Inflation persistence and the rational expectation hypothesis in an open economy model: an empirical evidence for the brazilian economy

Charles Lima de Almeida*
Geraldo da Silva e Souza**
Tito Belchior S. Moreira***

* Tribunal de Contas da União, charlesla@tcu.gov.br
** University of Brasilia, geraldosouza@unb.br
*** Catholic University of Brasília, tito@pos.ucb.br

Resumo - Este artigo tem por objetivo testar a validade da rigidez inflacionária e a hipótese de expectativas racionais no contexto da abordagem de Blanchard e Khan (1980), para a economia brasileira, no período de janeiro de 1994 a março de 2003. Utilizando o modelo de Fuhrer-Moore e GMM, obteve-se evidência em favor de ambas as hipóteses. Da equação de demanda encontrou-se evidência de que o efeito recessivo decorrente do aumento da taxa real de juros é menor do que o efeito expansivo associado à desvalorização do real. Da equação de oferta, encontrou-se evidência de que a compensação entre desemprego e inflação se verifica e que o efeito passthrough tem pequena influência na taxa de inflação.

Palavras-chave - modelo de Fuhrer-Moore; GMM; persistência da inflação; hipótese de expectativas racionais

Abstract - This paper aims at testing the validity of the inflation stickiness and the Rational Expectation Hypothesis in the context of the Blanchard and Kahn (1980) approach, for the Brazilian economy, during the period from 1994 to 2003. Using the Fuhrer-Moore model and GMM, we find evidence favoring both hypotheses. We also find evidence, from the demand equation, that the recessive effect due to the increase in the real interest rate is smaller than the expansive effect due to the devaluation of the domestic currency. From the supply equation, we find that the trade-off between unemployment and inflation holds while the passthrough effect shows low influence on the inflation rate.

Key-words - Fuhrer-Moore model; GMM; inflation persistence; rational expectations hypothesis
JEL classification - A10; C12; C13; E12

1. Introduction

Since Lucas (1972, 1976) the dominant assumption in macroeconomics concerning the formation of agent's expectations has been that they are rational. But what is the link between inflation stickiness and the rational expectation hypothesis? We begin with a note from Romer (1996). "The Lucas model was initially perceived as showing that rational expectations alone are enough to undo many of the central results of traditional Keynesian theory, most notably the stabilization powers of aggregate demand policy. If this were right, defending the traditional Keynesian position would require demonstrating that expectations are systematically irrational. Model of staggered adjustment show that this is unnecessary: if not all prices or wages are free to change every period, aggregate demand policy can be stabilizing even under rational expectations".

The New Keynesians shown that, in a rational expectation model, an induction of constraint of labor contract has lead wages not to adjust to equilibrium level immediately, which in turn would lead prices to have stagnant adjustment. Besides, New keynesian inflation stickiness and stick-price models have received attention increasingly in monetary policy analysis in more recent years.

It could be shown using Brazil's quarterly data for 1994-2003. Since the middle of the 1990's, the Brazilian economy has shown a moderate inflation rate. Before that period, the high inflation rate was explained by the fact that the economy was strongly indexed. The mechanisms of price indexation were significantly reduced with the stabilization plan (Real Plan) in 1994. This paper tests the validity of inflation stickiness and the Rational Expectation Hypothesis for the Brazilian economy during the period following 1994. The Blanchard and Kahn (1980)[1] approach is used to validate system solutions derived from GMM estimation. The questions we address in the article are: "Is there inflation stickiness in the period under study?", "How large is the cost of decreasing the inflation rate?", "What is the impact of the passthrough on the inflation rate?" ; and "Is there any evidence favoring the Rational Expectation Hypothesis?".

The article focuses on the derivation of a model that assumes rigid inflation, based on rational expectations and staggered, multi-period overlapping wage contracts. We explore the approaches of Fuhrer and Moore (1995) to characterize the dynamic relationship between interest rates, exchange rate, output and inflation for the Brazilian economy.

The model we use is derived from the expenditure function of the economy, the IS equation, and the Fuhrer and Moore (1995) supply function, the Phillips equation. The Rational Expectations Hypothesis is intrinsic to the derivation process and leads to a linear model involving output and inflation expectations. The interest rate is treated as exogenous. The resulting system is estimated via GMM, and the Rational Expectation Hypothesis is tested by means of the J statistics. Blanchard and Kahn (1980) theory is used to provide further support to the J test. This is done because the J test is known to have low power. Almeida, Souza and Moreira (2004) use this same approach to check analogous assumptions for a closed economy. Here we extend this work for an open economy. We focus on the effects of the real interest rate and the real exchange rate on the

[1] Many recent large macro-econometric models assume perfect foresight. This choice has been made possible by the development of simulation algorithms, which are powerful and easy to use. However, the existence and the uniqueness of a solution for these models are not warranted a priori. Blanchard and Kahn established local conditions for these properties, which are easy to check, in terms of eigenvalues computed at the steady state of the model.

real output gap. The passthrough effect is investigated by means of the Phillips curve.

The paper proceeds as follows. Section 2 introduces the economic model basing it on an IS dynamic equation and the Fuhrer and Moore (1995) supply function. In Section 3, we present the conditions necessary and sufficient for the existence of solutions for the linear system of rational expectations. In Section 4 we show the empirical findings for the Brazilian economy data. Finally, Section 5 shows a summary and closing remarks.

2. The model

The demand equation for the equilibrium model we propose is

(1)

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + a_3 (i_{t-1} - E_{t-1}\pi_t) + a_4 e_{t-1} + \varepsilon_t$$

where y_t is the output gap[2], π_t is the rate of inflation, i_t represents the nominal interest rate, $E_{t-1}\pi_1$ is the expected inflation rate with expectations form ed in period $t - 1$, e_{t-1} is the real exchange rate[3] in period t - 1 and ε is the error term capturing demand shocks.

The view that the inflation rate and not just the price level would exhibit some degree of stickiness has been adopted by Fuhrer and Moore (1995). They assume that wage negotiations are conducted in terms of the wage relative to an average of real contracts wages in effect over the life of a contract. The Fuhrer and Moore (1995) specification is given by

(2)

$$\pi_t = a_5 (\pi_{t-1} + E\pi_{t+1}) + a_6 (y_t + E_t y_{t+1} + a_7 (e_t - e_{t-1}) + \eta_t$$

In this expression $E_t y_{t+1}$ is the output gap expectation for instant $t + 1$ in instant t, Δe is change in the nominal exchange rate[4], and η_t is a supply shock.

The Fuhrer-Moore specification is closely related to, but distinct from, Taylor's original work on staggered, multi-period overlapping contracts and aggregate-price adjustment. Taylor's model (1979,1980) of price level adjustment leads to a reduced-form expression for the price level in which p_1 depends on p_{t+1} and $E_t (p_{t+1})$. The backward-looking aspect of price behavior causes unanticipated reductions in the money supply to cause real output declines. Only as contracts expire can their real value be reduced to levels consistent with the new, lower money supply. However, the inflation rate depends on $E_t (\pi_{t+1})$, not π_{t-1}, so the inflation process does not display stickiness. As Ball (1994) has shown, price rigidities based on backward-looking behavior in the price-level process need not imply that policies to reduce inflation by reducing the growth rate of money will cause a recession. In the Fuhrer-Moore specification, the backward-looking nature of the inflation process implies that reductions in the growth rate of money will be costly in terms of output.

3. Solving a system of rational expectations

The supply and demand equations of the Fuhrer-Moore equations are equivalent to the system of rational expectations

$$\begin{pmatrix} E_t(y_{t+1}) \\ E_t(\pi_{t+1}) \end{pmatrix} = A \begin{pmatrix} y_t \\ \pi_t \end{pmatrix} + C \begin{pmatrix} y_{t-1} \\ \pi_{t-1} \\ i_t \\ e_t \\ e_{t-1} \end{pmatrix}$$

where

$$A = \frac{1}{d} \begin{pmatrix} -(a_1 a_5 + a_6 a_3) & a_3 \\ a_6 (a_1 + 1) & -1 \end{pmatrix}$$

[2] As Carneiro and Wu (2002) argue, the fist two components of the IS curve are necessary to control the seasonal pattern, the inertia and the dynamics strongly present in the output time series which is observed in level.

[3] This is a bilateral exchange rate: Brazil / USA.

[4] This is a bilateral exchange rate: Brazil / USA.

and

$$C = \frac{1}{d}\begin{pmatrix} -a_5a_2 & -a_5a_3 & -a_3a_5 & -(a_4a_5 + a_3a_7) & a_3a_7 \\ a_6a_2 & a_5 & a_6a_3 & a_6a_4 + a_7 & -a_7 \end{pmatrix}$$

and $d = -a5 + a_6a_3$.

This system has the same form as that studied in Blanchard and Kahn (1980), i.e., it can be written as

$$\begin{pmatrix} y_t \\ \pi_1 \\ E_t(y_{t+1}) \\ E_t(\pi_{t+1}) \end{pmatrix} = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ c_{11} & c_{12} & a_{11} & a_{12} \\ c_{21} & c_{22} & a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} y_{t-1} \\ \pi_{t-1} \\ y_t \\ \pi_t \end{pmatrix} + \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ c_{13} & c_{14} & c_{15} \\ c_{23} & c_{24} & c_{25} \end{pmatrix} \begin{pmatrix} i_t \\ e_t \\ e_{t-1} \end{pmatrix}$$

Let D and F denote the parameter matrices appearing in this representation. We take i_t exogenous. Following the notation in Blanchard and Kahn (1980) let $X_t = (y_{t-1}, \pi_{t-1})'$ be the vector of predetermined variables and let $P_t = (y_t, \pi_t)'$ be the vector of non-predetermined variables. Thus we may write

$$\begin{pmatrix} X_{t+1} \\ E_t(P_{t+1}) \end{pmatrix} = D\begin{pmatrix} X_t \\ P_t \end{pmatrix} + F(i_t, e_t, e_{t-1})'$$

where E_t in all the above expressions denotes expectation conditional to the information set Ω_t (such sets form an increasing sequence of σ -fields).

According to Blanchard and Kahn (1980), the system above has a unique solution for y_t and π_t if and only if the matrix D has two eigenvalues outside the unit circle and two inside.

4. Empirical findings

The estimation process uses quarterly data and the variables are expressed in log scale. The sample period ranges from 1994:01 to 2003:03. The inflation is measured by the general price index IGP-DI/FGV[5]. The nominal exchange rate is the period average of the ask prices, and the nominal interest rate is the SELIC rate, the equivalent to US Fed funds rate[6]. The fiscal variable chosen is the current expenditure. The real interest rate was calculated by deflating the nominal interest rate using the IGP-DI index. In order to obtain the real exchange rate, the nominal rate was multiplied by the US producer price index and divided by IGP-DI index. The output gap is defined by the difference $y = Y^p - Y$, where Y^p is the log of the potential output and Y is the log of the current output[7]. To estimate Y^p, we use a two-stage procedure. Firstly, we estimate a Cobb-Douglas production function with labor and capital as inputs[8]. This is given by

$$\log Y_t = \beta_0 + \beta_1 \log L_t + \beta_2 \log K_t^* + \varepsilon_t$$

where $L_t = PLF_t(1 - u_t)$, PLF being the potential labor force of the economy and u, the unemployment rate. In the expression, $K_t^* = c_t(1 - \delta) K_t$, where $\delta = 0.0209$ is the depreciation rate, c_t is the rate of installed industrial capacity used and K_t is the capital stock. The sources for the unemployment rate, the potential labor force and installed industrial capacity used is IPEA-Brazil (Instituto de Pesquisas Econômicas e Aplicadas). The Central Bank of Brazil is the source for δ and K_t .

We find $\beta_0 = 0.38647\ (\pm 0.5194)$, $\beta_1 = 0.09\ (+0.16413)$ and $\beta_2 = 0.6\ (\pm 0.12184)$ with $R^2 = 0.78$.

On the second stage, we compute predicted values

$Y_t^P = \beta_0\ (PLF_t)^{\beta_1}\ (K_t)^{\beta_2}$

We notice that the observations Y_t^P , PLF_t and K_t are efficient in the sense that this frontier cannot be improved by a radial projection defined by Data Envelopment Analysis (DEA) efficient calculations.

The production function is well defined. Typically the regression of output on labor and capital is not spurious. Although not strictly necessary we look for evidence in this direction performing a cointegration test. The approach is somewhat heuristic given the small sample size. Results are shown in Tables A1 and A2 (Appendix).

[5] A composite price index (IGP-DI) is calculated by the Fundação Getulio Vargas (FGV) as a weighted average of IPA (Wholesale Prices), IPC-BR (Consumer Prices) and INCC (National Cost of Civil Construction). The weights are .6, .3 and .1, respectively..

[6] Freitas and Muinhos (2002) also use the SELIC rate in the IS curve. SELIC is the central depository of securities issued by the National Treasury and the Banco Central do Brasil.

[7] The inflation is defined as log (1 + p); output gap as log (1 + y) and the real interest rate as log (1 + r). In these expressions p and r are rates.

[8] See the unit root tests in Appendix.

We did not find any evidence of spurious regression.

We use GMM to eliminate the correlation between exogenous variables and disturbances and potential serial correlation. In the model of staggered contracts, the supply and demand equations are also contemporaneously correlated. Hence, these equations are estimated using an econometric technique that is consistent with the presence of heteroskedasticity and autocorrelation of an unknown way. Following Roberts (1997), we use Newey-West weights to estimate the variance-covariance matrix.

The equations are estimated assuming that the agents have perfect foresight. The unobservable variables $E_{t-1}(\pi_t)$, $E_t(y_{t+1})$ and $E_t(y_{t+1})$ are treated as in MacCallum (1976) and Roberts (2001). Actual future inflation and actual future output are used as proxies for the corresponding expectations. This approach requires the use of instrumental variables in the estimation process. To estimate the equations in Tables 1 and 2, the following instrumental variables were used: real interest rate, output gap, current expenditures, inflation rate and a dummy variable. In January 1999, a change of the exchange rate regimen occurred in Brazil.

The method of GMM with Bartlett kernel and Newey-West weights, applied simultaneously to both equations, leads to the statistics shown in Tables 1 and 2. The Rational Expectation Hypothesis is tested by the J-statistics associated with the over-identifying restrictions. The value of J does not indicate evidence against the Rational Expectation Hypothesis[9].

For the Fuhrer-Moore model $a_5 = 0.5$. A departure from this hypothesis is viewed as evidence against inflation persistence. We see from Table 1 that $(a_5 - 0.5)$ does not differ significantly from zero at the level $\alpha = 0.05$.

It is seen from the estimates shown in Tables 1 and 2 that $a_1 = 0.931723$, $a_2 = 0.040993$, $a_3 = 0.120209$, $a_4 = -0.341061$, $a_5 = 0.526484$, $a_6 = -0.012231$ and $a_7 = 0.002856$. Then

$$A = \begin{pmatrix} 0.926340 & -0.22769 \\ 0.044752 & 1.89410 \end{pmatrix} \text{ and } C = \begin{pmatrix} -0.040879 & 0.11987 \\ -0.000950 & -0.99722 \end{pmatrix}$$

with the notation of the previous section these matrices lead to the matrix of eigenvalues

$$\begin{pmatrix} 0.0463 & 0 & 0 & 0 \\ 0 & 0.8490 & 0 & 0 \\ 0 & 0 & 0.9625 - 0.3368i & 0 \\ 0 & 0 & 0 & 0.9625 + 0.3368i \end{pmatrix}$$

It is seen that has two roots outside the unit circle and two inside. This fact provides further support to the Rational Expectations Hypothesis in the sense that the Blanchard and Kahn (1980) condition is satisfied for the GMM estimates of the a_1. It implies that the model posits rational behavior in the sense that agents know the model and use all variable information in forming their forecasts.

The exchange rate and the output are two important variables to monetary policy since they have a direct effect on the inflation rate. The coefficient a_7 measures the direct effect of change of the nominal exchange rate on the inflation rate, and the sacrifice rate a_6 measures the effect of the economic activity level on the inflation rate. Both coefficients are shown in Table 1.

The estimation results for the supply equation, shown in Table 1, indicates a negative relation between current and expected output gap, $y_t + E_t y_{t+1}$, and the inflation rate. The elasticity coefficient of $-0.012231\ (\pm 0.001296)$ shows the concern of the workers with the relative wages[10]. This elasticity reinforces the stickiness hypothesis of the relationship between output and inflation. In the context of staggered prices or staggered wage contracts,

[9] This implies that there is no evidence against the model specification defined by equations (1) and (2).

[10] **Fuhrer and Moore's (1995) estimate** for US quarterly data is $3.2x10^{-7}$ with a t-statistic of 0.06, meaning that the estimate is only marginally significant, whereas our estimated coefficient is significant at the 1% confidence level.

the smaller the elasticity is, the smaller is the reaction of prices to changes in the output. Thus, the adjustment process of the output will be sluggish and a sacrifice rate[11] of the population will be high. See, for example, Chary, Kehoe, and McGrattan (1996).

The results of Table1 also imply a positive relation between passthrough and the inflation rate. The passthrough effect shows that a one percentage point increase in the change of nominal exchange rate will increase the inflation rate in $0.002856\ (\pm 0.000412)$ percentage points[12]. We note that this elasticity is low. The reason for this is that the economic sectors dependent on external inputs have absorbed great part of the costs of the currency devaluation, since in the period under analysis the economic growth rate oscillates between low and moderate. The firms have opted for not increasing their involuntary stocks. Moreover, the period is characterized by open trade, which generates competition among firms in the tradable goods sector.

Through the sacrifice rate, the Central Bank can put into action two relevant transmission mechanisms of monetary policy effects. The first relates changes in the real interest rate to changes in the aggregate demand. The second relates changes in the real exchange rate to changes in the aggregate demand through changes in net exports. Both mechanisms are represented in the demand equation shown in Table 2. We find evidence that the real interest rate and the real exchange rate affect the output gap positively and negatively, respectively. The signs found for the output gap lags are consistent with results obtained elsewhere (see Carneiro and Wu, 2002).

From Table 2 we see that the effect of the real interest rate[13] on the output gap is smaller than the effect of the real exchange rate. A one-percent point increase in the real interest rate increases the output gap in $0.12021\ (\pm 0.06296)$ percentage point. On the other hand, a one-percent point increase in the real exchange rate decreases the output gap in $0.34106\ (0.02591)$ percentage points. This means that a recessive effect (sacrifice rate) due to an increase in the real interest rate is smaller than the expansive effect due to the devaluation of the domestic currency, ceteris paribus. It is necessary to increase the real interest rate by 2.84 percentage points to achieve the same reduction of the output gap.

Considering the results shown in Tables 1 and 2, one can notice the stickiness of the inflation rate[14] for the Brazilian economy and the corresponding sacrifice rate. A one- percent point increase in the real interest increases the output gap by $0.12021\ (\pm 0.06296)$ percentage points. The final effect on the short run inflation rate is a decrease of 0.01 percentage points.

Table 1: Supply Equation. GMM estimation with Newey-West Weights and Bartlett kernel[a]

Variable	Parameter	Estimate	Stand. Error	t	p-value
Intercept		0.149958	0.015609	9.607	0.000
$\pi_{t-1} + E_t\pi_{t+1}$	a_5	0.526484	0.014328	36.745	0.000
$y_t + E_t y_{t+1}$	a_6	-0.012231	0.001296	-9.434	0.000
Δe_t	a_7	0.002856	0.000412	6.930	0.000
R^2		0.451896			
$J-statistic$		0.154195			

Note [a]: Instrument List – Real Interest Rate, Dummy Variable (b); Output Gap, Inflation Rate, Current Expenditures, Real Exchange Rate.
Note [b]: In 1999/01 there was a change of the exchange rate regimen, dummy variable.

[11] The term "sacrifice rate" is used to express the costs of a country with high unemployment and low economic activity levels experienced during the process of inflation stabilization.

[12] Belaisch (2003) argues that the passthrough in Brazil has fallen compared with estimates in other studies on earlier time periods, and remains low when compared with the passthrough in other Latin American countries.

[13] Notice that the coefficient of the real interest rate is not significant at the 5% confidence level, but it is marginally significant at the 6% confidence level.

[14] As one referee points out there are other approaches to test the inflation persistence hypothesis. For instance, one can use a unit root or test for fractional integration.

Table 2: Demand equation. GMM estimation with Newey-West Weights and Bartlett Kernel[a]

Variable	Parameter	Estimate	Stand. Error	t	p-value
Intercept		0.65133	0.05643	11.531	0.000
y_{t-1}	a_1	0.93172	0.01509	61.763	0.000
y_{t-2}	a_2	-0.04099	0.01987	-2.063	0.045
$i_{t-1} - E_{t-1}\pi_t$	a_3	0.12021	0.06296	1.909	0.063
e_{t-1}	a_4	-0.34106	0.02591	-13.162	0.000
R^2		0.82171			
$J-statistic$		0.154195			

Note [a]: Instrument List – Real Interest Rate, Dummy Variable (b); Output Gap, Inflation Rate, Current Expenditures, Real Exchange Rate.
Note [b]: In 1999/01 there was a change of the exchange rate regimen, dummy variable.

5. Conclusions

In this article, we propose an inflation stickiness model in the context of rational expectations for the Brazilian economy. The period under analysis is 1994:1 to 2003:03. Using GMM, the empirical results indicate that one cannot reject the Rational Expectation and the inflation persistence hypothesis. The Blanchard and Kahn (1980) condition is satisfied regarding the GMM estimates and the conditions for the existence of a unique solution to the corresponding linear system of rational expectations are satisfied.

The supply equation shows that there is evidence in favor of inflation persistence. Like in the Fuhrer-Moore model, the parameter a_5 does not differ significantly from 0.5. As expected there is a trade-off between inflation and unemployment: a one-percent point increase in the current and expected output gap decreases the inflation rate by 0.012231 percentage points. The low value of the elasticity of the output gap reinforces the output and inflation degree of stickiness. In the context of staggered prices or staggered wage contracts, the lower the elasticity is, the lower the reaction of prices to changes in the output. Thus the adjustment process of the output will be sluggish. On the other hand, the passthrough is positive, i.e., an increase of 1% in the nominal exchange rate leads to an increase of 0.002856% in the inflation rate.

The demand equation shows that the effect of the real interest rate on the output gap is smaller than the effect of the real exchange rate. A one-percent point increase in the real interest rate increases the output gap in $0.12021\ (\pm 0.06296)$ percentage point. On the other hand, a one-percent point increase in the real exchange rate decreases the output gap in $0.34106\ (0.02591)$ percentage points. This means that a recessive effect (the sacrifice rate) due to the increase in the real interest rate is smaller than the expansive effect due to the devaluation of the domestic currency, ceteris paribus.

Considering that the effect of the interest rate on the inflation rate is indirect and that it takes two periods to occur, the monetary transmission mechanism, from interest rate to the inflation rate, implies that a 1% increase in the real interest rate reduces inflation in 0.01%, in the short run. These results show that the data of the Brazilian economy validate the New-Keynesian proposal of the existence of nominal stickiness. In this context, we can conclude that

the monetary policy is not neutral.

The results on estimation point out that the inflation stickiness in the Fuhrer-Moore model is explained by the inertial component, π_{t-1} and by the rule of rational expectation formation, $E_t \pi_{t+1}$. New information on current and future monetary policies, available at the beginning of the period t affects the period $t+1$ through $E_t \pi_{t+1}$, but not, by definition, π_{t+1}. Therefore, the flexibility to change the inflation rate is limited to knowledge of future inflation in opposition to the Taylor model (1979, 1980). Thus, an unexpected inflationary process generates costs with the drop of the real output.

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Appendix

Table A1– Unit Root Tests

Variables	Lags	ADF Test	0.05 Critical Value	Phillips Perron Test	0.05 Critical Value	KPSS Test*	0.05 Critical Value
$LogL$	5	0.632	-3.562	2.271	-2.945	0.731	0.463
$\Delta LogL$	1	-5.255	-3.544	-5.226	-3.544	0.103	0.146
$LogK*$	5	-0.746	-3.562	-1.222	-3.540	0.731	0.463
$\Delta LogK*$	4	-5.090	-3.562	-3.860	-3.544	0.051	0.146
$LogY$	5	-2.444	-3.562	-1.870	-2.945	0.686	0.463
$\Delta LogY$	4	-3.608	-2.960	-10.426	-2.948	0.177	0.463
$Log\Delta e$	1	-3.974	-2.945	-3.513	-2.945	0.138	0.146
$Logy$	2	6.395	-1.951	-6.911	-3.540	0.086	0.216
$Log\pi$	2	-2.080	-1.951	-2.284	-1.950	0.1297	0.1460
$Log(i - E\pi)$	1	-3.836	-2.998	-4.600	-2.967	0.138	0.463
$Loge$	1	-3.854	-1.949	-3.854	-1.949	0.040	0.146

*Null Hypothesis: the variable is stationary.

Table A2 – Johansen Cointegration Test Summary: LogL, LogK*, LogY

Selected (0.05 level*) Number of Cointegration Relations by Model

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	1	1	1	1
Max-Eig	1	1	1	1	1

* Critical values based on MacKinnon-Haug-Michelis (1999)