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Dynamic Relationship Between Macroeconomic Instability and Private Investment in the Iranian Economy

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Abstract

This paper investigates the relationship between macroeconomic instability and private investment of the Iranian economy. The study uses a trivariate VAR(2)-GARCH(1,1)-in-Mean with diagonal BEKK approach to proxied inflation and exchange rate uncertainties as the main indicators of macroeconomic instability. Moreover, Bounds testing approach to level relationship applied to investigate the long-run relationship between macroeconomic instability and private investment. By taking the structural breaks into account, results of the paper reveal that there are mean spillovers between inflation, exchange rate and private investment. There also is a negative effect of macroeconomic instability on private investment over the period of study, 1988:1-2010:4. These results support Pindyck (1982, 1988, 1991), Caballero (1991), Ferderer (1993a), Caballero and Pindyck (1996).

Keywords: Private Investment, Macroeconomic Instability, Bounds Test Approach, Trivariate GARCH Model, Iran

JEL Classification: C22; E22, E31, F41

1. Introduction

This paper investigates the relationship between exchange rate and inflation uncertainties, as the most important indices to macroeconomic instability, and private investment in the Iranian economy.[1] Macroeconomic instability refers to phenomena that decrease the predictability of the domestic macroeconomic environment, leading to resource allocation distortion and hampering investment and growth (Montiel and Serven, 2004). The empirical evidence suggests that a

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[1] Heidari and Bashiri (2011) investigate the relationship between inflation uncertainty, as one of the most important index to macroeconomic instability, and economic growth for Iran. Moreover, Heidari et al. (2011) investigates the relationship between exchange rate uncertainty, another important index for macroeconomic instability, and economic growth in the Iranian economy.

competitive and stable macroeconomic environment characterized by low and stable internal and external deficits, low inflation and real depreciation of the exchange rate is conducive to higher growth led by significant private investment (See, e.g., Easterly and Schmidt-Hebbel, 1991).

In recent years there has been increasing interest in research relating to explore the relationship between macroeconomic instability and investment (see, e.g., Serven and Solimano, 1993; Pindyck and Solimano, 1993; Aizenman and Marion, 1993, 1995 and 1996; Bleaney, 1996; Ismihan et al. 2005; Ahmed and Qayyum, 2007; Imtiaz and Abdul, 2008; Sanogo and Gyengani, 2008; Kottaridi and Escaleras, 2008; Heidari and Hashemi Pourvaladi, 2011; among others). However, inflation uncertainty is the most important factor affecting private investment (see, e.g., Hartman, 1972; Abel, 1983; Pindyck, 1982; 1988, 1991; Caballero, 1991; Ferderer, 1993a; Caballero and Pindyck, 1996; Abel et al. 1996; Zelekha, 2010; among others). For example, Abel (1983) claims that when the profit function is convex to prices in perfect competition firms, prices uncertainty will raise the investment. Ferderer (1993a) states that uncertainty, because of its negative effect on credit liquidity, clearness of price indications and risk premiums manifested in interest rates, negatively affects investment. The empirical results about the relationship between inflation uncertainty, as an indicator of macroeconomic instability, and investment are mixed. (See, e.g., Zeira ,1990; Driver and Moreton ,1991; Caballero ,1991; Ferderer, 1993b; Aizenman and Marion ,1993; George and Morisset ,1995; Leahy and Whited , 1995; Glezakos and Nugent, 1997; Caruso , 2001; Mazeda Gil ,2004; da Silva Filho, 2007; Bond et al, 2008; Zelekha , 2010; and Fischer 2011, among others).

Theoretical papers in the case of investment under exchange rate uncertainty have a different conclusion about the relationship between these two variables (see, e.g., Dixit and Pindyck, 1994; Abel et al. 1996; and Lee and Shin, 2000, among others). Theory, however, predicts that the relationship between exchange rate uncertainty and investment are mixed, depending on assumptions on market competitiveness, risk neutrality, symmetry/asymmetry of investment adjustment costs and entrepreneurial attitudes toward risk (see, e.g., caballero, 1991 and Abel and Eberly, 1994). In developing countries such as Iran, in terms of strong economic dependence on crude oil revenue, the issue of exchange rate and its volatility is important. On one hand, with real exchange rate decreasing, domestic goods become more expensive than foreign goods and reduce investors export's income and lead to decrease the private investment. On the other hand, reducing the exchange rate, causes lower prices for imported capital goods, and this makes lower cost for domestic private investors. Moreover, with increasing exchange rate, foreign goods become expensive, and this, in turn, reduces consumption and increases the savings as the main source of capital for private investment. In empirical evidences, however, the relationship between exchange rate uncertainty and investment also are mixed (see, e.g., Cottani et al., 1990; Goldberg, 1993; Serven and Solimano, 1993; Bleaney, 1996; Darby et al., 1999, 2000; Bohm and Funke, 2001; Bleaney and Greenaway, 2001; Serven, 2002, 2003; Atella et al., 2003; Becker et al., 2003; Byrne and Davis, 2003, 2005; Hallett et al. 2004; Barrel et al. 2004; Pradhan et al. 2004; Ruiz and Pozo, 2007; Clause, 2008; Schmidt and Broll, 2009; and Heidari and Hashemi Pourvaladi, 2011 among others), though we may conclude that the results of these empirical studies are in line with this general believe that the exchange rate volatility has a negative effect on investment (see, e.g., Darby et al., 1999, 2000; Bleaney and Greenaway, 2001; Serven, 2002, 2003; Byrne and Davis, 2003, 2005; Ruiz and Pozo, 2007; Clause, 2008; Heidari and Hashemi Pourvaladi, 2011; among others).

In the empirical side with Iranian data, there are a lot of empirical investigations about macroeconomic uncertainties and investment in the literature (see, e.g. Gorji and Madani, 2003; Sharifazadeh and Hosseinzadeh Bahreyni, 2003; Daroughe and Mohammadi, 2005; Gaskar et.al, 2007; Moradpour et.al, 2008; Kazerouni and Doulati, 2008; Esmaeilzadeh Maghari, 2009; Heidari and Hashemi Pourvaladi, 2011; Pahlavani and Bashiri (2013); among others). To the best of our knowledge, there is not any empirical study on assessing the long-run relationship between macroeconomic instability and private investment with Iranian data by employing bounds test approach and using GARCH models. In this paper, Vectorautoregressive GARCH-in-Mean (VAR-GARCH-M) model with a diagonal BEKK model is used to generate the conditional variances of inflation and real exchange rate as proxies of inflation and real exchange rate uncertainty, to test the effect of these uncertainties on private investment which estimates a time-varying variance-covariance matrix simultaneously. In Iran, there have been many unusual policy changes and/or external shocks to the economy which results in the occurrence of multitude of structural breaks in the variables under consideration. So, we apply several structural break tests that developed and applied by Bai and Perrron (1998, 2003) and Zivot and Andrews (1992), Perron and Vogelsang (1992), Lumsdaine and Papell (1997) and Lee and Strazicich (2004). Thus the hypotheses that we are going to test with Iranian data are as follows:

- There are mean spillovers between inflation, exchange rate and private investment.
- Inflation uncertainty reduces investment.
- Exchange rate uncertainty affects investment negatively.

The rest of the paper is organized as follows. Section 2 outlines the model. Section 3 discusses the data. Section 4 presents the empirical results, and finally, section 5 concludes the paper.

2. The Model

We apply a Trivariate (TGARCH-M) with a diagonal BEKK approach to generate the conditional variances of inflation and real exchange rate as proxies of macroeconomic instabilities, to test the effect of these uncertainties on private investment. In the applied TGARCH-M models, the dependent variables in the mean equations are the inflation, real exchange rate and the private investment. As Pahlavani and Bashiri (2013), Heidari and Bashri (2011) and Dahmarde and Bashiri (2012) show, the first step to model a TGARCH-M model to simultaneously estimate the conditional means, variances, and covariances of variables is specifying the mean equation by testing for serial dependence in the data under investigation. Estimates of the mean and variance-covariance equations for the variables are as follows:

$$Y_{i,t} = \mu_i + \phi_{in} Y_{i,t-n} + \lambda_i du1995q1 + \rho_{ij} h_{i,t} + \varepsilon_{i,t} \qquad (1)$$

$$\varepsilon_t \mid \psi_{t-1} \approx N(0, H_t)$$

$$h_{i,t} = c_{ij} + \sum_{j=1}^{n} a_{ij} \varepsilon_{j,t}^2 + \sum_{j=1}^{n} b_{ij} h_{j,t-1} \qquad (2)$$

Where $Y_{i,t}$ is the i th variable such as inflation, real exchange rate and private investment. $du1995q1$ is the dummy for the 1995 structural break in the Iranian economy. The residual ε is innovation (disturbance) vector that assumed to be normally distributed with a time varying conditional variances. h_t is a conditional variance-covariance matrix in the defined variables that is always positive definite, ψ_{t-1} represents the information set at time $t-1$, a_{ij} and b_{ij} as diagonal matrices are 3×3 and the log-likelihood function is used to estimate the parameters of the models (see, e.g., Heidari and Bashiri, 2011).

From equation (2), the conditional variance for the ith variable is affected by past shocks and past conditional variances of all the variables in the system by capturing interdependencies or spillovers. Therefore, this specification allows for the cross sectional dependency of conditional volatilities among all the variables (see, e.g., Hammoudeh et.al., 2009).

Based on theoretical studies, many macroeconomic variables explain the behavior of private investment. However according to the empirical studies by Imtiaz and Abdul (2008) and Nurudeen (2009), we postulate the relationship among private investment and macroeconomic variables as bellow:

$$lprv = f(\lg dp, \lg ovi, lrer, \inf, unrer, un\inf) \qquad (3)$$

Where, $\lg dp$ is logarithm of growth domestic product, $lprv$ is logarithm of private investment, $\lg ovi$ is logarithm of government investment, $lrer$ is logarithm of real exchange rate, $\inf$ is inflation and $unrer$ and $un\inf$ are uncertainty of real exchange rate and inflation respectively.

Prior expectations are that gdp has positive effect on private investment. Government expenditures[1] can have positive as well as negative impact on investment (Dixit and Pindyck, 1994). The level of real exchange rate on private investment is unambiguous. Moreover, the private investment is affected negatively by inflation and macroeconomic uncertainty.

This paper applies Bounds testing approach to level relationship in order to investigate the long run relationship among variables under investigation. Bounds test approach to level relationship with in Autoregressive Distributed Lag (ARDL) modeling can be applied irrespective of whether the underlying regressors are I(1) or I(0) or

[1] Public development expenditure provides basic infrastructure to the private sector and promotes private investment. Where as the public consumption expenditures are a substitute of private investment, it is expected that this type of expenditure may negatively affect private investment.

fractionally integrated. The ARDL modeling approach involves estimating the following Error Correction Model (ECM):

$$\Delta lprv = c + \alpha_0 lprv_{t-1} + \beta_0 \lg dp_{t-1} + \gamma_0 \lg ovi_{t-1} + \varphi_0 \inf_{t-1} + \delta_0 lrer_{t-1} + \vartheta_0 un\inf_{t-1}$$
$$+ \mu_0 unrer_{t-1} + \alpha_i \Delta lprv_{(t-1,t-2,t-3)} + \beta_i \Delta \lg dp_{(t,t-1,t-2,t-3)} + \gamma_i \Delta \lg ovi_{(t,t-1,t-2,t-3)} +$$
$$\varphi_i \Delta \inf_{(t,t-1,t-2,t-3)} + \delta_i \Delta lrer_{(t,t-1,t-2,t-3)} + \vartheta_i \Delta un\inf_{(t,t-1,t-2,t-3)} + \mu_i \Delta unrer_{(t,t-1,t-2,t-3)}$$
$$+ Du93q1 + Du95q1 + \varepsilon_t \qquad (4)$$

Where, Δ is the difference operator, and ε_t is serially independent random errors with mean zero and finite covariance matrix. In equation (4), the null hypothesis of no long-run relationship $H_0 = \alpha_0 = \beta_0 = \gamma_0 = \varphi_0 = \delta_0 = \vartheta_0 = \mu_0 = 0$ against the alternative hypothesis of existence of a long-run relationship among the variables $H_1 = \alpha_0 = \beta_0 = \gamma_0 = \varphi_0 = \delta_0 = \vartheta_0 = \mu_0 \neq 0$ is tested by conducting a F-test. The F-test has a non-standard distribution which depends upon: 1) whether variables included 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; and 4) the sample size. Two sets of critical values are reported in Pesaran et al., (2001). These critical values provide bounds for all 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. Narayan (2005), fortunately, 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 long-run relationship, the Granger causality tests can be done under the Vector ECM (VECM).

By doing so, the short run deviations of series from their long run equilibrium are also captured by including an Error Correction term. The ECM model of cointegrated variables in this paper can be specified as follows:

$$\Delta lprv = \Delta c + \alpha \Delta lprv_{(t-1,t-2,t-3)} + \beta \Delta \lg dp_{(t,t-1)} + \gamma \Delta \lg ovi_{(t,t-1,t-2)} + \varphi \Delta \inf_{(t,t-1,t-2)}$$
$$+ \delta \Delta lrer_{(t,t-1,t-2,t-3)} + \vartheta \Delta un\inf_{(t,t-1)} + \mu \Delta unrer + \Delta Du93q1 + \Delta Du95q1 + ECM_{t-1} + \varepsilon_t \qquad (5)$$

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 ECM_{t-1} in the equation would meet conditions to have causation from independent variables to dependent variable.

3. Data

This paper uses quarterly data of the Iranian economy covering the period of 1988-2010. All data are gathered from Central Bank of Iran (CBI) and International Financial Statistics (IFS) CD-ROM. Summary statistics for the series are given in Table (1). The large value of the Jargue-Bera statistic for inflation and real exchange rate implies that, these series aren't normally distributed.

Table 1: Summary Statistics for Variables under consideration, 1998:1-2010:4

	$lprv$	$\lg ovi$	$lrer$	$\inf$	$\lg dp$
Mean	9.695868	9.080248	9.280653	17.90114	11.30095
Median	9.631378	9.055741	9.280653	16.01043	11.25699
Maximum	10.47425	9.898882	9.739827	71.05508	11.82787
Minimum	8.852068	7.976537	8.583498	-13.03819	10.69340
Std.dev	0.501256	0.494348	0.310736	12.63333	0.302616
Skewness	-0.047685	-0.376012	-0.807117	0.820494	0.028387
kurtosis	1.683637	2.683908	2.627247	5.599371	2.076382
Jarque-bera	6.677310 (0.035485)	2.550907 (0.279304)	10.40698 (0.005497)	36.22335 (0.0000)	3.282459 (0.193742)

Source: Authors calculation

Figure 1 shows the real exchange rate and inflation in the Iranian economy during 1988:1-2010:4. As Figure 1 shows, the Iranian economy has experienced volatile inflation and real exchange rate during the last three decades.

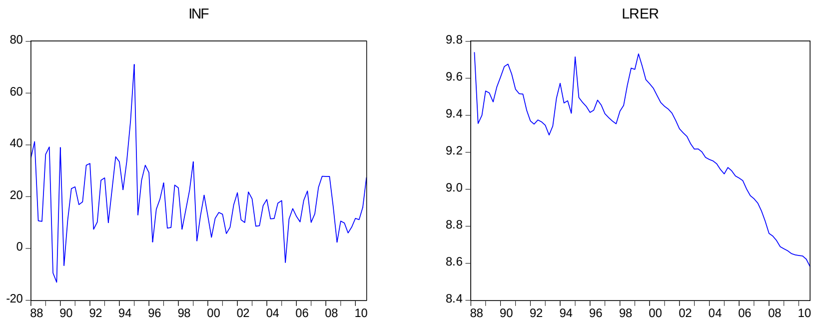

Figure 1: Inflation and real exchange rate in the Iranian economy during 1988:1-2010:4

Source of the data: Central Bank of Iran.

3.1. Standard Unit Root tests

In order to determine stationary properties of the series, we employ several tests such as Augmented Dickey Fuller (ADF), Philips-Perron (PP), Kwiatkowski et al (KPSS) and Ng-Perron (NP) tests. Table 2 presents the summery results of these tests.

Table 2: Results of standard unit root tests

	ADF	PP	KPSS	NP
$lprv$	I(1)	I(1)	I(1)	I(1)
$\lg ovi$	I(1)	I(1)	I(1)	I(1)
$\lg dp$	I(1)	I(1)	I(1)	I(1)
$lrer$	I(1)	I(1)	I(1)	I(1)
$\inf$	I(0)	I(0)	I(0)	I(1)

Source: Authors calculation

Table 2 shows the results of these standard unit root tests. The results, however are biased in favor of identifying data as integrated in the presence of structural break.

3.2. Unit Root tests with structural break

To carry out a test of no structural break against an unknown number of breaks in the variables under investigation, we use the endogenously determined multiple break tests that developed and applied by Bai and Perrron (1998, 2003). Table 3 presents results of different structural break tests for the variables under investigation.

Table 3: The Result of Structural Break Tests

	$lprv$	$\lg ovi$	$lrer$	$\inf$	$\lg dp$
SupF	×	√	√	×	√
SupF Conditional	×	√	×	×	√
UDmax-WDmax	√	√	√	×	√
BIC-LWZ	√	√	√	√	√
Sequential	×	×	×	√	×

Note: √ indicates the presence of structural break.
Source: Authors calculation

To carry out unit root tests with presence of structural breaks in the series under consideration, we use Perron (1990) and Lee and Strazicich (2003) tests. Table 4 shows the results of Perron's unit root test.

Table 4: The Result of Perron's (1990) Unit Root Test

Variable	model	Break point	Dummy	τ- statistic	Critical value 5%	result
$lprv$	(1)	1993q4	Du93q4,Dt93q4	-1.2693	-3.77	I(1)
$lprv$	(2)	1993q4	Du93q4,Tt93q4	-1.1076	-3.80	I(1)
$lprv$	(3)	1993q4	Du93q4,Dt93q4, Tt93q4	-0.5831	-3.99	I(1)
$lprv$	(1)	1996q3	Du96q3,Dt96q3	-1.3272	-3.76	I(1)
$lprv$	(2)	1996q3	Du96q3,Tt96q3	-1.7622	-3.87	I(1)
$lprv$	(3)	1996q3	Du96q3,Dt96q3,Tt96q3	-1.7083	-4.17	I(1)
$\lg ovi$	(1)	2004q4	Du2004q4,Dt2004q4	-0.9671	-3.80	I(1)
$\lg ovi$	(2)	2004q4	Du2004q4,Tt2004q4	-1.6716	-3.85	I(1)
$\lg ovi$	(3)	2004q4	Du2004q4,Dt2004q4,Tt2004q4	-1.4685	-4.18	I(1)
$\lg dp$	(1)	2002q4	Du2002q4,Dt2002q4	-3.5131	-3.76	I(1)
$\lg dp$	(2)	2002q4	Du2002q4,Tt02q4	-3.7092	-3.95	I(0)
$\lg dp$	(3)	2002q4	Du2002q4,Dt2002q4,Tt2002q4	-3.6743	-4.24	I(0)
$lrer$	(1)	1994q3	Du94q3,Dt94q3	-2.8945	-3.76	I(0)
$lrer$	(2)	1994q3	Du94q3,Tt94q3	-3.1690	-3.87	I(0)
$lrer$	(3)	1994q3	Du94q3,dt94q3,Tt94q3	-3.4727	-4.17	I(0)
$lrer$	(1)	1995q1	Du95q1,Dt95q1	-2.5263	-3.76	I(0)
$lrer$	(2)	1995q1	Du95q1,Tt95q1	-3.5647	-3.87	I(1)
$lrer$	(3)	1995q1	Du95q1,Dt95q1,Tt95q1	-3.7747	-4.17	I(1)

Source: Authors calculation

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 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. The results of Zivot and Andrews (ZA) and Lumsdaine and Papell (LP) tests are presented in Tables 5 and 6, respectively.

Table 5: ZA Unit Root Test Results

Variables	TB	τ_{ZA}	Result
$lprv$	1993q1	-4.4162	I(1)
$\lg dp$	1992q2	-5.7712	I(0)
$\lg ovi$	1994q4	-3.1920	I(1)
$\inf$	1995q4	-4.9574	I(0)
$lrer$	1998q3	-6.2291	I(0)

Source: Authors calculation

The critical values for ZA test at levels 1%, 5% and 10% are -5.57, -5.08 and -4.82, respectively.

Table 6: LP Unit Root Test Results

Variables	TB1	TB2	τ_{ZA}	Result
$lprv$	1990q3	1995q3	-6.9565	I(0)
$\lg dp$	1990q3	1992q2	-4.0402	I(1)
$\lg ovi$	1991q2	1996q2	-5.2305	I(1)
inf	1992q2	1995q4	-6.1968	I(1)
$lrer$	1991q4	1998q3	-6.0790	I(1)

Source: Authors calculation

The critical values for LP test at levels 1%, 5% and 10% are -7.34, -6.82 and -6.49, respectively. Based on this test $\lg dp$, $\lg ovi$, inf and $lrer$ are not stationary. Lee and Strazicich (2003) extended endogenous two breaks unit root test, and introduced a new procedure to capture two structural breaks. They proposed a Lagrange Multiplier (LM) unit root test in which the alternative hypothesis unambiguously implies trend stationary. Table 7 presents the results of Lee and Strazicich (LS) unit root test.

Table 7: LS Two Structural Breaks Unit Root Test Results

Variable	TB1	TB2	K	t-statistic	Result
$lprv$	1993q3	2004q1	8	-8.5842	I(0)
$\lg dp$	1991q1	1993q3	0	-5.8395	I(0)
$\lg ovi$	1992q4	1998q3	2	-5.4345	I(1)
inf	1995q1	1999q3	5	-7.0126	I(0)
$lrer$	1994q3	1998q3	4	-6.7013	I(0)

Note: 1) The critical values at 1, 5, 10% are -5.823, -5.286 and -4.989, respectively (Lee and Strazicich, 2003)
Source: Authors calculation

The results reveal that in the presence of two structural breaks, the null of unit root is rejected for $lprv$, $\lg dp$, inf and $lrer$; while the null can't be rejected for $\lg ovi$ 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 most of the cointegration tests such as Engel-Grenger (1987) and Johansen and Joselius (1992) are confident when the series are in the same order of integration, these tests can't be suitable for our study. Therefore, we use Bounds testing approach to level relationship developed by Pesaran et al. (2001) to address this issue.

4. Empirical Results

We apply a VAR(2)-GARCH-M model to estimate the relationships between inflation, exchange rate and private investment growth and their respective uncertainties simultaneously. The method for the estimation of the parameters is the maximum log-likelihood with BEKK approach. The estimation result of the model is reported in Table 8.

Table 8: Estimated parameters of the TGARCH model with BEKK approach

	Inflation		Private Investment		Real Exchange Rate	
		Coefficient- Z-Statistic		Coefficient Z-Statistic		Coefficient Z-Statistic
Mean Equation	μ_1	27.29874(3.66)	μ_2	0.019958(0.64)	μ_3	0.044285(0.79)
	ϕ_{11}	0.184127(1.20)	ϕ_{11}	0.000270(0.70)	ϕ_{11}	0.000523(0.91)
	ϕ_{12}	0.283266(2.20)	ϕ_{12}	-0.00027(-2.60)	ϕ_{12}	0.000302(0.63)
	ϕ_{21}	52.69023(1.58)	ϕ_{21}	0.642443(4.49)	ϕ_{21}	-0.248255(-1.34)
	ϕ_{22}	-57.53941(-1.38)	ϕ_{22}	0.113577(0.50)	ϕ_{22}	0.276958(1.75)
	ϕ_{31}	-22.08444(-0.65)	ϕ_{31}	0.030751(0.24)	ϕ_{31}	0.268670(1.16)
	ϕ_{32}	-22.77069(0.69)	ϕ_{32}	-0.05209(-0.54)	ϕ_{32}	0.224510(1.32)
	λ_1	-12.03613(-1.92)	λ_2	-0.01160(-0.39)	λ_3	-0.064526(-1.24)
GARCH in Mean	ρ_{11}	0.009338(0.43)	ρ_{12}	-6.75E-05(-2.29)	ρ_{13}	5.28E-05(0.59)
	ρ_{21}	112.6866(0.43)	ρ_{22}	-0.574510(-1.08)	ρ_{23}	-1.456884(-1.03)
	ρ_{31}	-656.4144(-0.61)	ρ_{32}	-5.99931(-2.70)	ρ_{33}	-8.572476(-0.86)
Variance Equation	c_{11}	66.84419(2.58)	c_{12}	-0.003020(-0.12)	c_{13}	-0.129067(-2.09)
	c_{22}	-4.63E-07(-0.10)	c_{23}	2.81E-06(0.16)	c_{33}	7.65E-05(1.05)
	a_{11}	0.688722(2.89)	a_{22}	0.251936(2.88)	a_{33}	0.742371(4.77)
	b_{11}	0.166230(0.60)	b_{22}	0.940003(42.83)	b_{33}	0.794929(16.38)

Source: Authors calculation

However, positive and significant inflation uncertainty means that it affects the level of inflation. Therefore, increasing inflation uncertainty raises the optimal inflation.

Following, Pahlavani and Bashiri (2013), Inflation uncertainty affects on the private investment growth negatively, supporting Pindyck (1982, 1988, 1991), Caballero (1991), Ferderer (1993a), Caballero and Pindyck (1996), hypothesis.

Pahlavai and Bashiri (2013) express that the negative effect of inflation uncertainty on the private investment implies than in the Iranian economy inflation uncertainty, because of instability of policies, reduces the information content of prices, distorts relative prices and long run contracts, and therefore lowers economic efficiency and investment.

Our empirical evidence also shows that private investment growth uncertainty has a negative and significant effect on the private investment growth. This result means that private investment growth uncertainty affects the level of private investment, reversely.

And finally, the coefficient of inflation in the mean equation is negative and significant, which means that inflation affects the private investment growth, reversely. As Valadkhani, (2004) expresses the rate of inflation has been used as a proxy for the nominal interest rate by Pesaran (1995) in his estimation of the real money balances for Iran and Khayum (1991) used price index as a proxy for the rate of interest in the context of developing countries

Figures 2 and 3 show that the conditional covariance and variance of inflation, exchange rate and private investment growth. It can be seen from the behavior of conditional covariance (Figure 2) that correlations between inflation, real exchange rate and private investment growth are unstable over the period of 1990-2000.

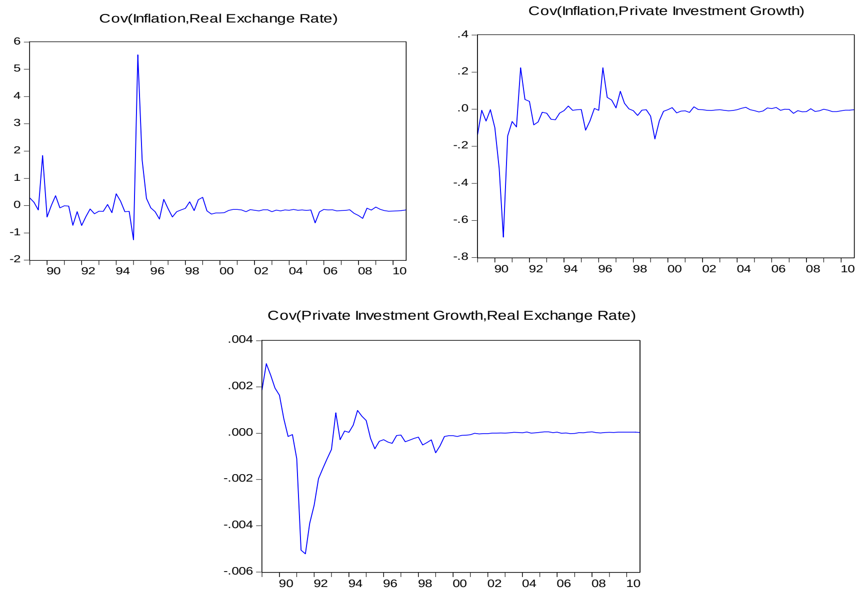

Figure 2: Estimated conditional covariance for inflation, private investment and real exchange rate

Source: Authors calculation

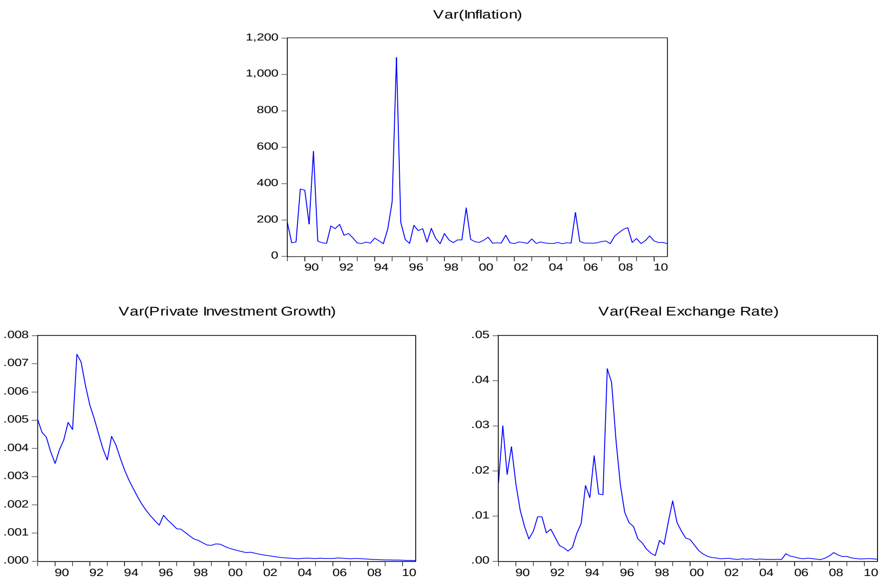

Figure 3: Estimated conditional variances of for inflation, private investment and real exchange rate

Source: Authors calculation

In the model, estimated conditional variance of inflation has the greatest peak at the time. Pahlavai and Bashiri (2013) (as cited Valadkhani (2004)) express higher inflation rates can discourage investors to obtain real assets. Under inflationary circumstances, the value of money deteriorates and it causes little incentive for people to deposit their funds in the banking system. This is the case particularly in Iran since nominal interest rates profit rates for term deposits and saving accounts are kept artificially low. Therefore, agents tend to invest in unproductive activities such as buying/selling foreign currencies, gold coins, cars, money laundering. It is interesting to recognize an increase in the growth of the consumer price index and its uncertainty under these circumstances are conjectured to produce a decline in the propensity to save as measured by funds flowing through financial intermediaries. This leads to a reduction in the funds deposit for investment through the banking system.

4.1. Bounds test approach to level relationship

As the unit root tests results confirm different order of integration for variables under consideration, we employ Bounds testing approach to investigate the long run relationship among variables under investigation. Table 9 presents critical values for F-statistic at 1, 5 and 10 percent.

Table 9: F- statistic Critical Values for Bounds Test

K=6	10%		5%		1%		F-statistic
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
F_V	2.657	3.776	3.077	4.284	4.000	5.397	5.055727
F_{IV}	2.088	3.103	2.431	3.518	3.173	4.485	3.487129
F_{III}	2.236	3.381	2.627	3.864	3.457	4.943	5.164346

Note: F_V, represents the F statistic of the model with unrestricted intercept and trend, F_{IV}, represents the F statistic of the model with unrestricted intercept and restricted trend and F_{III}, represents the F statistic of the model with unrestricted intercept and no trend.
Source: Authors calculation

As the critical F-statistics of the model III and V are bigger than the I(1) critical values in Table 9, 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 coefficients are presented in Table 9.

Table 10: Estimated Long- run Coefficients Using the RDL(4,2,3,3,4,2,1)

Variables	coefficient	Standard Error	T-Ratio[Prob
$\lg dp$	3.7392	0.45922	8.1425[.000]
$\lg ovi$	-1.0703	0.33245	-3.2194[.002]
$\inf$	-0.0075	-0.0044	-1.7162[.092]
$lrer$	0.4357	0.2259	1.9285[.059]
$un\inf$	-0.0013	0.5300e-3	-.2.5473[.014]
$unrer$	-8.5422	3.3929	-2.5177[.015]
$Du93q1$	0.22873	0.19545	1.1703[0.247]
$Du95q1$	-0.2026	0.15641	1.2953[0.201]
c	-2.68404	5.2249	-5.1370[0.000]
R-Squared =0.99838	adjusted-R-Squared=0.9976	DW-statistic=2.1188	

Source: Authors calculation

By taking dummy variables for structural breaks, results of the paper reveal that, as we expected, $\lg dp$ has positive effect on the $lprv$. Based on the acceleration theory, increases of $\lg dp$ causes to increase the private investment: our results show that one percent increase in $\lg dp$ leads to an increase in private investment by 3.74% in the long-run. However, $\lg ovi$ has negative effect on private investment, where one percent increases in the $\lg ovi$ leads to a 1.07% decrease in the private investment in the long-run. In an economy with limited resources like Iran, when government employs these resources, the resources which are available for the private sector, would decrease and lead to decrease the private investment.

Moreover, real exchange rate uncertainty positively affects the private investment. The result shows that an 1% increase in the real exchange rate uncertainty, increases private investment 0.43% in the long run. Uncertainty of inflation and real exchange rate also negatively affects on private investment.

In general, economic uncertainty makes undesirable conditions to investors and decreases the private investment. Finally, inflation negatively affects private investment in the long run. These results are in line with theoretical expectations.

Finally we did some diagnostic tastes for the fitted ARDL model. For instance in order to check instability of the estimated model, we used the Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUMQ) tests (Figure 4). This tests show a stable ARDL model.

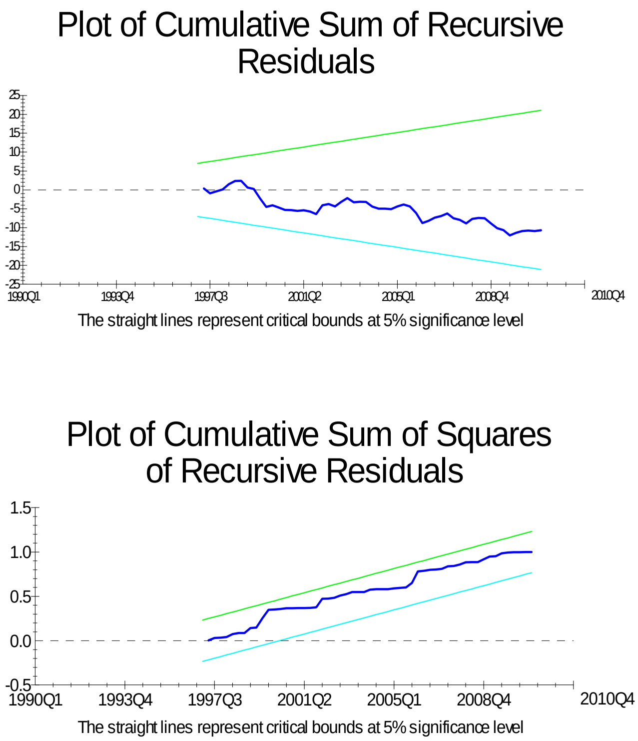

Figure 4: CUSUM and CUSUMQ tests

Source: Authors calculation

5. Conclusion

This paper investigates the long-run relationship between macroeconomic instability and private investment for the Iranian economy by employing Bounds testing approach to level relationship. The study uses a trivariate VAR(2)-GARCH(1,1)-M model with diagonal BEKK approach to proxied inflation and exchange rate uncertainties in a unified framework. In Iran, there have been many unusual policy changes and/or external shocks to the economy which resulted in the occurrence of multitude of structural breaks in the variables under consideration. By taking the structural breaks into account, results of the paper reveal that there are mean spillovers between inflation, exchange rate and private investment. There also is a negative effect of macroeconomic instability on private investment over the period of study, 1988:1-2010:4. These results support Pindyck (1982, 1988, 1991), Caballero (1991), Ferderer (1993a), Caballero and Pindyck (1996). In fact, in Iranian economy, macroeconomic instability refers to phenomena that decrease the predictability of the domestic macroeconomic environment, leading to resource-allocation distortion and hampering investment and growth.

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