A POWERFUL TEST FOR UNIT ROOT AND AN APPLICATION TO GNP OF SEVEN OECD COUNTRIES

A Master's Thesis

by
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To my grandmother and grandfather.

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AND AN APPLICATION TO GNP OF SEVEN OECD COUNTRIES

The Institute of Economics and Social Sciences
of
Bilkent University

by

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts.

Asst. Prof. Dr. Mehmet Caner (Supervisor)

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts.

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ABSTRACT

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Aliye Üstündağ

M.A. in Economics

Supervisor: Asst. Prof. Dr. Mehmet Caner

July 2000

This thesis uses a powerful test, Dickey-Fuller Generalized Least Squares (DF-GLS), to see whether unit root exists or not in real GNP of OECD Countries - Australia, Canada, Germany, Japan, Italy, U.K. and U.S. – for the years between the first quarter of 1960 and the second quarter of 1998 by using quarterly data that takes 1995 as base year. For this purpose a simple model with a deterministic component plus an error term, which is assumed to be AR (1), is used. The results of the regressions show the existence of unit root for all of the considered countries. Furthermore, we give finite sample performances of Augmented Dickey-Fuller (ADF) test and DF-GLS tests which Elliott et al. (1996) conducted by using Monte Carlo experiment.

Keywords: **Unit root, DF-GLS, deterministic component, AR (1), ADF and Monte Carlo experiment.**

ÖZET

BİRİM KÖK İÇİN GÜÇLÜ BİR TEST VE BU TESTİN YEDİ OECD ÜLKESİNİN GSMH'SINA UYGULAMASI

Aliye Üstündağ
İktisat Bölümü, Yüksek Lisans
Tez Yöneticisi: Yrd. Doç. Dr. Mehmet Caner
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Bu tez güçlü bir test kullanarak - Dickey-Fuller Genelleştirilmiş Küçük Kökler (DF-GLS) -, yedi OECD ülkelesinin - Avustralya, Almanya, Kanada, Japonya, İngiltere, İtalya ve ABD – reel GSMH'sında 1960'ın ilk çeyreği ve 1998'in ikinci çeyreği arasında kalan dönem için (1995 yılını esas alarak) birim kökün olup olmadığına bakar. Bu amaçla deterministic kısım ve hata teriminin toplamından oluşan ve hata terimi AR(1) olarak kabul edilen basit bir model kullanılmıştır. Regresyon sonuçları adı geçen bütün ülkelerde birim kökün varlığını göstermektedir. Ayrıca, Elliott ve diğerlerinin (1996) yapmış olduğu Monte Carlo deneyini kullanarak, geliştirilmiş Dickey-Fuller (ADF) ve DF-GLS testlerinin sonlu örnek performanları verilmiştir.

Anahtar Sözcükler: **Birim kök, DF-GLS, deterministik kısım, AR(1), ADF, Monte Carlo deneyi**

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Chapter 1

Introduction

The recent method employed by Elliott, Rothenberg and Stock (1996) for an autoregressive unit root, for testing whether a univariate time series is integrated of order one (difference stationary) against the hypothesis that it is integrated of order zero (trend stationary), opened a new debate in economic literature.

Interest in this field starts with the seminal works of Fuller (1976) and Dickey and Fuller (1979). They employed three types of tests and their test statistics to determine whether a series contains a unit root, unit root plus drift, and/(or) unit root plus drift plus a time trend under the assumption that the errors are statistically independent and uncorrelated. After Dickey and Fuller, Philips and Perron (1988) developed an extension of Dickey and Fuller's testing procedure under the assumption that the residuals of a unit root process are heteregenous and weakly dependent.

Although various testing principles developed in econometric literature, numerical calculations showed that power functions for these tests differ substantially and no general optimality theory have been developed in this field. Cheung and Chinn (1996) stressed that

> Recently, concern has arisen regarding the low power of conventional unit root tests, such as augmented Dickey-Fuller (ADF) test, and consequently, the apparent finding of a unit root in GNP data using these tests. For

> instance, Christiano and Eichenbaum (1990), Stock (1991), Rudebusch (1992, 1993), and Dejong, Nankervis, Savin, and Whiteman (1992) show that the ADF test has low power to differentiate between the trend and difference stationary properties of GNP…[1]

Furthermore, Caner and Killian (2000) examine whether real exchange rates are mean-reverting or not. They emphasized that the standard tests of unit root null hypothesis have not been able to provide guidance to economic theorists due to low power.[2]

However, the testing principle employed by Elliott et al. (1996) provides the locally most powerful test for testing whether the series is integrated of order one or integrated of order zero. DF-GLS test employed by Elliot et al. (1996) have higher-size adjusted power than the standard ADF test for almost all of the data generating processes.

Cheung and Chinn (1996) used Dickey- Fuller generalised least squares (DF-GLS) technique to study the persistence of U.S. GNP. They point out that the DF-GLS test of Elliott et al. (1996) is more powerful than the original ADF test and approximately uniformly most power invariant.[3]

Cheung and Lai (1998) again used DF-GLS test to examine the validity of parity reversion in real exchange rates during the post-Bretton Woods period. As Cheung and Chinn (1996), they indicated that:

[1] Cheung and Chinn (1996), page 1.
[2] Caner and Kilian (2000), pages 1-2.
[3] Cheung and Chinn (1996), page 1.

In studying the asymptotic power envelope for various unit root tests, Elliott et al. (1996) propose a simple modification of the augmented Dickey-Fuller (ADF) test such that the modified test can nearly achieve the power envelope using generalized least squares (GLS) estimation. The resulted DF-GLS test is shown to be approximately uniformly most powerful. Monte Carlo results confirm that the power improvement from using the DF-GLS test can be large relative to standard ADF test.[4]

Basically, there are two main differences between the testing procedure of Elliott et al. (1996) and Dickey and Fuller. Firstly, Elliott et al. (1996) assumes that errors are correlated and makes a transformation to make residuals of the unit root process uncorralated. Secondly, Elliott et al. (1996) use GLS technique whereas others use least squares (LS) technique.

In the thesis, we employ the procedure of Elliott et al. (1996) by using real GNP of seven OECD countries; Australia, Canada, Germany, Italy, Japan, U.K. and U.S. by using seasonally unadjusted data - which took 1995 as base year- for the years between the first quarter of 1960 and second quarter of 1998.

We assume that the data $y_1 \ldots y_T$ were generated as

$$y_t = u_t + d_t \qquad (1.1)$$

$$u_t = \alpha u_{t-1} + v_t \qquad (t=1 \ldots T) \qquad (1.2)$$

Where d_t and v_t are deterministic trend and unobserved zero-mean error process, respectively. As usual, our interest is in the null hypothesis $\alpha=1$(which implies the y_t are integrated of order one) versus $|\alpha|<1$(which implies the y_t are integrated of order zero).

[4] Cheung and Lai (1998), page 599.

The organization of the thesis is as follows: Chapter 2 provides a theoretical background in this field and presents the data generation process employed for testing process. Chapter 3 introduces and provides a comparison of the finite sample performance of usual Dickey-Fuller test and the test employed by Elliott et al. (1996). Finally, Chapter 4 provides the concluding remarks.

Chapter 2

Theoretical Background

2.1 Asymptotic Properties of a First-Order Autoregression When The True Coefficient is Less Than Unity in Absolute Value

If a univariate process contains a unit root, asymptotic distributions and rates of convergence for the estimated coefficients of unit root processes differ from those for stationary process.[1]

To see distributional properties of a stationary process, consider LS estimation of a Gaussian AR (1) process,

$$y_t = \alpha y_{t-1} + \nu_t \qquad (t=1,\ldots,T) \qquad (2.1)$$

where ν_t is i.i.d. $N(0, \sigma^2)$, and initial value of y is 0. The LS estimate of α is given by

[1] See Hamilton (1994), Chapters 16, 17, 18 for more detailed information.

$$\hat{\alpha}_t = \frac{\sum_{t=1}^{T} y_{t-1} y_t}{\sum_{t=1}^{T} {y_{t-1}}^2} \tag{2.2}$$

if $|\alpha|<1$, then

$$T^{1/2}(\hat{\alpha}_T - \alpha) \overset{L}{\rightarrow} N(0,(1-\alpha^2)) \tag{2.3}$$

Equation 2.3 is also valid when $\alpha=1$, and the variance of the left hand side approaches to zero. Thus,

$$T^{1/2}(\hat{\alpha}_T - 1) \overset{L}{\rightarrow} 0 \tag{2.4}$$

Although the distributional property does not change when the true value of α is unity, equation 2.4 is not very useful for hypothesis testing purposes.

We will consider if a univariate process contains a unit root for four main cases.

i- No constant term or time trend included in the regression; true process is a random walk.

ii- Constant term but no time trend included in the regression; true process is a random walk.

iii- Constant term but no time trend included in the regression; true process is a random walk with drift.

iv- Constant term and time trend included in the regression: true process is random walk with or without drift.

2.2 Asymptotic Properties of a First-Order Autoregression When The True Coefficient is Unity

Firstly, we will consider the case in which there is no constant term or time trend included in the regression where the true process is a random walk. Consider LS estimation of α which is assumed to be based on AR(1) regression,

$$y_t = \alpha y_{t-1} + v_t \qquad (t=1,\ldots,T) \qquad (2.2.1)$$

where v_t has properties described before. We deal with the properties of the equation 2.2; the deviation of LS estimate from the true value is characterized by:

$$T(\hat{\alpha}_T - 1) = \frac{T^{-1}\sum_{t=1}^{T} y_{t-1}u_t}{T^{-2}\sum_{t=1}^{T} y_{t-1}^{2}} \qquad (2.2.2)$$

After making necessary calculations, it is possible to observe that distribution of the LS estimate from the true value is characterized with 2.3. Nevertheless, the value of t-statistic substantially differs from those obtained when the true value of α is less than unity in absolute value. [2]

Second case is the one where there is a constant term but no time trend included in the regression and true process is a random walk. Again assume that the disturbance term has the same properties as we described before. Thus the model specified that is to be estimated by LS:

$$y_t = \lambda + \alpha y_{t-1} + v_t \qquad (t=1,\ldots,T) \qquad (2.2.3)$$

As in previous section, it is important to consider the properties of LS estimates of λ and α. Neither of the estimates has limiting gaussian distribution. Furthermore, t-statistics differ as well.[3]

Thirdly, assume that the equation is formed by a constant term but no time trend is included in the regression and the true process is a random walk with drift. The estimated equation is same with the equation for the second case we described but it differs in only one respect; the true process is supposed to be random walk with drift:

$$y_t = \lambda + \alpha y_{t-1} + v_t \qquad (t=1,\ldots,T) \qquad (2.2.4)$$

[2] See Hamilton (1994), pages 487-490 for more detailed explanation.
[3] See Hamilton (1994), pages 490-495 for details.

As in second case, it is important to consider the properties of LS estimates of λ and α. However, both of the estimated coefficients are gaussian. Thus, the standard LS F and t statistics can be calculated and usual tables for these statistics can be used.[4]

For the last case, assume that a constant term and a time trend included in the regression; true process is a random walk with or without drift. The estimated equation is:

$$y_t = \lambda+\alpha y_{t-1}+\delta t+v_t \qquad (t=1,\ldots,T) \qquad (2.2.5)$$

Then, the asymptotic distribution substantially differs from equation 2.3.[5]

2.3 The Data Generating Process

As it was indicated in Elliott et al. (1996), although econometricians have developed numerous alternative procedures for testing the hypothesis that a univariate time series is integrated of order one (α=1) against the hypothesis that it is integrated of order zero ($|\alpha|<1$), no general optimality theory have been developed. The DF-GLS test developed by Elliot et al. (1996) gives the most powerful test for unit root.

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[4] See Hamilton (1994), pages 495-497.
[5] See Hamilton (1994), pages 497-501.

The hypothesis testing problem is to test α=1, against trend stationary alternative |α|<1

2.3.1 The Dickey Fuller Family of Unit Root Tests

The currently most widely employed tests for a unit root, "augmented" versions of those developed by Dickey and Fuller (1979 and 1981), are based on the t-statistic for $\alpha = 1$ in the OLS regressions for de-meaned, de-trended and de-meaned and de-trended cases, respectively are:

$$\Delta y_t = (\hat{\alpha}_a - 1)y_{t-1} + \sum_{j=1}^{p} a_j \Delta y_{t-j} + v_{at} \qquad (2.3.3.1)$$

$$\Delta y_t = (\hat{\alpha}_b - 1)y_{t-1} + \hat{\alpha}_{00} + \sum_{j=1}^{p} a_j \Delta y_{t-j} + v_{bt} \qquad (2.3.3.2)$$

or

$$\Delta y_t = (\hat{\alpha}_c - 1)y_{t-1} + \hat{\alpha}_{01} + \hat{\alpha}_{11} t + \sum_{j=1}^{p} a_j \Delta y_{t-j} + v_{ct} \qquad (2.3.3.3)$$

The test equations were augmented with p lags of Δy_t on the right-hand side, thus v_t is approximated by a stationary AR(p).

The DF-GLS tests of Elliott et al. (1996) uses GLS technique as opposed ADF tests. The GLS test statistics are thus defined as the t-statistic on the coefficient of $y_{t-1}*$ in the LS regression is

$$\Delta y_t * = (\alpha * -1) y_{t-1} * + \sum_{j=1}^{p} a_j \Delta y_{t-j} * + \omega_t \qquad (2.3.3.4)$$

where ω_t is the error term, in which $y_t* = y_t$ (which corresponds to equation 2.3.3.1), or

$y_t* = y_t - \beta_{00,GLS}$ (which corresponds to equation 2.3.3.2), or

$y_t* = y_t - \beta_{01,GLS} - \beta_{11,GLS}t$ (which corresponds to 2.3.3.4).

We can define the $\beta_{i,j,GLS}$ by writing $\alpha_j = 1 + c_j/T$, (j = 0,1). Elliot et al. (1996) obtained $c_o = -7.0$ for de-meaned and $c_1 = -13{,}5$ for de-meaned and de-trended. $\beta_{00,GLS}$ is the OLS regression coefficient obtained by regressing the vector

$[y_1, y_2-\alpha_0 y_1, y_3-\alpha_0 y_2 \ldots, y_T-\alpha_0 y_{T-1}]'$,

on the vector

$[1, 1-\alpha_0, \ldots, 1-\alpha_0]'$.

Similarly, $[\beta_{01}, \beta_{11}]_{GLS}'$ results from the OLS regression of the vector.

$[y_1, y_2-\alpha_1 y_1, \ldots, y_T-\alpha_1 y_{T-1}]'$

on the matrix

$$\begin{bmatrix} 1, & 1-\bar{\alpha}_1,\ldots, & 1-\bar{\alpha}_1 \\ 1, & 2-\bar{\alpha}_1,\ldots, & T-(T-1)\bar{\alpha}_1 \end{bmatrix}'$$

Chapter 3

Data and Results

The data is gathered from IMF-IFS tape for seven OECD countries; Australia, Canada, Germany, Italy, Japan, U.K. and U.S. for the years between the first quarter of 1960 and the second quarter of 1998. We used real seasonally unadjusted GNP at constant prices, which took 1995 as base year.

As it can be seen from Tables I and II, for the GNP data under consideration, the sample value of the DF-GLS$^{\tau}$ is greater than the critical values that are obtained by Elliott et al. (1996). Thus, we cannot reject the null hypothesis, which states a univariate time series is integrated of order one.

TABLE I[1]

Critical Values For

Linear Trend: DF-GLS$^{\tau}$ with c = -13.5

		Level	
T	1%	5%	10%
50	-3.77	-3.19	-2.89
100	-3.58	-3.03	-2.74
200	-3.46	-2.93	-2.64
∞	-3.48	-2.89	-2.57

[1] See Elliott et al. (1996), page 825 for more detailed table.

TABLE II

Calculated Values For

Linear Trend: DF-GLS$^{\tau}$ with c = -13.5

Lag Length	OECD COUNTRIES						
p	Australia	Canada	Germany	Italy	Japan	U.K.	U.S.
1	-1.12	-0.44	-1.22	-0.16	0.73	-0.44	-1.55
2	-1.03	-0.42	-1.16	-0.44	0.10	-0.42	-1.45
3	-0.86	-0.86	-1.19	-0.26	-0.18	-0.86	-1.96
4	-1.13	-0.85	-1.78	-0.17	-0.21	-0.85	-1.97

Table III gives the sample values after 1974 for the same data. Except U.S. for all of the countries we fail to reject the null by using the critical values indicated in Table I. However, when the level is 5% and p≥3 we reject the null hypothesis that states the series is difference stationary. Similarly, at 10 % level when p≥2, we reject the null.

TABLE III

Calculated Values For

Linear Trend: DF-GLS$^{\tau}$ with c = -13.5

Lag Length	OECD COUNTRIES						
p	Australia	Canada	Germany	Italy	Japan	U.K.	U.S.
1	-2.04	-1.87	-1.51	-2.13	-1.38	-1.64	-2.66
2	-1.98	-2.04	-1.54	-2.23	-1.36	-2.12	-2.93
3	-2.48	-2.06	-1.67	-2.23	-1.53	-2.64	-3.09
4	-2.01	-1.96	-2.19	-2.44	-1.54	-2.76	-3.38

3.1 Finite Sample Performance

Elliott, Rothenberg, and Stock (1996) conducted a Monte Carlo experiment to see how well the asymptotic theory describes the small-sample properties of DF-GLS. They investigated tests based on the standard Dickey-Fuller t statistic (denoted DF-τ^{τ}) and the modified Dickey-Fuller t statistic (denoted DF-GLS$^{\tau}$) in the linear trend case. They considered $\{\eta_t\}$ as a set of standard normal variables. Although they used the three models for the $\{v_t\}$ process we considered only two of them:

	$u_t = \alpha_{t-1} + v_t$		(3.1.1)
I. MA(1):	$v_t = \eta_t - \theta\eta_{t-1}$	$(\theta = .8, .5, 0, -.5, -.8)$	(3.1.2)
II. AR(1)	$v_t = \phi v_{t-1} + \eta_t$	$(\phi = .5, -.5)$	(3.1.3)

In all of conditions they considered, since small-sample power typically depends on u_0 they restrict $u_0 = 0$. Although they employed two choices of lag length, we deal with the one that chooses lag length (p) by the Schwartz (1978) Bayesian information criterion (BIC) constrained so $3 \le p \le 8$ which is denoted as AR(BIC) estimator.

The results are summarized in Table IV. Tests were at the 5% significance level and the sample size T was 100. For $\alpha = 1$, the table report the observed rejection rates from 5000 Monte Carlo simulations when critical values were based on the limiting distributions. For $\alpha < 1$, the tables report size-adjusted power, which is the rejection rate when critical values are estimates from the $\alpha = 1$ Monte Carlo trials.

Table IV shows the size and size-adjusted power of selected tests of the I(1) Null: Monte Carlo Results of 5% level tests for linear trend for T=100. As it can be observed from the table, DF-GLS$^{\tau}$ and DF-τ^{τ} have similar size. However, the size-adjusted power of these tests differs and DF-GLS$^{\tau}$ yields better results. For instance, when the power of the DF-GLS$^{\tau}$ is 69%, the power of DF-τ^{τ} stays at 48% with AR(1) coefficient is 0.70 in equation 4.3.

The main conclusion that can be obtained from simulations is that the predicted superiority of the tests using local-to-unity estimates of the trend parameters is borne out by the Monte Carlo study. The modified Dickey-Fuller tests have higher size-adjusted power than the standard Dickey-Fuller t tests for almost all of the data generating process.

TABLE IV[2]

Size and Size-Adjusted Power of Selected Tests of The I(1) Null: Monte Carlo Results 5% Level Tests, Linear Trend ($z^t = (1,t)'$), T=100

Test Statistic	α	Asymptotic Power	MA(1),θ= -0.8	-0.5	0.0	0.5	0.8	AR(1),ϕ= 0.5	-0.5
DF-GLS$^\tau$(0.5)	1.00	0.05	0.11	0.08	0.07	0.11	0.58	0.06	0.07
AR(BIC)	0.95	0.10	0.11	0.10	0.10	0.11	0.12	0.10	0.10
	0.90	0.27	0.23	0.23	0.24	0.28	0.27	0.22	0.25
	0.80	0.81	0.53	0.57	0.61	0.72	0.70	0.48	0.63
	0.70	0.99	0.75	0.80	0.84	0.94	0.91	0.69	0.88
DF-τ^τ	1.00	0.05	0.10	0.07	0.05	0.09	0.58	0.05	0.06
AR(BIC)	0.95	0.09	0.09	0.08	0.08	0.09	0.08	0.08	0.08
	0.90	0.19	0.16	0.14	0.15	0.18	0.17	0.14	0.15
	0.80	0.61	0.36	0.36	0.39	0.51	0.50	0.30	0.42
	0.70	0.94	0.57	0.58	0.64	0.81	0.80	0.48	0.69

[2] See Elliott et al. (1996), page 829 for more detailed Monte Carlo results.

Chapter 4

Conclusion

Although lots of testing procedures developed for testing the hypothesis that a univariate time series is integrated of order one against the hypothesis that it is integrated of order zero, no general optimality theory have been developed and the power of these tests generally questioned in most of the papers in this field. However, the testing principle developed by Elliott et al.(1996) is one of the powerful tests in this field.

In our thesis, we applied the testing principle developed by Elliot et al. (1996) by using seasonally unadjusted real GNP of seven OECD countries; Australia, Canada, Germany, Italy, Japan, U.K., U.S., for two different time period; one for the years between the first quarter of 1960 and the second quarter of 1998, and one for the years between the first quarter of 1974 and the second quarter of 1998. Although Monte Carlo results - provided by Elliott et al. (1996) – suggest that the DF-GLS test applied to locally de-trended time series has the best overall performance in terms of small-sample size and power, we cannot reject the hypothesis we have stated before for larger span of data. However, for the period after 1974 we reject the null for only U.S. when the level is 5%, and 10% when $p \geq 3$ and $p \geq 2$, respectively.

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APPENDICES

APPENDIX A
THE DATA
AUTRALIA

1960-Q1	26.04
1960-Q2	26.09
1960-Q3	28.01
1960-Q4	27.05
1961-Q1	27.07
1961-Q2	26.08
1961-Q3	27.05
1961-Q4	27.05
1962-Q1	28.03
1962-Q2	28.02
1962-Q3	29.04
1962-Q4	29.08
1963-Q1	30.03
1963-Q2	29.02
1963-Q3	31.4
1963-Q4	31.07
1964-Q1	31.05
1964-Q2	32.0
1964-Q3	33.2
1964-Q4	33.9
1965-Q1	34.1
1965-Q2	34.2
1965-Q3	34.8
1965-Q4	34.7
1966-Q1	34.5
1966-Q2	34.4
1966-Q3	36.5
1966-Q4	36.7
1967-Q1	37.7
1967-Q2	37.0
1967-Q3	38.5
1967-Q4	38.7
1968-Q1	38.0
1968-Q2	38.9
1968-Q3	41.2
1968-Q4	42.4
1969-Q1	42.0
1969-Q2	42.2
1969-Q3	43.4
1969-Q4	44.4
1970-Q1	44.7
1970-Q2	45.5
1970-Q3	46.0
1970-Q4	46.6
1971-Q1	46.9
1971-Q2	47.0
1971-Q3	48.3
1971-Q4	48.6
1972-Q1	47.7
1972-Q2	48.9
1972-Q3	48.6
1972-Q4	49.5
1973-Q1	50.5
1973-Q2	50.7
1973-Q3	51.4
1973-Q4	53.1
1974-Q1	53.6
1974-Q2	52.1
1974-Q3	52.6
1974-Q4	53.1
1975-Q1	53.1
1975-Q2	53.5
1975-Q3	53.9
1975-Q4	54.1
1976-Q1	54.8
1976-Q2	55.5
1976-Q3	56.2
1976-Q4	56.2
1977-Q1	56.5
1977-Q2	56.9
1977-Q3	57.0
1977-Q4	56.5
1978-Q1	57.0
1978-Q2	58.1
1978-Q3	58.8
1978-Q4	59.4
1979-Q1	61.9
1979-Q2	60.4
1979-Q3	60.7
1979-Q4	62.3
1980-Q1	61.7
1980-Q2	61.7
1980-Q3	62.5
1980-Q4	63.4
1981-Q1	63.2
1981-Q2	64.6
1981-Q3	65.4
1981-Q4	65.9
1982-Q1	65.8
1982-Q2	66.0
1982-Q3	65.3
1982-Q4	64.1
1983-Q1	63.6
1983-Q2	63.7
1983-Q3	65.6
1983-Q4	67.8
1984-Q1	68.5
1984-Q2	69.2
1984-Q3	69.9
1984-Q4	70.1
1985-Q1	71.6
1985-Q2	72.8
1985-Q3	73.9
1985-Q4	74.1
1986-Q1	74.4
1986-Q2	74.1
1986-Q3	74.6
1986-Q4	75.9
1987-Q1	76.6
1987-Q2	77.7
1987-Q3	78.9
1987-Q4	80.5
1988-Q1	80.8
1988-Q2	81.0
1988-Q3	81.8
1988-Q4	83.3
1989-Q1	83.9
1989-Q2	85.7
1989-Q3	86.0
1989-Q4	86.2
1990-Q1	87.1
1990-Q2	87.4
1990-Q3	86.6
1990-Q4	87.0
1991-Q1	86.4
1991-Q2	85.8
1991-Q3	85.9
1991-Q4	86.2
1992-Q1	87.2
1992-Q2	87.4
1992-Q3	88.4
1992-Q4	89.4
1993-Q1	90.7
1993-Q2	91.1
1993-Q3	91.1
1993-Q4	92.7
1994-Q1	95.0
1994-Q2	95.6
1994-Q3	97.1
1994-Q4	97.7
1995-Q1	97.9
1995-Q2	99.3
1995-Q3	101.0
1995-Q4	101.8
1996-Q1	103.3
1996-Q2	103.0
1996-Q3	104.1
1996-Q4	105.1
1997-Q1	105.5
1997-Q2	107.5
1997-Q3	108.3
1997-Q4	109.7
1998-Q1	111.2
1998-Q2	112.5

CANADA

1960-Q1	27.01
1960-Q2	26.06
1960-Q3	27.0
1960-Q4	27.01
1961-Q1	26.09
1961-Q2	27.06
1961-Q3	28.01
1961-Q4	28.06
1962-Q1	29.04
1962-Q2	29.04
1962-Q3	29.09
1962-Q4	30.04
1963-Q1	30.06
1963-Q2	31.0
1963-Q3	31.04
1963-Q4	32.4
1964-Q1	33.0
1964-Q2	33.1
1964-Q3	33.6
1964-Q4	33.8
1965-Q1	34.9
1965-Q2	35.2
1965-Q3	35.7
1965-Q4	36.6
1966-Q1	37.5
1966-Q2	38.0
1966-Q3	38.1
1966-Q4	38.5
1967-Q1	38.4
1967-Q2	39.2
1967-Q3	39.4
1967-Q4	39.5
1968-Q1	39.9
1968-Q2	40.9
1968-Q3	41.6
1968-Q4	42.5
1969-Q1	42.8
1969-Q2	43.0
1969-Q3	43.6
1969-Q4	44.4
1970-Q1	44.4
1970-Q2	44.1
1970-Q3	44.9
1970-Q4	44.9
1971-Q1	45.3
1971-Q2	46.7
1971-Q3	48.1
1971-Q4	48.6
1972-Q1	48.4
1972-Q2	49.7
1972-Q3	49.9
1972-Q4	51.3
1973-Q1	52.9
1973-Q2	53.3
1973-Q3	53.5
1973-Q4	55.0
1974-Q1	55.5
1974-Q2	55.9
1974-Q3	56.2
1974-Q4	56.6
1975-Q1	56.5
1975-Q2	57.1
1975-Q3	57.9
1975-Q4	58.5
1976-Q1	59.8
1976-Q2	61.2
1976-Q3	61.6
1976-Q4	61.6
1977-Q1	62.6
1977-Q2	62.8
1977-Q3	63.2
1977-Q4	64.4
1978-Q1	65.0
1978-Q2	66.0
1978-Q3	66.4
1978-Q4	67.2
1979-Q1	68.0
1979-Q2	68.4
1979-Q3	69.1
1979-Q4	69.4
1980-Q1	69.6
1980-Q2	69.5
1980-Q3	69.2
1980-Q4	70.6
1981-Q1	72.1
1981-Q2	73.0
1981-Q3	72.3
1981-Q4	71.8
1982-Q1	71.0
1982-Q2	70.1
1982-Q3	69.7
1982-Q4	69.1
1983-Q1	70.3
1983-Q2	71.9
1983-Q3	73.0
1983-Q4	73.6
1984-Q1	74.8
1984-Q2	76.5
1984-Q3	77.4
1984-Q4	78.3
1985-Q1	79.2
1985-Q2	79.5
1985-Q3	80.5
1985-Q4	82.3
1986-Q1	82.8
1986-Q2	83.0
1986-Q3	83.4
1986-Q4	83.1
1987-Q1	85.1
1987-Q2	85.6
1987-Q3	87.3
1987-Q4	88.4
1988-Q1	89.6
1988-Q2	90.8
1988-Q3	91.1
1988-Q4	91.8
1989-Q1	92.7
1989-Q2	92.9
1989-Q3	93.2
1989-Q4	93.3
1990-Q1	93.7
1990-Q2	93.3
1990-Q3	92.8
1990-Q4	91.6
1991-Q1	90.4
1991-Q2	91.2
1991-Q3	91.4
1991-Q4	91.6
1992-Q1	91.6
1992-Q2	91.9
1992-Q3	91.9
1992-Q4	92.0
1993-Q1	92.9
1993-Q2	93.7
1993-Q3	94.1
1993-Q4	94.9
1994-Q1	95.9
1994-Q2	97.0
1994-Q3	98.4
1994-Q4	99.6
1995-Q1	100.8
1995-Q2	99.7
1995-Q3	99.9
1995-Q4	100.3
1996-Q1	100.4
1996-Q2	100.6
1996-Q3	102.5
1996-Q4	103.1
1997-Q1	104.4
1997-Q2	105.7
1997-Q3	106.8
1997-Q4	107.6
1998-Q1	108.4
1998-Q2	108.8

GERMANY

1960-Q1	32.0	1973-Q1	57.2	1986-Q1	71.2
1960-Q2	32.5	1973-Q2	57.3	1986-Q2	72.2
1960-Q3	33.7	1973-Q3	57.7	1986-Q3	72.9
1960-Q4	34.0	1973-Q4	57.7	1986-Q4	73.5
1961-Q1	34.4	1974-Q1	58.1	1987-Q1	71.5
1961-Q2	34.2	1974-Q2	57.9	1987-Q2	73.4
1961-Q3	34.9	1974-Q3	57.7	1987-Q3	73.9
1961-Q4	35.0	1974-Q4	56.9	1987-Q4	74.8
1962-Q1	35.5	1975-Q1	56.6	1988-Q1	74.8
1962-Q2	35.9	1975-Q2	56.4	1988-Q2	75.4
1962-Q3	36.8	1975-Q3	56.9	1988-Q3	76.6
1962-Q4	36.7	1975-Q4	57.8	1988-Q4	77.5
1963-Q1	35.4	1976-Q1	58.9	1989-Q1	78.3
1963-Q2	37.0	1976-Q2	59.7	1989-Q2	78.3
1963-Q3	38.3	1976-Q3	59.3	1989-Q3	78.9
1963-Q4	38.5	1976-Q4	61.0	1989-Q4	79.9
1964-Q1	39.0	1977-Q1	61.1	1990-Q1	81.9
1964-Q2	39.5	1977-Q2	61.3	1990-Q2	82.7
1964-Q3	39.9	1977-Q3	61.0	1990-Q3	84.1
1964-Q4	40.4	1977-Q4	62.8	1990-Q4	85.5
1965-Q1	41.1	1978-Q1	62.8	1991-Q1	94.4
1965-Q2	41.7	1978-Q2	62.8	1991-Q2	94.8
1965-Q3	42.0	1978-Q3	63.4	1991-Q3	94.3
1965-Q4	42.3	1978-Q4	64.7	1991-Q4	95.1
1966-Q1	43.0	1979-Q1	64.5	1992-Q1	96.9
1966-Q2	43.2	1979-Q2	66.6	1992-Q2	96.3
1966-Q3	43.2	1979-Q3	66.5	1992-Q3	96.2
1966-Q4	42.5	1979-Q4	66.9	1992-Q4	96.0
1967-Q1	42.3	1980-Q1	67.5	1993-Q1	94.7
1967-Q2	42.2	1980-Q2	66.9	1993-Q2	94.7
1967-Q3	43.2	1980-Q3	66.4	1993-Q3	95.7
1967-Q4	43.8	1980-Q4	66.2	1993-Q4	95.8
1968-Q1	42.9	1981-Q1	66.9	1994-Q1	96.9
1968-Q2	45.0	1981-Q2	66.9	1994-Q2	97.4
1968-Q3	45.8	1981-Q3	66.9	1994-Q3	98.0
1968-Q4	47.3	1981-Q4	66.6	1994-Q4	99.1
1969-Q1	46.3	1982-Q1	66.7	1995-Q1	98.7
1969-Q2	48.4	1982-Q2	66.5	1995-Q2	99.4
1969-Q3	49.2	1982-Q3	65.6	1995-Q3	99.2
1969-Q4	50.7	1982-Q4	65.7	1995-Q4	99.1
1970-Q1	49.2	1983-Q1	66.6	1996-Q1	99.1
1970-Q2	51.2	1983-Q2	67.2	1996-Q2	100.4
1970-Q3	51.3	1983-Q3	67.1	1996-Q3	100.8
1970-Q4	52.4	1983-Q4	68.3	1996-Q4	101.2
1971-Q1	51.6	1984-Q1	69.1	1997-Q1	101.6
1971-Q2	52.6	1984-Q2	68.0	1997-Q2	102.6
1971-Q3	52.8	1984-Q3	69.7	1997-Q3	103.2
1971-Q4	53.2	1984-Q4	70.0	1997-Q4	103.5
1972-Q1	53.8	1985-Q1	69.7	1998-Q1	105.0
1972-Q2	54.3	1985-Q2	70.5	1998-Q2	105.0
1972-Q3	55.1	1985-Q3	71.4		
1972-Q4	56.2	1985-Q4	71.6		

ITALY

1960-Q1	28.01
1960-Q2	28.06
1960-Q3	28.09
1960-Q4	29.0
1961-Q1	30.0
1961-Q2	30.07
1961-Q3	31.4
1961-Q4	31.9
1962-Q1	32.4
1962-Q2	32.8
1962-Q3	33.0
1962-Q4	33.5
1963-Q1	33.5
1963-Q2	34.5
1963-Q3	35.2
1963-Q4	35.7
1964-Q1	36.0
1964-Q2	35.6
1964-Q3	35.5
1964-Q4	35.4
1965-Q1	35.9
1965-Q2	36.6
1965-Q3	37.0
1965-Q4	37.6
1966-Q1	40.7
1966-Q2	41.3
1966-Q3	42.4
1966-Q4	42.6
1967-Q1	43.5
1967-Q2	44.4
1967-Q3	45.1
1967-Q4	46.0
1968-Q1	46.1
1968-Q2	47.1
1968-Q3	48.2
1968-Q4	49.3
1969-Q1	50.1
1969-Q2	51.0
1969-Q3	51.1
1969-Q4	50.1
1970-Q1	52.4
1970-Q2	53.1
1970-Q3	53.9
1970-Q4	53.7
1971-Q1	53.9
1971-Q2	53.9
1971-Q3	54.5
1971-Q4	54.9
1972-Q1	55.7
1972-Q2	55.5
1972-Q3	55.9
1972-Q4	56.4
1973-Q1	57.2
1973-Q2	58.7
1973-Q3	60.7
1973-Q4	61.6
1974-Q1	62.8
1974-Q2	62.8
1974-Q3	62.6
1974-Q4	61.1
1975-Q1	60.4
1975-Q2	60.3
1975-Q3	61.2
1975-Q4	62.1
1976-Q1	62.9
1976-Q2	64.3
1976-Q3	65.8
1976-Q4	66.8
1977-Q1	67.2
1977-Q2	66.9
1977-Q3	66.5
1977-Q4	66.7
1978-Q1	68.0
1978-Q2	68.7
1978-Q3	69.6
1978-Q4	71.0
1979-Q1	71.8
1979-Q2	72.2
1979-Q3	73.4
1979-Q4	75.6
1980-Q1	76.2
1980-Q2	76.2
1980-Q3	75.4
1980-Q4	75.6
1981-Q1	75.5
1981-Q2	76.4
1981-Q3	76.4
1981-Q4	76.5
1982-Q1	76.6
1982-Q2	76.8
1982-Q3	76.4
1982-Q4	76.3
1983-Q1	76.7
1983-Q2	77.0
1983-Q3	77.6
1983-Q4	78.6
1984-Q1	79.4
1984-Q2	79.4
1984-Q3	79.5
1984-Q4	79.7
1985-Q1	80.4
1985-Q2	81.4
1985-Q3	82.1
1985-Q4	82.8
1986-Q1	82.9
1986-Q2	83.8
1986-Q3	84.6
1986-Q4	84.9
1987-Q1	85.1
1987-Q2	86.5
1987-Q3	86.9
1987-Q4	88.1
1988-Q1	89.1
1988-Q2	89.6
1988-Q3	90.2
1988-Q4	91.1
1989-Q1	91.6
1989-Q2	92.1
1989-Q3	92.7
1989-Q4	93.9
1990-Q1	94.4
1990-Q2	94.5
1990-Q3	94.9
1990-Q4	94.5
1991-Q1	95.0
1991-Q2	95.3
1991-Q3	96.0
1991-Q4	96.3
1992-Q1	96.5
1992-Q2	96.6
1992-Q3	96.1
1992-Q4	95.5
1993-Q1	94.9
1993-Q2	95.0
1993-Q3	94.8
1993-Q4	95.6
1994-Q1	96.0
1994-Q2	97.0
1994-Q3	97.6
1994-Q4	98.0
1995-Q1	99.7
1995-Q2	99.6
1995-Q3	100.2
1995-Q4	100.6
1996-Q1	101.4
1996-Q2	100.3
1996-Q3	100.6
1996-Q4	100.3
1997-Q1	100.5
1997-Q2	102.3
1997-Q3	102.8
1997-Q4	103.1
1998-Q1	102.9
1998-Q2	103.5

JAPAN

1960-Q1	16.05	1973-Q1	53.9	1986-Q1	75.3
1960-Q2	16.05	1973-Q2	54.5	1986-Q2	76.5
1960-Q3	17.01	1973-Q3	54.5	1986-Q3	77.0
1960-Q4	17.08	1973-Q4	54.9	1986-Q4	78.0
1961-Q1	18.03	1974-Q1	53.5	1987-Q1	78.3
1961-Q2	18.07	1974-Q2	54.0	1987-Q2	78.7
1961-Q3	19.0	1974-Q3	54.7	1987-Q3	80.1
1961-Q4	19.09	1974-Q4	54.3	1987-Q4	81.9
1962-Q1	20.02	1975-Q1	54.2	1988-Q1	83.2
1962-Q2	20.05	1975-Q2	55.6	1988-Q2	83.8
1962-Q3	20.08	1975-Q3	56.1	1988-Q3	85.5
1962-Q4	21.01	1975-Q4	56.8	1988-Q4	86.6
1963-Q1	21.04	1976-Q1	57.3	1989-Q1	87.7
1963-Q2	22.0	1976-Q2	57.7	1989-Q2	87.6
1963-Q3	22.07	1976-Q3	58.5	1989-Q3	89.3
1963-Q4	23.04	1976-Q4	58.6	1989-Q4	90.4
1964-Q1	24.02	1977-Q1	60.0	1990-Q1	90.8
1964-Q2	24.09	1977-Q2	60.5	1990-Q2	92.7
1964-Q3	25.02	1977-Q3	60.8	1990-Q3	93.8
1964-Q4	25.05	1977-Q4	61.7	1990-Q4	95.0
1965-Q1	25.07	1978-Q1	62.7	1991-Q1	96.0
1965-Q2	26.01	1978-Q2	63.2	1991-Q2	96.6
1965-Q3	26.07	1978-Q3	64.1	1991-Q3	96.9
1965-Q4	27.0	1978-Q4	64.9	1991-Q4	97.7
1966-Q1	27.08	1979-Q1	58.8	1992-Q1	98.3
1966-Q2	29.0	1979-Q2	59.8	1992-Q2	98.0
1966-Q3	29.07	1979-Q3	60.4	1992-Q3	97.5
1966-Q4	30.2	1979-Q4	60.9	1992-Q4	97.5
1967-Q1	31.0	1980-Q1	61.8	1993-Q1	97.6
1967-Q2	31.08	1980-Q2	61.7	1993-Q2	97.9
1967-Q3	32.9	1980-Q3	62.2	1993-Q3	98.1
1967-Q4	33.6	1980-Q4	63.0	1993-Q4	98.0
1968-Q1	34.3	1981-Q1	64.0	1994-Q1	98.0
1968-Q2	35.6	1981-Q2	64.0	1994-Q2	98.5
1968-Q3	36.4	1981-Q3	64.7	1994-Q3	99.1
1968-Q4	38.7	1981-Q4	64.9	1994-Q4	98.8
1969-Q1	38.9	1982-Q1	65.6	1995-Q1	98.3
1969-Q2	40.0	1982-Q2	66.4	1995-Q2	99.8
1969-Q3	40.9	1982-Q3	66.7	1995-Q3	100.5
1969-Q4	42.7	1982-Q4	67.3	1995-Q4	101.2
1970-Q1	43.9	1983-Q1	67.6	1996-Q1	103.9
1970-Q2	44.3	1983-Q2	67.7	1996-Q2	104.0
1970-Q3	45.6	1983-Q3	68.8	1996-Q3	103.6
1970-Q4	45.5	1983-Q4	69.0	1996-Q4	104.7
1971-Q1	45.7	1984-Q1	70.1	1997-Q1	106.8
1971-Q2	46.4	1984-Q2	71.1	1997-Q2	103.8
1971-Q3	47.2	1984-Q3	71.5	1997-Q3	104.6
1971-Q4	47.7	1984-Q4	72.1	1997-Q4	104.2
1972-Q1	49.0	1985-Q1	73.2	1998-Q1	104.4
1972-Q2	50.0	1985-Q2	74.5	1998-Q2	103.7
1972-Q3	51.0	1985-Q3	75.0		
1972-Q4	52.2	1985-Q4	76.1		

U.K.

1960-Q1	44.9
1960-Q2	44.6
1960-Q3	45.2
1960-Q4	45.3
1961-Q1	46.0
1961-Q2	46.3
1961-Q3	46.2
1961-Q4	46.0
1962-Q1	46.2
1962-Q2	46.8
1962-Q3	47.2
1962-Q4	46.9
1963-Q1	46.8
1963-Q2	48.7
1963-Q3	49.0
1963-Q4	49.9
1964-Q1	50.5
1964-Q2	51.1
1964-Q3	51.1
1964-Q4	52.3
1965-Q1	52.3
1965-Q2	52.1
1965-Q3	52.5
1965-Q4	53.2
1966-Q1	53.3
1966-Q2	53.5
1966-Q3	53.6
1966-Q4	53.7
1967-Q1	54.3
1967-Q2	54.8
1967-Q3	54.8
1967-Q4	55.1
1968-Q1	57.0
1968-Q2	56.2
1968-Q3	57.2
1968-Q4	57.6
1969-Q1	57.6
1969-Q2	58.0
1969-Q3	58.3
1969-Q4	58.7
1970-Q1	58.4
1970-Q2	59.5
1970-Q3	59.9
1970-Q4	60.2
1971-Q1	59.6
1971-Q2	60.5
1971-Q3	61.3
1971-Q4	61.4
1972-Q1	61.1
1972-Q2	62.8
1972-Q3	62.9
1972-Q4	64.3

1973-Q1	67.5
1973-Q2	67.6
1973-Q3	67.7
1973-Q4	66.9
1974-Q1	65.2
1974-Q2	66.6
1974-Q3	67.2
1974-Q4	66.1
1975-Q1	66.4
1975-Q2	65.6
1975-Q3	65.4
1975-Q4	65.9
1976-Q1	67.3
1976-Q2	66.9
1976-Q3	67.5
1976-Q4	68.9
1977-Q1	68.8
1977-Q2	68.6
1977-Q3	69.2
1977-Q4	70.2
1978-Q1	70.7
1978-Q2	71.4
1978-Q3	72.0
1978-Q4	72.4
1979-Q1	72.0
1979-Q2	75.1
1979-Q3	73.4
1979-Q4	74.0
1980-Q1	73.6
1980-Q2	72.1
1980-Q3	71.6
1980-Q4	70.8
1981-Q1	70.7
1981-Q2	70.6
1981-Q3	71.5
1981-Q4	71.6
1982-Q1	71.7
1982-Q2	72.3
1982-Q3	72.4
1982-Q4	72.8
1983-Q1	74.3
1983-Q2	74.5
1983-Q3	75.2
1983-Q4	76.0
1984-Q1	76.8
1984-Q2	76.4
1984-Q3	76.4
1984-Q4	77.3
1985-Q1	78.5
1985-Q2	79.7
1985-Q3	79.9
1985-Q4	80.4

1986-Q1	81.5
1986-Q2	82.5
1986-Q3	83.5
1986-Q4	84.7
1987-Q1	85.2
1987-Q2	86.3
1987-Q3	87.8
1987-Q4	88.8
1988-Q1	90.1
1988-Q2	90.6
1988-Q3	92.0
1988-Q4	92.8
1989-Q1	93.1
1989-Q2	93.4
1989-Q3	93.5
1989-Q4	93.6
1990-Q1	94.0
1990-Q2	94.5
1990-Q3	93.6
1990-Q4	92.8
1991-Q1	92.4
1991-Q2	91.8
1991-Q3	91.6
1991-Q4	91.8
1992-Q1	91.1
1992-Q2	91.2
1992-Q3	91.6
1992-Q4	91.7
1993-Q1	92.6
1993-Q2	92.8
1993-Q3	93.7
1993-Q4	94.4
1994-Q1	95.5
1994-Q2	96.6
1994-Q3	97.6
1994-Q4	98.3
1995-Q1	98.7
1995-Q2	99.1
1995-Q3	99.7
1995-Q4	100.1
1996-Q1	100.4
1996-Q2	101.8
1996-Q3	102.5
1996-Q4	103.5
1997-Q1	104.3
1997-Q2	105.3
1997-Q3	106.2
1997-Q4	106.8
1998-Q1	107.6
1998-Q2	108.1

U.S.

1960-Q1	33.7	1973-Q1	57.6	1986-Q1	80.8
1960-Q2	33.5	1973-Q2	58.0	1986-Q2	80.9
1960-Q3	33.5	1973-Q3	57.8	1986-Q3	81.3
1960-Q4	33.1	1973-Q4	58.4	1986-Q4	81.7
1961-Q1	33.3	1974-Q1	57.8	1987-Q1	82.3
1961-Q2	33.9	1974-Q2	58.0	1987-Q2	83.1
1961-Q3	34.5	1974-Q3	57.4	1987-Q3	83.8
1961-Q4	35.2	1974-Q4	57.0	1987-Q4	85.0
1962-Q1	35.8	1975-Q1	56.2	1988-Q1	85.6
1962-Q2	36.2	1975-Q2	56.7	1988-Q2	86.4
1962-Q3	36.6	1975-Q3	57.8	1988-Q3	86.9
1962-Q4	36.6	1975-Q4	58.5	1988-Q4	88.0
1963-Q1	37.1	1976-Q1	59.8	1989-Q1	88.9
1963-Q2	37.5	1976-Q2	60.2	1989-Q2	89.6
1963-Q3	38.2	1976-Q3	60.5	1989-Q3	90.0
1963-Q4	38.5	1976-Q4	61.0	1989-Q4	90.1
1964-Q1	39.4	1977-Q1	61.8	1990-Q1	91.0
1964-Q2	39.9	1977-Q2	63.0	1990-Q2	91.3
1964-Q3	40.4	1977-Q3	64.0	1990-Q3	90.8
1964-Q4	40.5	1977-Q4	64.0	1990-Q4	89.9
1965-Q1	41.5	1978-Q1	64.3	1991-Q1	89.4
1965-Q2	42.1	1978-Q2	66.7	1991-Q2	89.8
1965-Q3	42.9	1978-Q3	67.3	1991-Q3	90.1
1965-Q4	43.9	1978-Q4	68.1	1991-Q4	90.3
1966-Q1	45.0	1979-Q1	68.1	1992-Q1	91.3
1966-Q2	45.2	1979-Q2	68.3	1992-Q2	91.9
1966-Q3	45.5	1979-Q3	68.7	1992-Q3	92.6
1966-Q4	45.9	1979-Q4	68.9	1992-Q4	92.3
1967-Q1	46.2	1980-Q1	69.2	1993-Q1	93.6
1967-Q2	46.3	1980-Q2	67.5	1993-Q2	94.1
1967-Q3	46.6	1980-Q3	67.5	1993-Q3	94.6
1967-Q4	47.0	1980-Q4	68.8	1993-Q4	95.8
1968-Q1	47.9	1981-Q1	70.1	1994-Q1	96.5
1968-Q2	48.7	1981-Q2	69.5	1994-Q2	97.6
1968-Q3	49.0	1981-Q3	70.3	1994-Q3	98.0
1968-Q4	49.3	1981-Q4	69.4	1994-Q4	98.9
1969-Q1	50.0	1982-Q1	68.3	1995-Q1	99.3
1969-Q2	50.1	1982-Q2	68.5	1995-Q2	99.4
1969-Q3	50.4	1982-Q3	68.2	1995-Q3	100.3
1969-Q4	50.2	1982-Q4	68.3	1995-Q4	100.9
1970-Q1	50.1	1983-Q1	69.0	1996-Q1	101.8
1970-Q2	50.2	1983-Q2	70.4	1996-Q2	103.3
1970-Q3	50.6	1983-Q3	71.7	1996-Q3	103.8
1970-Q4	50.1	1983-Q4	73.0	1996-Q4	104.9
1971-Q1	51.5	1984-Q1	74.7	1997-Q1	106.0
1971-Q2	51.8	1984-Q2	75.9	1997-Q2	107.0
1971-Q3	52.1	1984-Q3	76.5	1997-Q3	108.1
1971-Q4	52.3	1984-Q4	77.0	1997-Q4	108.9
1972-Q1	53.3	1985-Q1	77.8	1998-Q1	110.4
1972-Q2	54.5	1985-Q2	78.1	1998-Q2	110.9
1972-Q3	55.1	1985-Q3	79.3		
1972-Q4	56.1	1985-Q4	79.8		

APPENDIX B

FIGURES

Figure B.1. Real GNP of Australia

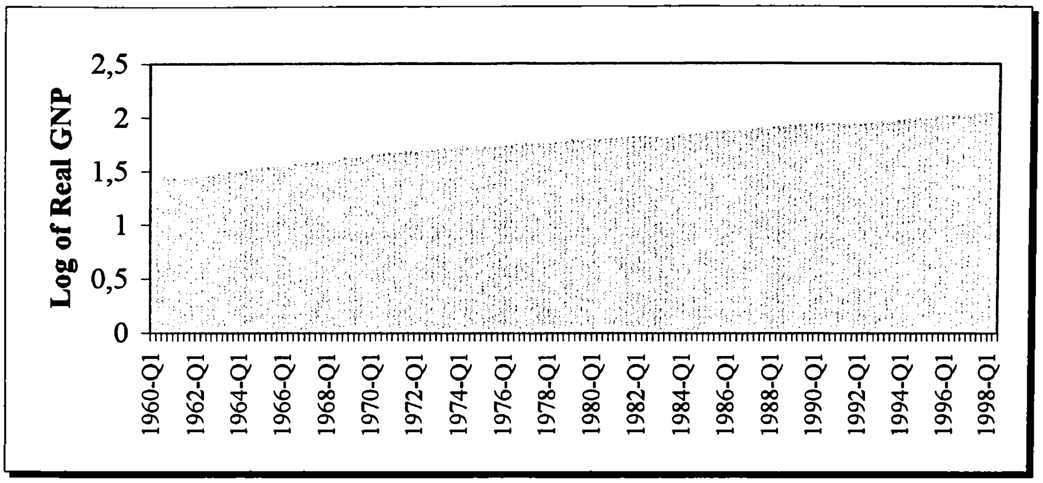


Figure B.2. Real GNP of Canada

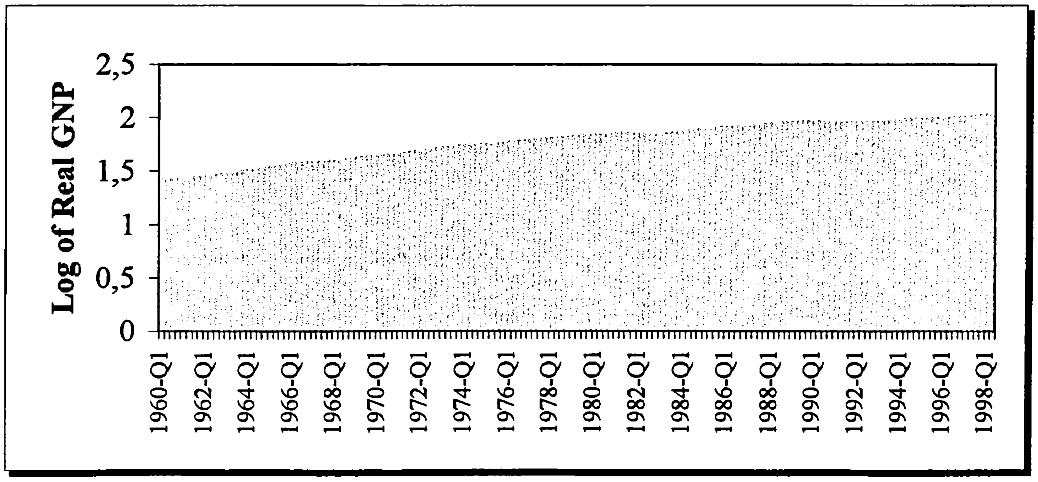


Figure B.3. Real GNP of Germany

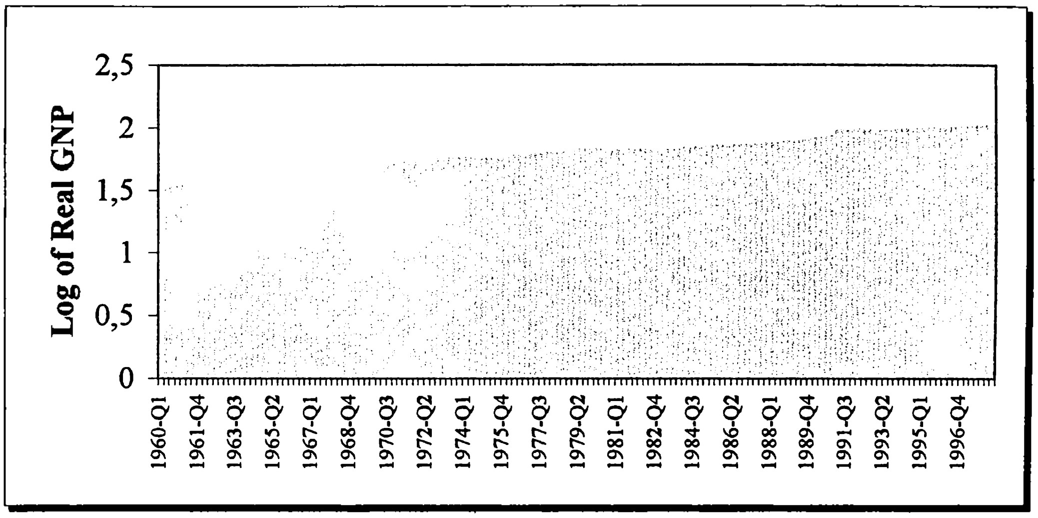


Figure B.4. Real GNP of Italy

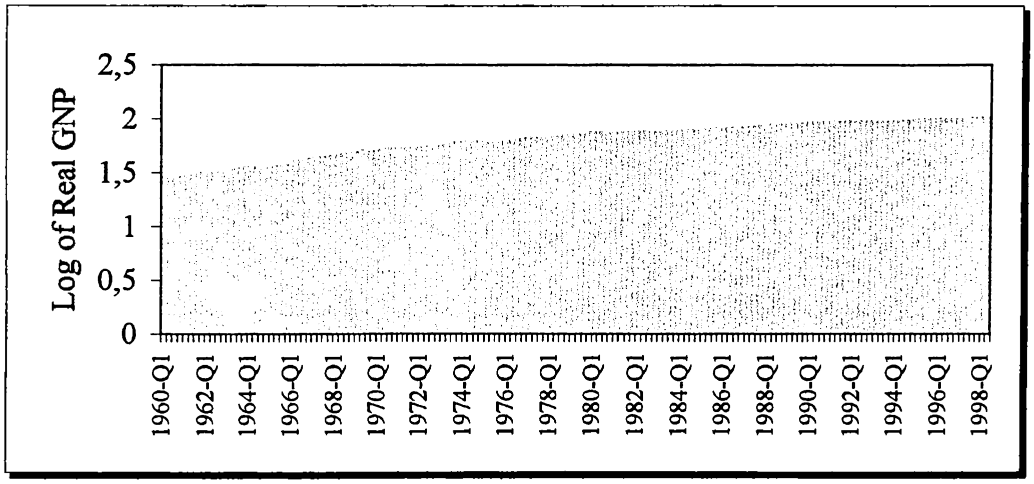


Figure B.5. Real GNP of Japan

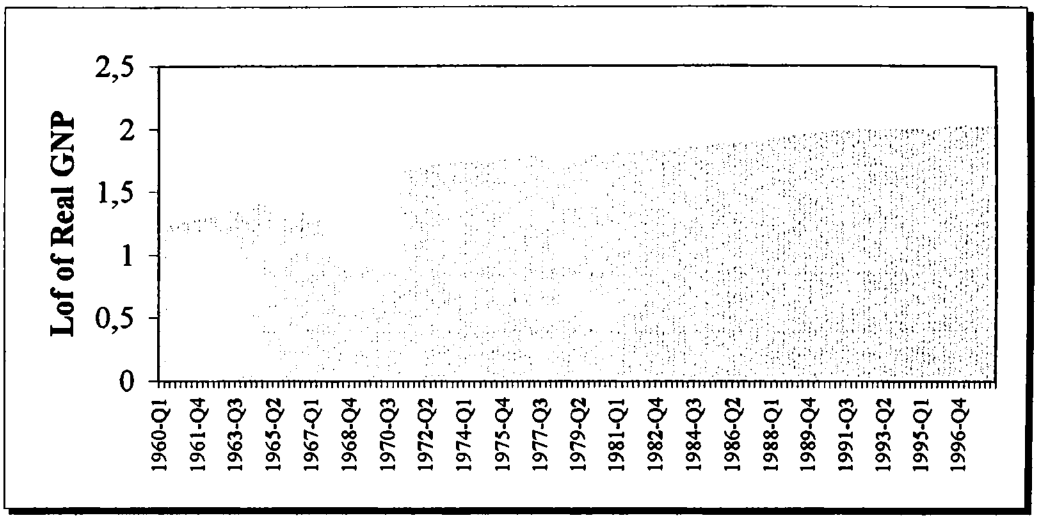


Figure 6.6. Real GNP of U.K.

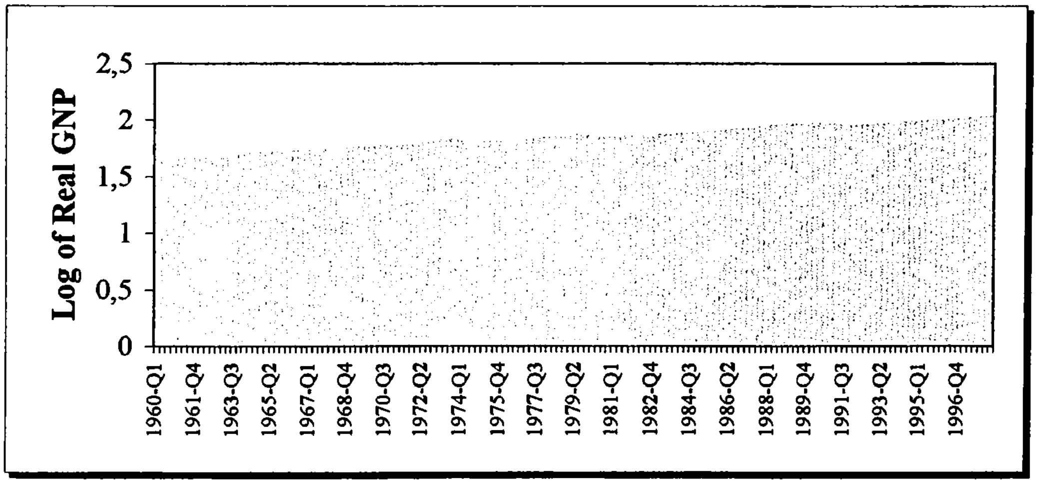
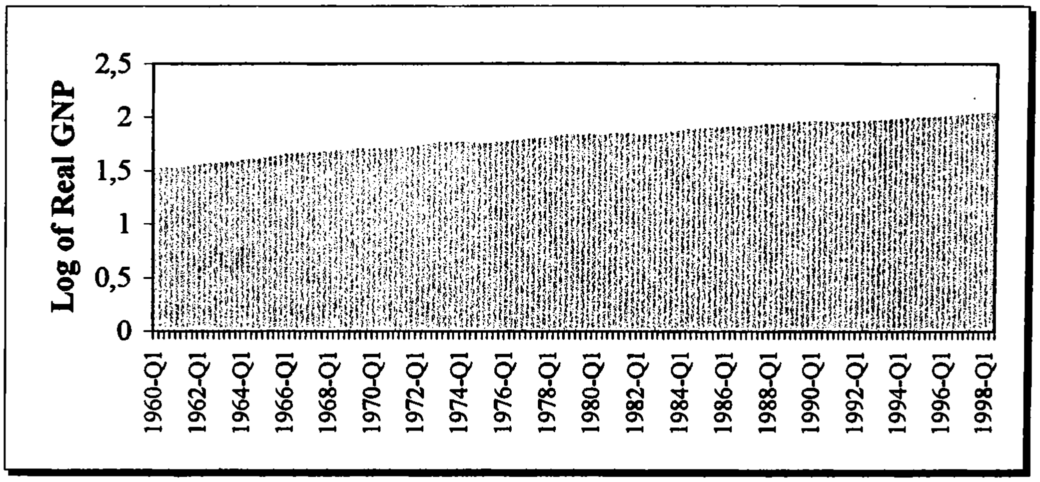


Figure 6.7 Real GNP of U.S.



APPENDIX C

Gauss Program

```
load dat[154,1]=italy.txt;
p=1;



pmax=4; dfgs=zeros(pmax,1);        do while p<=pmax;

        output file=ausq.out reset;
                y=ln(dat);
                t=rows(dat);
                rbar=1+(-13.5/t);

        yb=zeros(t,1);
        yb[2:t]=y[2:t]-(rbar*y[1:t-1]);
        yb=y[1]|yb[2:t];

    z=ones(t,1)~seqa(1,1,t);
    zb=zeros(t,2);
    zb[2:t.,]=z[2:t,.]-(rbar.*z[1:t-1,.]);
    zb=z[1,.]|zb[2:t,.];

        beta=inv(zb'zb)*zb'*yb;
         y=y-z*beta;
        dy=y[2:t]-y[1:t-1];

                x=y[p+1:t-1]~dy[p:t-2];
                        ki=2;
                        do while ki<=p;
                         x=x~dy[p+1-ki:t-1-ki];
                        ki=ki+1;

    endo;
```

```
        b=inv(x'x)*x'*dy[p+1:t-1];
        dc=zeros(p,1);
        ep={1};
        ep=ep~dc';
        rho=ep*b;
        res=dy[p+1:t-1]-(x*b);
        s2=res'res/(t-p-1);
        xx=inv(x'x);
        den=sqrt(diag(xx)*s2);
        dfgs[p]=rho/den[1];

p=p+1; endo;
dfgs;
```