed in the following sections.

(a) Structure of Inflation

The structure of inflation indicates the weights of the consumable basket that the NRB uses while compiling consumer price inflation. This structure has a substantial role in determining price development as well as the policy effectiveness of the central bank.

Nepal's inflation structure has been reorienting towards the non-food and services. Still, the size of food is substantial in the consumption basket. For instance, the Household Budget Survey of 2015 concluded that about 44 percent weight has to be given to food and beverage. <Table 2-1> shows that cereal grains and their products alone have more than 11 percent weight. Price stability is challenging in Nepal due to the large weight on food items in the consumption basket, and relatively higher volatility of food prices relative to non-food and services.

<Table 2-1>

Consumer Price Index Weight of Selected Commodities

Particulars	1995/96	2005/06	2014/15
Food and Beverage	53.2	46.8	**43.9**
Cereal grains and their products		14.8	11.3
Vegetable		5.7	5.5
Meat and fish		5.7	6.8
Milk products and eggs		5.0	5.2
Non-food and Services	46.8	53.2	**56.1**
Clothes and footwear		8.5	7.2
Housing and utilities		10.9	20.3
Transportation		6.0	5.3
Education		8.5	7.4

Source: Nepal Rastra Bank

(b) Status of Prices

Nepalese inflation remained at above the targeted level most of the time, near double digit levels. The average consumer price inflation has been 8.5 percent since 1974. The food inflation has been 9.0 percent, while non-food and services 8.2 percent in that period. <Table 2-2> shows that Inflation relatively moderated after the economic liberalization programs of the 1990s, which further eased during the first decade of the 2000s. Inflation remained very low in late 1999 and early 2001 as <Figure 2-10> illustrates.

< Table 2-2>

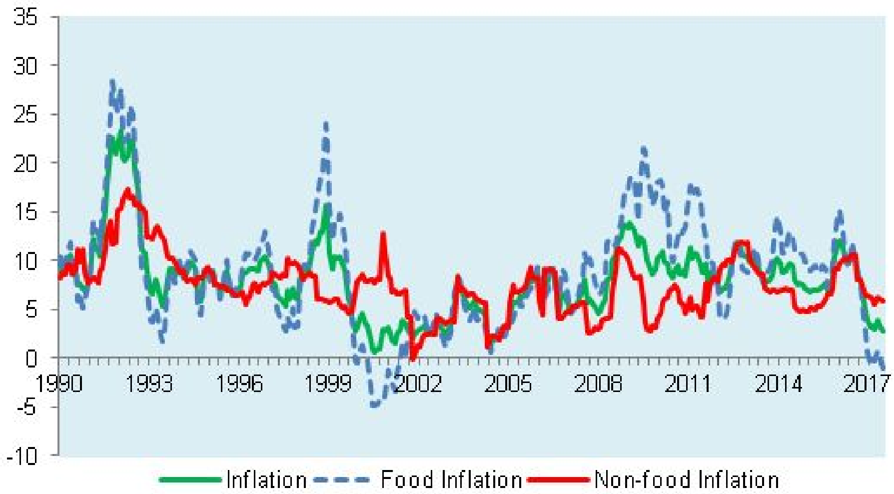
Historical Rate of Inflation in Nepal (Period Average)

Period	Overall	Food	Non-food and Services
1974~1990	9.3	9.3	9.7
1991~2000	9.4	9.5	9.1
2001~2010	6.4	7.7	5.4
2011~2017	8.4	9.3	7.6

Source: Nepal Rastra Bank.

<Figure 2-10>

Monthly Inflation Rate Movements: 1990 Jan - 2017 June



Source: Nepal Rastra Bank.

(c) Recent Scenario

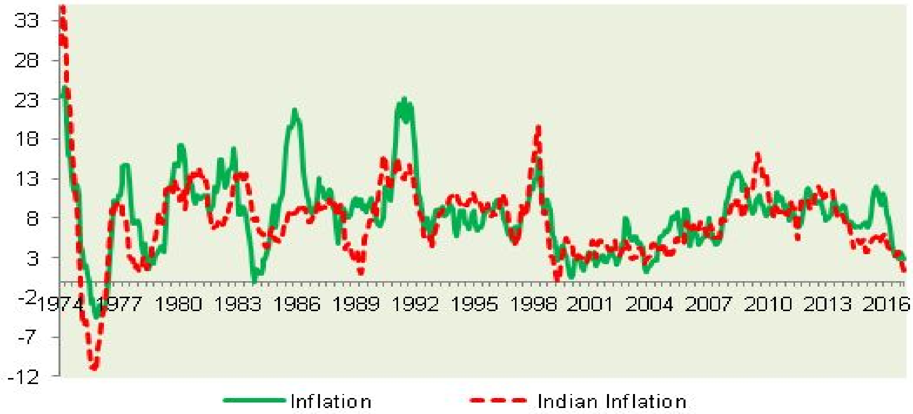
Due to the earthquake of April 2015, and the supply disruptions following the obstruction in the southern border during October 2015 to early 2016, consumer price inflation was at almost double digit levels in 2016. Since then, it has moderated. The annual average CPI inflation eased to 4.5 percent in 2017 from 9.9 percent in the previous fiscal year. Within the CPI, food inflation increased by 1.9 percent in 2017, from 10.9 percent in the previous year. Likewise, non-food inflation also moderated to 6.5 percent in 2017, compared to a 9.2 percent in the previous year. The decline in growth rate of prices of clothes and footwear, communication, transport among others, caused the moderation in non-food inflation in this period.

(2) Inflation differential between Nepal and India

Nepal has a pegged exchange rate regime with India. Thus, the price differential between India and Nepal has a substantial role in Nepal's inflation. This can be understood from <Figure 2-11>, which shows that the inflation differential between Nepal and India is minimal historically in recent years.

<Figure 2-11>

Monthly Inflation of Last 43 Years: Nepal and India



Source: Nepal Rastra Bank

<Table 2-3> shows that there was a wider gap in 2016 due to the supply constraints caused by obstructions in the southern border following the earthquake.

<Table 2-3>

Consumer Price Inflation Differentials between Nepal and India

Year	Nepal	India	Deviation
2015	7.2	5.3	1.9
2016	9.9	5.2	4.7
2017	4.5	3.4	1.1

Source: Nepal Rastra Bank

(3) Issues and Challenges

Despite low global inflation, Nepal has faced higher and more volatile inflation in the past. The following are the major issues and challenges.

- The first issue of inflation is the effectiveness of central bank policies in inflation control. This is because the NRB has multiple legal mandates that impede on the sole focus of price stability. Likewise, a less developed financial market also weakens the transmission mechanism of monetary policy.
- Structural factors such as difficult geography and landlockedness,

infrastructural constraints along with weak supply management system, among others, also affect inflation, which are beyond the control of the NRB.

- Nepal's inflation is strongly influenced by supply side factors, such as transportation, market competitiveness among others. This has further limited in the role of the central bank to contain inflation through the demand side.
- Nepal has a pegged exchange rate regime with India. It has been supportive in bringing price stability, since the level of prices move closely between Nepal and India. On the other hand, if prices go up in India, the NRB has limited control over it.
- In short, inflation is much affected by structural factors in Nepal than the demand factors alone. Containing inflation requires having proper coordination among monetary, fiscal and other direct policy measures.

(4) Inflation Outlook

Recently, consumer price inflation has remained on the lower side. In the past decade (2007-2017), inflation remained below 5 percent mainly due to lower inflation in India, an improved supply situation domestically, as well as the base effect of the previous year. Looking beyond, the government has set a 7 percent target for inflation in 2018. Likewise, Nepal's 14th Development Plan (2017-2019) has also aimed at containing inflation within 7 percent. The recent initiatives, such as introduction of interest rate corridor and more active open market operations for instance, undertaken by the NRB will help rein inflation within target. Moreover, India has set a clear path of monetary policy towards inflation targeting with a range of 4±2 percent. This would also help contain inflation at a lower level. Thus, inflation is expected to remain within the upper limit of 7 percent in the medium term.

B. Exchange Rate

(1) Historical Context

Exchange-rate management in Nepal started following the establishment of the NRB in 1956. A market determined exchange rate was in practice until 1960 before fixing the exchange rate of the Nepalese currency (NC) with the Indian currency (IC). Since then, the exchange-rate regime has evolved from a managed peg to a peg based on a basket of currencies (1983-1992), and then to the current pegged regime with IC (NRB, 1996). Since February 1993, Nepal has been maintaining a pegged exchange rate regime with IC at a constant rate of Rs. 1.6 per IC. The exchange rate for US dollar is set through the cross-rate of IC, while the rate for other foreign currencies are set based on the exchange rate movements with the US dollar.

(2) Movements in the Nominal Exchange Rate

Although the pegged exchange rate with the Indian currency has maintained the exchange rate stability with the Indian currency, exchange rates with other convertible currencies remained volatile. Nepal's nominal exchange rate with the US dollar (USD) has been depreciating significantly over time. For instance, <Figure 2-12> shows that NPR per USD was Rs. 18.30 in January 1985, Rs. 42.80 in July 1991, Rs. 49.84 in January 1995, Rs. 71.11 in January 2005 and Rs. 108.9 in December 2016.

<Figure 2-12>

Monthly Exchange Rate Movements: 1990 Jan - 2017 June

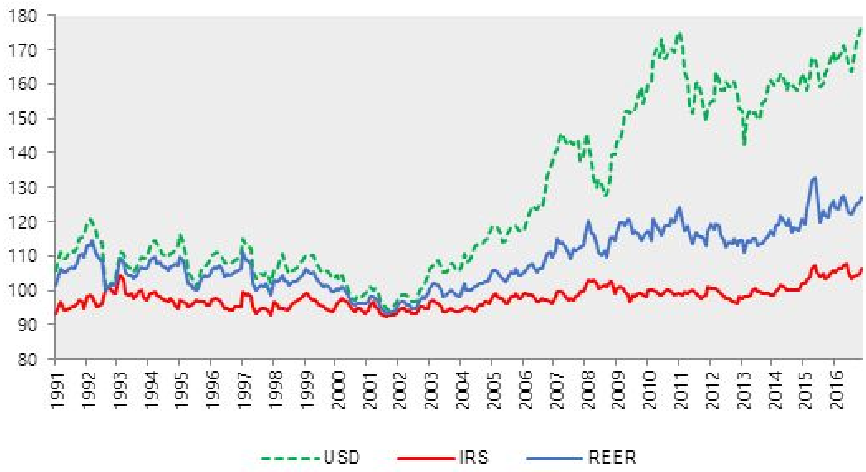
Source: Nepal Rastra Bank

(3) Real Exchange Rate

Using the consumer price index of advanced economies and consumer price index of India, the real exchange rate (RER) can be calculated. Despite NC-IC rate being maintained at the equilibrium level, the RER of NC with the US dollar is found to be overvalued significantly. For instance, during the period of August 1991 to January 2017, the NC-IC RER is found to be more or less in equilibrium but at a cost of allowing the US dollar to appreciate freely.

<Figure 2-13>

Real Exchange Rate Movements, 1993-2017



Source: Nepal Rastra Bank

Though the RER was close to the equilibrium and even undervalued from the beginning of 2001 to mid-2003, the rate increased thereafter, peaking at 175.1 on August 2011. The trade weighted real effective exchange rate (REER) also shows an overvaluation of the Nepalese Currency.

(4) Exchange Rate and Inflation Interactions

The impact of the exchange rate on the domestic prices is considered prominent in the small open economies like Nepal. There will be a lower level of exchange rate pass through in an economy, if inflation is stable and at a low level (Gagnon and Ihrig (2004), Choudri and Hakura (2006), Devereux and Yetman (2010)). Likewise, the pass-through would be higher from exchange rate change, if inflation is unstable and relatively high. Empirical and behavioral observations indicate that due to the pegged regime, coupled with substantial trade concentration, long open border among others, inflation in Nepal is found to be primarily determined by Indian inflation (ISD, 1994; NRB, 2007; NRB, 2001). The graphical plot of the monthly series of inflation from 1974 to 2017 also shows strong co-movements with Indian inflation, indicating strong evidence of full pass-through. This implies that the pass-through is much stronger after 1993 as shown by <Figure 2-11> above.

(5) Issues and Challenges

Nepal's exchange rate policy has been an issue as the economic reform agenda. The policy adopted in the 1960s has been still maintained. The level of peg has not been revised in the past 24 years. The peg with the Indian rupee has created a greater volatility of the exchange rate with other convertible currencies, which makes Nepal vulnerable to price shocks in trade with third countries. Furthermore, the pegged regime limits monetary policy autonomy unless capital account controls are properly enforced. Although a pegged regime has been supportive in maintaining a low inflation environment, its impact on economic growth and foreign trade has not been desirable as expected. Its role in attracting FDI from India may be positive, while that from other countries seems inconclusive.

In contrast, most of the literature argues that a pegged exchange rate regime has been an ideal option for Nepal given its small size, and long open border, high factor mobility, and high trade concentration with India. By eliminating the exchange rate risk, the pegged exchange rate regime lowers transaction costs and facilitates trade flows between Nepal and India. Furthermore, the pegged exchange rate provides a nominal anchor for monetary policy and helps maintain monetary and price stability.

(6) Exchange Rate Outlook

Since NC is pegged with IC, there would be no variation in the exchange rate between them. In the case of other currencies including the US dollar, the rate depends upon the Indian economy and the demand situation for the US dollar itself. Observing global economy, as well as the Indian economy, the exchange rate should not move drastically from the current level in the medium term.

C. Monetary Sector

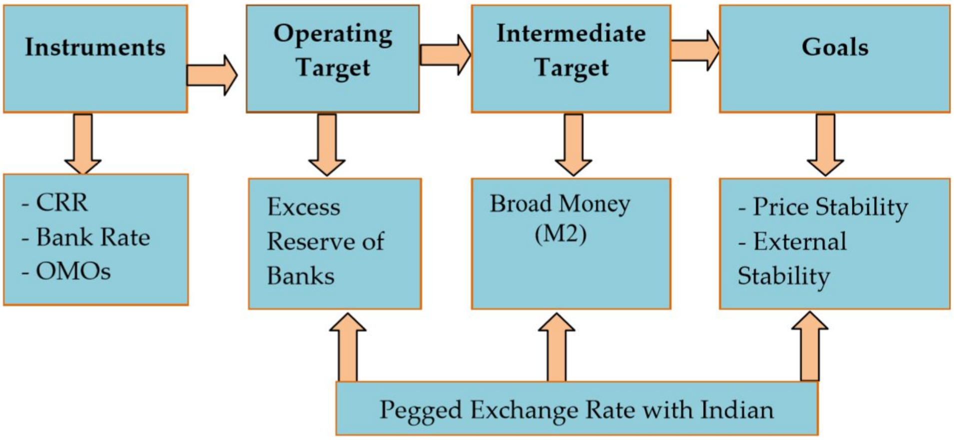
(1) Monetary Policy Framework

The history of monetary sector development in Nepal dates back to the 1960s after the establishment of Nepal Rastra Bank (NRB) in 1956. At that time, the primary responsibility of the NRB was to establish the foundation of banking and payment system development. This process continued until the first decade of the establishment of the NRB. In subsequent decades, the NRB gradually introduced various monetary and credit policy instruments. Until 2003, these instruments used to be implemented through the issuance of circulars or directives (NRB, 1996) instead of formulating and formally announcing the monetary policy document. Following the promulgation of new NRB Act in 2002, the monetary policy formulation process gradually became more consultative and participative. The internal work processes have also been redesigned with more focus on technical analysis and coordination within the bank as well as related stakeholders outside. With the view to making monetary policy assessment and communication more effective, the NRB has also initiated a quarterly policy review since 2017.

Maintaining stable prices and favorable balance of payments are the mandated goals of monetary policy in Nepal. Moreover, ensuring financial sector stability, facilitating economic growth and promoting access to finance are the other objectives of monetary policy. The NRB's monetary policy statement also incorporates a broad set of policy measures including monetary, financial and foreign exchange management policies. Monetary and financial sector policies are coordinated through macro-prudential measures.

<Figure 2-14>

Monetary Policy Framework of Nepal



Source: Nepal Rastra Bank

Given the pegged exchange rate with the Indian currency, broad money (M2) has been taken as an intermediate, and excess reserves of banks and financial institutions as an operating target of monetary policy in Nepal. Accordingly, the NRB estimates the targeted growth rate of monetary aggregates following the quantity theory approach and tries to achieve the target by affecting the reserves of the banking sector. Under this approach the target of monetary aggregates is set on the basis of growth and inflation projections. Moreover, the NRB also takes into account the short-term interest rates to affect the quantity of money. However, concerns are being raised whether the choice of quantity and price at the same time can be effective policy strategy (See <Figure 2-14>).

(2) Money Supply

The broad money supply (M2), which is taken as an intermediate target of monetary policy, increased by an average rate of 18 percent during the past 28 years (1990-2017). However, the growth rate has not been stable over the period recording the lowest rate of 4.4 percent in 2002 and the highest of 28 percent in 2011. The main reason for slowdown in the growth of money supply during the first half of the 2000s was slower growth of credit to the private sector owing to the ongoing political insurgency in the country. Prior to 2011, the monetary survey was constructed using the balance sheet of commercial banks (A class) only. Since 2011, the survey incorporated the balance sheets of all A, B and C class banks and financial institutions, resulting in a higher growth of M2 in 2011 as can be seen in <Figure 2-15>.

<Figure 2-15>

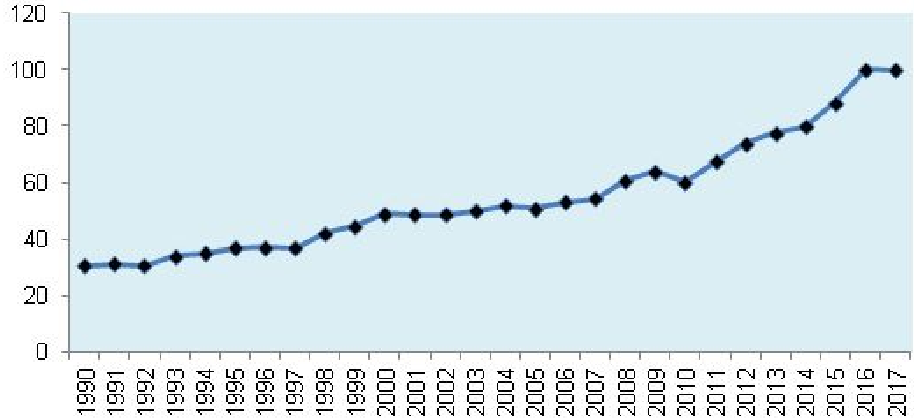
M2 Growth (y-o-y)

Source: Nepal Rastra Bank

There has been a remarkable shift in the level of monetization in the economy especially after 2000. The M2/GDP ratio, which stood at 30.5 percent in 1990, and 50 percent in 2002, reached to 99.7 percent in 2017, implying higher monetary deepening taking place in the economy as <Figure 2-16> shows.

<Figure 2-16>

M2/GDP Ratio



Source: Nepal Rastra Bank

The NRB has been compiling monetary statistics in accordance with the IMF's Monetary and Financial Statistics Manual (2000). The monetary survey is compiled based on balance sheets of the NRB and banks (A, B and C class banks and financial institutions). On the sources side of money supply, the net domestic assets (NDA) constitutes around a 60 percent share of broad money supply. Likewise, claims on the private sector account for more than 90 percent of total domestic assets.

On the uses side of M2, currency and deposits constitute 15 percent and 85 percent respectively. Time deposits comprise 44 percent of total domestic deposits in 2017, while this ratio was around 35 percent in previous years. The monetary survey for the past five years is given in <Table 2-4>.

<Table 2-4>

Monetary Survey

NRS. in Millions

Monetary Aggregates	2013 Jul	2014 Jul	2015 Jul	2016 Jul	2017 Jul
1. Foreign Assets, Net	468238	599220	747287	956022	1014725
1.1 Foreign Assets	54094	686759	847679	1069831	1107913
1.2 Foreign Liabilities	85856	87539	100392	113809	93189
a. Deposits	74332	80053	94396	109383	90340
b. Other	11523	7487	5996	4425	2849
2. Net Domestic Assets	847138	966747	1130514	1288556	1576977
2.1 Domestic Credit	1165866	1314305	1527346	1805695	2156288
a. Net Claims on Government	167788	141989	127211	87759	128075
Claims on Government	167973	165490	161025	202778	255761
Government Deposits	185	23501	33813	115018	127686
b. Claims on Non-Financial Govt. Ent.	11389	10417	10101	8227	9226
c. Claims on Financial Institutions	13663	11074	16089	17444	21834
Government	1317	1488	3261	3414	4286
Non-Government	12345	9586	12828	14029	17548
d. Claims on Private Sector	973026	1150825	1373945	1692265	1997153
2.2 Net Non-Monetary Liabilities	318728	347558	396831	517138	579311
3. Broad Money (M2)	1315376	1565967	1877802	2244579	2591702
3.1 Money Supply (a+b), M1+	925469	1130174	1376049	1634482	1623172
a. Money Supply (M1)	301590	354830	424745	503287	569402
Currency	195874	227537	270080	327483	361746
Demand Deposits	105716	127293	154664	175804	207656
b. Saving and Call Deposits	623879	775344	951304	1131195	1053770
3.2 Time Deposits	389907	435793	501753	610097	968530
4. Broad Money Liquidity (M3)	1389709	1646020	1972197	2353962	2682042

Source: Nepal Rastra Bank

(3) Issues and Challenges

The main challenge pertaining to the monetary and financial sector development in Nepal is to modernize the financial system with a developed set of institutions, instruments, infrastructure and information. The existing structure is inadequate for addressing the needs of modern financial services and products. This is also constrained by poor infrastructure and information. Several other issues are as follows.

- Expanding access to formal financial services and instruments to a large chunk of the unbanked population and regions also poses a challenge. Only 40 percent of the adult population has access to banks. Moreover, there is asymmetric distribution of branch networks with high concentration in the urban areas. State restructuring is underway in accordance with the new constitution of Nepal. The country is now divided into 7 provinces and 744 local levels governed by locally elected bodies. In order to provide financial services and to carry out government transactions, each local level needs to have bank branches, but not more than half of them are currently banked. The challenge is to extend branch networks to all local levels.
- Upgrading the monetary policy framework with a clearly specified set of objectives, instruments and targets is another challenge. So far, the NRB has adopted a monetary targeting (nominal GDP targeting) strategy for the conduct of monetary policy. Accordingly, the monetary aggregates are projected on the basis of targeted inflation, economic growth and income elasticity of money demand. Moreover, the monetary policy has multiple objectives focusing both on stability and growth. In this context, developing a suitable prerequisite for switching from quantity to price based targets is a challenging task.
- One of the major constraints for effective implementation of monetary policy in Nepal is weak transmission channels. Price channels are weak due to a number of factors such as inefficient money market, exchange rate peg, less sensitivity of interest rates, and so on. Likewise, limited outreach of banking services and inadequate financial resources constrain the effectiveness of quantity channels. In such a situation, transmitting monetary impulses to the real economy pose a challenge.
- Central bank independence plays a key role for effective formulation and implementation of monetary policy. It reflects the decisive power of the central banks in choosing appropriate goals and policy instruments to achieve them. Although the NRB Act of 2002 has given greater autonomy to the

NRB, in practice, policy decisions are not uninfluenced. Thus, enhancing central bank autonomy in line with the international best practice remains one of the key challenges.

(4) Monetary Sector Outlook

Despite having a number of challenges for effective monetary management in Nepal, some notable reforms have been made in recent years. Introduction of new instruments such as the deposit collection auction in August 2014, re-issuance of the NRB bond in May 2016, and refinement in the existing liquidity management and forecasting framework (LMFF) by capturing trend and seasonality of liquidity and introduction of interest rate corridor in August 2016, are some of the major reforms undertaken recently. It is expected that these reform initiatives will have positive effects on stabilizing short-term interest rates at least in the medium-term.

The success of a monetary aggregate targeting approach depends on the stability of the money demand function and ability of the central bank to control the money supply. Rapidly growing financial innovation has weakened the linkage between money supply and economic performance, thereby giving rise to close substitutes for money. Consequently, many central banks have shifted from monetary targeting to other strategies while conducting monetary policy. This concern is particularly important for Nepal in the medium-term, as the financial system is gradually approaching to a modernization stage. Although the current state of economic and financial development may not fully support a switch from the existing policy framework, the foundations are being laid gradually to modernize the monetary policy framework in line with best international practices.

To enhance the capability of staff for making research-based policy analysis, efforts are being undertaken in the Research Department to promote empirical and model-based research works. These steps will strengthen policy formulation, analysis and forecasting practices in future. Finally, gradual improvement in communication strategies adopted by the NRB, will enhance accountability and serve better market expectations.

4. Fiscal Sector

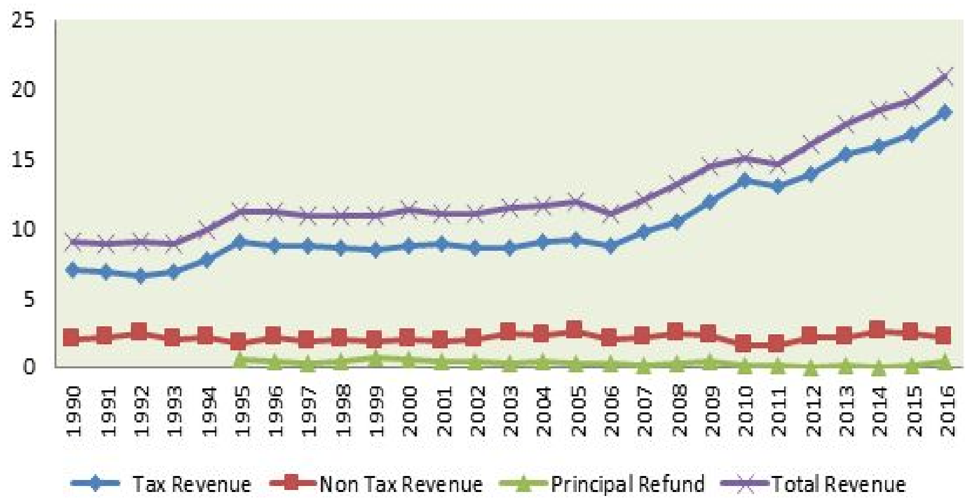
A. Revenue

As Nepal moved to liberal economic policies in the early 1990s, the tax system was modernized along with several measures of economic reforms. As a result, the revenue base has strengthened gradually. Public revenue as a percent of GDP increased from 8.83 percent in 1993 to 9.93 percent in 1994. Another remarkable change took place in the tax system in 1998, as Value Added Tax (VAT) was introduced as a modern tax system replacing existing sales tax, contract tax, hotel tax and entertainment tax. Likewise, there were structural breaks in public revenue mobilization in 2006 and 2012 as an outcome of various administrative reforms in the tax system.

Total public revenue mobilization as a percent of GDP increased from 8.98 percent in 1990 to 20.89 percent in 2016. Total revenue as a percent of GDP remained 12.65 percent on average during 1990-2016. Of the total revenue, the share of tax revenue of total revenue collection has increased slightly during each successive year, whereas the share of non-tax revenue has marginally declined each year as <Figure 2-17> illustrates.

<Figure 2-17>

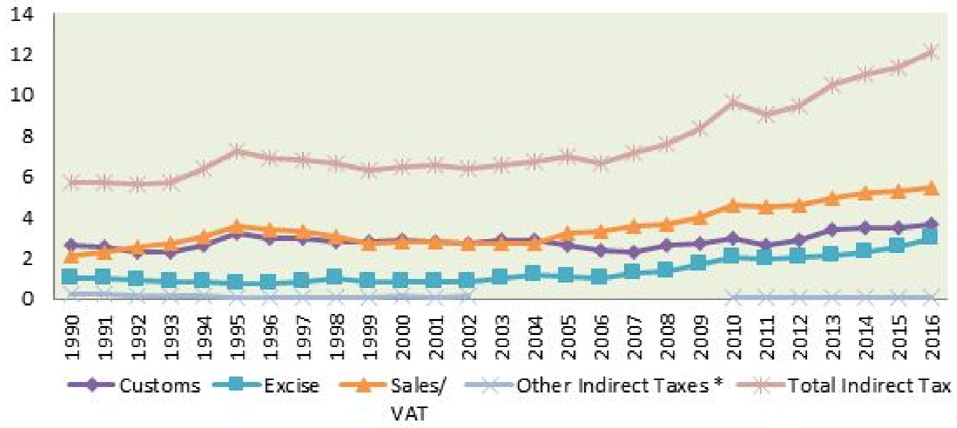
Public Revenue as Percent of GDP



Source: Nepal Rastra Bank

<Figure 2-18>

Indirect Taxes as percent of GDP



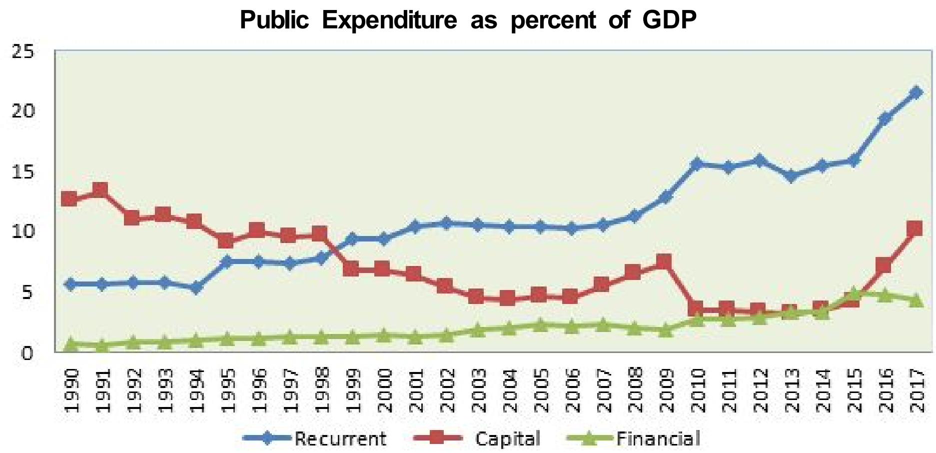
Source: Nepal Rastra Bank

Tax revenue as a percent of GDP shows that VAT, income tax, custom and excise taxes contribute 5.44 percent, 5.08 percent, 3.66 percent and 2.93 percent respectively. One of the important features of tax revenue in Nepal is that the indirect tax accounts for 75 percent in total tax revenue. Though there are some positive changes in revenue mobilization, a replacement of import based tax revenue by domestic production based revenue has been a challenging task. About 50 percent of tax revenue and two thirds of VAT is collected from imports, which can be seen in <Figure 2-18>.

B. Expenditure

Total government expenditure as percent of GDP remained 19.57 percent on average during 1990-2016. Total government expenditure, which was 19.02 percent of GDP in 1990 reached 22.23 percent in 2009 and 31.2 percent in 2016. <Figure 2-19> shows that the jump in government expenditure as percent of GDP in 2016 is due to a contraction of GDP and higher government expenditure accompanying the earthquake of April 2015.

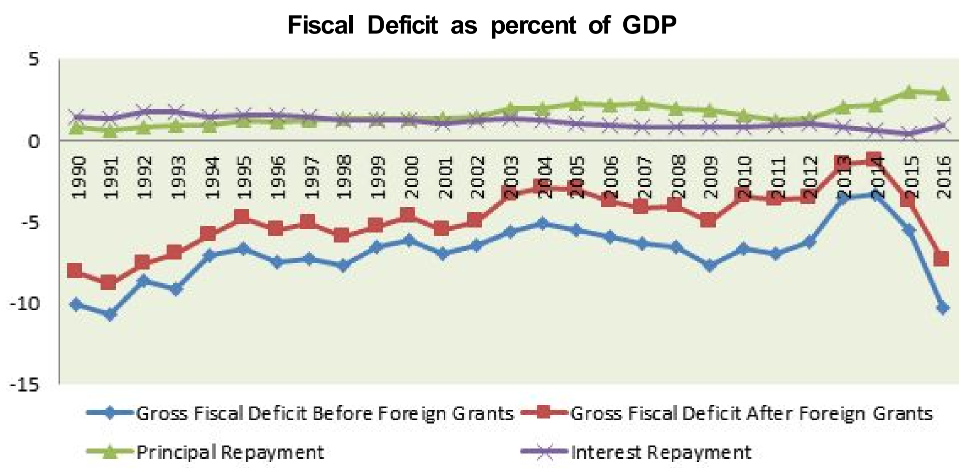
<Figure 2-19>



Source: Nepal Rastra Bank

Though government expenditure is within prudential levels even in difficult situations, it is becoming problematic in recent years due to ever increasing recurrent expenditures caused by rising administrative expenses, pension and social security liability for government and a small proportion of capital expenditure allocation with low budget performance. Recurrent expenditure, which was 5.68 percent of GDP in 1990, reached 10.38 percent in 2001 and reached 19.31 percent in 2016. The capital expenditure as a share of GDP was 12.57 percent in 1990 but shrank to 3.4 percent in 2010, and was 7.08 percent in 2016.

<Figure 2-20>



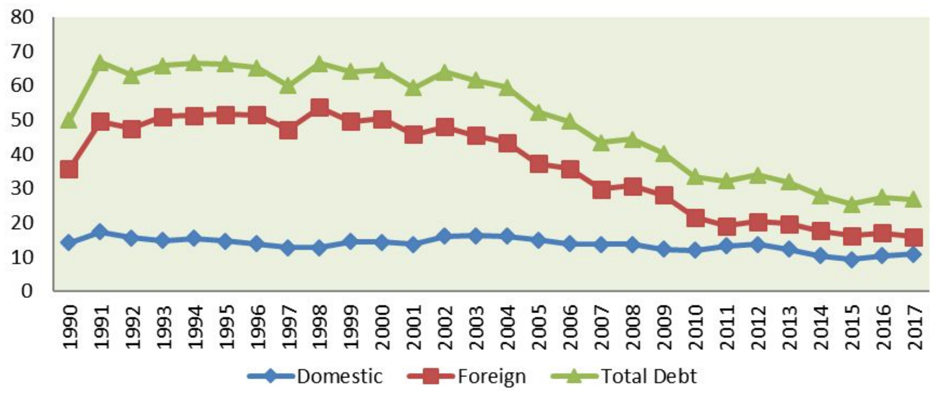
Source: Nepal Rastra Bank

The recurrent and capital expenditures hold 53.4 percent and 36.8 percent shares on average in total expenditure respectively during the period. The recurrent expenditure was below 40 percent and the capital expenditure above 50 percent during the period of 1990 to 1998. After 1998, the share of recurrent expenditure sharply increased and capital expenditure declined, reaching 71.8 percent and 15.2 percent in 2012. The capital expenditure, which accounted for 29.7 percent of the total expenditure in 2007, has fallen to 22.7 percent in 2016. However, the share of financial expenditure in the total expenditure has gone up slightly during the past decade (See <Figure 2-19> above).

Despite encouraging revenue mobilization as targeted in the government budget, public revenue has been insufficient to cover growing public expenditure. To finance this gap, the government has been mobilizing domestic and external loans. However, the utilization of domestic and foreign debts has not met the targets of capital expenditure. Consequently, the fiscal deficit has been small and there is some fiscal space for the execution of larger projects. The gross fiscal deficit after foreign grants as percent of GDP remained below 5 percent on average during the period. Exceptionally, it reached 7.33 percent of GDP in 2016 as <Figure 2-20> shows.

<Figure 2-21>

Public Debt as percent of GDP



Source: Nepal Rastra Bank

C. Outstanding Debt

The outstanding total debt as a share of GDP declined below 45 percent in the past decade from 66.76 percent in 1991. This ratio remained at 27.4 percent in 2016. Despite the need for large amounts of spending on social and economic overheads, the potential of resource mobilization through debt has not been utilized effectively as shown by <Figure 2-21>.

D. Issues and Challenges

A number of important issues regarding the fiscal policy and the government budget can be summarized as follows.

- Revenue collection has met and even exceeded the targets in the past decade. However, it is not adequate to meet growing public expenditure. Hence, additional administrative reforms along with the use of advanced information management systems should get priority so that revenue collection can function more efficiently.
- It is a challenge to manage both the growing trade deficit through import management, and replacing import based revenue sources by domestic production based revenue sources.
- As the nation moves to a federal system, the province and local level governments have more rights to mobilize revenue. Despite the potential of stronger revenue mobilization domestically, immediate challenges exist in revenue mobilization from province and local governments through capacity development.
- There is a challenge to maintain a proper balance between recurrent and capital expenditure along with enhancing the capital expenditure utilization capacity of the government. Fiscal management in the context of the federal system will be a challenge due to higher demand for administrative expenses. It is also a challenge to maintain transparency and accountability in the use of the public treasury to make it more result oriented in future.
- It is a major challenge of the country to achieve the goal of graduating to a developing nation by 2022, and middle income country by 2030, through the optimal use of available domestic and foreign resources. In this context, it is

challenging to make sustainable use of the fiscal space to attain ambitious development goals.

E. Fiscal Sector Outlook

The fiscal sector strengthened after the 1990s and remained sustainable mainly due to several economic reforms. It is expected that fiscal stability will be maintained on the revenue front in the short run. However, expenditure management may be challenging as a result of additional administrative expenses due to state restructuring.

The potential expenditure increase in the context of state restructuring and capacity generation limits of local and provincial governments may have pressure on fiscal management. Consequently, the available fiscal space is expected to be utilized in the medium and long-term.

5. Macroeconomic Model

A. Necessity of a Macroeconomic Model

Economic models are used to test different theories in a scientific and systematic manner. Econometricians use a blend of economic theory, mathematics, and statistics of the structure of the economy to construct a quantitative economic model. Thus, economic models play vital roles for analyzing the facts, and forecasting and comparing different policy options. In addition, policymakers need to predict the future direction of the economy before they can decide which policy to adopt and any such prediction benefits from being based on empirical analysis using appropriate forecasting tools.

Modeling and forecasting is of immense importance, as it describes the expected future behavior of all or part of the economy and helps form the basis of policy and planning in a more analytical and systematic way. Furthermore, it plays a vital role in the conduct of monetary policy. Central banks have long been concerned with estimating the transmission channels of monetary policy instruments with regard to achieving the ultimate policy objectives. Their decisions are based on forecasts and adjusted frequently in response to new developments in the money markets and economy. Moreover, modeling and forecasting are equally important for the fiscal policy makers to estimate the size of the revenue, expenditure and financing patterns of the budget. Forecasting techniques guide them to allocate budgetary need and assess the effectiveness of overall macroeconomic performance of the country.

Although macroeconomic modeling and forecasting practices were initiated in Nepal during 1980s, they were mainly confined to academic works rather than using them in formal policy formulation. In 1985, the National Planning Commission (NPC) designed a model for planning and policy analysis under the technical and financial assistance of UN-ESCAP, which was updated in 1989 incorporating the Social Accounting Matrix (SAM) during formulation of the Eighth Five Year Plan. In 2005, the Ministry of Finance, with the technical assistance of the Asian Development Bank, developed the Nepal Macroeconomic Model (NMEM) for analyzing debt sustainability, which was later upgraded by Nepal Rastra Bank (NRB) to make it useable for overall macroeconomic analysis. At present, the NRB has been using the upgraded NMEM and various sectoral models for forecasting macroeconomic variables and using them in policy planning. However, non-availability of data, complexity in operation as well as insufficient technical capacity has constrained the use of the model for policy formulation.

As a central bank, Nepal Rastra Bank (NRB) conducts various studies in different policy issues as and when required. The understanding of the inter linkages among macroeconomic variables and their changes facilitates the efficient conduct of monetary policy. Furthermore, as an economic advisor of the government, the NRB has to provide advice on various policy matters to the government based on macroeconomic models and different policy scenarios. In this context, a simplified and workable macroeconomic model equipped with policy simulation is desirable for the central banks.

The NRB believes that use of an appropriate model for identifying interrelationships and forecasting is crucial for making monetary and other macroeconomic policies more efficient.

B. Expected Outcome and Usage of the Model

A macroeconomic model should be able to identify the relationship among major macroeconomic variables. Likewise, it should be able to provide the projection of major variables at least up to the medium term. The modeling framework should be easy and understandable such that no special expertise is required for its use and modification.

The NRB needs a model which is customized enough so as to make it workable in the Nepalese context. The Nepalese economy does not have sufficient data at longer horizons and with higher frequency. Many crucial data for analysis such as quarterly GDP are unavailable. Moreover, the relationship shown by an economic model and the actual environment does not match very often. Some relationships may not exist based on economic theory and the approach applicable for other economies.

The model should also have the features of sectoral analysis and forecasting. It should cover the major components of real sector, monetary sector, government sector and external sector. For instance, the real sector model should be able to forecast not only economic growth, but also investment required for achieving a desired growth level, along with inflation and its components. Similarly, the monetary sector model should be able to perform beyond money supply, such as to project the currency demand, the trend of credit flow and the expected path of deposit growth, among others.

Ⅲ. A Small-Scale Short-Run Macroeconomic Model

Sections III and IV introduce macroeconomic models that consider the particular situation of the Nepalese economy. Because the time series data necessary for such a model is still lacking and is collected annually instead of quarterly, we do not use standard dynamic stochastic general equilibrium (DSGE) models used to make macroeconomic predictions. Instead, we introduce a small-scale model (Section III) and a medium-scale model that decomposes aggregate demand into separate categories (Section IV).

1. A Basic Small-Scale Macroeconomic Model

Before we introduce the Nepalese economic model, we begin with explaining a well-known linearized rational expectations model from New Keynesian economics, notably that of Clarida, Gali and Gertler (1999). The basic New Keynesian macroeconomic model is composed of an aggregate demand curve, also known as an Euler equation or an intertemporal IS Curve, an aggregate supply curve (or New Keynesian Phillips Curve), and a monetary policy curve which uses the interest rate as a policy variable. These can be simply described below.

$$y_t = E_t y_{t+1} - \psi r_t + v_t \quad (1)$$

$$\pi_t = \delta E_t \pi_{t+1} + \lambda_1 y_t + \eta_t \quad (2)$$

$$i_t = \phi_\pi \pi_t + \phi_y y_t + \epsilon_t \quad (3)$$

$$r_t = i_t - E_t \pi_{t+1} \quad (4)$$

y_t, π_t, i_t, r_t represent respectively the output gap, inflation, the nominal interest rate, and the real interest rate, and all variables are defined as deviations from the steady state. The output gap (y_t) is derived from applying the widely-used Hodrick-Prescott filter to decompose output into parts that are explicable by growth trends and parts that are explicable by business cycles.

Equation 4 represents the real interest rate as calculated by the Fisher equation. In this model, monetary policy is independently implemented following the Taylor Rule, a well-known rule in monetary policy.

The model above is listed in many macroeconomics textbooks as a helpful tool to explain the theoretical side of equilibrium. However, this model depends not on past values of variables, but on present or future values. Therefore, the model above is usually unable to explain actual past data. The explanatory power of the model above can be improved by adding lagged variables. A notable attempt at this is Cho and Moreno (2006).

A small-scale macroeconomic model that includes lagged variables is described as:

$$y_t = \mu_1 E_t y_{t+1} + \mu_2 y_{t-1} - \psi r_t + v_t \quad (5)$$

$$\pi_t = \delta_1 E_t \pi_{t+1} + \delta_2 \pi_{t-1} + \lambda_1 y_t + \eta_t \quad (6)$$

$$i_t = \rho i_{t-1} + (1-\rho)[\phi_\pi \pi_t + \phi_y y_t] + \epsilon_t \quad (7)$$

$$r_t = i_t - E_t \pi_{t+1} \quad (8)$$

As opposed to the model composed of equations 1 to 4, this model has more power in explaining actual past data. However, as Ball (1999) argues, a model that relies on lagged variables lacks in accurately explaining actual data. Because of this, there exists a trade-off between theoretical accuracy and explanatory power of actual data while building such macroeconomic models. Also, there are limitations depending on the computer program in use. To solve for equilibria of the model above, principally we would have to solve a rational expectations model. However, Eviews, the economic modelling program used in this project, is more suited to solve models with lagged variables rather than rational expectations models. Therefore, this study builds a model that uses only lagged variables and excludes variables that require rational expectations.

Such a model is simple, but has some explanatory power and is intuitive to understand. In this Section, we build a small-scale economic model of Nepal based on the model above. Subsections 2 to 4 discuss how to include unique economic characteristics of Nepal into this model, while Subsection 5 builds a specific model, and Subsection 6 shows estimation results.

2. Characteristics of the Nepalese Economy

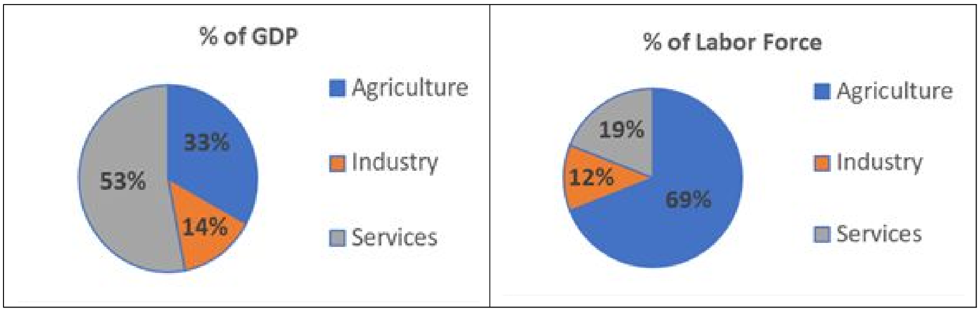
To analyze the Nepalese macroeconomy, we need to consider the country's high dependence on the agricultural sector, the overseas remittances which comprise around 30% of GDP, and its close relationship with India. This subsection discusses how to incorporate such characteristics into a model.

A. High Share of Agriculture in GDP and Labor Force

<Figure 3-1> shows that more than 30% of Nepal's GDP depends on agriculture, and 70% of the labor force work in the agricultural sector. Although the share of agriculture in GDP has been steadily declining, this can be interpreted as a rise in output value of the manufacturing and service sectors, and Nepal still depends on agriculture very heavily. This is also shown through <Table 3-1>. An interesting phenomenon is that the share of the labor force in agriculture has not decreased, unlike other countries. To reflect these characteristics into the macroeconomic model, we include summer rainfall, which affects agricultural output, as a variable in the aggregate supply curve or New Keynesian Phillips Curve. Following the country's high dependence on the agricultural sector, we also include the World Food Price Inflation index as an explanatory variable in order to reflect the high sensitivity of price level from changes in agricultural prices.

<Figure 3-1>

Share of Industry in Nepalese GDP and Labor Force



Source: World Bank Databank

<Table 3-1>

Share of Agriculture in GDP in South Asian Countries

Nepal	India	Afghanistan	Bangladesh	Bhutan	Maldives	Pakistan	Sri Lanka
33%	17%	22%	15%	16%	3%	25%	8%

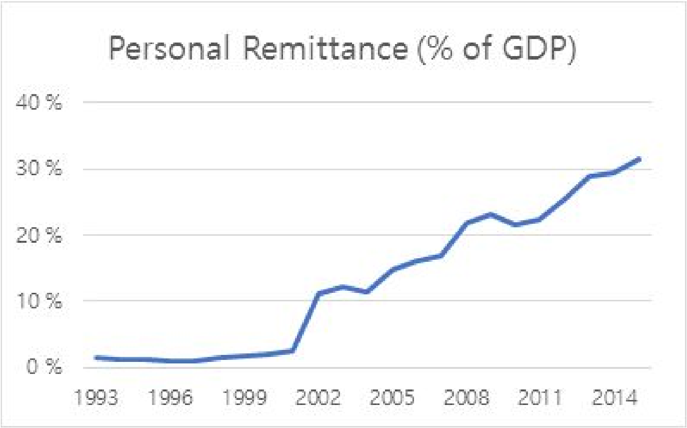
Source: World Bank Databank

B. High Dependence on Remittances

Remittances comprise more than 30% of the Nepalese economy. In a country with low exports, remittances may induce a large portion of imports, and therefore it may have various influences on the economy. When a large amount of remittances flow into the economy, the purchasing power of Nepalese citizens will increase, leading to increased private consumption and investment, and increased imports. On the other hand, when exchanging remittances into Nepalese rupees, the domestic money supply will increase, and will affect the NRB's monetary policy.

<Figure 3-2>

Personal Remittances as Percentage of GDP



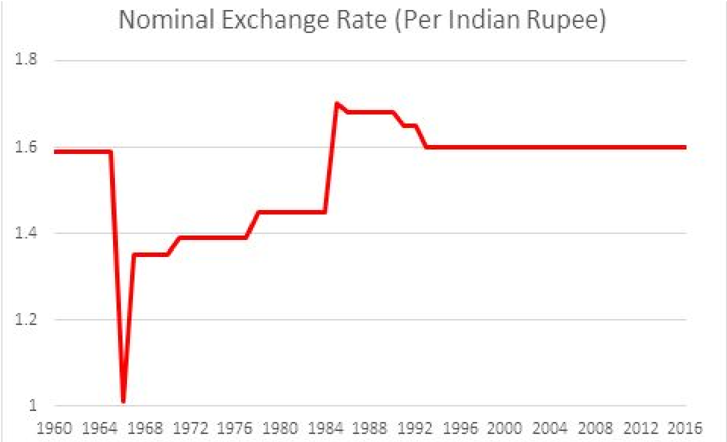
Source: World Bank Databank

C. Close Relations with India

Nepal has a close relationship with India. Since 1960, Nepal has pegged its currency to the Indian rupee. The fixed exchange rate was altered several times, until the most recent alteration in 1993, at 1.6 Nepalese rupees to the Indian rupee. To analyze the effects of the pegged exchange rate on the domestic economy, Subsection 3 deals with 3 different model types based on different exchange rate regimes. Also, 60% of Nepalese imports come from India. To incorporate this, we include India's price level as an explanatory variable in analyzing aggregate supply.

<Figure 3-3>

Nominal Exchange Rate of Nepalese Rupee and Indian Rupee



Source: Nepal Rastra Bank

D. Political Instability in Nepal

Following democratization starting from 2006, the monarchy fell in 2008 and Nepal became a republic. In December 2007, the Parliament passed legislation to change its country from a monarchy to a republic, which became effective in May 2008. Before 2007, civil war had destabilized the political situation in Nepal, but after the transition into a republic, the country has faced less civil turmoil and more political stability. We include a dummy variable for the year 2007 to increase the explanatory power of the model and to reflect the idea that citizens in 2007 could rationally expect the change into a republican government and would have changed their economic plans accordingly.

E. Limitations

Due to the limitations of time series data, it is not possible to use more theoretically rigorous and powerful DSGE models. This is because data on overseas remittances and many of the variables in the medium-scale model all begin at 1993. The medium-scale model was also built using time series data from 1993 to 2015.

Additionally, due to the lack of data on the Interest Rate Corridor initiated from the end of 2016, as well as the 7 percentage point difference between the Ceiling Rate and Floor Rate, there is some difficulty in applying this into the model. We expect to add the Ceiling and Floor Rates as variables into the model in the future as we accumulate more data.

We also do not include the US-based Great Recession and the Asian-based Financial Crisis as dummy variables into the Nepalese economy, as both events did not significantly affect the economy. The Indian demonetization of 2016 also has played a large effect on Nepal, but the lack of time series data meant that we could not consider this into our model. We also expect that more future data will help augment these aspects into the economic model.

3. Scenarios of Monetary Policy on the Currency Peg to the Indian Rupee

The model in this study is unique in including not just widely-used variables for monetary policy, but also hypothesizing several scenarios based on Nepalese monetary policy. This subsection includes three scenarios: an independent monetary policy with capital controls, a currency peg with the Indian rupee, and a partial currency peg that considers the existence of an underground economy and unofficial currency markets.

First, we build a model that assumes an independent Nepalese monetary policy with capital controls. According to the Impossible Trinity, the monetary authority can only accomplish up to two conditions of fixed exchange rates, free flow of capital, and independent monetary policy. In Nepal, we assume a fixed exchange rate and independent monetary policy, as well as capital controls.

As an example, when a foreign firm wishes to invest in Nepal, it requires the permission of the Department of Industries. To gain permission, the firm needs to submit detailed information on joint investment contracts and Nepalese and foreign individuals (or firms) involved. Also, foreigners need to submit separately a Certificate of Financial Credibility. Without this permission, there can be limitations in sending profits from Nepal to overseas.

Next, we build a model which assumes a currency peg. A currency peg with no capital controls would, according to the theory of interest rate parity, make the Nepalese and Indian nominal interest rates equal. Therefore, a currency peg model assumes the two countries' nominal interest rates to be equal. However, there can be differences in the real interest rate due to differences in inflation.

We also build a model with a partial peg with unofficial currency markets due to an underground economy, thereby letting the Nepalese nominal interest rate to somewhat but not entirely follow the Indian nominal interest rate. For instance, there still exists the practice of Hawala, a method of sending currency directly to Nepal through foreign and local brokers, without crossing through official channels such as banks. It is quicker to send money through this practice, but brokers can gain profits from commission fees and exchange rate differences. In some cases, it is used as a money laundering technique by criminal organizations, particularly around the Nepal-Indian border. This scenario assumes that the Nepalese real interest rate is affected by the Indian real interest rate, and is determined by the nominal interest rate through the Fisher Equation. The three scenarios on interest rates and monetary policy can be summarized as shown below.

<Table 3-2>

Monetary Policy Scenarios

Scenario	Nominal Interest Rate	Real Interest Rate	Monetary Policy
Independent Monetary Policy	$i_t \neq i_t^{IND}$	$r_t \neq r_t^{IND}$	$i_t = f(\pi_t, y_t, i_{t-1}, rer_t; z_t) + \epsilon_t$
Peg	$i_t = i_t^{IND}$	$r_t \neq r_t^{IND}$	Exogenous Real Interest Rate
Partial Peg	$i_t \neq i_t^{IND}$	$r_t \neq r_t^{IND}$	$r_t = f(r_t^{IND}; z_t) + \epsilon_t$

Note: 1) i_t: Nominal Interest Rate, r_t: Real interest Rate, y_t: Output Gap, π_t: Inflation, rer_t: Real Exchange Rate, z_t: Other Factors

2) IND stands for Indian variables. All others stand for Nepalese variables.

The policy variables are predicted as a linear function $f(\cdot)$. We can also include the characteristics of the Nepalese economy into the model. For instance, we can include monetary policy scenarios that include variables such as the share of remittances. This study uses nominal interest rate data as announced by each country's central bank.

4. Calculating the Real Interest Rate

We now explain the method of calculating the real interest rate, as this method differs in the literature. The real interest rate here stands for the ex-ante, determined by the Fisher equation as $r_t = i_t - E_t\pi_{t+1}$. To find the expected inflation $E_t\pi_{t+1}$, we need a rational expectations model. For these models, see Blanchard and Kahn (1980), Sims (2000), and Cho and Moreno (2011) for more details. However, in this study we look at a backward-looking model to find the real interest rate. Backward-looking models have stronger explanatory power of actual data than forward-looking models, and are used in most central banks.

To solve for the expected inflation rate in backward-looking models, we use Vector Autoregressions (VAR). We solve for, through VAR, variables x_t such as inflation, output gap, real exchange rate, the real interest rate and predict the expected value $E_t x_{t+1}$ at time t. If the expected inflation rate is denoted as $E_t\pi_{t+1}$, the real interest rate becomes $r_t = i_t - E_t\pi_{t+1}$. However, predictions through VAR can differ according to the variable of choice as well as the number of lag periods used. Therefore, we also use an adaptive expectation model to calculate the real interest rate $r_t = i_t - \pi_t$. Both scenarios derive expected values from structural equations of past data, and therefore are subject to the Lucas Critique. However, due to the data and software limitations, this study uses both methods. With the 3 monetary policy scenarios and the 2 methods of solving for the real interest rate, we have a total of 6 scenarios. The models are divided as such.

<Table 3-3>

Types of Models

Monetary Policy Scenario	Real Interest Rate Assumption	
	$r_t = i_t - \pi_t$	$r_t = i_t - E_t \pi_{t+1}$
Independent Monetary Policy	Model 1-A	Model 1-B
Peg	Model 2-A	Model 2-B
Partial Peg	Model 3-A	Model 3-B

5. A Small-Scale Macroeconomic Model

This subsection considers all 6 scenarios as determined by monetary policy scenarios and the real interest rate in use, and builds small-scale macroeconomic models for each of them. They are all basic New Keynesian macroeconomic models, and in this subsection we focus more on how these models can be used in economic trend analysis rather than actual prediction. Each model has its own strengths and weaknesses in terms of practicality and explanatory power, so instead of choosing a single model, this subsection focuses on analyzing each of the six models. In Section IV, we develop a medium-scale macroeconomic model that not only analyzes aggregate demand and monetary policy, but also make predictions.

A. Independent Monetary Policy

As mentioned above, if Nepal is to pursue an independent monetary policy and assume a fixed exchange rate with the Indian rupee, then it cannot pursue free flow of capital. In reality, the NRB also has some control over capital flows and thereby aims to pursue an independent monetary policy. In this case, the Taylor Rule can be applied when deciding the interest rate. Also, since Nepal is an open economy, the aggregate demand can be influenced by the exchange rate. In this case we need to explicitly insert an exchange rate policy. For simplicity, we use the real exchange rate data as an explanatory variable. We also include the real exchange rate instead of the nominal exchange rate in order to simplify the model. The model can be described as follows.

$$y_t = \beta_1 y_{t-1} - \beta_2 r_t + \beta_3 rer_t + z_1^T \delta + u_t \tag{9}$$

$$\pi_t = \gamma_1 y_t + \gamma_2 \pi_{t-1} + z_2^T \lambda + v_t \tag{10}$$

$$i_t = \rho i_{t-1} + (1-\rho)[\phi_\pi \pi_t + \phi_y y_t + \phi_{rer} rer_t] + z_3^T \alpha + \epsilon_t \tag{11}$$

$$r_t = i_t - \pi_t \text{ or } r_t = i_t - E_t \pi_{t+1} \tag{12}$$

z_1, z_2, z_3 are additional variable vectors that represent characteristics of the Nepalese economy, and δ, λ and α are parameter vectors for each of the additional vectors. For instance, if there are k variables in z_1, then z_1 is a $k \times 1$ vector, and δ is a $k \times 1$ vector. The simplest model would exclude these. In this study, we include the four characteristics of the Nepalese economy in Section II and in Subsection 6 report the results of prediction of actual data.

First, we consider the high dependence on agriculture industry by including rainfall and the World Food Price Inflation index into z_2. To consider the close relationship with the Indian economy, we also insert the Indian inflation rate as a variable in z_2. Also, we include a dummy variable representing the year 2007, when democratization led to the collapse of the monarchy, in z_1 and z_2. Lastly, we include the rate of foreign remittance flows in order to reflect the Nepalese economy's heavy reliance on them in z_1 and z_3.

The real exchange rate is derived by multiplying the Indian price level to the nominal exchange rate between the Indian rupee and the Nepalese rupee, then dividing that by the Nepalese price level. In this study, we take the log of the real exchange rate and subtract that from the average rate from the data in order to measure the percentage point gap between the data and the average rate. In this, both countries' price levels are calculated through the GDP deflator. The output gap, inflation rate, and real and nominal interest rates are considered as endogenous variables, while the exogenous variable is the real exchange rate. Equations (9) to (11) and one choice of Equation (12) determine the full model of four equations. When using the equation $r_t = i_t - \pi_t$, we can derive Model 1-A, and by using $r_t = i_t - E_t \pi_{t+1}$, we can arrive at Model 1-B.

B. Currency Peg

When there is a currency peg, the Nepalese nominal interest rate becomes equal to the Indian nominal interest rate ($i_t = i_t^{IND}$), and the Indian nominal interest rate is considered an exogenous variable. The economic model is as follows:

$$y_t = \beta_1 y_{t-1} - \beta_2 r_t + z_1^T \delta + u_t \qquad (13)$$

$$\pi_t = \gamma_1 y_t + \gamma_2 \pi_{t-1} + z_2^T \lambda + v_t \qquad (14)$$

$$r_t = i_t^{IND} - \pi_t \text{ or } r_t = i_t^{IND} - E_t \pi_{t+1} \qquad (15)$$

Even if the nominal interest rates are the same, depending on each country's inflation rate, the real interest rate can be different. When we use the equation $r_t = i_t^{IND} - \pi_t$ we arrive at Model 2-A, and by using $r_t = i_t^{IND} - E_t \pi_{t+1}$ we arrive at Model 2-B. From the assumption that $i_t = i_t^{IND}$, the nominal interest rate is considered an exogenous variable, and this leads to the real interest rate, via the Fisher Equation, to become an exogenous variable. That means Equations 13 and 14 determine the equilibrium of this macroeconomic model.

C. Partial Currency Peg

In the partial currency peg scenario, we assume that the underground economy and unofficial currency transactions lead to an unstable fixed exchange rate. Even if the fixed exchange rate is in place, there is no necessity for the Nepalese and Indian nominal interest rates to be the same. Therefore, in this situation, we add the assumption that the Nepalese real interest rate depends on the Indian real interest rate. This model can be described as below.

$$y_t = \beta_1 y_{t-1} - \beta_2 r_t + z_1^T \delta + u_t \qquad (16)$$

$$\pi_t = \gamma_1 y_t + \gamma_2 \pi_{t-1} + z_2^T \lambda + v_t \qquad (17)$$

$$r_t = \psi r_t^{IND} + \alpha x_t + e_t \qquad (18)$$

$$i_t = r_t + \pi_t \text{ or } i_t = r_t + E_t \pi_{t+1} \qquad (19)$$

Here, r_t^{IND} is the Indian real interest rate and x_t includes variables that can determine the Nepalese real interest rate, such as the real exchange rate. Therefore, the real interest rate now becomes an endogenous variable. If we use $i_t = r_t + \pi_t$, we arrive at Model 3-A, and using $i_t = r_t + E_t\pi_{t+1}$ leads us to Model 3-B. Equation 19 defines the nominal interest rate, so the model itself is comprised of Equations (16), (17) and (18).

6. Estimation Results of Small-Scale Models

In this section, we will look at the small-scale models with the monetary policy scenario and real interest rate that we believe explains Nepal the best: a model with an independent monetary policy with capital control. And we also add the characteristics of the Nepalese economy and look at how each model's explanatory power improves by including these characteristics. We also repeat our predictions by analyzing the currency peg and partial currency peg scenarios, thereby testing the model's robustness in various ways.

A. Baseline Model

The baseline model has only the independent monetary policy assumption without considering the unique characteristics of the Nepalese economy. This model can also be divided into two types. The first includes the current inflation as a proxy for expected inflation and corresponds to Model 1-A. The second uses VAR to calculate expected inflation, and corresponds to Model 1-B.

<Table 3-4> reports the estimation results of Model 1-A, and <Table 3-5> reports the estimation results for Model 1-B. We have ignored constant terms for convenience. In these tables, we can see that these models have low R^2 values and therefore low explanatory power. This may be due to lack of sufficient data and also due to the fact that Nepal is not yet a mature economy, whereas the basic model only explains advanced economies such as the United States.

<Table 3-4>

Model 1-A(Baseline): Independent Monetary Policy, $r_t = i_t - \pi_t$

$y_t =$	$0.166 y_{t-1}$	$-0.039 r_t$	$+0.008 rer_t$		$R^2 = 0.050$
	(0.207)	(0.074)	(0.025)		
$\pi_t =$	$0.803 y_t$	$+0.274 \pi_{t-1}$			$R^2 = 0.152$
	(0.644)	(0.208)			
$i_t =$	$0.935 i_{t-1}$	$+0.057 \pi_t$	$-0.265 y_t$	$-0.003 rer_t$	$R^2 = 0.891$
	(0.086)***	(0.046)	(0.148)*	(0.014)	

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

<Table 3-5>

Model 1-B(Baseline): Independent Monetary Policy, $r_t = i_t - E_t \pi_{t+1}$

$y_t =$	$0.181 y_{t-1}$	$+0.076 r_t$	$-0.000 rer_t$		$R^2 = 0.057$
	(0.207)	(0.120)	(0.023)		
$\pi_t =$	$0.803 y_t$	$+0.274 \pi_{t-1}$			$R^2 = 0.152$
	(0.644)	(0.208)			
$i_t =$	$0.935 i_{t-1}$	$+0.057 \pi_t$	$-0.265 y_t$	$-0.003 rer_t$	$R^2 = 0.891$
	(0.086)***	(0.046)	(0.148)*	(0.014)	

Note: Same as Note in <Table 3-4>

Looking first at the aggregate demand curve in Model 1-A, the output gap has a negative relationship with the real interest rate. This relationship is not statistically significant, but concurs with existing theory that a high real interest rate reduces consumption and investment. However, in Model 1-B, the output gap has a positive relationship with the real interest rate. This runs counter to existing theory, and it shows that calculating the expected inflation rate through VAR, although more theoretically significant, does not concur with theory. This may be a result of either not using a forward-looking model, a lack of data, or the unique political situation of Nepal.

Next, we see that a rise in the real exchange rate shows a relative decline in the Nepalese price level. This could lead to an increase in exports and aggregate demand. In our predictions, we see that, regardless of the derivation of the real interest rate, both Models 1-A and 1-B show an increase in aggregate demand due to an increase in the real exchange rate, showing an agreement between theoretical prediction and data analysis. Lastly, we see that the present output gap has a positive relationship with the past output gap, demonstrating persistence in the output gap.

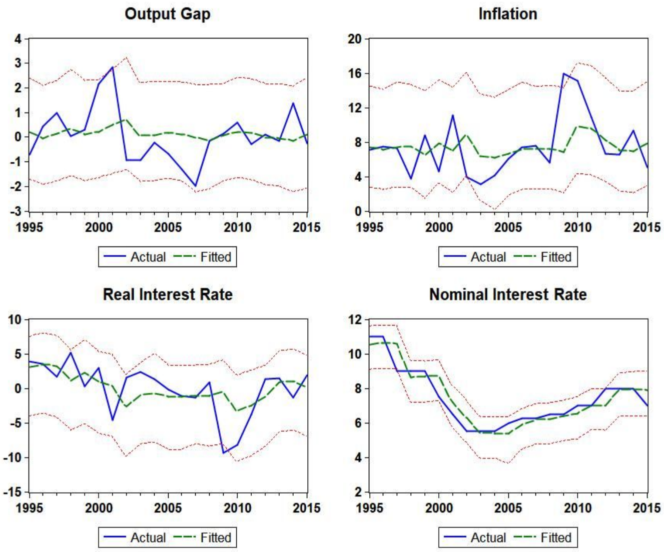
Next, we look at the estimation results of the aggregate supply or New Keynesian Phillips Curve. For inflation, present inflation is largely explained by past inflation, showing inflationary inertia. As for the output gap, it shows a positive relationship with the inflation rate, which corresponds to existing theory.

Lastly, for monetary policy, we assume that the nominal interest rate as a policy variable follows the Taylor Rule. For the nominal interest rate, the two models predict the same result. However, in the case of the real interest rate, the two models make different predictions due to the calculation method of the inflation rate, either through VAR or by using present inflation. Therefore, the two models differ in the predicted aggregate demand curve.

Looking at the estimation results for monetary policy, the parameter for the past interest rate is close to 1, thereby showing that the interest rate is stable over time. As for inflation, there is a positive relationship between present and past rates. This may imply that monetary policy has some role in suppressing inflation, but looking at the results that is not the case. Since $\phi_\pi = 0.057/(1-\rho) = 0.057/(1-0.935) = 0.877 < 1$, it runs counter to the Taylor Principle ($\phi_\pi > 1$) and therefore a decline in the real interest rate cannot suppress inflation. Therefore, it is difficult to say that the nominal interest rate policy was used to actually reduce inflation. Also, considering the negative relationship with the output gap, monetary policy was not used to stabilize the economy either. This is shown in <Figures 3-4 and 3-5> below, showing the results for Models 1-A and 1-B respectively.

<Figure 3-4>

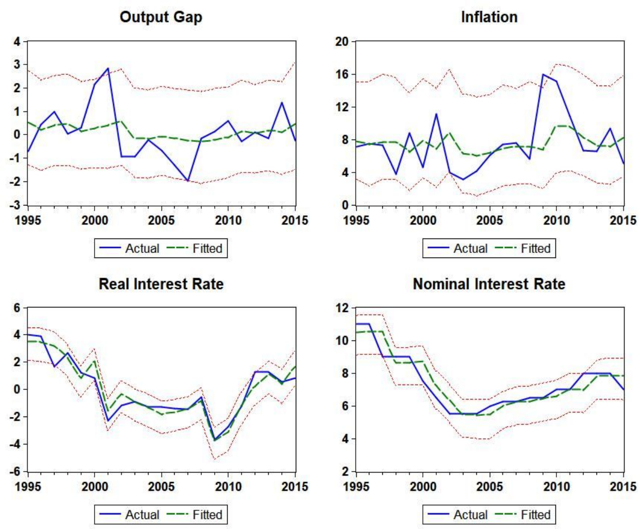
Model 1-A(Baseline): Independent Monetary Policy, $r_t = i_t - \pi_t$



Note: The unit of the vertical axis is measured in percentage.

<Figure 3-5>

Model 1-B(Baseline): Independent Monetary Policy, $r_t = i_t - E_t\pi_{t+1}$



Note: The unit of the vertical axis is measured in percentage.

(1) Including Remittances into the Model

Next we add into the model an explanatory variable for remittances, an important characteristic of the Nepalese economy. As mentioned in the beginning of this section, remittances take up 30% of GDP, which can become an additional income source for Nepalese citizens and affect consumption, investment and trade. On the other hand, an excessively high level of remittances can cause an increase in the domestic money supply due to currency exchanges and cause inflation, not to mention altering the nominal interest rate to maintain the currency peg. The following estimation results are from models that include remittances as an explanatory variable. rem represents the log level of remittances.

<Table 3-6>

Model 1-A with Remittances

$y_t =$	$0.400y_{t-1}$	$-0.020r_t$	$+0.014rer_t$	$-1.414rem_t$		$R^2 = 0.171$
	(0.249)	(0.071)	(0.024)	(0.900)		
$\pi_t =$	$0.803y_t$	$+0.274\pi_{t-1}$				$R^2 = 0.152$
	(0.644)	(0.208)				
$i_t =$	$0.895i_{t-1}$	$+0.032\pi_t$	$-0.254y_t$	$-0.001rer_t$	$-0.694rem_t$	$R^2 = 0.905$
	(0.088)***	(0.047)	(0.143)*	(0.013)	(0.447)	

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

<Table 3-7>

Model 1-B with Remittances

$y_t =$	$0.404y_{t-1}$	$-0.037r_t$	$+0.010rer_t$	$-1.394rem_t$		$R^2 = 0.171$
	(0.266)**	(0.124)	(0.023)	(0.889)*		
$\pi_t =$	$0.803y_t$	$+0.274\pi_{t-1}$				$R^2 = 0.152$
	(0.644)	(0.208)				
$i_t =$	$0.895i_{t-1}$	$+0.032\pi_t$	$-0.254y_t$	$-0.001rer_t$	$-0.694rem_t$	$R^2 = 0.905$
	(0.090)***	(0.047)	(0.143)*	(0.013)	(0.452)	

Note: Same as Note in <Table 3-6>

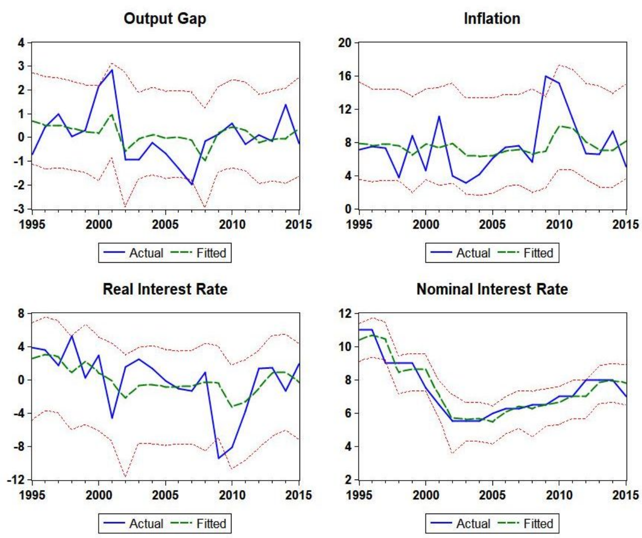
Looking at the output gap equation augmented with the remittances variable in

Models 1-A and 1-B, we see that the real interest rate shows a negative sign. In Model 1-B without the remittances variable, there was a positive relationship between the output gap and the real interest rate, which did not concur with existing theory. However, by including remittances, the model now better fits theory. Also, the output gap regression shows the correct sign for the coefficient of the real exchange rate. By adding remittances, the VAR model gains explanatory power. However, the remittances coefficients in Models 1-A and 1-B show a negative relationship. We conjecture that a large part of remittances go more towards imports rather than domestic consumption or investment, but we will discuss this in further detail in the next section where we discuss the aggregate demand in more detail.

As for monetary policy, the policy interest rate decreases but not statistically significantly as remittances increase. This policy can be interpreted as maintaining the currency peg in the currency exchange process. However, the current exchange rate still depends much on the past interest rate, and is one of the variables with the most explanatory power. <Figures 3-6 and 3-7> show the explanatory power of the two models with the remittances variable.

<Figure 3-6>

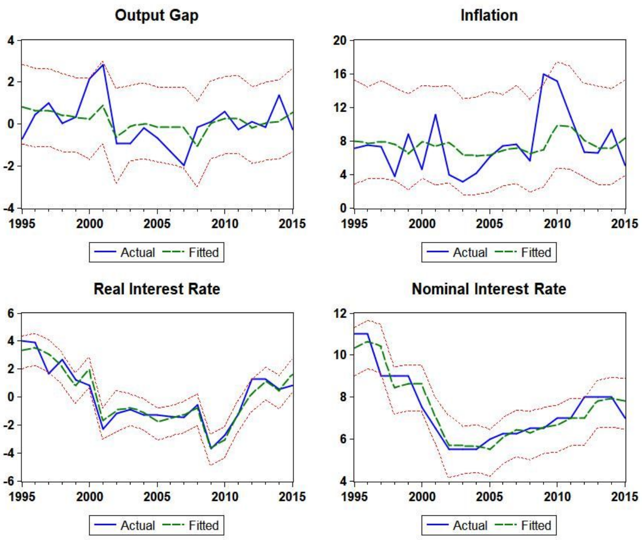
Model 1-A with Remittances



Note: The unit of the vertical axis is measured in percentage.

<Figure 3-7>

Model 1-B with Remittances



Note: The unit of the vertical axis is measured in percentage.

As for the other variables, they remain mostly the same as the models without remittances, and overall we can see that the R^2 value of the model has risen. <Figure 3-6> shows the predictions of Model 1-A with remittances, and <Figure 3-7> shows those of Model 1-B with remittances. Compared to the previous model, this model is better able to explain the output gap in the years 2002 and 2013, as well as inflation in 2003 and 2010.

(2) Supply Shocks

Next, we include the model Nepal’s high dependence on agriculture and the Indian economy. If low rainfall leads to low agricultural production, this could cause a supply shock that raises prices. Also, if the Indian price level rises, then import prices will rise and so will the Nepalese price level. More specifically, only the New Keynesian Phillips Curve changes, so we look only at this equation to look at the differences.

Next is the New Keynesian Phillips Curve regression, which includes the Indian price level and grain prices. In the case of the New Keynesian Phillips

Curve, we show only one example as the other definition of the real interest rate makes no difference. This equation includes rainfall($rain$), the change in world grain prices(f_{inf}), and the Indian inflation rate(π^{ind}).

<Table 3-8>

Model 1 with Supply Shocks

$\pi_t =$	$0.779y_t$	$+0.364\pi_{t-1}$	$-0.008rain_t$	$-0.042f_{inf\ t}$	$+0.353\pi_t^{IND}$	$R^2 = 0.359$
	(0.651)	(0.212)*	(0.004)*	(0.070)	(0.316)	

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

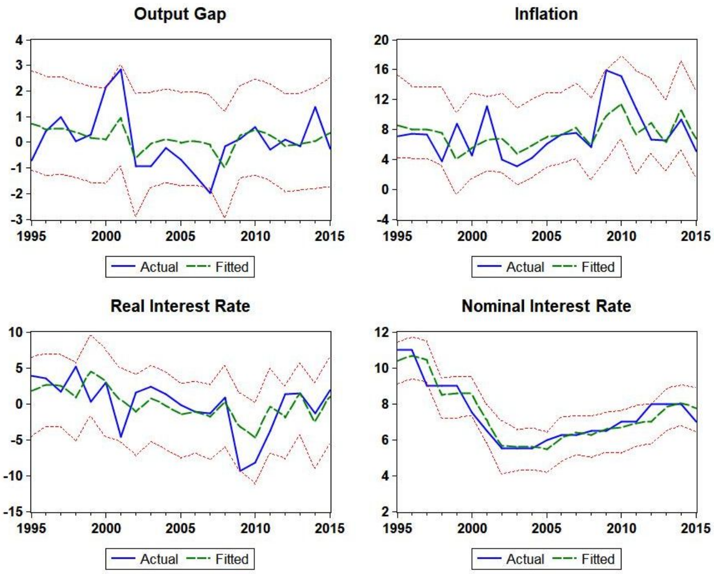
Looking at <Table 3-8>, the most important observation we note is the statistical significance of rainfall. This shows that the Nepalese economy's reliance on agriculture is heavily affected by rainfall. The rainfall variable moves in the opposite direction as inflation, and this can be interpreted that high rainfall increases grain production and lowers inflation. On the other hand, the change in world grain prices(f_{inf}) has a negative relationship with rainfall, which is the opposite of what we would expect and may be due to the lack in data. Lastly, rainfall shows a positive relationship with Indian inflation, which can be explained by the fact that imports from India comprise 60% of Nepal's imports, and the fixed nominal exchange rate between the Indian and Nepalese currencies.

If Indian prices rise, so do import prices and therefore the value of the Nepalese rupee falls along with the Indian rupee, which affects Nepal's inflation rate. Therefore, the sign of the parameter seems appropriate. The model's R^2 value at 0.359 has increased. The figures below show the model's estimation results with the addition of the supply shock.

We can verify that, compared to the previous model, this model better explains the sudden rise in inflation in 2010 and the fluctuation of inflation afterwards.

<Figure 3-8>

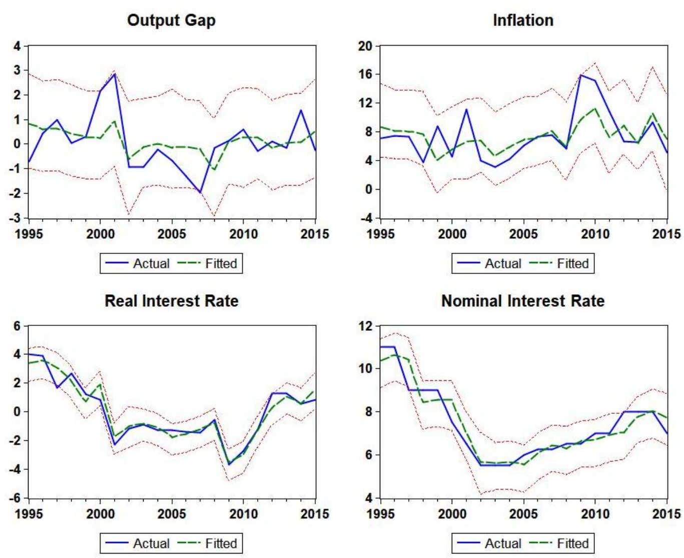
Model 1-A with Remittances and Supply Shocks



Note: The unit of the vertical axis is measured in percentage.

<Figure 3-9>

Model 1-B with Remittances and Supply Shocks



Note: The unit of the vertical axis is measured in percentage.

(3) Political Transition

As we have explained before, Nepal has undergone many political changes starting from the Nepalese Civil War in the 1990s. One notable change is the transition from a monarchy to a republic in 2008. Such changes in political structure and the end of civil war could change not only the expectations of economic agents regarding the future economy, but also greatly impact the real economy. Simultaneously, since 2007, a solution to the conflict has begun to emerge. According to the rational expectations theory, economic agents will predict future economic conditions using all available information and make economic choices based on these predictions. Thus, we have added a dummy variable of year 2007 to the model in order to capture the influence of the choices and predictions that the economic agents made based on their expectations of political change. In addition, though Nepal's volume of trade with India is high, their connection to the world economy is weak and their capital market is underdeveloped. As a result, using the finding of Khadka and Budhanthoki (2013) that the 2008 financial crisis did not have a big effect on Nepal, we do not add an additional dummy variable for these events. The dummy variable is included in the aggregate supply curve and the aggregate demand curve.

The estimation results for this model are shown in <Tables 3-9 and 3-10>. This is the final small scale model incorporating all of Nepal's characteristics on a small scale. The aggregate demand curve in Model 1-A, the output gap and the real interest rate have a negative relationship. We can see that, as according to economic theory, a high interest rate curbs economic expansion. The real exchange rate also has a positive relationship with the output gap. This reflects the economic expansion effect of increased exports. The 2007 dummy variable has a negative relationship. Considering that the year 2007 coincides with the end of the civil war, we can predict such a result came about as a result of economic agents that expected political stability in the near future putting off consumption expenditure and investment. The R^2 value for this equation increases and so this equation has higher explanatory power. The results for Model 1-B are similar to Model 1-A.

<Table 3-9>

Model 1-A(Final) with Remittances, Supply Shocks and Political Transition

$y_t =$	$0.298y_{t-1}$	$-0.037r_t$	$+0.016rer_t$	$-1.331rem_t$	$-2.095d_{2007}$		$R^2=0.323$
	(0.238)	(0.067)	(0.022)	(0.840)	(1.105)*		
$\pi_t =$	$0.860y_t$	$+0.365\pi_{t-1}$	$-0.008rain_t$	$-0.046f_{inf\ t}$	$+0.357\pi_t^{IND}$	$+1.220d_{2007}$	$R^2=0.363$
	(0.715)	(0.218)	(0.004)*	(0.073)	(0.326)	(3.738)	
$i_t =$	$0.895i_{t-1}$	$+0.032\pi_t$	$-0.254y_t$	$-0.001rer_t$	$-0.694rem_t$		$R^2=0.905$
	(0.087)***	(0.047)	(0.143)*	(0.013)	(0.447)		

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

<Table 3-10>

Model 1-B(Final) with Remittances, Supply Shocks and Political Transition

$y_t =$	$0.319y_{t-1}$	$-0.006r_t$	$+0.012rer_t$	$-1.420rem_t$	$-2.029d_{2007}$		$R^2=0.310$
	(0.237)	(0.114)	(0.022)	(0.855)	(1.132)*		
$\pi_t =$	$0.860y_t$	$+0.365\pi_{t-1}$	$-0.008rain_t$	$-0.046f_{inf\ t}$	$+0.357\pi_t^{IND}$	$+1.220d_{2007}$	$R^2=0.363$
	(0.715)	(0.218)	(0.004)*	(0.073)	(0.326)	(3.738)	
$i_t =$	$0.895i_{t-1}$	$+0.032\pi_t$	$-0.254y_t$	$-0.001rer_t$	$-0.694rem_t$		$R^2=0.905$
	(0.087)***	(0.047)	(0.143)*	(0.013)	(0.447)		

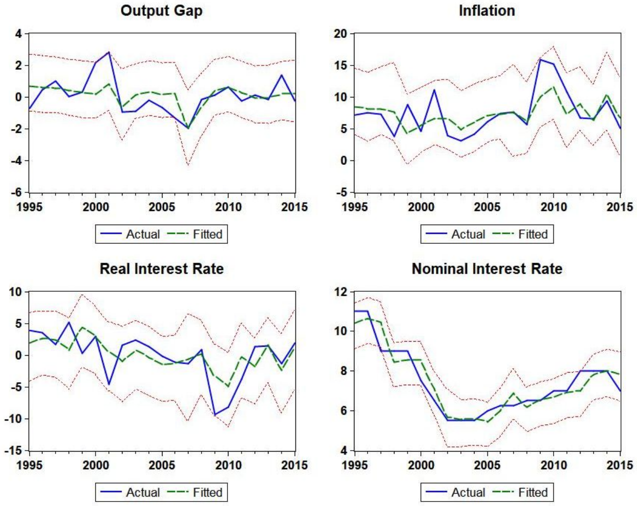
Note: Same as Note in <Table 3-9>

In the case of the aggregate supply curve expressed as a New Keynesian Phillips Curve, most of the coefficients were similar to the previous estimation and the 2007 dummy variable had a positive coefficient. This may be because civilian agents expected prices to rise with the transition from a monarchy to a republic as a result of more liberated economic activity and fewer policies that regulated the civilian economy such as price controls. However, it may reflect a rise in prices unique to 2007 that was not included in the model.

Overall, these results show the limitations of a small scale model, but the model's explanatory power did increase, and the model partially reflects the main characteristics of Nepal's economy. Below are the estimations of Model 1-A and Model 1-B which include all of Nepal's characteristics.

<Figure 3-10>

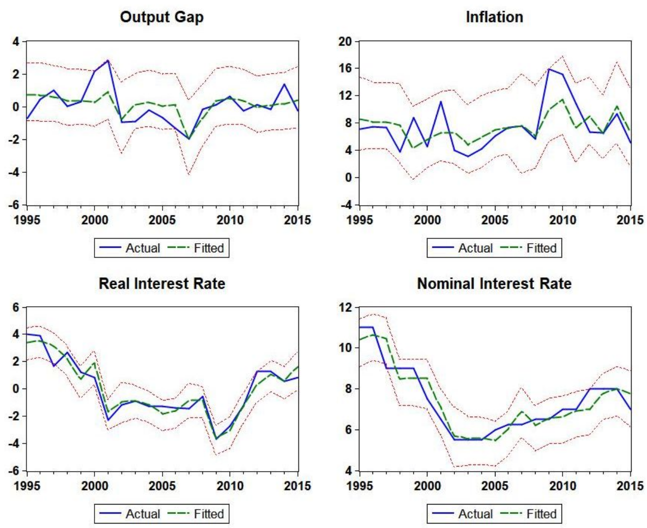
Model 1-A(Final) with Remittances, Supply Shocks and Political Transition



Note: The unit of the vertical axis is measured in percentage.

<Figure 3-11>

Model 1-B(Final) with Remittances, Supply Shocks and Political Transition



Note: The unit of the vertical axis is measured in percentage.

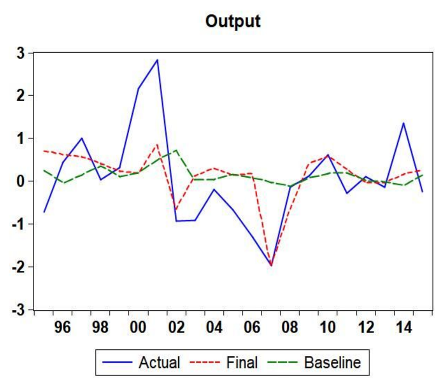
(4) Comparison of Improvements to the Models

We have examined Nepal's small scale economic model which includes remittances, rainfall, India's inflation, rise in world grain prices, the peg system with the Indian rupee, and political instability. The explanatory power of the small scale model has increased as we have incorporated more of Nepal's economic characteristics. We will compare these changes below.

In the case of the output gap, it is clear that the explanatory power of both Model 1-A and 1-B improved. In particular, the model sufficiently reflects the increase of the output gap in 2000, the decrease of the output gap in 2002, and the output gaps in 2007 and after 2010. Also, the final versions of both models show a higher correlation coefficient with the actual data and have a standard deviation that is more similar to the actual data than the baseline models.

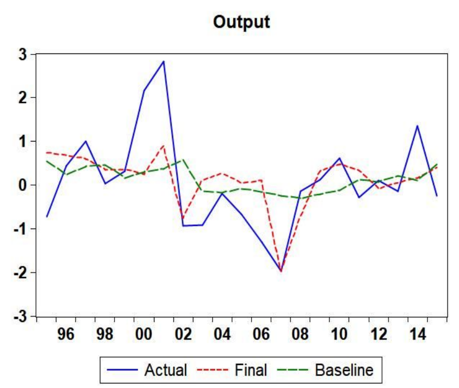
<Figure 3-12>

Model 1-A Estimated Output Gap(Baseline versus Final)



<Figure 3-13>

Model 1-B Estimated Output Gap(Baseline versus Final)



Note: The unit of the vertical axis is measured in percentage.

<Table 3-11>

Model 1-A Estimated Output Gap(Baseline versus Final)

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	1.102	1
Baseline Model	0.247	0.224
Final Model	0.626	0.568

<Table 3-12>

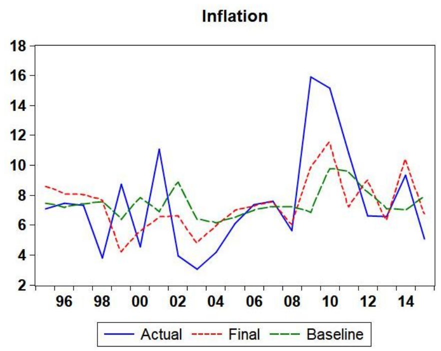
Model 1-B Estimated Output Gap(Baseline versus Final)

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	1.102	1
Baseline Model	0.262	0.238
Final Model	0.614	0.557

Inflation also shows a similar result. The models that incorporate Nepal's characteristics not only reflect the fluctuation of inflation after 2010 better than the baseline model, but also capture the decrease in inflation in 2003. The standard deviation for the final model is also more similar to the actual data, and the final model has a higher correlation coefficient with the actual data.

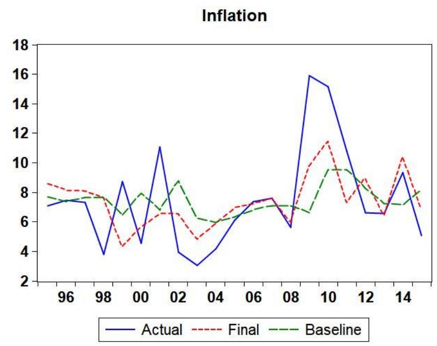
<Figure 3-14>

Model 1-A Estimated Inflation (Baseline versus Final)



<Figure 3-15>

Model 1-B Estimated Inflation (Baseline versus Final)



Note: The unit of the vertical axis is measured in percentage.

<Table 3-13>

Model 1-A Estimated Inflation(Baseline versus Final)

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	3.359	1
Baseline Model	0.976	0.275
Final Model	1.793	0.628

<Table 3-14>

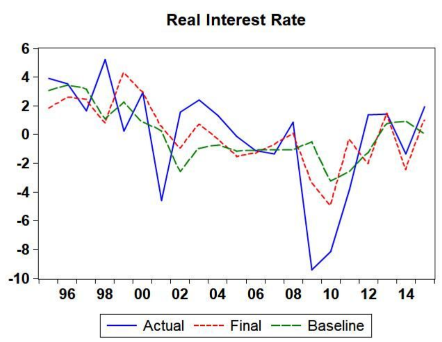
Model 1-B Estimated Inflation(Baseline versus Final)

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	3.359	1
Baseline Model	0.995	0.222
Final Model	1.768	0.632

In the case of the real interest rate, the final model for Model 1-A shows an improvement in explanatory power as it has a higher correlation coefficient with the actual data and a better standard deviation than the baseline model. The baseline model for Model 1-B shows a good fit, and therefore (though the final model shows a slight improvement in explanatory power) the improvement is negligible.

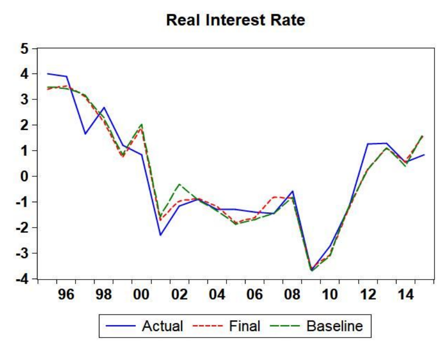
<Figure 3-16>

Model 1-A Estimated Real Interest Rate(Baseline versus Final)



<Figure 3-17>

Model 1-B Estimated Real Interest Rate(Baseline versus Final)



Note: The unit of the vertical axis is measured in percentage.

<Table 3-15>

Model 1-A Estimated Real Interest Rate(Baseline versus Final)

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	3.743	1
Baseline Model	1.886	0.496
Final Model	2.218	0.669

<Table 3-16>

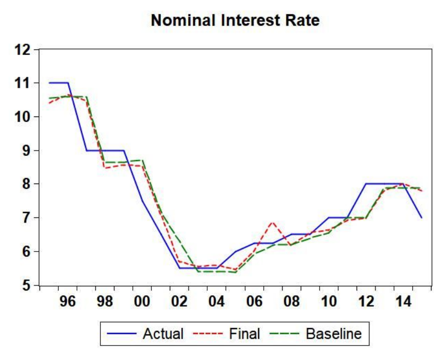
Model 1-B Estimated Real Interest Rate(Baseline versus Final)

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	2.064	1
Baseline Model	2.095	0.953
Final Model	2.050	0.958

The explanatory power of the baseline model for nominal interest rate was high, so there was no significant change in the final model. However, the explanatory power of the final model improved from 2001 to 2002.

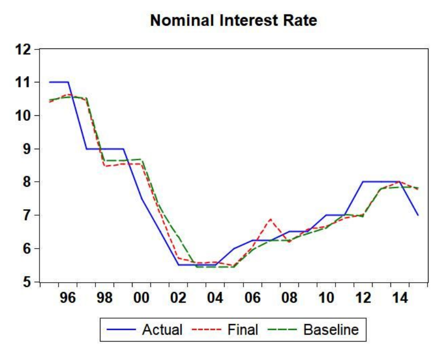
<Figure 3-18>

Model 1-A Estimated Nominal Interest Rate(Baseline versus Final)



<Figure 3-19>

Model 1-B Estimated Nominal Interest Rate(Baseline versus Final)



Note: The unit of the vertical axis is measured in percentage.

<Table 3-17>

Model 1-A Estimated Nominal Interest Rate(Baseline versus Final)

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	1.762	1
Baseline Model	1.780	0.936
Final Model	1.733	0.944

<Table 3-18>

Model 1-B Estimated Nominal Interest Rate(Baseline versus Final)

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	1.762	1
Baseline Model	1.739	0.936
Final Model	1.726	0.945

B. Currency Peg

Aside from an independent monetary policy with capital controls, we also consider a currency peg model without capital controls. In this case, as explained above, Nepal's nominal interest rate becomes equal to India's nominal interest rate through interest rate parity. Only the real interest rate differs from India due to different rates of inflation. Eventually, the real interest rate becomes an exogenous variable and so, under this model, we are only able to estimate the output gap and inflation. When estimating the output gap, we only consider the interest rate, rather than including the exchange rate itself. However, if Nepal retains its currency peg in order to stabilize prices while loosening capital controls in order to attract foreign investment, it is a monetary policy scenario that could occur and thus worth estimating. Also, in this section, we will examine the differences between the estimated coefficients in the final model with a currency peg, and the final model with an independent monetary policy. The table below shows the estimation results for the currency peg model.

<Table 3-19>

Model 2-A: Currency Peg

$y_t =$	$0.280 y_{t-1}$	$-0.011 r_t$	$-1.275 rem_t$	$-2.043 d_{2007}$			$R^2 = 0.299$
	(0.229)	(0.054)	(0.814)	(1.090)*			
$\pi_t =$	$0.860 y_{t-1}$	$+0.365 \pi_{t-1}$	$-0.008 rain_t$	$-0.046 f_{inf\ t}$	$+0.357 \pi_t^{IND}$	$+1.220 d_{2007}$	$R^2 = 0.363$
	(0.715)	(0.218)	(0.004)*	(0.073)	(0.326)	(3.738)	

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

<Table 3-20>

Model 2-B: Currency Peg

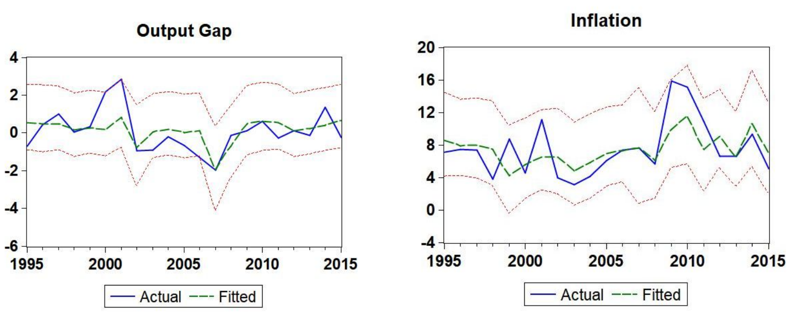
$y_t =$	$0.289y_{t-1}$	$+0.017r_t$	$-1.289rem_t$	$-1.971d_{2007}$			$R^2=0.299$
	(0.226)*	(0.085)	(0.804)	(1.103)*			
$\pi_t =$	$0.860y_{t-1}$	$+0.365\pi_{t-1}$	$-0.008rain_t$	$-0.046f_{inf\ t}$	$+0.357\pi_t^{IND}$	$+1.220d_{2007}$	$R^2=0.363$
	(0.715)	(0.218)	(0.004)*	(0.073)	(0.326)	(3.738)	

Note: Same as Note in <Table 3-19>

The estimation results are very similar to the results for the independent monetary policy with capital controls. There are only slight differences in the size of the coefficients. Only the estimated coefficient for the real interest rate in Model 2-B's output gap changed from negative to positive. Considering this result is not in line with economic theory, we can interpret this result as an indication that the currency peg is not appropriate for explaining Nepal's past economy or as the consequence of inadequate data.

<Figure 3-20>

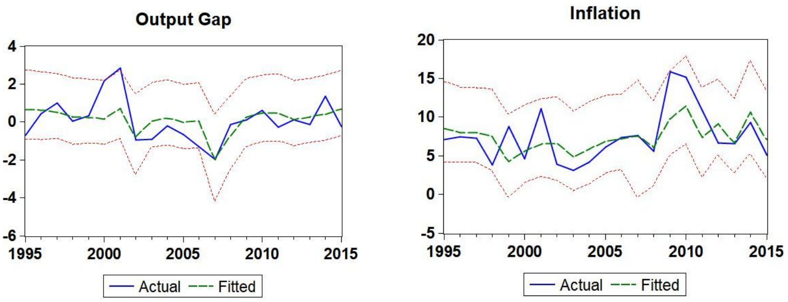
Model 2-A: Currency Peg



Note: The unit of the vertical axis is measured in percentage.

<Figure 3-21>

Model 2-B: Currency Peg

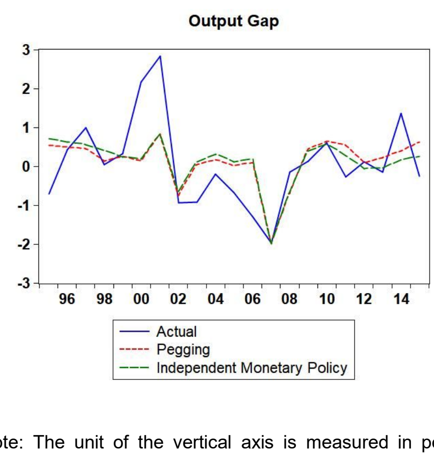


Note: The unit of the vertical axis is measured in percentage.

Next, we will compare the explanatory power of the pegged model with the independent monetary policy with capital control model. Since they are equivalent in the case of inflation (as they both use the same equation) and since the real interest rate and nominal interest rate are exogenous variables in the pegging model, we will only compare the output gap.

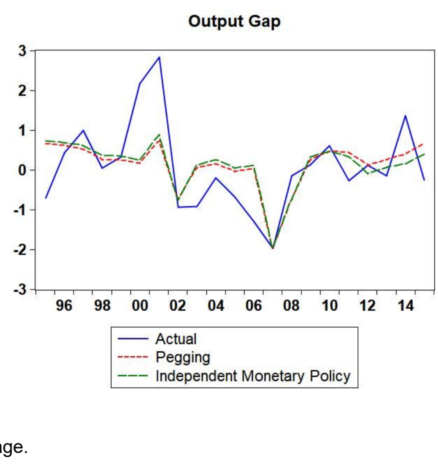
<Figure 3-22>

Models 1-A and 2-A Estimated Output Gap



<Figure 3-23>

Models 1-B and 2-B Estimated Output Gap



Note: The unit of the vertical axis is measured in percentage.

<Table 3-21>

Models 1 and 2 Estimated Output Gap

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	1.102	1
Model 1-A	0.626	0.568
Model 1-B	0.614	0.557
Model 2-A	0.602	0.547
Model 2-B	0.602	0.546

As one can see from the figure above, there is no significant difference between the two. This may be because we have not dealt with the separate segments of aggregate demand. We expect to see some differences in the medium scale model later. <Table 3-21> shows the standard deviations and the correlations with actual data of the estimators of each model.

C. Partial Pegging

We can consider not only a currency peg model, but also a partial pegging model. As we mentioned before, Nepal has various types of underground economies and illegal exchange transactions occur. Since various transaction routes exist, there is no reason for the nominal interest rate to be exactly the same. However, since pegging is still being used, we can conclude that Nepal's real interest rate depends on India's real interest rate. Thus, we report the results of replacing the equation indicating monetary policy with an equation estimating Nepal's real interest rate.

The significance and direction of the coefficients of the output gap equation are similar to the independent monetary policy model as can be seen from <Tables 3-22 and 3-23>. Note that Nepal's real interest rate and India's real interest rate have a high correlation. The coefficient for India's real interest rate is nearly 1 and highly significant, suggesting that Nepal and India's real interest rates are closely related to each other. This model can also explain why the two countries have different nominal interest rates. Also, since the explanatory power of the real interest rate is very high, we expect that it will provide accurate estimations of the aggregate demand in future predictions. The predictions of Model 3-A and Model 3-B are shown in <Figures 3-24 and 3-25>.

<Table 3-22>

Model 3-A: Partial Pegging, $r_t = i_t - \pi_t \ (r_t^{ind} = i_t^{ind} - \pi_t^{ind})$

$y_t =$	$0.272y_{t-1}$	$-0.020r_t$	$-1.246rem_t$	$-2.057d_{2007}$			$R^2 = 0.301$
	(0.232)	(0.062)	(0.819)	(1.088)*			
$\pi_t =$	$0.860y_{t-1}$	$+0.365\pi_{t-1}$	$-0.008rain_t$	$-0.046f_{inf\ t}$	$+0.357\pi_t^{IND}$	$+1.220d_{2007}$	$R^2 = 0.363$
	(0.715)	(0.218)	(0.004)*	(0.073)	(0.326)	(3.738)	
$r_t =$	$0.858r_t^{ind}$	$+0.160rer_t$					$R^2 = 0.459$
	(0.252)***	(0.055)***					

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

<Table 3-23>

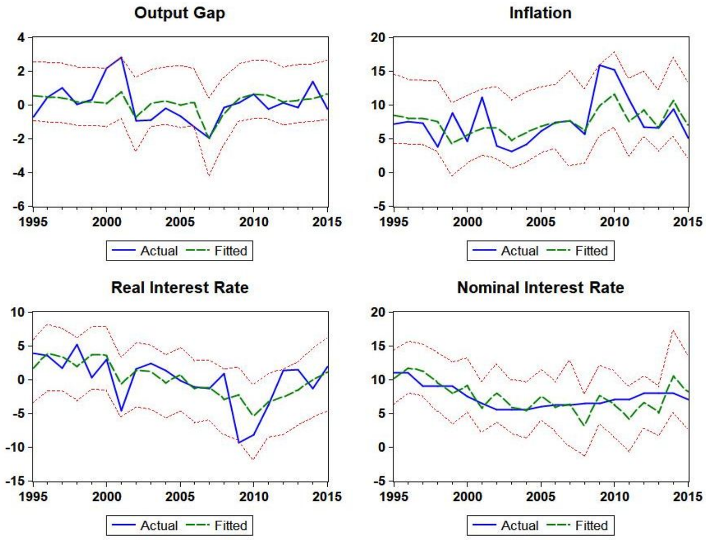
Model 3-B: Partial Pegging, $r_t = i_t - E_t\pi_{t+1} \ (r_t^{ind} = i_t^{ind} - E_t\pi_{t+1}^{ind})$

$y_t =$	$0.290y_{t-1}$	$+0.012r_t$	$-1.296rem_t$	$-1.988d_{2007}$			$R^2 = 0.297$
	(0.227)	(0.107)	(0.806)	(1.105)*			
$\pi_t =$	$0.860y_{t-1}$	$+0.365\pi_{t-1}$	$-0.008rain_t$	$-0.046f_{inf\ t}$	$+0.357\pi_t^{IND}$	$+1.220d_{2007}$	$R^2 = 0.363$
	(0.715)	(0.218)	0.004)*	(0.073)	(0.326)	(3.738)	
$r_t =$	$0.867r_t^{ind}$	$+0.046rer_t$					$R^2 = 0.708$
	(0.132)***	(0.024)*					

Note: Same as Note in <Table 3-22>

<Figure 3-24>

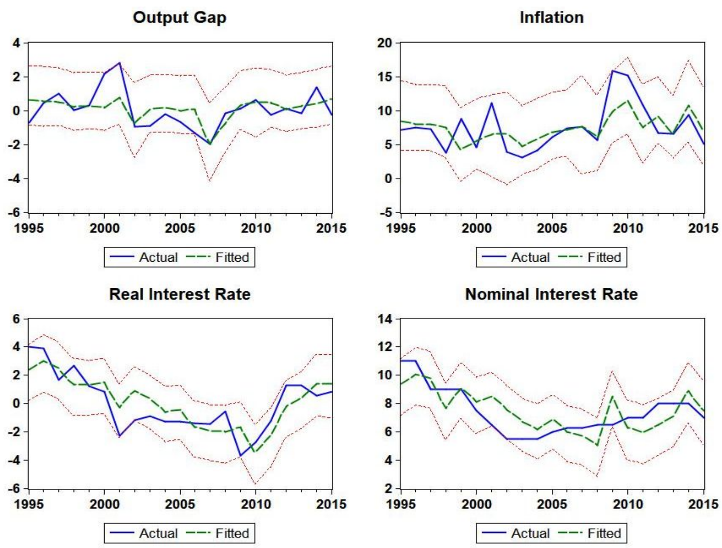
Model 3-A: Partial Pegging



Note: The unit of the vertical axis is measured in percentage.

<Figure 3-25>

Model 3-B: Partial Pegging

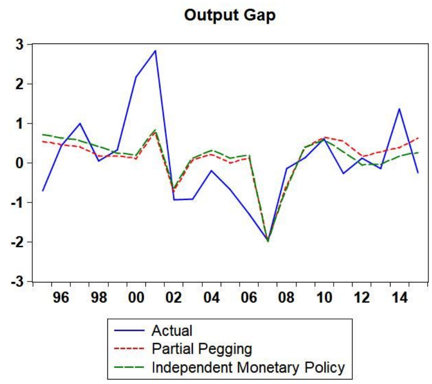


Note: The unit of the vertical axis is measured in percentage.

In the case of partial pegging, we first estimate the real interest rate then use this to estimate the nominal interest rate. Thus, we can compare all estimation variables except for inflation with the independent monetary policy model. We still have the same regression equation for inflation. Below is a comparison of the estimated output gap of the two models.

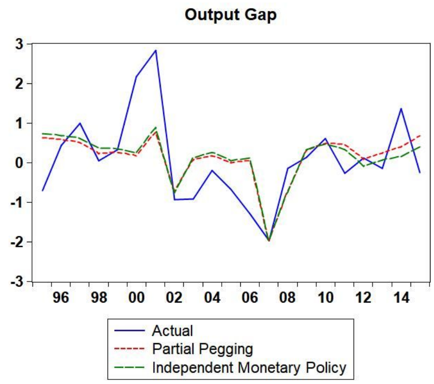
<Figure 3-26>

Comparison of the Estimated Output Gap of Models 1-A and 3-A



<Figure 3-27>

Comparison of the Estimated Output Gap of Models 1-B and 3-B



Note: The unit of the vertical axis is measured in percentage.

<Table 3-24>

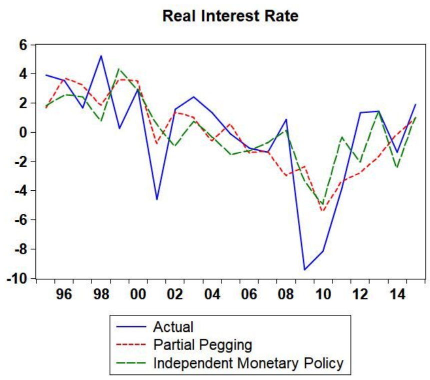
Models 1 and 3 Estimated Output Gap

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	1.110	1
Model 1-A	0.626	0.568
Model 1-B	0.614	0.557
Model 3-A	0.601	0.545
Model 3-B	0.605	0.549

The difference in the output gap is still small. This may be because the other explanatory variables all coincide, and thus the difference in real interest rates is not big enough to change the equation's explanatory power. Though it is a small difference, the independent monetary policy model shows a better standard deviation and has a higher correlation coefficient with the actual data. We will not compare inflation as both models have the same equation for the New Keynesian Phillips Curve. Next, we will compare the estimates for the real interest rate.

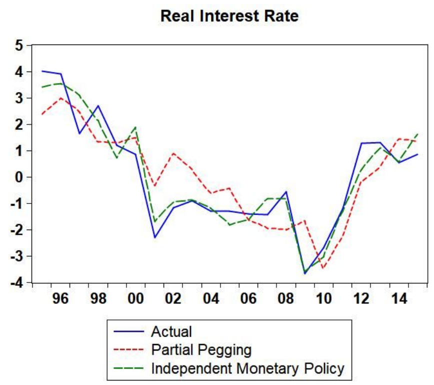
<Figure 3-28>

Models 1-A and 3-A Estimated Real Interest Rate



<Figure 3-29>

Models 1-B and 3-B Estimated Real Interest Rate



Note: The unit of the vertical axis is measured in percentage.

<Table 3-25>

Models 1-A and 3-A Estimated Real Interest Rate

$r_t = i_t - \pi_t$	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	3.743	1
Model 1-A	2.218	0.669
Model 3-A	2.549	0.676

<Table 3-26>

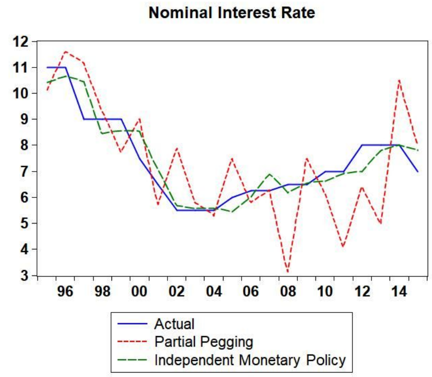
Models 1-B and 3-B Estimated Real Interest Rate

$r_t = i_t - E_t\pi_{t+1}$	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	2.064	1
Model 1-B	2.050	0.958
Model 3-B	1.766	0.812

Since the definition of the real interest rate changes in each case, we have two regression equations for the real interest rate. By definition, there are two types of actual data. Partial pegging is better explained by real interest rates that are derived from adaptive expectations based on lagged inflation. Independent monetary policy is better explained by real interest rates derived from Vector Autoregression (VAR). Next is the nominal interest rate.

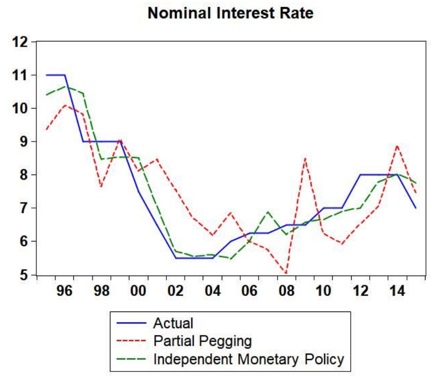
<Figure 3-30>

Models 1-A and 3-A Estimated Nominal Interest Rate



<Figure 3-31>

Models 1-B and 3-B Estimated Nominal Interest Rate



Note: The unit of the vertical axis is measured in percentage.

<Table 3-27>

Models 1 and 3 Estimated Nominal Interest Rate

	Standard Deviation (%) within the Sample Period	Correlation Coefficient with Actual Data
Actual Data	1.628	1
Model 1-A	1.733	0.944
Model 1-B	1.726	0.945
Model 3-A	2.313	0.671
Model 3-B	1.443	0.697

Since the equation for the nominal interest rate is the same regardless of whether VAR was used under independent monetary policy, the estimation for the nominal interest rate is the same. In the partial pegging model, there are two estimators for the nominal interest rate depending on whether we add expected inflation or estimated inflation to the estimated real interest rate according to the Fisher Equation. As a result, this model's explanatory power is weaker than the independent monetary policy model which estimates the nominal interest rate directly.

7. Summary and Future Plans

Through the small-scale model, we examine the basic mechanisms and incorporate various characteristics of Nepal's economy into the model. It is possible to intuitively understand the relationship between various variables through a relatively simple linear model. The model becomes more accurate as we incorporate more characteristics of Nepal's economy and many of the coefficient signs match our theoretical predictions.

However, there are many insignificant coefficients due to a small sample size. Also, the years 2002 and 2008~2010 show a big discrepancy between the estimation results and the actual numbers. In addition, further investigation is needed to explain why inflows of remittance have a negative relationship with aggregate output. In Section IV, we will use a medium-scale model to address these issues. We will also build a model that is applicable to real situations and conduct predictions using various scenarios.

IV. Medium-Scale Macroeconomic Model

In Section III, we analyzed aggregate demand using the output gap variable. However, this method does not separately estimate the movements of the various components of aggregate demand, but estimates it as a whole. Therefore, it may lack precision. In order to overcome these shortcomings, in this section, we will divide aggregate demand into consumption expenditure, government expenditure, investment, and imports and exports, and use a medium-scale model to analyze Nepal's macroeconomy. We can also divide aggregate demand and other equations into subsections. However, since our sample period is only 20 years, if we increase the number of coefficients to be estimated, then the degrees of freedom will decrease, depriving our estimations of any statistical significance. Therefore, we will divide up the aggregate demand only in this medium-scale macroeconomic model. We will also consider the volume of global trade, official development assistance, and other additional data while building our model.

We can increase the explanatory power of our model by using a medium-scale model. In particular, unlike the small-scale model, where the coefficient signs for remittances were illogical, the medium-scale model provides us with a sensible result. Also, we can examine various facets of Nepal's economy by analyzing the various factors of aggregate demand. Though the model's explanatory power is limited due to political instability, we can see that the model's estimates are very similar to the actual numbers after incorporating Nepal's characteristics to the model.

This section is organized as follows. In Subsection 1, we explain a model constructed by using log linearization. In Subsection 2, we expand the model using an error correction model and compare it with the original model. In Subsection 3, we analyze the estimation equations using the error correction model. Finally, in Subsection 4, we explain our predictions for the future of Nepal's economy using simulations.

1. Structure of the Medium-Scale Macroeconomic Model : Log-Linearized Version

The medium-scale macroeconomic model in this subsection has divided up aggregate demand and so a more detailed analysis is possible compared to Section III. We divide aggregate demand into consumption expenditure, government expenditure, investment, and imports and exports. All data is from the IMF and analyzed in real terms.

The error correction model is commonly used when empirically analyzing a medium-scale macroeconomic model. In order to do this, we need to apply asymptotic theory, which is based on a large amount of data. However, the data we use do not have observations with quarterly data, so we can use yearly data of only 20 years. The second-best method is to use log linearization. We will explain both the error correction method and the log linearization method, but first we will start with the log linearization model.

The usual form of a linearized model is the following. Here $x_{1,t}$ is the endogenous variable. The explanatory variables are $x_{2,t},...,x_{k,t}$, and the exogenous variables are $z_{1,t},...,z_{l,t}$. All equations have a constant term and an error term. The relationship between the endogenous, explanatory, and exogenous variables expressed in equation form is the following.

$$x_{1,t} = \beta_0 + \beta_2 x_{2,t} + ... + \beta_k x_{k,t} + \gamma_1 z_{1,t} + ... + \gamma_l z_{l,t} + u_{1,t} \qquad (1)$$

Next, we will divide the medium-scale macroeconomic model into aggregate demand, aggregate supply, and monetary policy, and explain the composition of each equation. Aggregate demand, as we mentioned above, will be divided into consumption expenditure, government expenditure, investment, and imports and exports.

A. Aggregate Demand

(1) Consumption Expenditure

Usually, consumption expenditure is analyzed using an Euler Equation expressing a household's optimal intertemporal consumption choice. Also, in the case of an open economy, it is best to divide consumer goods into domestic consumer goods and foreign consumer goods. However, since we do not have individual household consumption expenditure data, it is difficult for us to use the Euler Equation. Also, there is no data dividing consumption expenditure into consumption of domestic consumer goods and foreign consumer goods. As an alternative, we construct the consumption expenditure equation so that the part of consumption expenditure composed of imports would be captured by fluctuations in the real exchange rate. The equation is below.

$$\triangle \ln C_t = f(\triangle \ln C_{t-1}, \triangle \ln Y_t, \triangle \ln RER_t, \triangle r_t, Z_t) \qquad (2)$$

C_t : Consumption Expenditure, Y_t : Real GDP, RER_t : Real Exchange Rate, r_t : Real Interest Rate

The Z_t variable in equation (2) is additional variables aside from the basic variables of macroeconomic theory that can be added to the model in order to reflect Nepal's characteristics. The other equations in the model are expressed in the same way. In this model, we include remittances, ODA, and dummy variables for particular years.

Equation (2) is the log linearized Euler Equation modified to become backward-looking in order to reflect the characteristics of our data. Current consumption expenditure can be affected by lagged consumption expenditure, and conventionally $\triangle \ln C_t$ is expressed as an increasing function of $\triangle \ln C_{t-1}$. On the other hand, it is highly probable that $\triangle \ln C_t$ is a decreasing function of the real interest rate. If the real interest rate rises, then current consumption will decrease, because one can consume more in the future by saving now instead of consuming. If we linearize a conventional Euler Equation, the term $E_t \triangle C_{t+1}$ appears. We consider this as the expected increase in consumption expenditure.

One variable that can affect this is income. Thus, we include $\triangle \ln Y_t$ in this model as an explanatory variable. Since consumption expenditure usually rises when income rises, we expect $\triangle \ln C_t$ to be an increasing function of $\triangle \ln Y_t$. We add the real exchange rate which can affect consumption of foreign consumer goods. If the real exchange rate rises, or if the Nepal rupee depreciates compared to the Indian rupee, then foreign goods become more expensive and the consumption of imported goods will decrease. Inflow of remittances and various political shocks also can affect consumption expenditure.

(2) Government Expenditure

If we assume that government expenditure is determined by past government expenditure, the real interest rate, and real GDP, we can express government expenditure using the following expression.

$$\triangle \ln G_t = f(\triangle \ln G_{t-1}, \triangle \ln Y_t, \triangle r_t, Z_t) \qquad (3)$$

Similarly to consumption expenditure, government expenditure may change in the same direction as GDP. However, we must keep in mind that some components of government expenditure may act as an automatic stabilizer to readjust the amplitude of the business cycle. Thus, at times, government expenditure may behave in the opposite direction of GDP.

(3) Investment

It is known that if investment shocks and investment adjustment costs exist in investment choice, current investment is affected by past investment. Therefore, we added $\triangle \ln I_{t-1}$ as an explanatory variable. Also, if the real interest rate rises, then the interest on loans rises and so conventionally investment decreases. Investment is also affected by expected future profits, so we include current real GDP and the real exchange rate, which may affect future profits. In addition, investment may be affected by Official Development Assistance (ODA for short) and inflow of remittances. Similarly to consumption expenditure, investment may also be affected by political shocks and the earthquake of 2015.

$$\triangle \ln I_t = f(\triangle \ln I_{t-1}, \triangle \ln Y_t, \triangle \ln RER_t, \triangle r_t, Z_t) \quad (4)$$

(4) Exports and Imports

Variables that affect exports include past exports, the real exchange rate, and global economic trends. Here, the variables that express global economic trends are the World Trade Volume (WTV_t) and the GDP of Nepal's main trading partner, India. On the other hand, imports are affected by past imports, the real exchange rate, and domestic economic trends. Since the agents that decide the level of imports are domestic households, firms and the government, imports react more sensitively to domestic economic trends. A variable that reflects the domestic economic trend is Nepal's current national income. Also, since trade with India is crucial, we add India's GDP to the model. We also add remittances since it is used to purchase imports, and grain prices. The equation is as follows.

$$\ln EX_t = f(\ln EX_{t-1}, \ln WTV_t, \ln RER_t, \ln Y_t^{IND}, Z_t) \quad (5)$$

$$\ln IM_t = f(\ln IM_{t-1}, \ln WTV_{t,} \ln REM_t, \ln RER_t, \ln Y_t^{IND}, Z_t) \quad (6)$$

(5) National Income Accounting Identity

We can express domestic aggregate demand as the sum of consumption expenditure, government expenditure, investment, and exports, minus imports. Thus the national income accounting identity is written as below.

$$Y_t = C_t + I_t + G_t + EX_t - IM_t \quad (7)$$

Consumption expenditure, government expenditure, and investment are sustainable over long periods and have the tendency to continuously rise. Conventionally, in econometrics, we construct an error term using the long term relationship between these variables and substitute it into a difference equation. However, if the sample size is small, then it may be difficult to apply an error correction term model. Therefore, we will first apply log linearization, then use an error correction term to construct a model. We will choose the model with a higher explanatory power.

Similar to the other variables, exports and imports also show a consistent increase, but their fluctuations tend to be larger due to external factors. Also, if we use a difference variable, our explanatory power may drop. Thus, in this research, we do not use a difference variable and only use expressions that have been log-linearized.

B. Aggregate Supply

The aggregate supply curve can be derived by including sticky prices as introduced by Calvo (1983), which models optimal firm behavior for firms that produce intermediary and final goods. By using this, we can also derive the supply curves of firms that produce exports, imported investment goods, and imported consumer goods. However, there is no clear standard as to how we should determine which firms are export oriented firms and import oriented firms. Also, a lack of detailed capital data prevents us from using this method. Thus, this research will use a simple supply curve.

In the aggregate supply curve, inflation depends on past and future inflation, and the output gap ($\ln Y_t - \ln Y_t^P$, Y_t^P means potential GDP). In case of an open economy, supply is affected by economic trends in the global economy. This can be expressed through the real exchange rate. We can also add various state variables that affect future inflation as explanatory variables. However, if we add future inflation, problems of a lack of data and lower explanatory power arise. Instead, we construct a backward-looking model that does not include future inflation. In addition, aggregate supply can be affected by changes in world grain prices, India's inflation, and rainfall. These variables are added to Z_t. The equation is the following.

$$\pi_t = f(\pi_{t-1}, \ln Y_t - \ln Y_t^P, \ln RER_t, Z_t) \quad (8)$$

There are two methods to estimate potential GDP, at least. One is to estimate through a production function and the other is to use growth accounting.

However, in the case of the production function method, many errors can occur while estimating capital and labor productivity and we do not have the data to substitute for these factors. In this regard, it is difficult for us to use this method. As an alternative, we estimated potential GDP using the growth regression method to estimate the long term growth rate. Here, we assume the production function is a linear homogeneous function. Thus the sum of the incomes of the factors of production are equal to the GDP. Potential growth rate can be expressed as the sum of the mean of the rate of growth of capital and labor weighted by the income distribution between the factors of production, and the rate of growth of the total factor productivity.

$$\frac{\triangle Y_t}{Y_t} = \frac{\triangle A_t}{A_t} + \alpha \frac{\triangle K_t}{K_t} + (1-\alpha)\frac{\triangle L_t}{L_t} \tag{9}$$

(α: income distribution of capital, A: Aggregate Factor Productivity, K: Capital, L: Labor)

Potential GDP can be estimated by a quadratic function of lagged GDP and time.

$$\ln Y_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \epsilon_t \tag{10}$$

Here, if we express $\hat{\alpha}_i$ as the estimate of α_i, and ϵ_t as the error term, then potential GDP can be expressed using the following equation.

$$\ln Y_t^P = \hat{\alpha}_0 + \hat{\alpha}_1 t + \hat{\alpha}_2 t^2 \tag{11}$$

If we express the growth rate of potential GDP in time t as g_t^P, we can define it as $g_t^P = \ln Y_t^P - \ln Y_{t-1}^P$. This can also be applied to the level of capital input and the level of labor input. If we express capital and labor trend rate of growth as $\widetilde{g_t^K}$, $\widetilde{g_t^L}$, the aggregate factor productivity rate of growth, $\widetilde{g_t^A}$, can be derived using equation (9).

The estimate of future potential growth rate can be expressed as the following.

$$g^P_{T+i} = \widetilde{g^A_{T+i}} + \alpha \widetilde{g^K_{T+i}} + (1-\alpha)\widetilde{g^L_{T+i}} \tag{12}$$

(T: Most recent time period $i = 1,2,.....$)

For convenience, we will assume that aggregate productivity is maintained at the level of the last time period and that the income distribution of capital α is 0.35.

C. Monetary Policy

In Section III, we divided monetary policy into three scenarios: an independent monetary policy with capital control, pegging with the Indian rupee, and a partial pegging. Similarly, we will assume the same scenarios in the medium-scale macroeconomic model excluding the case of currency peg. For convenience, we will use the equations introduced in the previous section for monetary policy.

$$i_t = \rho i_{t-1} + (1-\rho)[\phi_\pi \pi_t + \phi_y y_t + \phi_{rer} rer_t] + z_3^T \alpha + \epsilon_t \tag{13}$$

$$r_t = \psi r_t^{IND} + \alpha x_t + e_t \tag{14}$$

Equation (13) expresses an independent monetary policy with capital control. Equation (14) expresses a monetary policy with partial pegging. In Section III, we calculated the real interests rate using the definitions $r_t = i_t - \pi_t$ or $r_t = i_t - E_t \pi_{t+1}$ according to vector autocorrelation. We used the same methods in this section.

D. Additional Explanatory Variables

As before, the explanatory variables labeled as Z_t are variables added to incorporate the characteristics of Nepal's economy. First, considering the reliance of the consumption expenditure, part of aggregate demand, on inflows of foreign currency, we include inflows of remittance and ODA. In order to capture the shock of the end of the monarchy in 2007 and the 2015 earthquake, we include dummy variables for these years.

In the case of government expenditure, the explanatory variables are similar to the variables for consumption expenditure aside from inflows of remittances and the real exchange rate. This is because the government's dependence on remittances is low considering the principal agents of remittance are mostly households.

In the case of investment, we add remittance as an explanatory variable, because it can flow into investment in the form of savings. Since the political transition in 2007 and the earthquake in 2015 can affect investment, we add dummy variables for these years. Lastly, considering that aid and foreign investment is important to Nepal as Nepal is still a developing country, we add ODA. In addition, since Nepal depends on imported raw materials, we add the real exchange rate.

In case of exports, we add the world trade volume, India's real GDP, the real exchange rate, and dummy variables for years with external shocks. All these variables are considered also for imports with the added variables of remittance and the change in world food prices. Since India has a profound impact on Nepal's trade as it is Nepal's main trading partner, we add India's real GDP as an explanatory variable.

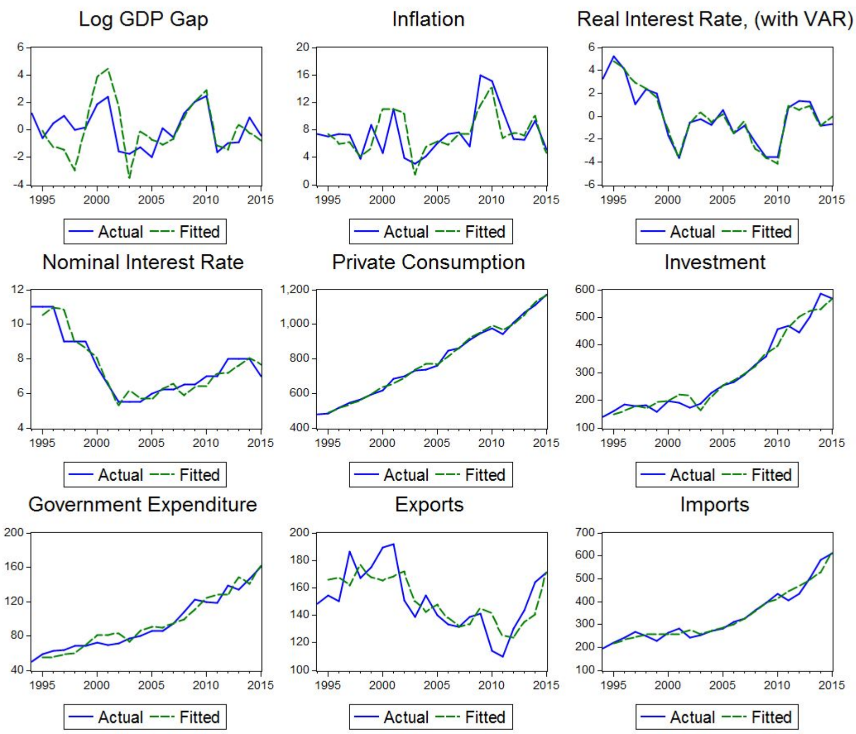
In the equation for aggregate supply, we add rainfall, India's inflation, and dummy variables for the political transition in 2007 and the earthquake in 2015. Lastly, in case of an independent monetary policy, in order to make a model reflecting remittance as before, we add the remittances variable to the basic Taylor Rule.

E. Model Estimation Results

In this subsection, for convenience, we will only use Model 1, which is newly defined here as a model that calculates expected inflation using VAR in the case of an independent monetary policy with capital control, since it has the best explanatory power. In <Figure 4-1> and <Table 4-1> below, we summarize the results of model estimation using log linearization. The figures show the model's explanatory power of past economic variables, and the table shows the estimated coefficients of the model, p-values for the estimations, and R^2.

<Figure 4-1>

Model 1(Medium-Scale): Independent Monetary Policy



Note: Log GDP gap, Inflation, nominal and real interest rates are measured annually in percentages, and Consumption, investment, government expenditure, exports, and imports are denominated in the local currency(billion Rupees), The solid line indicates actual data, and the dotted line indicates estimates.

In case of consumption expenditure, investment, and government expenditure, all are expressed as growth rates or increase rates, excluding data that are originally a ratio between the explanatory variable and the explained variable.

Consumption expenditure moves in the same direction as aggregate income, inflow of foreign currency, and the real exchange rate. On the other hand, it moves in the opposite direction as the real interest rate, consumption expenditure in the previous time period, and ODA. However, note that overall there are no statistically significant variables. In addition, contrary to our expectations, consumption expenditure moves in the opposite direction with the end of the monarchy and the 2015 earthquake, but this too has no statistical significance.

<Table 4-1>

Model 1(Medium-Scale): Independent Monetary Policy

Model Equation	R^2
$\triangle \ln C_t = -0.186\triangle\ln C_{t-1} - 0.756\triangle r_t + 0.296\triangle \ln Y_t + 0.019\triangle\ln REM_{t-1}$ (0.291) (0.988) (1.204) (0.021) $+0.091\triangle\ln RER_t - 0.002\triangle\ln ODA_t - 0.002d_{2007} + 0.028d_{2015}$ (0.206) (0.058) (0.034) (0.040)	0.521
$\triangle \ln G_t = -0.513\triangle\ln G_{t-1} + 3.734\triangle r_t + 5.170\triangle \ln Y_t + 0.094\triangle\ln ODA_t$ (0.233) (1.577)** (1.945)** (0.100) $+0.020d_{2007} + 0.093d_{2015}$ (0.059) (0.073)	0.440
$\triangle \ln I_t = -0.210\triangle\ln INV_t + 2.670\triangle r_t + 4.830\triangle \ln Y_t - 0.078\triangle\ln REM_{t-1}$ (0.335) (3.470) (3.972) (0.099) $-0.489\triangle\ln RER_t + 0.115\triangle\ln ODA_t + 0.030d_{2007} - 0.089d_{2015}$ (0.994) (0.245) (0.122) (0.161)	0.235
$\ln EX_t = 0.488\ln EX_{t-1} + 0.258\ln Y_t^{IND} - 0.392\ln WTV_t + 0.186\ln RER_t$ (0.191)** (0.660) (0.538) (1.037) $-0.016d_{2007} + 0.127d_{2015}$ (0.133) (0.158)	0.554
$\ln IM_t = 0.201\ln IM_{t-1} + 1.245\ln Y_t^{IND} - 0.576\ln WTV_t + 0.371\ln RER_t$ (0.291) (0.556)** (0.377) (0.705) $-0.036\ln REM_{t-1} + 0.036\pi_t^{FOOD} - 0.002d_{2007} + 0.062d_{2015}$ (0.051) (0.208) (0.086) (0.105)	0.964
$\pi_t = 0.397\pi_{t-1} + 1.114(\ln Y_t - \ln Y_t^P) - 0.00006RAIN_t - 0.053\pi_t^{FOOD}$ (0.217)* (0.513)** (0.00004) (0.073) $+0.136\pi_t^{IND} + 0.003d_{2007} - 0.031d_{2015}$ (0.376) (0.033) (0.035)	0.530
$i_t = 0.874i_{t-1} + 0.068\pi_t - 0.225(\ln Y_t - \ln Y_t^P) + 0.006RER_t - 0.007\triangle REM_t$ (0.084)*** (0.058) (0.135) (0.014) (0.005)	0.903

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

The direction of government expenditure is the same as gross income and real interest rates, and it is statistically significant. ODA also reacts in the same direction but is statistically insignificant. Previous year’s government expenditure moves in the opposite direction of government expenditure but also lacks statistical significance. Although there was an increase in government expenditure due to the abolition of the monarchy and the 2015 earthquake, they are not statistically significant factors.

Investment increases along with gross income and ODA. Also, investment reacts positively to the abolition of the monarchy in 2007 and negatively to the 2015 earthquake. Contradictory to the theory, an increase in remittance decreases investment and a rise in interest rate raises investment. However, the coefficients were not statistically significant.

India’s gross income reacts in a direction which increases both exports and imports, and such reaction seems to be larger in imports. On the other hand, an increase in the real exchange rate increases both exports and imports, and the fact that an increase in imports is more significant is not coherent with the existing theories.

The aggregate supply moves in the same direction as previous period’s inflation, India's inflation, and the output gap. In particular, the response to previous period’s inflation and the output gap is statistically significant. However, rainfall and the rate of increase of global food prices are not statistically significant.

In case of monetary policy, the magnitude of the coefficient is slightly different from that of the small scale model, but the direction of the sign is the same except for the real exchange rate. However, unlike in the small-scale model, the output gap is no longer significant and the value of R^2 is reduced.

In general, estimation results show that there are not many significant variables. It is also observed that some variables do not move in directions consistent with the existing theories. It may be because of potential abnormality in the time series data or loss of information on long-term relations due to log differentiation, which may result in lower explanatory power. In such a case, the estimates may be biased or may have lower efficiency, and due to loss of information, it would be difficult to improve power of the data. Consequently, it would make the prediction of future economic growth rate and inflation much more difficult. Therefore, in the next subsection, we will construct a model using the error correction model and confirm if there is an improvement in power compared to the current model. Then, we will re-analyze the model equations and proceed to estimation and simulation.

2. Construction of a Medium-scale Macroeconomic Model : Error Correction Model

This section introduces a model which applies the error correction model and compares its results with that from the model with log linearization. The error correction model was first used in Saran (1964) to resolve the spurious regressions problem due to abnormal changes in time series and to increase the accuracy of estimation using long-term relationships among time series data. If multiple time series are used, the consternation relationship of the time series is comprehensively considered. However, in this study, only the consternation relationship between each factor of GDP and GDP itself is used in the error correction model.

The time series data have an order of integration of 1, while the linear combination of them has consternation when an integration order is 0 and means a long-term equilibrium relationship. According to the Augmented Dickey-Fuller test conducted using Eviews (where an addition of intercept term is assumed), the null hypothesis that the log level time series data of GDP, private consumption, government expenditure, private investment, and imports (excluding exports) has a unit root when differenced once is rejected, and the test shows the integration order of those variables is 1. In case of exports, the null hypothesis that the unit root exists at the log level is rejected, implying that the order of integration is 0. In other words, only in case of exports does the integration order differ from the GDP. Also, as shown in <Figure 4-2> below, exports do not seem to have a long-term trend that is similar to GDP. Thus, only the error correction model of GDP and private consumption, GDP and government expenditure, GDP and private investment, and GDP and imports are implemented.

In addition, the export linear regression does not include the difference of GDP as an explanatory variable. Although this could theoretically be a misidentification error, excluding this from explanatory variables has higher power and increasing power is deemed more important in our empirical analysis.

$$\triangle \ln C_t = f(\triangle \ln C_{t-1}, \triangle \ln Y_t, \triangle \ln RER_t, \triangle r_t, Z_t, EC_{C_{t-1}}) \quad (15)$$

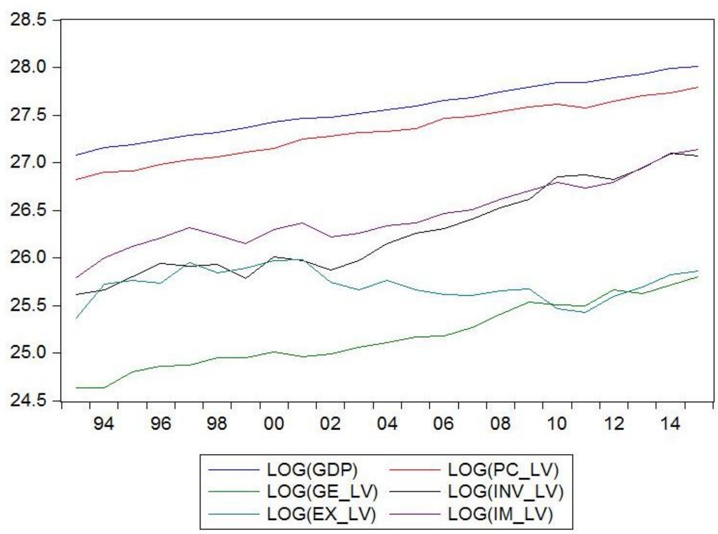
$$\triangle \ln G_t = f(\triangle \ln G_{t-1}, \triangle \ln Y_t, \triangle r_t, Z_t, EC_{G_{t-1}}) \quad (16)$$

$$\triangle \ln I_t = f(\triangle \ln I_{t-1}, \triangle \ln Y_t, \triangle \ln RER_t, \triangle r_t, Z_t, EC_{I_{t-1}}) \quad (17)$$

$$\Delta \ln IM_t = f(\Delta \ln IM_{t-1}, \Delta \ln RER_t, \Delta \ln Y^{IND}_{t-1}, Z_t, EC_{M_{t-1}}) \quad (18)$$

<Figure 4-2>

Trend of GDP and its Determinant Factors (Log Level)



Note: The unit of the vertical axis is measured in log level of each variable denominated in the local currency(billion Rupees), The error correction terms for each equation are residuals estimated from the linear regression equations (19) through (22). As shown in the error correction model, the error correction terms entered are the value from a period before. As we will see again in the estimation results, the error correction term has an estimation coefficient between −1 and 0 in all equations, indicating that error correction is working. Private consumption and private investment have a statistically significant value, indicating that the error correction model is valid. In the case of government expenditure and imports, the error correction term is not statistically significant. However, it is a well-known fact that GDP and its components have a long-term relationship, and improvement in model's power through such relationship is remarkable. Thus, we continue to use the error correction model.

$$C_t = \hat{\beta}_{00} + \hat{\beta}_{10} Y_t + EC_{C_t} \tag{19}$$

$$G_t = \hat{\beta}_{01} + \hat{\beta}_{11} Y_t + EC_{G_t} \tag{20}$$

$$I_t = \hat{\beta}_{02} + \hat{\beta}_{12} Y_t + EC_{I_t} \tag{21}$$

$$IM_t = \hat{\beta}_{03} + \hat{\beta}_{13} Y_t + EC_{M_t} \tag{22}$$

The equations that constitute the error correction model are summarized below. (23) to (27) are the aggregate demand sectors, including private consumption expenditure, government consumption expenditure, investment, exports, and imports, respectively. (28) is the aggregate supply, (29) is independent monetary policy with capital control, and (30) is under partial pegging.

$$\triangle \ln C_t = f(\triangle \ln C_{t-1}, \triangle \ln Y_t, \triangle \ln G_t, \triangle \ln RER_t, \triangle r_t, Z_t, EC_{C_{t-1}}) \tag{23}$$

$$\triangle \ln G_t = f(\triangle \ln G_{t-1}, \triangle \ln Y_t, \triangle \ln RER_t, \triangle r_t, Z_t, EC_{G_{t-1}}) \tag{24}$$

$$\triangle \ln I_t = f(\triangle \ln I_{t-1}, \triangle \ln Y_t, \triangle \ln G_t, \triangle \ln RER_t, \triangle r_t, Z_t, EC_{I_{t-1}}) \tag{25}$$

$$\ln EX_t = f(\ln EX_{t-1}, \ln WTV_t, \ln RER_t, \ln Y_{t-1}^{IND}, Z_t) \tag{26}$$

$$\Delta \ln IM_t = f(\Delta \ln IM_{t-1}, \Delta \ln RER_t, \Delta \ln Y_{t-1}^{IND}, Z_t, EC_{M_{t-1}}) \tag{27}$$

$$\pi_t = f(\pi_{t-1}, \ln Y_t - \ln Y_t^P, \ln RER_t) \tag{28}$$

$$i_t = \rho i_{t-1} + (1-\rho)[\phi_\pi \pi_t + \phi_y y_t + \phi_{rer} rer_t] + z_3^T \alpha + \epsilon_t \tag{29}$$

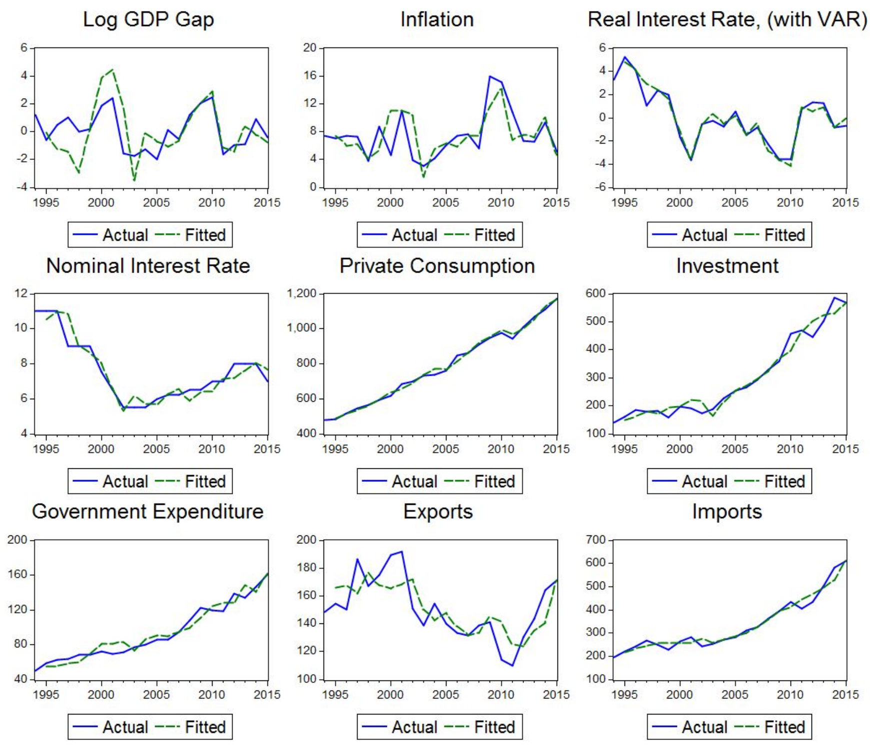
$$r_t = \psi r_t^{IND} + \alpha x_t + e_t \tag{30}$$

The implication of other variables is the same as that in Subsection 1, and EC_C, EC_G, EC_I and EC_M are error correction terms for private consumption expenditure, government consumption expenditure, investment, and imports, respectively.

The estimation results show a significant difference between two models in terms of explanatory power of the past data. This is shown in <Figure 4-3> and <Figure 4-4>. <Figure 4-3> schematizes the power of the model within the sample period using the log linearization model, and <Figure 4-4> corresponds to the error correction model. When we compare the two figures, we observe that the error correction model has greater power in economic growth rate and inflation compared to the log linearization model.

<Figure 4-3>

Model 1(Medium-Scale): Independent Monetary Policy

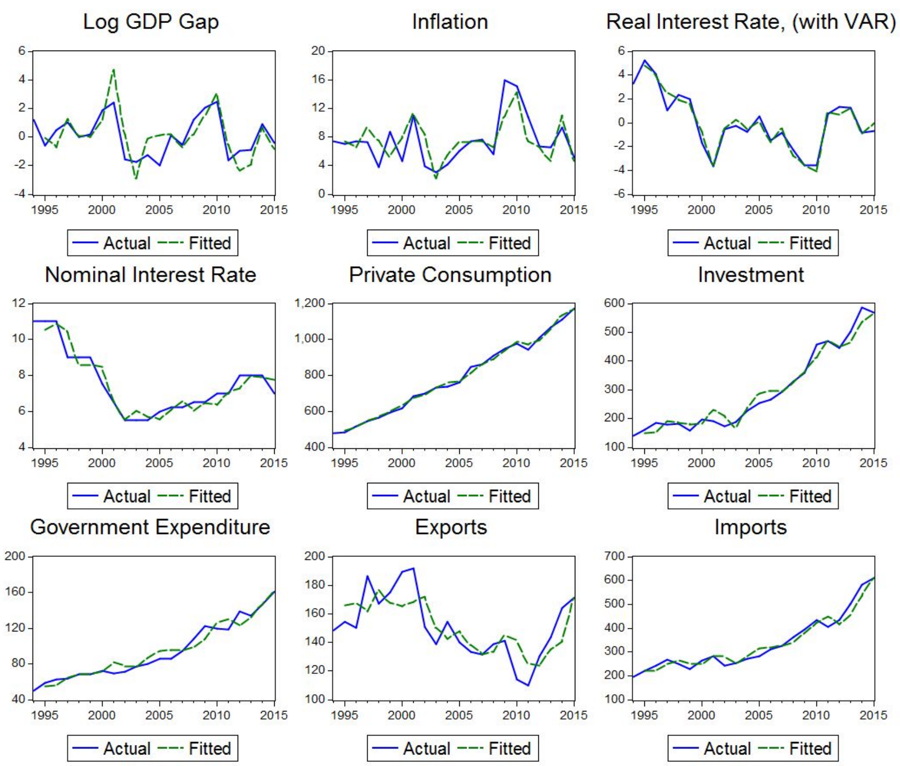


Note: Log GDP gap, Inflation, nominal and real interest rates are measured annually in percentages, and Consumption, investment, government expenditure, exports, and imports are denominated in the local currency(billion Rupees), The solid line indicates actual data, and the dotted line indicates estimates.

The log linearization model in <Figure 4-3>, in terms of economic growth rate, fails to correctly estimate the actual trend in the beginning of the sample period. Also, the variance of the estimated value is higher than the actual data. In particular, the model underestimates the economic growth rate in the late 1990s and tends to overestimate it in the early 2000s. In terms of inflation, we observe the period of rising inflation in the early 2000s is estimated as longer than the actual period. <Figure 4-4> shows that the error correction model generally corrects such problems. Therefore, the upcoming analysis results and future economic forecasts will be based on the error correction model in Subsection 3.

<Figure 4-4>

Model 2-B(Medium-Scale) Independent Monetary Policy with ECM



Note: Log GDP gap, Inflation, nominal and real interest rates are measured annually in percentages, and Consumption, investment, government expenditure, exports, and imports are denominated in the local currency(billion Rupees), The solid line indicates actual data, and the dotted line indicates estimates.

3. Estimation and Result of Mid-scale Macroeconomic Model

In this subsection, the estimation results of the medium-scale macroeconomic model with error correction will be introduced in case of independent monetary policy and in case of partial pegging, respectively.

A. Implementation of Independent Monetary System

The model is constructed considering exogenous variables that represent characteristics of the Nepalese economy and under an assumption that the country implements independent monetary policy as shown in (29). Then the real interest rate is calculated by using the vector autoregressive (VAR) model, or assuming adaptive expectations. These models are named as Model 2-A and Model 2-B, respectively. <Table 4-2> and <Table 4-3> depict the form and estimation result of the formulas that constitute each model.

Model 2-A is based on an assumption under which adaptive expectations align current inflation with inflation in the next period under an independent monetary policy with capital controls. First, in terms of private consumption expenditure, consumption expenditure in the previous year has a positive effect, unlike previous results. In other words, the result supports the habit formation theory, where past values of private consumption expenditure affect its current values. An increase in income leads to an increase in private consumption expenditure, and is statistically significant. The error correction term exhibits a statistically significant negative relationship. The current private consumption expenditure formula have higher R^2 values than the private consumption expenditure formula in Model 1, indicating an improvement in explanatory power.

Government expenditure is not notably different from Model 1. The sign of the dummy variable that represents the abolition of the monarchy changes in the opposite direction, but is not statistically significant.

Other explanatory variables in investment show no significant differences compared to those in Model 1, but investment in the previous year increases investment in the current year. Also, an increase in the value of R^2 attests the improved explanatory power.

<Table 4-2>

Model 2-A(Medium-Scale): Independent Monetary Policy with ECM

Model Equation	R^2
$\triangle \ln C_t = 0.040\triangle \ln C_{t-1} - 0.163\triangle r_t + 0.970\triangle \ln Y_t + 0.032\triangle \ln REM_{t-1}$ (0.217) (0.200) (0.419)** (0.020) $+0.220\triangle \ln RER_t - 0.005\triangle \ln ODA_t + 0.010 d_{2007} + 0.031 d_{2015} - 0.596 EC_C$ (0.216) (0.050) (0.029) (0.034) (0.261)**	0.675
$\triangle \ln G_t = -0.178\triangle \ln G_{t-1} + 0.182\triangle r_t + 1.402\triangle \ln Y_t + 0.030\triangle \ln ODA_t$ (0.320) (0.431) (1.071) (0.119) $-0.006 d_{2007} + 0.059 d_{2015} - 0.447 EC_G$ (0.073) (0.083) (0.332)	0.318
$\triangle \ln I_t = 0.047\triangle \ln INV_t + 0.800\triangle r_t + 2.866\triangle \ln Y_t - 0.117\triangle \ln REM_{t-1}$ (0.328) (0.947) (1.758) (0.101) $-0.647\triangle \ln RER_t + 0.122\triangle \ln ODA_t + 0.001 d_{2007} - 0.116 d_{2015} + 0.435 EC_I$ (0.973) (0.122) (0.114) (0.152) (0.233)	0.418
$\ln EX_t = 0.488 \ln EX_{t-1} + 0.258 \ln Y_t^{IND} - 0.392 \ln WTV_t + 0.186 \ln RER_t$ (0.191)** (0.660) (0.538) (1.037) $-0.016 d_{2007} + 0.127 d_{2015}$ (0.133) (0.158)	0.554
$\triangle \ln IM_t = 0.416\triangle \ln IM_{t-1} + 1.165\triangle \ln Y_t^{IND} + 0.430\triangle \ln WTV_t - 0.013\triangle \ln RER_t$ (0.386) (3.013) (0.528) (0.918) $+0.027\triangle \ln REM_{t-1} - 0.383\pi_t^{FOOD} - 0.056 d_{2007} - 0.001 d_{2015} - 0.575 EC_M$ (0.133) (0.424) (0.105) (0.127) (0.354)	0.267
$\pi_t = 0.397\pi_{t-1} + 1.114(\ln Y_t - \ln Y_t^P) - 0.00006 RAIN_t - 0.053\pi_t^{FOOD}$ (0.217)* (0.513)** (0.00004) (0.073) $+0.136\pi_t^{IND} + 0.003 d_{2007} - 0.031 d_{2015}$ (0.376) (0.033) (0.035)	0.530
$i_t = 0.874 i_{t-1} + 0.068\pi_t - 0.225(\ln Y_t - \ln Y_t^P) + 0.006 RER_t - 0.007\triangle REM_t$ (0.084)*** (0.058) (0.135) (0.014) (0.005)	0.903

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

Imports exhibits different results in many areas compared to the past. First, as global trade volume increases, imports increase. This implies that Nepal, whose import volume is greater than export volume, is more likely to import more as it more actively participates in global trade. Previously, remittances and imports have a negative relationship, but now the two variables have a positive relationship. One of the reasons behind the failure of an increase in foreign currency remittances to significantly increase gross income in the small-scale economic model of the previous chapter may be due to the possibility that foreign currency remittances are used for imports. The positive relationship between the foreign currency remittances and imports presents empirical evidence for such argument.

<Table 4-3>

Model 2-B(Medium-Scale): Independent Monetary Policy with ECM

Model Equation	R^2
$\triangle \ln C_t = 0.040 \triangle \ln C_{t-1} - 0.226 \triangle r_t + 0.896 \triangle \ln Y_t + 0.034 \triangle \ln REM_t$ (0.278) (0.908) (1.101) (0.020) $+ 0.125 \triangle \ln RER_t - 0.008 \triangle \ln ODA_t + 0.011 d_{2007} + 0.024 d_{2015} - 0.584 EC_C$ (0.183) (0.051) (0.031) (0.035) (0.279)*	0.658
$\triangle \ln G_t = -0.392 \triangle \ln G_{t-1} + 3.300 \triangle r_t + 4.801 \triangle \ln Y_t + 0.069 \triangle \ln ODA_t$ (0.285) (1.702)* (2.035)** (0.107) $+ 0.001 d_{2007} + 0.096 d_{2015} - 0.236 EC_G$ (0.065) (0.074) (0.313)	0.463
$\triangle \ln I_t = -0.130 \triangle \ln INV_t + 3.276 \triangle r_t + 5.501 \triangle \ln Y_t - 0.162 \triangle \ln REM_{t-1}$ (0.303) (3.126) (3.577) (0.099) $- 0.571 \triangle \ln RER_t + 0.159 \ln ODA_t - 0.021 d_{2007} - 0.061 d_{2015} - 0.456 EC_I$ (0.892) (0.221) (0.117) (0.145) (0.230)*	0.436
$\ln EX_t = 0.488 \ln EX_{t-1} + 0.258 \ln Y_t^{IND} - 0.392 \ln WTV_t + 0.186 \ln RER_t$ (0.191)** (0.660) (0.538) (1.037) $- 0.016 d_{2007} + 0.127 d_{2015}$ (0.133) (0.158)	0.554
$\triangle \ln IM_t = 0.416 \triangle \ln IM_{t-1} + 1.165 \triangle \ln Y_t^{IND} + 0.43 \triangle \ln WTV_t - 0.013 \triangle \ln RER_t$ (0.386) (3.013) (0.528) (0.918) $+ 0.027 \triangle \ln REM_{t-1} - 0.383 \pi_t^{FOOD} - 0.056 d_{2007} - 0.001 d_{2015} - 0.575 EC_M$ (0.133) (0.424) (0.105) (0.127) (0.354)	0.267

Model Equation	R^2
$\pi_t = 0.397\pi_{t-1} + 1.114(\ln Y_t - \ln Y_t^P) - 0.00006RAIN_t - 0.053\pi_t^{FOOD}$ (0.217)* (0.513)** (0.00004) (0.073) $+ 0.136\pi_t^{IND} + 0.003d_{2007} - 0.031d_{2015}$ (0.376) (0.033) (0.035)	0.530
$i_t = 0.874i_{t-1} + 0.068\pi_t - 0.225(\ln Y_t - \ln Y_t^P) + 0.006RER_t - 0.007\triangle REM_t$ (0.084)*** (0.058) (0.135) (0.014) (0.005)	0.903

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

Theoretically, there is no reason to have a long-term cointegration relationship, and therefore error correction terms regarding exports, monetary policy, and aggregate supply were excluded. Consequently, the results are not different from Model 1.

Overall, there are some cases where the explanatory power of the model is higher than that of Model 1, and sometimes more reasonable results are obtained as in the case of imports. However, since Model 1 uses an independent monetary policy assuming the real interest rate modelled from the VAR, it is difficult to directly compare the results with those in Model 2-A. Therefore, in order to compare the two models, it is necessary to construct an error correction model that derives the real interest rate in the same way under the independent monetary policy assumption. This model is called Model 2-B, and the results are summarized in <Table 4-3>.

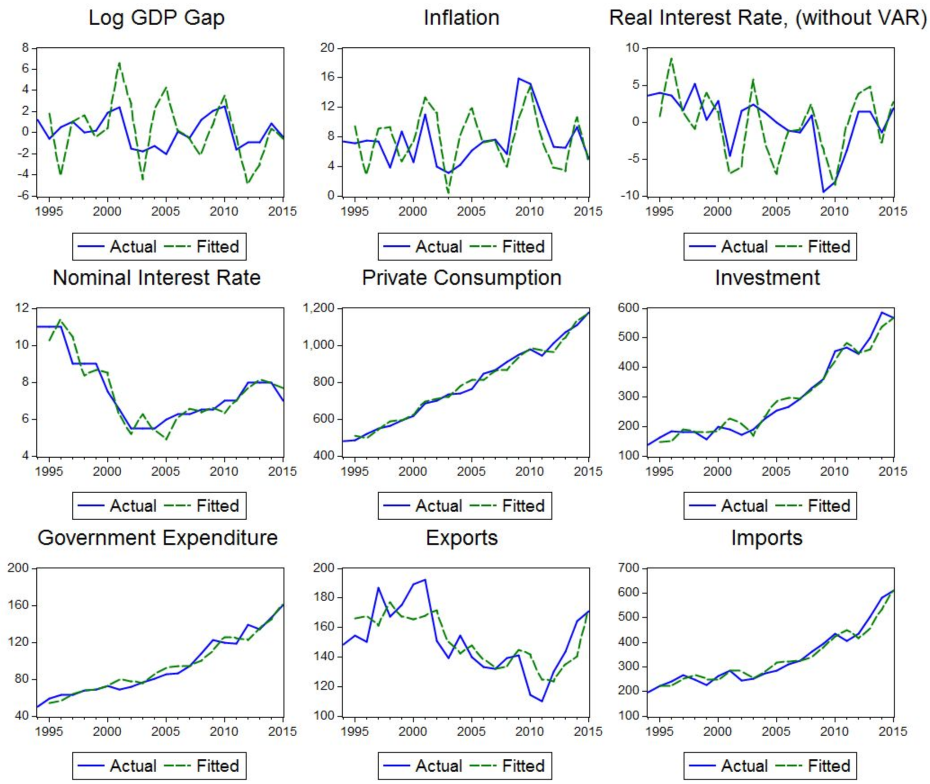
According to the estimation results, Model 2-B has a higher R^2 value than Model 1, indicating an improvement in power and returning the results that are more consistent with economic intuition. For example, the fact that the previous year's consumption is positively related to the current year's consumption and that foreign currency remittances has a positive relationship with imports demonstrate some cases in which the results are more consistent with existing economic theories compared to previous cases.

We now compare Model 2-A and Model 2-B. The results of Model 2-B are generally similar to those of Model 2-A. However, power is improved in Model 2-B due to an increase in R^2 of government expenditure and investment equations. On the other hand, the explanatory power for consumption is higher in Model 2-A. Therefore, a test is needed to determine which model better describes the data within the sample period. We compare <Figure 4-5> and <Figure 4-6>, in which the actual values of various economic variables within the sample period and the estimated values of the variables derived from the model are schematized. <Figure 4-5> shows the result of Model 2-A, and <Figure 4-6> shows the result of Model 2-B. It can be seen that Model 2-B in <Figure 4-6> better explains actual historical data.

In <Figure 4-5>, Model 2-A has greater variances of economic growth rate, inflation, and real interest rate compared to actual data and fails to generally explain the actual value properly. In particular, in case of the economic growth rate, the volatility of the economic growth rate estimated by the model is generally greater compared to the actual economic growth rate in the early 2000s. Also, the estimated real interest rate in the early 2000s and the mid 2000s has greater volatility than the actual value. Inflation in the late 1990s estimated by the model moves in the opposite direction of actual inflation. Therefore, Model 2-A does not explain the sample period data well enough.

<Figure 4-5>

Model 2-A(Medium-Scale): Independent Monetary Policy with ECM

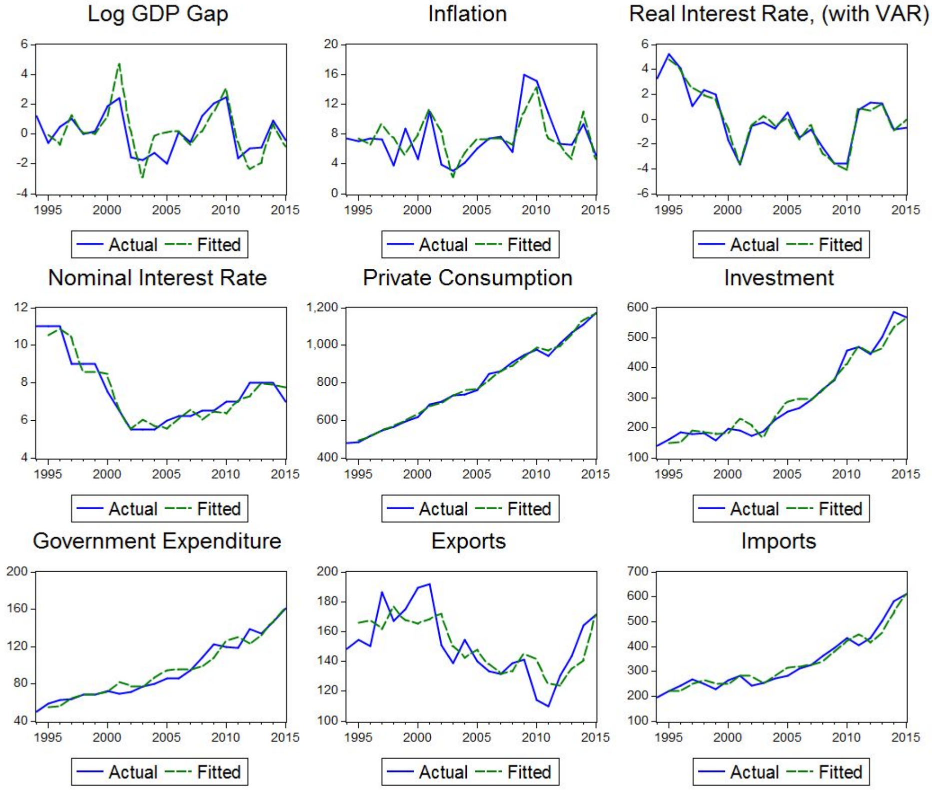


Note: Log GDP gap, Inflation, nominal and real interest rates are measured annually in percentages, and Consumption, investment, government expenditure, exports, and imports are denominated in the local currency(billion Rupees), The solid line indicates actual data, and the dotted line indicates estimates.

As shown in Model 2-B in <Figure 4-6>, such problems are improved significantly when the real interest rates based on VAR are used. Model 2-B explains actual GDP, inflation, and real interest rates better than Model 2-A. The volatility of the estimated value from the model is not much different from the actual value, and the case where the estimated value and the actual value move in opposite directions is hardly observed.

<Figure 4-6>

Model 2-B(Medium-Scale): Independent Monetary Policy with ECM

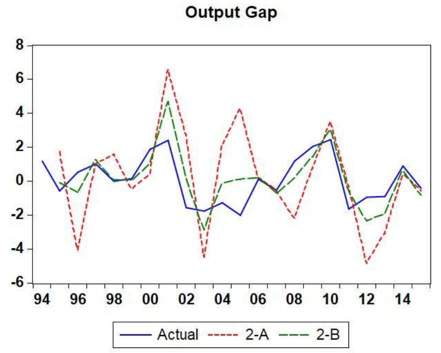


Note: Log GDP gap, Inflation, nominal and real interest rates are measured annually in percentages, and Consumption, investment, government expenditure, exports, and imports are denominated in the local currency(billion Rupees), The solid line indicates actual data, and the dotted line indicates estimates.

Another way to compare the explanatory power of the models is to use correlation coefficients between their estimated values and actual values. In this section, the method is applied to the output gap and inflation, and the results are summarized in <Figures 4-7 and 4-8> and <Tables 4-4 and 4-5>.

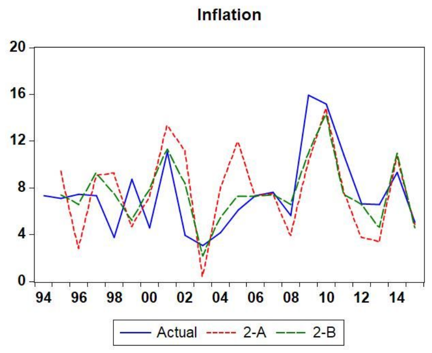
<Figure 4-7>

Models 2-A and 2-B(Medium-Scale) Estimated Output Gap



<Figure 4-8>

Models 2-A and 2-B(Medium-Scale) Estimated Inflation



Note: The unit of the vertical axis is measured in percentage.

<Table 4-4>

Models 2-A and 2-B(Medium-Scale) Estimated Output Gap

Output Gap	Standard deviation (%) within sample period	Correlation coefficient with actual data
Actual data	1.393	1
Model 2-A	2.889	0.285
Model 2-B	1.673	0.763

<Table 4-5>

Models 2-A and 2-B(Medium-Scale) Estimated Inflation

Inflation	Standard deviation (%) within sample period	Correlation coefficient with actual data
Actual data	3.356	1
Model 2-A	3.726	0.494
Model 2-B	2.697	0.733

It is confirmed from the correlation coefficient and the standard deviation that Model 2-B explains the output gap and inflation best. In Model 2-B, both the estimates of the output gap and inflation and the correlation coefficient with actual data are greater than those of Model 2-A. Consequently, the estimates of Model 2-B more closely represent the actual values. In the case of the output gap, Model 2-B better approximates the standard deviation of actual data. Therefore, the explanatory power of Model 2-B is superior.

B. Partial Pegging

In this subsection, we assume an economy in which the interest rate is determined by Equation (30) and the exogenous variables that represent characteristics of the Nepalese economy. In other words, this model acknowledges that the Nepalese real interest rate and the Indian real interest rate are related and that the fixed exchange rate between Nepalese Rupee and Indian Rupee may be unstable. There are two ways of calculating the real interest rate. One is a method using the vector autoregressive (VAR) model, and the other is a method of replacing current inflation with expected inflation. Model 3-A uses the latter method, while Model 3-B uses the former method. Estimation results are reported in the <table 4-6>.

In Model 3-A, the monetary policy assumes a partial pegging, and the real interest rate decision method assumes adaptive expectations. This model is a monetary policy modified version of Model 2-A. Consequently, we can expect almost no qualitative difference. However, it is observed that the real interest rate relies on the Indian real interest rate to a certain degree and that there is a positive relationship between Nepalese and Indian real interest rates.

<Table 4-6>

Model 3-A(Medium-Scale): Partial Pegging with ECM

Model Equation	R^2
$\triangle \ln C_t = 0.040 \triangle \ln C_{t-1} - 0.163 \triangle r_t + 0.970 \triangle \ln Y_t + 0.032 \triangle \ln REM_{t-1}$ (0.217) (0.200) (0.419)** (0.020) $+ 0.220 \triangle \ln RER_t - 0.005 \triangle \ln ODA_t + 0.010 d_{2007} + 0.031 d_{2015} - 0.596 EC_C$ (0.216) (0.050) (0.029) (0.034) (0.261)**	0.675
$\triangle \ln G_t = -0.178 \triangle \ln G_{t-1} + 0.182 \triangle r_t + 1.402 \triangle \ln Y_t + 0.030 \triangle \ln ODA_t$ (0.320) (0.431) (1.071) (0.119) $- 0.006 d_{2007} + 0.059 d_{2015} - 0.447 EC_G$ (0.073) (0.083) (0.332)	0.318

Model Equation	R^2
$\triangle \ln I_t = 0.047\triangle \ln INV_t + 0.800\triangle r_t + 2.866\triangle \ln Y_t - 0.117\triangle \ln REM_{t-1}$	0.418
(0.328) (0.947) (1.758) (0.101)	
$-0.647\triangle \ln RER_t + 0.122\triangle \ln ODA_t + 0.001 d_{2007} - 0.116 d_{2015} + 0.435 EC_I$	
(0.973) (0.122) (0.114) (0.152) (0.233)	
$\ln EX_t = 0.488 \ln EX_{t-1} + 0.258 \ln Y_t^{IND} - 0.392 \ln WTV_t + 0.186 \ln RER_t$	0.554
(0.191)** (0.660) (0.538) (1.037)	
$-0.016 d_{2007} + 0.127 d_{2015}$	
(0.133) (0.158)	
$\triangle \ln IM_t = 0.416 \ln IM_{t-1} + 1.165 \ln Y_t^{IND} + 0.430 \ln WTV_t - 0.013 \ln RER_t$	0.267
(0.386) (3.013) (0.528) (0.918)	
$+0.027 \ln REM_{t-1} - 0.383 \pi_t^{FOOD} - 0.056 d_{2007} - 0.001 d_{2015} - 0.575 EC_M$	
(0.133) (0.424) (0.105) (0.127) (0.354)	
$\pi_t = 0.397\pi_{t-1} + 1.114(\ln Y_t - \ln Y_t^P) - 0.00006 RAIN_t - 0.053\pi_t^{FOOD}$	0.530
(0.217)* (0.513)** (0.00004) (0.073)	
$+0.136\pi_t^{IND} + 0.003 d_{2007} - 0.031 d_{2015}$	
(0.376) (0.033) (0.035)	
$r_t = 0.905 r_t^{IND} + 0.142 RER_t$	0.439
(0.290)*** (0.057)**	

Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

Next, we introduce the assumption in which the real interest rate is determined by VAR for the partial pegging case. The results are summarized in <Table 4-7>. Model 3-B, which determines the real interest rate through VAR, is only an assumption on monetary policy modification of Model 2-B. Consequently, no significant difference is observed in other areas. The only difference is that the monetary policy formula represented by the Taylor Rule has been changed to a formula that represents the relationship between real interest rates in Nepal and real interest rates in India. In this case, as in Model 3-A, India's real interest rate and Nepal's real interest rate are positively correlated.

<Table 4-7>

Model 3-B(Medium-Scale): Partial Pegging with ECM

Model Equation	R^2
$\triangle \ln C_t = 0.040 \triangle \ln C_{t-1} - 0.226 \triangle r_t + 0.896 \triangle \ln Y_t + 0.034 \triangle \ln REM_t$ (0.278) (0.908) (1.101) (0.020) $+0.125 \triangle \ln RER_t - 0.008 \triangle \ln ODA_t + 0.011 d_{2007} + 0.024 d_{2015} - 0.584 EC_C$ (0.183) (0.051) (0.031) (0.035) (0.279)*	0.658
$\triangle \ln G_t = -0.392 \triangle \ln G_{t-1} + 3.300 \triangle r_t + 4.801 \triangle \ln Y_t + 0.069 \triangle \ln ODA_t$ (0.285) (1.702)* (2.035)** (0.107) $+0.001 d_{2007} + 0.096 d_{2015} - 0.236 EC_G$ (0.065) (0.074) (0.313)	0.463
$\triangle \ln I_t = -0.130 \triangle \ln INV_t + 3.276 \triangle r_t + 5.501 \triangle \ln Y_t - 0.162 \triangle \ln REM_{t-1}$ (0.303) (3.126) (3.577) (0.099) $-0.571 \triangle \ln RER_t + 0.159 \ln ODA_t - 0.021 d_{2007} - 0.061 d_{2015} - 0.456 EC_I$ (0.892) (0.221) (0.113) (0.145) (0.230)*	0.436
$\ln EX_t = 0.488 \ln EX_{t-1} + 0.258 \ln Y_t^{IND} - 0.392 \ln WTV_t + 0.186 \ln RER_t$ (0.191)** (0.660) (0.538) (1.037) $-0.016 d_{2007} + 0.127 d_{2015}$ (0.133) (0.158)	0.554
$\triangle \ln IM_t = 0.416 \triangle \ln IM_{t-1} + 1.165 \triangle \ln Y_t^{IND} + 0.43 \triangle \ln WTV_t - 0.013 \triangle \ln RER_t$ (0.386) (3.013) (0.528) (0.918) $+0.027 \triangle \ln REM_{t-1} - 0.383 \pi_t^{FOOD} - 0.056 d_{2007} - 0.001 d_{2015} - 0.575 EC_M$ (0.133) (0.424) (0.105) (0.127) (0.354)	0.267
$\pi_t = 0.397 \pi_{t-1} + 1.114 (\ln Y_t - \ln Y_t^P) - 0.00006 RAIN_t - 0.053 \pi_t^{FOOD}$ (0.217)* (0.513)** (0.00004) (0.073) $+0.136 \pi_t^{IND} + 0.003 d_{2007} - 0.031 d_{2015}$ (0.376) (0.033) (0.035)	0.530
$r_t = 0.798 r_t^{IND} + 0.037 RER_t$ (0.200)*** (0.035)	0.503

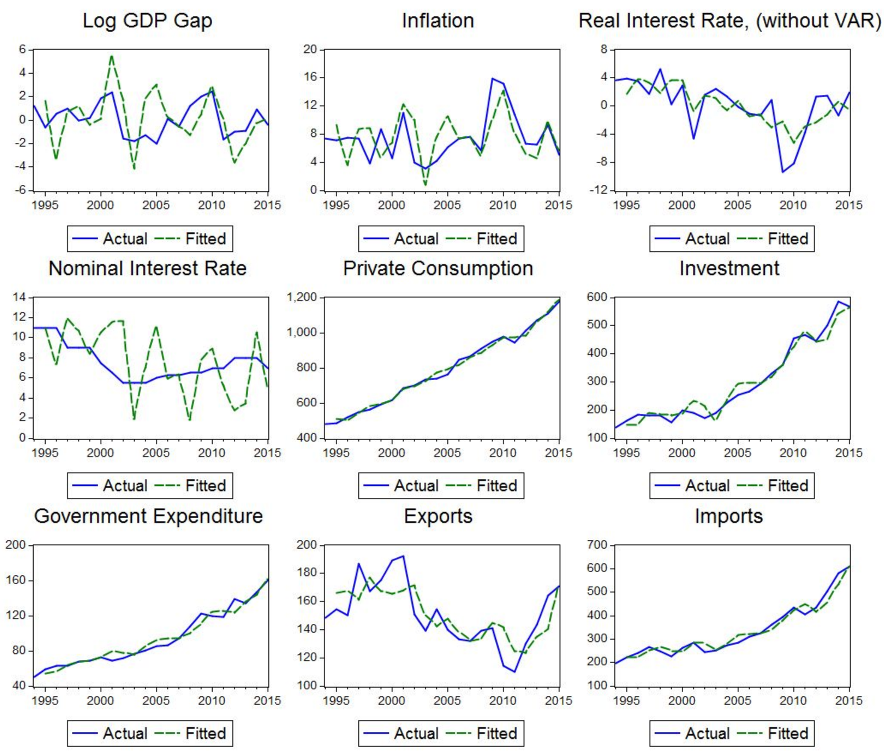
Note: The numbers in the parentheses are prediction errors, and ***, **, * each represent 1%, 5%, 10% statistical significance. For convenience we ignore constant terms.

As in the case where we assume an independent monetary policy, it is also necessary to select a model with relatively higher power. We compare Model 3-A and Model 3-B through <Figure 4-9> and <Figure 4-10> to examine which model better explains the trends of economic variables in the sample period.

In <Figure 4-9>, Model 3-A severely lacks the explanatory power to explain the nominal interest rate. There is a significant volatility in the estimated nominal interest rate compared to actual nominal interest rate. Also, there is a noticeable gap between estimated values and actual data. A similar issue occurs in case of the economic growth rate and inflation. Therefore, Model 3-A fails to explain the actual data well enough.

<Figure 4-9>

Model 3-A(Medium-Scale): Partial Pegging with ECM

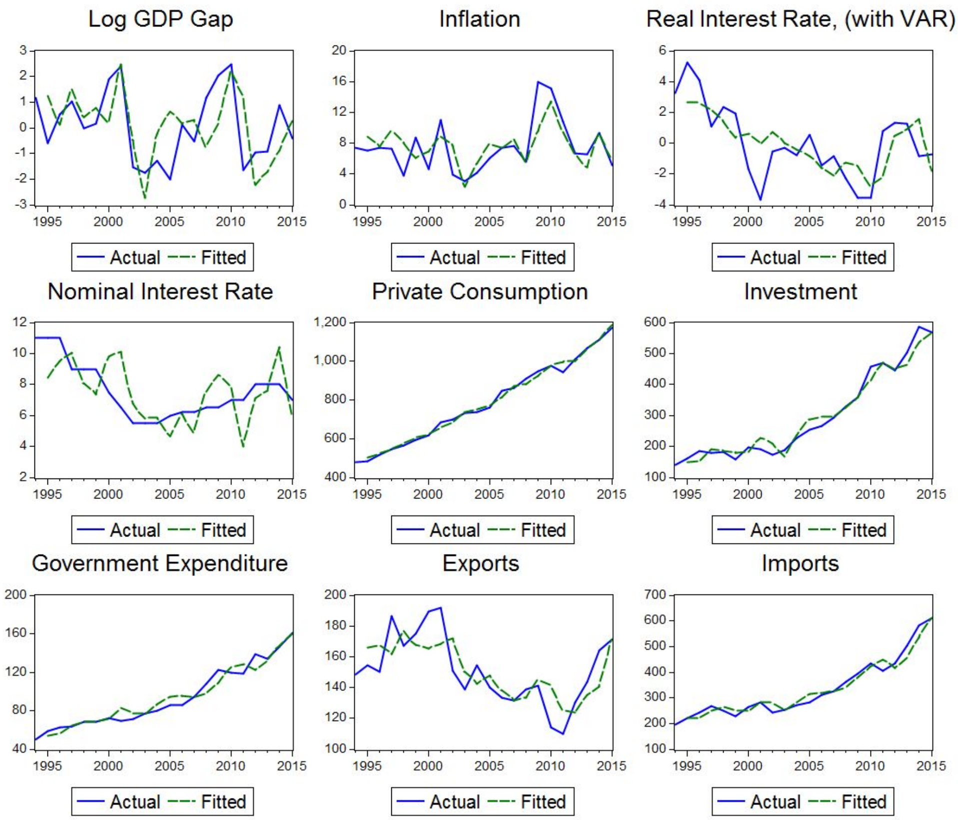


Note: Log GDP gap, Inflation, nominal and real interest rates are measured annually in percentages, and Consumption, investment, government expenditure, exports, and imports are denominated in the local currency(billion Rupees), The solid line indicates actual data, and the dotted line indicates estimates.

<Figure 4-10> shows the performance of Model 3-B, which changed the way the real interest rate is derived while maintaining the partial pegging assumption. Compared to <Figure 4-9>, Model 3-B is clearly better than Model 3-A in terms of actual economic growth rate and inflation. However, in terms of nominal interest rate, Model 3-B estimates still show greater volatility than the actual data. Furthermore, the volatility of the real interest rate estimated in Model 3-B is smaller than the actual data, and as a result we observe a discrepancy between the actual value and the estimated value.

<Figure 4-10>

Model 3-B(Medium-Scale): Partial Pegging with ECM

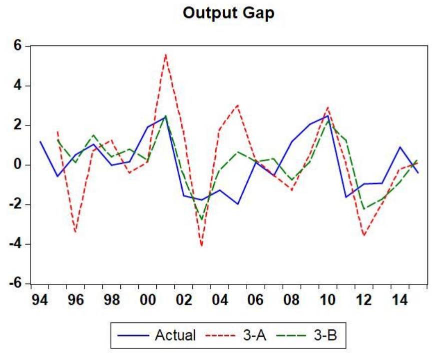


Note: Log GDP gap, Inflation, nominal and real interest rates are measured annually in percentages, and Consumption, investment, government expenditure, exports, and imports are denominated in the local currency(billion Rupees), The solid line indicates actual data, and the dotted line indicates estimates.

In order to conduct a more detailed comparison, <Figures 4-11 and 4-12> schematizes estimates of the output gap and inflation compared to actual values, and <Tables 4-8 and 4-9> report the standard deviations and the correlation coefficients.

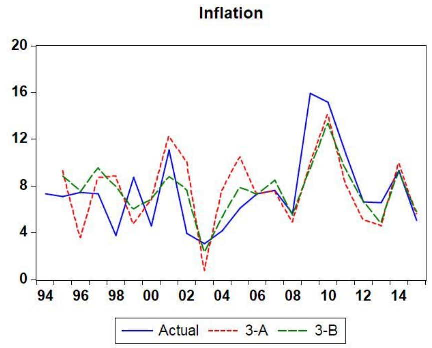
<Figure 4-11>

Models 3-A and 3-B(Medium-Scale) Estimated Output Gap



<Figure 4-12>

Models 3-A and 3-B(Medium-Scale) Estimated Inflation



Note: The unit of the vertical axis is measured in percentage.

<Table 4-8>

Models 3-A and 3-B(Medium-Scale) Estimated GDP

Output Gap	Standard deviation (%) within sample period	Correlation coefficient with actual data
Actual data	1.393	1
Model 3-A	2.309	0.300
Model 3-B	1.315	0.470

<Table 4-9>

Models 3-A and 3-B(Medium-Scale) Estimated Inflation

Inflation	Standard deviation (%) within sample period	Correlation coefficient with actual data
Actual data	3.359	1
Model 3-A	3.110	0.549
Model 3-B	2.261	0.730

Model 3-B's estimation of the output gap and inflation has greater explanatory power than that of Model 3-A. This result can be verified from the fact the correlation coefficient of Model 3-B is larger than that of Model 3-A.

Among the four models that we have discussed so far, Model 2-B, which determines the real interest rate by VAR under independent monetary policy, has the greatest explanatory power. Not only does it well explain data within the sample period, but the model also has the highest correlation coefficient with the actual data. Consequently, we conclude that Model 2-B best explains the Nepalese economy and its characteristics. In order to maintain credibility and validity of future simulations, it is imperative that we have a good explanatory power within the sample period. Therefore, the upcoming simulation will be based on Model 2-B.

4. Simulation using the Medium-scale Macroeconomic Model

In this subsection, we conduct three-year forecasts of economic growth rate and inflation. We also analyze how economic growth rates and inflation respond to changes in various exogenous variables that potentially affect the Nepalese economy. It is assumed, that in simulations based on Model 2-B, independent monetary policy is executed and the real interest rate is determined by VAR.

A. Economic Growth Rate and Inflation Forecast

Forecasts of the economic growth rate and inflation are implemented based on a growth accounting procedure and short-term analysis of the medium-scale model. Using the growth accounting procedure, we estimate potential growth rate and potential GDP from 2017 to 2019. It is assumed that there is no short-term disturbance factor. The estimation results are reported in <Table 4 -10>, <Figure 4-13>, <Figure 4-14>.

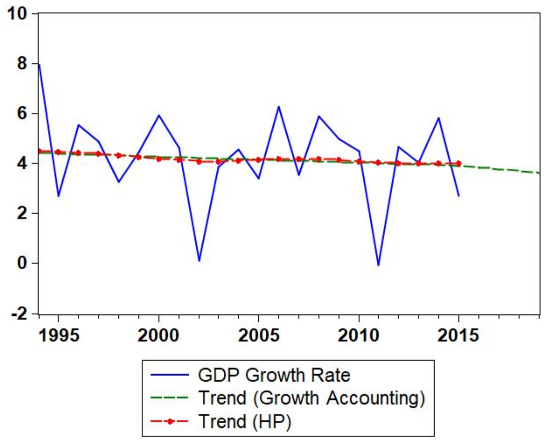
<Table 4-10>

Forecast of Potential GDP Growth Rate based on Growth Accounting

	Actual				Forecasted		
Year	2013	2014	2015	2016	2017	2018	2019
Growth Rate(%)	3.95	3.92	3.90	3.83	3.76	3.69	3.63

<Figure 4-13>

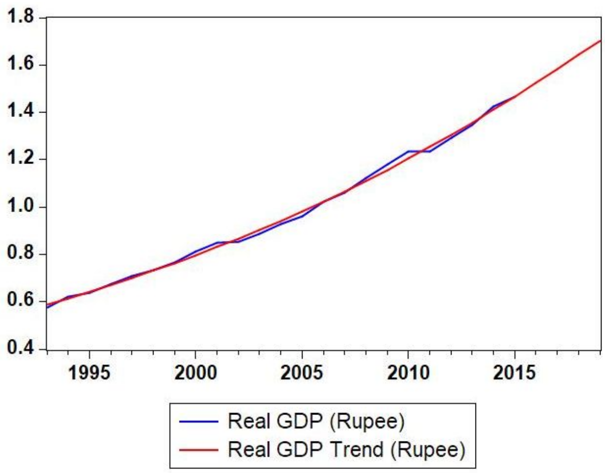
Forecast of Potential GDP Growth Rate based on Growth Accounting



Note: The unit of the vertical axis is measured in percentage.

<Figure 4-14>

Forecast of Potential GDP based on Growth Accounting



Note: The unit of the vertical axis is measured in trillion Rupees.

The actual growth rate until 2015 is around 3.9%, and it is assumed that similar level of growth rate will be maintained from 2016 to 2019. <Figure 4-14> shows the actual GDP and potential GDP, which is estimated from the potential growth rate forecast. Potential GDP is about 1.46 trillion Rupees in 2015 and is expected to increases to about 1.63 trillion Rupees in 2019.

The estimates derived using the growth accounting method can be used if the current economic conditions are maintained, and no additional disturbance occurs in the forecast period. In reality, however, there is a high possibility of disturbance due to change in exogenous variables during the forecast period. This may affect the economic growth rate and inflation. In order to reflect such a possibility, short-term growth rates and estimates of inflation are produced in this subsection using short-term analysis of the medium-scale model.

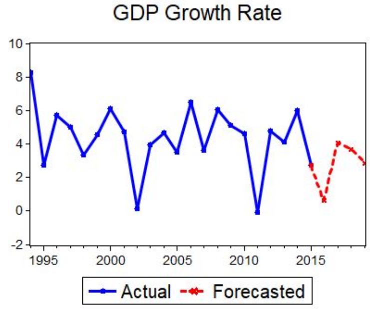
For short-term analysis, it is necessary to assume how the exogenous variables such as potential growth rate, real exchange rate, global trade volume, ODA, expected inflation composed by VAR, and exogenously calculated rainfall, global food price increase rate, inflation of India, foreign currency remittances, and GDP of India, would be determined between 2016 and 2019. The values of these variables during the forecast period are assumed to be equal to the moving average of the previous five years. However, rainfall during the sample period of 2016 ~ 2019 is set as the average rainfall during the monsoon period between 1993 and 2015.

When predicting the short-term economic growth rate and inflation using the medium-scale model instead of a growth accounting method, we use a 5-year moving average of the numbers calculated from our model. It is to overcome the limitation of our model that has a large variance. In addition, due to the large-scale short-term disturbance such as the currency reform in India and the aftereffect of the 2015 earthquake, the actual growth rates remains around 0.6%, which is far below the potential growth rate. There might be some temporary shocks that we were unable to incorporate into the model. Considering these limitations, we set the GDP growth rate for 2016 at 0.6%, and forecast the growth rate from 2017. As in GDP, the inflation rate is also set at 5.9% in 2016 before beginning forecasting from 2017.

Estimates of GDP growth and inflation rates based on using the medium-scale model short-term analysis are referred as baseline forecasts for convenience and are reported in <Figure 4-15> and <Figure 4-16>.

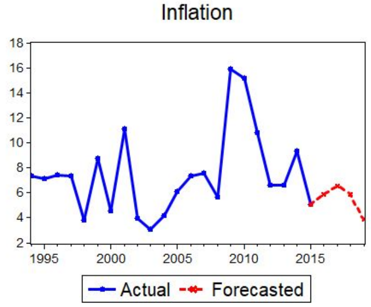
<Figure 4-15>

Baseline Forecast of GDP Growth Rate



<Figure 4-16>

Baseline Forecast of Inflation



Note: The unit of the vertical axis is measured in percentage.

In <Figure 4-15>, the short-term growth rate starts above the GDP growth rate estimated using growth accounting, but gradually returns to the potential GDP growth rate level. Inflation in <Figure 4-16> rises until 2018 and then declines. The forecast results of medium-scale short-term analysis are summarized in <Table 4-11>.

<Table 4-11>

GDP Growth Rate and Inflation Forecast using Mid-scale Short-term Analysis

Year	2016	2017	2018	2019
GDP growth rate(%)	0.6	4.07	3.64	2.82
Inflation(%)	5.9	6.56	5.84	3.89

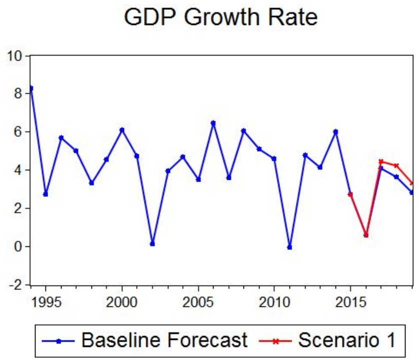
Estimates in this study tend to be somewhat lower than those from other institutions. The IMF forecasts 7.5%, 5% and 3.8% growth over the three years from 2017. The ADB projects growth rates to be 6.9% and 4.7% in 2017 and 2018, respectively. It is difficult to directly compare the suitability of the estimates when the forecasting models used in the two institutions are not made publicly available.

B. Change of Economic Growth Rate and Inflation by Scenario

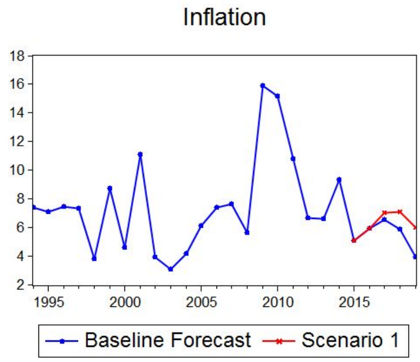
Now we analyze how economic growth and inflation react when the exogenous variables that affect the Nepalese economy change. Through this analysis, we are able to identify some important exogenous variables that affect the economy, and use them when establishing various economic policies such as monetary policy. We consider changes in three exogenous variables. We first analyze how India 's GDP affects the Nepalese economy when India’s GDP grows faster than expected. Next, we analyze the Nepalese economy when the real exchange rate increases above expectations. Lastly, we examine the response of the Nepalese economy when the foreign currency remittances decline.

For the first experiment (Scenario 1), we assume that India's economic growth rate is 10% higher than the baseline forecast. India is Nepal’s largest trading partner, and the Nepal’s exchange rate is determined by fixing the Nepalese Rupee to the Indian Rupee. In this regard, we may expect a strong reliance on the Indian economy. The simulation results that estimate the magnitude of such influence are reported in <Figure 4-17> and <Figure 4-18>. The effects on the economic growth rate and inflation when India's economic growth rate is 10% higher than the baseline forecast will be compared to baseline forecast in <Figure 4-15> and <Figure 4-16>.

<Figure 4-17>
Forecasted GDP Growth Rate under Scenario 1 (Higher India's Growth)



<Figure 4-18>
Forecasted Inflation under Scenario 1 (Higher India's Growth)



Note: The unit of the vertical axis is measured in percentage.

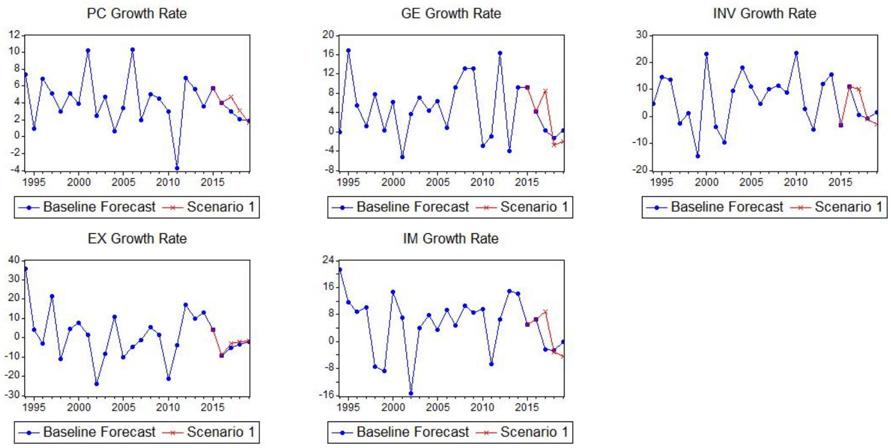
The forecast results show that increases in the GDP growth rate and inflation rate are greater than the baseline forecast. In order to further analyze the effects on GDP growth in detail, individual GDP components responses are analyzed and reported in <Figure 4-19>.

We observe that the components of aggregate demand have increased overall compared to the baseline forecast. Increases in private consumption expenditure, government consumption expenditure and investment are significant.

In theory, the positive effects of a neighboring country's economic development may spill over to the home country, and the estimation results of this experiment coincide with the existing theory. An increase in aggregate demand naturally leads to an increase in inflation, which coincides with estimation results here. The reason behind the decrease in the forecasted growth rate would be due to a decrease in the growth rate of government expenditure and investment.

<Figure 4-19>

Forecasted GDP Components under Scenario 1 (Higher India's Growth)

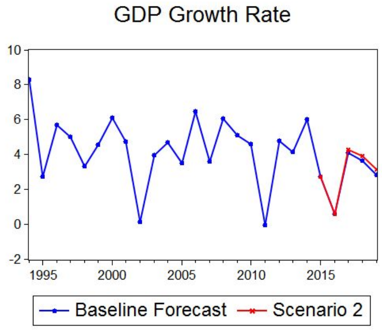


Note: The unit of the vertical axis is measured in percentage.

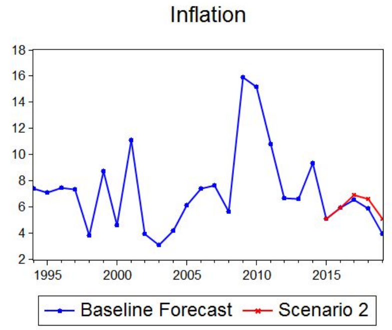
Next, we analyze the case in which the real exchange rate that affects Nepal's trade balance increases by an additional 10 percent than the baseline forecast (Scenario 2). Nepal's trade balance has consistently experienced deficit, and the magnitude of the trade deficit has not been reduced significantly. Theoretically, if the real exchange rate increases, higher import prices compared to export prices leads to an increase in export volume and a decrease in import volume. Therefore, the increase in the real exchange rate acts as a factor that increases aggregate demand. <Figure 4-20> and <Figure 4-21> show how the economic growth rate and inflation forecasts change in the simulation.

As expected, both the economic growth rate and inflation rate has increased. However, the magnitude of this increase is smaller compared to the first experiment, where India's GDP grows by additional 10 percent. This result seems to reflect one of the characteristics of the Nepalese economy, where the export volume is relatively small.

<Figure 4-20>
Forecasted GDP Growth Rate under Scenario 2 (Higher Real Exchange Rate)



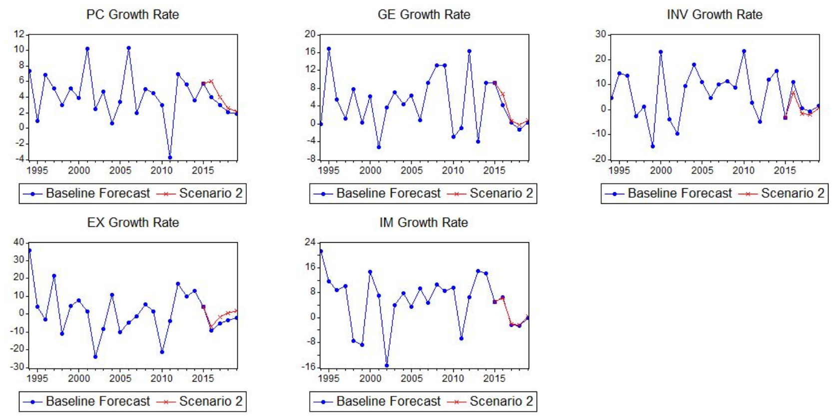
<Figure 4-21>
Forecasted Inflation under Scenario 2 (Higher Real Exchange Rate)



Note: The unit of the vertical axis is measured in percentage.

<Figure 4-22> shows the effect on the components of GDP. The growing trend of exports is evident. This result is consistent with the existing theory that an increase in the real exchange rate raises exports. Higher growth rate of private expenditure and government expenditure compared to the base forecast, contributed to the increase in economic growth and inflation estimates. On the other hand, although imports have increased, its growth rate is not significantly different from the baseline forecast.

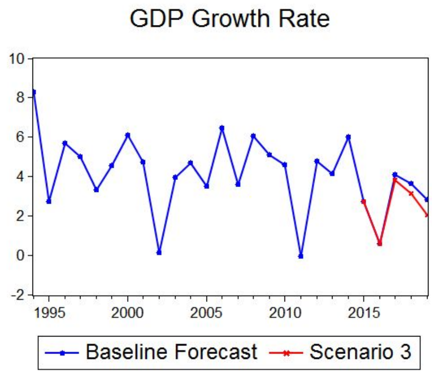
<Figure 4-22>
Forecasted GDP Components under Scenario 2 (Higher Real Exchange Rate)



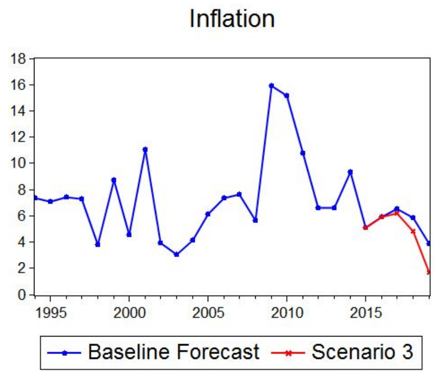
Note: The unit of the vertical axis is measured in percentage.

The last simulation assumes a 25 percent annual decrease in remittances for three consecutive years, beginning 2016 (Scenario 3). Again note that the remittance accounts for 30 percent of GDP in Nepal. Nepal's remittances to GDP ratio has grown steadily from 1993 to 2015 and then dropped in 2016, for the first time since the World Bank began to collect data in 1993. Here, we analyze the effects of possible future decrease in remittances on the economic growth rate and inflation and report the results in <Figure 4-23> and <Figure 4-24>.

<Figure 4-23>
Forecasted GDP Growth Rate under Scenario 3 (Reduced Remittances)



<Figure 4-24>
Forecasted Inflation under Scenario 3 (Reduced Remittances)



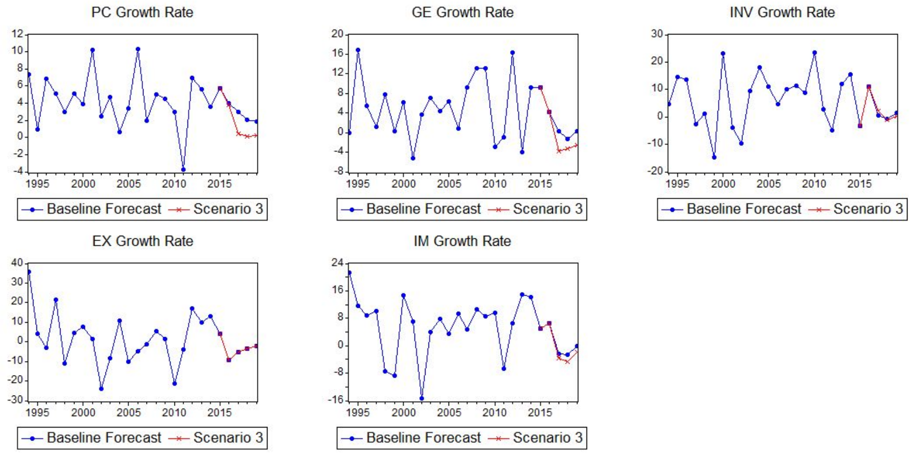
Note: The unit of the vertical axis is measured in percentage.

If remittances decline by 25% per year, estimates of both economic growth rate and inflation will be adjusted downwards compared to the baseline forecast. It is predicted that the decrease in remittances generally causes economic activity to shrink. <Figure 4-25> shows how each component of GDP responds to the decrease in remittances.

We expect that the decrease in remittances is followed by a reduction of the resources available for various consumption, investment activities and imports. In particular, the decline in private consumption expenditures and imports is particularly notable in the figure, which suggests that the remittances have a significant impact on household consumption and imports. In the case of exports, there was no significant difference from the baseline forecast, which suggests that the influence of remittances on exports is insignificant.

<Figure 4-25>

Forecasted GDP Components under Scenario 3 (Reduced Remittances)



Note: The unit of the vertical axis is measured in percentage.

Through the analysis results of this subsection, we could identify which variables have a significant impact on the Nepalese economy. In addition, we confirm the advantages of using the empirical medium-scale macroeconomic model with a theoretical basis. However, the simulation above assumes a model that considers independent monetary policy and expected inflation from a VAR. There are also assumptions on exogenous variables that constitute the model. Therefore, the forecasted economic growth rate and inflation of this study and the actual economic growth rate and inflation may be different. Should the Nepalese monetary policy authority attempt to execute an economic analysis using this study, the assumptions made in the simulations will have to be adjusted to more appropriately reflect Nepal's economic situation.

V . Conclusion

The goal of this project was to construct a macroeconomic model to help the Nepal Rastra Bank make the right policy decisions based on accurate economic forecasts. Nepal has acquired many macroeconomic models from many international organizations. However, Nepalese policymakers have been unable to adopt these models due to their excessive complexity and the lack of quarterly data, crucial to macroeconomic forecasts. Therefore, the researchers of this project focused on constructing an easily accessible, and easily modifiable model. We constructed the model so that Nepal's characteristics were well reflected and the available data is used to its full extent. Efficient policies are vital in order for Nepal, which is currently facing several social and economic issues, to become a developed country. We believe that Korea's experience with overcoming many political and economic problems to achieve a remarkable economic growth will assist Nepal in achieving sustainable growth and development.

Incorporating Nepal's characteristics into the model is important for improving the model's forecast ability. Through undertaking joint research with the Nepal Rastra Bank, we have studied important characteristics of Nepal's economy. Recently, as a result of a rapid growth in the service industry, the service industry has gained a greater share of Nepal's economy. However, growth in the agricultural sector is still high, and the importance of agriculture in Nepal's economy persists. Nepal relies heavily on remittances which are equivalent to one third of Nepal's GDP. A point of interest is the effect that the recent slowdown in the growth of remittances will have on the country's economy. Nepal's reliance on India's economy is also a major characteristic of the economy. A currency peg between India's rupee has been enforced for a long time, and most of Nepal's trade occurs with India.

In order to build a model that reflects these characteristics of Nepal's economy, we first constructed a small-scale short term macroeconomic model. The purpose of this small scale model was to understand the basic mechanisms of Nepal's economy, and to investigate ways to efficiently incorporate Nepal's characteristics into the model. Thus, we included rainfall, the growth rate of global grain prices, India's inflation on the supply side, the growth rate of remittances and the political transition (from a monarchy to a republic) on the demand side. Furthermore, in order to analyze the effects of the long-standing currency peg between India and Nepal, we designed three types of small scale model for three monetary policy scenarios: pegging, partial pegging, and an independent monetary policy. As a result, the explanatory power of the small scale model was high despite the limited size of data. The explanatory power of the independent monetary policy scenario turned out to be the best. This confirms and explains how Nepal is actually using an independent monetary policy with capital controls. However, the effect of remittances was estimated to be different from that predicted by economic theory, and an in-depth analysis of how various factors have affected GDP was not possible using this model.

Thus, we constructed a medium-scale model in order to overcome the limitations of the small-scale model. This medium-scale model is the main product of our research. By dividing up the demand side of the GDP into consumption expenditure, government expenditure, investment, and imports and exports, we were able to explain the changes in each of the factors using our medium-scale model. Through this process, we were also able to include characteristics of the Nepalese economy which we were not able to include in the small-scale model. On the demand side, we added a dummy variable reflecting the 2015 earthquake and a variable for ODA, a factor that could affect government expenditure and investment. In order to better explain the fluctuations in exports and imports, we also added the world trade volume and India's GDP as explanatory variables. From an econometric perspective, we used an error correction model to overcome the problems that could arise from non-stationary time series data, while maximizing the data's explanatory power. As a result, the model's explanatory power was very high despite the short time frame of the data. Not only were we able to explain GDP according to its separate factors, but also found out that the growth rate of remittances has a positive relationship with consumption expenditure and imports, consistent with standard economic theories. Thus, the medium scale model successfully overcame the key limitations of the small-scale model.

Using the medium-scale model, we conducted macroeconomic forecasts based on the model. First, by estimating potential GDP, we predicted that Nepal will have a growth rate of roughly 4% over the next three years. This is under the assumption that short term disturbances will not occur. This result also coincides with the potential growth rate predicted through the growth accounting method. Second, we estimated inflation to stay at around 5% to 6% over the next three years and stabilize thereafter. We understood this to be the effect of the peg with India's rupee in preserving the value of Nepal's rupee. In addition to these basic forecasts, we conducted forecasts of Nepal's economy under hypothetical situations including the rise of India's economy, a change in real exchange rates, and the reduction of remittances. If India's economy grows stronger and India's GDP increases, we expect that Nepal will experience an increase in GDP growth and inflation due to general increases in demand. If the real exchange rate appreciates, we expect this will not greatly affect Nepal's entire economy as trade is a small part of Nepal's economy, but we expect that exports will shrink significantly. Finally, if remittances decrease continuously, we expect consumption expenditure and imports will decrease as well, and consequentially the economy's growth rate and inflation will decrease. Such simulations of various situations will aid the Nepal Rasta Bank in considering how they will respond to each situation in advance.

We hope that the macroeconomic models developed through this research will help Nepal's policy makers forecast Nepal's future economy, and make accurate policy decisions. Since it is straightforward to continuously apply our models with updated data, we expect that, unlike previous models provided by other international organizations, our models may be continuously useful in future. We believe that by collecting quarterly data and training more experts, the Nepal Rastra Bank will be able to improve the explanatory power and predictive ability of our models, and thus contribute to the Nepalese economy.

<Appendix> Eviews Manual

The empirical analysis in this research was undertaken using Eviews. In this appendix, a simple guide to using Eviews for constructing models and generating forecasts will be presented. Subsection 1 provides the basic instruction for Eviews. Subsection 2 explains how to construct models and check for the fitness of models with the actual data. Subsection 3 presents methods to forecast future values of key variables.

1. The Basics of Eviews

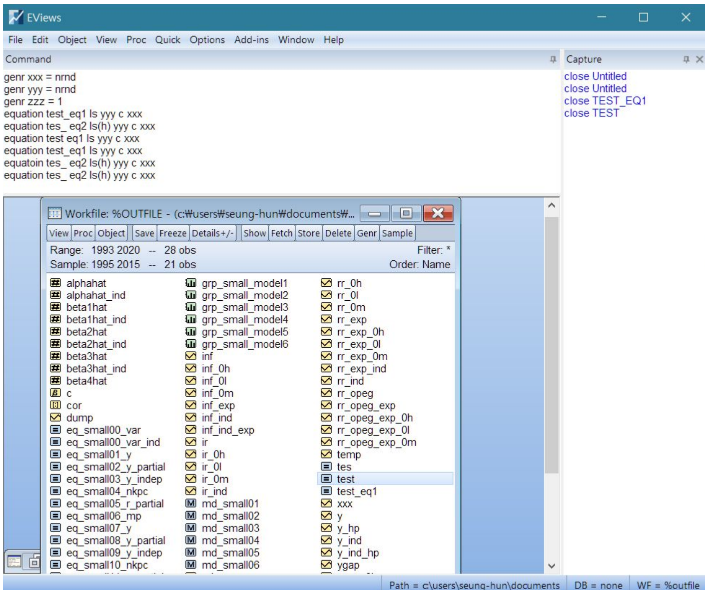
Before constructing the model, it is essential to understand the basic functions of the user interface in Eviews. Eviews is an accessible program, in the sense that those without significant amounts of programming experience can run various levels of regression analysis simply by clicking a few buttons on the menu bars. Well-trained professionals can speed up the process by typing in command keys directly. This subsection introduces the essentials of Eviews − command windows, workfiles, and program files.

A. User Interface of Eviews

We first explain the basic user interface of Eviews and ways to import data to Eviews. The basic user interface of Eviews is composed of three items: The command window where the user can type in commands one by one, the capture window where the user can keep track of all the processes undertaken in Eviews, and the workfile which stores data such as matrices, vectors, scalars, graphs, estimation results. They appear in <Figure A-1>. The user can customize the command and capture windows according to his/her preferences.

<Figure A-1>

Eviews User Interface



The menu bar on the top enables the user to execute simple processes with a simple click of the mouse. The user can bring in new data or open program files using the ‘File’ button. The ‘Edit’ button enables the user to undo certain processes, copy, cut, and paste. The ‘Object’ button allows the user to make graphs, equations, and models. The ‘Proc’ button allows the user to save a workfile in the computer or open previous workfiles. A simple regression analysis can be carried out by using ‘Quick’ button. The user can customize some settings in Eviews using the ‘Option’, ‘Add-in’, and ‘Window’ buttons. If the user needs some advice for running Eviews, the ‘Help’ button can be useful.

Buttons in the middle of the workfile enable users to speed up some key processes. The ‘Freeze’ button creates a spreadsheet allowing the users to save the work in the form of an Excel file. By using this, the user can store the values of variables or the results of equations in Excel and MS word. These features can be applied to graphs as well.

Importing foreign files, such as from Excel, is straightforward. First, Click on the 'File' button in the menu bar, select 'import', and then select 'import from file. Then the window with which the user can import foreign data appears. Select a target file, and then select which excel sheet to be imported to Eviews. By default, Eviews will import the entire cell from the first sheet. Afterwards, Eviews will store data in each column in the form of a series data. The user can designate a name to each series data. Lastly, the user can select how the workfile will be formulated. The next subsection addresses this in further detail. The same process can be carried out by typing in command keys in the program file. Since this method is complex, it will be explained in detail later.

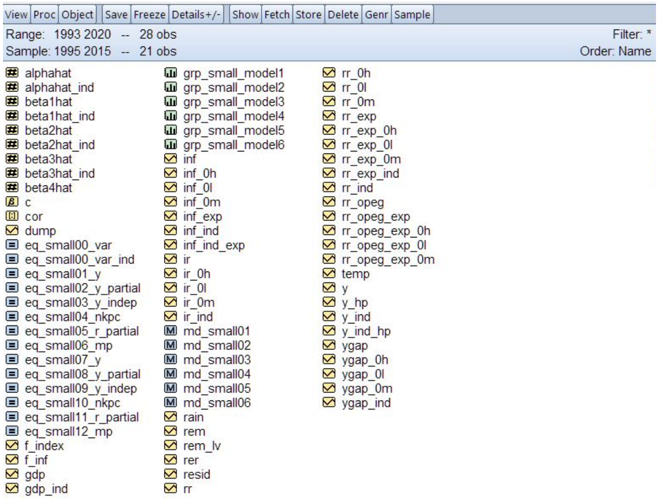
B. Eviews Workfile

To execute some procedures in Eviews, the user must first create a workfile. Workfile can be created from the 'File' button in the menu bar or by typing in command keys in the command window. With the former, the user must click on the 'New' button and select 'Workfile'. Then, Eviews will allow the user to set the structure and the duration of the data, The structure of the data can be Undated/Unbalanced, Dated − regular frequency, or Balanced Panel. The time periods that can be selected are weekly, monthly, quarterly, yearly. The user can nominate the initial and terminal points of the data, depending on his or her needs. However, it should be noted that when making workfiles through this method, the equations and new variables must be defined in a command window.

When creating the workfile through the command window, the user should type in 'create workfile (name of the workfile)'. The user can also designate the years in which the data begins and ends. By default, the 'c', the constant in the regression equation, and 'resid', the residual for the regression equation, will be stored in the workfile. The user can add time series data, equations and models in the workfile using command window. As an illustration, <Figure A-2> shows the workfile that the researchers have used in constructing the small-scale model.

<Figure A-2>

Eviews Workfile



Various types of data can be stored in the workfile. For instance, the user can store scalar data, such as mean or variance of a variable. The user can creates a group that stores a set of series data collectively. Graphs, equations, and models can also be stored. The workfile displays various types of data using different icons.

C. Eviews Program (prg) files

Eviews can be executed by clicking the mouse, or typing in commands one by one. However, Eviews also has a program file, which is similar to m files in Matlab and do files in STATA. The program file allows the user to store chains of commands in a single file and to execute them simultaneously. When used properly, the program file allows the user to execute procedures flexibly and quickly. Therefore, understanding how the program file works is helpful. <Figure A-3> is one portion of the program file that the researchers have used when constructing the small scale model.

<Figure A-3>

Eviews Program File

As can be seen from the figure, program files can store multiple commands in a single log file. When typing in command keys in the command window, the user has to execute them one by one, which can be time-consuming. On the other hand, program files can execute multiple commands simultaneously. However, when the command keys are typed in erroneously, the process will be interrupted. Thus, it is necessary to make sure that the command keys are typed in properly.

The top of the program window contains some buttons that allow users to execute some operations. The 'Run' button allows the Eviews to execute multiple commands simultaneously. The 'Print' button enables to printing of the entire program file. The user can save the program file separately using the 'Save' button and 'Save as' button. The former retains the name of the program file, whereas the latter allows the user to change the name. 'Cut' and 'Copy' buttons allow the user to cut or copy parts of the program. The 'Paste' button allows the user to paste parts of the program previously cut or copied. The 'Find' button can be used to find certain keywords in the program file, and the 'Replace' button can be used to change some keywords.

The user can type some messages which will not be executed by Eviews. The message line must start with the symbol “ ‘ ” to be not executed by program. The parts where the Eviews program do not recognize as a command will be displayed in green.

2. Constructing the Model

To construct a model in Eviews, it is necessary to define the variables to be used. In addition, defining whether the variables are either exogenous or endogenous, and either independent or dependent is required. This subsection explains the procedures with which the researchers have constructed the small-scale and medium-scale models.

A. Constructing the Small-scale Model

Constructing the small-scale model of Section III by Eviews requires several steps. Firstly, the Excel file containing the data on the Nepalese economy should be imported to Eviews. If necessary, natural logarithms or a Hodrick-Prescott filter may be applied to the Excel data. A set of dummy variables reflecting the distinctive nature of the Nepalsese economy and the real interest rate calculated under vector autoregression (VAR) methods is also created. Once these are all set, the user needs to define the equations in Section III, and merge them into a model.

<Figure A-4>

Importing the Data

```
'========================================================================
' Read a excel file & Save a work file
'========================================================================

%datafile = "C:₩Users₩computer₩Desktop₩Data_Baseline_Small_Scale.xls"


'========================================================================
' Read data from a excel file
'========================================================================

workfile %outfile a 1993 2020   'create the workfile

read(b2, s=sheet1) %datafile inf gdp ir rer inf_ind gdp_ind ir_ind rain rem_lv f_inf
```

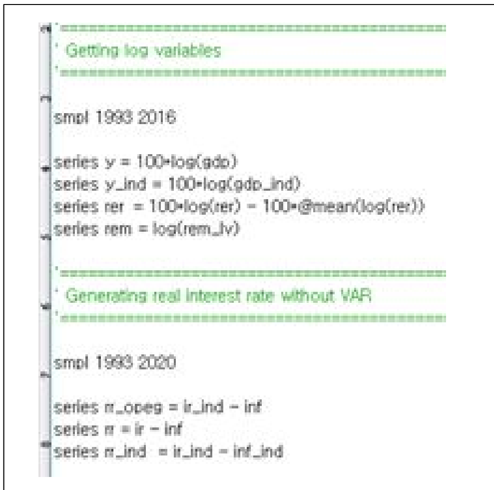
<Figure A-4> demonstrates how the external data can be imported to Eviews and how each variable is named. To import external data, the user must state the filepath in which the data is located. This can be done by typing in '%datafile = "(the file in which the data is located)" '. It is necessary to surround the filepath with double quotation marks. Afterwards, the user must create the workfile to carry out the computation. The 'workfile %outfile a 1993 2020' command in the <Figure A-4> creates the workfile. The 'a' indicates the annual data, and the '1993 2020' indicates the initial and terminal points in the time series data.

Next, the user should bring the data in the Excel file to the workfile and designate a name to the variables. The 'read(b2, s=sheet1)' command indicates that the Eviews brings data located below and the right of cell B2 on the sheet named 'sheet1' to the workfile. The user can designate a name on a column by column basis. The words appearing after '%datafile' in <Figure A-4> are the names of the variables used by the researchers.

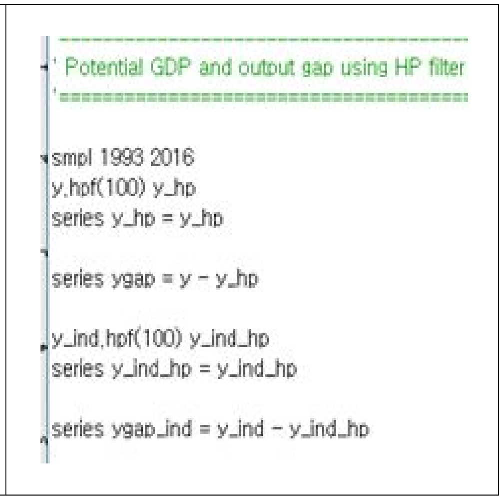
It is necessary to make some changes to the variables according to the requirements of the model. For instance, the GDP data used in the research is real GDP (base year : 2010) in Nepalese Rupee. It is necessary to convert these to log values. In addition, a Hodrick-Prescott filter is applied to generate the trend component and the cyclic component of the variations in GDP and to calculate the output gap. <Figure A-5> demonstrates these procedures.

<Figure A-5>

Applying Natural Logarithms



Hodrick-Prescott Filter



The new time series variables can be defined by setting time periods using the 'smpl 1993 2016' command, and naming them using the 'series (name) = (equations defining the new variable)', As for the Hodrick-Prescott Filter, the user can initiate by typing in (name of the variable to be filtered).hpf(λ) (name for the filtered variable). λ is a parameter determining the variance of the filtered variables. Conventionally, λ is set as 100 for annual data, 1600 for quarterly data, and 14400 for monthly data.

The series command can be used to define dummy variables reflecting the years in which events that had significant impact on the Nepalese economy occurred. For instance, the user can reflect the structural change after democratization of Nepal using dummy variables with value 1 for the year 2007 and 0 for other years. 'smpl 1993 2020' indicates the duration of the time series data, and ‘series dump = 0’ enforces the value 0 on all time periods. To implement the value of 1 in the year 2007, the user types in ‘smpl 2007 2007’ and ‘series dump = 1’. These series of commands define the variable named ‘dump’ which has the value 1 for the year 2007 and 0 for all other years, The procedure is demonstrated in <Figure A-6>.

<Figure A-6>

Defining Dummy Variables

```
'==========================================
' Generating dummies for outliers
'==========================================

'smpl 1993 2020
'series dumm = 0
'smpl 2002 2002
'series dumm = 1 'Maoist Dummy

'smpl 1993 2020
'series dume = 0
'smpl 2015 2015
'series dume = 1 'Earthquake Dummy

smpl 1993 2020
series dump = 0
smpl 2007 2007
series dump = 1 'Political transition Expectation
```

The real interest rate determined by Vector Autoregression method is defined as in <Figure A-7>.

Before defining the real interest rate, the user needs to calculate expected inflation based on vector autoregression methods. The ‘equation’ command will be used in this case. ‘equation eq_small00_var.ls inf c inf(-1) ygap(-1) ir(-1) rer(-1)’ command in the example above derives the backward-oriented expected inflation discussed in Section III. The coefficients of the independent variables in this equation can be stored using the ‘scalar’ command. For instance, ‘scalar beta1hat = eq_small00_var.@coef(2)’ command extracts the second coefficient in the eq_small00_var equation, which is the coefficient for inf(-1). Once each coefficient has been stored, the user is able to calculate expected inflation by using the ‘series inf_exp = alphahat + beta1hat*inf + beta2hat*ygap + beta3hat*ir + beta4hat*rer’ command. Lastly, different real interest rates have been defined as ‘rr_opeg_exp’ for the pegging regime and ‘rr_exp’ for other cases.

<Figure A-7>

Defining Real Interest Rate based on VAR Methods

```
'==========================================================================
'For Nepal
'==========================================================================

smpl 1994 2016
equation eq_small00_var.ls inf c inf(-1) ygap(-1) ir(-1) rer(-1)

scalar alphahat = eq_small00_var.@coef(1)
scalar beta1hat = eq_small00_var.@coef(2)
scalar beta2hat = eq_small00_var.@coef(3)
scalar beta3hat = eq_small00_var.@coef(4)
scalar beta4hat = eq_small00_var.@coef(5)

smpl 1993 2016
series inf_exp = alphahat + beta1hat*inf + beta2hat*ygap + beta3hat*ir + beta4hat*rer

smpl 1993 2016
series rr_opeg_exp = ir_ind - inf_exp
series rr_exp = ir - inf_exp
```

Once these procedures are set, the user defines the equations to be used for regression analysis. The equations can be defined using the ‘equation’ command. Once an equation is defined and estimated, the results can be viewed by clicking on the icon for that equation in the workfile. The left panel of <Figure A-8> shows how equations are defined, while the right panel shows the estimation results.

As can be seen in the left panel, the equations are defined with ‘equation name of the equation.ls dependent variable independent variable’ command, with ‘ls’ indicating least squares method. If the user wishes to use other estimation methods, different commands instead of ‘ls’ must be typed in. The ’c’ in the equation command indicates a constant in the equation. When the constant term is not needed, the ‘c’ term can be removed. $d(x)$ indicates the difference operator on a variable x. Thus, we have $d(x)=x_t-x_{t-1}$.

<Figure A-8>

Defining the Equations

```
' Estimating : with VAR : 07~12
'==========================================================

' 7. Peg without Capital Control with VAR
equation eq_small07_y.ls ygap c ygap(-1) rr_dpeg_exp d(rem) dump

' 8. Imperfect Peg with VAR
equation eq_small08_y_partial.ls ygap c ygap(-1) rr_exp d(rem) dump

' 9. Independent Monetary Policy with Capital Control with VAR
equation eq_small09_y_indep.ls ygap c ygap(-1) rr_exp rer d(rem) dump

' 10 NKPC
equation eq_small10_nkpc.ls inf c ygap(-1) inf(-1) rain f_inf inf_ind dump

' 11. Real rate Partial Dollarization(Not Perfect Peg) with VAR
equation eq_small11_r_partial.ls rr_exp c rr_exp_ind rer

' 12. Monetary Policy
equation eq_small12_mp.ls ir c ir(-1) inf ygap rer d(rem)
```

Estimation Results

Dependent Variable: YGAP
Method: Least Squares
Date: 08/20/17 Time: 02:07
Sample (adjusted): 1994 2015
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.556316	0.278340	1.998690	0.0629
YGAP(-1)	0.358173	0.231657	1.546133	0.1416
RR_EXP	0.038007	0.114217	0.332760	0.7436
RER	-0.008099	0.023384	-0.346346	0.7336
D(REM)	-1.471753	0.859419	-1.712497	0.1061
DUMP	-2.007421	1.146306	-1.751208	0.0991

R-squared	0.384217	Mean dependent var	0.228189
Adjusted R-squared	0.191785	S.D. dependent var	1.181974
S.E. of regression	1.062603	Akaike info criterion	3.186322
Sum squared resid	18.06601	Schwarz criterion	3.483879
Log likelihood	-29.04954	Hannan-Quinn criter.	3.256417
F-statistic	1.996638	Durbin-Watson stat	1.644615
Prob(F-statistic)	0.134002		

The right panel displays the estimation results of the equations. First, there are coefficients, standard errors, t-statistics, and p-values for each equation. In the bottom part of the picture, R-squared and Adjusted R-squared statistics indicate how well the regression accounts for the variation in the data. There are also values for sum-of-squared residuals and standard error of the regression (S.E of Regression). Moreover, one can check the mean of the dependent variable and its standard deviation. F-statistic and Prob(F-statistic) measure the fitness of the equation as a whole. There are Akaike, Schwarz, and Hanna-Quinn criteria which incorporate penalty factors for including additional explanatory variables. Log likelihood is a statistic measuring the fitness between the model and the actual data, whereas the Durbin-Watson statistic is used to detect the presence of autocorrelation.

<Figure A-9>

The Composition of the Model	Solving the Model and Defining Graphs
model md_small06 md_small06.merge eq_small09_y_indep md_small06.merge eq_small10_nkpc md_small06.merge eq_small12_mp md_small06.append rr_exp = ir - inf_exp	md_small06.solveopt(s=b, d=s) md_small06.stochastic(i=b, r=10000, b=0.9, c=t) md_small06.solve md_small06.makegraph(a, s=b) grp_small_model6 ygap inf rr_exp ir grp_small_model6.options linepat grp_small_model6.setelem(1) legend("Actual") lwidth(1.5) grp_small_model6.setelem(2) legend("Fitted") lwidth(1.5) grp_small_model6.axis font("Arial", 14, b) grp_small_model6.setfont text("Arial", 15, b) legend("Arial", 14)

Once the estimates for each equation are obtained, the user should merge them into a model and solve them, as demonstrated in <Figure A-9>. On the left, there is a model under the assumed setting of independent monetary policy with real interest rate determined by the VAR method. 'model md_small06' creates the model with the name md_small06 that contains a set of equations. In Section III, the model included aggregate demand (y_ind), independent monetary policy (mp), aggregate supply, based on the New-Keynesian Phillips Curve (nkpc), and real interest rates (rr_exp). The equations for aggregate demand, aggregate supply and independent monetary policy are already defined in <Figure A-8>, so the user can make use of 'merge' command, as in 'md_small06.merge name of the equation' to include them in the model. On the other hand, the equation for real interest rates is not estimated in <Figure A-8>, so the user must define it separately using the 'append' command. This can be implemented by the 'md_small06.append rr_exp = ir − inf_exp' command.

The right panel demonstrates the procedure of solving the model and displaying the results using graphs. The solveopt command allows the user to customize among various options for solving the model. The 'stochastic' command in the picture allows user to select different methods for solving stochastic models, which will be discussed in detail when explaining medium-scale models. Once the options are set, the Eviews will solve the model with the 'solve' command.

After Eviews solves the model, the results can be displayed in the form of a graph using 'makegraph' command. For instance, 'makegraph(a, s=b) grp_small_model6 ygap inf rr_exp ir' command lets Eviews depict graphs representing the output gap, inflation rate, the real interest rate, and the nominal interest rate from model md_small06. The 'a' indicates that actual data should be included as well, and 's=b' command includes estimated confidence intervals. The 'setelem(1) legend("Actual") lwidth(1.5)' command names the first data as Actual, where lwidth determines the width of the line representing that data. Moreover, the 'axis' command allows the user to customize some features appearing in the axis and 'setfont' command changes fonts in the other parts of the graph.

The graph is automatically stored in the workfile. However, the user can command Eviews to display the graph without having to find the icon indicating the graph in the workfile. The 'show grp_small_model6' command allows the user to see the graph on the user interface. The 'show' command can be applied to other types of variables. Lastly, the 'displayname' command allows the user to change the way some variable names are displayed. For example, 'ygap.displayname Output Gap' commands Eviews to display ygap in the program file as Output Gap.

B. Constructing the Medium-scale Model

Unlike the small-scale model, the medium-scale model adopts growth accounting methods and error correction methods (ECM). It also decomposes aggregate demand into five smaller categories. Apart from these, however, there is no difference between the two models. Therefore, this subsection will only explain methods for implementing growth accounting and ECM.

Looking at ECM first, it takes explicit account of deviations from the long-run equilibrium relationships that can be present among non-stationary time series. An ECM can be constructed by adding residuals obtained from a linear regression of nonstationary variables, which can be taken as a cointegration relationship, if present. For instance, in the two-variable case of GDP and private consumption, we compute residuals after conducting a linear regression that regresses GDP on private consumption. The underlying assumption is that these two variables are cointegrated with each other. This process is explained below in the ‘Cointegration’ discussion. Using the command ‘equation eq_pc_coint.ls pc c y’, we can execute the cointegration regression. In order to store the coefficients from the regression, we create a variable pc_coint using a command ‘coef(2) pc_coint’. We store the two coefficients obtained from eq_pc_coint by using a command ‘pc_coint=eq_pc_coint@coefs’. Finally, we create resulting residual data and save it into a time series variable called pc_error. This process can be executed by using “series pc_error=pc-pc_coint(2)*y-pc_coint(1)”

<Figure A-10>

Command Used in Error Correction Model

```
' (1) Private consumption
'=============================================
'Cointegration
'=============================================
equation eq_pc_coint.ls pc c y
coef(2) pc_coint
pc_coint=eq_pc_coint.@coefs
series pc_error = pc - pc_coint(2)*y - pc_coint(1)
'=============================================
'With Error Correction
'=============================================
equation eq_medium_pc1.ls d(pc) c d(pc(-1)) d(rr) d(y) d(rem(-1)) d(rer) d(oda) dumm  dume pc_error(-1)
equation eq_medium_pc2.ls d(pc) c d(pc(-1)) d(rr_exp) d(y) d(rem(-1)) d(rer) d(oda) dumm  dume pc_error(-1)
```

The commands below ‘With Error Correction’ set up the error correction model containing the residuals that we previously estimated. All other variables are the same as in the existing regression specification formula and are used as explanatory variables in their first differences. The residual term is added as a new explanatory variable in the model. As in standard practice, it is lagged once to reflect the time taken in adjusting towards the cointegrating relation present between the variables. Consequently, the command is ‘equation eq_medium_pc1.ls d(pc) c d(pc(-1)) d(rr) d(y) d(rem(-1)) d(rer) d(oda) dumm dume pc_error(-1)’, and the residual is added to the equation through ‘pc_error(-1)’.

<Figure A-11>

Growth Rate Accounting

```
*******************************
smpl 1993 2015 'Sample Period - Defining the variable
genr l = eap*hour
genr l = log(l)
genr k = log(k)

smpl 1994 2015 'Starting point(+1) - Growth Rate
genr gy = y - y(-1)
genr gl = l - l(-1)
genr gk = k - k(-1)
```

When implementing the growth rate accounting method, the user needs to calculate growth rates for labor and capital. The gy variable calculates the growth rate for output. The labor and capital growth rates are defined by the variables gl and gk.

Then, the user calculates the growth rate of total factor productivity. The equations eq_growth01, eq_growth_02, eq_growth03 estimate growth rates of output, labor, and capital when the model includes a trend and a squared-trend. The growth rate of total factor productivity is defined as 'gahat' variable.

The equations in <Figure A-13> calculate the potential growth rate of labor and capital based on previous model estimates. This is all stored in the matrix named 'glstar' and 'gkstar', respectively. The 'gystar' variable on the right panel stores the potential growth rate of the output. It has been renamed as 'gy_plot' for computational purposes described later.

<Figure A-12>

Total Factor Productivity

```
'Calculating the Growth rate of Total Factor Productivity
smpl 1993 2015
equation eq_growth01.ls y c t t^2
eq_growth01.fit yhat
genr gyhat = yhat - yhat(-1)
coef beta1=@coefs

equation eq_growth02.ls l c t t^2
eq_growth02.fit lhat
genr glhat = lhat - lhat(-1)
coef beta2=@coefs

equation eq_growth03.ls k c t t^2
eq_growth03.fit khat
genr gkhat = khat - khat(-1)
coef beta3=@coefs 'beta is a coefficient vector

genr gahat = gyhat - (1-alpha)*glhat - alpha*gkhat
scalar gastar = gahat(23) ' (Last Period(Datawise) - Start Period(Vector
Lengthwise) + 1 ex) 2015-1993+1=23)

matrix(5,3) zf
zf.fill 1,1,1,1,1,23,24,25,26,27,23^2,24^2,25^2,26^2,27^2 '23-> 2015 / 24 ->
2016 / 25 -> 2017 / 26-> 2018 / 27-> 2019
```

<Figure A-13>

Exogenous Variables

```
matrix (5,1) lstar
lstar = zf*beta2

matrix (5,1) kstar
kstar = zf*beta3

matrix (4,1) glstar
glstar(1) = lstar(2) - lstar(1)
glstar(2) = lstar(3) - lstar(2)
glstar(3) = lstar(4) - lstar(3)
glstar(4) = lstar(5) - lstar(4)

matrix (4,1) gkstar
gkstar(1) = kstar(2) - kstar(1)
gkstar(2) = kstar(3) - kstar(2)
gkstar(3) = kstar(4) - kstar(3)
gkstar(4) = kstar(5) - kstar(4)

scalar alpha2=0.35
```

Solving the Model

```
vector (4,1) gystar 'Assumption : growth rate of total factor productivity -
stable since 2015
gystar(1) = gastar + (1-alpha2)*glstar(1) + alpha2*gkstar(1)
gystar(2) = gastar + (1-alpha2)*glstar(2) + alpha2*gkstar(2)
gystar(3) = gastar + (1-alpha2)*glstar(3) + alpha2*gkstar(3)
gystar(4) = gastar + (1-alpha2)*glstar(4) + alpha2*gkstar(4)

smpl 1994 2015 'Potential GDP Growth Rate
series gy_plot = gyhat

smpl 2016 2019
series gy_plot
gy_plot(24) = gystar(1)
gy_plot(25) = gystar(2)
gy_plot(26) = gystar(3)
gy_plot(27) = gystar(4)
```

To calculate the growth rate of the trend component of GDP, GDP has to be decomposed into a trend component and a cyclical component. This process can be carried out using the 'y.hpf(100)' command, just as we did in the previous section. The 'y_trend' variable stores the value for the trend component of GDP. For the study at hand, 'y_trend' has been calculated for a total of 27 periods from 1993 to 2019.

<Figure A-14>

Exogenous Variables

```
smpl 1993 2015
y.hpf(100) y_hp
series y_hp = y_hp

smpl 1994 2015
series gy_hp = y_hp - y_hp(-1)
```

Solving the Model

```
smpl 1993 2019 'Potential GDP
series y_trend
y_trend(1) = y(1)
y_trend(2) = y_trend(1) + gy_plot(2)
y_trend(3) = y_trend(2) + gy_plot(3)
y_trend(4) = y_trend(3) + gy_plot(4)
y_trend(5) = y_trend(4) + gy_plot(5)
y_trend(6) = y_trend(5) + gy_plot(6)
y_trend(7) = y_trend(6) + gy_plot(7)
y_trend(8) = y_trend(7) + gy_plot(8)
y_trend(9) = y_trend(8) + gy_plot(9)
```

<Figure A-15>

Growth Rate Accounting

```
smpl 1993 2015
scalar y_trend_mean = @mean(y_trend) - @mean(y)

smpl 1993 2019
series y_trend
y_trend = y_trend - y_trend_mean
series y_trend_rupee = exp(y_trend)

smpl 1994 2019
series rt_g
rt_g = y_trend - y_trend(-1)
```

This figure demonstrates how the growth rate of the GDP trend component is calculated using the estimation of the trend component of GDP. 'y_trend_mean' is used to smooth out the trend component. Then, 'y_trend' is defined as the original trend component as discussed in <Figure A-15>, minus the mean of the trend component. Finally, the 'rt_g' variable calculates the growth rate of the GDP trend component based on these calculations.

3. Forecasting with Eviews

Eviews allows the user to predict future values. In order to conduct forecasting operations, the user needs to set assumptions for exogenous variables in the model. Once they are set, the user can generate predicted values for independent variables given these assumptions. The user can also conduct a scenario analysis on how the independent variables react to changes in the exogenous variables. The forecasting procedures will be discussed in the subsection that follows.

A. Assumptions on Exogenous Variables and Producting Baseline Forecasts

In order to carry out short-run forecasting operations, the user must set certain assumptions concerning the movements of exogenous variables in the model. Eviews will solve the model forward based on assumptions for the exogenous variables and the solutions for the model determined a priori in the in-sample analysis. <Figure A-16> demonstrates how the assumptions on exogenous variables can be set, and how the model can be solved to produce predicted future values of variables.

In the left panel, the assumption for the exogenous variable, Indian GDP, has been set. The g_ind_y, g_ind_y_avg, and g_ind_y_f variables, respectively, define the growth rate, averaged growth rate of the last five years, and growth rate at 2015. The '@movav' command calculates the averaged growth rate of the last five years. For instance, the g_ind_y_avg for the year 2010 calculates the average growth rate over the period of 2006 to 2010. The '@elem' operator extracts the value of a variable for the selected period. g_ind_y_f is the growth rate in 2015. For the period 2016 to 2019, the growth rate of Indian GDP is calculated as the growth rate of the previous year times g_ind_y_f.

<Figure A-16>

Exogenous Variables

```
'y_ind
smpl 1994 2015
series g_ind_y       = gdp_ind / gdp_ind(-1)
series g_ind_y_avg   = @movav(g_ind_y, 5)
scalar g_ind_y_f     = @elem(g_ind_y_avg, "2015")

smpl 2016 2019
series gdp_ind       = gdp_ind(-1) * g_ind_y_f
series y_ind         = log(gdp_ind)
```

Solving the Model

```
' Forecast with model 6
'==================================================
' Up to year 2019
smpl 2016 2019
 's: solution type (d/m/s/b/a) , d : solution dynamics (d/s/f)
md_medium06.solveopt(s=d,d=d,c=0.000075)
md_medium06.solve
```

The right panel contains the command keys solving the model over the period 2016 to 2019. The 'solve' command solves the model based on the assumptions that the user gave to the exogenous variables, and the coefficient values obtained when estimating it over the in-sample period. Note that, for the 'solveopt' command, the solution type has been set to 'd', instead of 's'. Option 'd' means that all equations in the model are solved for the simulation period in a way that they hold without error. Also, all coefficients and exogenous variables are fixed at their point estimates and assigned values as the equations are being solved. With option 's', equations are solved so that they have residuals matched with randomly drawn errors, assuming that coefficients and exogenous variables can also vary randomly. As for the solution dynamics, the example in the right panel is set to 'd'. Option 'd' means that model will be solved dynamically. In other words, it means that the model will calculate the endogenous variables, and Eviews will use those calculated endogenous variables to calculate the values for the endogenous variables in the next period. On the other hand, option 's', which was demonstrated in the small-scale version of the model, indicates that model will be solved, with Eviews using historical values to calculate the next period endogenous variables.

Once the 'solve' option is executed as in <Figure A-17>, the user can store the predicted values and show them in the form of a graph. The baseline predictions for the growth rate and the inflation rate are stored in the variable g_y_0 and inf_0, respectively. ygf_ma and inf_ma represent the predicted values for the growth rate and the inflation rate using the moving average method. To display the results in graphs, the user can utilize the ‘graph’ command. The ‘align’ command allows the user to customize the format in which the graphs are displayed. The first number in the bracket indicates the number of columns, while the second and third indicate the size of horizontal and vertical spaces in inches, respectively.

<Figure A-17>

Baseline Results	Graphs
' Save forecast data smpl 1994 2019 series yf = y_0 'y_0 : result of model simulation, 1993-2015 (Actual Data) 2016-2019 (Simulated Data) [Model solved from 2016 to 2019] series ygf = g_y_0 series inf_f = inf_0 ' Moving average smpl 2015 2015 series ygf_ma = ygf smpl 2016 2016 '2016 shock series ygf_ma = 0.006 smpl 2017 2019 series ygf_ma = @movav(ygf,5) smpl 2015 2015 series inf_ma = inf_f smpl 2016 2016 '2016 shock series inf_ma = 0.059 smpl 2017 2019 series inf_ma = @movav(inf_f,5)	' graph smpl 1994 2019 graph grp_forecast_y.line g_y ygf_ma graph grp_forecast_inf.line inf inf_ma grp_forecast_y.addtext(t, "Ariel", 20) GDP Growth Rate grp_forecast_inf.addtext(t, "Ariel", 20) Inflation grp_forecast_y.axis units(p) grp_forecast_inf.axis units(p) freeze(mode=overwrite, grp_forecast) grp_forecast_y grp_forecast_inf grp_forecast.options linepat grp_forecast.setelem(1) legend("Actual") symbol (filledcircle) lwidth(2.5) grp_forecast.setelem(2) legend("Forecasted") linecolor(red) symbol(diagcross) lwidth(2.5) grp_forecast.axis font("Ariel", 14) grp_forecast.setfont text("Ariel",23) legend ("Ariel",20) show grp_forecast.align(2,1,1)

B. Producing the Results

The user might be interested in possible effects on the predicted values of variables when assumptions to the exogenous variables are altered. For instance, one might want to know about how a boom in a neighboring country’s economy affects the domestic economy. Investigating such a scenario is possible in Eviews, which is demonstrated below.

<Figure A-18>

Scenario Analysis

```
md_medium06.scenario(n) "Scenario 2"
%mver="2"
%figtitle="10%p Increase in India GDP"
%scn_var="y_ind"
smpl @all
series {%scn_var}_{%mver} = {%scn_var}
smpl 2016 2019
!increase = log(1.1)
series {%scn_var}_{%mver} = !increase + {%scn_var}
md_medium06.override {%scn_var}
md_medium06.solve

' Moving average
smpl 2015 2015
series g_y_2_ma = @elem(ygf_ma,"2015")
series inf_2_ma = @elem(inf_ma,"2015")

smpl 2016 2016
series g_y_2_ma = @elem(ygf_ma,"2016")
series inf_2_ma = @elem(inf_ma,"2016")

smpl 2017 2019
series g_y_2_ma = @movav(g_y_2,5)
smpl 2017 2019
series inf_2_ma = @movav(inf_2,5)
```

This example generates the results when the Indian economic growth rate rises by an additional 10 percent. To alter the assumptions made to the exogenous variables, the commands ‘series {%scn_var}_{%mver} = {%scn_var}’ and ‘series {%scn_var}_{%mver} = !increase + {%scn_var}’ are useful. The user declares the exogenous variable to be altered by typing in its name in ‘%scn_var=(name of the exogenous variable)’. To differentiate from the original assumption the user enumerates the new exogenous variable in the {%mver} command (e.g., ‘{%mver}=“2”’). To increase Indian GDP by 10 percent for the period of 2016 to 2019, the user needs to limit the sample by ‘smpl 2016 2019’ and then type in ‘!increase = log(1.1)’. The user should solve the model again by typing in ‘solve’. The commands below Moving Average store new predicted values of the endogenous variables.

One can also examine how each component of GDP has been affected in the experiment above. To achieve this, one can take advantage of the fact that the baseline values have been stored under ‘_0’ and our scenario values under ‘_2’. This has been done by first creating a graph for each GDP component and then combining the graphs into one. Multiple graphs can be merged into one by using the ‘merge’ command as in the bottom panel.

<Figure A-19>

Decomposing Changes of Growth Rates

```
graph scen02_pc  d(pc_2) d(pc_0)
scen02_pc.setelem(1) linecolor(red) legend("New Prediction") lwidth(2) symbol
(diagcross)
scen02_pc.setelem(2) linecolor(blue)  legend("Baseline") lwidth(2)  symbol
(filledcircle)
scen02_pc.addtext(t, "Ariel", 20) PC Growth Rate
scen02_pc.axis units(p)
```

```
graph yindreasons.merge scen02_pc scen02_ge scen02_inv scen02_ex
scen02_im
yindreasons.axis font("Ariel", 17)
yindreasons.setfont text("Ariel",23) legend("Ariel",23)
show yindreasons.align(3,2,2)
```

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