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*Full Length Research Paper*

# Reinvestigating the relationship between exchange rate uncertainty and private investment in Iran: An application of bounds test approach to level relationship

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**This paper re-examines the effects of exchange rate uncertainties on investment for the period of 1960 to 2007 by using annual data and applying bounds test approach to cointegration in the Iranian economy. There are many unusual policy changes and external shocks, resulting in the occurrence of multitude breaks in Iranian macroeconomic variables. As standard unit root tests, such as Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests, are biased towards the null of a unit root in the presence of structural breaks, The study apply Lee and Strazicich tests to test the null hypothesis that the series has unit root against the alternative of stationary with endogenous structural change. The study use generalized autoregressive conditional heteroscedasticity (GARCH) family models to generate time-varying conditional variance of exchange rate as a standard measure of exchange rate uncertainty. This paper, contributes to the literature by employing the bounds test approach to cointegration proposed by Pesaran, et al. (2001) to investigate the long-run equilibrium relationship between exchange rate uncertainty and investment in Iran. The empirical evidence points out that exchange rate uncertainty has negative impacts on investment in Iran.**

**Key words:** Exchange rate uncertainty, investment, bounds test, Iran.

## INTRODUCTION

As investment plays an important role in economic growth, it is very important to explore determinents of it. There is a broad literature on this topic (Asant, 2000; Imtiaz and Abdul, 2008; and Nurudeen, 2009) among others. However, the most feature of investment is that, it is usually volatile as it depends on multiple factors.

Developing economies suffer from a high degree of macroeconomic uncertainty rather than developed economies, and the consequences of this excess volatility for aggregate performance have attracted some attention in recent empirical literature, (Frankel and Roze, 1996; Serven, 1997; Kaminsky and Reinhart, 1999; Kazerooni and Dolatti, 2007; Moradpour et al., 2008; and Kottaridi and Escaleras, 2008). In the case of investment, this concern has been renewed by recent theoretical work identifying several channels through which uncertainty can impact on investment. (Lucas, 1973; Friedman, 1977; Dixit and Pindyck, 1994; Dotsey and Sarte, 2000; Broda and Romalis, 2004; Clark et al., 2004; and Elder, 2004). However, the most of the empirical literature on the relationship between exchange rate and investment mainly focuses on the uncertainty of exchange rate, which provides evidence that uncertainty of exchange rate may negatively affects investment. (Darby et al., 2000; Bohm and Funke, 2001; Serven, 2002; Atella et al., 2003; Becker et al., 2003; Byrne et al., 2003; Serven, 2003; Ruiz et al., 2007; Clause, 2008; and Schmidt et al., 2008). In the case of Iran, Kazerooni and Dolatti (2007), by using annual data and employing the GARCH model, investigates the long-run relationship between the private investment and its determinants. They found a negative

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impact of real exchange rate uncertainty on private investment. Moradpour et al., (2008), also by employing annual data and GARCH model and using Wai and Wong (1981) model found a negative effect of real exchange rate uncertainty on private investments.

This paper investigates the effects of real exchange rate uncertainty on private investment in the Iranian economy. The paper contributes the literature in several aspects: First, the study employ annual Iranian data, a country that has experienced significant variability in exchange rate and investment over the last 30 years. Secondly, the study uses alternative GARCH models to generate time-varying conditional variance of exchange rate as a standard measure of exchange rate uncertainty. Thirdly, the study use bounds test approach to cointegration in order to investigate the long-run relationship between exchange rate uncertainty and investment. Fourthly, it uses three different specifications of exchange rate uncertainty measurement: the conditional variance, the conditional standard deviation, and the natural logarithm of the conditional variance. The main findings show that there is significant relationship between variables under consideration. Gross domestic product has a positive effect on private investment, while, government investment has a negative impact on private investment in Iran. Also, real exchange rate uncertainty negatively affects the private investment as expected. The coefficient of asymmetry in TGARCH and EGARCH models is insignificant which means that the news impact is symmetric.

## The measurement of uncertainty

There are a numbers of ways of measuring exchange rate uncertainty in the literatures (Bo, 1998; Aizenman and Marion, 1993; Ghosal, 1995; and Fountas et al., 2004). This paper, however, estimates real exchange rate uncertainty by assuming that uncertainty is due to the shocks of the exchange rate process. In doing so, the study use three alternative GARCH model specifications in dealing with the measurement of real exchange rate variability: Bollerslev's (1986) model, Taylor (1988) Schwert,s (1990) model, and Nelson's (1991) exponential GARCH (EGARCH) model. We allow for three specifications of the exchange rate uncertainty measurment: the conditional variance, the conditional standard deviation, and the natural log of the conditional variance. The Schwarts Bayesian criterion (SBC) suggests the choice of AR(1) model for the conditional mean. In all three alternative GARCH models, the asymmetry coefficient is statistically insignificant. Table (1) reports the results of these three alternative models. All three in-mean coefficients are not significant. Just in the Bollerslev's GARCH (1,1) model all of the coefficients are statistically significant. As can be seen from Table (1), in the estimated model, the coefficient of asymmetry is insignificant which means that the news impact will be symmetric. The asymmetry in the news impact can be tested by testing the null hypothesis that coefficient of asymmetry is equal to zero against the alternative hypothesis that it is different from zero. If the null was rejected, the news impact is asymmetric. With this result in hand, the null hypothesis can be rejected that the news impact is asymmetric.

## The model

Theories of investment indicate that private investment is determined by many macroeconomic variables. For example Imtiaz and Abdul (2008) and Nurudeen (2009) indicate that real income, public investment and exchange rate are the most important determinants of private investment. In the case of Iran, Kazerooni and Dolatti (2007) and Moradpour et al. (2008) show that private investment is a function of gross domestic product, public investment, exchange rate and uncertainty factors. Following these studies, we postulate the relationship between private investment and macroeconomic variables as:

$$\mathrm{lprv} = \mathrm{f}(\ \mathrm{lgdp},\ \ \mathrm{lgov},\ \ \mathrm{nrer}) \qquad (1)$$

Where, lprv, lgdp, lgov, nrer and $\varepsilon_t$ are the logarithm of private investment, the logarithm of gross domestic product, the logarithm of government investment, and real exchange rate uncertainty, respectively.

A prior expectation are that gdp has positive effects on investment, while government expenditures* can have positive as well as negative impacts on investment (Dixit and Pindyck, 1994). However, the private investment is affected negatively by macroeconomic uncertainty.

## DATA AND ECONOMETRIC METHODOLOGY

### Data

This paper uses annual data of the Iranian economy covering the period of 1960-2007. All data are gathered from Central Bank of Iran (CBI) and International Financial Statistics (IFS) CD-ROM. The data for lprv, lgdp, lgov and nrer includes logarithm of private gross domestic fixed capital formation, logarithm of gross domestic product, logarithm of public gross domestic fixed capital formation and real exchange rate uncertainty respectively. Summary statistics for the series are given in Table (2).

Table (2) presents the several descriptive statistics of the variables under consideration. For real exchange rate, the standard deviation is large and it indicates a presence of high volatility. Results of Jarque-Bera test is high for real exchange rate uncertainty and indicates rejection of normality for this series.

### Data properties

#### *Standard unit root tests*

In orde r to determine stationarity properties of the series, we

**Table 1.** Three alternative GARCH models.

| Model | The conditional variance | The conditional standard deviation | The natural log of the conditional variance | None |
|---|---|---|---|---|
| **Bollerslev's GARCH (1,1) model 1** | | | | |
| ARCH coefficient | 0.6254(0.2638)* | 0.6695(0.1084)* | 0.7728(0.2014) | 1.2515(0.005)* |
| GARCH coefficient | 0.5234(0.2146)* | 0.5902(0.1001) | 0.2438(0.0975)* | 0.0210(0.423)* |
| GARCH in mean | 2.5819(1.2191) | 1.3614(0.1385) | 0.0849(0.0097) | - |
| c | 0.0346(0.0112)* | 0.0321(0.0061)* | 0.0251(0.0085)* | 0.0144(0.108)* |
| **Taylor's/ Schwart's GARCH (1,1) model 2** | | | | |
| ARCH coefficient | 0.5360(0.6084) | 0.7251(0.3678)* | 0.9228(0.3244) | 0.0270(0.0113)* |
| GARCH coefficient | 0.4225(0.3198) | 0.3647(0.1927) | 0.4567(0.0994)* | 0.0798(0.157)* |
| GARCH in mean | 1.3253(1.1569) | 0.4820(0.2932) | 0.1332(0.0301) | - |
| TGARCH coefficient | 0.526(1.056) | 1.331(1.551) | 0.138(0.051) | 2.033(1.359) |
| c | 0.0351(0.0149)* | 0.0221(0.0094)* | 0.0279(0.0029)* | 0.0283(0.252)* |
| **Nelson's GARCH (1,1) model 3** | | | | |
| ARCH coefficient | 0.5720(0.3020)* | 0.7066(0.4354) | 0.8823(0.1965)* | 2.328(0.633)* |
| GARCH coefficient | 0.5225(0.1324) | 0.4589(0.1204) | 0.3955(0.0892) | 0.286(0.016)* |
| GARCH in mean | 2.5641(1.9627) | 0.8971(0.3221) | 0.1209(0.0451) | - |
| EGARCH coefficient | 0.158(1.850) | 0.399(0.024) | 0.191(0.367) | 0.0222(0.737) |
| c | 0.03621(0.0145)* | 0.02341(0.0051)* | 0.0278(0.0087)* | 5.872(0.221)* |

Notes: Table (1) reports parameter estimates of the various GARCH (1,1) models. The numbers in parentheses are standard errors. * indicates the significant coefficients.

**Table 2.** Summary statistics for variables, 1960-2007.

| Variable | lprv | lgdp | lgov | nrer |
|---|---|---|---|---|
| Mean | 8.263 | 9.834 | 7.526 | 0.154 |
| Median | 8.275 | 9.949 | 7.802 | 0.089 |
| Maximum | 9.404 | 10.774 | 8.693 | 0.976 |
| Minimum | 6.855 | 8.486 | 5.206 | 0.0002 |
| Std.dev | 0.681 | 0.595 | 0.923 | 0.191 |
| Skewness | -0.464 | -0.766 | -1.129 | 2.453 |
| kurtosis | 2.509 | 2.822 | 3.394 | 9.956 |
| Jarque-bera | 2.205 | 4.754 | 10.509 | 141.898 |

employ several tests such as Augemented Dickey-Fuller (ADF), Phillips-Perron (PP), Kwiatkowski et al. (1992) (KPSS) and Ng-Perron (2001) (NP) tests. Table 3 presents the results of these tests.

The results of ADF, PP, and NP with null hypothesis of a unitroot, reveal that lprv, lgov, and lgdp are non-stationary and nrer is stationary at their levels. While, with KPSS test, the study cannot reject the I(0) null at the 5% for lgdp, lgov, lprv, and nrer. As it can be seen, the results of these tests are not the same. The ADF and PP tests are known to suffer potentially severe finite sample power and size problems. The NP test suggested useful modification to the PP test to deal with these problems. On the other hand, the KPSS test uses a null hypothesis that the series is trend stationary. The results of these unit root tests, however, are biased in favour of identifying data as integrated in the presence of structural break. To determine the break point date in the series, the study uses a set of tests, which suggested in Bai and Perron (2003). The results of these tests show that there is at least one break in all of the series except the *lprv*. In the presence of structural break, the standard unit root tests are biased towards the non-rejection of the null hypothesis.

***Unit root tests with structural breaks***

Perron (1989) argues that in the presence of structural break, the

**Table 3.** ADF, PP, KPSS and NP tests results.

| Statistics level | Lprv | lag | lgdp | lag | lgov | lag | nrer | lag |
|---|---|---|---|---|---|---|---|---|
| τT (ADF) | -2.70 | 1 | -2.37 | 1 | -2.22 | 0 | -3.71** | 1 |
| τμ (ADF) | -1.78 | 1 | -1.66 | 1 | -2.37 | 0 | -3 ** | 1 |
| τ (ADF) | -1.50 | 0 | -2.03 | 1 | 1.78 | 0 | -1.67 ** | 0 |
| τT (PP) | -1.96 | 6 | -2.05 | 3 | -2.19 | 1 | -3.35** | 1 |
| τμ (PP) | -1.29 | 9 | -1.88 | 3 | -2.41 | 3 | -2.88** | 1 |
| τ (PP) | 1.71 | 10 | -3.08 | 4 | -1.89 | 1 | -1.53 | 1 |
| τμ(kpss) | 0.67 | 5 | 0.80 | 5 | 0.65 | 5 | 0.36 | 2 |
| τT(kpss) | 0.13 | 5 | 0.14 | 5 | 0.16 | 5 | 0.10 | 2 |
| MZaμ(np) | 0.22 | 0 | 0.43 | 1 | 0.42 | 0 | 5.15 | 2 |
| MZtμ(np) | 0.11 | 0 | 0.26 | 1 | 0.31 | 0 | 1.56 | 2 |
| MZaT(np) | -12.35 | 0 | -5.83 | 1 | -3.58 | 0 | -22.29 | 0 |
| MZTt(np) | -2.48 | 1 | -1.70 | 1 | -1.32 | 0 | -3.12 | 0 |
| **Statistics 1 difference** | **Δlprv** | **lag** | **Δlgdp** | **lag** | **Δlgov** | **lag** | **Δnlrer** | **lag** |
| τT (ADF) | -5.27* | 0 | -3.79* | 0 | -7.69* | 0 | -7.96* | 1 |
| τμ (ADF) | -5.33* | 0 | -3.73* | 0 | -7.56* | 0 | -8.15* | 1 |
| τ (ADF) | -5.13* | 0 | -2.94* | 0 | -7.01* | 0 | -8.21* | 1 |
| τT (PP) | -5.48* | 24 | -3.79* | 0 | -7.67* | 1 | -15.45* | 7 |
| τμ (PP) | -5.37* | 22 | -3.73* | 0 | -7.51* | 2 | -16.54* | 8 |
| τ (PP) | -5.02* | 12 | -2.94* | 0 | -7.03* | 3 | -15.92* | 7 |
| τμ(kpss) | 0.11 | 10 | 0.24 | 4 | 0.28 | 0 | 0.17 | 8 |
| τT(kpss) | 0.11 | 11 | 0.14 | 3 | 0.12 | 2 | 0.14 | 8 |
| MZaμ(np) | -21.79 | 0 | -16.47 | 0 | -22.88 | 0 | -3.56 | 5 |
| MZtμ(np) | -3.29 | 0 | -2.87 | 0 | -3.37 | 0 | 6.05 | 5 |
| MZaT(np) | -21.84 | 0 | -17.34 | 0 | -22.51 | 0 | 5.71 | 5 |
| MZTt(np) | -3.30 | 0 | -2.93 | 0 | -3.35 | 0 | 7.86 | 5 |

Note: τT represents the most general model with a drift and trend; τμ is the model with a drift and without trend; τ is the most restricted model without a drift and trend. Numbers in brackets are lag lengths used in ADF test (as determined by the AIC, set to maximum 3) to remove serial correlation in the residuals. When using PP test, numbers in brackets represent Newey-West Bandwith (as determined by Bartlett-Kernel). Both in ADF and PP tests, unit root tests were performed from the most general to the least specific model by eliminating trend and intercept across the models (See, Enders, 2004) The critical values are obtained from Mackinnon (1991) for the ADF and PP test and from Kwiatkowski et al(1992)for the KPSS test and from Ng-Perron (2001) for the NP test. Tests for unit roots have been carried out in EVIEWS 6.0.

standard unit root tests such as ADF and PP are biased towards the non-rejection of the null hypothesis. Perron (1989) introduces a procedure which is characterized by a single exogenous (known) break in accordance with the underlying asymptotic distribution theory. Perron uses a DF unit root tests that includes dummy variables to account for one known exogenous structural break. The break point of the trend function is fixed (exogenous) and chosen independently of the data. Perron's (1989) unit root tests allows for a break under both the null and alternative hypothesis. Table 4 shows the results of Perron's test.The results of perron's test indicate that in the presence of structural break, lgov , lgdp and nrer have a unit root and they are integrated of order one I(1), and lprv is stationary and it is integrated of order zero I(0).

However, Perron's known assumption of the break date was criticized and several studies have developed using different methodologies for endogenously determining the break date. Some of these include Banerjee et al. (1992), Zivot and Andrews (1992), Perron and Vogelsang (1992), and Lumsdaine and Papell (1997). These studies have shown that bias in the usual unit root tests can be reduced by endogenously determining the time of structural breaks.

Lee and Strazicich (2003) extended Lumsdaine and Papell (1997) endogenous two break unit root test, and introduced a new procedure to capture two structural breaks. They proposed two break minimum Lagrange Multiplier (LM) unit root test in which the alternative hypothesis unambiguously implies trend stationarity. Table 5 presents the results of Lee and Strazicich's unit root test.

The results in Table 5 reveal that, the null of unit root is rejected for lgov, lprv and nrer, while the null cannot be rejected for lgdp at 5% level of significance. In other words, in the presence of two possible structural breaks, the series are not in the same order of integration. Since the most of the cointegration tests such as Engel-Grenger, and Johansen and Joselius (1992), are confident when the series are in the same order of integration, these tests cannot be suitable for the study. Therefore, the study use bounds test approach to cointegration developed by Pesaran et al. (2001) to address this issue.

### *Bounds test approach to cointegration*

As variables under consideration are not integrated in the same

**Table 4.** Perron,s test results.

| Perron's model : $y_t = \alpha_0 + \alpha_1 DU_t + dD_t + \beta_t + \rho y_{t-1} + \sum_{i=1}^{n}\theta_i \Delta y_{t-1} + \varphi_t$ | | | | |
|---|---|---|---|---|
| **Variable** | **Lgdp (du73)** | **Lgov (du77)** | **Lprv (du73)** | **Nrer (du76)** |
| Coefficient | 0.989001 | 0.879034 | 0.170598 | 0.335860 |
| Standard error | 0.047112 | 0.060096 | 0.163525 | 0.188679 |
| τ -statistic | -0.2335 | -2.0129 | -5.07202 | -3.5199 |
| Critical value 1% | -4.39 | -4.34 | -4.39 | -4.39 |
| Critical value 2.5% | -4.03 | -4.01 | -4.03 | -4.03 |
| Critical value 5% | -3.76 | -3.72 | -3.76 | -3.76 |
| Critical value 10% | -3.46 | -3.44 | -3.46 | -3.46 |

Note: Three dummy variables, du73, du76, and du77 are due to the first oil shocks and pre-revolution strikes.

**Table 5.** Lee and Strazicich two structural break unit root test results.

| Variable | TB1 | TB2 | K | t-statistic |
|---|---|---|---|---|
| Lgdp | 1973 | 1983 | 2 | -5.7890*** |
| Lgov | 1977 | 1990 | 4 | -7.3967** |
| Nrer | 1976 | 2001 | 2 | -7.5516** |
| lprv | 1973 | 1993 | 4 | -7.8030** |

1) The critical values at 1, 5, 10% are -5.823, -5.286 and -4.989, respectively (Lee and Strazicich, 2003).
2) ** indicates that the corresponding null is rejected at the levels.
3) *** indicates that the null cannot be rejected at 1 and 5% levels.

order of integration, to investigate a long-run relationship, the bounds test for cointegration with in the autoregressive distributed lag (ARDL) modeling approach was adopted. This model can be irrespective of whether the underlying regressors are I(1) or I(0) or fractionaly integrated. The ARDL modeling approach involves estimating the following EC Model:

$$\Delta lprv = C_0 + C_{1t} + \alpha_0 lprv_{t-1} + \beta_0\, lgdp_{t-1} + \gamma_0\, lgov_{t-1} + \delta_0\, nrer_{t-1} + \beta_1 \Delta lgdp + \gamma_1 \Delta lgov + \delta_1 \Delta nrer + DU76 + DU77 + \varepsilon_t \quad (2)$$

Where, $\Delta$ is the difference operator, and $\varepsilon_t$ is serially independent random errors with mean zero and finite covariance matrix. In Equation (2), the null hypothesis of no cointegration is $H_0 : \alpha_0 = \beta_0 = \gamma_0 = \delta_0 = 0$ and the alternative hypothesis of cointegration is $H_1 : \alpha_0 = \beta_0 = \gamma_0 = \delta_0 \neq 0$. This hypothesis can be examined using the standard Wald or F-test. The F-test has a non-standard distribution which depends upon:

1) Whether included variables in the ARDL model are I(0) or I(1)
2) The number of regressors
3) Whether the ARDL model contains an intercept and/or a trend; a
4) The sample size. Two sets of critical values are reported in Pesaran et al. (2001).

These critical values provide critical value bounds for all applied classification of the regressors into purely I(1), purely I(0) or mutually cointegrated. However, these critical values are generated for sample sizes of 500 and 1000 observations and 20000 and 40000 replications respectively and are not suitable for our study. Narayan (2005), however, provides two sets of critical values for sample size ranging from 30 to 80 and for the two popular cases such as Pesaran et al. (2001): one which assumes that all the regressors are I(1), and the other assuming that are I(0). It is important to note that the critical values based on large sample size deviates significantly from small sample size. In the case of cointegration based on the bounds test, the Granger causality tests can be done under the VECM. By doing so, the short run deviations of series from their long run equilibrium are also captured by including an EC term. The EC model of cointegrated variables in this paper can be specified as follows:

$$\Delta lprv = \alpha_0 \Delta c + \alpha_1 \Delta t + \beta \Delta lgdp + \gamma \Delta lgov + \delta \Delta nrer + \Delta du76 + \Delta du77 + ECM_{t-1} + \varepsilon_t$$

Where, $ECM_{t-1}$ is the rate of adjustment of disequilibrium. Finally, according to the VECM for causality tests, having statistically significant F and t ratios for $ECT_{t-1}$ in Equation (3) would meet conditions to have causation from independent variables to dependent variable.

## EMPIRICAL RESULTS

In order to test for existence of a long-run relationship betwee n private investment and its determinants, the

**Table 6.** F- statistic critical values for bounds test.

| K=3 | 10% | | 5% | | 1% | | F-statistic |
|---|---|---|---|---|---|---|---|
| | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) | |
| FIV | 3.174 | 4.004 | 3.730 | 4.666 | 5.05 | 6.182 | 4.91 |
| FV | 3.673 | 4.715 | 4.368 | 5.545 | 5.995 | 7.335 | 5.83 |
| FIII | 2.873 | 3.973 | 3.50 | 4.70 | 4.865 | 6.360 | 4.75 |

FIV, represents the F-statistic of the model with unrestricted intercept and restricted trend, FV, represents the F statistic of the model with unrestricted intercept and trend, and FIII, represents the F statistic of the model with unrestricted intercept and no trend. The calculated F- statistics for above three models are 4.91, 5.83, and 4.75 respectively. As the critical F-statistics are bigger than the I(1) critical values in Table (6), we can reject the null hypothesis at the 5% level and accept the long-run relationship between private investment and its determinants. The estimation results of the ARDL model and long-run coefficient are as follows.
Source: Narayan (2005)

**Table 7.** Estimated long- run coefficient using the ARDL approach.

| **Equation 7. ARDL (1,0,0,0) selected based on SBC, dependent variable is lprv.** | | | |
|---|---|---|---|
| **Regressor** | **Coefficient** | **Standard error** | **T-ratio (prob)** |
| Lprv(-1) | 0.5335 | 0.1218 | 4.3788 (0.0001)* |
| Lgdp | 1.4623 | 0.4074 | 3.5889 (0.0011)* |
| Lgov | -0.3328 | 0.1591 | -2.0921 (0.0330)* |
| Nrer | -0.1554 | 0.1490 | -1.8432 (0.076)* |
| C | -7.4923 | 2.5383 | -2.9517 (0.0120)* |
| T | -0.0178 | 0.0099 | -1.7944 (0.084)** |
| Du76 | 0.1648 | 0.19957 | 0.82583 (0.215) |
| Du77 | -0.1567 | 0.20298 | -1.77583 (0.089)* |

*and ** indicate the statistical significance at the 5 and 10%, respectively.

bounds test approach to cointegration is employed. Table 6 gives the results of the bounds test under three different scenarios as suggested by Pesaran et al. (2001), which are restricted with deterministic trend (FIV), unrestricted deterministic trend (FV), and without deterministic trend (FIII). Intercept in these scenarios are all unrestricted. Critical values for F- statistic are taken from Narayan (2005) and presented in Table 6. The study use SBC to select the optimal lag length. The calculated F-statistics for above three models are 4.91, 5.83, and 4.75 respectively. As the critical F-statistics are bigger than the I(1) critical values in Table 6 the null hypothesis can be rejected at the 5% level and accept the long-run relationship between private investment and its determinants. The estimation results of the ARDL model and long-run coefficient are as follows.

The optimal lag is selected by using SBC. All levels estimates are significant and have the expected signs. As we expected, Lgdp has oppositive effect on the lprv (Table 7). Based on the ecceleration theory, the increase of lgdp cause to increase the private investment. 1% increase in lgdp leads to an increase in private investment by 1.46% in the long-run. However, lgov has negative effect on private investment. 1% increase in the lgov, leads to a 0.33% decrease in the private investment in the long run. In an economy with limited resources like Iran, with government employing these resources, the available resources in the private sector decreased and led to decrease in the private investment.

Real exchange rate uncertainty negatively affects the private investment. 1% increase in uncertainty, discourages private investment by 0.16% in the long run. In general, uncertainty of exchange rate makes undesirable conditions to investors and decreases the private investment. These results are in the line with theoretical expectations. Also, the results of empirical literatures in Iran such as Kazerooni and Dolatti (2007) and Moradpour et al. (2008) are confirmed with this paper.

The main result of this paper is that, exchange rate uncertainty has a negative and significant effect on private investment in Iran. This means that the increase in the uncertainty of real exchange rate, decrease the private investment. The results suggest that the real exchange rate uncertainty seems to become an impediment to the private investment. The results of short run dynamic coefficient associated with the long run relationships obtained from ECM model are given in Table 8.

All lagged changes in the variables are statistically

**Table 8.** Error correction representation for the selected ARDL model.

| **ARDL (1,0,0,0) selected based on SBC. dependent variable is ∆lprv .** | | | |
|---|---|---|---|
| **Regressor** | **Coefficient** | **Standard error** | **T-ratio(prob)** |
| ∆lgdp | 1.7222 | 0.4624 | 3.7244(0.0010)* |
| ∆lgov | -0.3180 | 0.1296 | -2.4533(0.0177)* |
| ∆nrer | -0.1286 | 0.1316 | -2.9773(0.0118)* |
| ∆c | -6.7969 | 2.4463 | -2.7785(0.0242)* |
| ∆t | -0.0175 | 0.0094709 | -1.8477(0.076)** |
| ∆Du76 | 0.16481 | 0.19957 | 0.82571 (0.217) |
| ∆Du77 | -0.15671 | 0.29198 | -1.77583(0.089)** |
| $ECM_{t-1}$ | -0.4021 | 0.16251 | -1.7471(0.093)** |

$$\mathrm{ECM} = -6.7969 + 1.7222\Delta \mathrm{lgdp} - 0.3180\Delta \mathrm{lgov} - 0.1286\Delta \mathrm{nrer} - 0.0175\Delta \mathrm{t} - 0.15671\Delta \mathrm{du77}$$

| | | |
|---|---|---|
| R-squared= 0.53 | R-bar-squared= 0.46 | F-stat= 7.27(0.00003) |
| SER= 0.17 | RSS= 1.07 | DW= 1.75 |
| AIC= -0.62 | SBC= -0.34 | |

*and ** indicate the statistical significance at the 5 and 10% respectively.

significant. The EC term, in the estimated equation is significant with theoretically correct sign. The estimated coefficient of $\mathrm{ECM}_{t-1}$ indicates that 40% of the disequilibrium in the private investment is corrected immediately that is, in the next year. In the estimated dynamic EC model, the coefficient of lagged changes in the private investment is positive and highly significant which shows that the previous period growth in private investment brings positive changes in the private investment over the short-run. This implies that investment decisions are based on previous behavior. The changes in the lgov negatively affect private investment, over the short-run, as it's coefficient is -0.3180. The estimated coefficient of changes in the lgdp is 1.7222. It means that, the changes in the lgdp positively affect private investment over the short run. Nrer also has a negative and significant effect on lprv in the short run as it's coefficient is -0.128.

To implement causality analysis among the variables, we conduct Granger causality F-test. The causality effect can be obtained by restricting the coefficient of the variables with its lags equal to zero (using the Wald test). If the null hypothesis of no causality is rejected, then the study will conclude that the relevant explanatory variable caused a dependent variable. Table (9) examines short run and long run causality within the ECM. The F-statistic on the explanatory variables in each equation indicates the statistical significance of the short run causal effects, while t-statistics on the coefficient of the long run causal effects.

According to Table 9, the signs of the EC term are all negative and significant at the 5% level. There is a significant uni-directional causality running from lgdp, lgov, and nrer to private investment. This implies that private investment in Iran is depending on from lgdp, lgov, and nrer where a decrease in lgdp leads to a decrease in private investment, and a decrease in lgov and nrer lead to increase in private investment.

## DISCUSSION

This paper re-investigates the empirical relationships between real exchange rate uncertainty and private investment in Iran over the period of 1960-2007. The standard unit root tests such as ADF, PP, KPSS and NP tests show that all variables appear to be either stationary, or integrated at order one. As, the structural break tests show at least one break in the series under consideration, the study employ unit root tests with structural breaks. The results show that the underlying variables are not at the same order of integration. Hence, to investigate a long-run relationship between variables under consideration, the study use bounds test approach to cointegration was developed by Pesaran et al. (2001). The result of bounds test shows that there is a long-run relationship between private investment and its determinants. It then, estimates ARDL and conditional ECM models to obtain the long-run and short-run coefficients.
The coefficient of lgdp shows that lgdp has higher impact on private investment as compared to the other variables. Private investment tends to positively respond to lgdp in both the short and long run. 1% increase in lgdp leads to an increase in private investment by 1.722% in the short run and 1.46% in the long run. Government non-development expenditure has considerable negative effect on the private investment. In the short run and long run, government investment is statistically significant. 1% increase in the lgov, leads to a 0.318% decrease in the private

**Table 9.** Results of Granger causality test.

| Dependent variable | F-statistic (probability) | | | | |
|---|---|---|---|---|---|
| | lgdp | lgov | nrer | lprv | ECM(-1)-t-stat |
| **Without deterministic trend** | | | | | |
| Lgdp | - | 0.96(0.19) | 0.39(0.71) | 1.11(0.25) | -2.09(0.03)* |
| Lgov | 0.17(.86) | - | 0.23(0.80) | 2.74(0.027) | -2.19(-.03)* |
| Nrer | 0.15(0.89) | 0.86(0.21) | - | 0.32(0.73) | -1.95(0.05)* |
| Lprv | 3.23(0.001)* | -2.56(0.01)* | -3.01(0.002)* | - | -2.26(0.02)* |
| **With deterministic trend** | | | | | |
| Lgdp | - | 1.13(0.25) | 0.30(0.74) | 1.29(0.22) | -2.35(0.01)* |
| Lgov | 0.01(0.99) | - | 0.19(0.83) | 2.85(0.01) | -2.01(0.03)* |
| Nrer | 0.06(0.94) | 0.57(0.37) | - | 0.49(0.62) | -2.67(0.01)* |
| Lprv | 2.99(0.00)* | -3.83(0.00)* | -3.01(0.00)* | - | -2.11(0.03)* |

*indicate the statistical significance at the 5% level.

investment in the short run and 0.33% in the long run. The main result of this paper is that, the presence of real exchange rate uncertainty has a negative impact on private investment. 1% increase in the uncertainty, discourages private investment by 0.129% in the short run and 0.16% in the long run.

In developing countries such as Iran in terms of strong economic dependence on oil, the issue of exchange rate and its volatility is important. On the one hand, with real exchange rate decreasing, domestic goods become more expensive than foreign goods and reducing investors's export's income and lead to decrease the private investment. Also, by reducing exchange rate, foreign goods more competitive power, with increased demand for foreign goods, investment incentives to local investors to lose. On the other hand, reducing the exchange rate, on the one hand imported capital goods prices declined and costs are reduced private investment, on the other hand, domestic producers, low competition and investment incentives are destroyed.

Also, increasing exchange rate, leads to higher prices of foreign goods, the entry of foreign consumer goods is low. This increase in savings is the main source of capital and focused private investment increases. Uncertainty of real exchange rate causes the uncertainty about the future assets values. Also, with volatility of real exchange rate, the price mechanism's efficiency to optimize the allocation of resources will be lose. All items listed led to uncertain economic conditions and will be lack of investors willing to invest. The results suggest that the real exchange rate uncertainty tuck to become an impediment to the private investment in Iran. The study results are consistent with others in Iran as well as around world.

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