CONTRATO DE CONSULTORIA No. 510277
ENTRE FONADE Y FEDESARROLLO

INFORME FINAL

'EL EFECTO DE LOS CHOQUES MACROECONOMICOS EN LA ECONOMIA COLOMBIANA'

Presentado al:	**Fondo Nacional de Proyectos de Desarrollo**
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Santafé de Bogotá, Febrero 28 de 1998

THE ROLE OF SHOCKS IN THE COLOMBIAN ECONOMY

INTRODUCTION

Every economy is subject to shocks. In the case of the Colombian economy external shocks have been the main concern given the fact that economy can be characterised as small and open exporting commodities with price volatility.[1] In the study of coffee shocks in Colombia, two main approximations have been used: on the one hand, the macroeconomic framework of the Real Business Cycle (RBC), used by Cárdenas (1991) and Suescún (1997). These works aim to see if there are comovements between coffee prices and macroeconomic aggregates such as the output rate of growth. While the first author interprets the country's business cycle as consequence of increases on coffee prices, the second does not find coffee related variables to be procyclical. Other authors like Kamas (1986) and Wunder (1992) have based their analyses on predictions made by the Dutch Disease theory (DD). The DD approach is concerned with shocks to the terms of trade and focuses on resource movements. In short, this approach foresees an appreciation of the real exchange rate after a positive export boom that causes recession in the tradables sector.[2] Both Kamas (1986) and Wunder (1992) find elements of DD in the Colombian economy following coffee booms. More recently, the discovery of oil has renewed the interest for this kind of analysis. Works by Perry, Lora and Barrera (1994) and Posada et al. (1994) have used computable general equilibrium models destined to capture sectoral movements of resources following the increase in oil production. These models predict Dutch Disease in a small scale, but have also stressed the sensitivity of their conclusions on assumptions such as the level of investment, behaviour of oil prices and policy priorities of the government (inflation versus growth targets).[3] If oil is a long run phenomenon, and oil prices are unstable and volatile as WB (1994) reports, predictions made by these works have to be read with a note of caution.

But external shocks are by no means the only or even main source of shocks to the economy. There have been fluctuations in the economy due to trade and financial liberalisation in the early 90s. More recently there have been demand shocks related to increases in expenditure. Additionally, money supply and exchange rates (at least during its fixed period) have been active instruments of economic policy with their correspondent effect on the rest of the economy, and

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[*] This work has been financed by Fonade and Colciencias to whom I am very grateful. I would also like to thank Fedesarrollo for offering me a wonderful environment to write this paper and meet great economists and great friends. This work would not be possible without the constant supervision of Dr. Jeremy Smith and the valuable help from Martha Misas and Jorge E. Restrepo. Finally, I would like to thank Dr. Alberto Carrasquilla for his careful reading, Dr. Fabio Sanchez for his patience and to all the other participants of the presentations at Fedesarrollo and the DNP.

[1] See Deaton and Laroque (1992).

[2] Corden (1984) makes a classic survey on this literature. Recent extensions are made by Bevan, Collier, and Gunning (1989) in what they call the theory of construction booms.

[3] See comments by Ramirez (1994).

there are many more examples of important sources of shocks other than changes in the terms of trade.

In Colombia many papers have addressed these issues in a separate manner while others have intended to find a link between them. In the context of the present work, we are more interested in the later group. Works by Reinhart and Reinhart (1991), Restrepo (1997), Carrasquilla, Galindo and Patrón (1994), Gaviria and Uribe (1993), and Urrutia and Suescún (1994), among others, aim to find the nature of the shocks and their means of propagation using the structural VAR methodology. The first two authors underline the (temporal) role of monetary shocks, Reinhart and Reinhart making use of two alternative models, one neokeynesian and the other of the real business cycle type, while Restrepo´s paper uses the IS-LM approach implemented by Clarida and Gali (1994) for the US economy. The paper by Carrasquilla et.al. emphasises the real exchange rate and its fundamentals. The article by Gaviria and Uribe stresses shocks on real variables such as productivity, and the work by Urrutia and Suescún aims to find out the role of changes in the terms of trade specifically due to changes in the international coffee price.

This paper aims to provide conclusions regarding the difference between supply and demand shocks. For supply shocks we understand those shocks associated to productivity increase and also include oil and gas findings giving they increase the wealth of the nation. As for demand shocks, they comprehend those caused by changes in government expenditure or changes in the terms of trade. The central hypothesis is that only supply shocks affect production in the long run while demand shocks have only a temporal effect. If the results of this analysis is consistent, i.e. if responses of the economy to demand shocks are consistently different from those to supply shocks, it would be possible to draw general conclusions on the way in which the Colombian economy reacts to specific shocks. The use of this hypothesis is based on works for the US economy by Blanchard and Quah (1989) and Blanchard (1989). Blanchard and Quah (1989) find that supply shocks have a lung-run positive effect on output and a short-run negative effect on employment, while demand shocks have only short-lived effects that increase both output and employment.

In looking for the above objectives, the first part of this paper (section II) will study the properties and behaviour of relevant quarterly series for the Colombian economy such as the output rate of growth, real and nominal exchange rates, money supply, interest rates, wages and unemployment among others. This section pays considerable attention to unit root tests, seasonal unit root tests, and structural breaks at seasonal and zero frequencies. This knowledge is crucial for the correct specification of structural VAR. Section III explains the structural VAR methodology and introduces the alternative ways of imposing restrictions that are going to be developed in the applied part of the work, or section IV. In this section there are three different structural VAR: the first one is based on a model for the Colombian economy developed by Reinhart and Reinhart (1991) and tested by those authors for annual data. This work uses their framework for quarterly

data. The model is based on a work by Clarida and Gali (1994), and the third part includes three bivariated structural VAR which reinforce some of the most important findings of the previous models reviewed in a summary at the end of the work.

II RELEVANT FEATURES OF COLOMBIAN MACROECONOMIC SERIES

The choice of appropriate macroeconomic data was defined by the models that are going to be implemented in the third section. They include GDP, money supply (M1), consumers price index (CPI), nominal and real exchange rates (TC and RER respectively), interest rates (INT), wages (W) and unemployment (U). The data base is for quarterly data during the period 1970-1996.

Structural VAR models require that the series included are in their stationary form. Unit root tests, both, for seasonal and zero frequencies are done in this section. Additionally, we present results for tests on structural breaks of tne series for seasonal and zero frequencies since their presence bias the results from the unit root tests. We also perform a visual inspection of the series, their correlograms, and other statistical information. Finally, this section selects the series to be included when more than one source is available and determines the sub-samples that would be interesting to look at.

2.1 How Big Is the Random Walk for the Colombian GDP?

The first step in our work is to understand the behaviour of the time series. First, because most econometric models assume stationarity in the data and when this condition is not present the relations shown by the models could respond only to spurious relationships rather than to long run (equilibrium) economic relationships.[4] Second, this analysis is specially important for the case of GDP because one of our major questions is how GDP responds to different type of shocks and how consistent this response is during the period of time we are studying.

2.1.1 Features of the GDP Series

There are several series for real GDP in Colombia because its yearly publication before the 70´s was undertaken by the Central Bank (Banco de la República) and since then is produced by the National Statistics Office (DANE). This break implied a change in methodology and the various series correspond to different attempts made in order to smooth it. The latest attempt is that by López, Gómez and Rodriguez (1996). First, they retrapolate the DANE series using the rates of

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[4]. For a extensive discussion on spurious regressions in econometrics see Granger and Newbold (1974) as well as Phillips (1986).

growth given by the Central Bank. Second, from this new series they check basic macroeconomic identities in order to guarantee consistency.[5] The main problem with the new series is due to the failure of the Central Bank series to account for some government enterprises. Other series we will examine are those by the Central Bank as quoted by Montoya (1996) and the third one by Cárdenas and Olivera (1995).

Although Colombian GDP is yearly, there are various exercises which convert it into quarterly data. We have worked with two such series from the National Planning Department (DNP): one beginning in 1975, and the other ('new'), which begins in 1977.

2.1.2 Visual Inspection of the Series and their Correlograms

Visual inspection of the series is a generalised practice used even in famous econometric papers and is a tool in the Box-Jenkins approach used to identify and estimate time series models. For example: The correlogram for a stationary series should converge to zero geometrically. Nevertheless, it has important shortcomings due to the difficulty in differentiating for example a unit root process from a trend stationary one. The main purpose of this section is to give an idea of the behaviour of the series and perhaps identify structural breaks on it, but it does not intend to classify the series in to trend stationary (TS) or difference stationary (DS) processes on this basis. This type conclusions will be reached once unit root tests are performed.

Graph 1 plots the logarithm and the first differences of: 1) the yearly GDP series by Lopez et.al (1950-93), 2) Cárdenas et.al (1950-1994), and 3) Central Bank (1925-1994). It also presents their respective correlograms.

The first row of graphs (a to c), shows the upward trend in all the GDP series while the second row (d to f) shows the slight discrepancy between their first difference prior to 1970.

In general terms, one can say that these graphs do not show a change in mean or variance in the series. Thus the series might be stationary in first difference. The correlograms of the series in levels, (g to i), show strong autocorrelation with a slow decrease as the lag length increases. This suggests that the series is non-stationary in levels. [6]

Graph 2 presents the same information for the two quarterly GDP series. It clearly shows the difference among both series: While the 'old' series show seasonal pattern peaking in the fourth quarter until 1985 and since then peaking in the second quarter as well. In the 'new' series seasonality is consistently represented by a slump in production during the second quarter. The seasonal break of the old' series is not present in the 'new' one, where only the degree of the slump is reduced between 1986 and 1992 without implying changes in the mean or variance of the

[5] Other attempts use the information given by the coefficient of regressions on the GDP components from both series, using the information for the years that both series overlap This exercise was made by Agudelo (1991); the main drawback is that it does not guarantee the accomplishment of macroeconomic identities.
[6] This is confirmed by a pronounced peak at low frequency in their spectrums (not shown here).

series in first differences. The correlograms for quarterly GDP series show strong autocorrelation suggesting, as the yearly series do, non-stationarity of the series. The correlogram for their first difference shows strong seasonal correlation even after three years.

2.1.3 Results from Unit Root Tests at Zero Frequency on Real GDP Series

Appendix 1 presents the methodology followed in order to test for unit root at the frequency zero. The tests are on the logarithm of real GDP. Every test performed on yearly GDP series during the period 1950-94 show non-stationarity, i.e. GDP~ I_0 (1), indicating that the series has to be differentiated one time to induce stationarity, i.e. ΔGDP~ I_0 (0). Results are robust for the different sources and for the sub-samples 1950-1983 and 1960-1993. They are also consistent for the ADF and the PP summarised in Table 1. Table 2 shows the Akaike Information Criterion (AIC) with which the lag length of the augmented part was chosen.

In model (i), besides the acceptance of unit root (Ho: γ=0 with the test τ_τ), all the yearly GDP series show that the trend is not significatively different from zero according to the $\tau_{\beta\tau}$ statistic and supported by the ϕ_3 test (Ho:$\gamma=\beta=0$). On the other hand, the ϕ_2 test (Ho:$\gamma=\beta=\alpha=0$) is rejected at least for two of the yearly GDP series indicating that for these series (Cárdenas and Central Bank) GDP is I_0(1) with drift.

Model (ii) is then estimated for the remaining yearly series (López et al.). The unit root hypothesis is accepted (τ_μ) and the drift (α) is statistically equal to zero according to both, the 't' test ($\tau_{\alpha\mu}$) and the ϕ_1 test (Ho:$\gamma=\alpha=0$). Thus, López's GDP series is I_0(1). Tests on the first difference ΔGDP confirm that all GDP~I_0(1).

For the quarterly series we got a 't' value for the unit root hypothesis that very nearly rejects this hypothesis, although it does suggest the series is still I_0(1). Notwithstanding, PP rejects the null hypothesis.

TABLE 1: ADF AND P&P TESTS FOR UNIT ROOT AT FREQUENCY ZERO

Source	Unit Root Test on	Augmented (No. lags)	't' Ho:γ=0 (τ_τ or τ_μ)	't' Ho:α=0 ($\tau_{\alpha\tau}$ or $\tau_{\alpha\mu}$)	't' Ho:β=0 ($\tau_{\beta\tau}$)	F test γ=β=0 (ϕ_3)	F test γ=β=α=0 (ϕ_2)	F test γ=α=0 (ϕ_1)	$SSR_{WR\tau,\phi3}$ / $SSR_{WR\mu,\phi2,\phi1}$	P&P (3 trun lags)*
Lopez	Y_t	(2)	-1.68	1.71	1.61	1.79	4.04		$SSR_{wr\tau}$ 0.008812	-0.99
1950-93	T=41		(-3.52)	(3.14)	(2.81)	(6.73)	(5.13)		$SSR_{\phi3}$ 0.009686	(-2.93)
		(2)	-0.96	1.22				4.56	$SSR_{wr\mu}$ 0.009451	-1.22
			(-2.93)	(2.56)				(4.86)	$SSR_{\phi1,2}$ 0.011782	(-2.93)
	ΔY_t	(2)	-3.56	3.42				6.34	$SSR_{wr\mu}$ 0.008830	-4.98
	T=40		(-2.94)	(2.56)				(4.86)	$SSR_{\phi1}$ 0.119410	(-2.93)
Cardenas	Y_t	(1)	-1.18	1.22	1.06	1.67	13.37		$SSR_{wr\tau}$ 0.015726	-1.26
1950-94	T=43		(-3.52)	(3.14)	(2.81)	(6.73)	(5.13)		$SSR_{\phi3}$ 0.017112	(-3.51)
	ΔY_t	(1)	-3.65	3.50				17.57	$SSR_{wr\mu}$ 0.016319	-6.53
	T=42		(-2.93)	(2.56)				(4.86)	$SRR_{\phi1}$ 0.031024	(-2.93)
Ctr-Bank	Y_t	(2)	-2.72	2.75	2.75	3.38	12.07		$SSR_{wr\tau}$ 0.033402	-2.17
1925-94	T=67		(-3.48)	(3.14)	(2.81)	(6.73)	(5.13)		$SSR_{\phi3}$ 0.037588	(-3.48)
	ΔY_t	(3)	-6.07	5.82				19.34	$SSR_{wr\mu}$ 0.032270	-7.23
	T=65		(-2.91)	(2.56)				(4.86)	$SRR_{\phi1}$ 0.052085	(-2.90)
Subsample	Y_t	(1)	-1.22	1.26	1.17	0.90	13.40		$SSR_{wr\tau}$ 0.018067	
Ctr-Bank	T=46		(-3.52)	(3.14)	(2.81)	(6.73)	(5.13)		$SSR_{\phi3}$ 0.018859	
1950-94	ΔY_t	(1)	0.57	4.10				9.19	$SSR_{wr\mu}$ 0.018715	-6.98
	T=46		(-2.93)	(2.56)				(4.86)	$SSR_{\phi1}$ 0.027108	(-2.93)
DNP	Y_t	(8)	-3.469	3.48	3.59	6.99	6.45		$SSR_{wr\tau}$ 0.010759	-5.66
quarterly	T=70		(-3.474)	(3.14)	(2.81)	(6.73)	(5.13)		$SSR_{\phi3}$ 0.013307	(-3.47)
data									$SSR_{\phi2}$ 0.014288	
1977:1-	ΔY_t	(8)	-2.57	2.22				3.45	$SSR_{wr\tau}$ 0.013065	-19.90
1996:3	T=69		(-2.90)	(2.56)				(6.73)	$SSR_{\phi1}$ 0.014595	(-2.90)

( ) In parentheses critical values at 5% significance levels from MacKinnon (1991) for τ_τ and τ_μ, and from D&F (1981) for $\tau_{\alpha\tau}$, $\tau_{\alpha\mu}$, $\tau_{\beta\tau}$, ϕ_1, ϕ_2, and ϕ_3.

* Phillips&Perron suggest a truncation lag equal to the number of serial correlation to include. The Newey West's suggestion for these exercises, based on the number of observations, was 3. Notwithstanding we run the test with different truncation lags (not reported)and conclusions reached with the standard regression never changed.

$F=[(SSR_\phi-SSR_{WR})/r]/(SSR_{WR}/T-K)$; SSR= sum of square residuals; SSR_{WR}= SSR without restrictions, $SSR\phi_i$ = SSR with the restrictions imposed by the ϕ_i test, r=number of restrictions, K=number of estimated parameters.

TABLE 2: AKAIKE INFORMATION CRITERION

YEARLY GDP	AIC with Lag Length	1	2	3
López et al.	Model (i) on Y_t	-8.19	-8.20	-8.17
	Model (ii) on Y_t	-8.20*	-8.18	-8.19
	Model (ii) on ΔY_t	-8.20	-8.22	-8.18
Cárdenas et al.	Model (i) on Y_t	-7.73	-7-70	-7.63
	Model (ii) on Y_t	-7.75	-7.69	-7.63
	Model (ii) on ΔY_t	-7.71	-7.65	-7.66
Central Bank 1925-94	Model (i) on Y_t	-7.43	-7.45	-7.45
	Model (ii) on Y_t	-7.38*	-7.37	-7.38**
	Model (ii) on ΔY_t	-7.39	-7.40	-7.45
Central Bank 1950-94	Model (i) on Y_t	-7.64	-7.62	-7.58
	Model (ii) on Y_t	-7.65	-7.62	-7.57
	Model (ii) on ΔY_t	-7.65	-7.61	-7.64
QUARTERLY GDP	AIC with Lag Length	4	8	12
DNP 1977:1-1996:3	Model (i) on Y_t	-7.88	-8.45	-8.33
	Model (ii) on Y_t	-8.07	-8.30	-8.18
	Model (ii) on ΔY_t	-8.27	-8.28	-8.18

* Residuals from these models do not resemble white noise, thus the AIC is not imposed

** The AIC is contradicted by the Schwarz criterion (not presented): thus two lags are applied.

2.1.4 Testing for Seasonal Roots

Testing for seasonal roots could be helpful for a better understanding and modeling of short-run relationships on macroeconomic variables. Although the quarterly GDP series is estimated from the annual series, other data such as interest rates, money supply, exchange rate, employment and other series are observed every quarter. Unit root tests such as the ADF test, tests for unit root at zero frequency, i.e., Ho: $Y_t \sim I(1,0)$.[7] But in practice, it could be testing Ho: $Y_t \sim I(0,1)$ ...because a unit root at lag four also implies a non-seasonal unit root' (Osborn, Chui, Smith, Birchenhall, 1988, p.365). Thus, series with quarterly or monthly observations with strong seasonal patterns could lead us to conclude there is a unit root at zero frequency when in fact, there could be additional unit roots on the unit circle.

The tests used here are the Hylleberg-Engle-Granger-Yoo (1990) (HEGY), the Hasza-Fuller (HF) and the Osborn, Chui, Smith, Birchenhall (OCSB). The first test allows testing for the existence of unit roots at each seasonal frequency independently. The HF and OCSB allow us to test unit roots for zero and seasonal frequencies simultaneously (see Appendix 1 for the methodology).[8]

2.1.5 Empirical Results from Seasonal Unit Root Tests on Real GDP Series

All the tests are on the logarithm of quarterly real GDP The series is given by the DNP for the period 1978:1 to 1996:3. Results from the HEGY test are reviewed in Table 4. There we present results for all the Auxiliary Regressions (ART). Those of type 1, (ART1) do not include deterministic elements, the ART2 include just the drift, the ART3 include the drift and seasonal dummies, the ART4 include both drift and trend, and finally, the ART5 include drift, trend and seasonal dummies. The number of lagged terms depends on the errors to be whitened. Thus, residuals were tested with several diagnostic tests such as the Autocorrelogram (Q), the Breush-Godfrey (LM) test, the White test, and the Jarque-Bera test. In all but one case (the ART4), four lags were enough for this purpose. We also took into account the Akaike Information Criterion (AIC) which confirmed the need of 4 lags in all but the ART4 where 8 lags were chosen.

Results from Table 3 are fairly robust: every Auxiliary Regression but ART1 accepts unit root at the zero frequency ('t' on π_1) and all of them accept unit root for half yearly frequency ('t' on π_2). For the annual frequency (F test on $\pi_3 \cap \pi_4$) the null is accepted when no seasonal dummy variables are included (ART1, ART2 and ART4). Nevertheless, in those auxiliary regressions that

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[7] The standard terminology designates a series Y_t to be integrated of order (d, D), ($Y_t \sim I(d,D)$) when one-period diferencing d, and seasonally diferencing D times induces stationarity. Alternatively, a unit root at zero frequency could be written as $I_0(1)$, and a unit root at the biannual frequency as $I_{\pi/2}(1)$.

[8] Oliveros (1995) finds that the HEGY test for series I(1,1) tends to recognise the presence of the seasonal component $(1-L^4)$, instead of $(1-L)(1-L^4)$.

seasonal dummy variables are included, (ART3 and ART5) at least one of them (the second quarter, Q2) is significatively different from zero and the hypothesis of unit root at the annual frequency is rejected.

ART5 is selected as the appropriate test, given the deterministic terms (constant, trend and seasonal dummy variables) are significatively different from zero. Thus, quarterly GDP has unit root at zero frequency as well as at the biannual frequency. Similar results are obtained by Otero (1995), although he uses the old GDP series by DNP which presents a structural break in the fourth quarter of 1985. On the other hand, results for Misas and Suescún (1993) accept unit root on GDP at the zero, biannual and annual frequencies for a series constructed by the Central Bank and for a shorter period: 1980:1- 1992:4.

In the same direction, Table 4 presents results from the OCSB test accepting the hypothesis of unit root at seasonal and zero frequencies given by the t values of β_1 and β_2. Nonetheless, there are contradictory results from the HF which rejects the null QGDP~I(1,1) given by the F test. These type of contradictions are not uncommon in econometric exercises and introduce a line of suspicion to the conclusion but the reader should be able to evaluate that there is stronger evidence of unit root at seasonal and zero frequencies for Colombian GDP.

TABLE 3: HEGY TEST ON GDP SEASONAL UNIT ROOTS

T=71 (4lags) T=67 (8lags)	Augmented part: NoLags	't' Ho:π_1=0	't' Ho:π_2=0	't' Ho:π_3=0	't' H:π_4=0	'F' $\pi_3 \cap \pi_4$=0	DRIFT t on α Ho:α=0	TREND t on β Ho:β=0	SEASONAL DUMMIES	SSR_{WR} SSR_R Akaike
ART 5	(4)	-2.33 (-3.71)	-2.67 (-3.08)	-2.53 (-1.93)	-2.77 (-1.91)	9.12 (6.55)	2.35 (3.14$\tau_{\alpha\tau}$)	2.50 (2.81$\tau_{\beta\tau}$)	Q1 -2.12 Q2 -3.18 Q3 0.22	0.008857 0.011462 -8.58
ART 4	(8)	-2.69 (-3.56)	-1.11 (-1.91)	0.17 (-1.92)	-0.41 (-1.90)	0.11 (2.95)	-2.70 (3.14$\tau_{\alpha\tau}$)	2.76 (2.81$\tau_{\beta\tau}$)		0.010591 0.010630 -8.33
ART 3	(4)	1.49 (-3.08)	-2.60 (-3.04)	-2.14 (-3.61)	-2.76 (-1.98)	7.83 (6.6)	-1.26 (2.56$\tau_{\alpha\mu}$)		Q1 -1.98 Q2 -2.79 Q3 0.47	0.009843 0.012289 -8.50
ART 2	(4)	1.03 (-2.96)	-1.75 (-1.95)	0.20 (-1.90)	-1.06 (-1.72)	0.63 (3.04)	0.91 (2.56$\tau_{\alpha\mu}$)			0.014025 0.014291 -8.28
ART 1	(4)	2.96 (-1.95)	-1.74 (-1.95)	0.20 (-1.93)	-1.01 (-1.70)	0.60 (3.26)				0.0142 0.014453 -8.29

( )In parenthesis critical values at 5% Significance Levels from HEGY (1990);_Critical Values for the deterministic elements here called $\tau_{\beta\tau}$, $\tau_{\alpha\tau}$ y $\tau_{\alpha\mu}$ (are from D&F(1981))

* Residuals show serial correlation with Breush-Godfrey (LM) Test.

$F=[(SSR_R-SSR_{WR})/r]/(SSR_{WR}/T-K)$; SSR= sum of square residuals; SSR_{WR}= SSR without restrictions, SSR_R = SSR with restrictions test, r=number of restrictions, K=number of estimated parameters.

TABLE 4: HF AND OCSB TESTS ON GDP SEASONAL UNIT ROOTS

Variable	Seas.Dummies	Lags	't' for β_1	't' for β_2	SSR_{WR}	SSR_R	HF 'F' test: $\beta_1 \cap \beta_2=0$
DQGDP T=73	No	1	1.18 (-1.95)	-2.14 (-2.60)	0.016162	0.019046	6.25 (3.26)
DQGDP T=64	Yes (D1 to D4)	2	-0.25 (-1.95)	1.45 (-2.60)	0.013743	0.018240	9.16 (3.26)

( )In parenthesis critical values at 5% Significance Level from Osborne et al. (1988)
$F=[(SSR_R-SSR_{WR})/r]/(SSR_{WR}/T-K)$; SSR= sum of square residuals; SSR_{WR}= SSR without restrictions, SSR_R = SSR with restrictions test, r=number of restrictions, K=number of estimated parameters.

2.2 Seasonal and Unit Root Tests for Other Macroeconomic Time Series

This section reviews the results from statistical analysis on other macroeconomic data that will be considered in our final models which include: money supply (M1), interest rates (INT), nominal exchange rate (ER or TC), real exchange rate (RER), consumer's price index (CPI) average wages (AW) and rate of unemployment (U). For some of these variables there is more than one source and therefore we present the results for every series we have. The first part of this section visually examines the features of each series. The second part considers the results of the HEGY test for seasonal unit roots, and finally, the third part, corroborates these results with the methodology proposed by Perron (1989, 1993) and Smith and Otero (1996) for series with structural breaks (in mean or/and variance).

2.2.1 Visual Inspection of the Series and their Correlograms

Graph 3 plots the logarithms, first differences and respective correlograms for two series of quarterly data for M1: the first, from the International Financial Statistics (IFS) and the other, M1r, from the Central Bank (Banco de la República).[9] These series are very similar: they show an upward trend for the logarithms with marked seasonal pattern specially after 1980:3. The first difference of the series, shown in Graph 3c and 3d, also reflect the 1980:3 break by the increase in the magnitude of the oscillations. This change is an indication of a structural break that will be taken into account latter on in this section and has been reported before by Montenegro et. al. (1987). The correlograms for the logarithms show high positive correlation slowly decreasing and for the first differences strong periodic correlation persisting over several years. The above features suggest that the series may have unit root and a seasonal component.

[9] M1r is a series revised and differs from the 'old' M1 because takes away the money from financial institutions that are not part of the banking system and the their deposits in the central bank.

There are also two series with quarterly data for interest rates, each one corresponds to different sources on the prime given to fix-period deposits before 1980:2.[10] The first series (I) shows the average prime given to 90-day deposits 'Certificados de Depósito a Término' (CDT-90 days), while the second (INT) takes the end of term yield by 120-day papers negotiable in the stock market known as 'Certificado de Ahorro Tributario' (CAT). [11] For the period 1980:2 - 1996:3 both series show the interest yielded by 90-day interest rate (CDT), taking the average rate for the first series (I) and the end of term for the second series (INT).[12] Graph 4 shows the dramatic differences between I and INT for the pre-1980:2 data as well as the break for both series at this point in time. The first series (I) reflects the fixed interest rates prevailing before 1980:2 to CDT 90-day while the second shows the higher volatility of the CAT-120 days. Graphs 4c and 4d for the first differences confirm this finding. Correlograms for the logarithms for I and INT (Graphs 4e and 4f) show a slow decreasing correlation, while the autocorrelation for their first difference is very small and does not indicate any seasonal pattern.

The quarterly nominal exchange rate (ER or TC) series was taken from the Central Bank. It represents pesos per dollar at end of the quarter. Graph 5a shows the upward trend and Graph 5d shows the break in 1991:4 reflected in the change of the variance in the ER first differences. This break corresponds to the change from a crawling peg system to a flexible exchange rate system introduced in November 1991. The logarithm (LER) shows strong but decreasing autocorrelation, and the first differences (DLER) has positive correlation (Graph 5g).

Logarithms of real exchange rate (LERE) shows a change in mean by 1985 reflecting the real devaluation of around 50% (Graph 5b), the correlogram for the first difference presents no change in variance (Graph 5e). Correlograms for the logarithms show positive autocorrelation decreasing smoothly and small correlation for the first differences (Graph 5h). Thus, from the visual analysis the series seems to have all the characteristics of an I(1) series. The third group of graphs correspond to the terms of trade, calculated as the ratio from the prices of exports and imports, both from the IFS-IMF. The series in levels show the peaks of the two international coffee price hikes in the late 70's and in 1986, as well as the fall of this price after the end of the International Coffee Agreement in 1989 (Graph 5c). In first differences there seems to be no significative change in mean or variance and the correlograms are compatible with the hypothesis that the series is non-stationary in levels but in first differences (Graphs 5f and 5i).

As for the Consumers Price Index (CPI) it presents an ascending path for the plot in logarithms (Graph 6a), and a significant positive correlation for the series in levels as well as a

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[10] Only from 1980:2 there is official data for 90 days CDT CDT are certificates offered by banks and financial corporations. They were fixed during the 70's and in consequence did not reflect market information

[11] CAT certificates were given to exporters and represented a proportion of the export value. Exporters could negotiate the certificate in the stock market.

[12] In international studies of the interest rate it is frequent to find the series in levels without taking its natural logarithm Notwithstanding, in the present study we take the natural logarithm, base on Banerjee et.al.

quite strong seasonal correlation for the series in first differences (Graph 6g). The rate of unemployment for the 4 major cities, (UN), has a seasonal pattern reflected in the correlogram for the series in first differences (Graphs 6b, 6e and 6h).[13] Finally, the average nominal wage shows *no change* in mean or variance. The correlogram in levels presents an initial strong positive correlation that decreases sooner than in most of the series here analysed, though not as quick as in an I(0) series, thus, it seems the series also follows an I(1) (Graphs 6c, 6f and 6i).

2.2.3 Empirical Results from Seasonal Unit Root Tests

From the visual analysis of the series M1, UN and CPI have a seasonal pattern. Consequently, we decided to use the HEGY procedure to test for seasonal roots in all the series and contrast its findings with the ADF and Phillips and Perron test for unit root. Results for the seasonal unit roots are showed in Table 5. For all the series analysed we could only reject the presence of unit root at zero frequency for interest rates when residuals are not normal, and for wages when correcting residuals for non-normality[14]. As for seasonal frequencies, only M1[15] and interest rate, (INT), show seasonal unit root at the biannual frequency, while none of the series seem to have unit root at the annual frequency.[16] Deterministic seasonal components are important for most of the series, the exceptions are INT and ER. The same exercise was made with a sub-sample for the sub-period (1977:1-1996:3) and the above results seem to be quite robust.[17]

One methodological innovation in the above regressions is the introduction of a dummy (do) for outliers identified in some of the estimations which lead the residuals to be non-normal, these outliers are given at the bottom of Table 5. Having ignored these non-normality of the residuals could have led us to conclude, for example, that interest rates were a stationary series when they are not.

As mentioned, Augmented Dickey Fuller (ADF) and Phillips and Perron (PP) tests were also applied to the series. Table 6 shows results for the whole sample as well as tests performed in

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(1993) finding: if the series are cointegrated in levels they will be cointegrated in their logarithms, but not *vice versa*.

[13] As in the case of INT, the rate of unemployment (UN), could have been introduced in levels, notwithstanding, the analysis is made on its natural logarithms which do not affect results of cointegration tests.

[14] The introduction of dummies for outliers make residuals conform to a normal distribution, nonetheless, critical values estimated by HEGY do not take into account the possible effect of these variables on the distribution. Since HEGY´s critical values are not intended for cases with dummies other than the seasonal ones, they are just presented to have an imperfect indication of the parameter's significance.

[15] Both M1 series give consistent results, for this reason we will not differentiate in this analysis among them

[16] Misas and Suescún (1993) also find that M1 has a unit roots at zero and seasonal frequency (at the annual frequency). The discrepancy on the seasonal frequency could be attributed to two factors: the longer period studied in the present study 1970:1-1996:3 Vs 1980:1- 1992:4; and the fact that we chose M1 revised which is a different series than the M1 these authors used.

[17] These results are not shown and will be given on request to the author.

sub-samples for those series where there seem to be structural breaks. The first feature of these tests is the impossibility for many series to whiten the residuals by adding additional lags. Those series are: M1, INT, ER, CPI and WAGES. This problem affects critical values which are base upon correct model specification, thus, we proceeded to identify the cause of the non-whiteness which in almost every case was the non-normality of residuals. Once the outliers were identified the respective dummy variable was added to the model. This procedure whitened the residuals for CPI and WAGES, and the sub-samples of INT and ER. Notwithstanding, residuals for the whole sample of M1, INT and ER could not be whitened with this procedure. Table 6 shows that most of the series have a unit root at the zero frequency. The exceptions are: INT for the whole sample and sub-sample 1980:3-96:3 and RER in the sub-sample 1985:2-1996:3. Results by Phillips and Perron test confirm these findings except for CPI series where the dummy for outliers was introduced to estimate the ADF (and could not be included to perform the PP).

There are two important cases for which there are differences in the test's results for some of the series sub-samples: INT has unit root in the sub-sample 1970:1-1980:2, (the CAT period), while seems an stationary series for the whole sample and the sub-sample 1980:2- 96:3; and RER has unit root for the whole sample and sub-sample 1970:1-85:1 but is stationary after 1985:2.

TABLE 5: HEGY TEST ON SEASONAL UNIT ROOTS[18]

EXERCISE WITH SAMPLE 1970-96, AND CRITICAL VALUES FOR T=100

T=79	NoLags	't' Ho:π_1=0	't' Ho:π_2=0	't' Ho:π_3=0	't' H:π_4=0	'F' $\pi_3 \cap \pi_4$=0	DRIFT t on α Ho:α=0	TREND 't' on β Ho:β=0	SEASONAL DUMMIE	SSR_{WR} SSR_R Akaike
M1-IFS T=97	ART5 (6)	-1.57 (-3.53)	-1.30 (-2.94)	-4.08 (-3.48)	-1.91 (-1.94)	10.99 (6.60)	1.70 * (3.14$\tau_{\alpha\tau}$)	1.62 (2.81$\tau_{\beta\tau}$)	Q1 -3.59 Q2 -4.38 Q3 -3.15	0.110488 0.140094 -6.47
M1r-BdR T=102	ART 5 (1)	-2.72 (-3.53)	-1.52 (-2.94)	-2.77 (-3.48)	-2.73 (-1.94)	7.18 (6.60)	2.87 (3.14$\tau_{\alpha\tau}$)	2.70 (2.81$\tau_{\beta\tau}$)	Q1 -3.61 Q2 -3.42 Q3 -2.17	0.080428 0.092985 -6.95
INT RTE** CAT-CDT T=92	ART 2 (8)	-3.58 (-2.88)	-2.22 (-1.95)	-2.16 (-1.90)	-1.64 (-1.68)	3.79 (3.08)	3.65 (2.56$\tau_{\alpha\mu}$)			0.958624 1.047223 -4.32
INT RTE* CAT-CDT T=92	ART 2 (11)	-2.09 (-2.88)	-1.60 (-1.95)	-3.23 (-1.90)	-2.29 (-1.68)	8.07 (3.08)	2.14 (2.56$\tau_{\alpha\mu}$)			0.716666 0.868924 -4.49
NOM ER* T=93	ART 1 (10)	1.06 (-1.97)	-3.79 (-1.92)	-3.51 (-1.90)	-1.60 (-1.68)	6.82 (3.12)				0.020500 0.024038 -8.10
REAL ER T=104	ART 3 (0)	-1.22 (-3.08)	-4.90 (-3.04)	-6.03 (-3.61)	-6.31 (-1.98)	67.31 (6.60)	1.31 (2.56$\tau_{\alpha\mu}$)		Q1 -2.46 Q2 -1.81 Q3 1.13	0.080012 0.192215 -7.02
CPI* T=104	ART 5 (0)	-3.31 (-3.53)	-8.17 (-2.94)	-4.95 (-3.48)	-6.42 (-1.94)	44.67 (6.60)	3.90 (3.14$\tau_{\alpha\tau}$)	3.36 (2.81$\tau_{\beta\tau}$)	Q1 4.05 Q2 3.83 Q3 -1.32	0.015103 0.029457 -8.64
UNEMP T=78	ART 3 (1)	-2.00 (-3.08)	-3.61 (-3.04)	-6.66 (-3.61)	-2.30 (-1.98)	24.64 (6.60)	1.61 (2.56$\tau_{\alpha\mu}$)		Q1 4.86 Q2 1.93 Q3 -1.03	0.450113 0.771533 -4.92
WAGES** T=71	ART 5 (3)	-2.50 (-3.53)	-3.42 (-2.94)	-4.13 (-3.48)	-2.25 (-1.94)	8.71 (6.60)	2.56 (3.14$\tau_{\alpha\mu}$)	2.45 (2.81$\tau_{\beta\tau}$)	Q1 4.19 Q2 2.51 Q3 0.62	0.088444 0.113284 -6.95
WAGES* T=71	ART 5 (4)	-4.26 (-3.53)	-4.52 (-2.94)	-4.05 (-3.48)	-2.23 (-1.94)	12.72 (6.60)	4.10 (3.14$\tau_{\alpha\tau}$)	4.20 (2.81$\tau_{\beta\tau}$)	Q1 5.08 Q2 2.01 Q3 1.40	0.041403 0.059563 -7.00

** Residuals are non-normal but the regression is presented to show the changes in the results once errors are whithened.

* Residuals are made normal by adding an outlier dummy: for interest rates (CAT_CDT) in 1992:2, for nominal exchange rate in 1994:1; for CPI in 1977:2; and for Wages two dummies were introduced, one for 1979:1 and 1986:2, and the other for 1993:2. Critical values for π´s do not take into account these dummies and thus they should only be used as indication of the significance but not as a method of contrast, since we do not know the way these variables affect their distribution.

( )In parenthesis we present critical values at 5% Significance Levels from HEGY (1990);_Critical Values for the deterministic elements here called $\tau_{\beta\tau}$, $\tau_{\alpha\tau}$ y $\tau_{\alpha\mu}$ are from D&F(1981)

[18] Based on similar results found for M1, from now on the analysis will be based just on M1 revised form the Central Bank. The interest rate series based on yields to CDT (I) will not be analysed given the serious break presented in 1980:1 and the fact that it was heavily controlled before that date.

TABLE 6: ADF AND P&P TESTS FOR COLOMBIAN MACROECONOMIC SERIES

Variable	Sample or Sub-sample	Unit Root Test on	Augmented (No. lags)	't' Ho:γ=0 (τ_τ or τ_μ)	't' Ho:α=0 ($\tau_{\alpha\tau}$ or $\tau_{\alpha\mu}$)	't' Ho:β=0 ($\tau_{\beta\tau}$)	F test γ=β=0 (ϕ_3)	F test γ=β=α=0 (ϕ_2)	F test γ=α=0 (ϕ_1)	P&P (3, trun lags)
M1R/[1]	1970:1-96:3	T=98	(7)/[2]	-0.50 (-3.45)	2.56 (3.11)				-29.14 (4.71)	0.11 (-2.89)
	1970:1-80:4	T=33	(4)	-2.86 (-3.53)	2.90 (3.20)	2.91 (2.85)				-2.81 (-3.52)
	1981:1-96:3	T=65	(6)	-0.23 (-2.91)	1.03 (3.14)					0.04 (-2.91)
INT	1970:1-96:3	T=95	(11)/[3]	-3.58 (-2.89)	3.65 (2.54)				7.16 (4.71)	-3.17 (-2.89)
	1970:1-80:2	T=40	(0)	-2.43 (-2.93)	2.53 (2.56)					-2.17 (-2.93)
	1980:3-96:3	T=65	(0)/[4]	-3.44 (-2.90)	3.44 (2.56)					2.56/[5] (-2.91)
NOMINAL ER	1970:1-96:3	T=99	(7)/[3]	-0.47 (-2.89)	1.45 (2.54)				1.38 (4.71)	0.86 (-2.89)
	1970:1-91:4	T=86	(1)/[4]	-0.43 (-3.46)	0.89 (3.11)	2.01/[6] (2.79)				-0.49 (-3.46)
	1992:1-96:3	T=19	(1)	-2.37 (-3.67)	2.31 (3.20)	2.36 (2.85)				-3.57 (-3.67)/[7]
REAL ER	1970:1-96:3	T=102	(4)	-1.76 (-2.89)	1.76 (2.54)				1.57 (4.71)	-1.19 (2.89)
	1970:1-85:1	T=60	(0)	-1.14 (-2.91)	1.11 (2.56)					-1.18 (-2.91)
	1985:2-96:3	T=46	(0)	-4.69 (-2.93)	4.72 (2.97)					-4.37 (-2.93)
CPI	1970:1-96:3	T=103	(4)/[4]	-3.20/[8] (-3.45)	3.99 (3.11)	3.23 (2.79)	5.60 (6.49)	10.69 (4.88)		-3.96/[5] (-3.45)
UNEMPL	1976:1-96:3	T=74	(8)	-2.46 (-2.90)	2.48 (2.56)				1.83 (4.86)	-2.50 (-2.90)
WAGES	1976:1-96:3	T=76	(4)/[4]	-0.86 (-2.90)	2.72 (2.56)				10.56 (4.86)	-0.29 (-2.90)

( ) In parentheses we present critical values at 5% from MacKinnon (1991) for τ_τ and τ_μ, and from D&F (1981) for $\tau_{\alpha\tau}$, $\tau_{\alpha\mu}$, $\tau_{\beta\tau}$, ϕ_1, ϕ_2, and ϕ_3.

/1 Montenegro et.al. (1987) suggests a seasonal break in 1980:4; Otero (1996) assumes the time break in 1980:1.

/2 Residuals show high autocorrelogram for lags 5th, 13th and 14th.

/3 Residuals do not follow a normal distribution even after introducing dummies for outliers. These results are subject to this problem.

/4 In order to have normality in the residuals, a dummy (do) was introduced in 1992:2 for INT, in 1974:4, 1985:1 and 1985:2 for ER; in 1977:2, for CPI; and in 1988:2 for WAGES.

/5ADF differs from PP due perhaps to the fact that the ADF was calculated using the dummy (do) for outliers.

/6 The trend term was left because if left, γ becomes positive.

/7 The PP's null Ho. cannot be rejected at 10% critical value (-3.28), which is consistent with the ADF's result.

/8 The ADF's null Ho. is rejected at 1% critical value (-3.15), which is consistent with the rejection using PP.

$F=[(SSR_{\phi}-SSR_{WR})/r]/(SSR_{WR}/T-K)$; SSR sum of square residuals; SSR_{WR}= SSR without restrictions, $SSR\phi_i$ = SSR with the restrictions imposed by the ϕ_i test, r=number of restrictions, K=number of estimated parameters.

2.2.3 Structural Breaks in M1r, Interest Rates and Real Exchange Rate.

Findings form HEGY tests and ADF tests lead us to believe that many macroeconomic series have a unit root. These findings are similar to those found by Nelson and Plosser (1982) for macroeconomic series of the United States of America. Their results were nevertheless challenged by Perron (1989) who finds that usual tests are not able to reject the unit root hypothesis if the deterministic path of the series has a single break.

In the visual analysis there was evidence of breaks in the series, some due to changes in the methodology of recollection or to the change of source which is the case of INT; some due to changes in seasonal behaviour, which is the case of M1, and others because there was an important event such as the real devaluation of 1985 which seems to have changed the features of the RER series. Some of these structural breaks changed the statistical features of the series as was pointed out in last section: INT and RER become stationary series after their time breaks. It is important, therefore, to implement the methodology proposed by Perron (1989 and 1993) in order to test if the series really do have a unit root with possibly non-zero drift, or if they are trend-stationary processes with a one time break in the intercept and/or the slope. Additionally, there is one test for quarterly data with breaks in their level and/or seasonal behaviour presented by Smith and Otero (1996). These authors have developed the relevant procedure for a break consistent of change of level (intercept), and/or seasonal behaviour. (See Appendix 2 for a review of the methodology)

Tests using Perron were performed in the series with breaks but residuals never became i.i.d., not even after correcting for outlier observations that made residuals no normal in their distribution.

Notwithstanding, we use the test for quarterly data with breaks in their level and/or seasonal behaviour by Smith and Otero (1996). The results in Table 7 show: 1) that M1 has a unit root at the zero frequency and the biannual frequency, (the same result from the original HEGY); 2) In the same way, RER only has unit root at zero frequency. 3) On the other hand, results for INT differ from original HEGY, after correcting for the structural break due to different papers in the market, INT has only unit root at zero frequency and no unit root at the biannual frequency.

2.2.4 Summary of Statistical Features of the Series

This section summarises the results of all the tests implemented until now (see Table 8). First we note that all the series have unit root at zero frequency. These results seem robust for most tests and sub-samples except for the case of wages. Only two series have seasonal unit roots. This result is also consistent with other works on the same series. As for structural breaks, INT is the series more sensitive to this issue. This weakness reflects the fact that INT is a

compilation of two different series: the first part gives the yields for CAT and the second part the yield for CDT, being CAT and CDT two different papers in the market. Other series which seems to have a structural break is the RER, which seems stationary after the break in 1985:2.

TABLE 7: SMITH AND OTERO TEST FOR STRUCTURAL BREAKS IN SERIES WITH SEASONAL COMPONENTS. EXERCISE WITH SAMPLE 1970-96.

Variable	Type of Model Time Break (TB) NoLags ( )	't' $Ho:\pi_1=0$	't' $Ho:\pi_2=0$	't' $Ho:\pi_3=0$	't' $Ho:\pi_4=0$	'F' $\pi_3 \cap \pi_4=0$
M1r T=100 λ=0.4	CHANGE IN PATTERN & LEVEL TB=80:3 (3)	-3.21 (-4.06)	-3.32 (-3.47)	-2.22 (-4.17)	-5.08 (-2.05)	15.13 (1.42)
RER T=103 λ=0.6	CHANGE IN LEVEL TB=85:3; DO=1 FOR 85:4 (0)	-2.48 (-3.64)	-9.88 (-2.01)	-9.23 (-1.95)	-9.39 (-1.66)	116.86 (0.06)
INT RTE CAT-CDT* T=96 λ=0.4	CHANGE IN LEVEL TB=1980:1 (7)	-2.92 (-3.65)	-4.15 (-2.01)	-3.01 (-1.98)	-0.74 (-1.67)	4.50 (0.06)

* Residuals are made normal by adding an outlier dummy: for RER in 1985:4.
( )In parenthesis critical values at 5% Significance Levels from Smith and Otero (1996).
λ=TB/T.

TABLE 8: TIME SERIES PROPERTIES

Series	Properties	Comments
GDP-Yearly	$I_0(1)$	Robust to 6 series and simmilar to other papers.
GDP-Quarterly	$I_0(1)$ and seasonal unit root	Robust to HEGY and OCSB tests. Simmilar results to other series analysed by Suescún and Misas (1993) and Otero (1995).
M1R-Quarterly	$I_0(1)$ and seasonal unit root	Robust to 2 series, to sub-samples and to tests on structural breaks.
INT-Quarterly	$I_0(1)$	Structural break in the series make tests results vary when changing the sample.
NOM-ER-Quarterly	$I_0(1)$	Robust to all the tests and different sub-samples.
RER-Quarterly	$I_0(1)$	Robust to all the tests but for the subsample 85:2-96:3 the series is stationary.
CPI-Quarterly	$I_0(1)$	PP rejects the null Ho of unit root.
UNEMPL-Quarterly	$I_0(1)$	Robust to all the tests.
WAGES-Quartely	$I_0(1)$	Non-robust results. Correcting for outliers changes conclusions.

III METHODOLOGY FOR STRUCTURAL VAR

3.1 Introduction

This section reviews what a structural VAR aims, its relevance for economic analysis and some of the ways it can be estimated.

Structural VARs aim to predict the relative importance of economic disturbances (say real and nominal or supply and demand) in economic variables and their dynamic effects. The seminal works are those by Blanchard (1989), Blanchard and Quah (hereafter B&Q, 1989) and Clarida and Gali (hereafter C&G, 1994). Their models have a common objective with the present work, they aim to explain the sources of macroeconomic fluctuations as well as to assess the main dynamics steaming from different shocks. This methodology provides links between the usual *reduced model* estimated with the standard VAR methodology with its *structural form*. One important advantage of this methodology is the possibility to have long-run relationships among variables, as well as account for contemporaneous effects among variables and innovations. Structural VARs explain the contemporaneous correlation among residuals of a standard or reduced VAR. In standard VAR the residual associated to each variable represents either a shock in the variable or the contemporaneous effect of other shock in this variable while for structural VAR residuals, often called structural shocks, represent autonomous changes of the variables.

The standard VAR methodology estimates a reduced form of the following type:

$$x = F(L)\,x(-1) + Ft + u. \qquad (1)$$

where F(L) are polynomials in the lag operator L such that the individual coefficients of $F_{ij}(L)$ are denoted by $(\phi_{ij}(k))$. For example, the second coefficient of $F_{21}(L)$ is $(\phi_{21}(2))$. The residuals are assumed to be serially uncorrelated but contemporaneously correlated. In a two variable model with just one lag and a constant, the system is:

$$Y_t=\phi_{10}+\phi_{11}Y_{t-1}+\phi_{12}Z_{t-1}+u_{1t} \qquad (1a)$$

$$Z_t=\phi_{20}+\phi_{21}Y_{t-1}+\phi_{22}Z_{t-1}+u_{2t} \qquad (1b)$$

where u_{1t} and $u_{2t} \sim N[0,\Omega_u^2]$

The 'structural VAR methodology' finds a link between this representation and the structural representation

$$Ax = B(L)\,x(-1) + Bt + Ce \qquad (2)$$

where e is the white noise vector of structural innovations (or pure or structural shocks) with zero correlation across innovations i.e., the covariance matrix of innovations is diagonal V(e) = D; C *captures* different effects of innovations on other right hand side variables if it differs from the identity matrix;[19] t is the vector of deterministic variables; x is the vector of macroeconomic variables in their stationary form and A captures contemporaneous interactions between endogenous variables. A, B and C are full rank matrices.[20] In two variable and one lag model the structural system is:

$$Y_t=\alpha_{12}Z_t+b_{10}+b_{11}Y_{t-1}+b_{12}Z_{t-1}+e_{yt} \quad (2a)$$

$$Z_t=\alpha_{21}Y_t+b_{20}+b_{21}Y_{t-1}+b_{22}Z_{t-1}+e_{zt} \quad (2b)$$

where e_{1t} and $e_{2t} \sim N[0,\Omega_e^2]$

An important difference between reduced (1) and structural (2) forms are the contemporaneous effects among endogenous variables captured by A in the structural form. It is also interesting to recall that the reduced VAR residuals (u_t) are composites of structural shocks (e_t). This is easier seen if we rewrite (2) as:

$$x = A^{-1}B(L)\,x(-1) + A^{-1}Bz + A^{-1}e \quad (2')$$

Where $A^{-1}B(L)=F(L)$, $A^{-1}Bz=F$ and $A^{-1}e=u$. In this way the link between u_t and e_t becomes explicit as: $u_t = A^{-1}e_t$. In the simplest two variable model:

$$u_{1t}=(e_{yt}-\alpha_{12}e_{zt})/(1-\alpha_{12}\alpha_{21}) \quad (3)$$

$$u_{2t}=(e_{zt}-\alpha_{21}e_{yt})/(1-\alpha_{12}\alpha_{21}) \quad (4)$$

The structural VAR cannot be estimated directly due to the correlation between the regressors and the residuals: for example, Z_t is correlated with e_{yt}. The issue is then to use the reduced VAR to recover the information on the structural VAR. In the simplest example (two variables, one lag and a constant), the standard VAR estimates: the two intercepts (n x 1, where n is the number of variables included), the four coefficients (n x n), and the three elements $((n^2+n)/2)$ of the symmetric var-cov matrix (Σ_u). While, the correspondent structural VAR needs to estimate the same six coefficients plus the two feedback coefficients, and the diagonal var-cov matrix of

[19] The only study of the above quoted that assumes $C\neq I$ is that by Blanchard (1989).
[20] Matrices A and C are generally normalised so their diagonal elements are equal to unity.

innovations with its three variances. [21] From this example, it is clear that in order to go from the reduced form to the structural form one needs a set of just identifying restrictions on A. In principle $(n^2-n)/2$ restrictions will suffice but given non-linearities in the system more restrictions could be *needed*.

The advantage of orthogonalised innovations (e_t) over non-orthogonalised ones (u_t) is their uncorrelatedness, both across time and across equations, i.e., independence of the various shocks. Besides, their impulse response and variance decomposition take into account the co-movement existent among the system's variables.

The aim of orthogonalisation is to find a non-singular matrix for which:

$A\Sigma_u A' = \Sigma_e$

By definition:

$\Sigma_u = (1/T)\Sigma u_t u'_t$ and $\Sigma_e = (1/T)\Sigma e_t e'_t$

given $e_t = Au_t$

$\Sigma_e = (1/T)\Sigma\ (Au_t)(u'_t A')$
$= A\Sigma_u A'$

where, $E(e_t, e'_t) = D$, and D=diagonal matrix

3.2 Ways to Impose Restrictions

3.2.1 Choleski Decomposition

The Choleski factorisation imposes A to be lower triangular with positive elements in the diagonal. For the Choleski factorisation there is only one matrix A for which $A\Sigma A' = I$, which satisfy that the new innovations $e_t = Au_t$ have a var-cov matrix such that $E(e_t, e'_t) = I$ (i.e. it has to be diagonal). There is a different factorisation for every order of variables and the outcome varies the most when the innovations u_t are correlated. Thus, the most sensitive issue when dealing with

[21] The key assumption that $cov(e_{yt}\ e_{zt})=0$ is consequence of the independence of the shocks. Stockman (1994), severely criticises this assumption on C&G´s paper expressed by uncorrelated demand and supply innovations. According to this author, in a general equilibrium model 'increases in demand raise investment, which raises future capital stock and supply... similarly, an increase in technology raises not only supply but also affects demand by raising wealth and the marginal product of future capital'. (Stockman, 1994, p.62). The fact is that e_{1t} is intended to be the orthogonalised portion of the demand shock, or the part of demand that does not change in response to aggregate supply.

Choleski decomposition is the ordering of variables: using semi-structural interpretation where from theory it is possible to assume that movements in one variable precede those of others.

This methodology has been widely criticised. Its main shortcoming according to Blanchard (1989) and Stockman (1994) is the fact that these restrictions do not necessarily have economic sense since it implies that the first equation has only one endogenous variable, the second equation two endogenous variables and so on, for example:

> ... *only supply shocks are expected to influence relative output levels in the long run, while both supply and demand shocks are expected to influence the real exchange rate in the long run. Shocks on money are expected to have no long-run impact on either relative output levels or the real exchange rate.'* C&G (1994, p.29).

3.2.2 Structural Decomposition

This method follows the seminal works by Sims (1986) and Bernanke (1986). Their aim is to incorporate more economical rationality to the set of restrictions imposed on A. They assume a model for the non-orthogonal innovations, u_t, such that: $Au_t=e_t$, where $E(e_t, e'_t)= D$, where D is a diagonal matrix. Using a likelihood based function, the objective is to minimise $-2\log|A|+ \sum \log(A\Sigma_u A')$.

3.2.3 Restrictions à la Blanchard and Quah

The purpose here is to offer a structural interpretation to shocks (e_t). In B&Q (1989) for example, they intend to decompose GNP into its permanent and temporal components. Using a bivariate moving average model (BMA), they assume that one of the shocks (supply) has permanent effect on the variable to be decomposed (GNP), while the other (demand), has only temporary effects on the same variable, i.e. the accumulated effect of demand shocks on GNP is zero in the long run. For the second variable, in their case unemployment rate, they assume that both type of shocks have only temporary effects.

Transforming the variables into their stationary form, the moving average representation takes the following form:

$$x_t = C(L)\, e_t \qquad (5)$$

where the variance-covariance matrix for structural shocks (e) is normalised and off-diagonal elements assumed to be zero (Σ_e=I). The coefficients $C_{ij}(L)$ represent the impulse response of a variable j to the i shock. B&Q do not identify the variables with the structural shocks which they assume exogenous supply and demand shocks. The complete identification of the structural

shocks is achieved by the key assumption to differentiate the shocks so that one (aggregate demand) has a temporary effect while the other, (aggregate supply) has a permanent effect on the variable to decompose, in their case GNP. The restriction imposed is expressed by $C_{11}(L)=0$.

Given the variables are stationary, there exists a reduced-form VAR representation:

$$x_t = F(L)\,x(-1) + u_t \qquad (6)$$

where each observable u_t is a composite of non-observable structural shocks e_{it}, precisely of the form:

$$u_{1t} = c_{11}(0)e_{1t} + c_{12}(0)e_{2t} \qquad \text{and} \qquad (7)$$

$$u_{2t} = c_{21}(0)e_{1t} + c_{22}(0)e_{2t} \qquad (8)$$

in matrix form,

$$u_t = C(0)\,e_t \qquad (9)$$

Thus, in order to identify the structural shocks (e) we need to impose four restrictions in order to identify the four coefficients from C(0). These restrictions are:[22]

$Var(u_1)= c_{11}(0)^2 + c_{12}(0)^2$

$Var(u_2)= c_{21}(0)^2 + c_{22}(0)^2$

$Cov(u_1, u_2)= c_{11}(0)\, c_{21}(0) + c_{12}(0)\, c_{22}(0)$

$0= c_{11}(0)[1-\Sigma\phi_{22}(k)] + c_{21}(0)\Sigma\phi_{12}(k)$[23]

The first step is to estimate the standard VAR and then to use its residuals (u), to calculate the variance-covariance matrix as well as the sums $[1-\Sigma\phi_{22}(k)]$ and $\Sigma\phi_{12}(k)$, for k ranging from 0 to p (being p the lag length used to estimate the VAR). With these values one solves the four restrictions above for $c_{11}(0)$, $c_{12}(0)$, $c_{21}(0)$ and $c_{22}(0)$. Since two of the restrictions are expressed in a quadratic form, it is possible to have multiple solutions which have the same coefficients in absolute terms, but different sign. The selection of the set of coefficients depends on their economic interpretation.

The next step is to recover the 'structural shocks (e) using the relation described by equation (7). What I do is to premultiply the vector of standard errors (u) by the inverse of matrix C(0) with the expected signs.

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[22] See Appendix 3 for the derivation of restrictions.

[23] When the restriction is $C_{12}(L)=0$, Restriction 4 changes to $0= c_{12}(0)[1-\Sigma\phi_{22}(k)] + c_{22}(0)\Sigma\phi_{12}(k)$.

$C^{-1}(0)\, u_t = e_t$ (10)

With these residuals $\{e_t\}$ one should be able to obtain impulse response functions and variance decomposition, but first we need to recover the coefficients C(L), (we only know C(0)).

Remember that the bivariate moving average representation (BMA) can be expressed by (3): $x_t=C(L)e_t$

or when including constant term, by:

$$x_t= \mu +C(L)e_t$$

where μ is the vector of the unconditional means of x_t. The C(L) coefficients of the BMA representation can be obtained from its respective VAR. Let the VAR representation be

$x_t = F(L)\, x(-1) + u_t$ or including the intercept,

$x_t = F_0 + F_1\, x_{t-1} + u_t$

Iterating backwards once and twice, this becomes:

$$\begin{aligned} x_t &= F_0 + F_1\,(F_0 + F_1\, x_{t-2} + u_{t-1}) + u_t \\ &= Fo + F_1\,(F_0 + F_1(F_0 + F_1\, x_{t-3} + u_{t-2}) + u_{t-1}) + u_t \\ &= Fo + F_1\, F_0 + F_1^2\, F_0 + F_1^3\, x_{t-3} + F_1^2\, u_{t-2} + F_1\, u_{t-1} + u_t \\ &= (I+F_1+F_2)\, F_0 + F_1^3\, x_{t-3} + F_1^2\, u_{t-2} + F_1 u_{t-1}+ u_t \end{aligned}$$

which after n iterations becomes:

$$x_t = (I+...+F_n)\, F_0 + F_1^{n+1}\, x_{t-n+1} + \Sigma F_1^n\, u_{t-n}$$

The stability condition requires that F_1^n vanishes as n approaches infinity. Assuming this convergence we have the expression:

$x_t = \mu + \Sigma F_1^n\, u_{t-n}$ (11)

in terms of the structural errors (e), using the relation between residuals (u) and structural shocks (e) given by equation (2'), this expression becomes:

$x_t = \mu + \sum F_1^n A^{-1} e_{t-n}$

where F is the matrix of standard VAR coefficients and A is the matrix of contemporaneous coefficient of the structural VAR.

C(L) coefficients are then obtained making use of the following equality

$x_t = \mu + C(L)e_t = \mu + \sum F_1^n A^{-1} e_{t-n}$

thus,

$C(L)e_t = \sum F_1^n A^{-1} e_{t-n}$ (12)

IV BEHAVIOUR OF MACROECONOMIC SHOCKS IN COLOMBIA

4.1 Introduction

In the first part of this work it was said that the broad aim of this paper was to find clues on the importance of shocks in macroeconomic variables using the structural VAR methodology. Here we present five models that could lead us to useful insights on the role of supply and demand shocks in real and nominal variables. In specific we are interested in the effects of shocks to production, monetary variables and nominal and real exchange rates.[24] The first model is based on a paper by Reinhart and Reinhart (henceforth R&R, 1991) which takes into account the short-run relationship between the stock of money (M1), production (GDP), consumer price index (CPI) and nominal exchange rates (TC). The short-run restrictions are imposed following the principles inherent to a neokeynesian and a real business cycle model, and thus, enables the possibility of evaluation as to which of them better describe the behaviour for the Colombian figures in a given period. The second model follows very closely the work by Clarida and Gali (henceforth C&G, 1994). This model estimates a three-equation open macro model and identifies structural shocks to supply, demand and money. The restrictions are imposed following Blanchard and Quah (henceforth, B&Q, 1989) and adopt a Choleski decomposition in the long-run: supply shocks affect GDP, real exchange rates (RER) and nominal M1 in the long run; demand shocks affect RER and M1; and monetary shocks only affect M1. Finally, the last section estimates a group of three bivariate models that impose long run restrictions following the methodology imposed by B&Q (1989). All these models aim to find the long-run effect of demand and supply shocks for a given group of variables: the first model includes nominal and real exchange rates (TC and RER correspondingly), the second one RER and CPI, and the third includes GDP and CPI.

4.2 A re-estimation of Reinhart & Reinhart's model

This model aims to show how the most important macroeconomic variables are related in the Colombian economy and how is their response to different types of shocks. This section follows the exercise by Reinhart and Reinhart (R&R, 1991) which estimates two alternative models: the first one, called the Neokeynesian model, assumes M1 to be the most exogenous variable; the second one, the Real Business Cycle (RBC) approach, assumes that GDP is only affected by real variables and thus it is the most exogenous variable while M1 accommodates to nominal and real shocks. The procedure follows the methodology by Blanchard (1989) where restrictions in the short

[24] A very important uncial objective was to see the effect of oil prices on the Colombian macroeconomic behaviour. Unfortunately, there is little quarterly data for this topic and even yearly data for government revenues from oil production lack of sense since they fall for those years when production and exports actually increased dramatically. These data was kindly given by the DNP.

run dynamics are used to implement a Bernanke decomposition. **Appendix 4** presents a detailed description of the original models whose initial variables and equations were nominal M1, GDP, CPI, average wage (AW), interest rates (INT), and nominal exchange rate (TC). **Appendix 4** also shows the steps followed in the present paper for these models estimations.

Prior to the presentation of the results it is important to underline differences between the current estimation and that from R&R. First, the present paper uses quarterly data while R&R uses yearly data. The use higher frequency should provide a better understanding of the short-run dynamics. Second, the period of time covered differs as well: this paper covers 1977:1-1996:3 while R&R covers 1960-1987. Third, here we perform identification tests, granger causality tests and block exogeneity tests which suggest that some variables in the original (R&R) models are redundant for this data set (see **Appendix 4** for the results of these tests). Thus, the system is reduced to four variables and equations: M1, GDP, CPI, and TC. Fourth, in this paper we test for cointegration (Johansen in CATS). Results presents in **Appendix 4** suggest two cointegrating vectors. In consequence, the VAR cannot be estimated in differences since it would entail misspecification and will not include the long run information that gives stability to the model. Instead we estimate a VEC.[25] Nonetheless, we find no cointegrating equations among the variables for the period 1977:3-1991:1, and the SVAR for Neokeynesian and RBC relationships (without the equations for average wages and interest rates) is estimated for this sub-sample. Finally, we do an estimation introducing real exchange rates (RER) instead of nominal exchange rates (TC).[26]

According to common wisdom, we expect a shock in M1 to increase aggregate demand and supply in the short run since prices do not react immediately. Nevertheless the preasure on supply should rise prices and bring demand to its long run level. A shock in M1 should also depreciate the nominal exchange rate (TC) according to either the PPP (where $TC= p-p^{*}+\mu$, p are prices and p^{*} are external prices), or the monetary model.

Second, a shock in GDP, say an increase in productivity, should increase GDP in the long run, prices fall in consequence of the additional supply, and the nominal exchange rate appreciate according to the PPP or the monetary model. The real exchange rate depreciates if the increase in supply is for non-tradables, whose prices should fell in consequence.

Third, shocks in prices should eventually be accommodated by M1 and create an inertia in prices' behaviour. This could increase costs and shift of demand towards imported products affecting negatively GDP. The increase in prices depreciates the nominal exchange rate and the effect in real exchange rate is expected to be little significative in the long run since the change in prices does not reflect productivity changes.

A nominal devaluation can lead to inflation that will eventually be accommodated by M1. Demand shifts towards cheaper imported goods but an increase in exports make an empirical

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[25] None of the available papers on structural VAR (SVAR) have found cointegration, and therefore, there is little said on Structural VEC. For this reason this attempt will not be taken here.

question the final effect on GDP Finally, shocks in real exchange rates, say a real depreciation that reflects higher competitivity should give similar results to a shock in GDP.

4.2.1 Results from the VEC in Four Variables for the period 1977:1 - 1996:3

In this section we show the results of two VEC in four variables because there are at least two cointegrating relationships between them which are presented in Appendix 4. The first estimation includes M1, GDP, CPI and TC, and the second M1, GDP, CPI and RER. These models leave out two variables introduced in R&R's model (wages and interest rates), because these variables fell to prove important for the model (see Appendix 4). It is important to note that the impulse-response of a VEC differs from that of a SVAR. In a VEC, the residuals (u_t) are correlated and therefore the shocks are somewhat connected.

The impulse responses for the model with TC are in Graph 7 and the variance decomposition in Graph 8. First we will focus on the effects of one standard deviation of M1 on the other variables of the model (first column of graphs). M1 increases in response to the shock in itself while production rises very little since the increase in demand is quickly matched by increase in prices. The only unexpected result here comes from the appreciation of the nominal exchange rate which, in principle, is not supported by any of the prevailing theories on exchange rate which expect an increase in domestic currency to depreciate the nominal exchange rate other things left equal. It is possible that the nominal exchange rate is reflecting that it was fixed for most of the period under study and thus its response obeys to policy decisions taken at times when there was an expansion in M1 as a way to reduce inflationary preassures. Graph 9 shows the impulse response for a (VEC) estimated including the real exchange rate RER instead of the nominal exchange rate (TC). In this case the increase in M1 is followed by an increase in production and prices rise only one year after the shock, expressing price rigidities. Due to this price behaviour RER appreciates only two years after the shock.

The second column shows the responses to one standard deviation in production. In Graph 7 we see the model with TC in which, according to the general hypotheses of the paper, GDP responds more positively to supply shocks than to any other shock. Accordingly, prices contract after this increase in supply. The nominal exchange rate, on the other hand, is not substantially affected. Graph 9 shows the responses for the model with RER. As expected, RER depreciates after an exogenous increase in production making domestic goods more competitive in the international market.

The third column shows responses to a CPI shock: in this case the responses follow an expected path: M1 increases after the second quarter, CPI rises and do not decline in the medium term.. This increase in domestic prices has a contractionary effect on production reflecting the

[26] This change was made for suggestion of Dr. Fabio Sanchez.

costs' increase, and/or the shift of demand towards imported goods. Thus there is a deterioration in the current account and the productive sector that is offset by the depreciation.

Finally, the effect of a depreciation of the nominal exchange rate, (Graph 7), is of little importance on the other variables, the main effect is on itself but this fades away in the medium term. Thus, the way in which movements of nominal exchange rate affect other macroeconomic variables seems not to be through its direct effect but rather through its effect on other variables not introduced in this model, for example real exchange rate. In fact, the effect of a depreciation of the RER, Graph 9, which reflects a more competitive economy, shows a more sustained increase in production, a reduction in inflation in the short-run, and shows an important inertia in the RER after its own shock.

Graphs 8 and 10 show the variance decomposition of the two VEC estimated. They show which percentage of the variance of a variable is due to changes (shocks) in other variables. In both models the graphs show that the variance of most variables is highly explained by their own shocks. Notwithstanding, in the model with nominal exchange rate (TC) the CPI explains at least 20% of the variance of GDP, M1 and TC in the medium term. On the other hand, in the model with real exchange rates (RER) M1 and RER explain between 20% and 40% of the variance of GDP in the medium term while GDP and CPI are responsible for around 30% of RER's variance.

Summarizing the findings of this section some interesting insights are: supply shocks are important sources of economic dynamism in the Colombian economy, the opposite happens with increases in consumers' prices which are accommodated in the medium term by money supply and deteriorate production. Finally, real exchange rate is a more relevant variable than nominal exchange rate in terms of its responses to shocks in other macroeconomic variables. In other words, within this model, real exchange rates are more closely related to different economic signals than nominal exchange rates. An obvious explanation of this is the fixed regime (crawling peg) of the nominal exchange rate until 1991:3.

4.2.2 Results for the SVAR in Four Variables for the Period 1977:1 - 1991:1

It was possible to estimate a SVAR for the sub-period 1977:1-1996:1 because there are no cointegration relationships for the group of four variables (M1, GDP, CPI and TC) during this period. Although in this case average wages and interest rates were not included as in the original models by R&R the restrictions imposed still reflect the difference stressed by the original article: in the neokeynesian model M1 is the most exogenous variable while in the RBC it is GDP. The impulse-responses of a SVAR are called structural shocks. These structural shocks (e_t) are orthogonal and therefore only take into account the variable's responses to a single shock, controlling for the effects of other shocks while keeping the co-movement existing among the system's variables. For instance, the response of GDP to a structural supply shock will not include

its effect in aggregate demand and its consequent effects on GDP. These short-run restrictions are imposed using the Bernanke procedure in RATS The model is run with variables in differences and with 4 lags according to the AIC shown by Table 9

TABLE 9: CHOOSING THE LAG LENGTH

	3 LAGS	4 LAGS	5 LAGS
AIC	-33.93	-34.29	-34.18
SBC	-31.62	-31.37	-30.65

Although the restrictions imposed in each model are dissimilar, the impulse-response Graphs show only small differences between them. Graphs 11 to 14 show the impulse responses for the RBC model and Graphs 15 to 18 show those for the neokeynesian model. This similarity may be suggesting that the contemporaneous restrictions imposed to the short-run matrix are not significative with this data set. Additionally, the Graphs also resemble the findings by the previous VEC estimation. This implies certain independence of the reduced form residuals (u_t).[27] As expected, Graphs 12 and 16 show that a supply shock makes GDP rise in the long-run and that this effect is slightly more strong in the RBC model (Graph 12) reflecting the weight this model puts on real variables. Other supply shock effects are the fall in prices due to the productivity gain for the first three quarters in the RBC model and its little effect in the nominal exchange rate in the medium term. Once again this reflects the fact that the nominal exchange rate was fixed in Colombia until 1991:3.

Graphs 11 and 15 show the effects of demand structural shocks. In both cases supply rises as response to the increase in demand although for an unexpected long time. Money supply rises but there is only mild increase in prices in the medium term suggesting again some price rigidities. The effect in nominal exchange rates is an appreciation which resembles results from the VEC.

Graphs 13 and 17 show the effect of monetary shocks. These shocks severely reduce production and have a higher inflationary effect than demand shocks. The nominal exchange rate depreciates as expected by the monetary and PPP models.

Finally, Graphs 14 and 18 show the effect of a depreciation of the nominal exchange rate. For both models, the neokeynesian and the RBC, for at least the first 6 quarters there is no effect in any of the variables except itself. This result resembles once again results from the VEC and point out to the fixed nature of the variable and the relevance of looking for a model with RER. However, with our data set there are cointegrating relationships that make impossible the estimation of a SVAR.

[27] Note that reduced form residuals u_t (from the VEC) are linear combinations of structural residual e_t (from the SVAR) and that u_t are correlated while e_t are not correlated.

4.3 Model with GDP, RER and CPI: An Estimation Using Clarida and Gali's Work[28]

The aim of the work by C&G (1994) is to identify sources of real exchange (RER) fluctuations in a bilateral context. The model is based in four macroeconomic equations: an IS, an LM, one for price setting, and one for the parity in interest rates. It also identifies three stochastic shocks: one for demand, other for supply and a third for money. The variables included in the VAR are: output (GDP), real exchange rate (RER) and consumer's price index (CPI). CPI is included since Cumby and Huizinga (1990) show its importance in forecasting changes in bilateral RER[29] Additionally, lagged CPI differentials can be correlated with nominal shocks (monetary). GDP is introduced to capture the effect of real supply and demand shocks, that should have an influence in the RER behaviour. The final element of the structural VAR is the RER. Summarising, the vector x=[GDP, RER, CPI]'. The order obeys to the assumed impact of the respective shocks under the flexible price hypotheses: GDP is affected only by supply shocks in the long run, RER is affected by both supply and demand shocks,[30] and CPI is affected by supply and demand shocks as well as by monetary shocks. [31] In conclusion the system is triangular in the long run. Under sluggish price assumption, the model shows some differences in the short run but in the long run the RER and CPI are expected to converge to the flexible price solution in a single period. The main difference with sluggish price is that all three structural shocks affect all the variables in the short run. Positive supply, demand and monetary shocks affect positively GDP in the short run. For RER there is an overshooting with a monetary shock which did not have any effect in RER in the flexible price model. On the other hand, supply shocks in sluggish price depreciates RER but less than with flexible price. Finally, demand shocks appreciate RER but less than in the flexible price model. Thus, supply and demand shocks within the sluggish price model have an undershooting effect on RER with respect to the flexible price model.

The first step is to chose the lag length of the VAR. Table 10 shows the AIC and SBC for 4 to 8 lags with centered seasonal dummies included in order to account for the seasonal components of the quarterly series. The AIC and SBC clearly prefer the model with 4 lags.

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[28] The introduction of this exercise follows a request by the *'interventor'* of this project Dr. Fabio Sánchez. I wish to gratefully acknowledge Jorge Enrique Restrepo for his help in the programming of this model in RATS. Restrepo (1997) has recently published an article which includes this exercise, and his results are on the same line as the ones presented here. Both estimations make use of DNP quarterly GDP and in consequence the period of time is the same. The main difference among these works are the treatment of the series, while Restrepo filters the series with a MA methodology, the present work introduces seasonally centered dummies to account for the seasonal deterministic and stochastical components of the series. Series other than GDP are different in these works (our series are for the end of quarter) and we use CPI while Restrepo uses inflation.

[29] In our case we find that CPI is important for the system since Granger-cause itself and GDP

[30] In specific, C&G's model predicts that the 'flexible-price' RER depreciates in response to a supply disturbance and appreciates in response to a demand disturbance.

[31] CPI is expected to rise with positive monetary and demand shocks, while it declines after a supply shock.

TABLE 10: CHOOSING THE LAG LENGTH

	4 LAGS	5 LAGS	6 LAGS	7 LAGS	8 LAGS
AIC	-24.41	-24.30	-24.20	-24.27	-24.25
SBC	-22.93	-22.53	-22.13	-21.90	-21.57

Next we test for cointegration with the Johansen procedure (CATS), (see **Appendix 5**). According to Pantula (see Harris, 1995), it is advisable to estimate Johansen cointegration test in models 2 to 4, in order to choose the type of deterministic components that it should include. In this case, no cointegrating relationship was found. Results are reported in Table 11.

TABLE 11: CHOOSING THE RANK OF COINTEGRATION AND DETERMINISTIC COMPONENTS[32]

4 LAGS	MODEL 2, CI-MEAN			MODEL 3, DRIFT			MODEL 4 CI-DRIFT		
Ho: r=	Eigenval.	λ max	Trace	Eigenval.	λ max	Trace	Eigenval.	λ max	Trace
0	0.4476	40.95*	52.03*	0.3695	31.82*	39.64*	0.4183	37.39*	50.22*
1	0.0860	6.21	11.08	0.0685	4.89	7.81	0.1121	8.21	12.83
2	0.0682	4.88	4.88	0.0414	2.92	2.92	0.0648	4.62	4.62

* Accept the null that there are 'r' cointegrating relationships (10%)

Tests of Granger-causality given in Table 12 show that GDP and RER Granger-cause themselves and CPI Granger-cause itself and GDP. Table 13 gives the variance correlation matrix of residuals indicating a relatively low correlation (as a rule of thumb we consider a correlation bigger than 20% to be high).

TABLE 12: GRANGER CAUSALITY TESTS

	DGDP	DRER	DCPI
G.C. DGDP	4.85**	1.35	2.10*
G.C. DRER	0.54	4.92**	1.26
G.C. DCPI	1.23	1.41	2.99**

**Reject the null that $\{y_t\}$ does not Granger-cause $\{x_t\}$ at 5%, * 10%. VAR run in differences.

TABLE 13: COVARIANCE\CORRELATION MATRIX OF RESIDUALS

	DGDP	DRER	DCPI
DGDP	0.0017774001	-0.1021129533	-0.052913047
DRER	-0.00003282660	0.00058144008	-0.1052731509
DCPI	-0.00000743959	0.00002677096	0.00011122119

numbers on and above the diagonal indicate the correlation

Graphs 19 to 21 show the impulse response of the structural VAR. Graph 19 shows that supply shocks have a significatively bigger effect on GDP than in the other variables and this effect is positive and keeps production above its previous mean in the medium term. RER depreciates to

a supply shock (reflecting the productivity gain) and thus CPI falls. Graph 20 shows the responses to a demand shock: here GDP rises after this positive shock but only in the short-run since the positive effect is reversed the second quarter after the shock and the long run effect is negligible as expected. RER appreciates after the demand shock due to the positive effect of demand in increasing the prices of non-tradables which also increase the CPI. With rational expectations, the model predicts that a fraction of any shock to demand will be partially reversed in the following period, thus, the expectation that the demand disturbance will be reversed sets up the expectation of depreciation and the magnitude of present appreciation is dampened, but in the graph we do not see this behaviour. Graph 21 depicts the effects of a positive monetary shock: there GDP increases due to the effect in real balances but soon prices catch up deroding the initial rise in GDP. RER depreciates but as prices increase the initial depreciation is slowly reversed as was expected in the model.

4.4 Three Bivariated SVAR Using B&Q Decomposition.[33]

The first one follows the exercises by Lee and Enders (1993) and by Apergis and Karfakis (1996), which aims "to decompose real and nominal exchange rates in to the components induced by real and nominal factors" as presented in Enders (1995, p.338). An application for Colombia data was made by Carrasquilla, Galindo y Patrón (1994). The two variables are real and nominal exchange rates and the two structural shocks are demand and supply shocks. Supply shocks can be regarded as changes in productivity in the labour force or due to exogenous changes in technology: one example relevant for the coffee sector, (the main export after oil) could be the introduction of more productive varieties of coffee during the first half of the 80's. Another source of real shocks is the exogenous increase in the nations resources due to important oil findings after the second half of the 80's. The interpretation given by Carrasquilla et.al. corresponds to real and nominal shocks where real shocks are interpreted as increases in national savings, one of the RER fundamentals.

Following the methodology by Blanchard and Quah this exercise decomposes matrix C (eq. 5): the assumption made for obtaining the structural shock is that demand (or nominal) shocks do not affect real exchange rate in the long run, only supply (or real) shocks do. This long run restriction is shared by the works previously mentioned and is supported by several models such as those of Dornbush (1976). In terms of the BMA representation the restriction can be written as $C_{12}(L)=0$ in the expression (5) $x_t=C(L)e_t$ which in matricial form can be expressed as:

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[32] The analysis of residuals is not reported given they are irrelevant when there is no cointegration.
[33] The estimation of the models in this section was made with Dra. Martha Misas using a program designed by her in SAS.

$$\begin{bmatrix} RER \\ TC \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_D \\ \varepsilon_S \end{bmatrix}$$

where ε_D and ε_S are the demand and supply shocks.

The second and third models have the same objective and the variables are RER and CPI and GDP and CPI. The restrictions and assumptions follow the same line as the first model.

These three bivariated models do not have cointegrating relationship among their variables, all of which are I(1) according with the results reported earlier in this work. Using the restrictions 1 to 4 obtained by imposing a B&Q decomposition explained in detail in the last section and the coefficients obtained from the standard VAR and the variance-covariance matrix we obtain the structural residuals and the MA coefficients.

The impulse-response shown in Graphs 22 to 24 show that in every case a the accumulated effect of a real shock in the real variable (RER, or GDP) has the expected long run effect, while the effect of a nominal shock is only in the short run and in most cases statistically insignificant. This is not the case though, for nominal variables (TC and CPI).

A closer analysis to Graph 22 shows that a supply shock (of 1%) depreciates the real exchange rate at about 0.07% in the long run reflecting this competitivity gain of the economy Nominal exchange rate depreciates more, near 0.10%, after a supply shock. The lower graphs in Graph 22 show the response to a demand shock. At first sight the effect on RER seems puzzling to say the less, but the confidence bands show that statistically this response is non-significant. The last graph shows how an unanticipated shock in demand that is accommodated leads to depreciation of the exchange rate which is significant statistically and has a long run effect.

Graph 23 describes the response of RER and CPI to supply and demand shocks. First one observes the long run depreciation of the RER after a supply shock, the magnitude is similar to the response of the same variable in the last model, which is a reassuring coincidence. The deflationary effect of a supply shock is present one quarter after the shock, due to some price rigidity. The response of RER to a demand shock is an appreciation due to the pressure in the prices of non-tradables. For the same reason the response to the same shock on the CPI is inflationary.

Finally, Graph 24 shows the responses of GDP and CPI to unexpected supply and demand shocks. First we see that the level of production rises in the long run after a positive supply shock caused, for example, by an increase in productivity. The effect in prices is negligible statistically talking. On the other hand, a demand shock has a significative inflationary effect while it leaves production unchanged in the long run (the confidence bands indicate that the GDP changes are statistically zero). It is interesting to note that the inflationary effect of a demand shock is of similar magnitude in the last two models.

SUMMARY

This paper had the broad objective of looking to the dynamic effects of macroeconomic shocks in the behaviour of macroeconomic variables. The central hypothesis is that supply shocks have a long run effect on real variables while demand and monetary shocks have only short-run effect. Several models were estimated, each approached the imposition of restrictions in a different way, nevertheless, their results are quite consistent. In terms of the central hypotheses for the structural VARs it is possible to conclude that in every case the effects of a supply shock differ importantly to demand shocks. In particular supply shocks affect real variables and more importantly, this lasted for the medium to long run. Thus, GDP rises more and for a longer period after a supply shock according to results from the estimation of the Clarida & Gali model, as well as the bivariated SVAR for the system GDP-CPI. The same result appears from the Reinhart & Reinhart SVAR which did not impose long-run restrictions but short-run ones. Other consistent consequences of a supply shock are the depreciation of the real exchange rate which reflects the productivity gain implied by this kind of shocks and the deflationary impact on the consumers price index, at least for the short-run (See results from Clarida and Gali and the bivariate model including RER-CPI).

Demand shocks, on the other hand, have a positive effect on production but it last considerably shorter: 2 quarters in the estimations using Clarida and Gali and the bivariated SVAR between GDP-CPI. Additionally, in this last estimation the coinfidence bands show that the effect could be considered as null. Other common responses to demand shocks are: an appreciation of the real exchange rate and the increase in the consumers price index.

It also follows from the estimations that for the Colombian economy the international evidence on output-inflation trade-offs exist, i.e., inflation rates do not increase output in average, nonetheless, they do in the short run according to rational expectations theory: Output will be high only when the money supply is and has been higher than it had been expected to be that is, higher than average' (Lucas and Sargent).

Appendix 1: Testing for Unit Root at Zero Frequency and in Seasonal Frequencies

A.1.1 Unit root Test

Unit root test on the series is fundamental for this work given it provides us with information on the memory of the series: if the series is non-stationary (i.e. it has a unit root $I_0\sim(1)$), any shock on the permanently affects future observations and this implies long run memory Two problems of non-stationary series are: spurious regression and that standard distribution of test statistics do not hold. Besides, unit root analysis is a step previous to the cointegration analysis which provides information on any 'stable' long run relationship among the variables to be included in our model.

Following the methodology proposed by Dickey and Fuller (1981), we consider the three following models (ADF tests):

I. $\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \Sigma\delta\Delta Y_{t-i} + \varepsilon$

II. $\Delta Y_t = \alpha + \gamma Y_{t-1} + \Sigma\delta\Delta Y_{t-i} + \varepsilon$

III. $\Delta Y_t = \gamma Y_{t-1} + \Sigma\delta\Delta Y_{t-i} + \varepsilon$

beginning with the first, and testing for unit root (Ho:γ=0).[34] If this hypothesis is accepted, we test for the presence of the trend (Ho: β=0 given γ=0 with the statistic $\tau_{\beta\tau}$);[35] and for the joint hypothesis Ho:$\gamma=\beta=0$ (or ϕ_3 statistic); when all but the last hypothesis are accepted the series is $I_0(1)$ with drift, if, on the other hand, all hypotheses are accepted test for Ho: $\gamma=\beta=\alpha=0$ (ϕ_2 statistic).

When every hypothesis is accepted the second model is tested in the following way: first one tests for unit root (Ho:γ=0) and then for the presence of the drift, (Ho: α=0 given γ=0, with the $\tau_{\alpha\mu}$ statistic), as well as for the joint Ho: $\gamma=\alpha=0$ (ϕ_1). Rejection of the Ho: α=0 suggests that model I should be implemented.[36] When all the hypotheses are accepted the series most likely is $I_0(1)$.

The third model is estimated and tested when the initial value of the series is zero since the t-ratio in model III, τ, is dependent upon Y_0=0 and the t-ratio τ varies with Y_0 (Dickey & Fuller 1981). As this value is unknown in our case, we shall never use this third model.

The number of lagged dependent variables ($\Sigma\Delta Y_{t-i}$) are chosen as the smallest i such that the errors are approximately white noise. For this we test for autocorrelation and serial correlation with a Q test as well as with the Breush-Godfrey LM test (for 4 lags), for normality with the Jarque-Bera statistic and for heteroscedasticity with White's test. We also test for a variety of i values and

[34] Critical values for Ho:γ=0 are from Fuller (1976) and MacKinnon (1991). All other critical values are given by Dickey and Fuller (1981).

[35] However, the t-ratio τ_τ is not invariant to $\beta\neq0$,. Independence is obtained by including time squared in the model, but this transformation does not apply to models with variables measured in logarithms which is our case, as growth in GDP cannot increase indefinitely.

see if the ADF results are robust; The Akaike Information Criteria (AIC) is also used. A final criteria depends on the sample size, $i=T^{1/3}$, which yields a lag i=3 for T=41 and i=4 for T=70).[37]

An additional test for unit root is that by Phillips and Perron (PP) which is less sensitive to lag overspecification.

A.1.2 Tests for Seasonal Unit Roots in quarterly data

We test with three different types of tests for seasonal unit roots: the Haza-Fuller (HF), the Osborne-Chui-Smith-Birchenhall (OCBS) and the Hylleberg, Engle, Granger and Yoo (HEGY). The null hypothesis is $Y_t \sim I(1,1)$ which for quarterly data represents the need to apply the filter (1-L)(1-L^4), (or $\Delta\Delta_4$), to induce stationarity on Y_t. The HF is an F-test on $\beta_1 \cap \beta_2 = 0$ in equation (13) and the OCBS test looks at the t-ratios for β_1 and β_2 in the same equation (13):

$$\Delta\Delta_4 Y_t = \beta_1 Z_{4,t-1} + \beta_2 Z_{5,t-4} + \Sigma\phi_i \Delta\Delta_4 Y_{t-i} + \varepsilon_t \qquad (13)$$

where $Z_{4,t} = \phi(L)(1-L^4)Z_t = \phi(L)\Delta_4 Z_t$ and $Z_{5,t} = \phi(L)(1-L)Z_t = \phi(L)\Delta Z_t$; Z_t are the residuals of the regression of $\Delta\Delta_4 Y_t$ on seasonal dummies and the polynomial ϕ consists of the coefficient estimates of:

$$\Delta\Delta_4 Y_t = \Sigma\phi\Delta\Delta_4 Y_{t-i} + \varepsilon_t = \phi(L)\Delta\Delta_4 Y_t + \varepsilon_t \qquad (14)$$

The HEGY test looks for the significance of the parameters π_i on the following model:

$$\Delta_4 Y_t = \pi_1 z_{1,t-1} + \pi_2 z_{2,t-1} + \pi_3 z_{3,t-2} + \pi_4 z_{3,t-1} + \Sigma\gamma_i \Delta_4 Y_{t-i} + \varepsilon_t \qquad (15)$$

where

$$z_{1,t} = (1+L+L^2+L^3)Y_t = S_4(L)\,Y_t$$
$$z_{2,t} = -(1-L+L^2-L^3)\,Y_t$$
$$z_{3,t} = -(1-L^2)Y_t$$

The significance of any π_i implies as in the ADF test, that there is no unit root in the associated frequency: t-statistic on π_1 to test the null that there is a unit root at zero frequency, on

[36] This second model is inappropriate if α is non-zero, because the t-ratio on γ varies with the size of α (Bannerjee et al., 1993 p.p.170-71). Thus, when α is non-zero the first model is implemented since in that case γ is invariant to the size of the drift (α), but varies with β.

[37] Using the correct lag length is important since the power of the ADF test is severely reduced when irrelevant lags are included. On the other hand, under specifying the lag length could lead to reject the null hypothesis when it is true.

π_2 to test for a unit root in the biannual frequency, and an F test on π_3 and π_4 to test for roots of annual frequency.[38] Rejection of all these null hypotheses implies stationarity of the process. The critical values are given by Hylleberg *et al.* (1990). Deterministic elements such as constant, trend and seasonal dummies should be present in equation (13) when significant. Lagged values of the dependent variable ($\Delta_4 Y_t$) are included in equation (13) in order to render the errors approximately white noise. [39] It should be noticed that the inclusion of the deterministic elements change the t distribution: if the trend and drift are significant the t distribution for π_1 changes; if (the three) dummy variables are included the t distribution for π_2, π_3, and π_4 changes.

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[38] The polynomial $(1-L^4)=(1-L)(1+L)(1-iL)(1+iL)$ for quarterly data has the unit roots of 1, -1, i, and -i which correspond to: zero frequency, 2 cycles per year, and one cycle pre year. The root i is indistinguishable from the root -i, and are interpreted as the annual cycle (Hylleberg et al. 1990).

[39] The inclusion of lagged terms does not affect the distribution under the null as happens with the Dickey-Fuller procedure. Nevertheless, the order of augmentation affects the power of the test: too many parameters decreases the power of the tests, while too few may render the size far greater than the level of significance. Engle *et al.* (1993) allows 'holes' in the lag distribution to minimise this problem.

Appendix 2: Tests for Structural Breaks

A. 2.1 Perron

The methodology proposed by Perron (1989 and 1993) aims to test if the series really have a unit root with possibly non-zero drift, or if they are trend-stationary processes with one time break in the intercept and/or the slope.

The first step to Perron's test is to 'detrend' the series using one of the following models:

Null Hypotheses:unit root with drift	Alternative Hypotheses:trend stationary
(16) $Y_t=\alpha+y_{t-1}+dD(TB)_t+\hat{}y_t$,	(16) $Y_t=\alpha_1+\beta t+(\alpha_2-\alpha_1)DU_t+\hat{}y_t$,
(17) $Y_t=\alpha_1+y_{t-1}+(\alpha_2-\alpha_1)\ DU_t+\hat{}y_t$,	(17) $Y_t=\alpha+\beta_1 t+\ (\beta_2-\beta_1)DT_t^*+\hat{}y_t$,
(18) $Y_t=\alpha_1+y_{t-1}+dD(TB)_t+(\alpha_2-\alpha_1)\ DU_t+\hat{}y_t$,	(18) $Y_t=\alpha_1+\beta_1 t+(\beta_2-\beta_1)DT_t+(\alpha_2-\alpha_1)DU_t+\hat{}y_t$,

where: D(TB)=0 for $t \neq$ time break (TB) and 1 for t=TB, i.e. pulse dummy;

DU=0 for $t \leq$ time break, and 1 otherwise, i.e. change of level dummy;

DT*=0 for $t \leq$ time break, and t-TB otherwise; i.e slope dummy, and

DT=0 for $t \leq$ time break, and t otherwise.

Under the null hypotheses, model (16) describes the crash model', model (17) the 'changing growth model' and model (18) allows for both effects to take place *simultaneously*. The detrended series are the residuals $\hat{}y_t$ which are used in an ADF type of unit root test:

$\hat{}y_t=\gamma\hat{}y_{t-1}+\sum\delta\Delta\ Y_{t-i}+\varepsilon_t$ for models (16) and (18); and

$\hat{}y_t=\sum w_i\ D(TB)_{t-i}+\gamma\hat{}y_{t-1}+\sum\delta_i\ \Delta Y_{t-i}+\varepsilon_t$ for model (17) according to the *Erratum* to the first article (Perron, 1993).

When the residuals are identically and independently distributed (i.i.d.), the distribution of γ depends on the proportion of observations occurring previous to the break (λ=TB/T, where TB is the time break and T the total number of observations). The null hypothesis is $\gamma=1$ (unit root) and critical values are in Perron (1987 and 1993).

A.2.2 Smith and Otero

The test for quarterly data with breaks in their level and/or seasonal behaviour was made by Smith and Otero (1996). These authors have developed the relevant procedure for a break consistent of change of level (intercept), and/or seasonal behaviour. The transformation needed to obtain the detrend series is:

(19) $y_t = \alpha_1 + \beta t + \Sigma_{i=1}^{4} \delta_i D_{it} + (\alpha_2 - \alpha_1) DU_t + \hat{}y_t$ for a change of level

(20) $y_t = \alpha + \beta t + \Sigma_{i=1}^{4} \delta_i D_{it} + \Sigma_{i=1}^{4} \omega_i D_{it} DU_t + \hat{}y_t$ for a change in level and seasonal pattern.

Where D_t represents the seasonal dummies and DU=0 for $t \leq$ time break, and 1 otherwise. These residuals constitute the detrended series to which the seasonal unit root test (HEGY, ART4 for case (19) and ART5 for case (20)) is applied using the critical values by Smith and Otero (1996).

Appendix 3: Restrictions from B&Q

Restrictions 1 and 2 follow from the fact that u_{1t} is the one step ahead forecast error of the first variable and u_{2t}, that of the second variable

$u_{1t}= \Delta y_t - E_{t-1}\Delta y_t$ and (21)

$u_{2t}= \Delta z_t - E_{t-1}\Delta z_t$ (22)

which should be equivalent to the BMA one step ahead forecast errors

$c_{11}(0)\, e_{1t} + c_{12}(0)\, e_{2t}$ and (23)

$c_{21}(0)\, e_{1t} + c_{22}(0)\, e_{2t}$ (24)

Thus

$u_{1t}= c_{11}(0)\, e_{1t} + c_{12}(0)\, e_{2t}$ and (25)

$u_{2t}= c_{21}(0)\, e_{1t} + c_{22}(0)\, e_{2t}$ (26)

Given the $var(u_{it})= E(u_{it}u_{it})=E(u_{it}^2)$, and that $E(e_{it}^2)=1$ and $E(e_{it}\, e_{jt})=0$, we have that:

$var(u_{1t})= c_{11}(0)^2 + c_{12}(0)^2$ and (RESTRICTION 1) (27)

$var(u_{2t})= c_{21}(0)^2 + c_{22}(0)^2$ (RESTRICTION 2) (28)

Restriction 3 comes from the definition of covariance $E(u_{1t}\, u_{2t})$, which using (25) and (26) yields:

$cov(u_{1t}\, u_{2t})= c_{11}(0)\, c_{21}(0) + c_{12}(0)\, c_{22}(0)$ (RESTRICTION 3). (29)

The last restriction depends on the restriction imposed in the BMA representation, say it is that $C_{12}(L)=0$.[40] This restriction needs to be rewritten for the VAR. Let the VAR representation be:

$x_t = F(L)\, L\, x_t + u_t$ (30)

in order to express this in a BMA rewrite it as:

$[I-F(L)L]x_t = u_t$ (31)

The corresponding BMA is then:

[40] This restriction differs from that in Enders, which is $C_{11}(L)=0$. The restriction here developed will be used in model 1.

$x_t = [I-F(L)L]^{-1} u_t$

If $[I-F(L)L]= G$, $G^{-1}= (1/|G|)*\text{adj } G$.
Set $x_t=[y,z]'$. where

$$y_t=(1/|G|) \{(1-\Sigma\phi_{22}(k)L^{k+1}) u_{1t}+(\Sigma\phi_{12}(k)L^{k+1})u_{2t}\} \quad (32).$$

Replacing (25) and (26) in (32)

$$y_t=(1/|G|) \{(1-\Sigma\phi_{22}(k)L^{k+1}) (c_{11}(0) e_{1t} +c_{12}(0) e_{2t})+(\Sigma\phi_{12}(k)L^{k+1}) (c_{21} (0) e_{1t}+c_{22}(0) e_{2t})\} \quad (33)$$

The restriction set on y is that $\{e_{2t}\}$ has no long run on y_t, thus

$$(1-\Sigma\phi_{22}(k)L^{k+1}) c_{12}(0) e_{2t} + (\Sigma\phi_{12}(k)L^{k+1}) c_{22}(0) e_{2t} = 0 \quad \text{(RESTRICTION 4)} \quad (34)$$

When the restriction is that $\{e_{1t}\}$ has no long run on y_t the restriction 4 is

$$(1-\Sigma\phi_{22}(k)L^{k+1}) c_{11}(0) e_{1t} + (\Sigma\phi_{12}(k)L^{k+1}) c_{21}(0) e_{1t} = 0 \quad (35)$$

Appendix 4: Reinhart and Reinhart Model

A.4.1 Initial Models

This section shows the neokeynesian and RBC models estimated by Reinhart and Reinhart (1991). These models give the framework for the short-run relationships between the variables: while the neokeynesian assigns M1 as the most exogenous variable, the RBC model gives this role to GDP and thus assuming that M1 is endogenous and adjust to shocks in other variables while GDP only reacts to real shocks.

A.4.1.1 Neo-Keynesian Model

The initial model has 6 equations: one for nominal money supply which is considered exogenous (eq. I); another for a traditional demand for money (eq. V), a third one for the product which is comparable to an IS (eq. II). Wages follow the relationship established by a Phillips curve (eq. IV), prices are fixed via mark-up (eq. III)[41] and the final equation is for the nominal exchange rate (eq. VI) Deterministic components and lagged values are omitted in the following representation:

I. $\Delta M1_t = e^M_t$

II. $\Delta GDP_t = a_{21}\Delta M_t + a_{23}\,\Delta P_t + e^S_t$

III. $\Delta P_t = a_{34}\Delta W_t + e^P_t$

IV. $\Delta W_t = a_{42}\Delta GDP_t + e^W_t$

V. $\Delta INT_t = a_{51}\Delta M_t + a_{52}\Delta GDP_t + a_{53}\,\Delta P_t + e^I_t$

VI. $\Delta TC = a_{61}\Delta M_t + a_{62}\Delta GDP_t + a_{63}\,\Delta P_t + a_{65}\Delta INT_t + e^{TC}_t$

A.4.1.2 Real Business Cycle Model

The second model is based on the Real Business Cycle theory where one expects real shocks to have positive effects in real variables. The model contains the same variables but the restrictions change. The only equation that remains unchanged is that for prices. The main differences among the models are in the equations for GDP and M1: while M1 is now considered endogenous and disappears from the interest rates and exchange rates equations, GDP is considered to be affected only by its own (real) shocks.

I. $\Delta M1_t = a_{12}\Delta Y_t + a_{23}\,\Delta P_t + a_{16}\,\Delta TC_t + e^M_t$

II. $\Delta GDP_t = e^S_t$

III. $\Delta P_t = a_{34}\Delta W_t + e^P_t$

[41] Some exercises were made including money and production as determinants of prices in the short run.

IV. $\Delta W_t = a_{42}\Delta GDP_t + a_{43}\,\Delta P_t + e^W_t$

V. $\Delta INT_t = a_{52}\Delta GDP_t + a_{53}\,\Delta P_t + e^I_t$

VI. $\Delta TC = a_{62}\Delta GDP_t + a_{63}\,\Delta P_t + a_{65}\Delta INT_t + e^{TC}_t$

A.4.2 Model Estimation

The first step for the model estimation was to chosė the lag length of the VAR. Table 14 shows the AIC and SBC for 4 to 8 lags with centered seasonal dummies included in order to account for the seasonal components of the quarterly series. Both indicators clearly prefer 4 lags.

TABLE 14: CHOOSING THE LAG LENGTH

	4 LAGS	5 LAGS	6 LAGS	7 LAGS	8 LAGS
AIC	-24.41	-24.30	-24.20	-24.27	-24.25
SBC	-22.93	-22.52	-22.13	-21.90	-21.57

The second step followed before estimating the model with quarterly data,[42] was to perform identification tests for the short run matrix and tests on granger causality and block exogeneity. The identification tests show that the matrix of short run coefficients were not well defined.[43] We introduced changes in the price equation making them, for example, depend on M1, and/or production, nonetheless the results did not improve. Additionally, the Granger-causality tests and block exogeneity (or causality) tests showed little relevance of some variables initially included.[44]

Results for Granger-causality are shown in Table 15. Average wages (AW) and interest rates (INT), do not Granger-cause any other variable within the system, thus, test for block exogeneity are done for these variables. These tests determine whether lags of one variable Granger-cause any other variable in the system.[45] Results for the block causality test for average wage (AW) and interest rates (INT), cannot reject with 97% and 95% significance levels that these variables do not help forecasting any of the variables in the system.[46] Thus; the system is reduced to four variables: M1, GDP, CPI, and TC. Once again a lag length test is performed in the new VAR with its variables in levels. Results in Table 16 reveals that 5 lags is the indicated length.

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42 R&R estimated the model with yearly data for the period 1960-1987. Our estimation is with quarterly data for 1977:1=1996:3.

43 Test of overidentification $\chi^2(4)$=27.75, with significance level=0.0000 for the Neokeynesian model. The RBC model is just-identified.

44 Sims (1980) suggests not using the t-tests of individual coefficients to evaluate the importance of a certain variable since in a VAR variables are usually highly collinear.

45 The block causality test is based on a likelihood test of the type suggested by Sims (1980): $(T-c)(\log|\Sigma_r| - \log|\Sigma_u|)$, where c is the number of parameters estimated in each equation of the unrestricted (u) system, T the number of observations, and Σ the var-cov matrix of the restricted (r) and unrestricted (u) systems. This stastistic follows a χ^2 distribution.

46 The test for DAW has a chi-squared (36)= 21.81, while the test for INT has a chi-squared (36) = 23.27.

TABLE 15: GRANGER CAUSALITY TESTS[47]

	DM1	DGDP	DCPI	DAW	DINT	DTC
G.C. DM1	5.20**	2.97**	2.76**	0.22	0.92	1.09
G.C. DGDP	2.51*	6.49**	2.22*	1.92	1.73	1.47
G.C. DCPI	1.75	1.68	3.48**	0.62	1.60	0.60
G.C. DAW	0.86	0.56	1.53	1.62	0.16	4.00**
G.C. DINT	0.64	1.05	0.60	0.55	1.00	2.74**
G.C. DTC	1.86	0.70	0.30	0.52	1.21	3.05**

**Reject the null that $\{y_t\}$ does not Granger-cause $\{x_t\}$ at 5%, * 10%. VAR run in differences.

TABLE 16: CHOOSING THE LAG LENGTH

	4 LAGS	5 LAGS	6 LAGS	7 LAGS	8 LAGS
AIC	-31.00	-31.07	-30.84	-30.80	-30.53
SBC	-28.53	-28.08	-27.33	-26.75	-25.94

The next step was to test for cointegration. This consideration was not present in the original R&R work. It is important since introducing cointegrating relationships helps the model to explain long-run equilibrium relationships among the variables. On the other hand, the existence of this relations prevents doing a structural VAR, (SVAR) since there are technical problems beyond the aim of this paper as to how to introduce the restrictions in such cases.

Cointegration tests in this multivariate model follow Johansen (RATS) (see Appendix 5). According to Pantula (see Harris, 1995), it is advisable to estimate Johansen cointegration test in models 2 to 4, in order to choose the type of deterministic components that it should include. Table 17 shows the results for cointegration as well as the analysis univariate and multivariate of the residuals (before choosing the order of cointegration as suggested by Hansen and Juselius, 1995). These tests are important since the choice of the cointegration rank should be made in a correctly specified model.[48] A multivariated and univariated analysis of the residuals show low correlation. Results concerning normality are less satisfactory, but the models are less dependent on this assumption. Graphs 7 to 13 report auto and cross-correlations as well as histograms, standardised residuals, actual and fitted residuals. Following Pantulas method Model 4 (with drift in the cointegrating vector), is the best one for the system with 5 lags. In this case, both the λ_{MAX} and trace suggest 2 cointegrating vectors (shown at the bottom of Table 17.

[47] A variable $\{y_t\}$ is said to Granger cause another variable $\{x_t\}$ if $\{y_t\}$ contributes in the forecasting of $\{x_t\}$. The test is a F-test under the null Ho: $a_{i2}=0$, for i=1 to k, where k is the lag lenght, in the following expression: $x_t = a_{10} + a_{11}(1)x_{t-1} + \ldots + a_{21}(1)\, y_{t-1} + \ldots + e_t$

[48] The test of normality is based on a multivariate version of the univariate Shenton-Bowman test. Auto- and crosscorrelation is tested by Ljung-Box, and two LM type tests for first and fourth order autocorrelation. (Critical value for normality is 5.99 (Misas and Oliveros, p.41. 1997)?).

TABLE 17: CHOOSING THE RANK OF COINTEGRATION AND DETERMINISTIC COMPONENTS

5 LAGS	MODEL 2, CI-MEAN			MODEL 3, DRIFT			MODEL 4 CI-DRIFT		
Ho: r=	Eigenvalue	λ max	Trace	Eigenvalue	λ max	Trace	Eigenvalue	λ max	Trace
0	0.5122	45.94*	94.35*	0.4933	43.51*	87.62*	0.4971	43.99*	100.20*
1	0.3783	30.42*	48.40*	0.3558	28.15*	44.11*	0.3706	29.64*	56.21*
2	0.1893	13.43*	17.98*	0.1893	13.43*	15.96*	0.2271	16.49*	26.57*
3	0.0687	4.55	4.55	0.0388	2.53	2.53	0.1458	10.08	10.08
UNIVARIATE AND MULTIVARITE ANALYSIS OF RESIDUALS									
Multiva	LB(16)	LM(1)	LM(4)	NORM	Univari	M1	GDP	CPI	TC
p-values	0.08	1.00	0.76	0.00	Normalit	0.054	4.883	10.430	4.111
	M1	GDP	CPI	TC	TREND				
EIGEN-	-6.208	1	6.097	-1.037	0.078				
VECTOR	0.273	1	-0.652	-2.098	0.125				

* Accept that there are 'r' cointegrating relationships (10%).

According to the first cointegrating vector, a one percentile point increase in GDP rises M1, TC and reduces CPI. This relationship is quite the expected one for all the variables but TC if the increase in GDP is assumed as a supply shock. Generally speaking it is difficult to find economic sense to a second eigenvector. A test on β about the significance of the trend is performed and in fact, the t-values for the trend are significative. Finally, no test is performed on α (test for weak exogeneity) since the t-values for every variable are significative at least for one of the cointegrating vectors.[49]

Given that there are two cointegration relationships in the system, the VAR cannot be estimated in differences since it would entail misspecification and will not include the long run information that gives stability to the model. Thus, we consider more appropriate to estimate a VEC with 5 lags. None of the available papers on structural VAR (SVAR) have found cointegration, and therefore, there is little said on Structural VEC. For this reason this attempt will not be taken here. Nonetheless, we found no cointegrating equations among the variables for the period 1977:3-1991:1, and the SVAR for Neokeynesian and RBC relationships is estimated for this sub-sample. The results for these estimations are in Section 4.1.

[49] Quoting Harris (1995, p.100), 'It is usually not valid to condition the VECM on x_{it} unless the variable is weakly exogenous in the full system'.

Appendix 5: Testing for Cointegration following the Johansen Procedure (RATS)

The first issue testing for cointegration using the Johansen procedure, is to **select the number of lags** in the following model:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \alpha\beta' z_{t-1} + \mu + \delta t + \varepsilon_t$$

Three criteria were taken into account: the AIC, SBC and ratio tests. The second issue is to decide whether or not to include seasonal dummies. In previous section we proved that GDP and M1 had one unit root at zero frequency and a seasonal root for the biannual frequency. In such cases it is recommended to **include centered seasonal dummies** that pick up both the stochastic and the deterministic components of the series.[50] Some additional exercises were made with seasonally filtered data (using multiplicative x-11), but results (not showed) were very similar.

The third set of decisions are on which type of the **deterministic component** to include. The model above can be rewritten as:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \alpha \begin{Bmatrix} \beta \\ \mu_1 \\ \delta_1 \end{Bmatrix} z_{t-1} + \alpha\, \mu_2 + \alpha\, \delta_2\, t + \varepsilon_t$$

Johansen procedure considers five models:[51]

- The first model does not consider constant or trend, (i.e. restricts μ=0 and δ=0), which is rarely applicable to economic data because an intercept is generally needed to account for the unit of measurements of the variables.
- The second model, considers only the intercept in the cointegration relationship (δ=0, μ_2=0, and μ_1 unrestricted).
- The third model allows for linear trend in the data and non-zero intercept in the cointegration relations, (δ=0, and μ unrestricted).
- The fourth model additionally considers that the cointegration space has a linear trend, (which could account for example for exogenous growth. Restrictions are: δ_2=0 and δ_1 and μ are unrestricted). According to the authors this is the model one should estimate if the data is trend stationary.
- The fifth model allows for quadratic trends (unrestricted δ and μ), and as model 1 is unlikely with economic time series.

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[50] Centered seasonal dummies are constructed such that they sum to zero at each t, e.g. for quarterly data $\sum_{i=1}^{4}$ Sdum'= 0, where $Sdum_t$ '=S_t -1/4

[51] See Hansen and Juselius (1995) for a precise accounting of the Johansen procedure for cointegration test in a multivariate model:

Pantula developed a method to chose the **cointegration rank** and the deterministic components of the model. First, models 2 to 4 should be estimated and their results, in terms of the λ_{max} and trace statistics, organised from the most restrictive alternative (r=0 in model 2) through to the least restrictive alternative (r=n-1 in model 4). The method consists of testing the hypotheses from the left to the right (from model 2 to model 4) and beginning with the rejection of Ho: r=0 for model 2 and then for model 3 and then four If still the null is rejected, go to Ho:r=1 for model 2 and so forth, stopping when the null is not rejected, (e.g. r=1 for model 4). In some cases the two tests give contradictory advise as to which cointegration rank to choose. There is evidence that trace is more robust to inclusion of dummies, as in our case.

After choosing the cointegration rank and the model, we tested for multivariate (and univariate) residuals to be gaussian, and test restrictions on α which are tests on weak exogeneity, and/or tests on β which test whether the cointegration tests are unique and whether they tell us anything about economic relationships underlying the long run model.[52] When the variables are no cointegrated, there is no long run relationship of equilibrium between them. A VAR in first differences (involving no long-run elements) is then suggested. When the variables are cointegrated, a VEC (i.e., a VAR in differences, with the residuals of the cointegration relationship lagged one period), is then suggested. The last stage corresponds to the impulse response and variance decomposition analysis.

[52] According to Harris (1995) the Johansen procedure only determines how many unique cointegration vectors span the cointegration space, and since any linear combination of stationary vectors is also stationary, the estimates of any particular column in β are not necessarily unique.

REFERENCES

Agudelo, M. (1991), 'Compatibilización de las dos fuentes de Ahorro y la Inversión: Creación de nuevas Series', *Ensayos sobre Política Económica*' No. 19, pp.97-118.

Apergis, N. and Karfakis, C. (1996), 'Sources of Fluctuations in Exchange Rates: a Structural VAR Analysis'. *Applied Economics Letters*. 3.

Banco de la República (1993), 'El Indice de la Tasa de Cambio Real', Notas Editoriales, *Revista del Banco de la República*, No.787, Vol.LXVI, May, pp.III-XIX.

Banerjee, A., Dolado, J., Galbraith, J., and Hendry, D.F. (1993). *Co-Integration, Error Correction and the Econometric Analysis of Non-Stationary Data*. Oxford University Press.

Bernanke, B. (1986), 'Alternative explanations of money-Income Correlation', *Carnegie-Rochester Conference Series on Public Policy,* 25.

Bevan, Collier and Gunning, (1991b), 'The Macroeconomics of External Shocks', in Lall and Subramanian (eds.), *Current Issues in Development Economics*, Macmillan, U.K.

Blanchard, O.J. (1989), A Traditional Interpretation of Macroeconomic Fluctuations', *The American Economic Review*, December.

-------- and D. Quah (1989), The Dynamic effects of Aggregate Demand and Supply Disturbances', *The American Economic Review*, December.

Cárdenas, M. (1991), 'Coffee Exports, Endogenous State Policies and the Business Cycle' Ph.D. Dissertation, University of California, Berkeley.

Cárdenas, M. and Olivera, M. (1995), 'La Crítica de Lucas y la Inversión en Colombia: Nueva Evidencia', Mimeo, FEDESARROLLO, Bogotá.

Carrasquilla, A., Galindo, A. and Patrón, H. (1994), 'Devaluación, Tasa de Cambio Real e Inflación: Un Enfoque Estructural', *Asimposio XIV de Mercado de Capitales,* Asociación Bancaria y de Entidades Financieras de Colombia.

Clarida, R. and Gali, J. (1994), 'Sources of Real Exchange Rate Fluctuations: How Important Are Nominal Shocks?', *Carneige-Rochester Conference Series on Public Policy*, 41.

Corden, W. (1984), 'Booming Sector and Dutch Disease Economics: Survey and Consolidation', *Oxford Economic Papers*, 36(3).

Deaton, A. and Laroque, G. (1992), 'On the Behaviour of Commodity Prices', *Review of Economic Studies*, 59(1).

Dickey, D.A. and Fuller, W.A. (1981), 'Likelihood Ratio Statistics for Autorregresive Time Series with a Unit Root', *Econometrica*, Vol.49, No.4, pp.1057-1072.

Enders, W. (1996), *Rats Handbook for Econometric Time Series*, John Wiley & Sons, inc.

Enders, W. (1995), *Applied Econometric Time Series* , John Wiley & Sons, inc.

Engle, R.F., Granger, C.W.J., Hylleberg, S. and Lee, H.S. (1993), 'Seasonal Cointegration: the Japanese Consumption Function', *Journal of Econometrics*, Vol.55, pp.275-298.

Fuller, W.A. (1976), *Introduction to Statisitical Time Series*, New York, Wiley

Gaviria, A. and Uribe, J.D. (1993), 'Origen de las Fluctuaciones Económicas en Colombia', *Ensayos sobre Economía Cafetera*, No.9. pp.49-57

Granger, C.W.J. and Newbold, P. (1974),* 'Spurious Regressions in Econometrics', *Journal of Econometrics*, Vol.2, pp.111-120.

Granger, C.W.J. and Sikilos, P. (1995), 'Systematic Sampling, Temporal Aggregation, Seasonal Adjustment, and Cointegration. The Theory and Evidence', *Journal of Econometrics*, Vol.66, pp.357-369.

Hansen, H. and Juselius, K. (1995), *Cats in Rats. Cointegration Analysis of Time Series*, Estima, Evanstone, Illinois, USA.

Harris, R. (1995), *Using Cointegration Analysis in Econometric Modeling*. Prentice Hall.

Hylleberg, S., Engle, R.F., Granger, C.W.J., and Yoo B.S. (1990), 'Seasonal Integration and Cointegration', *Journal of Econometrics*, No.44, pp.215-238.

Kamas, L. (1986), Duthc Disease Economics and the colobian Export Boom', *World Development* 14(9).

Lee, , B.S. and Enders, W. (1993), 'Decomposing Real and Nominal Exchange Rate Movements'. Iowa State University.

López, A., Gómez, C. and Rodriguez, M. (1996), 'La Caida de la Tasa de Ahorro en Colombia durante los Años Noventa: Evidencia a Partir de una Base de Datos para el Periodo 1950-1993', *Borradores Semanales de Economía*, No.57, Banco de la República. Colombia.

MacKinnon (1991), 'Critical Values for Cointegration Tests', in Engle and Granger eds. *Long-Run Economic Relationships.*

Misas. M. and Suescún, R. (1993), Funciones de Demanda de Dinero y el Componente Estacional del Mercado Monetario', *Ensayos de Política Económica* No.23, pp. 55-80. Banco de la República. Colombia.

Montenegro, A., Correa, M.C., and Garcia M.I. (1987), 'La Estacionalidad de los Meidos de Pago al final del Año', *Revista del Banco de la República*, No.719, Vol.LX, September, pp.11-30. Banco de la República. Colombia.

Montoya, I.D. (1996), 'Desagregación Trimestral del PIB en Colombia: Un Estudio Comparativo (1925-1992), Mimeo, Banco de la República, Colombia.

Nelson, C. and Plosser, C. (1982), 'Trends and random Walks in Macroeconomic Time Series: Some Evidence and Implications', *Journal of Monetary Economics* 10.

Ocampo, J.A. (1989). 'Ciclo Macroeconómico y Comporamiento Macroeconómico en Colombia', *Coyuntura Económica*, 19(3) and 19(4).

Oliveros, H. (1995). 'Estacionalidad y Pruebas de Raices Unitarias: Algunas Consideraciones Generales', *Borradores Semanales de Economía*, No.40, Banco de la República, Colombia.

Osborne, D.R. (1993), 'Discussion: Seasonal Cointegration', *Journal of Econometrics*, pp.299-303.

Osbome, D.R., Chui, A.P.L., Smith J.P., Birchenhall, C.R. (1988), 'Seasonality and the Order of Integration for Consumption', *Oxford Bulletin of Economics and Statistics*, 50, 4, pp. 361-377.

Otero, J. (1996), 'Coffee, the Money Market and the Real exchange Rate in Colombia', Thesis Proposal, . Department of Economics, University of Warwick, U.K.

Perron, P. (1993), 'Erratum', *Econometrica*, Vol. 61, No.1. pp.248-249.

Perron, P. (1989), 'The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis', *Econometrica*, Vol. 57, No.6. pp.1361-1399.

Perry, G., Lora, E. and Barrera, F. (1994), 'Cusiana y la Política Macroeconómica', in DNP and World Bank (eds.) *Cusiana un Reto de Política Económica*, Tercer Mundo Editores, Bogotá.

Phillips, P.C.B. (1986), 'Understanding Spurious Regressions in Econometrics', *Journal of Econometrics*, 33, pp.311-340.

Ramirez, M. (1994), 'Comentarios al Trabajo del DNP', in DNP and World Bank (eds.) *Cusiana un Reto de Política Económica*, Tercer Mundo Editores, Bogotá.

Reinhart, C. and Reinhart, V. (1991), 'Fluctuaciones del Producto y Choques Monetarios: Evidencia Colombiana', *Ensayos sobre Política Económica*, No. 20. pp. 53-85.

Restrepo, J.E., (1997), 'Modelo IS-LM para Colombia', *Archivos de Macroeconomía*, No. 65, DNP.

Sims, C. (1980), 'Macroeconomics and Reality', *Econometrice*, 48, pp.1-49.

-------, (1986), 'Are forecasting Models Usable for Policy analysis?', *Federal Reserve Bank of Minneapolis Quarterly Review*, Winter.

Smith, J. and Otero, J. (1996), 'Structural Breaks and Seasonal Integration', *Warwick Economic Research Papers* No. 435. Department of Economics, University of Warwick, U.K.

Suescún, R. (1997), Bonanzas, Enfermedad Holandesa y Ciclo Económico Real en Colombia', *Coyuntura Económica*, 27(2).

Stockman, A. (1994), 'Sources of Real Exchange Rate Fluctuations', *Carniege-Rochester Conference Series on Public Policy*, 41.

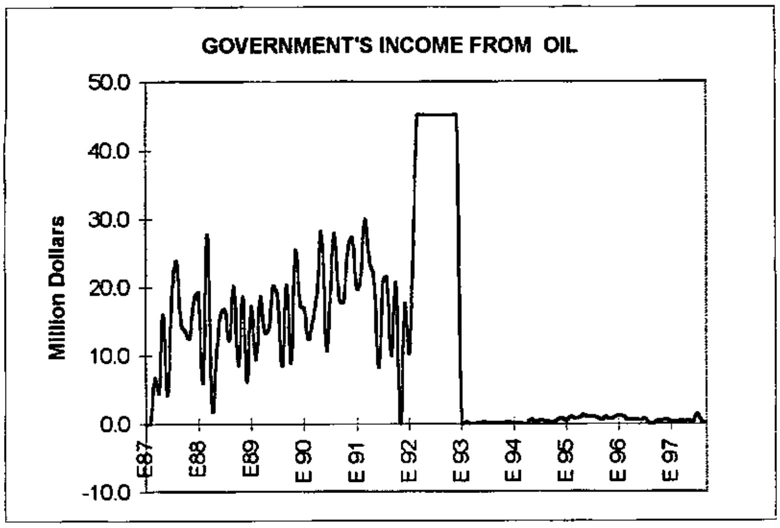
Tolosa, J. (1995), 'Redefinición de los Principales Agregados Monetarios', *Revista del Banco de la República*, No.812, Vol.LXVIII, June, pp.88-113.

Urrutia, M. and Suescún, R. (1994), 'Las Bonanzas Cafeteras y la 'Enfermedad Holandesa' en Colombia', in DNP and World Bank (eds.) *Cusiana un Reto de Política Económica*, Tercer Mundo Editores, Bogotá.

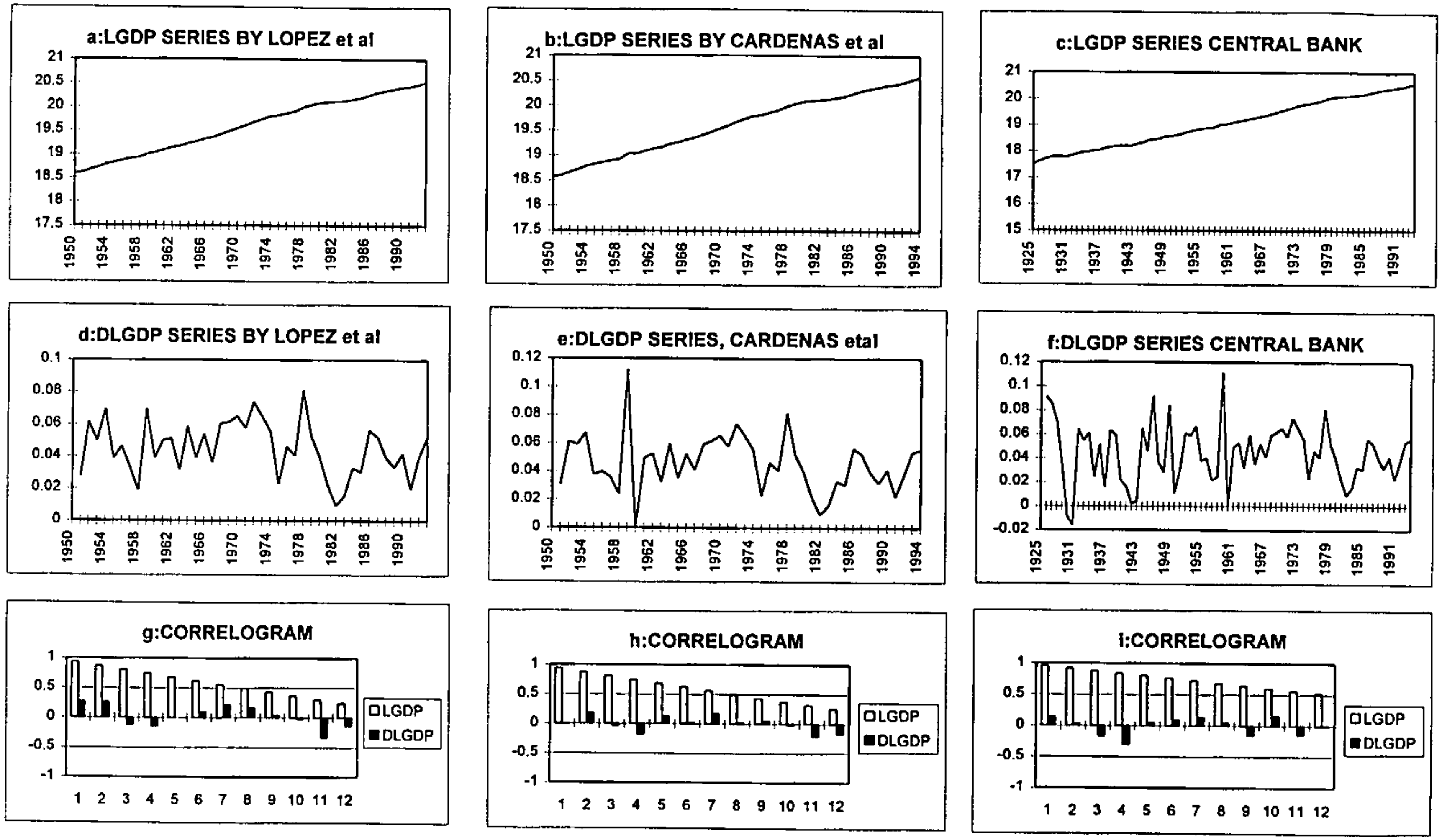
Valderrama, F. (1997), 'Trimestralización del Producto Interno Bruto por el Lado de la Oferta', *Archivos de Macroeconomía* No. 54. Departamento Nacional de Planeación, DNP, Bogotá.

WB (1994), *Nigeria. Macroeconomic Risk Management: Issues and Options*, Report No.11983-UNI, Washington.

Wunder, S. (1992), 'Dutch Disease Theory and the Case of Colombia', *Okonomisk Institut*, Ph. D. dissertation, Kobenhavs Universitet.

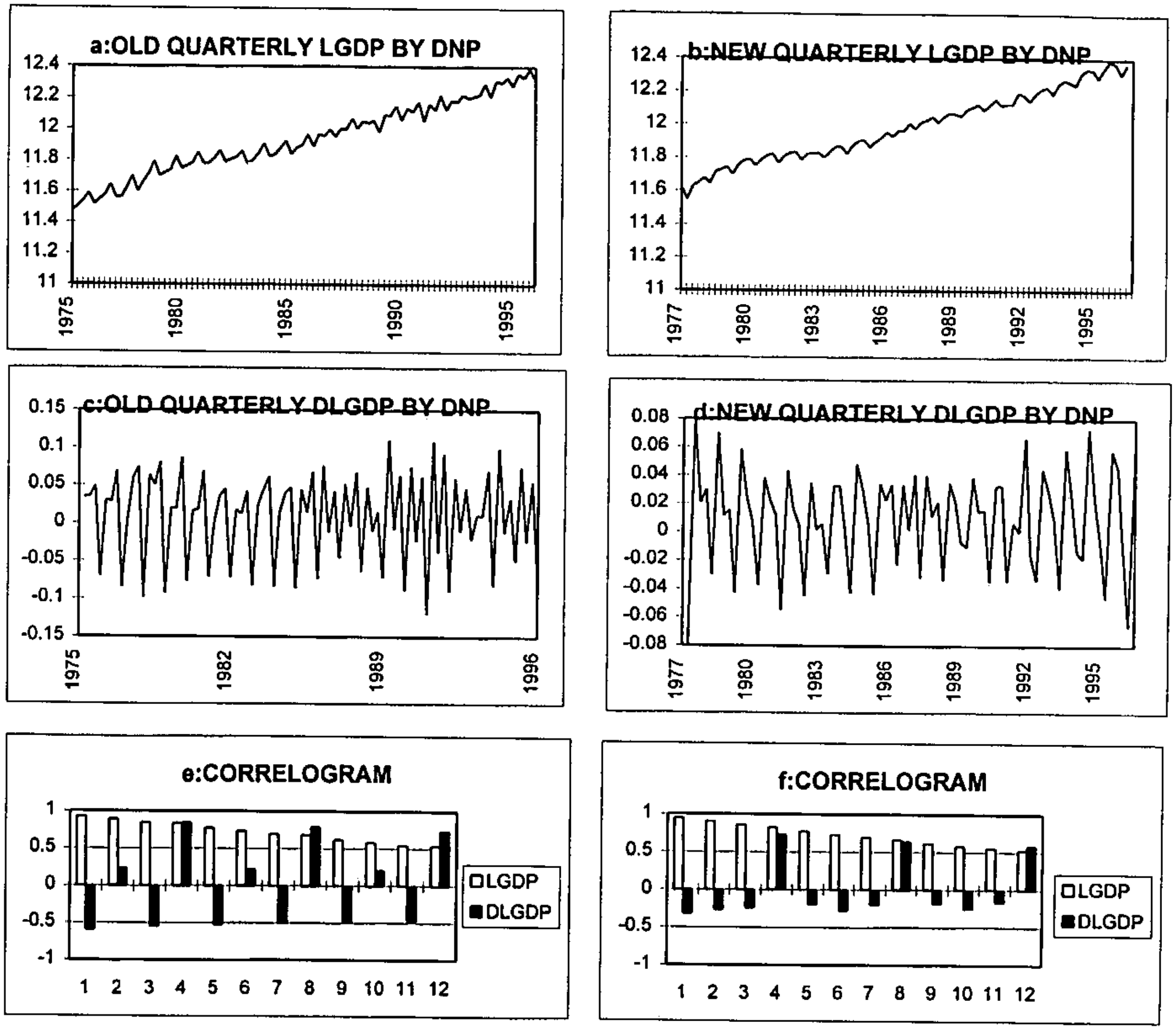

GOVERNMENT'S INCOME FROM OIL
Million Dollars
50.0
40.0
30.0
20.0
10.0
0.0
-10.0
E87
E88
E89
E 90
E 91
E 92
E 93
E 94
E 95
E 96
E 97

GRAPH 1



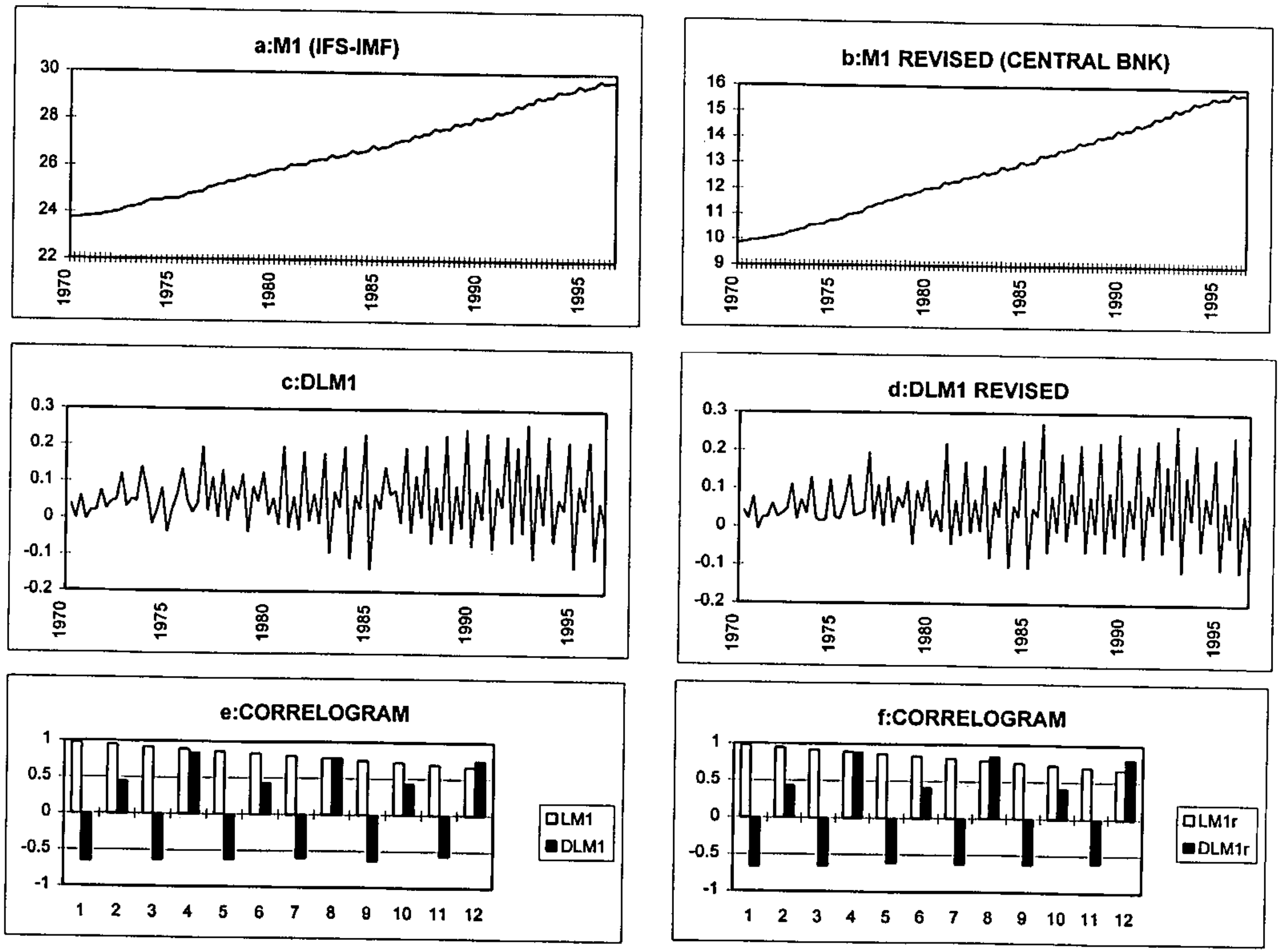
SOURCES: LOPEZ ET.AL. (1996), CARDENAS ET.AL.(1995), MONTOYA (1996)

GRAPH 2



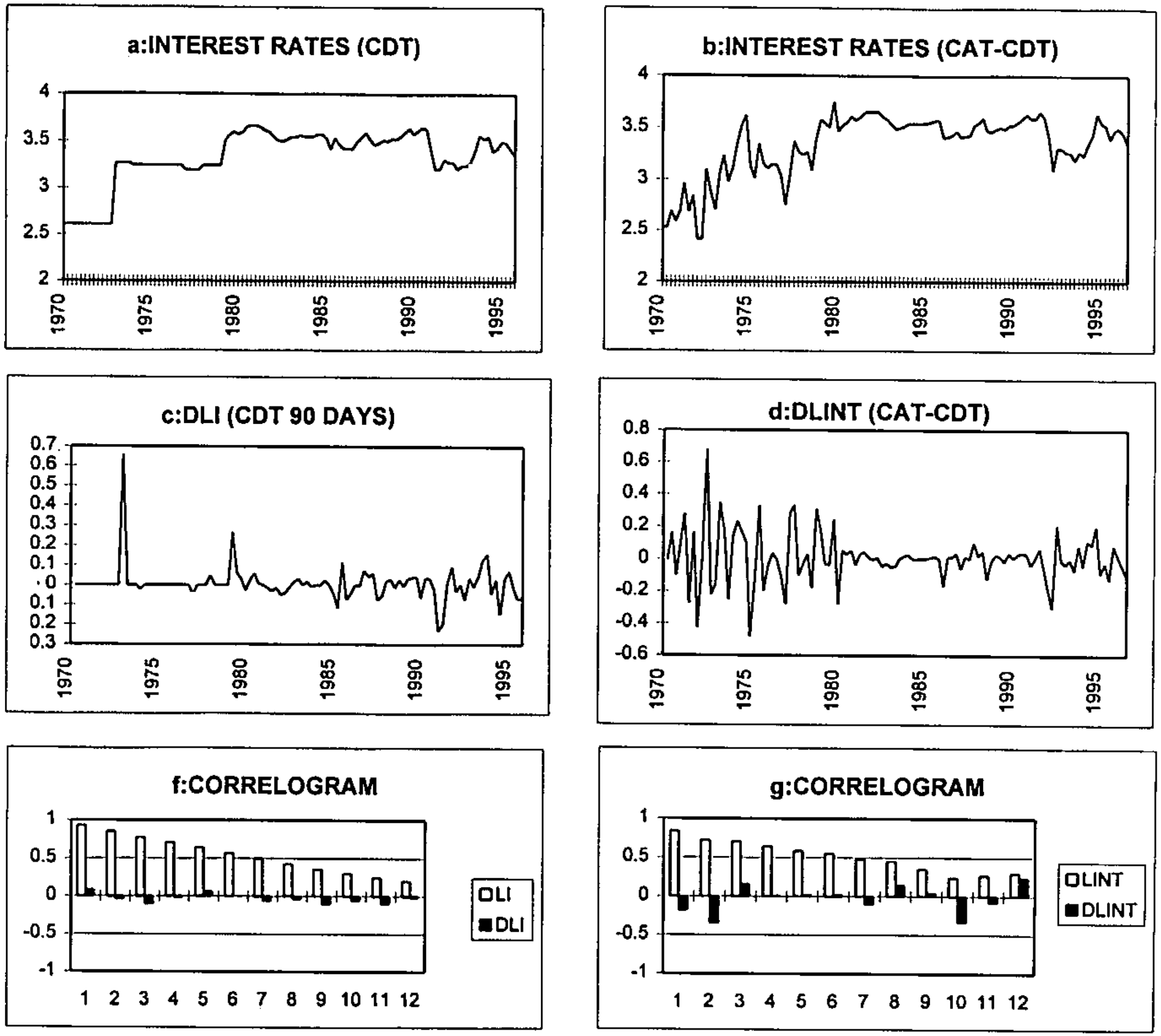
SOURCE: NATIONAL PLANNING DEPARTMENT (DNP).

GRAPH 3



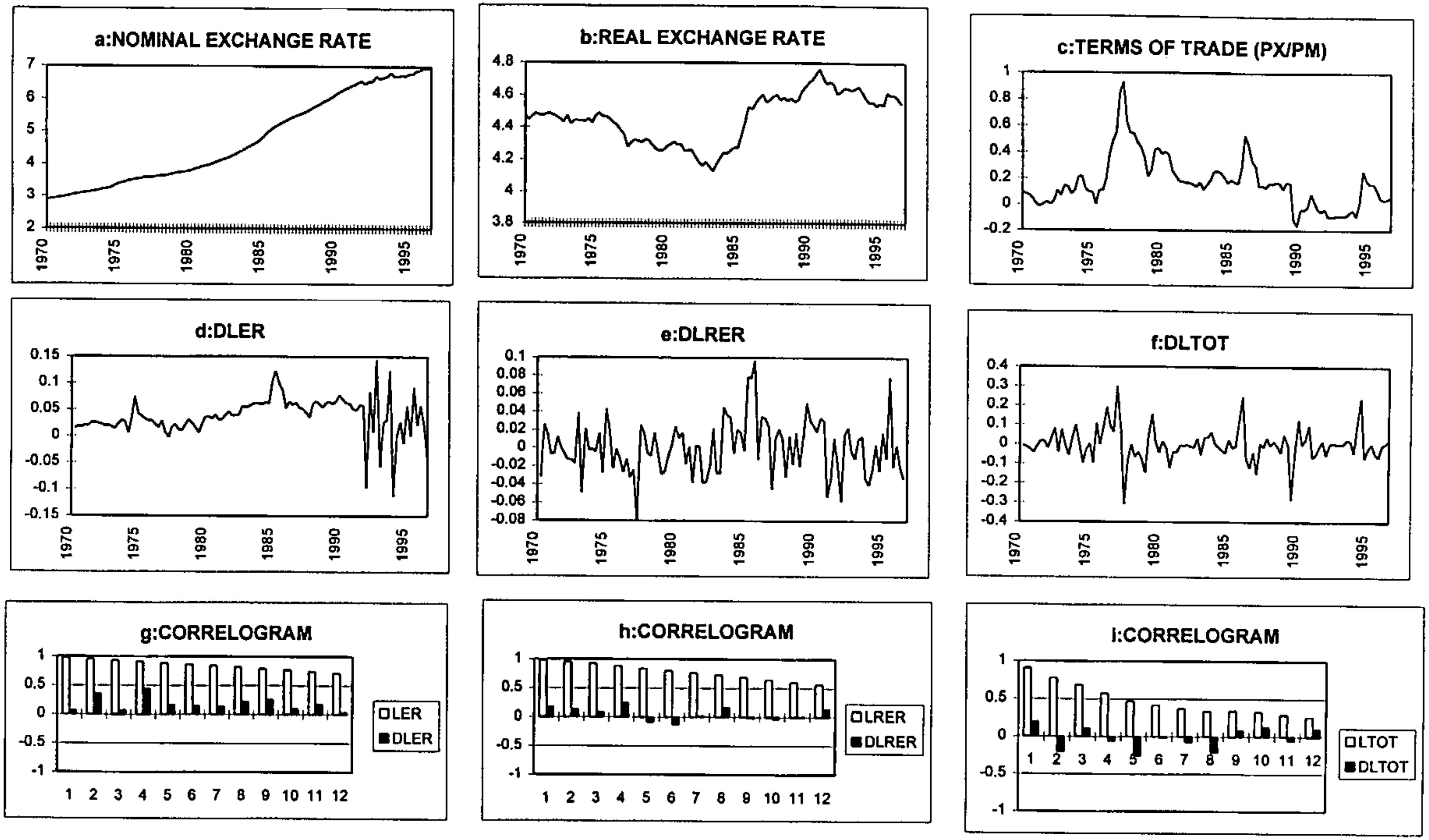
SOURCES: M1 by IFS-IMF; M1R by REVISTA BANCO DE LA REPUBLICA (1995)

GRAPH 4



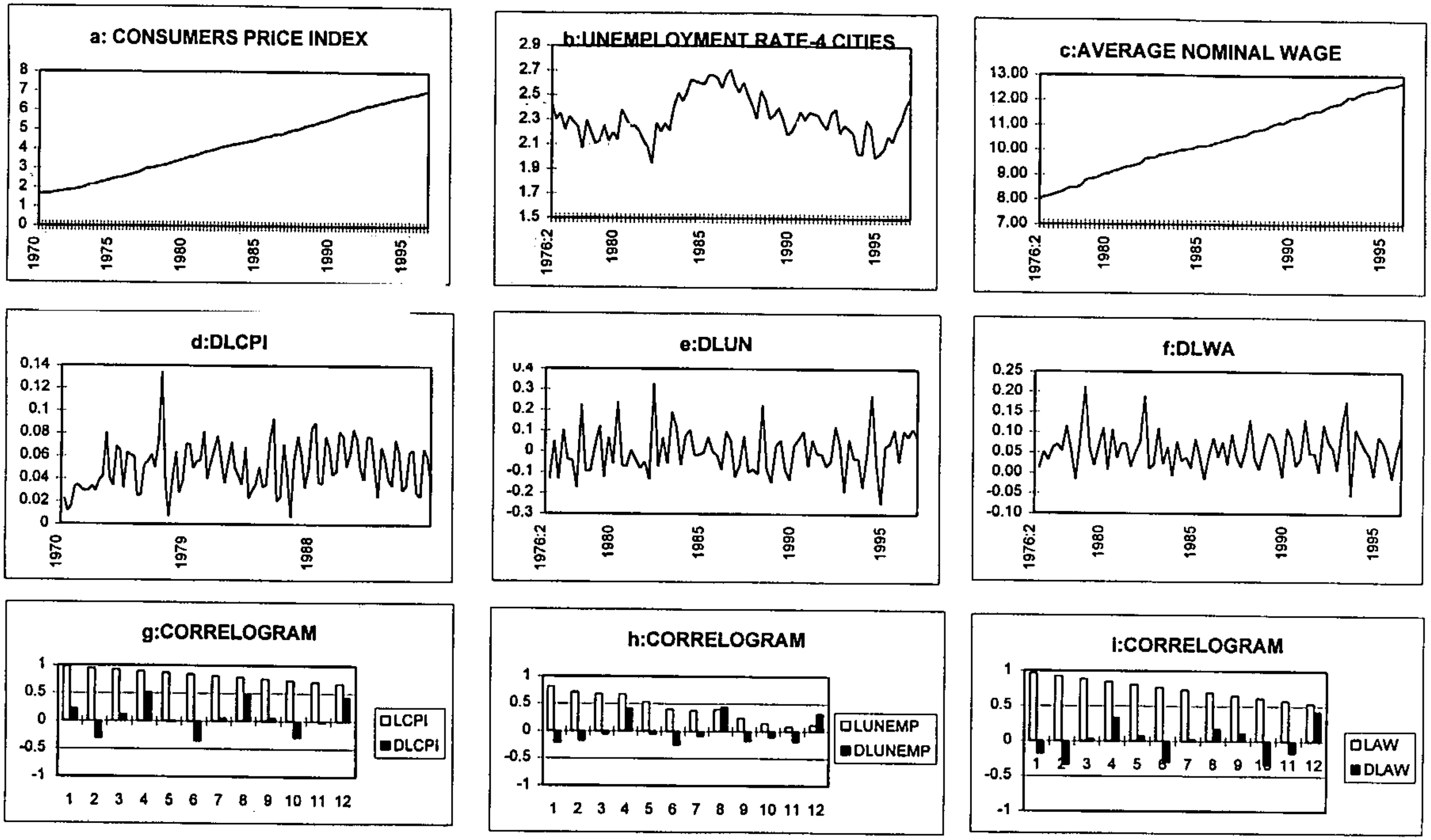
SOURCE: INT RATE (CDT-90 DAYS) AVERAGE PERIOD.1971:1-1979:4 FROM TORO (1993) AND 1980:1-1996:3 FROM REVISTA BANCO DE LA REPUBLICA. INT(CAT, 120 DAYS-CDT, 90 DAYS) END QUARTER FROM TORO (1987) AND REVISTA DEL BANCO DE LA REPUBLICA.

GRAPH5



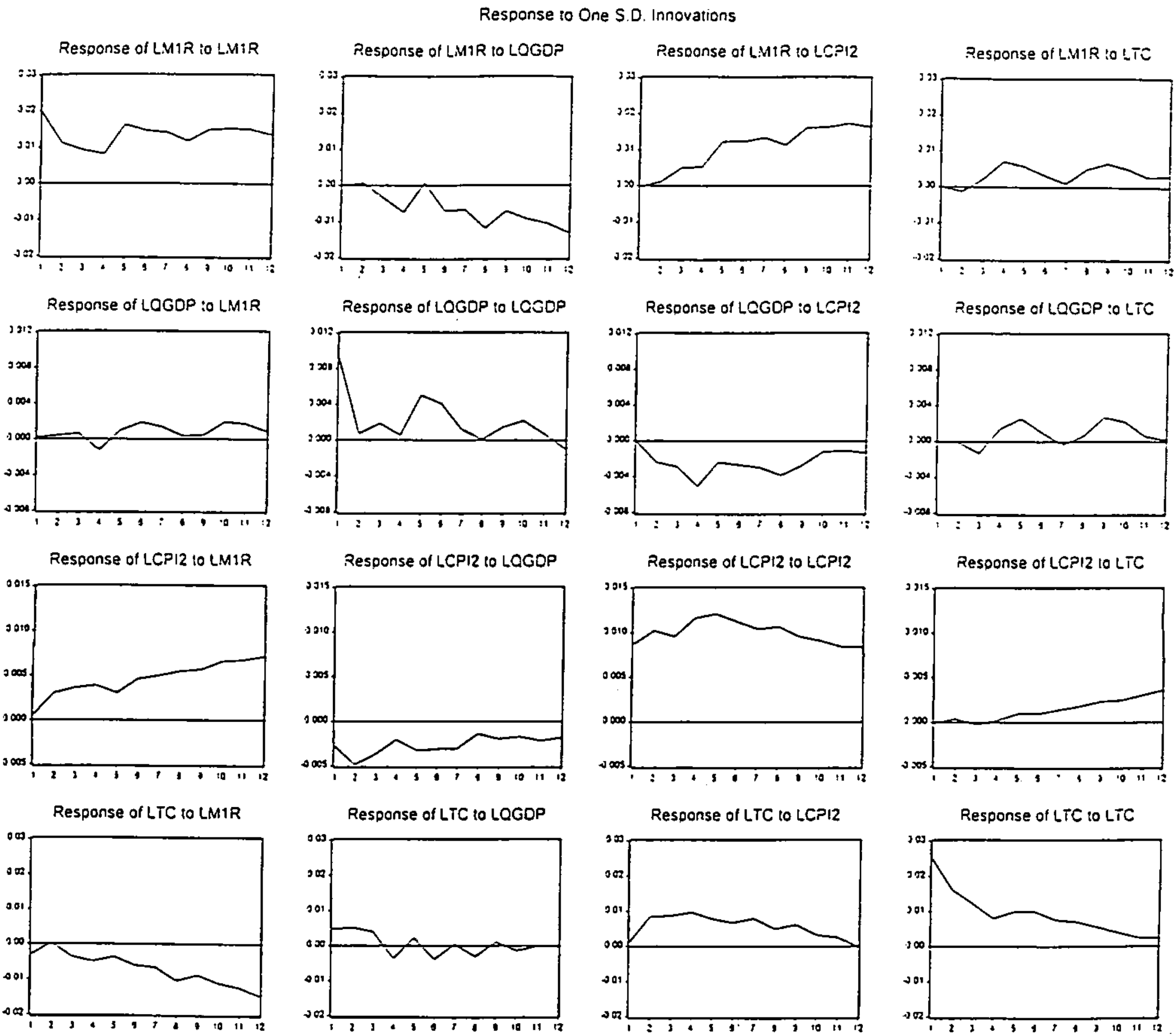
SOURCE: ER (PESOS PER DOLLAR) REVISTA DEL BANCO DE LA REPUBLICA; RER, END OF PERIOD;1970:1-1977:4 HERRERA (1990);1975:1-1996:3 REVISTA DEL BANCO DE LA REPUBLICA (ITCR1);TOT, END OF PERIOD, IFS-IMF,PX/PM.

GRAPH 6



SOURCES:CPI FROM IFS; UNEMPLOYMENT RATE FROM 1976-1993 DANE(1994, A1, TAB1);1994-96 DANE (1996, ESPECIAL, TAB5)4 CITIES. AW FROM ENCUESTA NACIONAL DE HOGARES, CALCULOS DNP-UMACRO.

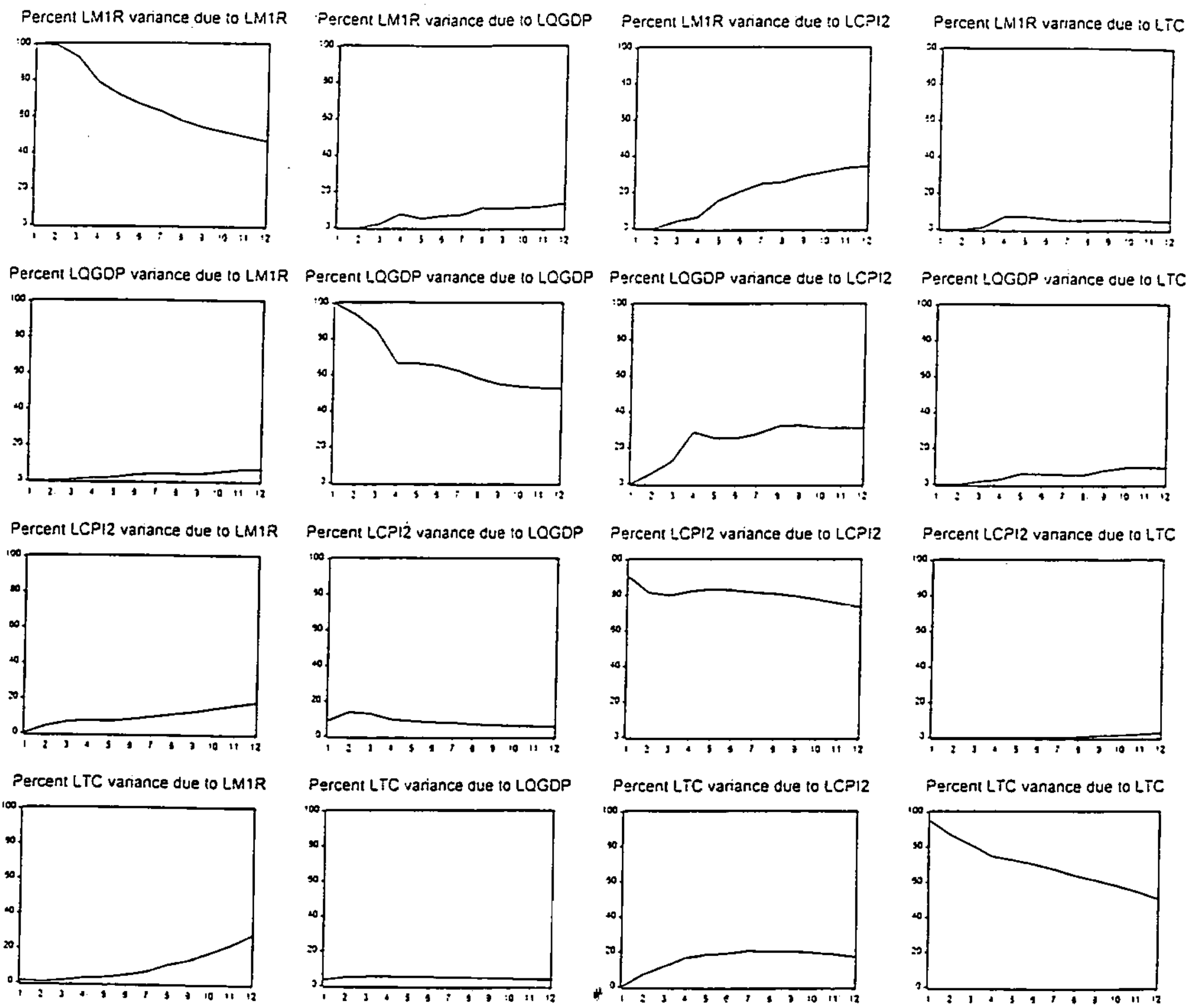
GRAPH 7
R&R VEC WITH TC



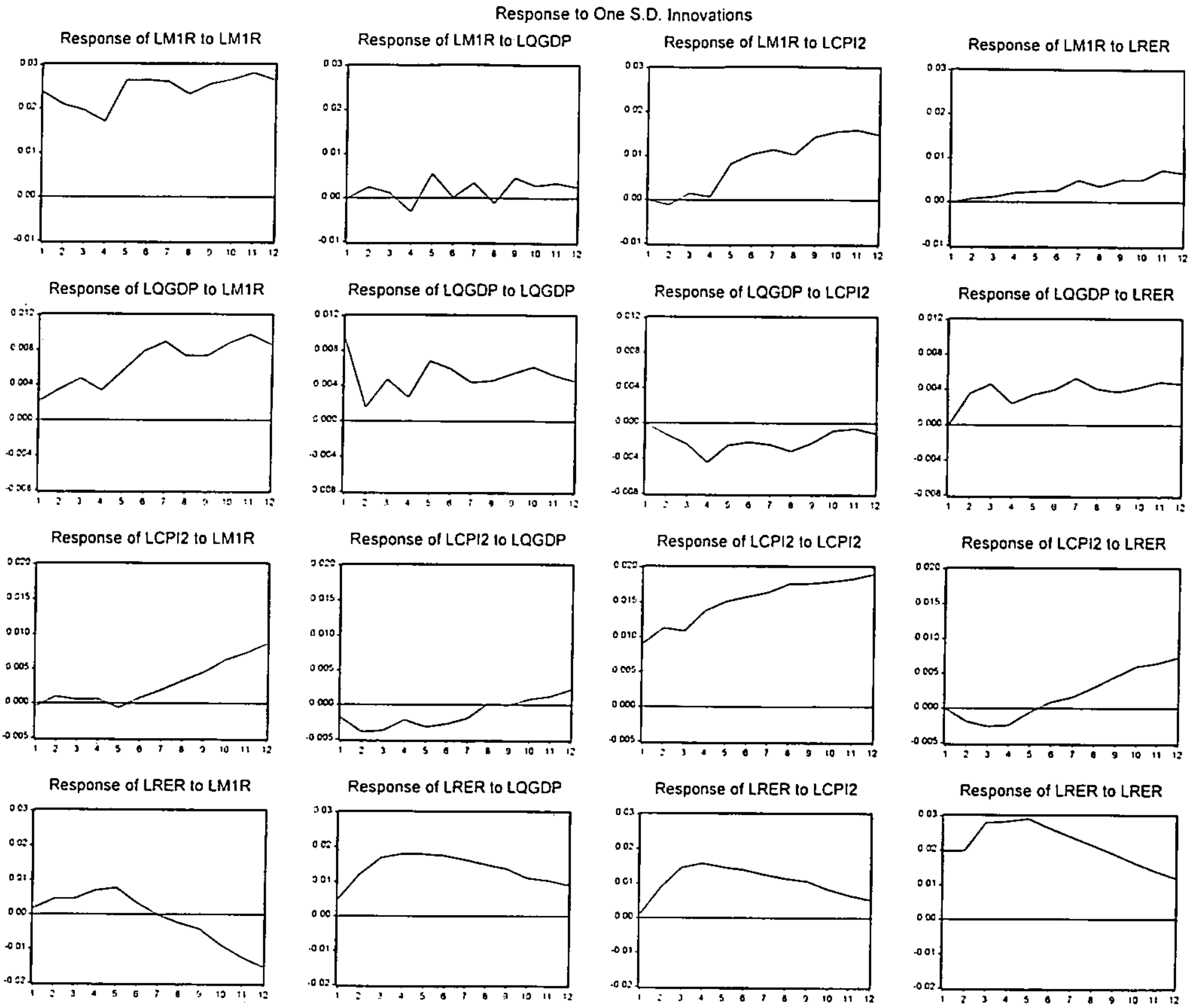
R&R: 4 lags, 3CI cointf, centered seasonal dummies, 1991:1 dummy

GRAPH 8
R&R VEC WITH TC

Variance Decomposition



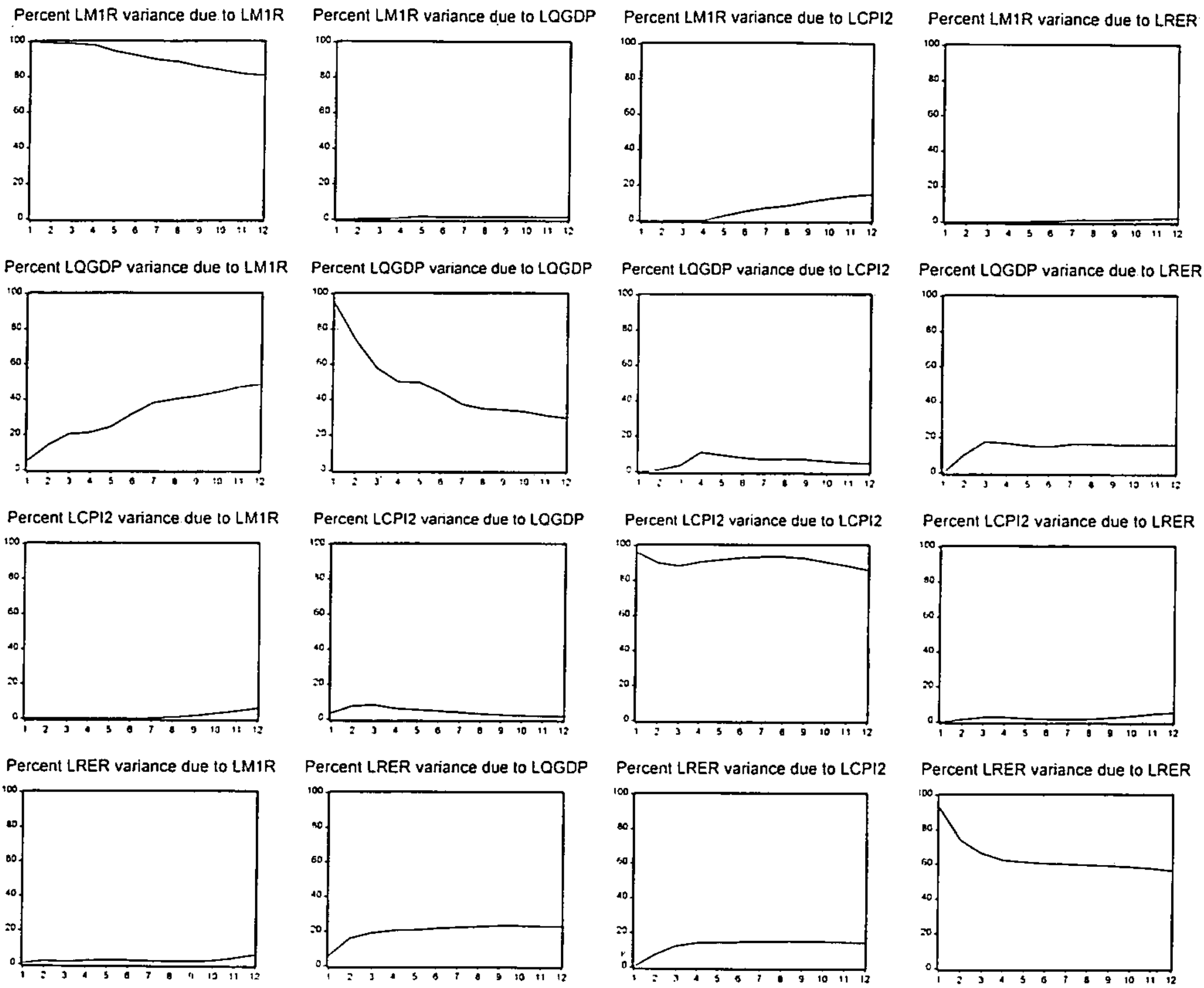
GRAPH 9
R&R VEC WITH RER



R&R. 4 LAGS. 1 CI CIDRIFT. CENTERED DUMMIES. RER INSTEAD OF TC

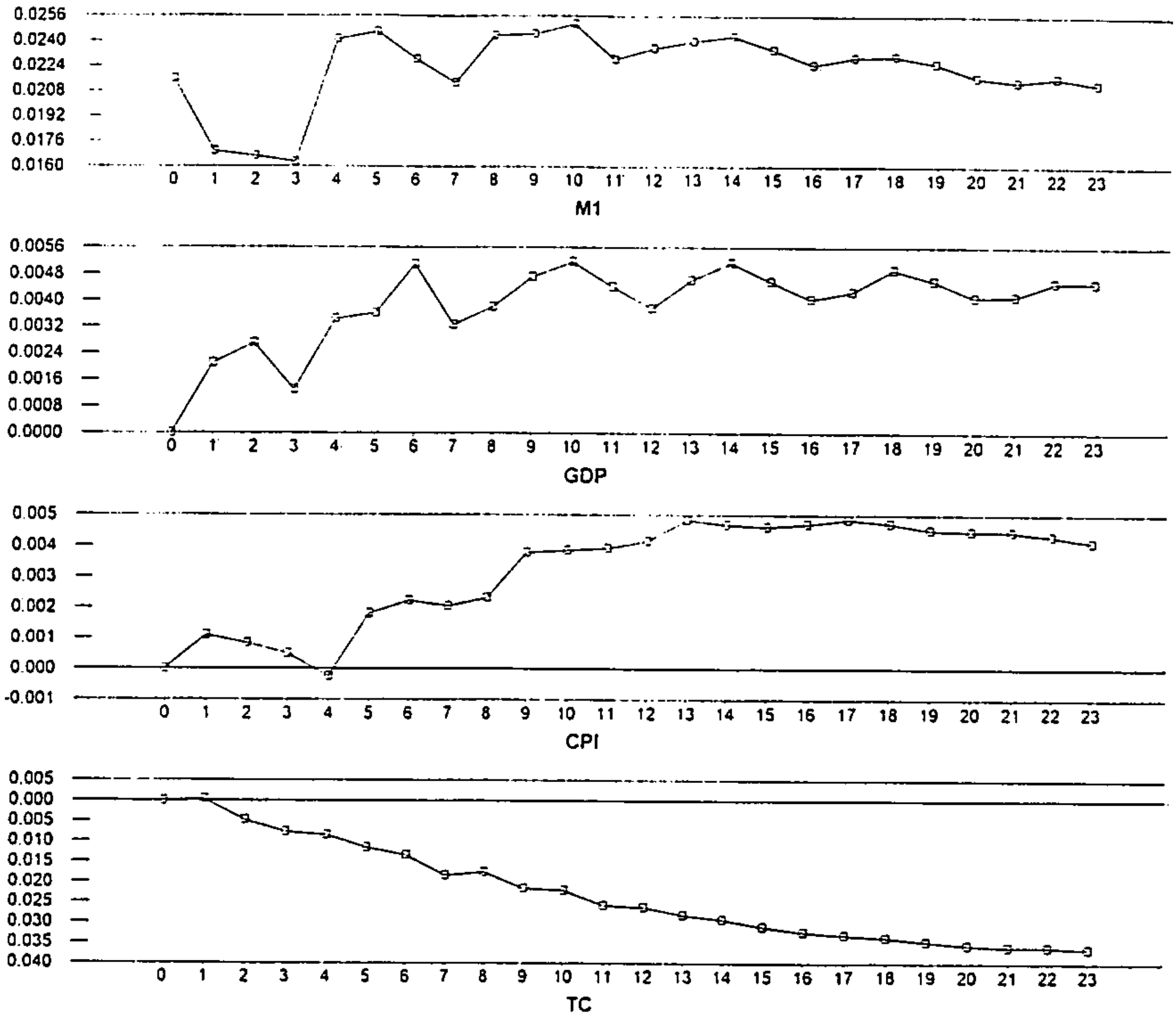
GRAPH 10
R&R VEC WITH RER

Variance Decomposition

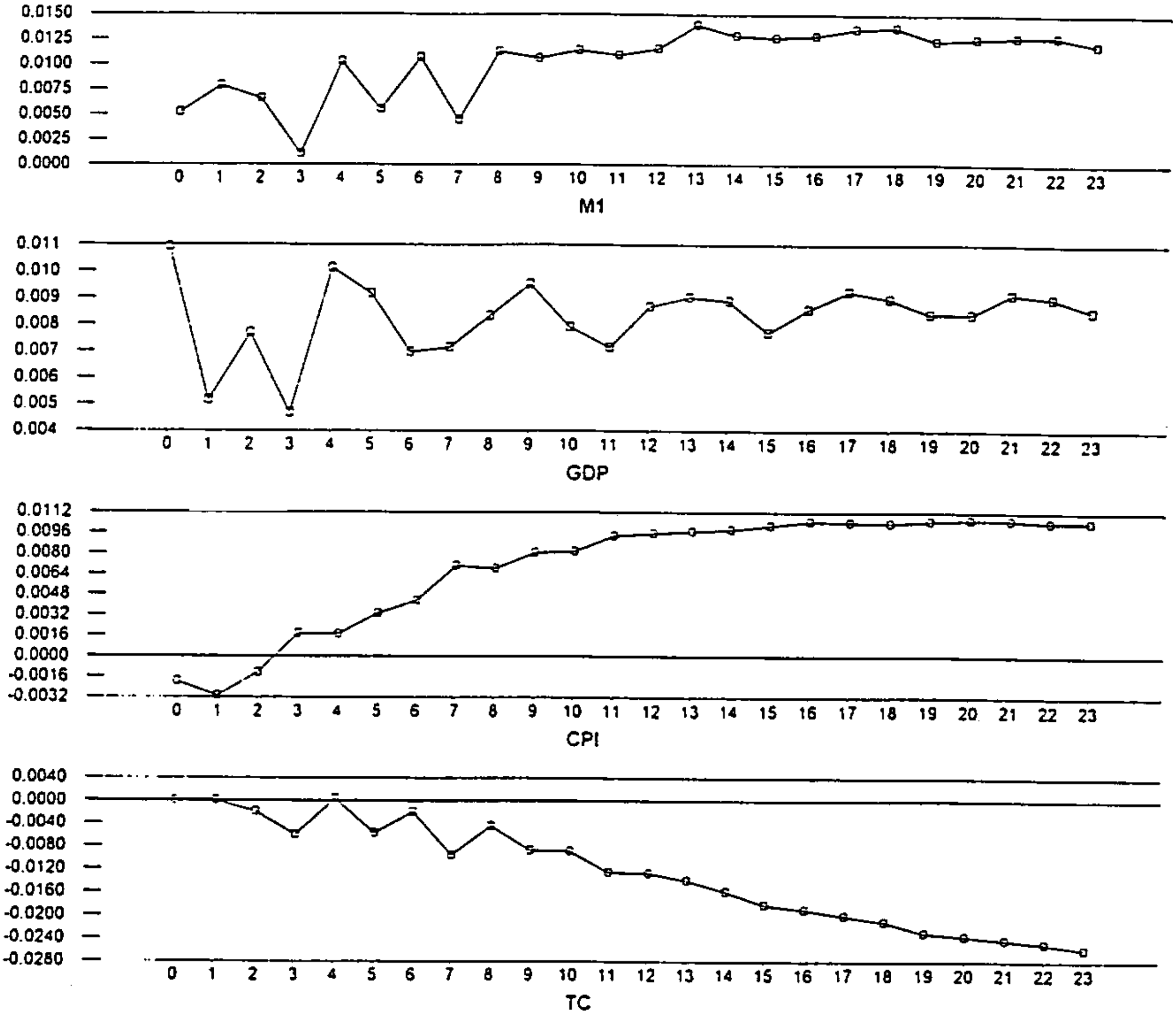


R&R: 4 LAGS, I CI CIDRIFT, CENTERED SEASONAL DUMMIES

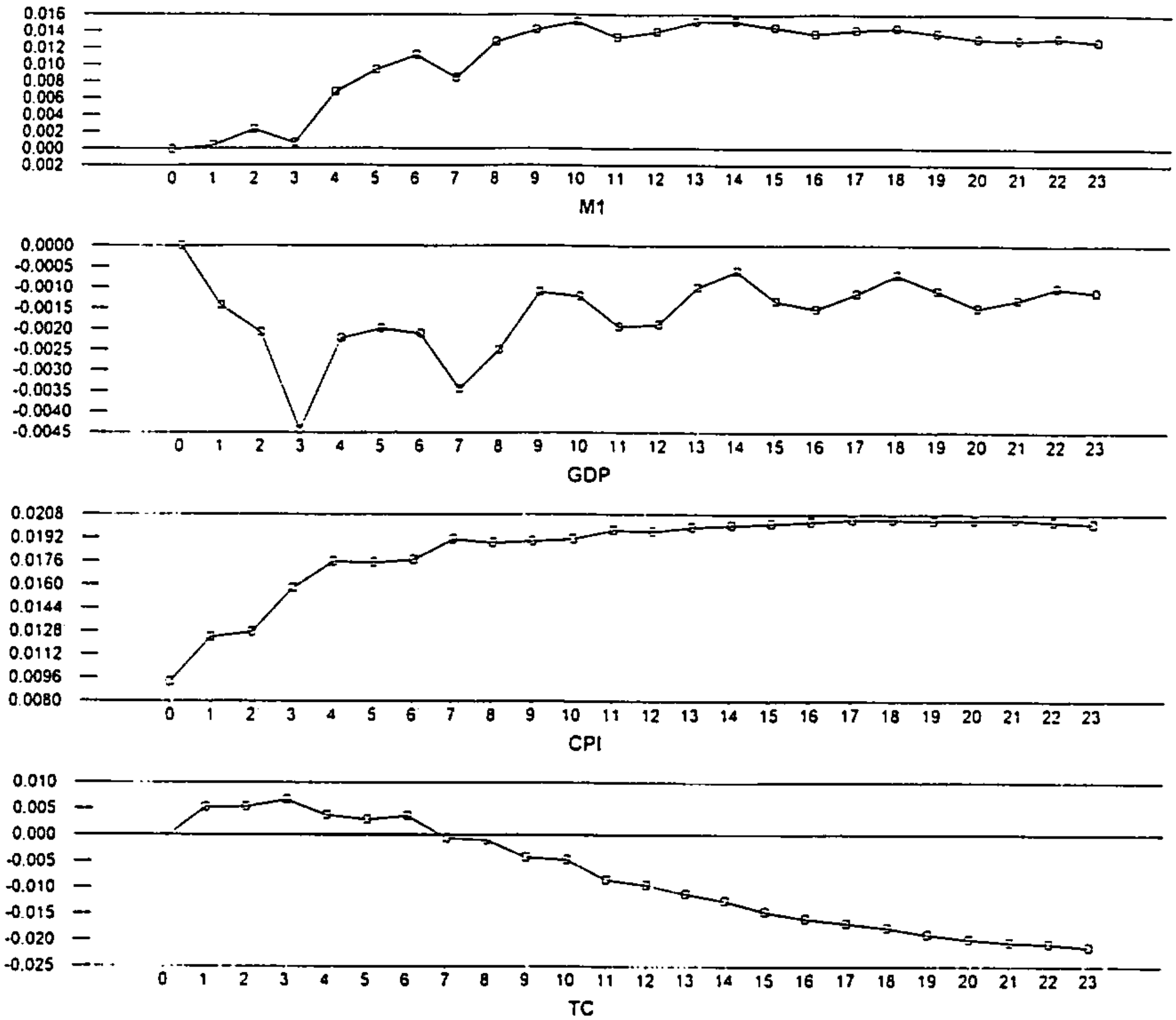
GRAPH 11
R&R SVAR-RBC
RESPONSE TO A DEMAND SHOCK



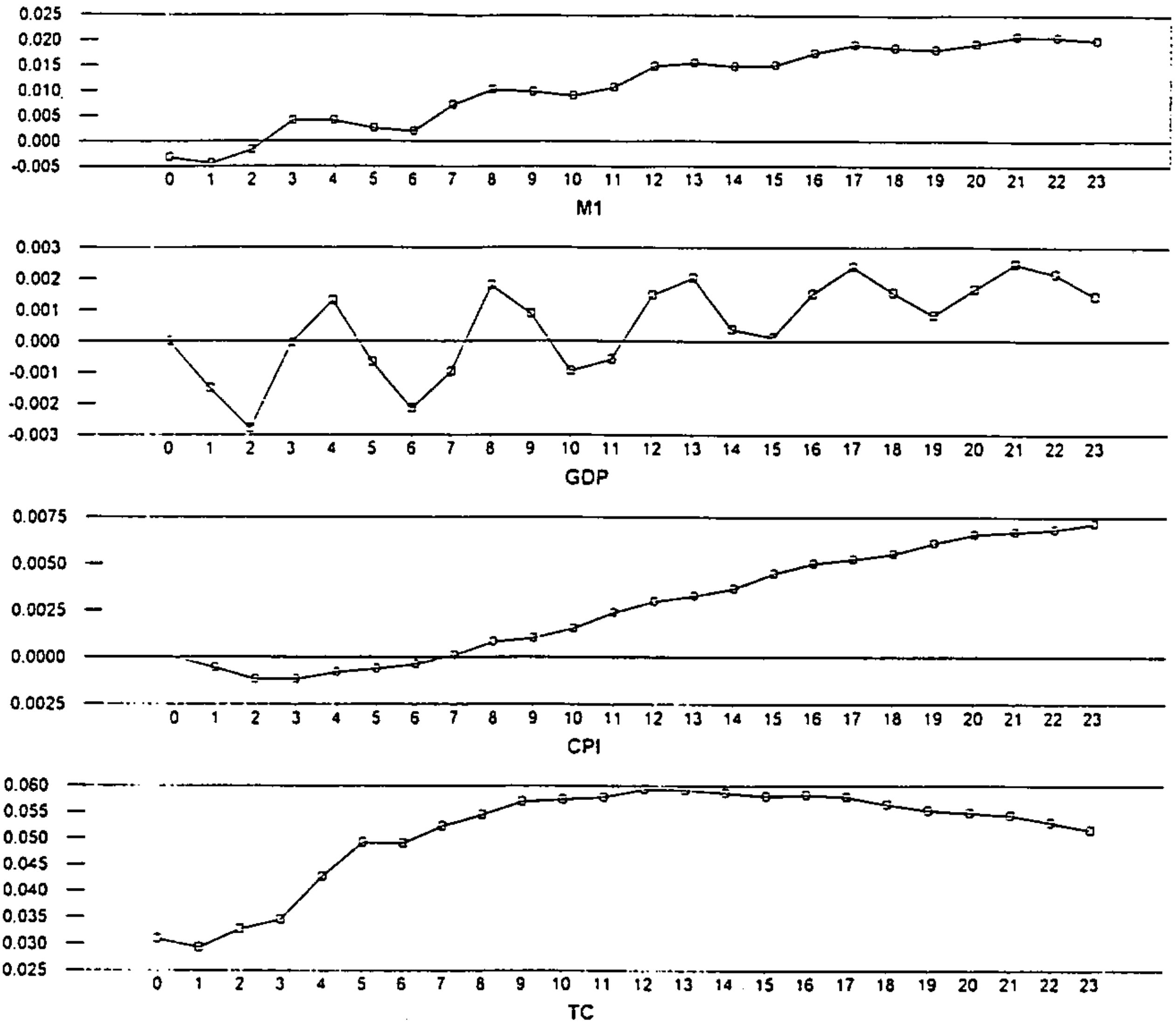
GRAPH 12
R&R SVAR-RBC
RESPONSE TO A SUPPLY SHOCK



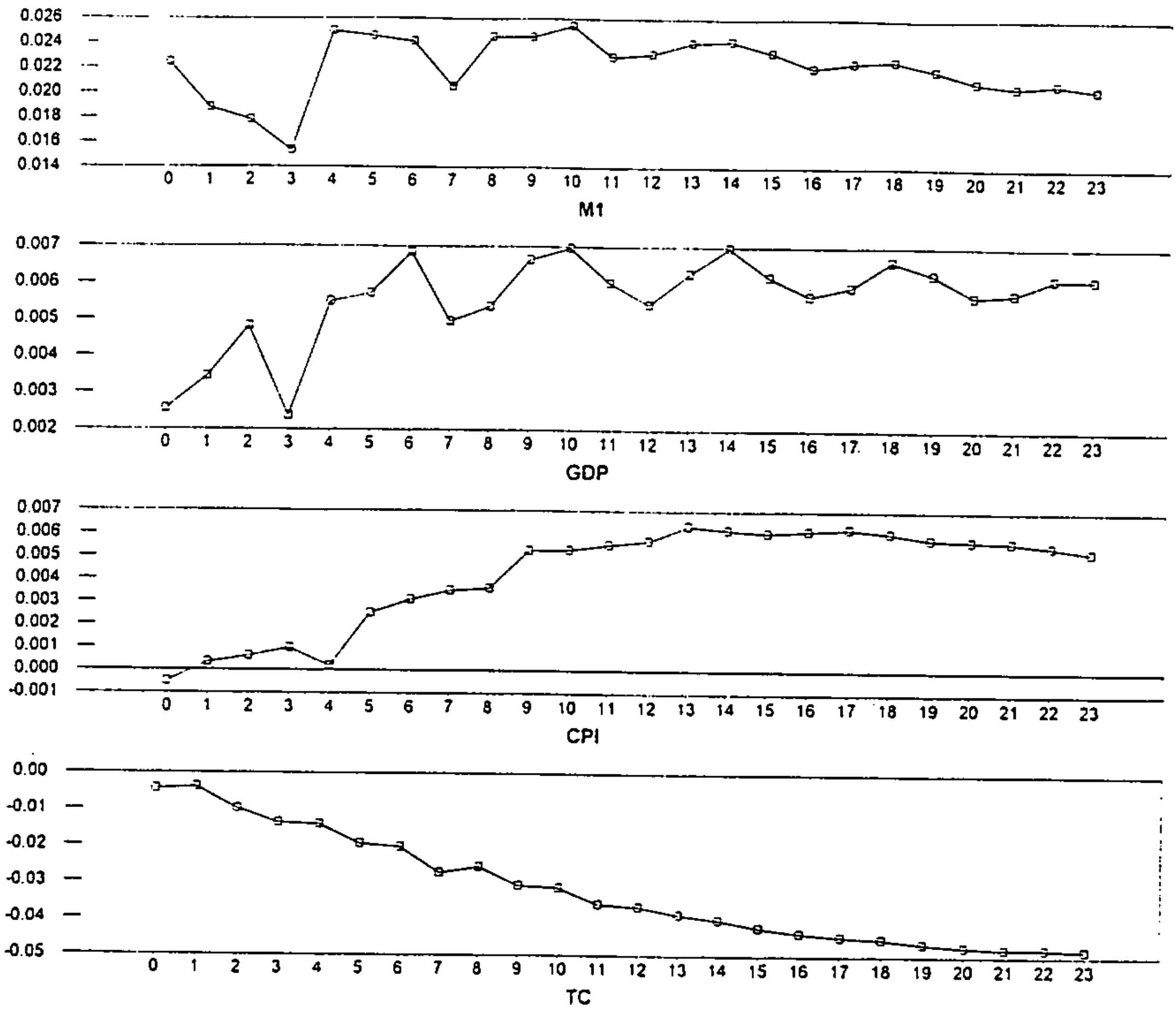
GRAPH 13
R&R SVAR-RBC
RESPONSE TO A MONETARY SHOCK



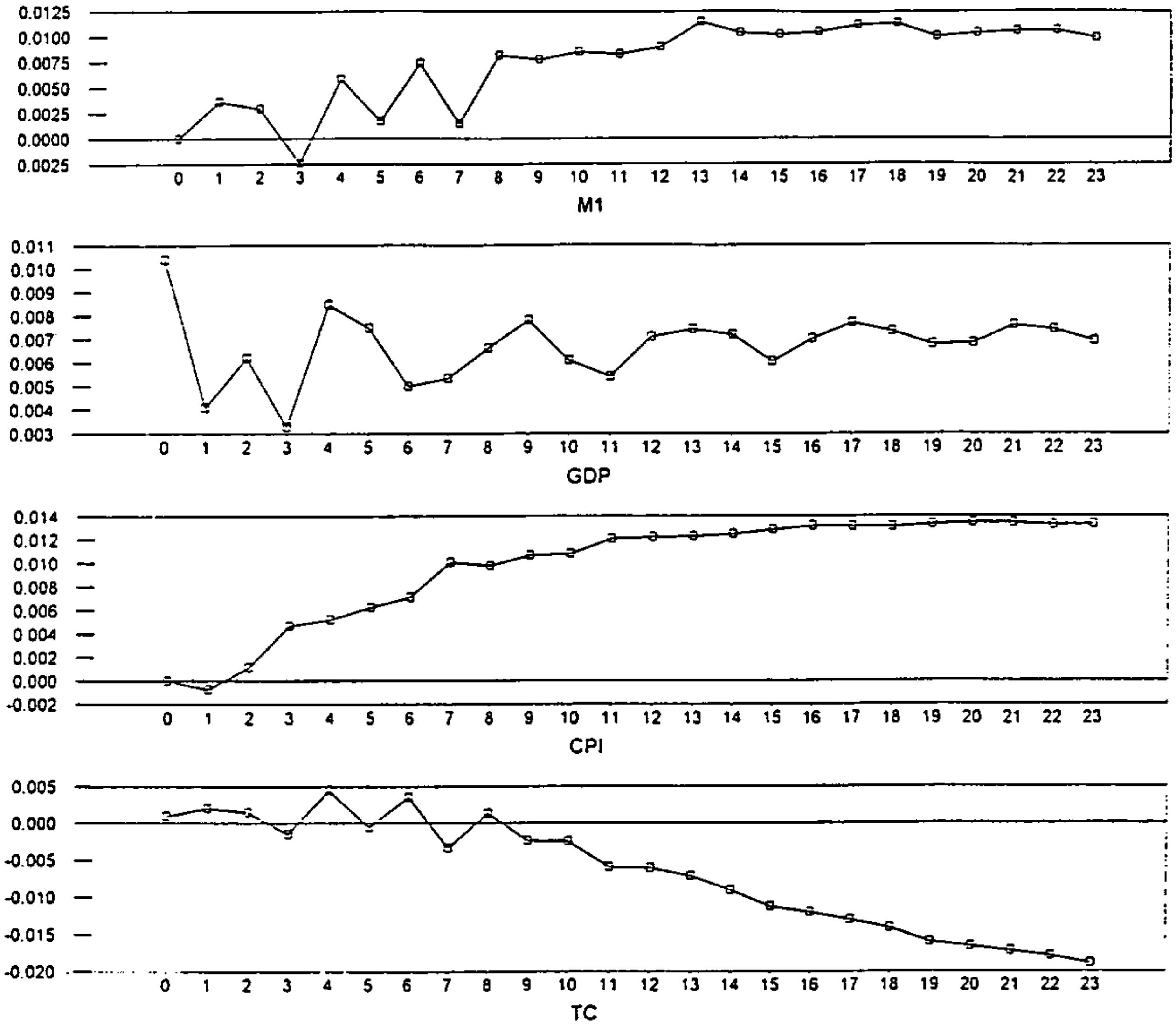
GRAPH 14
R&R SVAR-RBC
RESPONSE TO A SHOCK IN TC



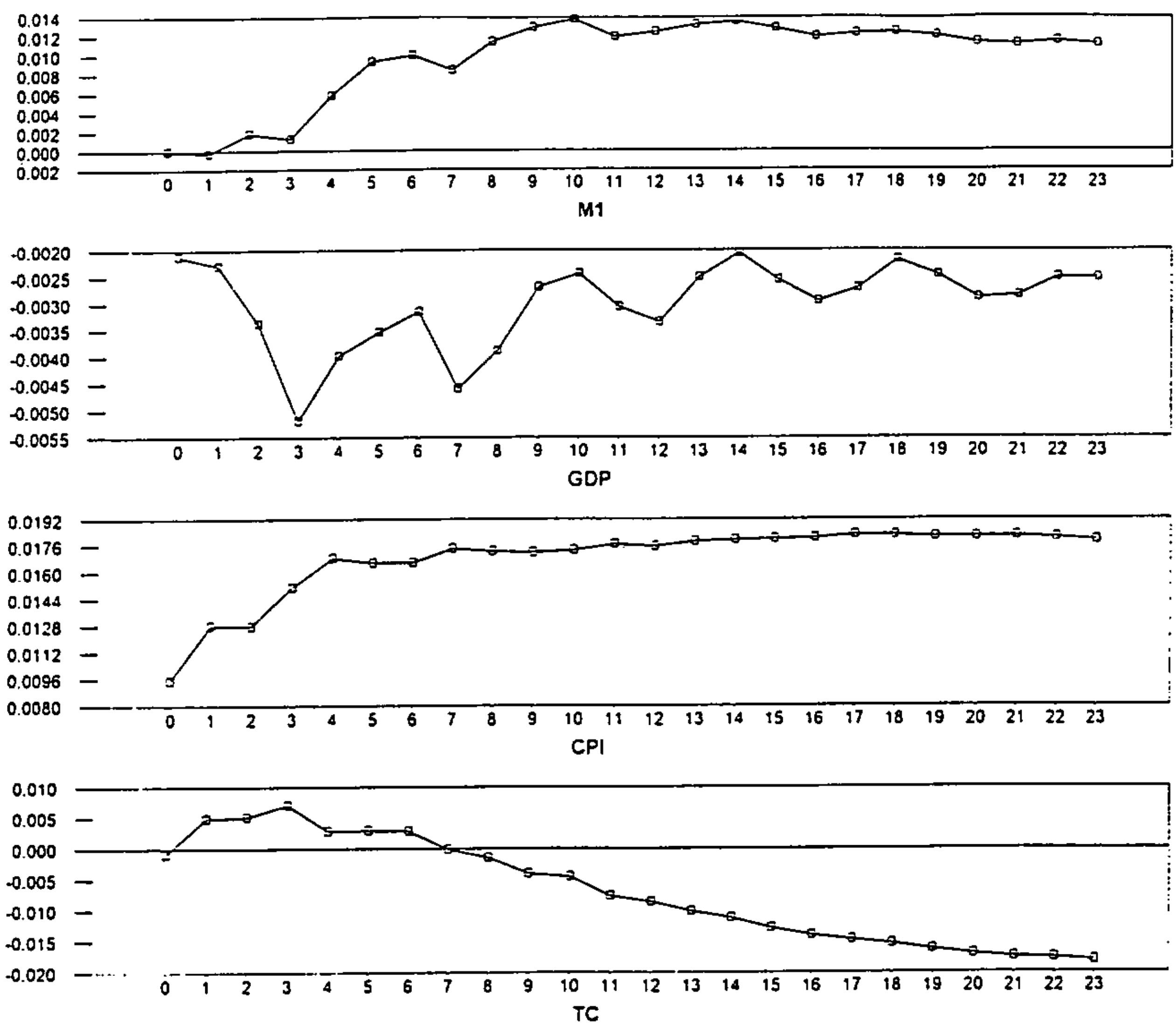
GRAPH 15
R&R SVAR-NEOKEYNESIAN
RESPONSE TO A DEMAND SHOCK



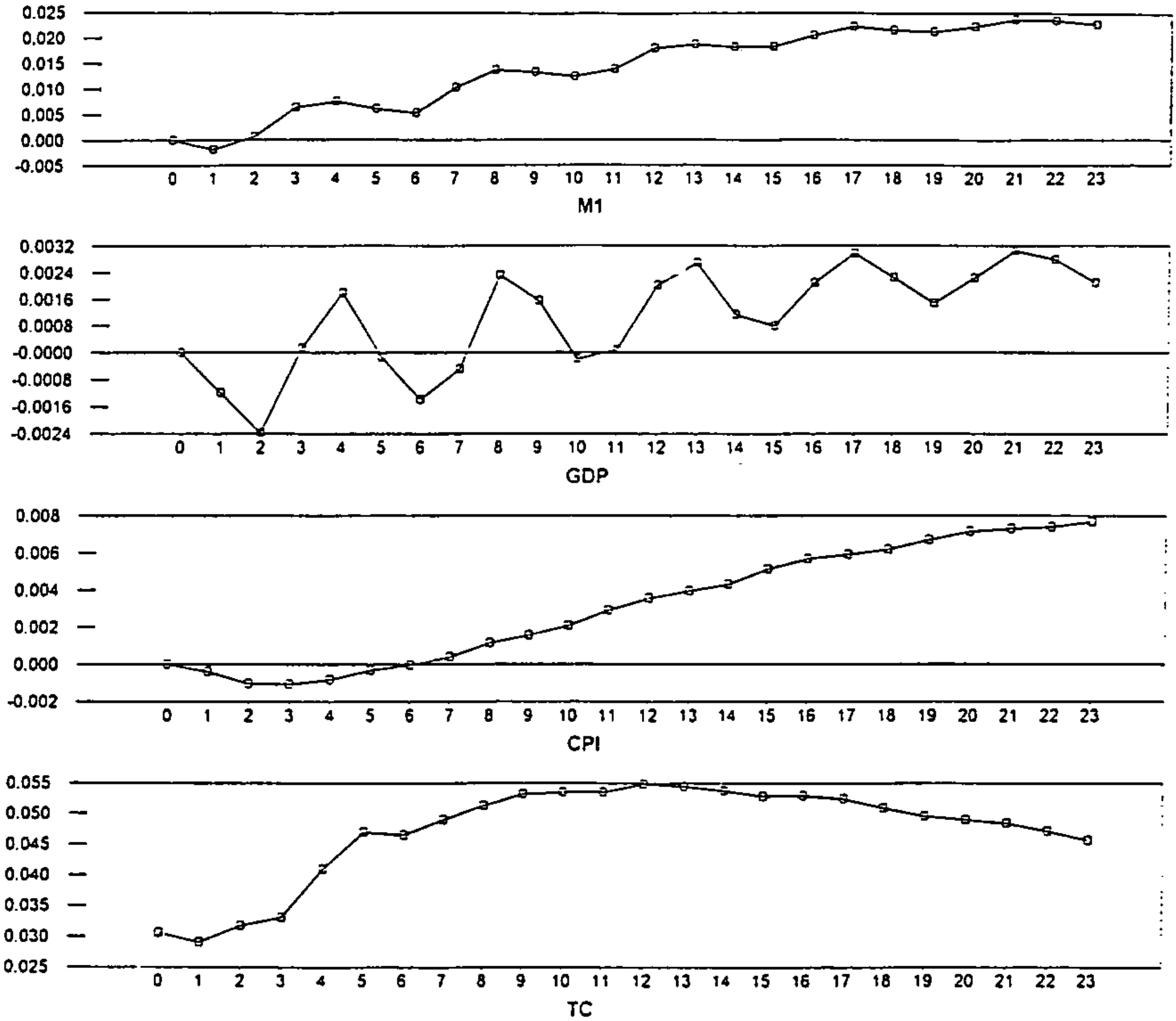
GRAPH 16
R&R SVAR-NEOKEYNESIAN
RESPONSE TO A SUPPLY SHOCK



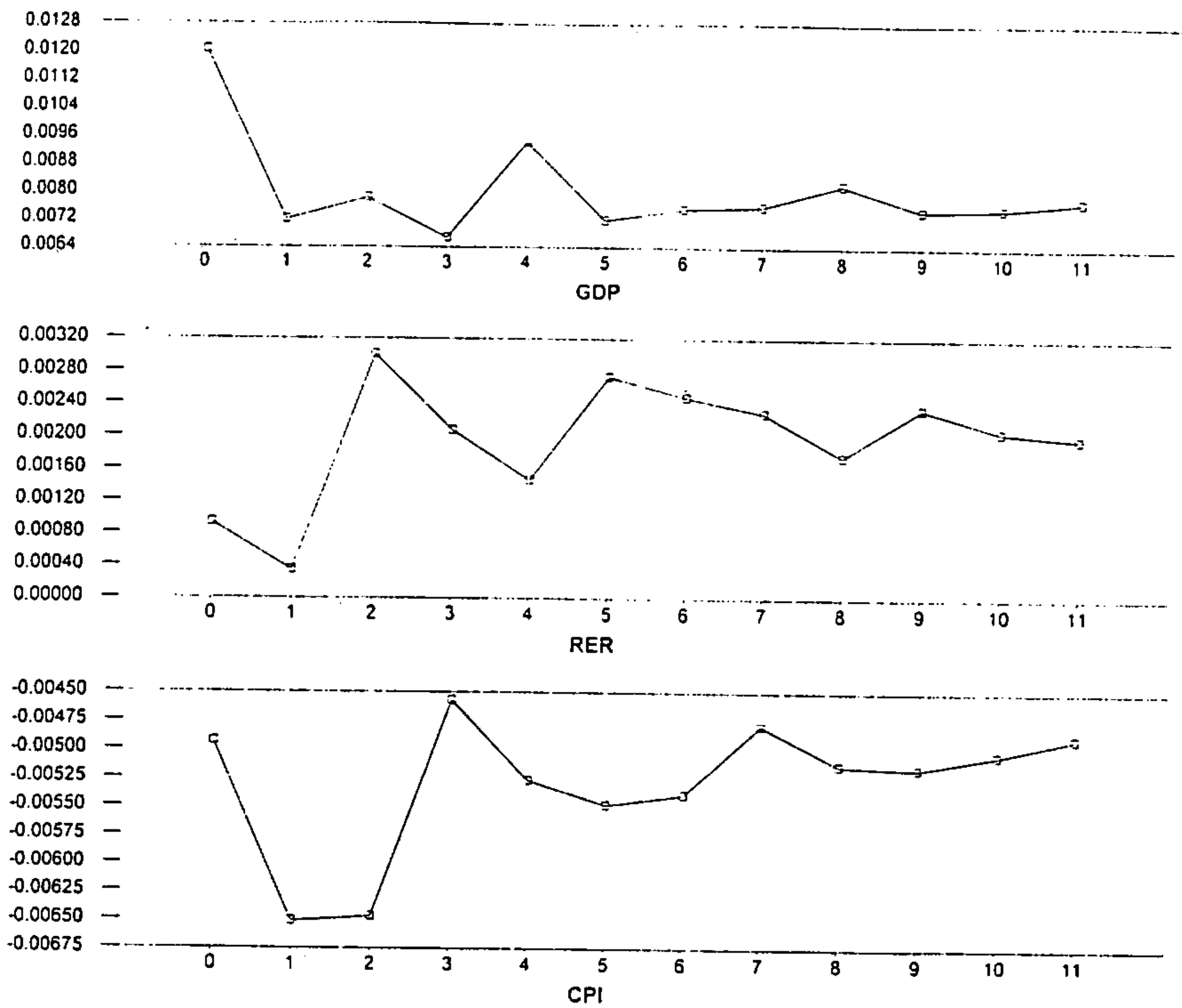
GRAPH 17
R&R SVAR-NEOKEYNESIAN
RESPONSE TO A MONETARY SHOCK



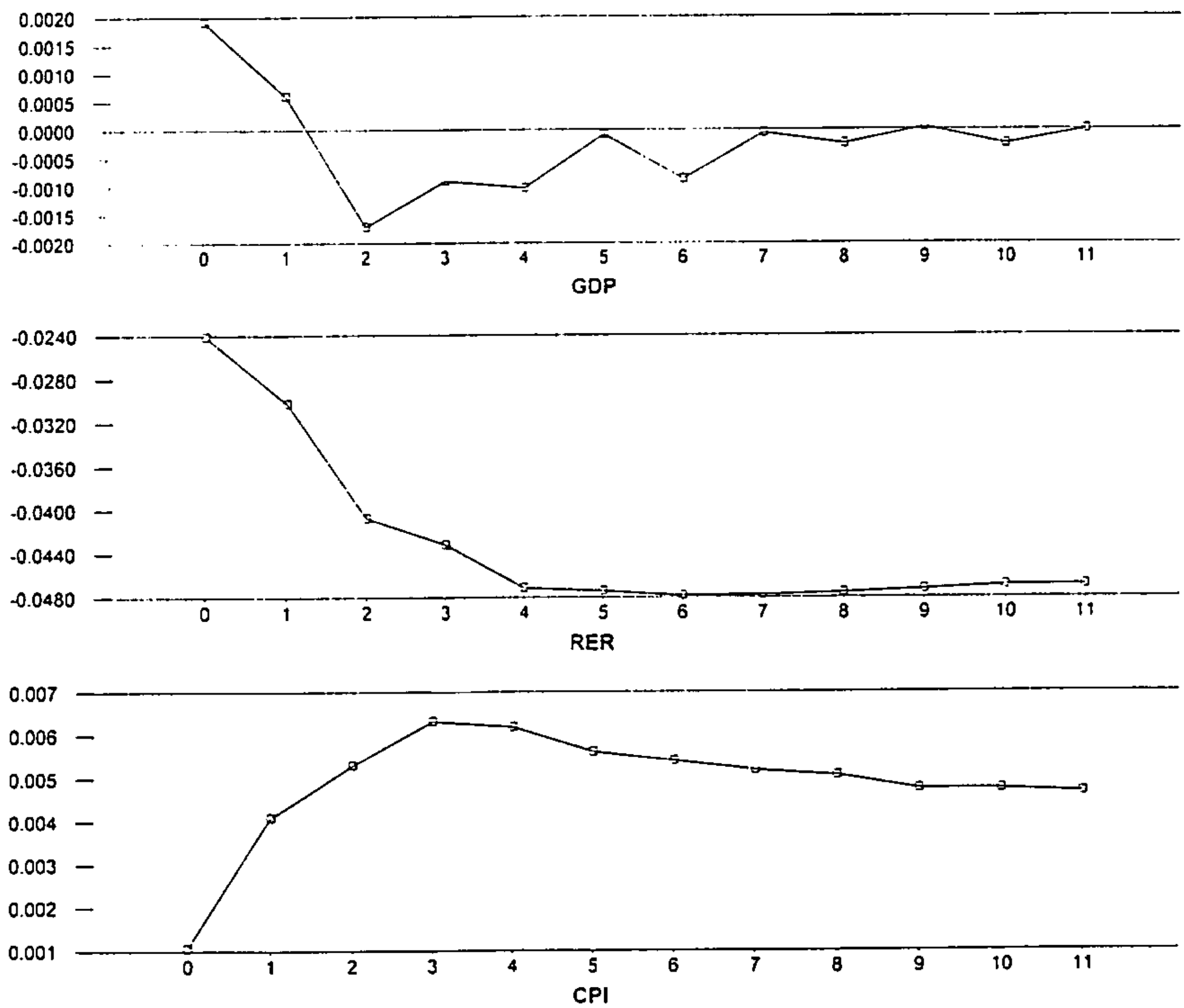
GRAPH 18
R&R SVAR-NEOKEYNESIAN
RESPONSE TO A SHOCK IN TC



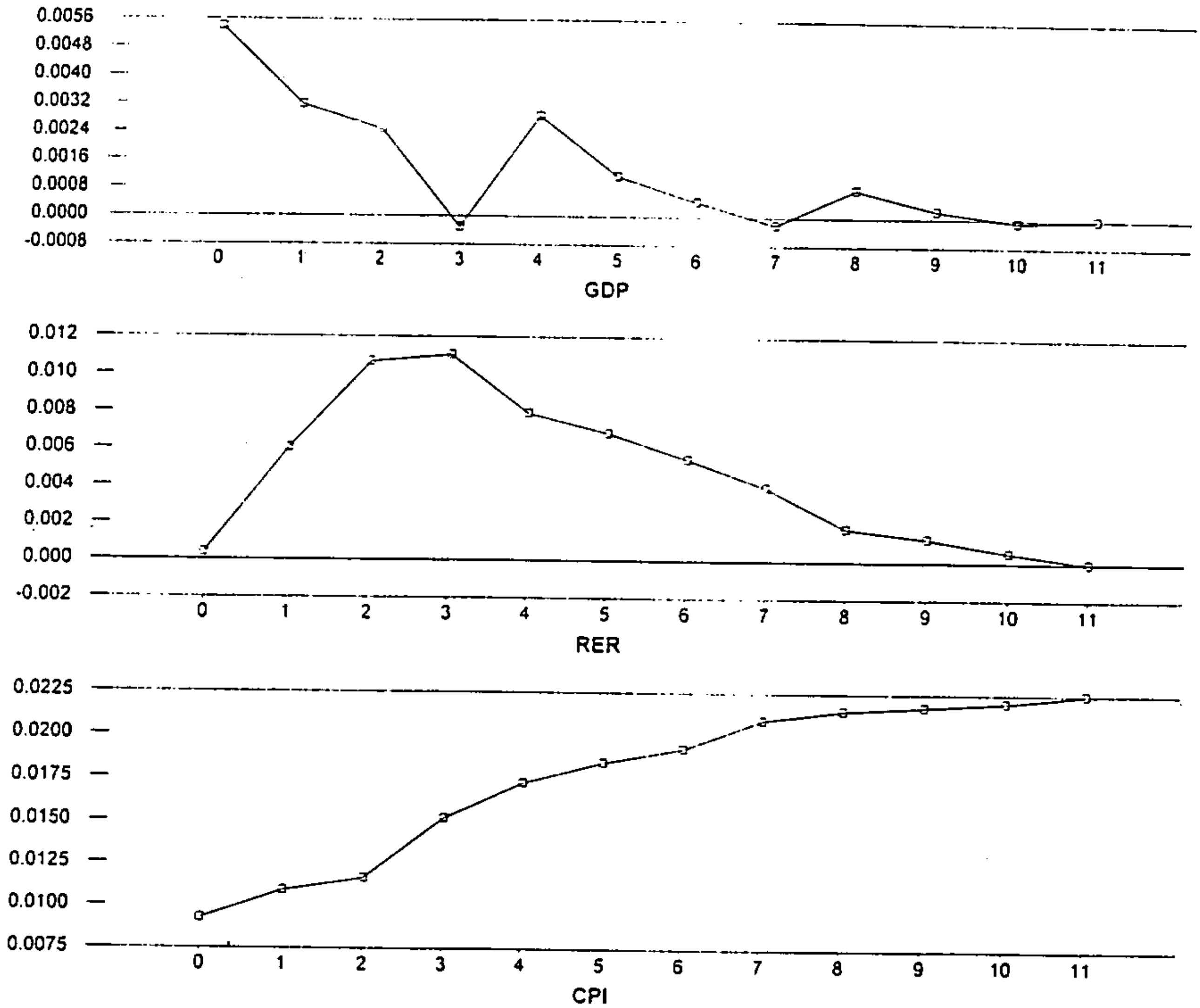
GRAPH 19
C&G SVAR
RESPONSE TO A SUPPLY SHOCK



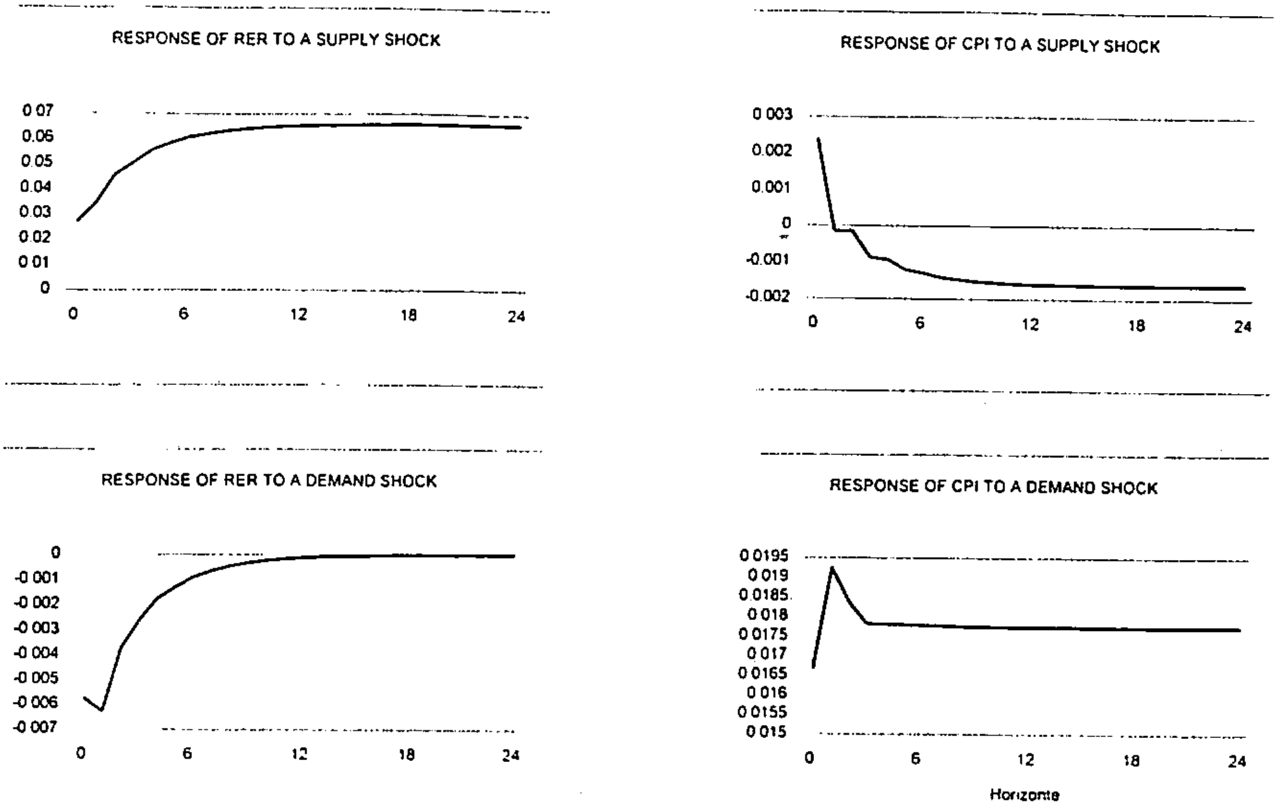
GRAPH 20
C&G SVAR
RESPONSE TO A DEMAND SHOCK



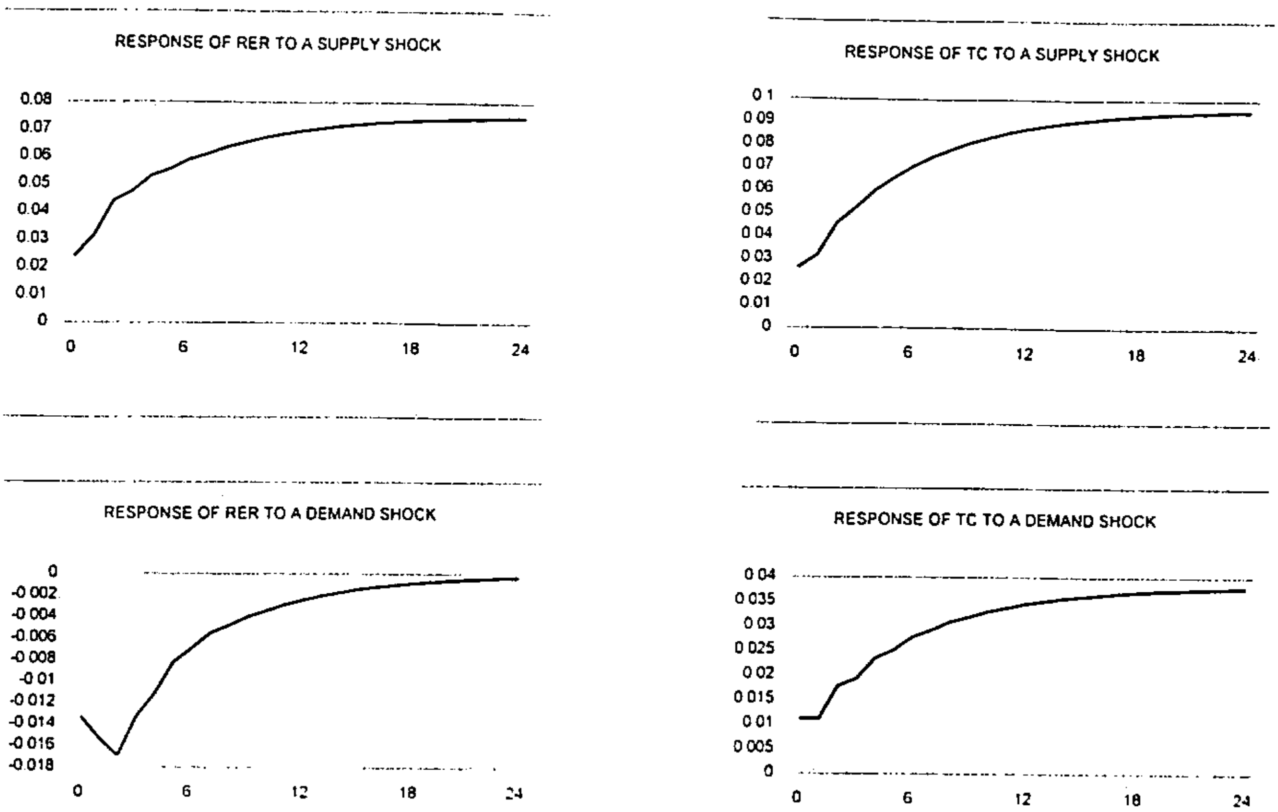
GRAPH 21
C&G SVAR
RESPONSE TO A MONETARY SHOCK



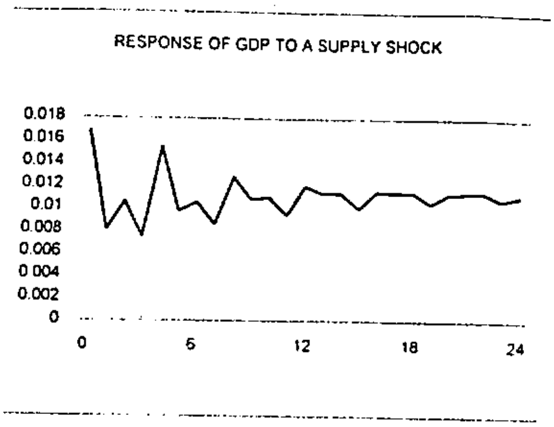
GRAPH 22
RER-CPI SVAR

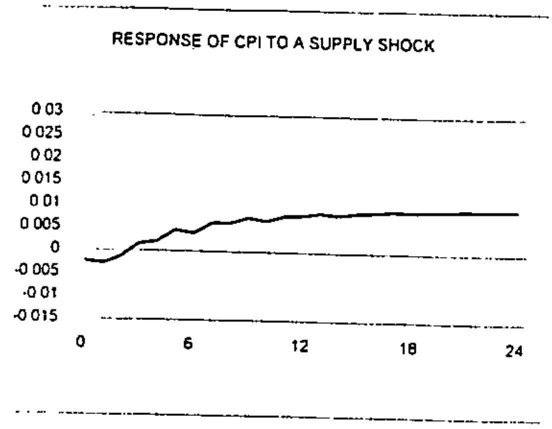


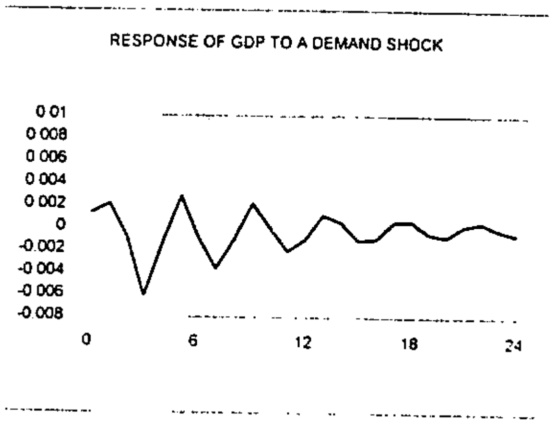
GRAPH 23
RER-TC SVAR

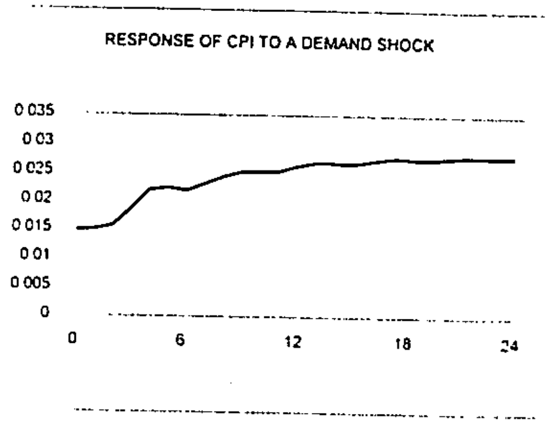


GRAPH 24
GDP-CPI SVAR

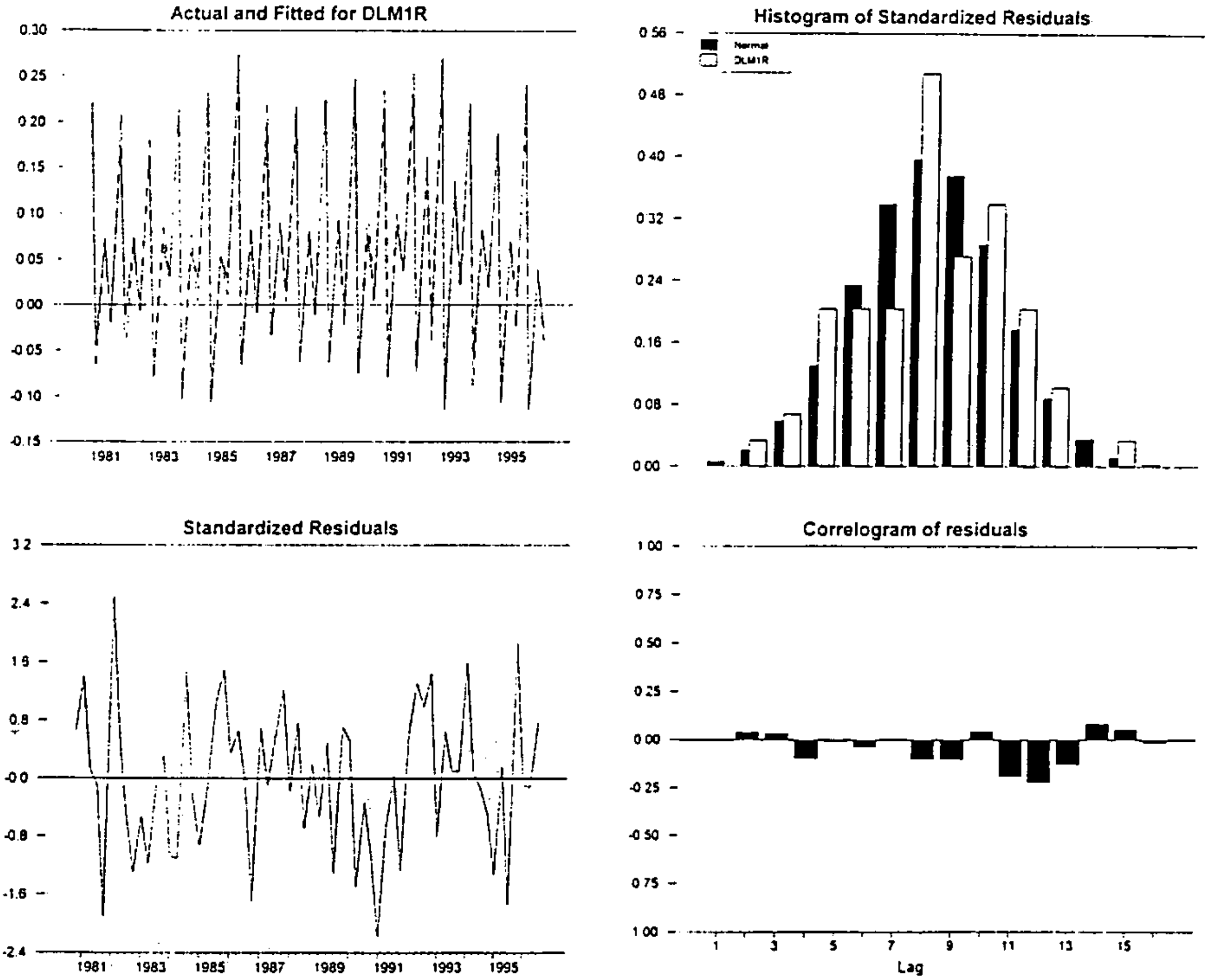




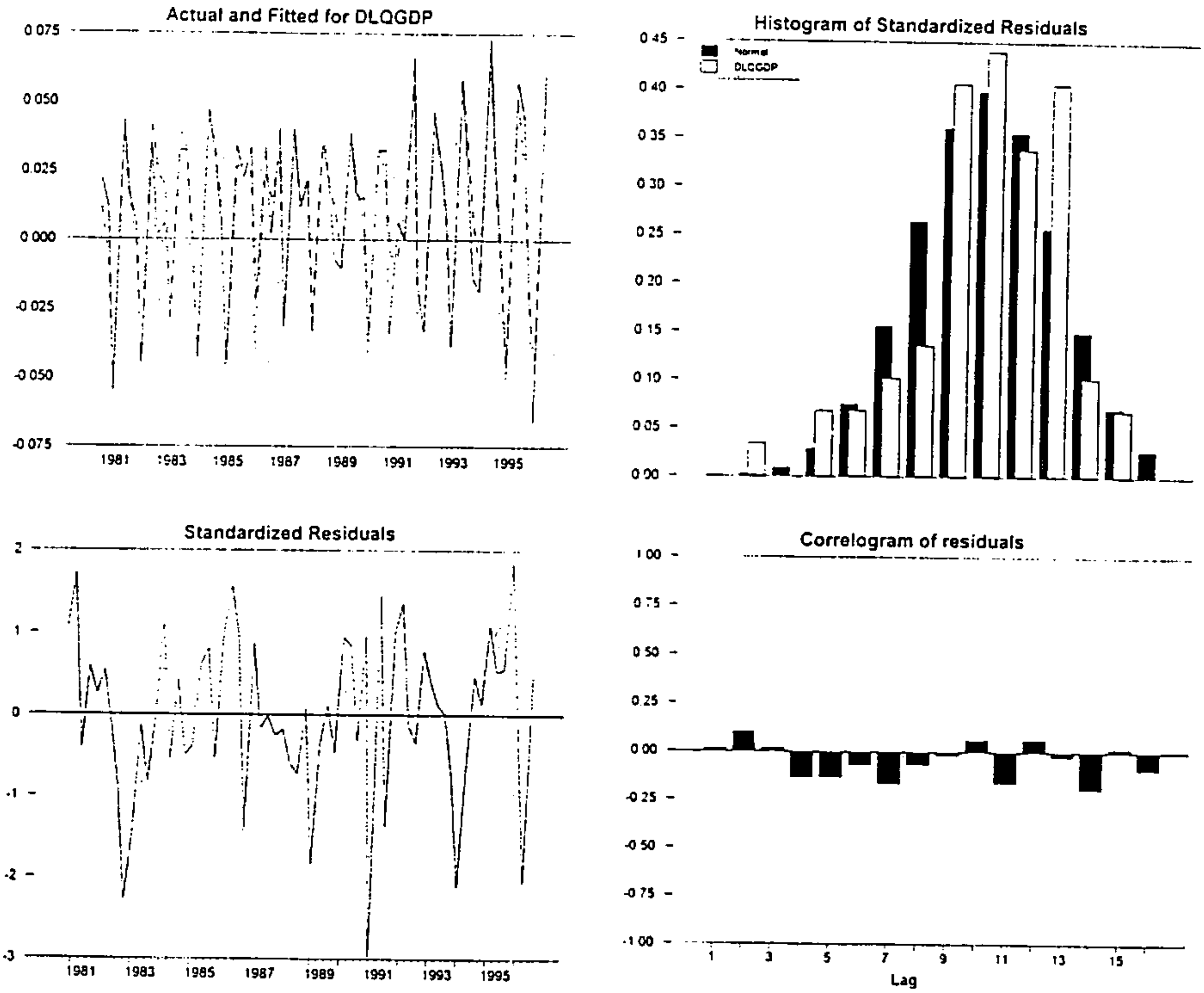




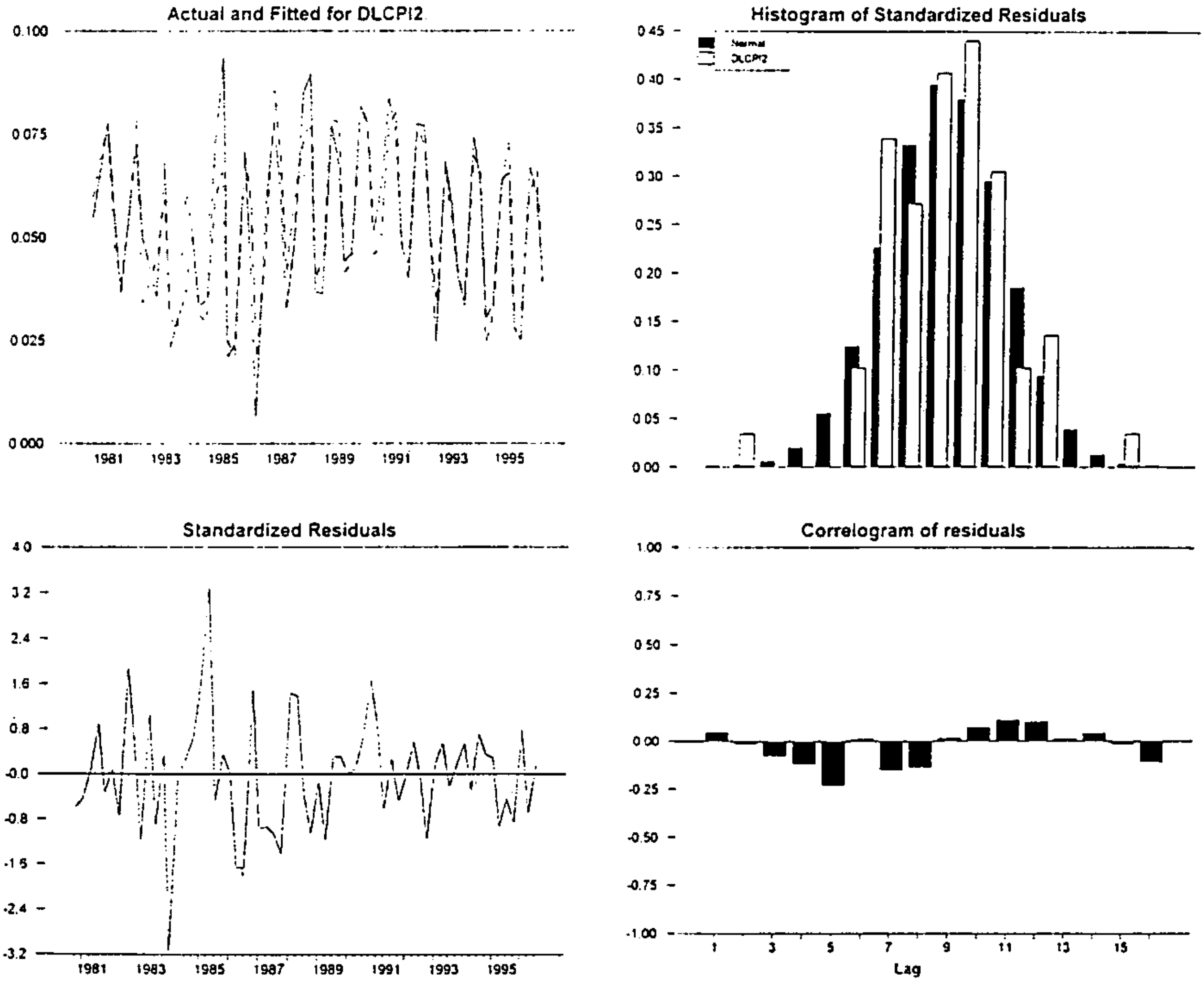
GRAPH 25


Actual and Fitted for DLM1R
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
1981
1983
1985
1987
1989
1991
1993
1995
Histogram of Standardized Residuals
0.56
0.48
0.40
0.32
0.24
0.16
0.08
0.00
Standardized Residuals
3.2
2.4
1.6
0.8
-0.0
-0.8
-1.6
-2.4
1981
1983
1985
1987
1989
1991
1993
1995
Correlogram of residuals
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
0.75
1.00
1
3
5
7
9
11
13
15
Lag

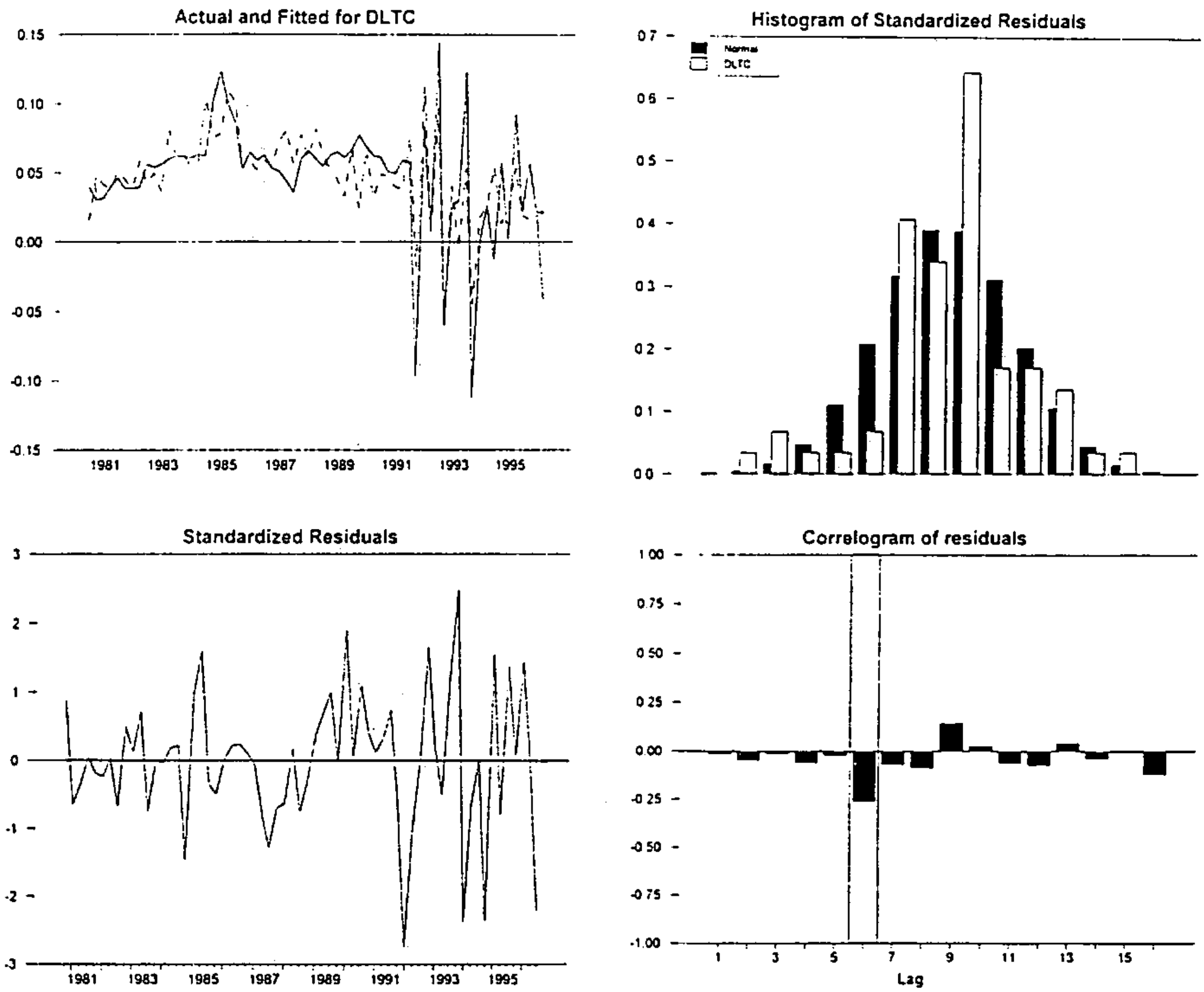
GRAPH 26


Actual and Fitted for DLQGDP
0.075
0.050
0.025
0.000
-0.025
-0.050
-0.075
1981 1983 1985 1987 1989 1991 1993 1995
Histogram of Standardized Residuals
Normal
DLQGDP
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Standardized Residuals
2
1
0
-1
-2
-3
1981 1983 1985 1987 1989 1991 1993 1995
Correlogram of residuals
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1 3 5 7 9 11 13 15
Lag

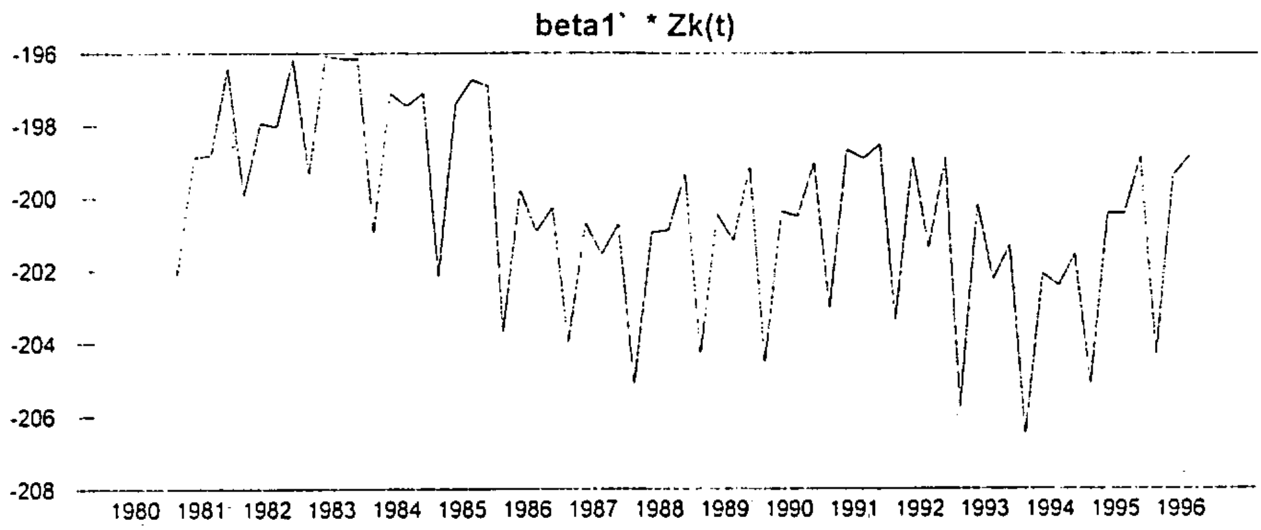
GRAPH 27

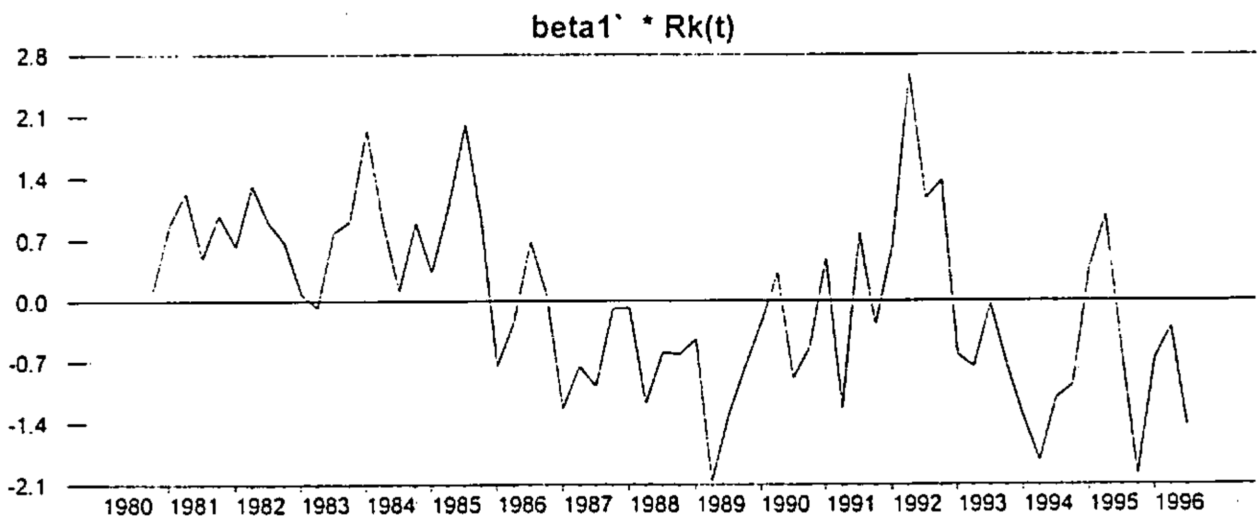

Actual and Fitted for DLCPI2
0.100
0.075
0.050
0.025
0.000
1981 1983 1985 1987 1989 1991 1993 1995
Histogram of Standardized Residuals
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Normal
DLCPI2
Standardized Residuals
4.0
3.2
2.4
1.6
0.8
-0.0
-0.8
-1.6
-2.4
-3.2
1981 1983 1985 1987 1989 1991 1993 1995
Correlogram of residuals
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1 3 5 7 9 11 13 15
Lag

GRAPH 28

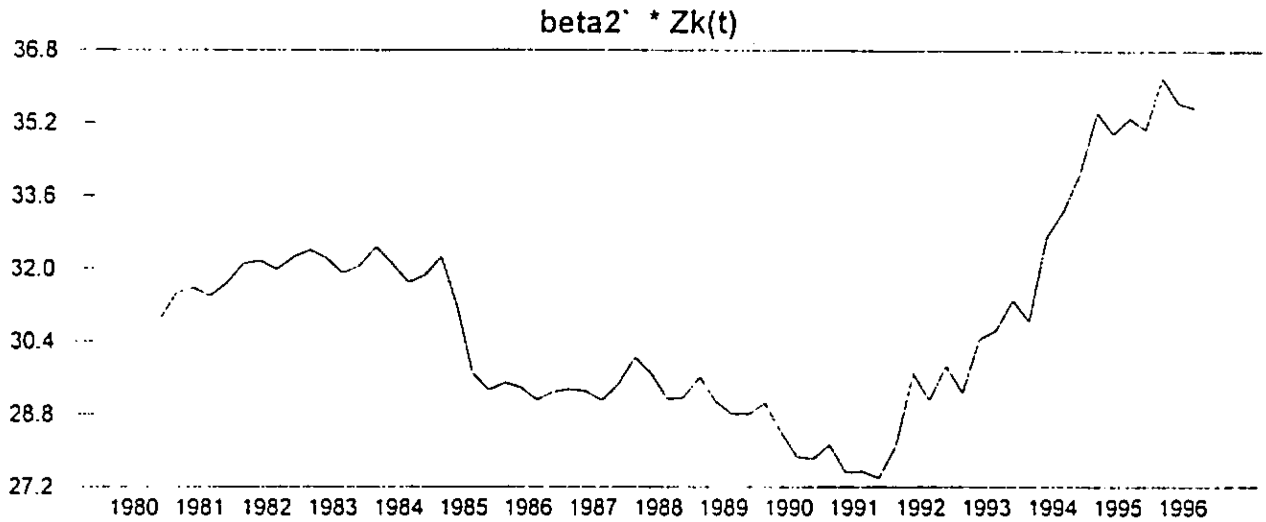

Actual and Fitted for DLTC
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
1981 1983 1985 1987 1989 1991 1993 1995
Histogram of Standardized Residuals
Normal
DLTC
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Standardized Residuals
3
2
1
0
-1
-2
-3
1981 1983 1985 1987 1989 1991 1993 1995
Correlogram of residuals
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1 3 5 7 9 11 13 15
Lag

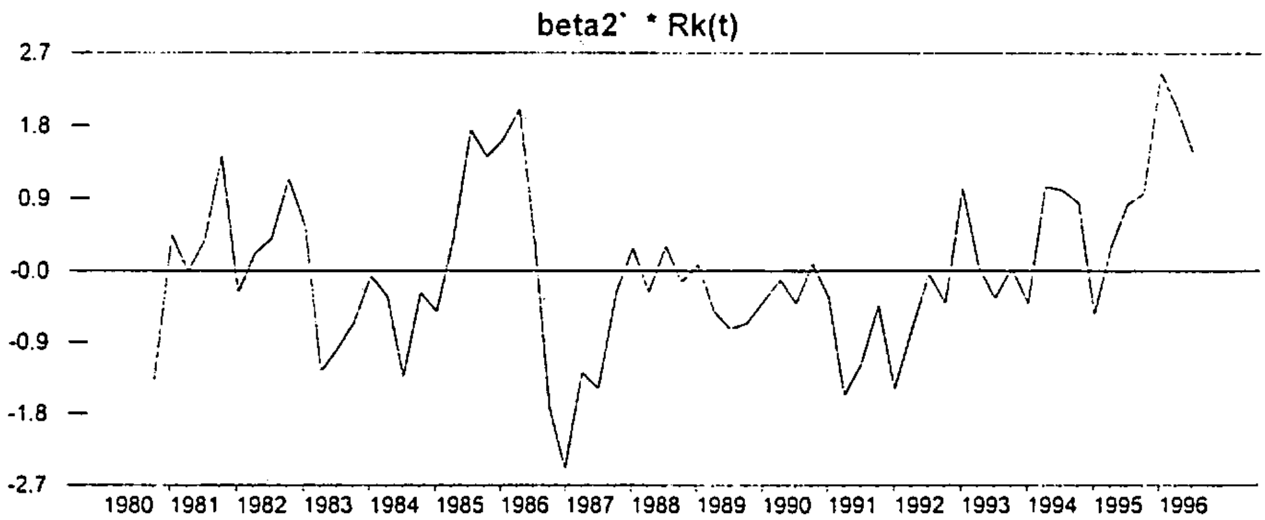
GRAPH 29


beta1` * Zk(t)
-196
-198
-200
-202
-204
-206
-208
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996

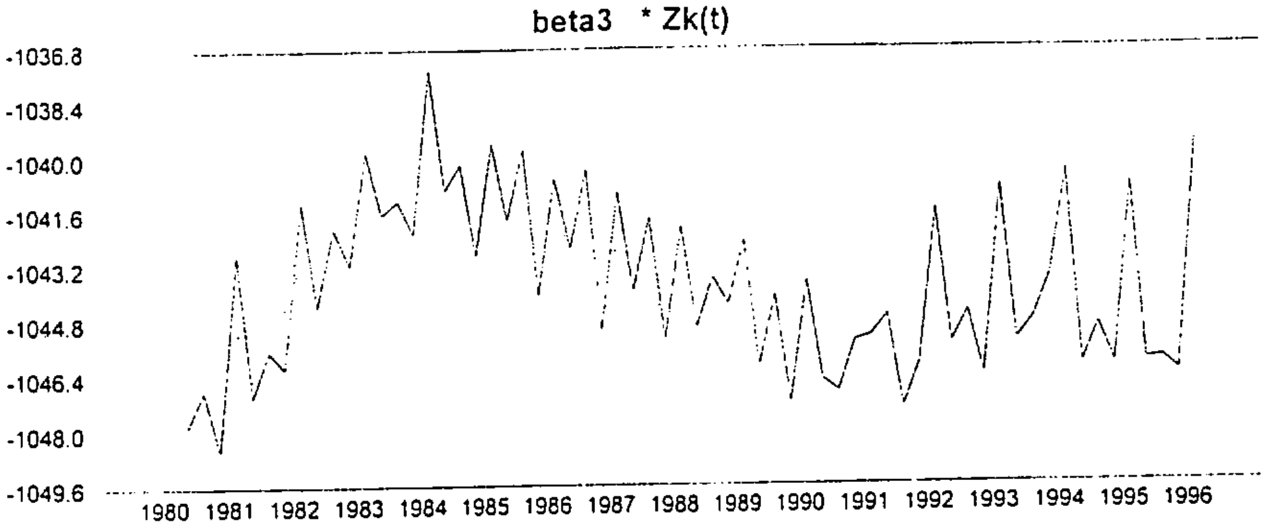

beta1` * Rk(t)
2.8
2.1
1.4
0.7
0.0
-0.7
-1.4
-2.1
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996

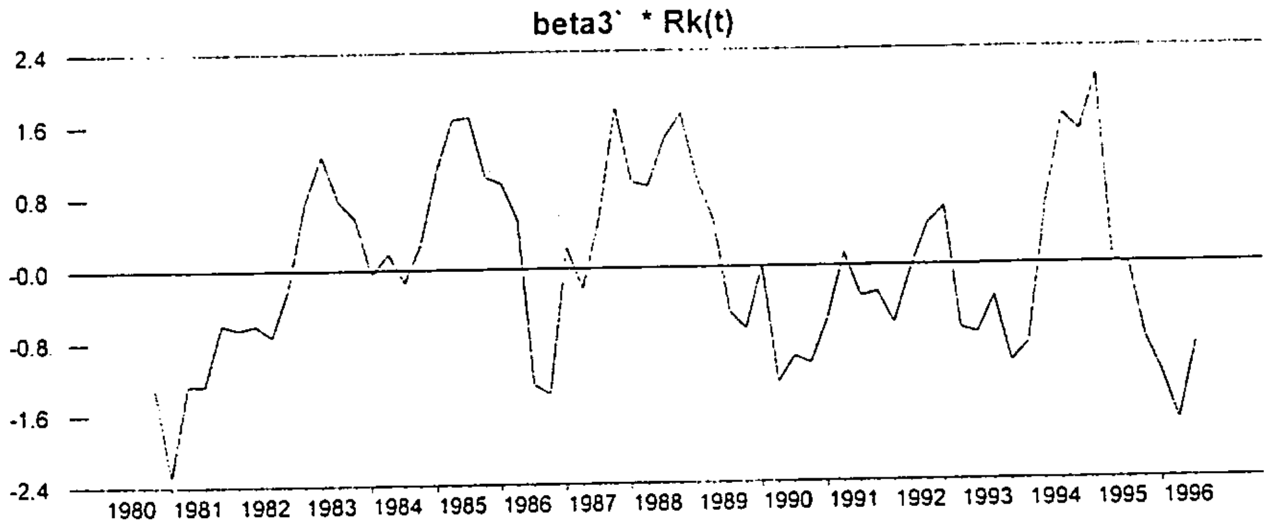
GRAPH 30


beta2' * Zk(t)
36.8
35.2
33.6
32.0
30.4
28.8
27.2
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996


beta2' * Rk(t)
2.7
1.8
0.9
-0.0
-0.9
-1.8
-2.7
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996

GRAPH 31


beta3 * Zk(t)
-1036.8
-1038.4
-1040.0
-1041.6
-1043.2
-1044.8
-1046.4
-1048.0
-1049.6
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996


beta3` * Rk(t)
2.4
1.6
0.8
-0.0
-0.8
-1.6
-2.4
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996

obs	YGDPBNK	YGDPCAR	YGDPLOP
1925	40631000	NA	NA
1926	44511000	NA	NA
1927	48520000	NA	NA
1928	52084000	NA	NA
1929	53958000	NA	NA
1930	53494000	NA	NA
1931	52641000	NA	NA
1932	56130000	NA	NA
1933	59286000	NA	NA
1934	63016000	NA	NA
1935	64557000	NA	NA
1936	67972000	NA	NA
1937	69030000	NA	NA
1938	73522000	NA	NA
1939	78033000	NA	NA
1940	79722000	NA	NA
1941	81058000	NA	NA
1942	81225000	NA	NA
1943	81559000	NA	NA
1944	87072000	NA	NA
1945	91156000	NA	NA
1946	99917000	NA	NA
1947	1.04E+08	NA	NA
1948	1.07E+08	NA	NA
1949	1.16E+08	NA	NA
1950	1.17E+08	1.16E+08	1.17E+08
1951	1.21E+08	1.19E+08	1.21E+08
1952	1.29E+08	1.27E+08	1.28E+08
1953	1.36E+08	1.35E+08	1.35E+08
1954	1.46E+08	1.44E+08	1.45E+08
1955	1.52E+08	1.50E+08	1.50E+08
1956	1.58E+08	1.56E+08	1.58E+08
1957	1.61E+08	1.61E+08	1.63E+08
1958	1.65E+08	1.65E+08	1.66E+08
1959	1.85E+08	1.85E+08	1.78E+08
1960	1.85E+08	1.85E+08	1.85E+08
1961	1.94E+08	1.94E+08	1.94E+08
1962	2.05E+08	2.05E+08	2.05E+08
1963	2.11E+08	2.11E+08	2.11E+08
1964	2.24E+08	2.24E+08	2.24E+08
1965	2.32E+08	2.32E+08	2.33E+08
1966	2.45E+08	2.45E+08	2.46E+08
1967	2.55E+08	2.55E+08	2.55E+08
1968	2.71E+08	2.71E+08	2.71E+08
1969	2.88E+08	2.88E+08	2.88E+08
1970	3.07E+08	3.07E+08	3.07E+08
1971	3.26E+08	3.26E+08	3.26E+08
1972	3.51E+08	3.51E+08	3.51E+08

obs	YGDPBNK	YGDPCAR	YGDPLOP
1973	3.74E+08	3.74E+08	3.74E+08
1974	3.96E+08	3.96E+08	3.96E+08
1975	4.05E+08	4.05E+08	4.05E+08
1976	4.24E+08	4.24E+08	4.24E+08
1977	4.42E+08	4.42E+08	4.42E+08
1978	4.79E+08	4.79E+08	4.79E+08
1979	5.05E+08	5.05E+08	5.05E+08
1980	5.26E+08	5.26E+08	5.26E+08
1981	5.38E+08	5.38E+08	5.38E+08
1982	5.43E+08	5.43E+08	5.43E+08
1983	5.51E+08	5.51E+08	5.51E+08
1984	5.70E+08	5.70E+08	5.70E+08
1985	5.88E+08	5.88E+08	5.88E+08
1986	6.22E+08	6.22E+08	6.22E+08
1987	6.55E+08	6.55E+08	6.55E+08
1988	6.82E+08	6.82E+08	6.82E+08
1989	7.04E+08	7.04E+08	7.05E+08
1990	7.33E+08	7.33E+08	7.35E+08
1991	7.50E+08	7.50E+08	7.50E+08
1992	7.79E+08	7.79E+08	7.80E+08
1993	8.22E+08	8.22E+08	8.22E+08
1994	8.69E+08	8.69E+08	NA

obs	QGDP	QOLDGDP	M1R	M1	INT
1970:1	NA	NA	18746.00	2.03E+10	12.60000
1970:2	NA	NA	19569.00	2.11E+10	12.50000
1970:3	NA	NA	19987.00	2.11E+10	14.70000
1970:4	NA	NA	21627.00	2.24E+10	13.30000
1971:1	NA	NA	21477.00	2.23E+10	14.60000
1971:2	NA	NA	22028.00	2.28E+10	19.30000
1971:3	NA	NA	22577.00	2.32E+10	14.60000
1971:4	NA	NA	23993.00	2.51E+10	17.20000
1972:1	NA	NA	24623.00	2.57E+10	11.20000
1972:2	NA	NA	25488.00	2.69E+10	11.20000
1972:3	NA	NA	26685.00	2.82E+10	22.10000
1972:4	NA	NA	29842.00	3.19E+10	17.70000
1973:1	NA	NA	30446.00	3.28E+10	15.00000
1973:2	NA	NA	32662.00	3.46E+10	21.20000
1973:3	NA	NA	33852.00	3.62E+10	25.30000
1973:4	NA	NA	38572.00	4.16E+10	19.60000
1974:1	NA	NA	39411.00	4.49E+10	22.50000
1974:2	NA	NA	40015.00	4.42E+10	28.40000
1974:3	NA	NA	40752.00	4.52E+10	33.60000
1974:4	NA	NA	46113.00	4.91E+10	37.20000
1975:1	NA	95708.00	47223.00	4.72E+10	22.90000
1975:2	NA	99074.00	48290.00	4.83E+10	20.40000
1975:3	NA	102604.0	51445.00	5.14E+10	28.40000
1975:4	NA	107720.0	58915.00	5.89E+10	23.30000
1976:1	NA	100417.0	60621.00	6.18E+10	22.40000
1976:2	NA	103446.0	62745.00	6.27E+10	23.20000
1976:3	NA	106391.0	65278.00	6.53E+10	23.10000
1976:4	NA	114009.0	79383.00	7.94E+10	20.80000
1977:1	112040.6	104713.0	80996.00	8.10E+10	15.70000
1977:2	103483.0	105214.0	90446.00	9.04E+10	20.80000
1977:3	112038.9	111710.0	90661.00	9.07E+10	29.00000
1977:4	114343.7	120270.0	103504.0	1.04E+11	26.20000
1978:1	117809.9	108968.0	104761.0	1.03E+11	25.40000
1978:2	114289.9	116078.0	113543.0	1.12E+11	26.20000
1978:3	122551.0	122032.0	119617.0	1.18E+11	21.90000
1978:4	123939.4	132238.0	134880.0	1.33E+11	29.90000
1979:1	125851.9	120471.0	128879.0	1.28E+11	35.70000
1979:2	120556.8	122876.0	141949.0	1.40E+11	34.60000
1979:3	127784.4	125213.0	148162.0	1.46E+11	33.30000
1979:4	130926.1	136559.0	167637.0	1.66E+11	42.50000
1980:1	131887.3	126408.0	167900.0	1.68E+11	32.10000
1980:2	127036.0	128476.0	175600.0	1.77E+11	33.93000
1980:3	131942.8	130797.0	173600.0	1.74E+11	34.86000
1980:4	134894.4	140084.0	216500.0	2.12E+11	36.81000
1981:1	136497.7	130416.0	207000.0	2.07E+11	35.53000
1981:2	129198.0	130493.0	222600.0	2.20E+11	36.66000
1981:3	134920.0	135294.0	218000.0	2.13E+11	38.25000
1981:4	137120.0	141534.0	259200.0	2.56E+11	38.62000

obs	QGDP	QOLDGDP	M1R	M1	INT
1982:1	137859.5	131686.0	255900.0	2.54E+11	38.45000
1982:2	131798.4	133986.0	275600.0	2.73E+11	38.84000
1982:3	136469.0	135675.0	273200.0	2.69E+11	37.06000
1982:4	136708.8	141470.0	321500.0	3.21E+11	36.16000
1983:1	137491.5	130224.0	296500.0	2.92E+11	34.43000
1983:2	133504.2	133426.0	317500.0	3.15E+11	32.95000
1983:3	137920.1	139384.0	327100.0	3.25E+11	33.05000
1983:4	142464.6	148346.0	405100.0	3.97E+11	33.65000
1984:1	142539.6	136476.0	364900.0	3.56E+11	34.52000
1984:2	136548.1	138407.0	386600.0	3.79E+11	34.49000
1984:3	143251.4	144025.0	398000.0	3.90E+11	34.47000
1984:4	147515.9	150947.0	499700.0	4.92E+11	34.53000
1985:1	148324.8	138463.0	448900.0	4.29E+11	34.63000
1985:2	142002.1	144742.0	472900.0	4.59E+11	34.93000
1985:3	146943.1	146816.0	486900.0	4.73E+11	35.54000
1985:4	150290.5	157238.0	640400.0	5.45E+11	35.64000
1986:1	155434.8	146063.0	599900.0	5.84E+11	30.13000
1986:2	151898.6	157549.0	652100.0	6.31E+11	30.50000
1986:3	157082.2	155738.0	645700.0	6.25E+11	30.92000
1986:4	157364.1	162430.0	784500.0	7.61E+11	32.07000
1987:1	163889.4	155067.0	758200.0	7.34E+11	30.18000
1987:2	158762.0	163343.0	829900.0	8.28E+11	30.66000
1987:3	165293.1	162701.0	840700.0	8.32E+11	30.70000
1987:4	167218.3	174056.0	1044600.	1.02E+12	33.92000
1988:1	170825.2	163252.0	979800.0	9.55E+11	34.64000
1988:2	165178.3	171192.0	1063400.	1.04E+12	36.38000
1988:3	171021.6	169391.0	1049500.	1.02E+12	32.14000
1988:4	174765.1	171957.0	1314500.	1.28E+12	31.85000
1989:1	173549.0	160038.0	1232200.	1.20E+12	32.69000
1989:2	171735.2	178721.0	1353300.	1.32E+12	33.20000
1989:3	178567.6	177341.0	1322300.	1.29E+12	32.70000
1989:4	181217.5	188972.0	1694700.	1.65E+12	33.91000
1990:1	184034.1	172960.0	1578600.	1.54E+12	34.06000
1990:2	177780.6	186422.0	1705100.	1.66E+12	35.04000
1990:3	183659.6	182086.0	1710700.	1.67E+12	36.37000
1990:4	189785.2	193791.0	2122500.	2.12E+12	37.52000
1991:1	183397.3	171881.0	1959800.	1.95E+12	36.13000
1991:2	184615.2	191542.0	2140800.	2.14E+12	36.23000
1991:3	184641.8	184367.0	2219600.	2.21E+12	38.62000
1991:4	197321.6	202185.0	2795400.	2.79E+12	36.39000
1992:1	194089.5	184796.0	2621000.	2.62E+12	29.97000
1992:2	187711.1	196223.0	3084400.	3.20E+12	22.11000
1992:3	196291.2	194247.0	3008100.	3.09E+12	27.26000
1992:4	202220.3	203444.0	3941800.	4.02E+12	26.98000
1993:1	204203.3	199144.0	3512700.	3.61E+12	26.09000
1993:2	196379.6	201294.0	4022700.	4.11E+12	26.02000
1993:3	208253.3	203324.0	4108400.	4.07E+12	24.26000
1993:4	213499.2	218081.0	5124800.	5.14E+12	26.37000
1994:1	210637.4	200925.0	4827400.	4.84E+12	25.31000

obs	QGDP	QOLDGDP	M1R	M1	INT
1994:2	206740.7	222000.0	5246100.	5.13E+12	28.30000
1994:3	222440.5	219424.0	5342400.	5.27E+12	30.94000
1994:4	228094.9	226702.0	6419000.	6.54E+12	37.87000
1995:1	226966.0	215702.0	5760600.	5.73E+12	34.63000
1995:2	216794.0	232440.0	6179600.	6.31E+12	33.75000
1995:3	229670.0	226936.0	6033200.	6.49E+12	29.79000
1995:4	240193.0	239805.0	7682600.	8.06E+12	32.40000
1996:1	236560.0	224192.0	6846800.	7.24E+12	32.90000
1996:2	221459.0	NA	7107300.	7.60E+12	31.36000
1996:3	235251.0	NA	6920300.	7.49E+12	28.12000

obs	I	CPI2	TC	RER	UN
1970:1	NA	5.185243	18.14000	87.86000	NA
1970:2	NA	5.305367	18.42000	85.03000	NA
1970:3	NA	5.366922	18.76000	87.27000	NA
1970:4	NA	5.453251	19.09000	88.60000	NA
1971:1	13.60000	5.640932	19.49000	87.98000	NA
1971:2	13.60000	5.836143	19.87000	87.45000	NA
1971:3	13.60000	6.017822	20.38000	88.52000	NA
1971:4	13.60000	6.195753	20.91000	88.53000	NA
1972:1	13.60000	6.382672	21.42000	87.96000	NA
1972:2	13.60000	6.601894	21.90000	86.81000	NA
1972:3	13.60000	6.800089	22.33000	85.68000	NA
1972:4	13.60000	7.066605	22.79000	84.21000	NA
1973:1	13.60000	7.371393	23.20000	87.54000	NA
1973:2	13.60000	7.990057	23.52000	83.30000	NA
1973:3	13.60000	8.325656	24.07000	85.11000	NA
1973:4	13.60000	8.615420	24.79000	84.95000	NA
1974:1	26.20000	9.227355	25.47000	84.84000	NA
1974:2	26.20000	9.843861	25.61000	84.54000	NA
1974:3	26.20000	10.16115	26.57000	85.95000	NA
1974:4	26.20000	10.82639	28.63000	83.62000	NA
1975:1	25.60000	11.50588	29.86000	87.29000	NA
1975:2	25.60000	12.21429	31.00000	89.00000	NA
1975:3	25.60000	12.52026	32.02000	87.04000	NA
1975:4	25.60000	12.84939	32.96000	86.92000	NA
1976:1	25.60000	13.53902	33.95000	85.87000	11.40000
1976:2	25.60000	14.31106	34.70000	83.61000	10.00000
1976:3	25.60000	15.21736	35.29000	82.60000	10.50000
1976:4	25.60000	16.00305	36.32000	79.97000	9.200000
1977:1	25.60000	17.21255	36.59000	78.09000	10.20000
1977:2	25.60000	19.69043	36.50000	72.12000	9.800000
1977:3	25.60000	20.54642	37.14000	73.99000	9.400000
1977:4	25.60000	20.68910	37.96000	75.22000	7.900000
1978:1	24.40000	21.49220	38.42000	74.80000	9.900000
1978:2	24.40000	22.91155	38.87000	74.18000	9.000000
1978:3	24.40000	23.55810	39.75000	75.47000	8.200000
1978:4	24.40000	24.46208	41.00000	75.02000	8.400000
1979:1	25.60000	26.25756	42.02000	72.90000	9.500000
1979:2	25.60000	28.18088	42.71000	71.04000	8.400000
1979:3	25.60000	29.61944	43.00000	70.41000	9.000000
1979:4	25.60000	31.31649	44.00000	70.64000	8.500000
1980:1	25.60000	33.12337	45.62000	72.34000	10.80000
1980:2	33.40000	35.94600	47.32000	73.15000	10.10000
1980:3	35.50000	37.41843	48.92000	74.38000	9.400000
1980:4	36.60000	39.51764	50.92000	73.08000	9.470000
1981:1	35.60000	42.22383	52.49000	73.16000	9.100000
1981:2	36.50000	45.63444	54.18000	70.38000	8.400000
1981:3	38.70000	48.24401	56.39000	70.58000	8.000000
1981:4	39.00000	50.03603	59.07000	70.66000	7.000000

obs	I	CPI2	TC	RER	UN
1982:1	39.00000	52.87682	61.40000	67.97000	9.730000
1982:2	38.40000	56.84899	63.84000	65.51000	9.040000
1982:3	37.20000	59.74759	66.42000	64.15000	9.660000
1982:4	36.60000	62.39845	70.29000	65.56000	9.130000
1983:1	34.80000	64.64219	74.19000	63.81000	11.06000
1983:2	33.40000	69.18664	78.51000	62.02000	12.41000
1983:3	33.00000	70.80523	83.40000	64.88000	11.58000
1983:4	33.50000	72.97712	88.77000	67.30000	12.47000
1984:1	34.60000	75.60320	94.47000	69.61000	13.84000
1984:2	34.60000	79.51343	100.4000	69.24000	13.61000
1984:3	35.20000	82.21880	107.0100	70.69000	13.41000
1984:4	34.90000	85.12896	113.8900	71.90000	13.34000
1985:1	34.90000	91.57774	126.2700	71.69000	14.32000
1985:2	34.80000	100.5527	142.9000	77.55000	14.32000
1985:3	35.60000	102.6874	157.9000	83.81000	14.06000
1985:4	35.70000	105.1822	172.2000	92.38000	12.91000
1986:1	34.20000	112.9027	181.5300	91.27000	14.25000
1986:2	30.50000	118.0186	193.7600	94.50000	15.04000
1986:3	34.30000	118.7949	205.5600	97.68000	13.34000
1986:4	31.90000	125.7573	219.0000	100.0000	12.49000
1987:1	30.60000	135.9322	231.0800	95.60000	13.47000
1987:2	30.60000	144.4975	243.3200	96.70000	12.21000
1987:3	30.50000	149.2567	254.3900	98.74000	11.23000
1987:4	32.90000	156.6122	263.7000	99.70000	10.10000
1988:1	34.30000	170.4776	280.0900	96.56000	12.66000
1988:2	36.40000	186.4711	299.2800	97.83000	11.70000
1988:3	33.80000	193.4839	317.9600	96.08000	10.11000
1988:4	31.90000	200.6264	335.8600	97.69000	10.40000
1989:1	32.50000	216.7577	357.7200	95.73000	11.00000
1989:2	33.50000	232.0413	381.7900	96.86000	10.10000
1989:3	33.10000	242.4984	405.8400	101.8300	8.840000
1989:4	34.00000	253.9917	433.9200	105.0200	9.120000
1990:1	33.80000	275.6218	468.9600	107.6900	9.700000
1990:2	35.00000	297.9677	502.3900	109.7200	10.70000
1990:3	36.40000	313.6194	534.9000	113.4700	10.00000
1990:4	38.00333	333.5930	568.7300	116.9300	10.60000
1991:1	35.75167	362.7353	598.4600	110.8600	10.50000
1991:2	37.04600	391.0051	628.8200	106.9900	10.40000
1991:3	38.35850	410.6174	667.1800	108.1900	9.700000
1991:4	37.67833	427.2711	706.8600	106.2500	9.300000
1992:1	29.94333	461.7102	641.5900	100.2800	10.53000
1992:2	24.59000	498.6852	697.5700	101.8500	10.91000
1992:3	24.84333	524.1941	702.8100	104.1900	9.010000
1992:4	27.31000	537.1599	811.7700	103.8500	9.580000
1993:1	26.45333	575.1370	766.4100	102.6700	9.300000
1993:2	26.53667	609.4602	787.1200	103.6800	9.000000
1993:3	24.71667	634.2397	810.8400	105.0600	7.600000
1993:4	25.62333	656.5583	917.3300	101.5900	7.600000
1994:1	25.47333	707.3512	819.5100	97.56000	10.00000

obs	I	CPI2	TC	RER	UN
1994:2	26.59000	753.4677	819.6400	95.21000	9.500000
1994:3	30.22667	776.6725	842.0000	95.63000	7.400000
1994:4	35.37333	803.4971	831.2700	93.29000	7.600000
1995:1	33.91333	856.4880	880.2300	94.92000	7.900000
1995:2	34.83000	914.5927	881.2300	93.87000	8.800000
1995:3	29.79667	940.7827	966.7800	101.5200	8.400000
1995:4	30.81333	964.5009	987.6500	99.47000	9.300000
1996:1	33.08667	1031.404	1046.000	99.82000	10.00000
1996:2	32.62667	1095.626	1069.110	97.70000	11.20000
1996:3	30.45000	1138.893	1025.060	94.51000	12.00000

obs	OILREV
1970:1	NA
1970:2	NA
1970:3	NA
1970:4	NA
1971:1	NA
1971:2	NA
1971:3	NA
1971:4	NA
1972:1	NA
1972:2	NA
1972:3	NA
1972:4	NA
1973:1	NA
1973:2	NA
1973:3	NA
1973:4	NA
1974:1	NA
1974:2	NA
1974:3	NA
1974:4	NA
1975:1	NA
1975:2	NA
1975:3	NA
1975:4	NA
1976:1	NA
1976:2	NA
1976:3	NA
1976:4	NA
1977:1	NA
1977:2	NA
1977:3	NA
1977:4	NA
1978:1	NA
1978:2	NA
1978:3	NA
1978:4	NA
1979:1	NA
1979:2	NA
1979:3	NA
1979:4	NA
1980:1	NA
1980:2	NA
1980:3	NA
1980:4	NA
1981:1	NA
1981:2	NA
1981:3	NA
1981:4	NA

obs	OILREV
1982:1	NA
1982:2	NA
1982:3	NA
1982:4	NA
1983:1	NA
1983:2	NA
1983:3	NA
1983:4	NA
1984:1	NA
1984:2	NA
1984:3	NA
1984:4	NA
1985:1	NA
1985:2	NA
1985:3	NA
1985:4	NA
1986:1	0.000000
1986:2	0.000000
1986:3	0.000000
1986:4	0.000000
1987:1	6.649000
1987:2	4.067000
1987:3	14.75000
1987:4	18.00100
1988:1	27.81300
1988:2	97.83000
1988:3	20.23200
1988:4	6.091000
1989:1	18.55100
1989:2	20.16900
1989:3	20.38900
1989:4	17.40400
1990:1	15.19400
1990:2	10.87700
1990:3	18.41000
1990:4	27.19500
1991:1	30.03900
1991:2	8.157000
1991:3	9.878000
1991:4	17.47000
1992:1	45.07292
1992:2	45.13408
1992:3	45.13408
1992:4	45.13408
1993:1	0.021817
1993:2	0.312310
1993:3	0.225517
1993:4	0.242175
1994:1	0.023668

obs	OILREV
1994:2	0.284247
1994:3	0.373492
1994:4	0.875712
1995:1	0.721809
1995:2	0.909176
1995:3	0.567622
1995:4	0.997254
1996:1	0.611859
1996:2	0.484825
1996:3	0.094791