AN ECONOMETRIC ANALYSIS OF THE IMPACT OF REAL EFFECTIVE EXCHANGE RATE ON ECONOMIC ACTIVITIES IN NEPAL

By:

NARA BAHADUR THAPA*

Abstract

This paper tests the relationship between REER and GDP on the Nepalese economy. In the literature, two channels of transmission exist for the real exchange rate to affect economic activities; these are the aggregate demand channel and the aggregate supply channel. The traditional view has it that the real exchange rate operates through the aggregate demand channel. This means that the depreciation of the real exchange rate enhances the international competitiveness of domestic goods, boosts net exports and eventually enlarges GDP. The aggregate supply channel, on the other hand, purports that the depreciation of the real exchange rate increases the cost of production and helps redistribute income in favour of the rich. These two effects lower aggregate demand causing economic contraction. The empirical study shows that the traditional view holds for Nepal and implies that Nepal should at least keep the real exchange rate constant.

* Deputy Director, Research Department, Nepal Rastra Bank, Baluwatar, Kathmandu, NEPAL.

1. Introduction

The successful and effective conduct of monetary policy requires the selection of an intermediate monetary target. The need for an intermediate monetary target variable arises because monetary instruments (such as bank rate, cash reserve requirements, open market operations) and the ultimate goals of monetary policy (such as a higher rate of economic growth, price stability, a surplus in the balance of payments) do not have a direct relationship. This implies that monetary authorities cannot directly exercise control over monetary policy objectives. Hence, there evolves a need for an appropriate intermediate monetary target variable (Thapa, 2001). Variables such as money supply, domestic credit, nominal income, inflation rate, exchange rate etc. are some of the candidates for intermediate target variable of monetary policy. Among these candidates, exchange rate is emerging as an important target variable for the country such as Nepal. Before we decide on choosing exchange rate as an intermediate target variable, we must know the link between the exchange rate and the ultimate policy objective such as a higher rate of economic growth. In the literature, there are economic theories establishing a link between the real exchange rate and the real economic growth rate. It is to be noted that the nominal exchange rate management depends on the real exchange rate and the real exchange rate is influenced, among others, by nominal exchange rate (Montiel, 1997). This means that the real exchange rate misalignment occurs in markets in which actual exchange rates are not allowed to adjust to changes in economic fundamentals (Prick and Vollrath, 1994). Against this perspective, this paper attempts to investigate the relationship between the real exchange rate and real economic activities in Nepal. Before this is done, the remainder of this section discusses as to why exchange rate can be important policy target variable for the Nepali economy.

Nepal is a small open economy. The small size of the Nepali economy is evident from the magnitude of GDP which stood at US dollar 5.5 billion in the fiscal year 2000/01. The degree of openness of the Nepali economy can be judged from the share of its total trade in GDP, which stood at 43.8 percent in 2000/01. Adding the net non-factor services to the total merchandise trade the extent of openness reaches 55.2 percent of 2000/01 GDP. The ratio would still increase further if we were to add private remittances on this. It is argued in the literature that the real exchange rate stability and correction of exchange rate misalignment are the crucial conditions for improving economic performance of small and open less developed countries such as Nepal. Empirical evidence from countries of Latin America, Asia and Africa is often cited to support the view that the link between RER behaviour and economic performance is strong (Cottani et al, 1990).

Currently, Nepal is adopting dual exchange rate arrangement. It is dual because the Nepali currency (NC) is pegged with the Indian currency (IC) whereas it floats with the convertible currencies. This system of exchange rate was introduced since February 12, 1993

(Thapa, 1996). Prior to March 4, 1992, the rupee was theoretically pegged to a currency basket. The regime of currency basket system was introduced since June 1, 1983 (Maskay and Thapa 2000). The basket regime had two notable features. First, the currency basket, at which the NC was pegged, was never disclosed. Second, although the rupee was pegged to a currency basket, the NC-IC rate remained fixed. This shows that Nepal has been following the de facato pegged exchange rate system since the 1960s. Changes in NC-convertible currencies' rates or for that matter the NC-US dollar rate are effected to avoid the emergence of broken cross rates between the NC vis-à-vis the US dollar and the IC vis-a vis the US dollar (Thapa, 1999). Under the circumstances, the nominal changes in the NC-IC rate occur whenever NC is devalued/revalued officially. On the other hand, the NC- US dollar rate changes occur whenever the IC-US dollar rate changes. India has flexible exchange rate regime. In this context, it has to be taken a note that the market forces such as demand for and supply of dollar also affect the NC-US dollar rate in the domestic market even though such changes may be emanating from India.

The point is that Nepal cannot keep the NC overvalued against the US dollar relative to the IC-US dollar rate. In that case, due to the open border with India, it will be hard for Nepal to meet the demand for the US dollar. On the supply side, private remittances and export earnings will be routed through India if NC is overvalued against the US dollar in relation to IC vis-à-vis the US dollar rate. In the process, Nepal will face a situation of dwindling inflow of convertible currencies and increasing inflow of IC reserves. This means that the composition of Nepal's international reserves will change in favour of IC. Nor has Nepal incentive to keep the NC significantly undervalued against the US dollar relative to the IC-US dollar rate. Obviously, the advantages of significantly undervalued currency exist in terms of enhanced incentive for Nepali exports to overseas market. But Nepal being a small economy has theoretically unlimited world market for its products. But the fact is that Nepal has problems in the supply side. Hence, Nepali export base has remained fragile for a long period of time. On the other hand, there are many underlying disadvantages of keeping the NC undervalued against the US dollar. Escalation of budget deficit due to increasing foreign debt servicing for the government and increased cost of raw materials are the two examples of disadvantages arising from unnecessarily undervaluation of NC against the US dollar. This suggests the need for keeping the real exchange rate (RER) constant.

The RER is an important macroeconomic policy variable in the sense that it indicates the country's international competitiveness. The RER is the nominal exchange rate (index) adjusted for price changes in the domestic economy relative to those of trading partners'. In the case of Nepal, the NC-IC rate is officially pegged, and hence changes in the RER with IC occur due mainly to changes in domestic prices in relation to Indian prices unless the NC is devalued or revalued against the IC. The case is different for the RER of NC vis-à-vis the US dollar. In this case, changes in the RER of NC vis-à-vis the US dollar occur due to (i)

changes in nominal exchange rate of NC vis-à-vis the US dollar and (ii) changes in domestic prices vis-à-vis the US prices. In order to get a single index of exchange rate, a trade weighted RER is calculated which is known as the real effective exchange rate (REER).

This paper attempts to examine the econometric relationship between the REER and the economic activities in Nepal. The gross domestic product (GDP) approximates the economic activities. Hence, the relationship is tested between the REER and the GDP. The relationship is examined based on the standard theories of aggregate demand (AD) and aggregate supply (AS).

The outline of this paper is as follows. Following this introductory section, the second section enlists the objectives of the study. The third section makes the theoretical review focusing on transmission mechanism of REER on real economic activities. The fourth section discusses the methodological issues of the study. The fifth section deals with data and estimating equation. The sixth section applies the model for Nepal and makes the empirical analysis of the model. The seventh section concludes the study.

2. The objectives of the Study

The specific objectives of the study are as follows:

- To analyse the transmission mechanism of exchange rate on economic activities
- To analyse the impact of REER on the Nepali economy
- To test the Marshall-Lerner condition of currency depreciation

3. Review of Transmission Mechanism

In the literature, two views exist on the transmission mechanism of the real exchange rate on economic activities. For the sake of analysis, economic activities are proxied by the GDP. This paves the way for investigating the relationship between the REER and the GDP. The channels of transmission of real exchange rate on the GDP operate through both sides: demand for and supply of output. The analytical tools are the aggregate demand (AD) and the aggregate supply (AS). The traditional view has it that the real exchange rate operates through AD channel. It is argued that the depreciation of the real exchange rate enhances the international price competitiveness of domestic goods. In the process, this helps improve the current account balance of the country. With the improvement of international competitiveness of domestic goods, the net export increases. This, in turn, helps increase AD in the economy. On the other hand, if there is misalignment in the form of currency overvaluation, it will hurt tradable activities and thus lowering net export and AD in the

economy (Cottani et al, 1990). In contrast to this view, there are arguments that a real depreciation can generate adverse effects resulting in overall economic contraction. Economic contraction occurs through the following channels. First, a nominal depreciation of the currency leads to a rise in general price level. This lowers aggregate demand, which, in turn, causes economic contraction. The second channel works through the income redistribution. It is argued that a real depreciation can help transfer income from individuals with a high marginal propensity to consume to those with a low marginal propensity. This lowers aggregate demand, which, in turn, causes output to fall. Apart from this, transmission mechanism also operates through aggregate supply channel. It is contended that a real depreciation can reduce aggregate supply. This is so because a real depreciation causes the cost of imported raw materials to go up. This reduces the importation of raw materials and thereby lowering the level of aggregate supply (Papazoglou, 1999).

The above theoretical review presents us the two contrasting views: real depreciation of the currency leading to economic expansion and real depreciation leading to economic contraction. Before testing these conflicting theoretical views on the Nepali economy, let us first discuss the methodological issues of the study.

4. Methodological Issues

There are two methodological issues to be discussed. The first issue relates to the choice of the methodology for the calculation of REER for Nepal. The second issue pertains to the construction of a model establishing a relationship between the REER and the GDP.

4.1 Calculation of REER

Nepal quotes both buying and selling rates of NC with 12 foreign currencies. Only buying rates of NC are also quoted for 8 foreign currencies. Given the pegged exchange rate regime of NC with IC, nominal exchange rate between NC and IC remains constant unless authorities devalue or revalue. On the other hand, nominal exchange rates of NC with other currencies are subject to change on a daily basis. For the purpose of the study, we can calculate the nominal exchange rate indices of NC with 20 foreign currencies. We can also construct RER indices of NC with these currencies by taking price differential of Nepal with those currencies' countries. We need to arrive at a single measure of exchange rate index for the study. Calculating the REER index has the following merits. Unlike the nominal exchange rate (NER) and the RER, which are bilateral exchange rate indices, the REER is the composite exchange rate index. The composite exchange rate index i.e. REER can be arrived at by taking trade shares of trade partner countries and multiply such trade weights with respective RER indices and sum them up. For the purpose of the study, the NER index is calculated in terms of foreign currency value of local currency. In this case, a rise in the index

represents a nominal appreciation of the local currency. While calculating the RER, the NER is adjusted for the price differential by keeping the domestic price (P) in the numerator and foreign prices (P^f) in the denominator. Thus, a rise in the RER index also shows a real appreciation of local currency. The procedure for the construction of these indices involves three steps. These steps are explained symbolically as follows.

The first step consists of the calculation of nominal exchange rate index (NERi).

NER = 1/ nominal rate of foreign currency unit quoted in local currency value …..(1)

This refers to unit(s) of foreign currency divided by unit(s) of local currency value of that (those) of foreign currency. Once this ratio is recast into the index form, NERi can be obtained.

The second step involves the calculation of real exchange rate index (RERi). The following formula is used for this.

$RERi = NERi*(P/P^f)$ …….…… (2)

The third step involves the calculation of the real effective exchange rate index (REERi). In this step, trade weights are adjusted with the respective RERi. The following formula is used for the calculation of REERi.

$$REER_i = \sum_{i=1}^{n} (RERif_1 * TWf_1) + (RERif_2 * TWf_2) + ... + (RERif_n * TWf_n).....(3)$$

Where, REERi = the real effective exchange rate index
$RERif_1$ = the RER index with currency of country one
$RERif_2$ = the RER index with currency of country two
$RERif_n$ = the RER index with currency of country n

TWf_1 = trade weight of trade partner country one
TWf_2 = trade weight of trade partner country two
TWf_n = trade weight of trade partner country n

Although Nepal trades with a number of countries, there are following limitations in the construction of a comprehensive REER index. First, except a few countries, Nepal's trade with other countries is insignificant. Hence, there is no need to calculate the RER of NC with all the currencies of trade partner countries. Second, we do not have accurate time series data

of trade with all trade partner countries separately. Because of these constraints, the NER and the RER indices are constructed with respect to IC and US dollar. India is a major trade partner, as Nepal's trade with India constitutes 40 percent of the total trade. Nepal's most of trade with countries other than India is carried through the US dollar. Hence, other than the IC, the NER and the RER indices are constructed with respective to the US dollar. This is done because we have consistent time series trade data classified as with India and with the rest of world (ROW). The US dollar is chosen to represent the ROW. Hence, identity (3) can be rewritten as:

$$REERi = \sum (RERi_{IC} * TW_{India}) + (RERi_{\$} * TW_{ROW}) \quad \ldots\ldots (4)$$

Where, $RERi_{IC}$ = the real exchange rate index of NC with IC
TW_{India} = Nepal's trade weight (share) with India
$RERi_{\$}$ = the real exchange rate index of NC with the US dollar
TW_{ROW} = trade weight with the ROW

4.2 The Model

The model must accurately capture the relationship between the GDP and the real exchange rate. The model takes the GDP as the dependent variable and the real exchange rate as the explanatory variable. The relationship between the GDP and real exchange rate can be established only when we have a full-fledged GDP accounting model. For the purpose of the study, the transmission mechanism that has been discussed in section 3 is taken as the basis for the model building. This means that the model must capture both the factors affecting the supply side of GDP and the factors affecting the demand side of GDP.

Against this background, let us first start with AD side of the GDP. The standard framework for demand side GDP in an open economy is as follows.

$$GDP = C + I + G + (X-M) \quad \ldots\ldots (5)$$

Where, C = private sector consumption expenditure
I = private sector investment expenditure
X = exports of goods and services
M = imports of goods and services

The term (X-M) in identity (5) can be netted out. The resultant term is the net exports (NX). The NX is the net external demand for domestic goods and services. With this modification, identity (5) can be rewritten as.

$$GDP = C + I + G + NX \quad \ldots\ldots (6)$$

The term C representing the private sector expenditure in the above identity is the positive function of income and, to some extent, the negative function of real interest rate. The term investment (I) in identity (6) can be said to be the negative function of real interest rate. The government expenditure is the exogenous factor, which depends on the government policy. The term NX, i.e. the external demand for domestic goods and services can be postulated as the negative function of real exchange rate. On the basis of these ultimate determinants of real GDP, identity (6) can be rewritten in the following equation.

$$GDP = a + (-)\ b_1(r-p^e)\ (-)\ b_2(q)\ (+)\ b_3(g) + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (7)$$

Where, r = nominal interest rate
P^e = expected inflation rate
q = real exchange rate
g = government expenditure
U_t = an error term

Nominal interest rate depends on, among others, total money supply in the economy. Nominal interest rate is said to be the negative function of money supply. If we are to replace the term $(r\text{-}p^e)$ by money supply term (m), we can rewrite equation (7) as:

$$GDP = a + b_1(m) - b_2(q) + b_2\ (g) + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots...\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ (8)$$

The term money supply has positive impact on real GDP. This is because with the increase in nominal money supply, nominal interest rate comes down. Investment, among others, depends on real interest rate. A fall in the nominal interest rate induces investment to go up. With the rising investment, real GDP increases.

On the supply side, three proximate determinants such as labour (L), capital (K) and total factor productivity (TFP) are used to account for the real GDP growth. The determinants of AS of real GDP can be written in the following functional form.

$$GDP = f(L, K, TFP) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (9)$$

It is clear from equation (9) that AS or real GDP goes up with the increased use of labour force i.e. increased employment, capital and increased TFP. Let us forget about TFP for the time being and think of production of output from a producer's viewpoint. A producer will employ more labour only when real wages fall. Similarly, more capital will be demanded and more investment will be made only when real interest rate falls. Taking these arguments into account and dropping TFP, equation (9) can be rewritten as follows:

$$AS \text{ or } GDP = a - b_1(w) - b_2(r-p^e) + U_t \quad \ldots\ldots (10)$$

It is to be noted that apart from labour cost in the form of wages and capital cost in the form of interest payments, a producer incurs cost of working capital, for that matter, raw-material cost in the form of rising prices of such inputs. Small and open economies such as Nepal generally import most of the raw materials. The cost of imported raw materials, among others, depends on the real exchange rate. By introducing the real exchange rate, equation (10) can be rewritten as:

$$GDP = a - b_1(w) - b_2(r\text{-}pe) + b_3(q) + U_t \quad \ldots\ldots (11)$$

As discussed earlier, the real exchange rate is defined in such a way that a rise in it shows a real appreciation of domestic currency. Unlike the AD, an appreciation of real exchange rate creates a positive impact on the AS. That is to say a real appreciation of domestic currency lowers the cost of raw materials and thus leads to an expansion of real output. This conclusion is in contrast to the traditional view. According to the traditional view a real appreciation lowers international competitiveness, which, in turn, causes net exports to fall. A fall in net export, in turn, lowers the AD. At the theoretical level, an appreciation of real exchange rate has an ambiguous impact on real output. This issue, which is not resolved at the theoretical level, becomes an empirical issue. These two conflicting theoretical views are put to an empirical test on the Nepali economy by rearranging equation (8) and equation (11) as below.

$$GDP = a + b_1(m) + b_2(w) + b_3(q) + b_4(g) + U_t \quad \ldots\ldots (12)$$

5. Data and Estimating Equation

This section has two parts. The first part discusses data used for the study. The second part deals with the estimating equation.

5.1 The Data

Equation 12 has been chosen as the estimating equation for the study. The data used for the variables in equation (12) are as follows. GDP in equation (12) is the real GDP at producers' price. Both the monetary aggregates, narrow money (M_1) and broad money (M_2) are used for the study. M_1 is defined as currency in circulation outside the Nepal Rastra Bank (NRB) and domestic demand deposits held at the commercial banks and other deposits other than that of commercial banks' held at the NRB. M_2 consists of M_1 and quasi money. Both M_1 and M_2 are 12 months average. Similarly, for the calculation of the REER index, 12 months average nominal exchange rates are used.

Wage rate selection is the difficult exercise in Nepal. Wage rates are available for carpenter both skilled and semi-skilled; mason both skilled and semi-skilled; industrial labourers of highly skilled, skilled, semi-skilled and un-skilled; agriculture labourers both male and female and casual labourers both male and female. These wage rates are available for Kathmandu, Birgunj, Biratnagar, Bhairahawa and Nepalgunj. Most of these wage rates are available from the fiscal year 1977/78 onwards. However, wage rates for casual labourers are available only from fiscal year 1987/88 onwards. The other constraint is that these wage rates are available on annual basis. Among these various wage rates, it is difficult to make a choice of one single rate. Of these wage rates of five places, wage rates of Kathmandu are considered to be more representative. This is on the ground that most of economic activities are undertaken in the Kathmandu valley. Once this is resolved, the next question that arises is as to which wage rate is to be selected for the study. Among the wage rates of carpenter, masons, industrial labourers, agriculture labourers and casual labourers, wages of industrial labourers and agriculture labourers are more or less administered and this is reflected in time series data of these wages. Therefore, there is no question of selecting wages of industrial labourers and agriculture labourers. In the case of wage rate of casual labourers, time series data are available from the fiscal year 1987/88 onwards only. With this, the choice narrows down to wages of carpenter and mason. Of these two, wages of mason is found to be more representative and hence, this is selected for the study.

Most of the data are taken from various issues of Economic Survey, Ministry of Finance and Quarterly Economic Bulletin, NRB. Most of data on wages that are available are not published. The sample period of the study is from the fiscal year 1978/79 to 1999/2000. The choice of study period is constrained by wage data availability from the fiscal year 1978/79 onwards. The econometric study is conducted on annual data. This is again due to non-availability of quarterly data on GDP and wages.

5.2 The Estimating Equation

Equation (12) needs to be log transformed before it is put to an empirical test. The log-transformed equation (12) can be represented as below.

$$Log(RGDP)= C + b_1log(AM_1) - b_2log(W) -+ b_3log(REER) + b_4log(RGEXP) + U_t \quad \ldots\ldots(12a)$$

Where, log (RGDP) = log-transformed real GDP
Log (AM_1) = log-transformed 12-month average narrow money
Log (W) = log transformed wage rate
Log (RGEXP) = log-transformed government's real total expenditure
Log (REER) = log-transformed the real effective exchange rate index

6. Empirical Analysis

This section has two parts. The first part deals with stationarity test and co-integration test of the model. The second part reports and discusses the regression results.

6.1 Stationarity Test

Time series econometric study is not complete without performing stationarity test on variables used for the study. Regression run on non-stationary time series variables produces spurious results, which are meaningless. Therefore, it is important to make sure that variables are stationary. This means that a stationary time series has three characteristics namely finite mean, variance and auto-covariance over time (Gujarati, 1995). Currently, there are two stationarity tests available to us. These are (i) the correlogram method and (ii) the unit root method. The correlogram method is rather pictorial and gives us the autocorrelation coefficients at various lags of the series. Generally, the maximum length of the lag is upto one third of the sample size. A non-stationary time series starts with a very high coefficient and the coefficients taper off very slowly. A non-stationary time series has also very high Ljung-Box Q statistics with low p-values. That means that a stationary time series must have almost zero autocorrelation and partial autocorrelation coefficients at all lags and all Q statistics should also be insignificant with high p-values. But it is argued that the correlogram test is not a formal test. It rather involves subjective judgement applied to the time series graph of the series (Johnston and DiNardo, 1997).

The other stationary method is the unit root test. Among these two, the unit root test method is widely used as formal statistical tests. The widely used unit root tests are the Dicky-Fuller (DF) and the Augmented Dicky-Fuller (ADF) tests. To apply these unit root tests, consider the following equation.

$$Y_t = a + \rho Y_{t-1} + U_t \quad \ldots\ldots \quad (13)$$

The time series Y is considered stationary if ρ lies between -1 and 1. On the other hand, if ρ equals to or greater than one then the series is non-stationary, hence explosive. This means that a stationary time series must have ρ value of less than one. The null hypothesis of unit root test is that the series has a unit root. Symbolically,

$$H_0: \rho = 1$$

Alternatively, the unit root test measure involves the following process.

$D(Y_t) = a + \delta Y_{t-1} + Ut$ ………………………………………………………………. (14)

Where $\delta = \rho - 1$

D = the difference operator.

In this instance, the null hypothesis is that the δ has zero value. Symbolically,

$H0: \delta = 0$

If ρ carries the value of 1, δ will be zero and if ρ is greater than 1, then δ will have a value greater than zero. In the latter's case, the series is explosive. It is clear that a series to be stationary, ρ value should not exceed one. It follows that the coefficient of δ must be negative with the corresponding negative DF t-statistic and MacKinnon critical values.

To ascertain the stationarity of the variables used for the study, both the correlogram method and the unit root measure are applied on the individual time series. Both the tests show that time series data used for the study contains unit roots and hence are not stationary.

6.2 Stationarity Test Results: The Unit Root Method

This section reports the stationary test results of the study. To start with, the correlogram method has been used to test the stationarity in the variables used for the study. Annex 1 contains the correlogram test results for the stationarity. The correlogram test results in annex 1 clearly show that all the variables in log levels are not stationary. Non-stationarity is revealed in high coefficient value of AC, PAC and Q statistics in subsequent lags of these variables. The corresponding low P-values substantiate that these variables are not stationary at log levels.

The correlogram method is not sufficient to test whether the time series data are stationary or non-stationay. Hence the unit root method is also used to ascertain whether the time series data are stationary or nonstationary. Table 1 reports the unit root test results performed on these variables.

Table 1: Stationary Test: The Unit Root Method

		ADF Test	MacKinnon	Critical	Value
	Variable	Statics	1 %	5 %	10 %
1	Log (RGDP) without C and T	5.39	-2.66	-1.96	-1.62
	Log (RGDP) with C	1.42	-3.73	-2.99	-2.63
	Log (RGDP) with C and T	-2.5	-4.39	-3.61	-3.24
	ΔLog (RGDP) with C	-4.97	-3.75	-3.0	-2.64
2	Log (AM1) without C and T	2.5	-2.67	-1.96	-1.62
	Log (AM1) with C	0.23	-3.75	-3.0	-2.64
	Log (AM1) with C and T	-2.98	-4.42	-3.62	-3.25
	ΔLog (AM1) with C	-2.78	-3.77	-3.0	-2.64
3	Log (AM2) without C and T	3.08	-2.67	-1.96	-1.62
	Log (AM2) with C	0.43	-3.75	-3.0	-2.64
	Log (AM2) with C and T	-3.04	-4.42	-3.62	-3.25
	ΔLog (AM2) with C	-3.37	-3.77	-3.0	-2.64
4	Log (REER) without C and T	-0.5	-2.67	-1.96	-1.62
	Log (REER) with C	-0.97	-3.75	-3.0	-2.64
	Log (REER) with C and T	-3.85	-4.42	-3.62	-3.25
	ΔLog (REER) with C	-3.66	-2.68	-1.96	-1.62
5	Log (RGEXP) without C and T	3.37	-2.67	-1.96	-1.62
	Log (RGEXP) with C	-2.0	-3.75	-3.0	-2.64
	Log (RGEXP) with C and T	-0.94	-4.42	-3.62	-3.25
	ΔLog (RGEXP) with C	-2.89	-3.77	-3.0	-2.64
6	Log (WSMKTM) without C and T	1.65	-2.68	-1.96	-1.62
	Log (WSMKTM) with C	-2.69	-3.77	-3.0	-2.64
	Log (WSMKTM) with C and T	1.02	-4.44	-3.63	-3.25
	ΔLog (WSMKTM) with C	-4.12	-2.67	-1.96	-1.62

The unit root test results given in Table 1 show three things. First, as depicted by the correlogram test, the unit root test results also show that the time series data used for the study are not stationary at log levels. Second, time series data used for the study are time trended. Third, the first difference time series data used for the study are more or less stationary at 5 percent MacKinnon critical value.

6.3 Cointegration Test

Individual time series data might be non-stationary but their linear combination might be stationary. A linear combination of variables of a model is said to be co-integrating of order I (0) if the regression residuals are stationary. The co-integrating process of variable Y as a dependent variable and X as an independent variable can be written as below:

Ut = Yt-a - bXt ………………………………………………………………………… (15)

Where U is the residual or error term

If Ut, the residual is stationary, the two time series Y and X are said to be co-integrated. This implies that there is long-term equilibrium relationship among the variables. If the model is in level form and Ut, the linear combination of variables is stationary; we do not lose any long-term information. This will not be possible if variables are used in the first difference form.

Table 2: Co-integration Test

Equa-tion	Depend Variable	Independent Variable					DF-t-Statistics	MacKinnon Critical Value		
								1%	5%	10%
1	Log RGDP	C	$LogAM_1$	LogREER	LogRGEXP	LogWSMKTM	-4.3	-6.1	-5.1	-4.7
2	Log RGDP	C	$LogAM_2$	LogREER	LogRGEXP	LogWSMKTM	-3.6	-6.1	-5.1	-4.7
3	ΔLog GDP	C	$\Delta LogAM_1$	ΔLogREER	ΔLogRGEXP	ΔLogWSMKTM	-5.0	-6.2	-5.2	-4.7
4	ΔLog GDP	C	$\Delta LogAM_2$	ΔLogREER	ΔLogRGEXP	ΔLogWSMKTM	-4.4	-6.2	-5.2	-4.7

Table 2 shows the co-integration test results. The regression results show that the models at log levels do not have co-integrating relationships. To use technical phrase, the model used for the study are not co-integrating of I (0) order. When the first log difference variables are used, both the models (equation 3 and 4) are not co-integrating at 1 percent level. However, when M_1 is used as one of the independent variables, the first log difference model has co-integrating relationship at about 5 percent level. When M_2 is used, the first log difference model does not have co-integrating relationship even at 10 percent level. Clearly, M_1 produces better result than M_2.

6.4 Regression Results

After having performed the stationarity test on the variables and co-integration test on equation, this section reports and discusses the regression results of the study.

Real GDP growth rate regressed on REER growth rate along with M_1 growth rate
The regression result is based on the first difference log transformed time series data. The following model uses M_1 as one of the arguments.

$$\Delta \text{Log (RGDP)} = 0.03 + 0.23\ \Delta \text{Log } (AM_1) - 0.34\ \Delta \text{Log (REER)} + 0.02\ \Delta \text{Log (RGEXP)}$$
(0.20) (0.16) (0.01) 0.82)
$$-.027\Delta \text{Log(WSMKTM)}$$
(0.01)

$F = 4.03$ (0.02) Adj. $R^2 = 0.37$ DW = 2.44 …….. (16)
Figures in bracket indicate P-value

The regression result of equation (16) shows that all the coefficients have appropriate signs. However, except REER and WSMKTM, coefficients of other variables are not statistically significant not even at 10 percent. The statistical insignificance of M_1 coefficient suggests that interest rate channel is not important to boost the economic activities in Nepal. Curiously, the coefficient on real government expenditure has also remained statistically insignificant. It implies that those two factors such as international competitiveness represented by REER and the labour costs are more significant variables in influencing economic activities in Nepal.

Real GDP growth rate regressed on REER growth rate along with M2 growth rate. When M_2 is used in place of M_1, the model produces the following results.

$$\Delta \text{Log (RGDP)} = 0.03 + 0.21\ \Delta \text{Log } (AM_2) - 0.34\ \Delta \text{Log (REER)} - 0.02\ \Delta \text{Log (RGEXP)}$$
(0.40) (0.30) (0.01) 0.85)
$$-0.22\ \Delta \text{Log (WSMKTM)}$$
(0.02)

$F = 3.6$ (0.02) Adj. $R^2 = 0.33$ DW = 2.28…… (17)
Figures in bracket indicate P-value

Like equation (16), coefficients of all variables except for dlog (RGEXP) have appropriate signs. The results are more or less the same as that of equation (16). Only difference is that unlike model (16), model (17) has no co-integrating relationship even at 10

percent. Hence, the results suggest that M_1 compared to M_2 is more relevant monetary variable for Nepal.

6.4 The Marshall-Lerner Condition

The regression result of the model shows that the effect of real exchange rate operates through the aggregate demand channel rather than the aggregate supply channel. This conclusion implies that the Marshall-Lerner condition of currency depreciation holds for Nepal. The following section discusses the result of the model encapsulating the Marshall-Lerner condition.

The Marshall-Lerner condition of currency depreciation can be written algebraically as below (Williamson and Milner, 1991).

$$\eta_x + \eta_m > 1 \quad \text{……} \quad (18)$$

Where, η_x = price elasticity of demand for exports
η_m = price elasticity of demand for imports

Price here refers to exchange rate of local currency with foreign currencies. Such price (exchange rate) changes when a currency appreciates or depreciates in terms of foreign currency. In order to obtain price elasticity of export and imports, we need to construct both export demand and import demand model. The following demand models for exports and imports are constructed and estimated for the study (Barth and Hemphill, 2000). First, consider the following import demand model.

Log (RMROW) C + log (RGDP) + log (ER) + log (RP) ……………………………(19)

Where, RMROW = real import from the rest of world
ER = exchange rate expressed in terms of NC
RP = relative price, which is the ratio of local price to foreign price

Consider the following export demand model.

Log (RXROW) C + log (RGDP) + log (ER) + log (RP) ……………………..……(20)

Where, RXROW = real export to rest of the world

Both export and import demand models are constructed for export to and import from third countries. This is done primarily because for most of time of the study period the exchange rate of NC with the US dollar has been flexible. This is not the case with the

exchange rate of NC with IC. Therefore, it has been thought that export to and import from third countries will be more responsive to NC-US exchange rate.

Variables of model (21) and (22) are not stationary at log level. However, both the models are found to have co-integrating relationship. While the model (21) has one co-integrating equation with eigenvalue significant at 5 percent, the model (22) has two co-integrating equations with eigenvalue significant at one percent

The Following is the regression result of equation 21 and 22.

Log (RMROW) = -19.2 + 2.5 log (RGDP) -0.4 log (ER) -0.3 log (RP)
(0.03) (0.01) (0.15) (0.02)
F =133 (0.0) Adj. R^2 = 0.94 DW = 0.70……..…… (21)

Log (RXROW) = 1.5 – 0.7 log (RGDP) + 2.4log(ER) + 0.4log(RP)
(0.8) (0.5) (0.00) (0.04)
F= 92.2 (0.0) Adj. R^2= 0.91 DW = 1.0…….. (22)
Figures in bracket indicate P-value

The above result shows that $\eta_x + \eta_m > 1$ holds for Nepal. The sum of export (2.4) and import (-0.7) price elasticity is more than one. It is 1.4 (i. e. 2.4-0.7), which is greater than one. Clearly, the sum of price elasticity of export and import demand is higher than unity in Nepal. This result supports the earlier result that the real appreciation of exchange rate has negative impact on AD and hence real GDP.

7. Conclusions and Recommendations

Exchange rate is one of the important candidates for the intermediate monetary policy target. The selection of exchange rate as an intermediate monetary policy target presupposes the investigation of empirical relationship between the RER and the economic activities. A priori relationship between the RER and economic activities is considered to be strong for a small open economy such as Nepal.

Two views exist on the transmission mechanism of the real exchange rate on economic activities. The traditional view has it that the transmission mechanism of exchange rate operates through the AD channel. The real appreciation/depreciation affects country's international competitive adversely or favourable. The increase and decrease in country's international competitiveness is considered to have corresponding impact net export, which is one of the components of AD. The traditional view suggests the negative relationship between the RER and economic activities. The contrary view is that real depreciation lowers

economic activities. This channel is purported to operate through AS. The logic behind this hypothesis is that real depreciation, among other things, increases the cost of production. This compresses AS, thus lowering economic activities. These contrasting theoretical views are tested on Nepali economy.

By constructing a full-fledged GDP accounting model these views are tested. The empirical results suggest that the traditional view holds for Nepal. This means that the effect of real exchange rate operates through the AD channel rather than through the AS channel. This implies that an appreciation of REER reduces the real rate of economic growth. The result also suggests that between two measures of money supply, M1 has the stronger empirical relationship than M2.

Testing the Marshall-Lerner condition has also substantiated the model. The empirical result shows that the Marshall-Lerner condition ($\eta_x + \eta_m > 1$) holds for Nepal.

The empirical results have two policy implications for Nepal. First, Nepal must use the real exchange rate as one of the macro economic policies. For this, Nepal should continue to keep real exchange rate constant. Second, M1 continues to be a relevant monetary policy variable for Nepal.

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Annex 1: Stationary Test: The Correlogram Method

	Log RGDP				Log AM1				Log AM2			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.9	0.9	21.2	0.0	0.9	0.9	20.3	0.0	0.9	0.9	20.3	0.0
2	0.8	-0.1	37.9	0.0	0.8	-0.1	36.1	0.0	0.8	-0.1	36.1	0.0
3	0.7	-0.1	50.3	0.0	0.6	-0.1	47.9	0.0	0.6	-0.1	47.9	0.0
4	0.5	0.1	59.1	0.0	0.5	-0.1	56.1	0.0	0.5	-0.1	56.1	0.0
5	0.4	-0.1	64.8	0.0	0.4	-0.1	61.1	0.0	0.4	-0.1	61.1	0.0
6	0.3	-0.1	67.6	0.0	0.3	-0.1	63.5	0.0	0.3	-0.1	63.5	0.0
7	0.2	0.0	68.7	0.0	0.1	-0.1	64.2	0.0	0.1	-0.1	64.2	0.0
8	0.1	-0.1	68.9	0.0	0.0	-0.1	64.2	0.0	0.0	-0.1	64.3	0.0
9	0.0	0.0	68.9	0.0	-0.1	-0.1	64.5	0.0	-0.1	-0.1	64.5	0.0
10	-0.1	-0.1	69.6	0.0	-0.2	-0.1	65.8	0.0	0.0	-0.1	65.8	0.0
11	-0.2	-0.1	71.7	0.0	-0.3	-0.1	68.7	0.0	-0.3	-0.1	68.7	0.0
12	-0.3	0.0	75.7	0.0	-0.3	-0.1	73.9	0.0	-0.3	-0.1	73.9	0.0

	Log (REER)				Log (RGEXP)				Log (WSMKTM)			
	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.9	0.9	19.0	0.0	0.9	0.9	19.4	0.0	0.9	0.9	21.6	0.0
2	0.7	-0.2	31.7	0.0	0.7	-0.1	33.9	0.0	0.8	-0.1	38.7	0.0
3	0.5	0.0	39.7	0.0	0.6	-0.1	43.9	0.0	0.7	-0.1	51.8	0.0
4	0.4	0.1	45.0	0.0	0.4	-0.1	49.8	0.0	0.5	-0.1	60.9	0.0
5	0.3	0.0	48.6	0.0	0.3	0.0	53.2	0.0	0.4	-0.1	66.7	0.0
6	0.2	-0.3	50.0	0.0	0.2	0.0	55.1	0.0	0.3	-0.1	69.7	0.0
7	0.1	0.1	50.4	0.0	0.1	-0.1	55.8	0.0	0.2	-0.1	70.8	0.0
8	0.0	-0.1	50.4	0.0	0.1	-0.1	55.9	0.0	0.1	-0.1	71.0	0.0
9	-0.1	-0.2	50.7	0.0	-0.1	-0.1	56.0	0.0	-0.1	-0.1	71.1	0.0
10	-0.2	-0.1	52.2	0.0	-0.2	-0.1	57.1	0.0	-0.2	0.0	72.2	0.0
11	-0.3	0.0	55.7	0.0	-0.2	0.0	59.9	0.0	-0.2	0.0	74.8	0.0
12	-0.3	-0.1	61.8	0.0	-0.3	0.0	64.4	0.0	-0.3	0.0	79.5	0.0

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