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ABSTRACT

It is a stylised fact that financial "repression" retards economic growth. Hence, financial liberalisation is advocated to remove the stranglehold on the economy. Financial liberalisation policy argues that deregulation of interest rate would result into a higher real interest rate which would lead to increased savings, increased investment and achieve efficiency in financial resource allocation. Past studies have reported inconclusive results regarding the interest rate effects on savings and investment. This paper examines the financial liberalisation hypothesis by employing autoregressive distributed lag (ARDL) modelling approach on Nepalese data. Results show that the real interest rate affects both savings and investment positively.

Key Words: Financial Liberalisation, Interest Rate Effects, Unit Roots, Cointegration, ARDL Modelling

The financial system plays a vital role in the process of economic development. Its primary task is to move scarce funds from those who save to those who borrow for consumption and investment[1]. By making funds available for lending and borrowing, the financial system facilitates economic growth. It is undeniable that both technological and financial innovations have a direct link on economic growth since

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[1] In addition to matching savers and investors, Todaro and Smith (2003:733-734) list 5 other functions that are vital at the firm level and for the economy as a whole. These include: provision of payments services, generation and distribution of information, allocation of efficient credit, pricing, pooling and trading of risks and lastly, increasing liquidity of assets.

large technological innovations require large investments that are financed by banks, finance and insurance companies.

The financial system in many developing countries was highly regulated up to about the 1980s. The government regulated the interest rates and imposed credit ceilings[2], owned banks and financial institutions and framed regulations with a view to making it easy for the government to acquire the financial resources at a cheap rate. Due to the highly controlled state of the financial sector and the concomitant interest rate distortions, the financial system could not mobilise the necessary funds. As a consequence, investment could not increase to the desired level. This ultimately stifled economic growth in these developing countries.

McKinnon (1973) and Shaw (1973) termed this state of affair as "financial repression". They strongly advocated for the liberalisation of financial sector so as to make it a catalyst in the growth process of the economy. With the support of international institutions like the World Bank and the International Monetary Fund, many developing countries started liberalising their financial system with a view to making their financial sector more efficient.

The aim of this paper is to test the financial liberalisation hypothesis that specifically relates to the effects of interest rate on savings and investment. In section 1, the theoretical foundation of financial liberalisation hypothesis is discussed. Section 2 reviews the findings of the previous studies on the effects of interest rate on savings and investment. The data and methodological framework used in this study is presented in section 3. In section 4, unit root tests are conducted within the framework of recent

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[2] Commercial banks and other financial intermediaries are subject to numerous lending restrictions and face mandatory interest rate ceilings on loanable funds at levels well below the market clearing rates. The rationale for maintaining the artificial interest rate ceilings is to finance the government budget deficit by selling low interest bonds to commercial banks.

techniques of determining endogenous structural break in time series data. These tests are robust and have higher power than the conventional unit root tests. Section 5 deals with the concept and rationale for using the ARDL modelling approach in this study. In section 6, the empirical results are presented and interpreted along with their policy implications for the Nepalese economy. Finally, the concluding remarks are presented in section 7.

1. Financial Liberalisation Hypothesis

McKinnon (1973) and Shaw (1973) argued that in a "repressed" financial system, real deposit rates of interest on monetary assets are often negative and rates also become highly uncertain. Added to the former are the fear of expected persistent inflation and devaluation of the currency leading to capital flight, which discourages savings. This paucity of savings forces the authorities to impose lending restrictions and mandatory interest rate ceilings that are always below the market clearing levels. As a consequence, it provides explicit subsidy to preferred borrowers (rent seekers) who are powerful enough to gain access to the rationed credit. Hence, they argue higher real interest rates can increase the supply of loanable funds in the market by attracting higher household savings and converting them into bank deposits. This in turn leads to higher investment and accelerates economic growth in the economy.

Interest rate can be viewed as the price of borrowed money or as the opportunity cost of lending money for a specified period of time. During this period, inflation can erode the real value and return of financial assets and lenders need to be compensated for an expected decrease in the purchasing power of these assets (Bascom 1994). The

real interest rate, the rate adjusted for anticipated inflation, is thus vital for the supply and demand for loanable funds

McKinnon (1973) and Shaw (1973) further assert that higher real interest rate also helps channel the funds to the most productive enterprises and facilitate technological innovation and development. They maintain that by paying a rate of interest on financial assets that is significantly above the marginal efficiency of investment in existing techniques, one can induce some entrepreneurs to disinvest from inferior processes to improved technology and increased scale in other high yielding enterprises. The release of resources from inferior production mode is as important as generating new net savings.

Savings provides the resources for investment in physical capital. Hence, it is an important determinant of growth[3]. Increased savings is also beneficial in reducing foreign dependence[4] and insulating the economy from external shocks.

Lewis (1992) holds the view that raising interest rates on deposits held in the banking sector will have two beneficial effects – the savings effect and the portfolio (investment) effect. Raising the real return available to income-earners cause consumption to fall and the supply of savings to increase. This savings effect alleviates the chronic shortage of investment resources. An increase in the rate of return to deposits relative to returns on other assets will elicit a portfolio response as wealth-holders move out of other assets into deposits in the banking system.

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[3] According to the neo-classical growth theory, an increase in the savings rate raises the long-run level of capital and output per capita.

[4] Most developing countries face either a shortage of domestic savings to match investment opportunities and/or a shortage of foreign exchange to finance needed imports of capital and intermediate goods.

2. Previous Studies on Interest Rate Effects

Interest Rate Effect on Savings

The financial liberalisation theory hypothesises the positive effects of interest rate on savings and investment. The World Bank (1987) cited evidences from several developing countries where interest rate deregulation generated increased savings and investment. However, subsequent studies do not support this finding. Most of the empirical studies have reported the interest rate effect on savings to be either inconclusive or negative.

Fry (1988) demonstrated that when real deposit interest rates have any significant effect on national savings ratios, the magnitude was of no great policy significance. He argued that only in countries where the real deposit rate was negative by a considerable margin could there be much scope for increasing savings directly by raising the deposit rate. Bayoumi (1993) examined the effects of interest rate deregulation on personal savings in the eleven regions of the United Kingdom.. He argued that deregulation produces an exogenous short-run fall in savings, some of which is recouped over time.

Bandiera *et al.* (2000) examined the effects of various financial liberalisation measures[5] in eight selected countries from 1970-1994. They found that there was no evidence of positive effect of the real interest rate on savings. In most cases the relationship was negative. Loayza *et al.* (2000) also documented that the real interest rate had a negative impact on the private savings rate. They used a sample of 150 countries with data spanning from 1965 to 1994. They found that a 1 per cent increase in the real interest rate reduced the private saving rates by 0.25 per cent in the short run.

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[5] These include interest rate deregulation, pro-competition measures, reduction of reserve requirements, easing of directed credit, privatisation of banks, stringent prudential regulation, securities markets deregulation and capital account liberalisation.

Reinhart and Tokatlidis (2001) used data of 50 countries consisting of 14 developed and 36 developing ones over the period 1970-1998. They found that in the majority of cases higher real interest rates were associated with reduced savings in the sampled countries. Similarly, Schmidt-Hebbel and Serven (2002) argued that the sign of the interest rate elasticity of savings was ambiguous, both theoretically and empirically. Higher interest rates increased savings through the substitution effect, but could ultimately reduce the savings rate if the associated income and wealth effects were sufficiently strong. This theoretical ambiguity has not been resolved as yet, and the direction of the response of aggregate savings to an exogenous increase in the interest rate still remains vastly controversial.

Interest Rate Effect on Investment

Changes in interest rates can further trigger an investment response in the economy. Lewis (1992) argued that when the interest rate paid to depositors was raised, the borrowing rate also had to be raised in order to avoid large operating losses in the banking sector. The rise of real borrowing cost results in decline in desired real investment. Therefore, the negative response of investment to higher borrowing rates swamps the positive effect of higher deposit rates on savings.

Morisset (1993) estimated a model for Argentina over the 1961-1982 period. Argentina was affected by various interest rates policies during that period. Simulation results indicated that the quantity of private investment was little responsive to movements in interest rates. He argued that the positive effect on the domestic credit market suggested by McKinnon and Shaw might be offset by the negative effect of a portfolio shift from capital goods and public bonds into monetary assets. He further demonstrated that the financial liberalisation policy could increase the demand for credit

by the public sector, therefore limiting the funds available to the private sector (crowding out effect).

Bascom (1994) argued that, under a deregulated environment, higher real interest rates become a disincentive to domestic investment. Banks are prone to extend credit to unproductive enterprises or projects, resulting in large and unsustainable bad debt portfolios, bank failures and business bankruptcies. Eventually, government intervention is necessary to protect depositors and provide assistance to the distressed banks and their borrowers.

3. Methodological Framework and Data

Various measures were implemented at different times under the financial liberalisation process in Nepal[6]. However, in this study we concentrate only on the interest rate effects on savings and investment, as this is the crux of the McKinnon-Shaw financial liberalisation hypothesis. We test the McKinnon-Shaw hypothesis on the Nepalese economy by employing a recently popularised cointegration analysis known as autoregressive distributed lag (ARDL) modelling approach. The McKinnon-Shaw hypothesis consists of two distinct relationships i.e., the interest rate-savings nexus and the savings- investment nexus.

In order to test the interest rate effect on savings, the following relationship is examined:

$$LTDR_t = \alpha_0 + \alpha_1 LGDPR_t + \alpha_2 DRR_t + \alpha_3 LPBB_t + e_t \qquad (1)$$

Theoretically, aggregate savings is a function of aggregate income and interest rate on savings. Savings can be proxied by deposits held at banks and aggregate income can be

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[6] A brief discussion of the financial liberalisation process in Nepal is given in Appendix 1.

proxied by gross domestic product. Similarly, the deposit rate offered by banks can be used as the proxy for return on savings. The regressand in equation (1) is the log of the real time deposits held at banks (LTDR) and the regressors include the log of the real gross domestic product (LGDPR) and real deposit rate (DRR). As increased number of bank branches is viewed to have positive effect on increasing the volume of bank deposits, the log of the average population density per bank branch (LPBB) has also been included in equation (1) to capture the impact of branch proliferation on bank deposits. In equation (1), α_0 is the constant and e is the error term. The coefficients α_1 and α_2 are expected to be positive while the coefficient α_3 is expected to be negative.

The second part of the McKinnon-Shaw hypothesis is associated with the positive effect of real interest rate on investment via savings. Therefore, the following relationship is analysed:

$$LTBCR_t = \beta_0 + \beta_1 LTDR_t + \beta_2 LRR_t + \beta_3 RFR_t + \beta_4 BCBR_t + e_t \qquad (2)$$

Investment can be proxied by the total bank credit. The log of the total bank credit in real terms (LTBCR) is the regressand in equation (2) and the regressors include the log of the total real time deposits (LTDR), the real bank lending rate (LRR), the real refinance rate (RFR) and the volume of real borrowings from the central bank (BCBR). The expected signs of the coefficients β_1 and β_4 are positive while that of the coefficients β_2 and β_3 are negative.

The data used in this study covers a 34-year period (136 quarterly observations) starting from 1970 quarter 1 and ending in 2003 quarter 4. The sources of the data include various issues of Economic Survey published by His Majesty's Government of Nepal, Ministry of Finance, and Quarterly Economic Bulletin published by Nepal Rastra Bank (the central bank of Nepal).

4. Unit Root Test in the Presence of Structural Break[7] in Data

The relationship between time series variables can be analysed by cointegration test. Prior to conducting the cointegration test, it is essential to check each time series for stationarity. If a time series is non-stationary, the regression analysis done in a traditional way will produce spurious results. Therefore, the unit root test is conducted first. Hence it is imperative to review some of the recently developed models and tests for unit roots which we are going to use in this paper.

Traditional tests for unit roots (such as Dickey-Fuller, Augmented Dickey-Fuller and Phillips-Perron) have low power in the presence of structural break. Perron (1989) showed that in the presence of a structural break in time series, many perceived non-stationary series were in fact stationary. Perron (1989) re-examined Nelson and Plosser (1982) data and found that 11 of the 14 important US macroeconomic variables were stationary when known exogenous structural break is included[8]. Perron (1989) allows for a one time structural change occurring at a time T_B ($1 < T_B < T$), where T is the number of observations.

The following models were developed by Perron (1989) for three different cases:

Null Hypothesis:

Model (A) $y_t = \mu + dD(TB)_t + y_{t-1} + e_t$ (3)

Model (B) $y_t = \mu_1 + y_{t-1} + (\mu_2 - \mu_1)DU_t + e_t$ (4)

Model (C) $y_t = \mu_1 + y_{t-1} + dD(TB)_t + (\mu_2 - \mu_1)DU_t + e_t$ (5)

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[7] Structural breaks are common in time series data. Examples of structural break can be regime change, change in policy direction, external shocks, war etc. that may affect economic time series.

[8] However, subsequent studies using endogenous breaks have countered this finding with Zivot and Andrews (1992) concluding that 7 of these 11 variables are in fact non-stationary.

where $D(TB)_t = 1$ if $t = T_B + 1$, 0 otherwise, and

$DU_t = 1$ if $t > T_B$, 0 otherwise.

<u>Alternative Hypothesis</u>:

Model (A) $y_t = \mu_1 + \beta t + (\mu_2 - \mu_1)DU_t + e_t$ (6)

Model (B) $y_t = \mu + \beta_1 t + (\beta_2 - \beta_1)DT_t^* + e_t$ (7)

Model (C) $y_t = \mu_1 + \beta_1 t + (\mu_2 - \mu_1)DU_t + (\beta_2 - \beta_1)DT_t + e_t$ (8)

where $DT_t^* = t - T_B$, if $t > T_B$, and 0 otherwise.

Model A permits an exogenous change in the level of the series whereas Model B permits an exogenous change in the rate of growth. Model C allows change in both. Perron (1989) models include one known structural break. These models cannot be applied where such breaks are unknown. Therefore, this procedure is criticised for assuming known break date which raises the problem of pre-testing and data-mining regarding the choice of the break date (Maddala and Kim 2003). Further, the choice of the break date can be viewed as being correlated with the data.

Unit Root Tests in the Presence of a Single Endogenous Structural Break

Despite the limitations of Perron (1989) models, they form the foundation of subsequent studies that we are going to discuss hereafter. Zivot and Andrews (1992), Perron and Vogelsang (1992), and Perron (1997) among others have developed unit root test methods which include one endogenously determined structural break. Here we review these models briefly and detailed discussions are found in the cited works.

Zivot and Andrews (1992) models are as follows:

Model with Intercept

$$y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{\lambda}) + \hat{\beta}^A t + \hat{\alpha}^A y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^A \Delta y_{t-j} + \hat{e}_t \qquad (9)$$

Model with Trend

$$y_t = \hat{\mu}^B + \hat{\beta}^B t + \hat{\gamma}^B DT_t^*(\hat{\lambda}) + \hat{\alpha}^B y_{t-1} + \sum_{j=i}^{k} \hat{c}_j^B \Delta y_{t-j} + \hat{e}_t \tag{10}$$

Model with Both Intercept and Trend

$$y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\hat{\lambda}) + \hat{\beta}^C t + \hat{\gamma}^C DT_t^*(\hat{\lambda}) + \hat{\alpha}^C y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^C \Delta y_{t-j} + \hat{e}_t \tag{11}$$

where, $DU_t(\lambda) = 1$ if $t > T\lambda$, 0 otherwise;

$$DT_t^*(\lambda) = t - T\lambda \text{ if } t > T\lambda, \text{ 0 otherwise.}$$

The above models are based on the Perron (1989) models. However, these modified models do not include DT_b.

On the other hand, Perron and Vogelsang (1992) include DT_b but exclude t in their models. Perron and Vogelsang (1992) models are given below:

Innovational Outlier Model (IOM)

$$y_t = \mu + \delta DU_t + \theta D(T_b)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \tag{12}$$

Additive Outlier Model (AOM) – Two Steps

$$y_t = \mu + \delta DU_t + \tilde{y}_t \tag{13}$$

and

$$\tilde{y}_t = \sum_{i=0}^{k} w_i D(T_b)_{t-i} + \alpha \tilde{y}_{t-1} + \sum_{i=1}^{k} c_i \Delta \tilde{y}_{t-i} + e_t \tag{14}$$

$\tilde{y}$ in the above equations represents a detrended series y.

Perron (1997) includes both t (time trend) and DT_b (time at which structural change occurs) in his Innovational Outlier (IO1 and IO2) and Additive Outlier (AO) models.

Innovational Outlier Model allowing one time change in intercept only (IO1):

$$y_t = \mu + \theta DU_t + \beta t + \delta D(T_b)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \tag{15}$$

Innovational Outlier Model allowing one time change in both intercept and slope (IO2):

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \delta D(T_b)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \tag{16}$$

Additive Outlier Model allowing one time change in slope (AO):

$$y_t = \mu + \beta t + \delta DT_t^* + \tilde{y}_t \tag{17}$$

where $DT_t^* = 1(t > T_b)(t - T_b)$

$$\tilde{y}_t = \alpha \tilde{y}_{t-1} \sum_{i=1}^{k} c_i \Delta \tilde{y}_{t-i} + e_t \tag{18}$$

The Innovational Outlier models represent the change that is gradual whereas Additive Outlier model represents the change that is rapid. All the models considered above report their asymptotic critical values.

More recently, additional test methods have been proposed for unit root test allowing for multiple structural breaks in the data series (Lumsdaine and Papell 1997; Bai and Perron 2003) which we are not going to discuss here.

Regarding the power of tests, the Perron and Vogelsang (1992) model is robust. The testing power of Perron (1997) models and Zivot and Andrews models (1992) are almost the same. On the other hand, Perron (1997) model is more comprehensive than Zivot and Andrews (1992) model as the former includes both t and DT_b while the latter includes t only.

Shrestha-Chowdhury General-to-Specific Search Procedure for Unit Root Test

Given the complexities associated with testing unit roots among a plethora of competing models discussed above, there is a need for a general-to-specific testing procedure to

determine the stationarity of a time series. The researcher has to apply certain judgement based on economic theory in order to make assumptions about the nature of the time series. But such assumptions may not be always true and may lead to misspecification and totally wrong inferences. For these reasons, one faces the problem of selecting an appropriate method of unit root test.

Against this backdrop, we have followed the sequential procedure proposed by Shrestha and Chowdhury (2005) in selecting an optimal method and model of the unit root test. The Shrestha-Chowdhury general-to-specific model selection procedure is outlined in Appendix 2. The results of the unit root test conducted employing the above mentioned sequential search procedure allowing for one unknown structural break in the time series is presented in Table 1. As can be seen from Table 1, different models are optimal for different variables. Specifically, Perron AO model offer best fit for 3 variables (namely, LTDR, LPBB and LTBCR), Perron IO2 model for 3 variables (namely, DRR, LFR and BCBR) and Perron and Vogelsang and Zivot and Andrews model for 1 variable each.

[Table 1 about here]

The results show that among the variables included in equation (1), LTDR, LGDPR and LPBB are non-stationary while DRR is stationary. The regressand LTDR undergoes a structural break in 1980 Q4. The data reveals that the total real time deposits at banks jumped to Rs.[9] 11,749 million in the fourth quarter of 1980 from Rs.11,221 millions in the previous quarter, registering an increase of 4.7 per cent.

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[9] The Nepalese currency is known as Rupees and abbreviated as Rs.

Similarly, in equation (2), LTBCR, LTDR, BCBR and LPBB are non-stationary variables, while LRR and LFR are stationary. The test results show that the variable LTBCR undergoes a structural break in 1995 Q2. In this quarter the real total bank credit increased by 6.8 per cent compared to the previous quarter.

The information on the structural break in the time series is crucial in correctly specifying the model. Therefore, based on the information of the structural break date in LTDR, equation (1) is modified as follows:

$$LTDR_t = \alpha_0 + \alpha_1 LGDPR_t + \alpha_2 DRR_t + \alpha_3 LPBB_t + \alpha_4 D_{LTDRt} + e_t \qquad (1a)$$

In the above equation, the dummy variable D_{LTDR} represents the structural break in LTDR and takes the value of 0 until 1980 Q4 and 1 from 1981 Q1 onwards.

Similarly, equation (2) is modified to include the structural break in the regressand LTBCR as follows:

$$LTBCR_t = \beta_0 + \beta_1 LTDR_t + \beta_2 LRR_t + \beta_3 RFR_t + \beta_4 BCBR_t + \beta_5 D_{LTBCRt} + e_t \qquad (2a)$$

The dummy variable D_{LTBCR} in the above equation represents the structural break in LTBCR and takes a value of 0 until 1995 Q2 and a value of 1 from 1995 Q3 onwards.

5. ARDL Modelling Approach to Cointegration Analysis

Several methods are available for conducting the cointegration test. The most commonly used methods include the residual based Engle-Granger (1987) test, and the maximum likelihood based Johansen (1991; 1995) and Johansen-Juselius (1990) tests. Due to the low power and other problems associated with these test methods, the OLS

based autoregressive distributed lag (ARDL) approach to cointegration has become popular in recent years[10].

The main advantage of ARDL modelling lies in its flexibility that it can be applied when the variables are of different order of integration (Pesaran and Pesaran 1997). Another advantage of this approach is that the model takes sufficient numbers of lags to capture the data generating process in a general-to-specific modelling framework (Laurenceson and Chai 2003). Moreover, a dynamic error correction model (ECM) can be derived from ARDL through a simple linear transformation (Banerjee *et al.* 1993). The ECM integrates the short-run dynamics with the long-run equilibrium without losing long-run information. It is also argued that using the ARDL approach avoids problems resulting from non-stationary time series data (Laurenceson and Chai 2003).

As mentioned earlier, the variables considered in this study are a mix of I(0) and I(1) series. The cointegration test methods based on Johansen (1991; 1995) and the Johansen-Juselius (1990) require that all the variables be of equal degree of integration, i.e., I(1). Therefore, these methods of cointegration are not appropriate and cannot be employed. Hence, we adopt the ARDL modelling approach for cointegration analysis in this study.

The ARDL framework for equation (1a) and (2a) are as follows:

$$\Delta LTDR_t = \delta_0 + \sum_{i=1}^{p} \varepsilon_i \Delta LTDR_{t-i} + \sum_{i=1}^{p} \phi_i \Delta LGDPR_{t-i} + \sum_{i=1}^{p} \varphi_i \Delta DRR_{t-i}$$

$$+ \sum_{i=1}^{p} \gamma_i \Delta LPBB_{t-i} + \lambda_1 LTDR_{t-1} + \lambda_2 LGDPR_{t-1} + \lambda_3 DRR_{t-1}$$

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[10] The early discussion on ARDL modelling approach can be found in Charemza and Deadman (1992) and others. Pesaran and Pesaran (1997), Pesaran and Smith (1998), and Pesaran and Shin (1999) popularised ARDL approach and it is now widely used in empirical research.

$$+ \lambda_4 LPBB_{t-1} + \lambda_5 D_{LTDRt} + u_{1t} \qquad (1b)$$

$$\Delta LTBCR_t = \mu_0 + \sum_{i=1}^{p} v_i \Delta LTBCR_{t-i} + \sum_{i=1}^{p} \pi_i \Delta LTDR_{t-i} + \sum_{i=1}^{p} \varpi_i \Delta LRR_{t-i}$$

$$+ \sum_{i=1}^{p} \theta_i \Delta RFR_{t-i} + \sum_{i=1}^{p} \rho_i \Delta BCBR_{t-i} + \sigma_1 LTBCBR_{t-1} + \sigma_2 LTDR_{t-1}$$

$$+ \sigma_3 LRR_{t-1} + \sigma_4 RFR_{t-1} + \sigma_5 BCBR_{t-1} + u_{2t} \qquad (2b)$$

In the above equations, the terms with the summation signs represent the error correction dynamics while the second part [terms with λs in equation (1b) and with σs in equation (2b)] correspond to the long run relationship. The null hypotheses in (1b) and (2b) are $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$ and $\sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = \sigma_5 = 0$, respectively, which indicate the non-existence of the long run relationship.

The ARDL method estimates $(p+1)^k$ number of regressions in order to obtain the optimal lags for each variable, where p is the maximum number of lags to be used and k is the number of variables in the equation. Since we are using quarterly data, 4 lags are selected as the maximum lag (p) following Pesaran and Pesaran (1997). The optimal model can be selected using the model selection criteria like Schwartz-Bayesian Criteria (SBC) and Akaike Information Criteria (AIC)[11]. In this study, the optimal model is selected on the basis of their prediction power by comparing the prediction errors of the models. To ascertain the appropriateness of the ARDL model, the diagnostic and the stability tests are conducted and are reported in Appendix 3 and 4 respectively.

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[11] The model selection criteria are a function of the residual sums of squares and are asymptotically equivalent.

6. Empirical Results

The total number of regressions estimated following the ARDL method in equation (1b) is $(4+1)^4 = 625$. The model selected by SBC and AIC are (2,0,0,0) and (4,3,4,0), respectively. The AIC based model is selected here as it has the lower prediction error than that of SBC based model[12].

The long run test statistics (Table 2) reveal that the real interest rate on deposit (DRR) is the key determinant of the time deposits held by banks. The coefficient of DRR is 0.102, which is positive and statistically significant at the 5 per cent level. It suggests that in the long run, an increase of one per cent in the real interest rate is associated with an increase of Rs. 1.1074 million in real time deposits[13] in Nepal. Our finding completely contradicts the earlier findings reported by Bandiera *et al.* (2000), Loayza *et al.* (2000) and Reinhart and Tokatlidis (2001). These studies found no evidence of the positive effect of real interest rate on savings and in most cases they found the effect to be negative.

[Table 2 about here]

The short run dynamics of the model is shown in Table 3. The coefficient of LGDPR is not statistically significant. However, the coefficient of ΔLGDPR is statistically significant at the 5 per cent level. This implies that although there is no statistically significant long run impact of real income on real savings in Nepal (Table 2), a change in the real income is associated with a change in the real savings in the

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[12] The mean prediction error of AIC based model is 0.0005 while that of SBC based model is 0.0063.
[13] LTDR is in the natural log form while DRR is in the level form. An anti-log of the coefficient of DRR, which is 0.1020, is 1.1074.

short run. Similarly, a change in the real deposit rate (ΔDRR) has a statistically significant positive effect on the change in real savings (ΔLTDR). However, the change in the lags of DRR, i.e., ΔDRR1, ΔDRR2, and ΔDRR3 has a negligible negative impact on the change in real savings.

[Table 3 about here]

The coefficient of ECM_{t-1} is found to be small in magnitude and is statistically significant. It demonstrates that there is a long run relationship between the variables. The coefficient of ECM term is -0.0375, which suggests a slow adjustment process. Nearly 4 per cent of the disequilibria of the previous quarter's shock adjust back to the long run equilibrium in the current quarter.

Overall, our findings demonstrate that the real deposit rate plays a positive role in increasing the real time deposits in the Nepalese economy. This finding clearly supports the first part of the McKinnon-Shaw hypothesis.

Now we turn to testing the second part of the McKinnon-Shaw hypothesis with equation (2b). In equation (2b), the SBC selects an ARDL model of (4,1,0,0,0) while the AIC selects a model of (4,1,3,2,0). The SBC based model is selected here, as the prediction power of this model is superior to that of the AIC based model[14]. The ARDL test results are given below in Table 4 and Table 5.

[Table 4 about here]

The long run results reported in Table 4 show that the real savings is the key determinant of real bank loans (a proxy for investment). The coefficient of LTDR is

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[14] The mean prediction error of SBC and AIC based ARDL models are 0.0014 and –0.0089, respectively.

0.5561, which is highly significant. This implies that an increase in the real time deposits by Rs. 1 million would lead to an increase in real bank lending by Rs. 556 thousand in the long run. Similarly, volume of borrowing by banks from the central bank also has a highly significant positive impact on bank lending. The real lending rate (LRR) is found to be negative but statistically insignificant which suggests that the lending rate of banks does not determine the volume of bank lending in Nepal. Our findings contradict the claim made by Lewis (1992) that the positive effect of higher deposit rates on savings is cancelled by the negative response of investment due to higher borrowing rates.

Table 5 reports the short run dynamics of the second part of the McKinnon-Shaw hypothesis. The coefficient of ECM_{t-1} is –0.1678, which is highly statistically significant. It implies that the disequilibrium occurring due to a shock is totally corrected in six quarters at a rate of about 17 per cent a quarter. The ECM result also shows that a change in borrowing by commercial banks from the central bank ($\Delta BCBR$) is associated with a positive change in the real bank lending ($\Delta LTBCR$) although such a change is negligible. However, the coefficient of $\Delta LTDR$ shows that a change in the real time deposits is negatively associated with the change in real bank lending.

[Table 5 about here]

7. Conclusion

The empirical test results of this study show that the real interest rate has a significant positive effect on savings. As savings is found to be positively associated with investment, the real interest rate effect on investment through increased savings is also clearly evident. This strongly supports the crux of the McKinnon-Shaw financial

liberalisation hypothesis. Our findings add a new dimension to the existing literature on the interest rate effect of financial liberalisation. First, our result is based on a novel but robust econometric procedure. Secondly, our findings contradict the conclusions reached by the majority of past studies except the World Bank (1987). Previous studies failed to support the positive interest rate effect of financial liberalisation on savings and investment. These studies have reported the interest rate effects on savings and investment to be either inconclusive or negative (Fry 1988; Lewis 1992; Bayoumi 1993; Morriset 1993; Bascom 1994; Bandiera *et al.* 2000; Loayza *et al.* 2000; Reinhart and Tokatlidis 2001; Schimidt-Hebbel and Serven 2002;). However, our results are in line with the findings of the World Bank (1987) which reports that liberalisation of interest rates generates more savings and investment. Our empirical findings have a significant policy implication that the savings and investment can be facilitated by maintaining a higher real interest rate. Thus, further deregulation of interest rates is advocated for generating higher savings and investment in Nepal.

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APPENDIX

1. Financial Liberalisation Process in Nepal

Nepal started the financial liberalisation process with partial deregulation of the interest rate in 1984. Since then, various liberalisation measures have been implemented in phases, which include removal of entry barriers of banks and financial institutions (1984), reforms in treasury bills issuance by introducing open market bidding system (1988), introduction of prudential norms (1984), full deregulation of interest rates (1989), establishment of Credit Information Bureau for providing information on borrowers (1989), shift in monetary policy stance from direct to indirect (1989), reform in capital markets through the establishment of Security Exchange Company and introduction of floor trading (1992), reduction in statutory reserve requirement (1993), and enactment of Nepal Rastra Bank Act (2001) and Debt Recovery Act (2002). The above measures were aimed at "widening" and "deepening" of the financial sector in Nepal.

2. Shrestha-Chowdhury (2005) Sequential Procedure for Unit Root Test

The Shrestha-Chowdhury general-to-specific sequential procedure involves the following steps:

Step 1. Run Perron (1997): Innovational Outlier Model (*IO2*)

As mentioned earlier, this model includes t (time trend) and DT_b (time of structural break), and both intercept (DU) and slope (DT).

- Check *t* and DT_b statistics

- If both *t* and DT_b are significant, check *DU* and *DT* statistics

- If both *DU* and *DT* are significant, select this model

- If only *DU* is significant, go to Perron (1997): *IO1* model.

This model includes t (time trend) and DT_b (time of structural break), and DU (intercept) only.

- If only *DT* is significant, go to Perron (1997): Additive Outlier model (*AO*)

This model includes t (time trend) and DT_b (time of structural break), and slope (DT) only.

In some cases, t and DT_b may be insignificant in IO2 but significant in IO1 or AO. Therefore, IO1 and AO tests should be conducted after IO2 in order to check the existence of such a condition.

Step 2. If only t is significant in Stage 1, go to Zivot and Andrews (1992) models:

Zivot and Andrews (1992) models include t but exclude DT_b.

- Run Zivot and Andrews test with intercept, trend, and both separately and compare the results. Select the model that gives the results consistent with the economic fundamentals and the available information.

Step 3. If only DT_b is significant in Stage 1, go to Perron and Vogelsang (1992) models:

Perron and Vogelsang (1992) models include DT_b but exclude t.

- Run *IOM* and *AOM*. Compare the statistics and select the appropriate model.

Step 4. If both t and DT_b are not significant in Stage 1, this implies that there is no statistically significant time trend and/or structural break in the time series. In such a case, certain judgement is to be used to select the test method.

The rationale behind employing the above sequential procedure is that the inclusion of irrelevant information and the exclusion of relevant information may lead to misspecification of the model. For example, the Perron 1997 – IO2 model includes t, DT_b, DU and DT. If the test results of a time series show that the DT is not relevant or significant, then using this model (IO2) for that time series involves the risk of the misspecification, because the irrelevant information (DT) is included in the model. In this case, the model that includes t, DT_b and DU, but excludes DT should be preferred. This means that Perron 1997-IO1 model may be appropriate for this time series. If in a model t, DT_b, DU and DT are significant, then using the Perron 1997 – IO1 model will be inappropriate and will lead to misspecification since Perron 1997 – IO1 model excludes DT.

3. Test Statistics of the ARDL Models

The key regression statistics and the diagnostic test statistics are given below. The high values of R^2 for both the ARDL models show that the overall goodness of fit of the models is satisfactory. The F-statistics measuring the joint significance of all regressors

in the model are statistically significant at the 1 per cent level for both the models. Similarly, the Durbin-Watson statistics for both the models are more than 2.

The diagnostic test results show that both the models pass the tests for functional form and normality. However, the results indicate that there exists serial correlation and heteroscedasticity in both the models. The ARDL model has been shown to be robust against residual autocorrelation. Therefore, the presence of autocorrelation does not affect the estimates (Laurenceson and Chai 2003, p.30). Since the time series constituting both the equations are of mixed order of integration, i.e., I(0) and I(1), it is natural to detect heteroscedasticity.

A. Interest Rate and Savings (Equation 1b)

$R^2 = 0.9993$

Durbin-Watson Statistic $= 2.1215$

$F_{(16, 111)} = 10920.2$ (0.000)

Serial Correlation $F_{(4, 107)} = 5.1425$ (0.001)

Functional Form $F_{(1, 110)} = 0.3951$ (0.531)

Normality $\chi^2 (2) = 3.1082$ (0.211)

Heteroscedasticity $F_{(1, 126)} = 4.1105$ (0.045)

B. Interest Rate and Investment (Equation 2b)

$R^2 = 0.9985$

Durbin-Watson Statistic $= 2.0510$

$F_{(11, 116)} = 6855.6$ (0.000)

Serial Correlation $F_{(4, 112)} = 4.6084$ (0.002)
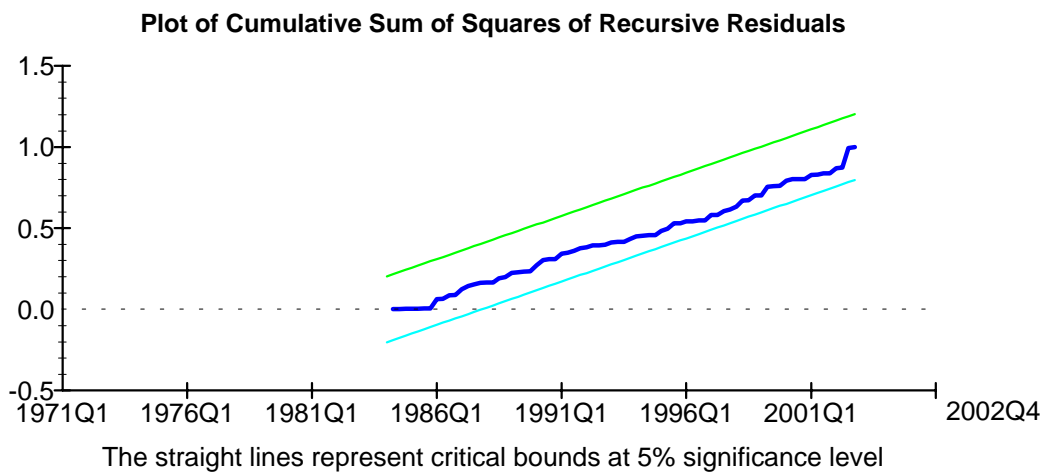
Functional Form $F_{(1, 115)} = 0.0053$ (0.942)
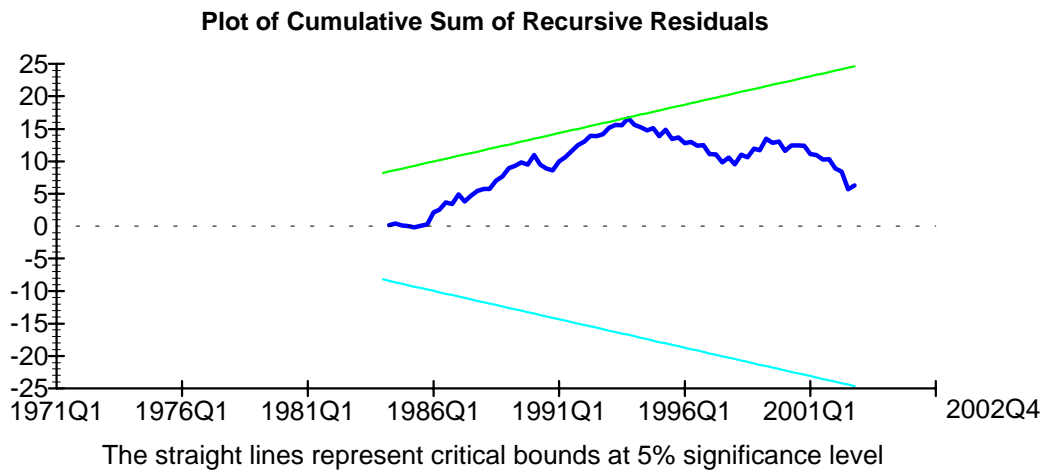
Normality $\chi^2 (2) = 0.1641$ (0.921)

Heteroscedasticity $F_{(1, 126)} = 5.4799$ (0.021)

4. Plot of CUSUM and CUSUMSQ (Stability Test)

The plot of the stability test results (CUSUM and CUSUMSQ) of the ARDL models are given below. The CUSUM and CUSUMSQ plotted against the critical bound of the 5 per cent significance level show that both the models are stable over time.

A. Interest Rate and Savings (Equation 1b)

Plot of Cumulative Sum of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

Plot of Cumulative Sum of Squares of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

B. Interest Rate and Investment (Equation 2b)

Plot of Cumulative Sum of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

Plot of Cumulative Sum of Squares of Recursive Residuals

The straight lines represent critical bounds at 5% significance level

Table 1. **Unit Root Test Results**

	Series	Selected Model	T_b	$T_\alpha = 1$	Result
1	LTDR	Perron AO	1980 04	-3.9549	N
2	LGDPR	Perron and Vogelsang	1974 01	-1.2295	N
3	DRR	Perron IO2	1979 03	-6.1978 *	S
4	LPBB	Perron AO	1985 03	-3.4495	N
5	LTBCR	Perron AO	1995 02	-2.8173	N
6	LRR	Zivot and Andrews	1975 04	-6.8249 *	S
7	RFR	Perron IO2	1979 03	-7.0035 *	S
8	BCBR	Perron IO2	1988 03	-4.7839	N

Note: S = Stationary, N = Non-stationary.
* Significant at 5% level
Critical values at 5% level:
*   Perron IO2 = -5.08*
*   Perron IO1 = -4.80*
*   Perron AO = -4.83*
*   Zivot and Andrews = -5.08*
*   Perron and Vogelsang = -4.19*

Table 2. **ARDL (4,3,4,0) Model Long Run Results**

Dependent Variable: LTDR

Regressor	Coefficient	Standard Error	T-Ratio
Constant	-10.5308	12.6147	-0.8348
LGDPR	1.6860	1.1457	1.4716
DRR	0.1020	0.0452	2.2534**
LPBB	0.2571	0.5998	0.4287
D_{LTDR}	0.6141	0.3968	1.5473

**   Significant at 5% level

Table 3. **ARDL (4,3,4,0) Model ECM Results**

Dependent Variable: ΔLTDR

Regressor	Coefficient	Standard Error	T-Ratio
ΔConstant	-0.3948	0.4868	-0.8109
ΔLTDR1	0.2072	0.0905	2.2904**
ΔLTDR2	-0.2593	0.0916	-2.8304***
ΔLTDR3	0.1204	0.0894	1.3466
ΔLGDPR	0.6193	0.3052	2.0292**
ΔLGDPR1	-0.1739	0.3299	-0.5271
ΔLGDPR2	-0.5260	0.2985	-1.7622*
ΔDRR	0.0020	0.0008	2.6322**
ΔDRR1	-0.0024	0.0008	-2.8545***
ΔDRR2	-0.0023	0.0008	-2.8167***
ΔDRR3	-0.0019	0.0008	-2.3136**
ΔLPBB	0.0096	0.0197	0.4905
$\Delta\,D_{LTDR}$	0.0230	0.0134	1.7205
ECM_{t-1}	-0.0375	0.0155	-2.4131**

*   *Significant at 10% level*
**   *Significant at 5% level*
*** *Significant at 1% level*

Table 4. **ARDL (4,1,0,0,0) Model Long Run Results**

Dependent Variable: LTBCR

Regressor	Coefficient	Standard Error	T-Ratio
Constant	4.1879	0.8408	4.9811***
LTDR	0.5561	0.0843	6.6003***
LRR	-0.0168	0.0218	-0.7699
RFR	0.0149	0.0204	0.7312
BCBR	0.0002	0.0000	3.6743***
D_{LTBCR}	0.3676	0.0823	4.4640***

*** *Significant at 1% level*

Table 5. **ARDL (4,1,0,0,0) Model ECM Results**

Dependent Variable: ΔLTBCR

Regressor	Coefficient	Standard Error	T-Ratio
ΔConstant	0.7029	0.1114	6.3111***
ΔLTBCR1	0.2955	0.0854	3.4598***
ΔLTBCR2	-0.5593	0.0549	-10.1937***
ΔLTBCR3	0.1655	0.0761	2.1748**
ΔLTDR	-0.3953	0.1321	-2.9922***
ΔLRR	-0.0028	0.0035	-0.8091
ΔRFR	0.0025	0.0033	0.7586
ΔBCBR	0.00003	0.00001	3.3566***
Δ D_{LTBCR}	0.0617	0.0190	3.2505
ECM_{t-1}	-0.1678	0.0407	-4.1228***

** *Significant at 5% level*
*** *Significant at 1% level*