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2008

# A model of inflation for Sri Lanka

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## Publication Details

This article was originally published as Cooray, AV, A model of inflation for Sri Lanka. *Review of Applied Economics*, 4(1-2), 2008, 35-44.

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Business | Macroeconomics | Social and Behavioral Sciences

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## **A MODEL OF INFLATION FOR SRI LANKA**

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**Abstract:** This paper uses two models: an open economy model and a closed economy model to estimate a price equation for Sri Lanka. The results suggest greater support for the open economy model. Consistent with previous studies for Sri Lanka, supply side factors appear to be important in influencing the general price level in Sri Lanka.

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## **1 Introduction**

This study develops a model of inflation for Sri Lanka in order to see what factors influence the general price in Sri Lanka. One of the many explanations for the continuing increase in price level, is the monetarist theory of the excessive growth in money supply. A consequence of financial deregulation in Sri Lanka has been the growth in all monetary aggregates. Money supply as defined by M2, which rose threefold during the 1965-1977 period, rose 23 fold during the 1978-1996 period. The lack of fiscal restraint has been a prime factor underlying this monetary expansion. The adoption of liberalized trade and payment policies together with the introduction of a floating exchange rate system added further pressure on prices. With the removal of import and exchange controls during the post liberalization period, imports began to gain greater significance in affecting prices. By 1987, external trade accounted for 57% of the GDP the difference between the 1950's and post liberalization period being that imports had come to account for a larger share of the GDP than exports. With imports beginning to gain greater importance in price determination, the impact of exchange rate movements on the rate of inflation has also come to acquire greater significance and is therefore included as a likely explanatory variable in the empirical study that follows.

Studies on inflation in Sri Lanka include those by Nicholas (1990), Nicholas and Yatawara (1991), Weerasekera (1992), Rupananda (1994). These studies suggest the importance of supply side factors as affecting the general level of prices. Hence in estimating a price equation for Sri Lanka, two models are examined;

- 1) a closed economy model based on the monetarist explanation of inflation modified to incorporate the time lags in the adjustment of prices to changes in money supply <sup>1</sup>, and
- 2) an open economy model which incorporates in addition to the variables in (1), the import price index and foreign exchange rate<sup>2</sup>.

The rest of the paper is structured as follows. Section 2 examines the data. Section 3 estimates two price equations for Sri Lanka for the closed and open economy models. Section 4 summarizes the conclusions.

## **2 Data**

All data has been obtained from the annual reports and monthly bulletins of the Central Bank of Sri Lanka and the International Financial Statistics. The empirical analysis makes use of annual, quarterly and monthly data. The annual data covers the period 1978-2006, comprising in sum a total of 29 observations. The sample size is clearly very small, however, this is the longest time period for which data is available given that exchange rates are floating. Due to the limited number of annual observations, quarterly and monthly data for the period 1978-2006 is also used. This test involves estimating the effects of money supply, real GNP,

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<sup>1</sup> Monetarist models of inflation for less developed countries can be found in the works of Harberger(1963), Vogel (1974), Bomberger and Makin (1979), Saini (1982, 1984), and Rao, Fahimuddin and Bajpai ( 1996), Masih and Masih (1998).

<sup>2</sup> Several studies on inflation have incorporated exchange rates and foreign prices as additional variables - Diz (1970), Lowinger (1978), Nugent and Glezakos (1979), Sheehey (1979), Saini (1984), Moser (1995) - in some cases primary explanatory variables. See Otani (1975), Aigbokhan (1991), Gali and Monacelli (2005).

import prices and exchange rate on the Colombo Consumer Price Index (CCPI). Data on the CCPI, money supply, real GNP and import price index have been used for this purpose. Real GNP figures were available only for the 1982-2006 period with 1982 as the base year. For the period before 1982 these figures were approximated by deflating nominal GNP by the CCPI. Due to the lack of quarterly and monthly data on real GNP, quarterly and monthly series have been constructed subject to the constraint that real GNP grew at a constant rate each quarter/month throughout the year. A similar procedure has been used for the construction of quarterly and monthly series for import prices.

### 3 The Estimation of a Suitable Price Equation for Sri Lanka

#### *A Preliminary Test*

This section attempts to analyse the main factors influencing the rate of inflation in Sri Lanka. As mentioned in section 1, two models are estimated. A closed economy model and an open economy model.

The closed economy price equation is given by<sup>3</sup>,

$$P_t = a_1 + a_2 M_t + a_3 M_{t-1} + a_4 P_{t-1} + a_5 GNP_t + u_t \quad (1)$$

the open economy price equation is given by;

$$P_t = a_1 + a_2 M_t + a_3 M_{t-1} + a_4 P_{t-1} + a_5 GNP_t + a_6 IMP_t + a_7 ER_t + u_t \quad (2)$$

where,

$P_t$  = Colombo Consumer Price Index

$M_t$  = Money supply ( $M_2$ )

---

<sup>3</sup> The effects of changes in money supply are not instantaneously reflected in prices. Therefore  $M_{t-1}$  is designed to capture the lagged response of prices to money supply.  $P_{t-1}$  is incorporated to capture the lagged effects of prices on current prices. The limited number of observations precludes the use of too many lagged variables. Theoretical justification for the inclusion of lagged variables of money supply can be found in the works of Harberger (1963), Diz(1970), Saini(1982, 1984), Bomberger and Makin (1979).

$P_{t-1}$  = Colombo Consumer Price Index lagged by one period

$GNP_t$  = Real Gross National Product

$IMP_t$  = Import price index

$ER_t$  = Official exchange rate Rupee/US Dollar

$u_t$  = random error term

All variables are expressed in terms of their logarithms.

**(Table 1, about here)**

A number of alternative specifications of equations (1) and (2) were estimated in arriving at the final model. Two alternative specifications appeared promising for Sri Lanka. Panel 1 reports the estimated regression coefficients based on the variable deletion tests carried out on equation (1), and panel 2 reports the estimated regression coefficients based on the variable deletion tests carried out on equation (2). The  $t$  statistics are reported within parentheses. In order to determine the best specification, diagnostic tests have been carried out. The models appear to be well specified on the basis of these tests. The J test from Davidson and MacKinnon (1981) and JA test from Fisher and McAleer have been used to compare the alternative specifications. The non-nested hypothesis tests are reported below. The results reported in Table 2 suggest that the open economy price equation performs better for all three data sets.

**(Table 2, about here)**

The ADF test for unit roots has been employed to detect the presence of unit roots. Table 3 reports results of unit root tests. All variables exhibit the presence of a unit root at the 10%, 5% and 1% levels. Inspection of the results for the first differences indicate that with the exception of the import price index for the monthly data, that all variables

are I(1) series at the 1%, 5% or 10% levels of significance. Further differencing shows import prices to be a I(2) series.

**(Table 3, about here)**

Having established the time series properties of the variables, cointegration tests have been carried out to examine the existence of a long run relationship between the variables. The cointegrating regression equations take the following form;

Annual data,

$$P_t = \beta_0 + \beta_1 M_t + \beta_2 IMP_t + \beta_3 ER_t \quad (3)$$

quarterly data,

$$P_t = \delta_0 + \delta_1 GNP_t + \delta_2 IMP_t + \delta_3 ER_t \quad (4)$$

monthly data,

$$P_t = \eta_0 + \eta_1 ER_t \quad (5)$$

**(Table 4, about here)**

The unit root tests for the residuals reported in Table 4 indicate the existence of a long run relationship between the variables. The existence of a long run relationship between the variables calls for the use of an error correction model to correct for the likely disequilibrium that could arise between the variables in the short run. Hendry's (1986) general to specific modeling method has been employed to model the short run adjustment associated with the cointegrating relationships. The results for the optimal error correction models are reported below where  $EC_{t-1}$  is the error correction term.

Annual data;

$$\Delta P_t = .004 + .56 \Delta M_t - .12 \Delta IMP_t + .13 \Delta ER_t - 1.31 EC_{t-1} \quad (6)$$

(0.16)      (3.99)      (1.26)      (0.86)      (-5.30)



$$\chi^2_{sc} = 2.04 \quad \chi^2_{ff} = .79 \quad \chi^2_n = 2.86 \quad \chi^2_{hs} = .00$$

Quarterly data;

$$\Delta P_t = 0.02 - .78 \Delta RGNP_{t-1} - .40 \Delta P_{t-2} + .05 \Delta ER_t - .11 \Delta IMP_t - .52 EC_t \quad (7)$$

$$(3.05) \quad (-1.96) \quad (4.39) \quad (-0.39) \quad (0.83) \quad (-5.98)$$

$$\chi^2_{sc} = 5.96 \quad \chi^2_{ff} = 0.17 \quad \chi^2_n = 7.2 \quad \chi^2_{hs} = 1.09$$

Monthly data;

$$\Delta P_t = 0.01 + .41 \Delta P_{t-1} - .24 \Delta P_{t-2} + .23 \Delta ER_t - .11 \Delta ER_{t-1} - .14 EC_t \quad (8)$$

$$(2.68) \quad (3.94) \quad (-2.15) \quad (0.65) \quad (-0.33) \quad (-2.38)$$

$$\chi^2_{sc} = 18.54 \quad \chi^2_{ff} = .79 \quad \chi^2_n = 10.30 \quad \chi^2_{hs} = 0.56$$

The annual data indicates that money supply is important in affecting prices in the long run while the monthly data shows that the lagged rates of inflation are more important in affecting prices in the short run. The error correction terms in all three equations are significant implying that approximately the entire disequilibrium in price level is corrected by the end of the first year, and 13% by the end of each month. Except the  $\chi^2$  statistic for normality in equation (8), the  $\chi^2$  statistics for serial correlation, functional form, normality and heteroscedasticity are insignificant at the 5% level implying that the models are correctly specified.

For purposes of comparison, Johansen's(1988) technique has also been applied to the quarterly and monthly data. The lack of sufficient observations precludes the use of this method for the annual data. Table 5 displays the test statistics and the estimated cointegrating vectors from the Johansen procedure for the quarterly data. Panel 3 presents the estimated cointegrating vector. The coefficients in parenthesis are

normalized on the CCPI. The coefficients of real GNP, exchange rate and import price index have the expected sign and is of reasonable magnitude, providing evidence in support of a long run relationship between real GNP, exchange rates and import prices.

**(Table 5, about here)**

Table 6 presents the computed test statistics for the monthly data. The estimated coefficient exchange rate is correctly signed and is of reasonable magnitude. The results are therefore consistent with those obtained under the Engel Granger (1987) technique. The results point to the importance of supply side factors in price level movements in Sri Lanka.

**(Table 6, about here)**

#### **4 Conclusions**

This study suggests the importance of supply side factors as affecting the general level of prices in Sri Lanka. A long run relationship is found between the price level, real GNP, the exchange rate and import prices. With the opening up of the economy, import prices and exchange rate movements appear to have a significant impact on the general level of prices. Alexius (1997) studying the case of Sweden, finds that in a small open economy such as Sweden that the nominal exchange rate and import prices are central factors in influencing the level of prices. The effects of exchange rate movements on import prices appear to be influenced by country size according to Alexius. The country size argument could also perhaps be applied to Sri Lanka. The results are consistent with the studies of Nicholas (1990), Nicholas and Yatawara (1991), Weerasekera (1992), Rupananda

(1994) who also find supply side factors as important determinants of the general price level in Sri Lanka.

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**TABLE 1: FACTORS INFLUENCING THE RATE OF INFLATION IN SRI LANKA**

Data Frequency	Dependent Variable	constant	Independent Variables					R <sup>2</sup>	Diagnostic Tests
<b>Closed Economy</b>									
		M <sub>t</sub>	M <sub>t-1</sub>	P <sub>t-1</sub>	GNP <sub>t</sub>	IMP <sub>t</sub>	ER <sub>t</sub>		
<b>Model</b>									
Annual	P <sub>t</sub>	6.82 (2.8)	0.65 (3.7)	0.49 (2.1)	-0.90 (-2.5)			.996	$\chi^2_{sc}=0.11$ $\chi^2_{ff}=0.08$ $\chi^2_n=1.12$ $\chi^2_{hc}=0.47$
Quarterly	P <sub>t</sub>	-0.13 (-0.5)	0.15 (1.2)	0.95 (15.6)				.998	$\chi^2_{sc}=16.3$ $\chi^2_{ff}=0.32$ $\chi^2_n=0.84$ $\chi^2_{hc}=4.5$
Monthly	P <sub>t</sub>	0.18 (0.20)	0.17 (3.1)	0.87 (18.9)				.993	$\chi^2_{sc}=30.1$ $\chi^2_{ff}=0.18$ $\chi^2_n=0.32$ $\chi^2_{hc}=5.2$
<b>Open Economy</b>									
<b>Model</b>									
Annual	P <sub>t</sub>	-0.32 (-1.16)	0.46 (6.7)			0.20 (2.8)	0.30 (1.9)	.987	$\chi^2_{sc}=1.47$ $\chi^2_{ff}=0.24$ $\chi^2_n=1.40$ $\chi^2_{hc}=2.58$
Quarterly	P <sub>t</sub>	-1.99 (-2.2)		0.60 (6.0)	0.29 (2.6)	0.23 (4.3)	0.19 (2.4)	.997	$\chi^2_{sc}=14.8$ $\chi^2_{ff}=1.40$ $\chi^2_n=2.85$ $\chi^2_{hc}=4.16$
Monthly	P <sub>t</sub>	0.11 (1.4)		0.78 (11.7)		0.14 (2.5)	0.27 (2.8)	.994	$\chi^2_{sc}=41.9$ $\chi^2_{ff}=0.01$ $\chi^2_n=0.16$ $\chi^2_{hc}=4.7$

$\chi^2_{sc}$ =lagrange multiplier test of residual serial correlation ;  $\chi^2_{ff}$ =Ramsy's RESET test using the square of the fitted values;  $\chi^2_n$ =test of skewness and kurtosis of residuals ;  $\chi^2_{hc}$ = based on the regression of squared residuals on squared fitted values

**TABLE 2: NON NESTED HYPOTHESIS TESTS**

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**Annual Data**Regressors for model M1: Constant  $M_t$   $P_{t-1}$   $RGNP_t$ Regressors for model M2: Constant  $M_t$   $IMP_t$   $ER_t$ 

<u>Test Statistic</u>	<u>M1 against M2</u>	<u>M2 against M1</u>
J-Test	2.96(.002)	0.716(.470)
JA-Test	2.95(.003)	0.584(.540)

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**Quarterly Data**Regressors for model M1: Constant  $M_t$   $P_{t-1}$ Regressors for model M2: Constant  $P_{t-1}$   $RGNP_t$   $IMP_t$   $ER_t$ 

<u>Test Statistic</u>	<u>M1 against M2</u>	<u>M2 against M1</u>
J-Test	4.67(.000)	0.072(.955)
JA-Test	0.76(.435)	0.071(.943)

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**Monthly Data**Regressors for model M1: Constant  $M_{t-1}$   $P_{t-1}$ Regressors for model M2: Constant  $P_{t-1}$   $IMP_t$   $ER_t$ 

<u>Test Statistic</u>	<u>M1 against M2</u>	<u>M2 against M1</u>
J-Test	2.18(.031)	0.828(.408)
JA-Test	2.15(.031)	0.826(.407)

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**TABLE 3: UNIT ROOT TESTS FOR THE SERIES**

Data Frequency	Variable	k*	$\tau_{\alpha 1}$	Variable	k	$\tau_{\alpha 1}$
Annual	$P1_t$	0	-2.30	$\Delta P1_t$	0	-3.44**
	$M_t$	2	-2.41	$\Delta M_t$	0	-2.63*
	$IMP_t$	0	-1.42	$\Delta IMP_t$	0	-3.16**
	$ER_t$	0	-2.25	$\Delta ER_t$	0	-5.57***
Quarterly Data	$P1_t$	2	-2.71	$\Delta P1_t$	1	-4.67***
	$GNP_t$	3	-2.21	$RGNP_t$	4	-2.78*
	$IMP_t$	1	-2.72	$\Delta IMP_t$	0	-3.01**
	$ER_t$	0	-2.14	$\Delta ER_t$	0	-8.80***
Monthly	$P1_t$	2	-3.16	$\Delta P1_t$	1	-7.48***
	$IMP_t$	1	-2.72	$\Delta IMP_t$	1	-2.34
	$ER_t$	1	-2.17	$\Delta ER_t$	0	-6.41***

Note : significance levels: 1%, -4.07 : 5%, -3.46: 10% , -3.16

Significance levels first differences: 1%, -3.51 : 5%, -2.90 : 10% -2.58 (Davidson and MacKinnon)

k\* refers to the order of the autoregression used to calculate the ADF statistic

**TABLE 4: TESTS FOR COINTEGRATION**

DATA	DEPENDENT	CONSTANT	INDEPENDENT VARIABLES				ADF
FREQUENCY	VARIABLE		$M_t$	$IMP_t$	$ER_t$	$RGNP_t$	
Annual	$P_t$	-0.31	0.45	0.25	0.28		-5.06
Quarterly	$P_t$	-5.66		0.51	0.39	0.76	-4.69
Monthly	$P_t$	0.15			1.84		-3.93

Significance levels: 1%, -4.29 ; 5%, -3.74 ; 10%, -3.45 (Davidson and MacKinnon)

**TABLE 5: COINTEGRATION TESTS FOR QUARTERLY DATA****A. Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix**

List of Variables included in the cointegrating vector:

 $P_t$   $GNP_t$   $ER_t$   $IMP_t$  Intercept

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
$r = 0$	$r = 1$	39.5098	28.2700	25.8000
$r \leq 1$	$r = 2$	17.2370	22.0400	19.8600
$r \leq 1$	$r = 3$	9.6131	15.8700	13.8100
$r \leq 3$	$r = 4$	7.1321	9.1600	7.5300

**B. Cointegration LR Test Based on Trace of the Stochastic Matrix**

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
$r = 0$	$r = 1$	73.4919	53.4800	49.9500
$r \leq 1$	$r = 2$	33.9821	34.8700	31.9300
$r \leq 1$	$r = 3$	16.7451	20.1800	17.8800
$r \leq 3$	$r = 4$	7.1321	9.1600	7.5300

**C Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets)**List of Variables included in the cointegrating vector:  $P_t$   $GNP_t$   $ER_t$   $IMP_t$  Intercept

Vector	$P_t$	$GNP_t$	$ER_t$	$IMP_t$	Intercept
1	-1.5039	-.37097	.74569	1.2958	6.6821
	(-1.0000)	(-.24668)	(.49585)	(.86167)	(4.4433)

**TABLE 6: COINTEGRATION TESTS FOR MONTHLY DATA**

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**A. Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix**

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List of Variables included in the cointegrating vector:

 $P_t$     $ER_t$    Intercept

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
$r = 0$	$r = 1$	49.4800	15.8700	13.8100
$r \leq 1$	$r = 2$	10.5755	9.1600	7.5300

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**B. Cointegration LR Test Based on Trace of the Stochastic Matrix**

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Null	Alternative	Statistic	95% Critical Value	90% Critical Value
$r = 0$	$r = 1$	60.0555	20.1800	17.8800
$r \leq 1$	$r = 2$	10.5755	9.1600	7.5300

---

**C Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets)**

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List of Variables included in the cointegrating vector:  $P_t$     $ER_t$    Intercept

Vector	$P_t$	$ER_t$	Intercept
1	.40387 (-1.0000)	-.66173 (1.6385)	-.26606 (.65877)
2	2.8906 (-1.0000)	-5.1597 (1.7850)	-1.0680 (.36947)

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