UNIVERSIDADE FEDERAL DO CEARÁ
CURSO DE PÓS-GRADUAÇÃO EM ECONOMIA
CAEN

Roberto Tatiwa Ferreira

FORECASTING QUARTERLY BRAZILIAN GDP GROWTH RATE WITH LINEAR AND NONLINEAR DIFFUSION INDEX MODELS

FORTALEZA
2005

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Tese submetida à Coordenação do Curso de Pós-Graduação em Economia, da Universidade Federal do Ceará, como requisito parcial para obtenção do grau de Doutor em Economia.

Orientador: Prof. Luiz Ivan de Melo Castelar

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2005

Esta Tese foi submetida como parte dos requisitos necessários à obtenção do grau de Doutor em Economia, outorgado pela Universidade Federal do Ceará, e encontra-se à disposição dos interessados na Biblioteca do Curso de Pós-Graduação em Economia – CAEN da referida Universidade.

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Tese aprovada no dia 05 de Maio de 2005 pela seguinte Banca Examinadora

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Aos meus pais Roberto e Elna

AGRADECIMENTOS

Aproveito esta oportunidade para agradecer as pessoas e instituições que, de forma direta ou indireta, colaboraram para a continuação da minha formação acadêmica, representada aqui pelo meu doutoramento. Neste sentido, quero agradecer aos meus pais, pelo incentivo, direcionamento e apoio contínuo que sempre recebi deles para minha jornada pessoal que alcança a conclusão de mais uma fase.

Meu sincero muito obrigado ao Prof. Ivan Castelar, que me acompanha como orientador acadêmico e para assuntos aleatórios desde o mestrado, por sua orientação, estímulo científico e por sua contribuição na minha formação teórica, para a qual também contribuíram e aproveito para agradecer, os professores Emerson Marinho, Ronaldo Arraes, Paulo Neto, Flávio Ataliba, José Raimundo, Marcos Senna e Marcos Holanda.

Agradeço ao Prof. Herman Bierens pela sua orientação e ajuda durante minha estadia na Pennstate, oportunidade esta que agradeço à CAPES e a seu programa de doutorado sanduíche no exterior.

Enfim, quero agradecer a toda a comunidade do CAEN que através da amizade e, muitas vezes, pelo esforço em comum, estiveram comigo durante todo o tempo.

RESUMO

Esta Tese estuda modelos lineares e não lineares de índices de difusão para prever, em um período à frente, a taxa de crescimento trimestral do PIB brasileiro. Os modelos de índice de difusão assemelham-se aos modelos de fatores dinâmicos. Estes fatores são variáveis não observáveis e representam uma característica em comum às variáveis explicativas, permitindo a redução significativa do número dessas no modelo econométrico proposto para atender o objetivo principal deste trabalho. Além de parcimoniosos, os modelos utilizados nesta Tese se propõem a capitar as fases de recessão e expansão econômica, através de modelos não lineares do tipo *Threshold Effect* e *Markov-Switching*, servindo o primeiro destes dois para testar a hipótese de que existe não linearidades na variável sob estudo.

Palavras-Chaves: Previsão, PIB, Índice de Difusão, *Threshold*, *Markov-Switching*.

ABSTRACT

The present study uses linear and non-linear diffusion index models to produce one-step-ahead forecast of quarterly Brazilian GDP growth rate. Diffusion index models are like dynamic factors models. These factors are latent variables that represent a common property from the explanatory variables, then allowing a considerably reduction of its number in econometric models elaborated to attend the main objective of this work. The non-linear diffusion index models used in this thesis are not only parsimonious ones, but also they try to capture economic cycles using for this goal a Threshold diffusion index model and a Markov-Switching diffusion index model. The former is used, besides for forecasting purpose, also to test if there is a non-linear pattern in the quarterly Brazilian GDP growth rate.

Key Words: Forecasting, Brazilian GDP, Diffusion Index, Threshold, Markov-Switching.

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1. INTRODUCTION

Forecasting, from the point of view of econometrics, is the process to select and estimate a model in order to make statements about the future. The period in the future to be forecast can vary from short to long time. When short period is the target, one can consider technology constant and to predict some values is the main objective. In the long term the variations in the technology must be forecast and its effects on the model should be considered (GRANGER, 1980).

Recent lessons in economic forecasting practice have showed that the lack of parsimony is an important cause of forecast failure. This should be expected because the more coefficients there are in a model, more uncertainty about the estimated parameters is introduced and this can reflect negatively on the model's forecast efficiency. Not only does this mean that some variables, which could give important information about the series to be predicted, would likely be out of the model, but also that lags of the included variables would be restricted.

Factor models for time series have been used to allow the construction of large number of cross-sections in macro forecasting models. The main idea is that all the information included in a large number of variables could be captured by a few numbers of common factors between them. At least two distinct literatures have been using this method. One of these branches is represented by the dynamic factor models (GEWEKE 1977; SARGENT AND SIMS 1977;GEWEKE

AND SINGLETON 1981; ENGLE AND WATSON 1981; STOCK AND WATSON 1989,1991; QUAH AND SARGENT 1993; KIM AND NELSON 1998). The main characteristic in these studies is the effort to estimate the unobservable common factors among some macroeconomic variables, relying on the use of Maximum likelihood estimation(MLE), Kalman filter or both.

The other factor model approach is represented by diffusion index models (CONNOR AND KORAJCZYK 1993; GEWEKE AND ZHOU 1996; FORNI AND REICHLIN 1996, 1998; STOCK AND WATSON 1998, 2002), which uses principal components to estimate these common factors. This method allows a larger information set than MLE, and it seems to be more appropriate to compute factor estimates when the sample period is short, but there are a medium number of related variables into the information set.

Besides the lack of parsimony, there are many others causes of forecast failure. A major one occurs when structural breaks exist in the series to be forecast. In this case non-linear models and the Intercept Correction technique could be tried to improve on predictions made by linear models.

There are three major classes of non-linear models - Markov Switching (MS), Threshold autoregressive (TAR) and Smooth Transition (STAR) models. These models have been used in macroeconometrics to characterize business cycles such as expansions and recessions.

However, when the subject is forecast efficiency, it seems to be no clear consensus as to whether non-linear models improve on out-of-sample prediction performance (DE GOOIJER AND KUMAR,1992). CLEMENTS AND KROLZIG (1998) and CLEMENTS AND SMITH (1999), using simulation based evaluations of non-linear forecast devices, point out in the direction that linear models are robust forecast mechanism.

On the other hand, CLEMENTS AND FRANCES (1999) find weak evidence that a TAR model of US GNP provides better forecasts than a linear AR model. CLEMENTS, FRANCES, SMITH and DIJK (2003) have compared point, interval and density forecasts. They find that density and interval forecasts from non-linear models are likely to be better than those from linear models. In the same direction the findings by DIJK AND SILVERSTOVS (2003), which have used non-linear and linear models to forecast the growth rate of industrial production of the G7 countries, support the idea that non-linear models may outperform linear models in terms of describing the uncertainty of a time series.

CHAUVET (1998, 2001) suggested a Markov Switching dynamic factor model, and in a later study she applied this kind of non-linear factor model to produce a monthly indicator of Brazilian GDP and used it to forecast the growth rate of that variable. She has found that the non-linear models present better predictive performance.

The main objective of this work is to forecast the Brazilian GDP growth rate. Some authors have been studying different models to forecast the variable in question MOREIRA, FIORÊNCIO AND LOPES (1996) used a VAR, VEC, BVAR and BVEC. MOREIRA AND AMENDOLA (1998) used a Bayesian vector autoregressive model of lead variables and a dynamic Bayesian model that extracts trend, seasonal and cyclical patterns to the same purpose. Furthermore, CHAUVET (2001) and CHAUVET, LIMA AND VASQUEZ (2002) show that using non-linear models to forecast Brazilian GDP growth rate improve on linear models.

In this study the diffusion index (DI) model and a threshold diffusion index model (TARDI) was used to forecast Brazilian GDP growth rate and these predictions were compared to linear AR forecasts. DI forecasts were made using two kinds of data sets. In the first one, factors were estimated from the current values of 72 predictors. The second data set was constructed allowing for lags[1] of these predictors. Quarterly data were used from 1975.Q1 to 2003.Q3. One step ahead forecasts were produced in a simulated real time design.

After the best linear DI model is chosen, a Time-Varying-Parameter DI model was tried. Moreover, the linear DI model was tested for the existence of a threshold effect in short and long differences of the endogenous variable and estimated

[1] Sets with one up to three lags were applied.

following the method presented in HANSEN (1997). Another non-linear model used int his work was a Markov switching DI model.

Once all the models were estimated and used to forecast, a linear combination of these individual predictions will be checked attempting to improve the forecast performance. Also, part of the sample will be reserved to simulate ex-ante forecast.

There are at least three important contributions provided by this work that are important to stress. First, it applies the DI method to forecast an important Brazilian macroeconomic variable, and this has not been done up to now in Brazil. Second, a starting point to the question whether it is a good idea to use forecast diffusion index for ex-ante predictions will be proposed. Third, and the most important one, was the use of a Threshold and a Markov Regime Shift specification of a DI model. Those types of models had not been suggested or tried before, and their predictive power is analyzed from an empirical point of view.

Besides this introduction this study has four more sections. The first section explains the data used in this work and gives a first sighting of the variable to be forecast. The second one, as usual, contains a review of the most important theoretical background of the work. Subjects such as latent variables and factor models, the estimation process and forecast environment used in this study are presented. The third one contains the main results of the forecasting experiment. The conclusions and main remarks are presented in the last section.

2. THE DATA

The quarterly sample data used in this study cover major Brazilian macroeconomic series available from 1975.Q1 to 2003.Q3. In this study the time series to be forecast is the growth of Brazilian GDP[2] . There are two periods for forecast horizon. Traditional out-of-sample predictions are produced for 2002:1 to 2003:3. The 2003:4 up to 2004:3 available data were used to simulate *ex-ante* forecast.

The explanatory variables (x_t), which served to compute the diffusion index used in this work, are composed of a total of 72 national and international macroeconomic variables, selected[3] to represent categories such as real output, income and earnings; production capacity constraints; employment; real retail; credit constraints; interest rates; price index; investment; exchange rate; money aggregates; balance of payment results; international trade; economic indicators of industrialized countries and miscellaneous. These macroeconomic categories are in tune with STOCK AND WATSON (1998), but they are not the same. First, USA economy has a large data bank with some category variables that are not available in Brazilian data bank. Second, Brazilian economy is very dependent on its external sector and international economy indicators. Balance of payment and international reserves have influenced Brazilian economic growth and economic policies,

[2] $y_t = Ln(gdp_t/gdp_{t-1})$

[3] These selected variables were chosen to represent main macroeconomic categories with the same length and number of observations of quarterly Brazilian GDP data.

such as huge exchange rates devaluations. Thus, this study included some international macroeconomic variables to capture these external effects on the Brazilian economy. A list of these variables is presented in table A.1 in Appendix II.

The estimation and asymptotic results presented in STOCK AND WATSON (1998) assume that $x_t(0)$, i.e., all the series in the data matrix are stationary. Thus, these 72 series have been analyzed for unit-roots and seasonal patterns, with some usual tools such as plots and correlograms of the series, and ADF tests for unit root processes. All the nonnegative series were expressed in logs, except for the percentage scaled ones. Nominal variables[4] in R$ (Brazilian currency) were deflated. Seasonal adjustments were made based on the Census X-11 procedure[5]. Moreover, first and second differences were taken to achieve stationarity when needed. Another common practice on empirical studies is to screen the data for outliers. The aim of this study has not been to do so. The plot of data shows that there are some outliers at the end of out-of-sample forecast period, and this study aims to see if the type of models used here, specially the non-linear

[4] Later a few words about the inflationary process of Brazilian economy will be discussed. For now it is important to remember that this economy, in its earlier past, has suffered with intense inflationary process, thus some nominal variables looks non-stationary because they included the price growth into their values. TOMEK (2000) suggested that some careful must be taken to choose the right deflator. This work applied the usual deflator for Brazilian macroeconomic time series.

[5] This procedure can be explained as follow: a) let y_t be the series to be adjusted. A centered moving average of y_t is computed and stored as x_t; b) compute $d_t = y_t - x_t$; c) the seasonal index i_q for quarter q is the average of d_t using data only of the q quarter; d) compute $s_j = i_j - \bar{i}$, where $\bar{i}$ is the index average; e) the seasonally adjusted series is obtained by taking the difference $y_t - s_j$.

ones, are capable of forecasting them. There are also some outliers far from the beginning of out-of-sample-forecast period, and this seems not to harm the forecast quality of almost all models presented in this work. The only exception where an intervention analysis made some significant difference was in the case of Markov-switching models. In this type of model it is expected that outliers can be harmful to the estimates related to transitional probabilities. After these transformations the sample started at 1976.Q1. These variables and their transformations are presented in Table A.1 in Appendix II.

The next two plots give a first insight into the variable to be forecast in this study. Figure 1 shows that there are some peaks that are candidates for structural breaks occurred in the series under observation and that economic cycles seem to be very short.

Brazilian economic policies from 1939 to 2003 are characterized by two distinct objectives. From 1939 to 1984, several economic development plans were implemented. All these plans were based on huge public investments and expenditures. The main objective was the same - acceleration of economic growth.

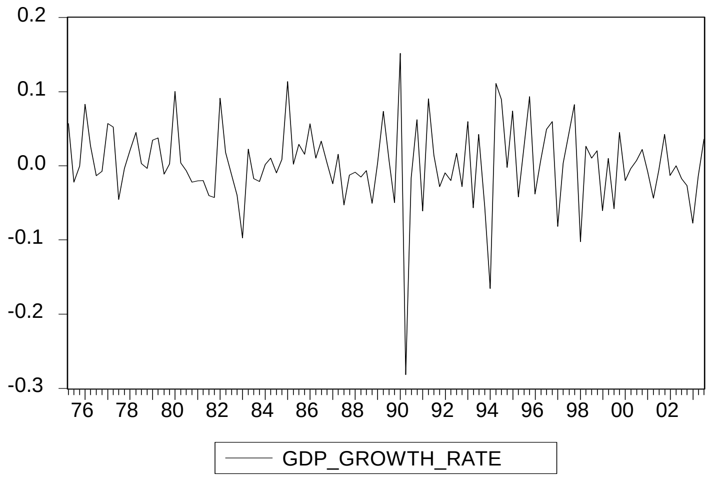


Figure 1 - Brazilian's GDP Growth Rate : 1975:2 - 2003:3

Public debt and the inflation process have also grown, especially after international economic recession caused by oil crises. In the 80's Brazilian economy was going through a profound stag-inflationary process, and the focus changed from economic growth to macroeconomic stabilization plans. From 1987 up to now there have been seven of these plans. As one can see at Figure 1, it seems that the beginning of these stabilization plans caused a pronounced expansion of growth rates volatility, and this is easy to understand once some details of these plans are checked. Thus, below there is a brief list of these plans and its basic actions, extracted from the publication series by Central Bank of Brazil, entitled Public Finance.

LIST OF BRAZILIAN'S STABILIZATION PLANS :1986 TO 1994

Cruzado Plan

President of the Republic: José Sarney

Minister of Finance: Dilson Domingos Funaro

Central Bank: Fernão Carlos Botelho Bracher

Principal measures:

a) price freeze, at the levels in effect on 2.27.1986;

b) alteration of monetary standard from the cruzeiro to the cruzado (Cz$1.00 = Cr$1,000.00) as of 2.28.1986;

c) alterations in wages, salaries, pensions and earnings in general to be determined annually. Following the first collective bargaining agreement, wages would be automatically readjusted whenever accumulated growth in the Consumer Price Index (IPC) reached 20%;

d) rate of exchange determined for the period from 3.3.1986 to 10.15.1986 (US$1.00 = Cz$13.84);

e) creation of a table for conversion of payment obligations expressed in cruzeiros, with no preset monetary indexing clause;

f) effective as of 3.11.1986, prohibition of monetary adjustment clauses in contracts with terms of less than one year; contracts including such clauses would be automatically null and void;

g) the Readjustable National Treasury Obligations (ORTN) was renamed the National Treasury Bond (OTN). The first OTN were issued on 3.3.1986, with a unit value of Cz$106.40 and remained at that value up to 3.1.1987.

Bresser Plan

President of the Republic: José Sarney

Minister of Finance: Luiz Carlos Bresser Pereira

Central Bank: Fernando Milliet de Oliveira

Principal measures:

a) ninety day price freeze, including those charged on services, tariffs and real estate lease contracts, at the levels in effect on 6.12.1987;

b) creation of the URP as the reference factor for price and wage alterations. The value of the URP was defined according to average monthly growth in the IPC for the immediately previous quarter and its application to each month of the subsequent quarter;

c) the rate of exchange was altered by 9.50% on 6.16.1987, after which the system of crawling peg devaluations was applied;

d) monetary contractual obligations and credit securities that had been constituted in cruzados in the period from 1.1.1987 to 6.15.1987, with no adjustment or monetary indexing clauses, or with preset monetary indexing clauses, were deflated for each day remaining to maturity through application of a conversion table.

Summer Plan

President of the Republic: José Sarney

Minister of Finance: Maílson Ferreira da Nóbrega

Central Bank: Elmo de Araújo Camões

Principal measures:

a) price freeze for an undetermined period of time at the levels in effect on 1.14.1989;

b) alteration of the monetary standard from the cruzado to the cruzado novo (NCz$1,00 = Cz$1,000.00) as of 1.16.1989;

c) salaries and other earnings and pensions for the month of February 1989 were altered to their respective real average values for 1988;

d) as of February 1989, payments of civil service wages against the National Treasury operating account were to be effected up to the tenth day of the subsequent month;
e) on 1.16.1989, the rate of exchange was altered by 16.381% and maintained at that level until 4.14.1989, when it was then set at a fixed level that remained in effect until 5.4.1989; this was followed by a series of crawling peg devaluations up to 7.3.1989, when a new devaluation in the amount of 11.892% was announced;
f) creation of a conversion table for payment of obligations expressed in cruzeiros, with no monetary indexing clause nor preset monetary indexing factor;
g) elimination of the daily indexed OTN fiscal on 1.16.1989, followed by elimination of the OTN on 2.1.1989. The OTN-fiscal was used as the official indexing factor for payment of taxes and fiscal contributions.

Collor Plan I

President of the Republic: Fernando Affonso Collor de Mello
Minister of Finance: Zélia Maria Cardoso de Melo
Central Bank: Ibrahim Eris

Principal measures:

a) alterations in the prices of goods and services were prohibited as of 3.15.1990, without prior authorization of the Ministry of Finance;
b) alteration of the monetary standard from new cruzado to cruzeiro (Cr$1.00 = NCz 1.00), effective as of 3.16.1990;
c) authorization was given to the Minister of Finance to issue norms defining the minimum monthly percentage growth permitted for wages in general, as well as for the minimum wage. This percentage would be valid for the wages of the

current month. Wage increases above the minimum level defined by the government could be freely negotiated among the parties involved, but would not be taken into consideration for purposes of calculating average monthly price growth. In the same way, the Minister was authorized to issue specific acts determining the maximum monthly percentage increase of authorized prices for goods and services in general;

d) determined that exchange rates on purchase and sale operations would be freely negotiated among the contracting parties in spot and futures operations carried out with institutions authorized to deal in exchange;

e) the possibility of Banco Central acting on the free rate market as buyer and seller of currency was created;

f) the demand for deposit at Banco Central of exchange operations formalized for purposes of payment of import operations was eliminated;

g) suspended payment of interest and other charges on foreign currency deposits;

h) imposed an obligatory lengthening of the average terms of securities, while fostering a sharp reduction in the corresponding financial charges. The lengthening of terms was achieved through issue of National Treasury Bonds Special Series (BTN-E), since maturity of these papers was to begin as of September 1991, in twelve successive installments, while National Treasury Financing Bills (LFT) registered average terms ranging from six to nine months;

i) created Privatization Certificates;

j) imposed an embargo on financial assets, a rate increase and broadening of the range of facts that generate taxes. Ceilings were imposed on releases of financial assets for a single holder of these assets at the same financial institute. For balances registered under demand deposits and savings accounts, a maximum limit of Cr$50 thousand was defined. As of 9.16.1991, the amounts above this limit were converted into twelve monthly and successive installments in equal amounts, with monetary updating based on the change in the value of the BTN-Fiscal, plus interest of 6% per year or a pro rata fraction. The following limits were defined for time deposits, with or without issue of certificates, exchange bills, interfinancial deposits, debentures and other financial assets, as well as the resources contracted by financial institutions through committed operations:

j.1) committed operations: Cr$25 thousand or 20% of the redemption value of the operation, whichever is largest, on the maturity date of the original term of the investment;

j.2) other assets and investments, excluding interfinancial deposits: 20% of the redemption value on the maturity date of the original term of the papers.

The treatment given to the amounts above the stated limits were given treatment identical to that applied to demand deposits and savings accounts;

l) restricted the presence of the State in the economy through deregulation and privatizations;

m)imposed temporary levying of the Financial Operations Tax (IOF) on stock and security redemption operations, transmission of proprietorship of gold and stocks traded on stock exchanges, as well as withdrawals from savings accounts;

n) redemptions of investments of unidentified origin were subjected to payment of the income tax at a 25% rate.

Collor Plan II

President of the Republic: Fernando Affonso Collor de Mello
Minister of Finance: Zélia Maria Cardoso de Melo
Central Bank: Ibrahim Eris

Principal measures:

a) determined that the prices of goods and services in effect on 1.30.1991 could only be increased with the prior and express authorization of the Ministry of Finance;

b) introduced rules determining that salaries for the month of February 1991, with the exception of the wages, earnings and other incomes and monetary advantages paid to civilian and military employees of the direct federal public administration, semi-autonomous government entities and foundations, as well as the monthly benefits paid by the Social Security System or National Treasury were to be altered on the basis of the average salary of the last twelve months, while duly complying with the principle that salaries cannot be reduced. The earnings of civilian and military public sector personnel, as well as the earnings paid to pensioners, were altered by 9.36% in the month of February 1991. Wage policy in the period from March 1 to August 31, 1991, was to be based exclusively on the granting of wage advances;

c) defined rules determining that contractual and monetary obligations constituted in the period from 9.1.1990 to 1.31.1991, without adjustment clauses or preset monetary indexing clauses, would be subjected to deflation upon maturity through application of a conversion table;

d) based on a methodology announced by the CMN, created the TR as the instrument to be used in calculating earnings on short-term financial investments. A period of sixty days was defined for the CMN to define the methodology for calculating the TR;

e) as of 2.1.1991, abolished the BTN - Fiscal and the BTN (which had been instituted by laws 7,777, dated 6.19.1989 and 7,799, dated 7.10.1989, respectively), the Largest Reference Value (MVR), overnight operations for individual and nonfinancial corporate investors, monetary indexing, the fiscal value adjustment index (IRVF) and the basic food supply index (ICB);

f) duly respecting the authorization granted and the limits defined in budget legislation as well as in additional budget credits, created the National Treasury Note (NTN) to be issued with the purpose of providing the National Treasury with the resources required to maintain budget equilibrium or for the carrying out credit operations based on anticipated revenues.

Immediate Action Program (PAI)

President of the Republic: Itamar Augusto Cautiero Franco

Minister of Finance: Fernando Henrique Cardoso

Central Bank: Francisco Roberto André Gros

Principal measures:

a) revision of 1993 budget law with spending cuts of US$6 billion;

b) increase in public sector revenues, not only through adoption of such transitory solutions as creation of the Provisional Tax on Financial Transactions (IPMF), but also through improvements in the instruments used in tax inspection activities and combating tax evasion;

c) normalization of the payments made by state and municipal treasuries on their debts with the federal government in an overall amount equivalent to approximately US$40 billion;

d) strengthening of the instruments of control and inspection of state banks with the objective of not allowing them to operate as financing agents of their respective treasuries;

e) extension of the provisions of the so-called iowhite collar lawl. to the government financial system, subjecting managers of financial institutions who grant loans to their own controlling stock holders or to companies controlled by them to imprisonment for periods from two to six years;

f) reorganization of federal banks by redefining their roles, with the purpose of eliminated duplicate activities and predatory reciprocal competition, streamlining their structures, while also granting Banco Central greater autonomy to control and inspect the activities of these institutions;

g) accelerate and expand the scope of the National Privatization Program (PND), in order to give continuity to the process of redefining the role of the State and resolving the question of public sector financial imbalances.

Real Plan

President of the Republic: Itamar Augusto Cautiero Franco

Minister of Finance: Rubens Ricúpero

Central Bank: Pedro Sampaio Malan

Principal measures:

a) alteration of the monetary standard from the cruzeiro real to the real (R$1,00 = CR$2,750.00), effective as of 7.1.1994;

b) reduction in IOF rates on the operations to which law 8,033, dated 4.12.1990, refers;

b.1) from 8% to zero on transmission or redemption of public and private securities, including short-term investments;

b.2) from 25% to zero on transmission of the stocks of open capital corporations;

b.3) from 20% to zero on withdrawals against savings accounts;

b.4) from 35% to 15% on transmission or redemption of securities representative of gold assets;

c) interruption of the system of converting taxes according to the Ufir until 12.31.1994, provided that they were paid within the original periods specified in tax legislation. In the case of unduly paid taxes and contributions, compensation or restitution based on the change in the value of the Ufir calculated as of the date of payment was ensured;

d) extinction of the daily Ufir, which would henceforward be set on a quarterly basis, at the same time in which alterations in the value of state fiscal units were tied to the Ufir;

e) in public sector contracts with no monetary updating clause, permission to deduct the expectation of inflation for the period between the final date of the period of performance of the liability and the date on which payment is effectively due. If the contract does not explicitly cite expected inflation, the General Price Index - Domestic Supply (IGP-DI) is to be adopted and applied pro rata tempore for the scheduled payment period. In contracts in which there are monetary updating clauses, the appropriate deduction is to be applied;

f) determined that allocations in the General Federal Government Budget (OGU) and their proposed alterations would be updated to the average price in effect in 1994 through application of the multiplier 66.8402 to the amounts expressed in terms of April 1993 prices, and then converted into real on July 1, 1994;

g) suspension until June 30, 1995:

g.1) of the granting of endorsements or any other guaranties by the National Treasury, granted for any reason whatsoever;

g.2) of approval of new projects financed in the Foreign
Financing Commission (Cofiex) framework;
g.3) of the opening of special credits in the National Budget;
g.4) of conversion of credits originating in the Result Account
to be Offset (CRC) into federal public securities,
according to the terms of laws 8,632/1993 and 8,724/
1993;
g.5) of placements abroad of any securities or liabilities of
any type;
g.6) of contracting of new internal or external credit
operations, except operations for amortization of the
indexed principal of the internal or external debt or those
referring to commercial operations;
h) determined that the positive result of Banco Central operations
were to be deposited at the National Treasury on a half-yearly
basis up to the 10th day of the month subsequent to calculation
of such results.

Source: Central Bank of Brazil

The Collor Plan I, in the beginning of the 90's, is the responsible for the major shift on the variable under analysis. Afterwards another stabilization plan called Real in 1994 can explain the expressive changes observed in the plot. In 1998 the Brazilian economy was hit by an international financial crisis, and by the end of 2003 presidential election and the expectation of new directions in economic policy pushed the economy to a recession once more.

Figure 2, bellow shows a Kernel density[6] graph of the series plotted in figure 1. This plot shows that the variable in question seems to be better approximated by a mixture of normal distributions rather than by a simple normal distribution. This fact seems to suggest that a nonlinear model may produce a better approximation than a linear one. This will be checked later through a threshold test.

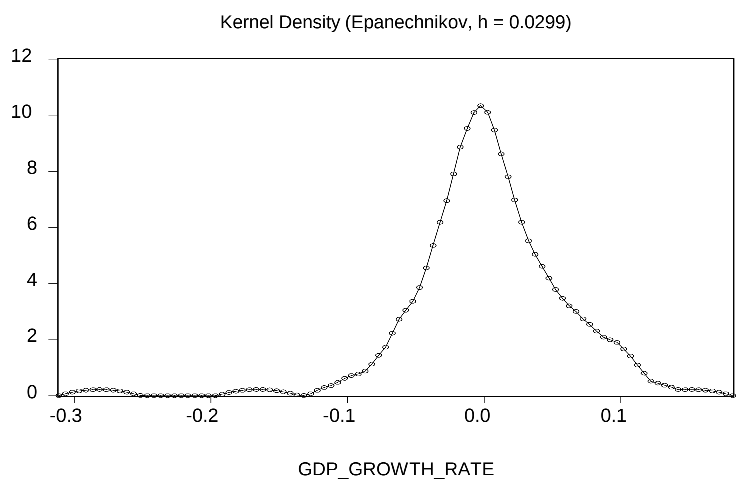


Figure 2 - Kernel Density of Brazilian's GDP Growth Rate

[6]The Kernel function used was an Epanechnikov with the bandwidth (h) selected by the Silverman (1986) criterion:
$h=0.9kn^{-1/5}\min\{s,R/134\}$, where k is a canonical bandwidth transformation factor, n is the number of observation, s is the standard deviation and R is the interquantil of the series.

3. THEORETICAL ASPECTS

3.1. THE EVOLUTION OF BUSINESS CYCLE THEORY

The fact that economic growth is not continuous but subject to oscillations has been a point that has demanded explanation by economists. This subsection presents a summary of the principal contributions to this problem. The intent is to justify the methodology applied and described later in this work, and to point out some candidates as explanatory variables for the elaboration of an econometric model to forecast these economic cycles. Instead of a chronological presentation, the neighborhood principle will be followed; i.e., the order here will follow the main schools of economic thought.

In 1913, Shumpeter described the economic cycle as the result of private investment fluctuations caused by the irregular movement of innovations. The innovations are produced by scientific and technological progress. For Shumpeter, new investments would create new flow of income and demand, and this movement presents a reversion of direction as soon as the new investments are completed. It can be noticed that his work has inspired New Classical, Keynesian and New Keynesian economists.

FRIEDMAN AND SCHWARTZ (1963) and FRIEDMAN (1969), rehabilitated the point of view of the business cycle treated as a monetary phenomenon, as per Wicksell's early work. For these authors, changes in the growth rate of the stock of money are necessary and sufficient to induce changes in the growth rate of money income. The work of FRIEDMAN (1969) also brings three important conceptual innovations - the representative agent, the anticipations and the use of Walrasian general equilibrium models.

The basic idea in Friedman's work is that there is a Wicksellian natural rate of interest (r_n), which is not known by the monetary authorities. If this rate is fixed under its natural value by expansion of money supply this causes an immediate effect and a medium term effect. The short term effect is almost the same proposed by Wicksell - if $r < r_n$ there is an excess of supply in the bond market. The money supply then expands, increasing nominal output. The difference now, is that the demand stimulus will raise the prices which cancel the initial increase in nominal money supply and the economy will adjusts until $r = r_n$. Adjustment periods depend on how fast the price expectation adjusts itself.

New Classical school, represented by LUCAS (1977), which is considered as the predecessor of Real Business Cycle School, based his model on the concept of a representative agent and Walrasian general equilibrium theory. For this author, the cyclical fluctuations are explained by the rational adjustment process of decentralized economic agents and their choices, i.e., economic fluctuations are the result of the agent's optimal response to unexplained changes or shocks. The cycle is defined as oscillations in GNP around a trend and comovements among different macroeconomic variables. These fluctuations have no uniformity in period and amplitude.

The representative agent is a worker-producer with rational expectations, in the sense of MUTH (1961), but without full information about general price changes. Changes in money stock imply price movements. Price changes have a permanent and a transitory component. Based on past experience and expectations, the agent imperfectly infers about movements in price components and makes a choice.

Relative prices in the economy are subject to changes in tastes and technology. Now suppose that there is an unexpected rise in the money supply which causes an increase in the general price level. In the Luca's model, the agents will misunderstand this general price increase as a increase in its own relative price, expanding investment, labor supply and output. When the mistake is perceived, investment, labor supply and output will fall until a new equilibrium is reached. This process produces not only a cycle in the economy but also comovements among output, prices, employment and investment.

The main critique to Lucas's model relies on the fact that the informational asymmetries place a positive value on information, and in an Arrow-Debreu economy there should exist a market for that profit opportunity. Hence, these kinds of informational asymmetries are not compatible with general equilibrium and rational expectations. Thus, the Lucas's model is not an equilibrium model for business cycle at all.

The Real Business Cycle (RBC) model of PRESCOTT (1986) is an intertemporal Walrasian equilibrium model that avoids the contradiction presented in LUCAS (1977). The RBC model is based on rational expectations, on the existence of exogenous random shock that affects the production function, on an intertemporaly rational optimizing behavior of the representative agent, and on the hypothesis that all contingent markets clear at every single period.

The exogenous shock included in the production functions of this kind of model is the generator of the business cycle. However, the results of this RBC model are a little odd in terms of cycles; firstly, because the solution of this model does not present any comovement between macro variables and, secondly, because output fluctuates, but employment does not. The most elegant solution to these problems was proposed by KING AND PLOSSER (1984). They introduced financial transaction services in the production function and their model included three different exogenous shocks. With these changes they allow the RBC model to present comovement between real output and money.

The Keynesian School sees the business cycle completely different. In 1936, Keynes and his General Theory started a new chapter in macroeconomics. He not only created new concepts and a new form to understand the economy with aggregate variables. Sticky prices, sluggish wages, and an underemployment equilibrium in which economic cycles are natural part of the economy, but also gave the public sector the responsibility to smooth these oscillations using fiscal and monetary policies, which can cause effect on output and employment because nominal prices and wages rigidities are assumed.

Another important source of business cycle for Keynes was the trade cycle, but the most important cause for this phenomenon is indeed the nonlinear collapse of the marginal efficiency of capital and its effect on the psychology of investment decisions. This scenery is worsened through the fluctuation on other Keynesian variables, such as the propensity to consume and the preference for liquidity.

SAMUELSON (1939) presented a model based on the multiplier concept and on the principle of acceleration discovered by AFTALION AND CLARK (1913). This principle implies that durable goods demand is proportional to output growth, and this produces a constant capital-output ratio. Thus, to keep this constant relation, investment decisions are very unstable. Samuelson used this instability in investment decisions to explain the business cycles. The main problem with his model is that cycles are produced as a result of the solution to a second order difference equation, which presents explosive and ending cycles.

The IS-LM, a neoclassical synthesis of Keynesian theory is the most common model used to explain the relationships among aggregate variables. The

MUNDELL (1968) and FLEMING (1962) model is an IS-LM with static exchange rate expectations that shows in what conditions of capital mobility, change in the exchange rate, and monetary and fiscal policies can produce effects on the real side of the economy. BERNANKE (1983) and BLINDER (1987), using IS-LM models, found that borrowing constraints would increase the output variance.

Instead of static exchange rate expectations, DORNBUSH (1976) based his exchange rate overshooting model on rational expectations. This model shows the relationship between the differential of domestic and foreign interest rate and exchange rate, and its effect on inflation and output, including the impact of the monetary policy on these variables.

The New Keynesian School has proposed a representative agent model with similar methodology applied by the New Classical school, but contrary to the later the former bases its model on market structure and nonlinearities that can arise in some economic variables.

Based on these structural market aspects - imperfect competition in the goods, labor and credit market - MANKIW (1985) proposed a "menu cost" model of cycles, formulated with microeconomic foundations, in which price rigidity is a consequence of optimizing behavior. His model exhibits an asymmetry between contractions and expansions caused by a downward price rigidity. The menu cost model can explain how small frictions in nominal variables would cause a great effect on the whole economy, explaining and reinforcing Taylor's model previous results.

Following the New Keynesian lines, BENASSY (1986) proposed a dynamic model in which the business cycle is endogenously generated. He used an IS-LM model with fixed wage, flexible price and dynamic and cyclical non-Walrasian adjustment process. The cycle is constantly fed by the dynamic process of demand expectations, and this is not explosive because there is a stabilizing factor - a movement of wages following a Phillips curve. If there is an increase in demand, output will rise, but the wages will also increase inducing a reduction in output, reducing again the wages. This adjustment process pushes the system toward long run equilibrium.

DI MATEO (1984), formulated an endogenous growth cycle model, based on a dynamic and nonlinear system which exhibits a comovement between output, employment, and profit. The business cycle in this model is produced by fluctuations in profits and employment ratio. A raise in the average profits means a lower labor share. This raises the growth of employment, which in its turn raises wages. The rising wages reduces profits, creating a reduction on investment. This will diminish employment. With the employment reduction, wages will fall. But lower wages means a higher profit share starting the cycle again.

A consensual point among economic models is that a good model of business cycles must reproduce some stylized facts. BURNS AND MITCHELL (1946) present a statistical description of the cycle phenomenom. They argue that during an economic cycle there is a comovement between macroeconomic aggregate variables. Economists agree that a good business cycle model must reproduce this comovement among output, trade, exchange rate, employment, inflation, money aggregates and interest rate. But there is no agreement on what set of explanatory variables should be used to explain or forecast economic cycles.

3.2. DIFFUSION INDEX MODEL

The models used in this work to forecast Brazilian GDP growth rate are constructed considering comovement, economic phases and the possibility of the existence of structural breaks. The Diffusion Index (DI) model and its application to forecast output, following STOCK AND WATSON(1998, 2002) is used to elaborate parsimonious models that capture the mentioned comovement. Besides the comovement the economy would be subject to nonlinearities which cause multi-equilibria which can be summarized in economic cycles. Threshold autoregressive models proposed by TONG (1983) and used by POTTER (1995) is a possibility to model these nonlinearities. Another way to do this is following the ideas presented by HAMILTON (1989). The Markov regime shifting model proposed by Hamilton is a latent variable model that captures economic cycles.

Therefore, once the best linear DI model is selected for forecasting purposes, nonlinearities are considered through a Time Varying DI model (TVPDI); a Threshold Autoregressive DI Model (TARDI) and a Markov Shifting DI model (MSDI). The intercept correction and combining forecast techniques are also applied. A description of these models is presented in the next subsections.

According to BARTHOLOMEW AND KNOTT (1999), factor models, thus DI models, are models with latent variables. This means that some variables are unobservable. Let f represent r of those variables and x to be k observable or *manifest* ones, with $r < k$. Following the ideas presented in RUMMEL (1970), the commom factor analysis model expresses the data matrix $X_{(T\times k)}$ as a linear combination of unknown linearly independent vectors, usually called as common factors, plus a unique factor. For $i = 1, ..., k$ this can be represented as:

$$\begin{bmatrix} x_{1i} \\ \vdots \\ x_{Ti} \end{bmatrix} = \lambda_{i1} \begin{bmatrix} f_{11} \\ \vdots \\ f_{T1} \end{bmatrix} + ... + \lambda_{ir} \begin{bmatrix} f_{1r} \\ \vdots \\ f_{Tr} \end{bmatrix} + \begin{bmatrix} e_1 \\ \vdots \\ e_t \end{bmatrix} \tag{3.1}$$

Where, each individual f above is a factor score; each column vector with these factor scores is a common factor; each λ is the factor load, and each e represents the above mentioned unique factor. The usual definition of common factors is that they are linear functions (of unknown) variables contributing to the common variance of the whole set of variables.

On the other hand, the unique factor contributes only to the variance of the variable to which it is linked. The unique factor is usually split in two components: specific variance and random errors.

Another way to express the system presented in eq(3.1) is for a given time period $T = t$, that system can be rewritten as,

$$x_{1t} = \lambda_{11} f_1 + ... + \lambda_{1r} f_r + e_{1t}$$

$$\vdots$$

$$x_{kt} = \lambda_{k1} f_1 + ... + \lambda_{kr} f_r + e_{kt}$$

or simply,

$$x_t = \Lambda F_t + e_t \tag{3.2}$$

Where, $x_{t=}[x_{1t}, ..., x_{kt}]'$ is a $(k \times 1)$ vector, Λ is a $(k \times r)$ matrix of factor loadings, $F_t = [f_1, ..., f_r]'$ is a $(r \times 1)$ vector, $e_t = [e_{1t}, ..., e_{kt}]'$ is a $(k \times 1)$ vector of errors component, and $r < k$. Assuming that these common parts are not correlated with the unique part; and that those unique parts are not correlated across time, and that $F'F = FF' = I_r$, it is easy to show that[7] $plim(1/n)XX' =$

[7] Assuming that the data is well behaved to apply the Khinchine's weak law of large numbers.

$\Sigma = \Lambda\Lambda' + \Psi$, and thus that $var(x_i) = \sum_{j=1}^{r} \lambda_{ij}^2 + \psi_i$.

Now one can notice that not only are all k variables in X matrix are represented by a linear combination of the r common factors plus a unique factor, producing a smaller subset of variables, but also that these r common factors and their factor loadings are sufficient to explain a common variance structure of all k variables, which by no means can be used to capture any possible comovements between these variables.

Let y_{t+1} be the series to be forecast, the class of linear models used in this work, are of the form

$$y_{t+1} = c + \alpha(L)y_t + \beta(L)x_t + \epsilon_{t+1} \tag{3.3}$$

for t=1,...,T and $\alpha(L)$ and $\beta(L)$ are polynomials in the lag operator of dimension q_1 and q_2. There are $(q_1 + q_2) \times k$ parameters in (3.3). In applications where k is large, the estimation of those parameters could be very imprecise. Furthermore, for prediction purpose parsimony may yield better Minimum Square Forecast Error. This is well described in a quotation by CLEMENTS AND HENDRY (1998):

> *"Policy analysis will often require a relatively detailed characterization of the channels of influence of the policy variables on the behavioral variables in the macroeconometric model,while a good forecasting performance may only be obtained from a model containing fewer parameters. Thus, the proprietors of large-scale models who routinely forecast*

and undertake policy analysis may find they require different models for each of these exercises".

Assuming that[8] $E(\epsilon_{t+1}|F_t, y_t, x_t, F_{t-1}, y_{t-1}, x_{t-1}, ...) = 0$ and also that (y_{t+1}, x_t) has a dynamic factor representation, with $\bar{r}$ ($\bar{r} < k$) dynamic factors f_t ,STOCK AND WATSON (2002) redefined (3.3) as

$$y_{t+1} = c + \alpha(L)y_t + \beta(L)f_t + \epsilon_{t+1} \tag{3.4}$$

$$x_t = \lambda(L)f_t + e_t \tag{3.5}$$

where $\lambda(L) = I + B_1(L) + ... + B_pL^p$, each B_i is a $(k \times \bar{r})$ matrix and f_t is a $(\bar{r} \times 1)$ vector of factors. Thus, a factor model can replace the large amount of information contained in those k variables by a smaller group of r factors. Also, modeling all lag polynomials as having finite order of at most q, Stock and Watson developed a static representation of eq(3.5). The system in its time invariant representation is presented below.

$$y_{t+1} = c + \alpha y_t + \beta' F_t + \epsilon_{t+1} \tag{3.6}$$

$$x_t = \Lambda F_t + e_t \tag{3.7}$$

[8] This next assumption implies that $E(y_{t+1}|\beta_t, y_t, X_t, \beta_{t-1}, y_{t-1}, X_{t-1}, ...)$ depends only on F_t

where $\alpha = (\alpha_0, ..., \alpha_q)'$, $F_t = (f_t', ..., f_{t-q}')'$ is a $(r \times 1)$ vector with $r \leq (q+1)\bar{r}$, $\Lambda_i = (\lambda_{i0}, ..., \lambda_{iq})$ and $\beta = (\beta_0, ..., \beta_q)'$. If the usual infinite lag assumption were applied, then this static representation of a dynamic factor model would have infinitely many factors. Furthermore, the main advantage of the last representation is to allow the estimation of factors by principal component, which has some advantage over dynamic factor model obtained through maximum likelihood estimation (MLE).

First, principal components are simpler to calculate and allow for a bigger set of variables than MLE. Second, STOCK AND WATSON (1998) shows that factors estimated by principal components are consistent as the number of variables goes to infinity, even for a fixed time period of observations for the series, and this is a good characteristic for empirical work when there are a reasonable number of variables, but just a few observations of them.

3.3. TIME VARYING PARAMETER DIFFUSION INDEX MODEL

The problems generated by the existence of structural breaks and the shifts in the parameters of a model can be avoided if one allows these parameters to vary. The Time-Varying-Parameter (TVP) model is a special case of the general state-space model. This model can be represented as follows.

$$y_{t+1} = \beta_{1t} + \beta_{2t} F_t + \epsilon_{t+1} \tag{3.8}$$

Where,

$$\beta_{it} = \delta_i + \phi_i \beta_{it-1} + v_{it}\ ,\ \ i = 1, 2 \tag{3.9}$$

$$\epsilon_t \sim iid\ N(0, R) \tag{3.10}$$

$$v_{it}\ \sim iid\ N(0, Q) \tag{3.11}$$

$$E(\epsilon_t v_{is}) = 0 \text{ for all t and s} \tag{3.12}$$

This model can be written in the state-space (SS) representation and estimated using the Kalman filter and MLE. The SS representation is made up of a measurement equation, which describes the relation between data and unobserved state variables, and a transition equation used to specify the dynamics of the state variables.

In the Time-Varying-Parameter of the linear diffusion index model (TVPDI) proposed here, the measurement and transition equations are respectively expressed as:

$$y_{t+1} = H_t \beta_t + \epsilon_{t+1}, \text{ and} \tag{3.13}$$

$$\beta_t = \mu + A_t \beta_{t-1} + v_t \tag{3.14}$$

Where $H_t = [1 \ \hat{F}_t]$, $\beta_t = [\ \beta_{1t} \ \beta_{2t}]'$, $\mu = \delta_i(1-\phi_i)$, $A_t = \begin{bmatrix} \phi_1 & 0 \\ 0 & \phi_2 \end{bmatrix}$, and $v_t = [v_{1t} \ v_{2t}]'$. Once in the state-space form an interactive procedure using Kalman filter and MLE is available to produce estimates of the parameters in the model, and inference can be made about the unobserved state vector β_t. This estimation procedure will be described later in its own subsection.

3.4. THRESHOLD DIFFUSION INDEX MODEL

Switching-regime models, such as the threshold autoregressive (TAR) model, have been used in empirical macroeconomic studies to capture expansions and recessions phases of the business cycle or any other situation that requires a split in the sample induced by different regimes. TAR models were first proposed by TONG (1978) and further developed by LIM AND TONG (1980) and TONG (1983). HANSEN (1996a, 1996b,1997 and 2000) shows how to estimate and to make inference in a TAR model. A two regime threshold autoregressive diffusion index model (TARDI) can be expressed as:

$$y_{t+1} = (c_1 + \alpha^{1\prime} y_t + \beta^{1\prime} F_t) I(g_{t-1} \leq \gamma) + \tag{3.15}$$

$$+(c_2 + \alpha^{2\prime} y_t + \beta^{2\prime} F_t) I(g_{t-1} > \gamma) + \epsilon_{t+1}$$

$$x_t = \Lambda F_t + e_t \quad (3.16)$$

Where $\alpha^j = (\alpha_1^j, ..., \alpha_q^j)'$, $\beta^j = (\beta_1^j, ..., \beta_q^j)'$ for $j = 1, 2$, g_{t-1} is a known function of the data and $I(.)$ is the indicator function. Let $z_t = (1\ y_t\ F_t)'$, $\pi^j = (c_j\ \alpha^j\ \beta^j)$, $z_t(\gamma) = (\ z_t I(g_{t-1} \leq \gamma)\ z_t I(g_{t-1} > \gamma))'$ and $\theta = (\ \pi^1\ \pi^2)' g_{t-1}$ then eq(3.15) should be written as:

$$y_{t+1} = z_t(\gamma)'\theta + \epsilon_{t+1} \quad (3.17)$$

3.5. MARKOV-SWITCHING DIFFUSION INDEX MODELS

Another way to model either regime shifts or economic phases is to use models of the type proposed by HAMILTON (1989, 1993), where the parameters of the model are allowed to change according to the economic regime, and this regime is treated as an unobservable variable modeled as a first order Markov-switching process. The next few equations will describe the Markov-switching diffusion index model (MSDI) used in this study.

$$y_{t+1} = c_{St} + \beta_{St}' F_t + \epsilon_{t+1} \quad (3.18)$$

$$x_t = \Lambda F_t + e_t \quad (3.19)$$

$$\epsilon_t \sim iid\ N(0, \sigma^2_{St}) \quad (3.20)$$

$$c_{St} = c_0(1 - S_t) + c_1 S_t \quad (3.21)$$

$$S_t = 0 \text{ or } 1 \quad (3.22)$$

$$P[S_t = 1 | S_{t-1} = 1] = p \text{ and } P[S_t = 0 | S_{t-1} = 0] = q \quad (3.23)$$

As one can see this model allows the coefficients of the model to change according to the unobservable economic phase. In this set up there are two possible regimes representing respectively economic recession and expansion. The model set in the equations above, also tries to capture the comovement between macroeconomic variables and the business cycle pattern, as in the TARDI model. But unlike TARDI model, the MSDI model does not use any kind of variable to capture the cycle and to split up the sample.

3.6. ESTIMATION, TESTING, FORECASTING AND COMBINING FORECASTS

3.6.1. Estimation procedure of DI Model

The estimation[9] procedure for the autoregressive diffusion index model represented by (3.6) and (3.7) is composed of two steps. First, the exact number of

[9] A Gauss program was use to estimate the DI model, and to produce forecasts.

factor is unknown. Thus, under the hypothesis of the existence of n $(n < k)$ common factors, the observed data x_t are used to estimate these factors. The static formulation of a dynamic factor model presented in (3.6) and (3.7) allows the use of principal components technique to estimate the unobservable common factors. Since principal components are very sensitive to data scaling, standardized values of x_t were used. The factors estimates $\hat{F}_t$ are the eigenvectors associated with the n largest eigenvalues of the standardized $(T \times T)$ matrix $k^{-1} \sum_{i=1}^{k} \underline{x_i x_i}'$, where $\underline{x_i} = (x_{i1}, ..., x_{iT})$ is a $(T \times 1)$ vector. Appendix I shows further details of the estimation procedure by principal components.

Thus, these factors estimates have the properties of the eigenvalue-eigenvector problem in principal components. This means that the first factor is the eigenvector associated with the largest eigenvalue, and it can be understood as a linear combination of observed data that explain the largest part of the variance of the data. Following this pattern, the second factor is the eigenvector associated with the second largest eigenvalue and represents a linear combination of the data which best explain the part of the variance that is not explained by the first factor, and so the other factors. Moreover, another main characteristic of the principal component solution is the rotation that guarantees that each of these factors will be linearly independent of the others, avoiding, therefore, any degree of collinearity that may exist between the regressors.

In the second step, y_{t+1} is regressed onto a constant, $\hat{F}_t$ and y_t to obtain estimates of $\hat{c}, \hat{\alpha}$ and $\hat{\beta}$. This two step estimation method was adopted in STOCK AND WATSON (1998, 2002)[10].

Three types of panel sets were tried. The first panel set was made up of the current values of the 72 macroeconomic variables described earlier in section 2. The second and the third sets allowed for one and two lags, respectively, of these series. Thus, in the second stacked panel the numbers of columns of x_t were 144, and in the third this number jumped to 216 series.

3.6.2. Estimation procedure of TVPDI Model

As stated before, the state space representation of TVPDI model in equations (3.13) and (3.14) can be estimated by a interactive MLE and Kalman filter estimation. The basic Kalman filter is composed of two procedures - prediction and updating. In the prediction step, an optimal prediction of y_t is made with all available information up to time t-1 (ψ_{t-1}). To do this, first a expectation about β_t conditional on ψ_{t-1} must be made.

Afterwards when y_t is observed, the prediction error is computed and used to make a better inference of β_t. This is the aim in the updating step. In the next period this new expectation about β_t is used in the prediction step, and this is

[10] Stock and Watson (1998) show that the estimated factors are uniformly consistent, and that these estimates are consistent even when there is a time variation in Λ. Moreover, they also have shown that if r is unknown and even if $m \geq r$ the efficient forecast MSE can be achieved.

done until the end of the sample.

Let ψ denote the information set as before and consider the following definitions:

a) $\beta_{t|t-1} = E[\beta_t|\psi_{t-1}]$;

b) $P_{t|t-1} = E[(\beta_t - \beta_{t|t-1})(\beta_t - \beta_{t|t-1})']$;

c) $\beta_{t|t} = E[\beta_t|\psi_t]$;

d) $P_{t|t} = E[(\beta_t - \beta_{t|t})(\beta_t - \beta_{t|t})']$;

e) $y_{t|t-1} = E[y_t|\psi_{t-1}]$;

f) $\eta_{t|t-1} = y_t - y_{t|t-1}$; and

g) $U_{t|t-1} = E[\eta_t^2|\psi_{t-1}]$.

The prediction and updating steps consists of the following equations[11].

Prediction equations:

$$\beta_{t|t-1} = \mu + A_t\beta_{t-1|t-1} \tag{3.24}$$

$$P_{t|t-1} = A_t P_{t-1|t-1} A_t' + Q \tag{3.25}$$

$$\eta_{t|t-1} = y_t - H_t\beta_{t|t-1} \tag{3.26}$$

$$U_{t|t-1} = H_t P_{t|t-1} H_t' + R \tag{3.27}$$

Updating equations:

[11] For more details and derivation of the Kalman filter, see Hamilton(1994) and Harvey(1989)

$$\beta_{t|t} = \beta_{t1|t-1} + K_t \eta_{t|t-1} \tag{3.28}$$

$$P_{t|t} = P_{t|t-1} - K_t H_t P_{t|t-1} \tag{3.29}$$

Where $K_t = P_{t|t-1} H_t' U_{t|t-1}^{-1}$. Given initial values for the parameters of the model, for $\beta_{0|0}$ and $P_{0|0}$, the Kalman filter produces the prediction error $\eta_{t|t-1}$ and its variance $U_{t|t-1}$. Remembering that ϵ_t and v_t are both assumed to be Gaussian, the conditional distribution of y_t on ψ_{t-1} is also Gaussian.

$$y_t | \psi_{t-1} \sim N(y_{t|t-1}, U_{t|t-1}) \tag{3.30}$$

Thus, the likelihood function can be expressed as

$$lnL = -\frac{1}{2} \sum_{t=1}^{T} ln(2\pi U_{t|t-1}) - \frac{1}{2} \sum_{t=1}^{T} \eta_{t|t-1}' U_{t|t-1}^{-1} \eta_{t|t-1} \tag{3.31}$$

Estimates of the unknown parameters in the prediction and updating equations are obtained when the likelihood function is maximized with respect to them. A nonlinear numerical optimization procedure is used for this purpose. At each search step these prediction and updating equations from the Kalman filter are computed and the likelihood function is evaluated, until convergence is reached[12].

[12] It was used the E-views 3.1 program to estimate this model, and the Marquardt algorithm was used in the numerical optimization.

3.6.3. Estimation procedure of TARDI Model

The estimation[13] of the TARDI model will follow the ideas presented in HANSEN (1997). Two kinds of functions will be used as g_{t-1}, the traditional short lag approach $(Ln(gdp_{t-1}/gdp_{t-2}))_{t-d}$, and the long difference $Ln(gdp_{t-1}/gdp_{t-d})$ where d is a positive integer called *delay lag.* Since in this case the regression equation is both nonlinear and discontinuous, the estimates of the parameters θ and γ will be obtained by sequential conditional least squares. Let $\gamma = g_{t-1}$ and $\Gamma = [\underline{\gamma}, \overline{\gamma}]$, the LS estimate of γ can be found by a direct search of values of Γ that minimizes the residuals of the regression of y_t onto $z_t(\gamma)$. In other words,

$$\widehat{\gamma} = \underset{\gamma \in \Gamma}{argmin} \ \frac{1}{n} \left(y_t - z_t(\gamma)'\hat{\theta}(\gamma) \right)' \left(y_t - z_t(\gamma)'\hat{\theta}(\gamma) \right) \tag{3.32}$$

Where,

$$\hat{\theta}(\gamma) = \left(\sum_{t=1}^{n} z_t(\gamma) z_t(\gamma)' \right)^{-1} \left(\sum_{t=1}^{n} z_t(\gamma) y_t \right) \tag{3.33}$$

After obtaining $\hat{\gamma}$ the Least Squares estimates of θ is computed as $\hat{\theta} = \hat{\theta}(\hat{\gamma})$.

3.6.4. Testing for Threshold

HANSEN (1996,1997,2000) shows how one can test the null hypothesis $H_0 : \pi^1 = \pi^2$; i.e., to test the null hypothesis of linearity against the alternative of a TAR

[13] An adaptation of Hansen's Gauss program was used to estimate, to forecast and to test for the threshold effect.

model. Neglected heteroskedasticity in this case may cause spurious rejection of H_0. A heteroskedasticity-consistent Wald test suggested by HANSEN (1996) is presented below.

$$W_n = \sup_{\gamma \in \Gamma} W_n(\gamma) \tag{3.34}$$

Where,

$$W_n(\gamma) = (R\hat{\theta}(\hat{\gamma}))'[R(M_n(\gamma)^{-1}V_n(\gamma)M_n(\gamma)^{-1})R']^{-1}(R\hat{\theta}(\hat{\gamma})) \tag{3.35}$$

In eq(3.35), $R = [I \quad -I]$; $M_n(\gamma) = \sum_{t=1}^{n} z_t(\gamma)z_t(\gamma)'$; $V_n(\gamma) = \sum_{t=1}^{n} z_t(\gamma)z_t(\gamma)'\hat{e}^2$ and $\hat{e}_t^2 = (y_t - z_t(\gamma)'\hat{\theta}(\gamma))^2$. As one can see, the $W_n(\gamma)$ statistic does not follow an asymptotic χ^2 distribution, thus the distribution of W_n is nonstandard. HANSEN (1996) derives the asymptotic distribution and a p-value transformation of the test statistic presented in eq(3.34). The asymptotic p-value approximation is obtained by simulation (bootstrap). The bootstrap suggested by Hansen is in fact a four step procedure, as follows:

i) Let u_t^* $(t = 1, ..., n)$ be *i.i.d.* $N(0, 1)$ random draws;

ii) Set $y_t^* = u_t^*\hat{e}$;

iii) Obtain $W_n^*(\gamma)$, and thus W_n^*, and

iv)The asymptotic p-value is computed counting the percentage of bootstrap samples in which $W_n^* > W_n$.

To access the asymptotic distribution Hansen used a Likelihood Ratio test. In the case of homokedasticity this test converges in distribution to ξ. In the other case the test converges in distribution to $\kappa^2\xi$. In both situations, $\xi = \max_{s\in\Re} [2W(s) - \mid s \mid]$, where $W(.)$ is a two sided Brownian motion, and $P(\xi \leq x) = (1-\exp(-x/2)^2$. In the presence of heteroskedasticity κ^2 must be estimated. This can be done with the Nadaraya-Watson kernel estimator, such as presented below.

$$\widehat{\kappa}^2 = \frac{\sum K\left(\frac{\hat{\gamma}-g_{t-1}}{h}\right)\hat{r}_{2t}}{\sum K\left(\frac{\hat{\gamma}-g_{t-1}}{h}\right)\hat{r}_{1t}} \tag{3.36}$$

Where,

$K(u) = \frac{3}{4}(1-u^2)I\{\mid u \mid \leq 1\}$ is a Epanechnikov kernel function, h is the bandwidth which may be selected by a minimum mean square error criterion, $\hat{r}_{1t} = ((\hat{\pi}^1 - \hat{\pi}^2)'x_t)^2$, and $\hat{r}_{2t} = ((\hat{\pi}^1 - \hat{\pi}^2)'x_t)^2\hat{e}_t^2$.

3.6.5. Diagnostic Tests for TARDI Model

a) Testing for Serial Correlation.

Consider a general non-linear model

$$y_t = F(x_t, \theta) + \epsilon_t \tag{3.37}$$

A Lagrangian Multiplier (LM) test statistic such as $nR^2 \sim \chi^2_{(q)}$ could be useful to test for the presence of qth order serial dependence in the residuals. R^2 is the coefficient of determination from the regression of $\hat{\epsilon}_t$ on $\frac{\partial F(x_t,\hat{\theta})}{\partial \theta}$ and q lagged residuals. However, $F(.)$ is not continuously differentiable in the case of a TAR model, and thus this test statistic is not longer appropriate to test for serial correlation in this type of model. A possible way to circumvent this problem is to approximate a Tar model with a Smooth Transition AR (STAR) (FRANCES AND DIJK, 2000). However, this would require to estimate a STARDI model, which is beyond the scope of this work.

b) Testing for Remaining Nonlinearity.

Is the nonlinear model able to capture all the nonlinear pattern of the time series under observation? To answer this relevant question, the test procedure described in subsection 3.2.2 may be applied again to the resulting subsamples of a TAR model.

For example, in a 2-regime TAR model, one could test for remaining nonlinearity simply using the procedure to test $H_0 : \pi^1 = \pi^2$ into the two sub samples $g_{t-1} \leq \hat{\gamma}$ and $g_{t-1} > \hat{\gamma}$.

3.6.6. Estimation procedure of MSDI Model

The estimation[14] procedure to the Markov-switching diffusion index model is centered on the evaluation of a weighted likelihood function. The weights in this case are the filtered probabilities of each regime to occur. The density function of y_t conditional on the past information set (ψ_{t-1}) is given by:

$$f(y_t|\psi_{t-1}) = \sum_{S_t=0}^{1} f(y_t, S_t|\psi_{t-1}) \tag{3.38}$$

$$= \sum_{S_t=0}^{1} f(y_t|S_t, \psi_{t-1}) f(S_t|\psi_{t-1})$$

$$= \frac{1}{\sqrt{2\pi}\sigma_0} exp\left[\frac{-(y_t - c_0 - \beta_0 \hat{F}_t)^2}{2\sigma_0^2}\right] P[S_t = 0|\psi_{t-1}] +$$

$$+ \frac{1}{\sqrt{2\pi}\sigma_1} exp\left[\frac{-(y_t - c_1 - \beta_1 \hat{F}_t)^2}{2\sigma_1^2}\right] P[S_t = 1|\psi_{t-1}]$$

Thus, the likelihood function can be written as

$$lnL = \sum_{t=1}^{T} ln[\sum_{S_t=0}^{1} f(y_t|S_t, \psi_{t-1}) P[S_t|\psi_{t-1}]] \tag{3.39}$$

[14] A Gauss program was use to estimate this model. It was used the optimum command and the Broyden-Fletcher-Goldfarb-Shanno was used as algorithm in the nonlinear optimization.

Before the evaluation of the likelihood function, the weighting factors $P[S_t = j|\psi_{t-1}]$ for $j = 0, 1$ must be calculated. This is accomplished through the following procedure. At the beginning of the t-th iteration $P[S_{t-1} = i|\psi_{t-1}]$ for $i = 0, 1$ is known. Thus,

$$P[S_t = j|\psi_{t-1}] = \sum_{i=0}^{1} P[S_t = j, S_{t-1} = i|\psi_{t-1}] \tag{3.40}$$

$$= \sum_{i=0}^{1} P[S_t = j|S_{t-1} = i]P[S_{t-1} = i|\psi_{t-1}]$$

When y_t is known, then the above probability can be updated as follow,

$$P[S_t = j|\psi_t] = P[S_t = j|\psi_{t-1}, y_t] \tag{3.41}$$

$$= \frac{f(S_t = j, y_t|\psi_{t-1})}{f(y_t|\psi_{t-1})}$$

$$= \frac{f(y_t|S_t = j, \psi_{t-1})P[S_t = j|\psi_{t-1}]}{\sum_{j=0}^{1} f(y_t|S_t, \psi_{t-1})P[S_t = j|\psi_{t-1}]}$$

These procedures may be interacted to produce $P[S_t = j|\psi_t]$ for $t = 1, ..., T$. To start the described filter, the steady-state probabilities can be used as $P[S_0 = j|\psi_0]$. A detailed derivation of these steady-state probabilities is found in HAMILTON (1994). By now these probabilities may be computed by the equations below.

$$P[S_0 = 0|\psi_0] = \frac{1-q}{2-p-q} \tag{3.42}$$

$$P[S_0 = 1|\psi_0] = \frac{1-p}{2-p-q}$$

After $P[S_t = j|\psi_{t-1}]$ is calculated, the log likelihood function is maximized with respect to $c_0, c_1, \beta_0, \beta_1, \sigma_0^2, \sigma_1^2, p$ and q. To do this, a similar procedure as the one described in the last paragraph of the estimation procedure of TVPDI model is used. Once p and q are estimated the expected duration of a regime may be computed. Defining D as the duration of state 1[15], for example, it follows that,

D=1⇒S_t=1 and $S_{t+1} \neq 1$ ⇒ P[D=1]=1-p
D=2⇒S_t= S_{t+1} =1 and $S_{t+2} \neq 1$ ⇒ P[D=2]=p(1-p)
⋮
D=n⇒S_t= S_{t+1}=...=S_{t+n} = 1 and $S_{t+n+1} \neq 1$ ⇒ P[D=n]=p^{n-1}(1-p)
Thus,

$$E(D) = \sum_{j=1}^{\infty} jP[D=j] \tag{3.43}$$

$$= (1-p) + 2p(1-p) + 3p^2(1-p) + ...$$

$$= \frac{1}{1-p}$$

[15]The duration of state 0 is obtained changing p by q.

3.6.7. Forecasting

The forecasting environment used in this work is based on a common practice nowadays - simulated real-time design forecasts. The simulated real-time forecasting environment has also influenced the estimation procedure. Predictions were made in a recursive fashion, except for TVPDI model. For the DI model after each forecast, the sample was updated and the model was re-estimated, BIC was again computed, and another round of forecasts was produced. Thus, as the forecast period begins at 2002.Q1 the models were estimated from 1975.Q4 up to 2001.Q4 and the first period forecast was computed. Then, actual values at 2002.Q1 of these variables were included in the estimation sample, and the model and BIC for the DI model were re-estimated from 1975.Q4 up to 2002.Q1 and a forecast to $y_{2002:Q2}$ was generated. This step was repeated until the forecast of $y_{2003:Q3}$ was produced. Another difference is about the sample length of TARDI model which was composed by the quarters between 1976.Q2 to 2001.Q4.

The general equation used for DI models, to make one step ahead forecasts, is:

$$\hat{y}_{T+1|T} = \hat{c}_h + \sum_{i=1}^{q_1} \hat{\alpha}_i y_{T-i+1} + \sum_{j=1}^{q_2} \hat{\beta}_j \hat{F}_{T-j+1} \qquad (3.44)$$

Where, $y_{t+1} \langle \ln(\frac{y_{t+1}}{y_t})$ and $y_t \langle \ln(\frac{y_t}{y_{t-1}})$. Variations of (3.44) were used to forecast. As in STOCK AND WATSON (2002), the DI model uses only the current factor to forecast. DI-AR model is the DI model plus lags of the dependent variable $[1 \leq q_1 \leq 3]$. Another DI forecasts based on these two variations were tried. The DI-Lag allowed lags on the factors $[1 \leq q_2 \leq 3]$ and DI-AR-Lag models which used current and lags of the factors and lags of the dependent variable. Moreover, results of these models, where the number of factors and lags were chosen by Bayesian Information Criterion(BIC), are presented as DI-BIC, DIAR-BIC, DILAG-BIC and DIARLAG-BIC, respectively.

The number of factors in a model depends if the model has lagged factors or not. DILAG and DIARLAG models used one up to three factors, while DI and DIAR models used up to five factors.

The autoregressive models (AR) were used as a benchmark for DI models' performance, and they were estimated making all $\hat{\beta} = 0$ in (3.44) and allowing for lags $[1 \leq q_1 \leq 3]$ to be set by BIC. In the case of the time varying parameter diffusion index (TVPDI) model, an equation similar to eq(3.44) was also used to compute the one step ahead forecast.

The one step ahead forecast equation of the TARDI model is

$$\hat{y}_{T+1|T} = \left(\hat{c}_1 + \sum_{i=1}^{q_1} \hat{\alpha}_i^1 y_{T-i+1} + \sum_{j=1}^{q_2} \hat{\beta}_j^1 \hat{F}_{T-j+1} \right) I(g_{t-1} \leqslant \hat{\gamma}) +$$

$$+\left(\hat{c}_2+\sum_{i=1}^{q_1}\hat{\alpha}_i^2 y_{T-i+1}+\sum_{j=1}^{q_2}\hat{\beta}_j^2\hat{F}_{T-j+1}\right)I(g_{t-1}>\hat{\gamma})+\epsilon_{t+1} \quad (3.45)$$

The variables tried in function g_{t-1} were the short and long differences of log of GDP . The *delay lag* interval search was $d=[1,...,4]$.

The derivation of the one step ahead equation of Markov-switching diffusion index (MSDI) model is not straight forward as the others. To derive this function, the conditional expectation $E(y_{T+1}|\psi_T)$ was used as the optimum predictor for $\hat{y}_{T+1|T}$. That is,

$$\hat{y}_{T+1|T}=E(y_{T+1|T})=\int y_{T+1}f(y_{T+1}|\psi_T)dy_{T+1} \quad (3.46)$$

$$=\int y_{T+1}\left(\sum_{j=0}^{1}P[y_{T+1},S_{T+1}=j|\psi_T]\right)dy_{T+1}$$

$$=\int y_{T+1}\left(\sum_{j=0}^{1}f(y_{T+1}|S_{T+1}=j,\psi_T)P[S_{T+1}=j|\psi_T]\right)dy_{T+1}$$

$$=\sum_{j=0}^{1}P[S_{T+1}=j|\psi_T]\int y_{T+1}f(y_{T+1}|S_{T+1}=j,\psi_T dy_{T+1}$$

$$=\sum_{j=0}^{1}P[S_{T+1}=j|\psi_T]E(y_{T+1}|S_{T+1}=j,\psi_T)$$

Where,

$$E(y_{T+1}|S_{T+1} = j, \psi_T) = c_j + \beta_j \hat{F}_t \tag{3.47}$$

$$P[S_{T+1} = j|\psi_T] = \sum_{i=0}^{1} P[S_{T+1} = j|S_T = i]P[S_T = i|\psi_T] \tag{3.48}$$

In the next section the practical problems and results of the estimation and forecasting procedures will be presented. A comparison of forecast efficiency for all the models is also calculated. This comparison is made up of ratios of Mean Square Forecast Error (MSFE) and plots of realized values against the predicted ones.

3.6.8. Combining Forecasts

Since BATES AND GRANGER (1969) the practice of pooling forecasts[16] has shown consistent evidence in the sense that combined prediction may produce a smaller mean squared forecast error than individual forecasts of the same event.

This fact is not difficult to understand. First, if each of the individual forecasts provides only partial and non-overlapping information about some future event, it is natural to expect that its combination will present a larger information set. Moreover, NEWBOLD AND GRANGER (1974) also shows that pooling is a

[16] Usually an (weighted) average of individual forecast

good practice when its components are differentially biased information sets. For example, combining an upward and a downward biased forecast is expected to outperform both isolated results.

What happens if overlapping information sets were combined? DIEBOLD (1989) and NEWBOLD (1998) show that if fixed weights are being used in the averaging process than pooling may produce poorer predictions. Their suggestion is to test for forecast encompassing first, and then to exclude encompassed forecasts from the combination.

This picture is completely different when structural breaks are considered. CLEMENTS AND HENDRY (2001) show that in the presence of structural breaks a combination with an encompassed forecast may do better than another without it. Therefore, in this kind of situation, pre test for forecast encompassing can not produce a conclusive result about the choice of the components of certain forecast combinations.

Other topics about this subject are nonlinear pooling process, fixed versus time-varying weights, and parametric, semiparametric and nonparametric methods to calculate these weights. Nowadays, one can use elaborated procedures to combine forecasts. However, as STOCK AND WATSON (1998, 2003) show, simple processes for combining forecasts usually produce results as good as more sophisticated ones.

With these ideas in mind, this work will use the following combining process. Let $If_t = [if_t^1 ... if_t^n]$ be the vector of n individual forecast made at time t, and $W_t = [w_t^1 ... w_t^n]'$ to be the vector of weights used in the pooling process. Then the type of combination used in this work can be described as:

$$C_t = If_t.W_t \tag{3.49}$$

Five different processes will be used to calculate W_t, and then $If_t.W_t$:

a) Average - C_t will be the arithmetic average of If_t;

b) Median - C_t will be the median of If_t;

c) Regression 1 - $C_t = \alpha + w_t^1 if_t^1 + ... + w_t^n if_t^n + e_t$

d) Regression 2 - $C_t = w_t^1 if_t^1 + ... + w_t^n if_t^n + e_t$, subject to $\sum_i w_t^i = 1$; and

e) Variance of forecast error - $\left[\frac{\sum_t (ef_t^i)^2}{\sum_i (\sum_t (ef_t^i)^2)}\right]^{-1}$, where ef_t^i is the forecast error of the individual forecast i at time period t.

The method (d) is called the constrained regression form[17]. In this case, if all individual forecasts are unbiased, the combination will too. GRANGER AND RAMANATHAN (1984) show that the unconstrained form (c) is expected not only to produce smaller errors than (d), but also to give unbiased combined forecast even if the component forecasts are biased. The inverse of the variance proportion of the forecast error technique follows BATES AND GRANGER (1969).

[17]Both (c) and (d) are estimated by OLS.

4. EMPIRICAL RESULTS

4.1. Diffusion Index Results

The efficiency measure of the different prediction mechanisms used in this study was the ratio[18] of the Mean Square Forecast Error (MSFE) of AR(1)[19] to the others DI models. The DI one step ahead forecasts for the growth of seasonally adjusted GDP were better than the ones from AR(1) model, except for DI-AR and for the DI-AR-Lag forecasts. One can see that the simplest DI model, with just one factor, could improve almost 35% on AR(1) forecasts. Moreover, the model selection by BIC in the case of pure DI models without the autoregressive part has the same forecast efficiency as the unique fixed factor DI model. Also, allowing for factor lags does not improve on the fixed DI model.

After that two stacked panels were used to estimate the factors loadings. They include one and two lags of all the series contained in the unstacked model, respectively. The results of stacked data were not better than the results of the unstacked panel. Indeed, some of the models did worse with stacked data. A next step was to verify if a binary panel data would predict better. Thus, the positive values of the unstacked panel were set equal to one, and the negative values were

[18]This efficiency measure is very used on empirical work of this nature. For example it was also used by STOCK AND WATSON (1998) and by BRISSON AND CAMPBELL (2003).

[19]The AR(1) was chosen because it generated the best forecasts among AR(p) models, for p = 1,2,3.

set equal to zero. The results of this procedure were very similar to the original unstacked panel.

The result that only a small set of factors could be used to forecast is in tune with other recent similar studies, for example STOCK AND WATSON (1998) and BRISSON AND CAMPBELL (2003). Indeed, the forecasts generated by DI models with one, two or three factors are so similar that their plots are indistinguishable; i.e., the plots become a thick line.

Based on that, all the analyses from now on will be concentrated on the fixed DI model with only one factor, because it is more parsimonious and it was chosen by BIC criterion. Table A3 on appendix III presents the main OLS results for the recursive estimation of linear DI model. All the slopes parameters are significant at the 5% level and the R^2 is around 0.09.

Figure 3 plots actual and forecast values of the AR(1) model (FAR) and of the fixed DI model (FDI) with only one factor for the growth of GDP. One can see that not only does the DI model forecast values closer to actual values, but also that it predicts changes of direction more accurately than the AR model. If the large shift at 2003.Q1, beginning in 2002.Q3 due to presidential election and the market's negative expectations about the upcoming economic policy, were included in the model, these forecasts probably would have had a better performance.

TABLE1 :One Step Ahead Forecasts of DI Models: 2002.Q1to2003.Q3

	Models	Models
	DI	**DI-AR**
num. fac.		
$r = 1$	0.65	1.00
$r = 2$	0.65	1.08
$r = 3$	0.64	1.08
$r = 4$	0.81	1.78
$r = 5$	0.82	1.84
num. Lags	**DI-Lag**	**DI-AR-Lag**
$q_2 = 1$	0.65	1.50
$q_2 = 2$	0.65	1.08
$q_2 = 3$	0.64	1.08
BIC	**DI-BIC**	**DIAR-BIC**
	0.65	1.00
BIC	**DILAG-BIC**	**DIARLAG-BIC**
	0.65	1.50

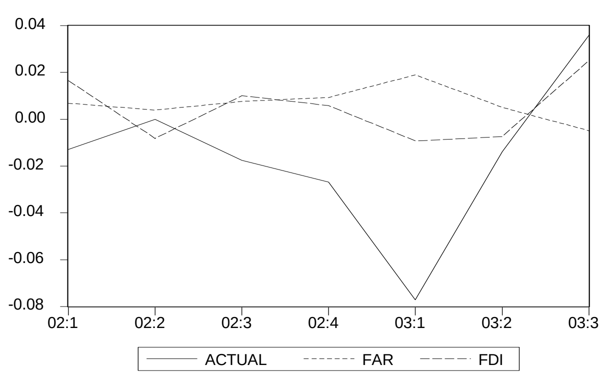


Figure 3 - Actual, AR and DI Forecast

4.2. Time Varying Parameter Diffusion Index Results

Some variations of this model were tried over the state equation. These variations included lag length and stationary and nonstationary autoregressive coefficients.

The best forecast model was the one with the same structure as equations (3.8) and (3.9). The parameters of the model were not significant and the predictions were better than in the Autoregressive model, but worse than in the linear DI model. Its MSE ratio compared to the AR(1) model was 0.81, meaning that this model improved on AR(1) model something around 19% in terms of predictive accuracy. But, as discussed before, DI model improved almost 35% on AR(1) model.

STOCK AND WATSON (1994) shows that TVP models hardly improve on recursive least squares when the subject is to produce one step ahead forecast. In this study the same result occurs with DI models. Only TVPDI forecasts were not generated recursively and they were the worst among DI models.

Figure 4a below plots actual, AR and TVPDI forecast values, while Figure 4b plots actual, TVPDI and DI forecast values.

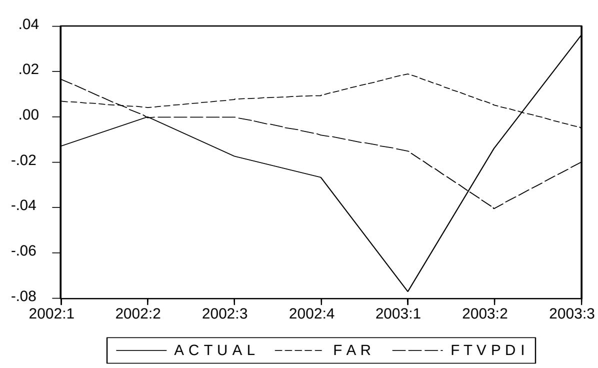


Figure 4a - Actual, AR and TVPDI Forecast

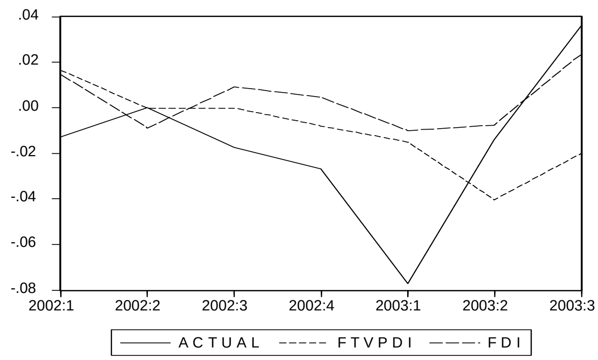


Figure 4b - Actual, TVPDI and DI Forecast

4.3. Threshold Autoregressive Diffusion Index Results

In dealing with TAR models, it is usual to test for the existence of the different regimes before forecasting. Thus, the selected linear DI model specification to forecast the growth of Brazilian GDP has been tested against the alternative of a two regime TAR model. It was used for this purpose an adaptation of the GAUSS code presented by HANSEN (1997). As stated before, short and long differences of GDP were tried as the threshold effect variable. The integer *delay lag* was allowed to vary into the set $d = [1, ..., 4]$.

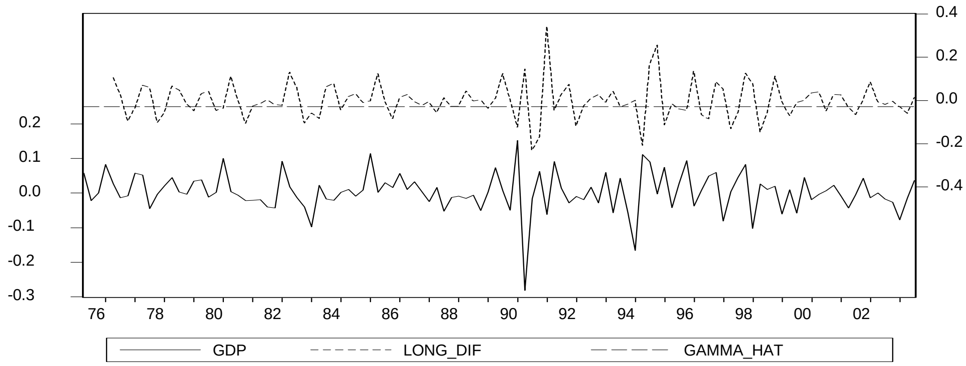
Table 2 presents a summary of the testing results. The $p-values$ suggest that there is a significant threshold effect at less than a 5% significance level when the long difference $Ln(gdp_{t-1}/gdp_{t-3})$ is considered.

TABLE2 :Testing for Threshold Effect:1976.Q2 to 2001.Q4

g_{t-1}	$\widehat{\gamma}$	$p-value$
$(Ln(gdp_{t-1}/gdp_{t-2}))_{t-1}$	0.0934	0.5070
$(Ln(gdp_{t-1}/gdp_{t-2}))_{t-2}$	-0.0497	0.3360
$(Ln(gdp_{t-1}/gdp_{t-2}))_{t-3}$	0.0598	0.2420
$(Ln(gdp_{t-1}/gdp_{t-2}))_{t-4}$	0.0571	0.7160
$Ln(gdp_{t-1}/gdp_{t-2})$	0.1338	0.6920
$Ln(gdp_{t-1}/gdp_{t-3})$	-0.0286	0.02600
$Ln(gdp_{t-1}/gdp_{t-4})$	0.0682	0.2300

Figure 5a and 5b, presented below, shows how the threshold variable represented by the long difference $Ln(gdp_{t-1}/gdp_{t-3})$ splits the sample under observation. Then, the TARDI model was estimated and used to forecast. Table 3A and 3B present the summary of the estimation procedure[20].From these tables it is possible to verify that the estimated values of the parameters were almost constant. This pattern changes substantially in 2003.Q1, when the growth of Brazilian GDP suffered a huge dive.

[20] SD and df means standard deviation and degree of freedom, respectively.



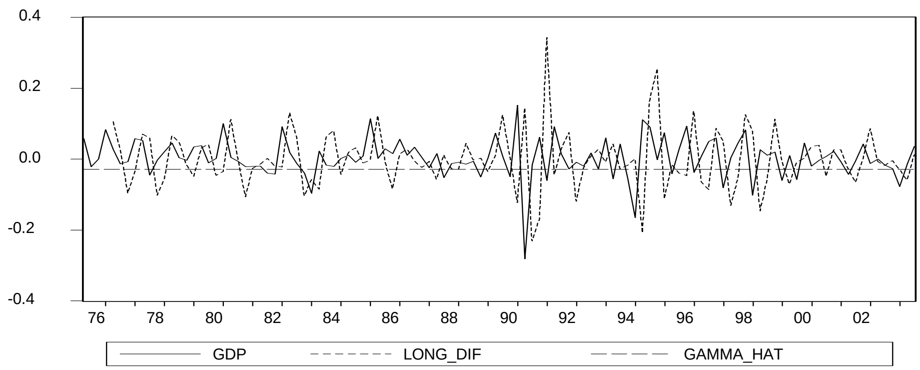


Figure 5a and 5b -Spliting the Sample

TABLE3A−Estimatinon Results for Regime 1: $g_{t-1} \leqslant \hat{\gamma}$

OBS	$\hat{c}_1$	$\hat{\beta}_0^1$	SD_{c1}	$SD_{\beta 1}$	$\widehat{\gamma}$	df
01.$Q4$	0.02402	0.06851	0.00796	0.07036	-0.02858	33
02.$Q1$	0.02402	0.06851	0.00796	0.07036	-0.02858	33
02.$Q2$	0.02402	0.06851	0.00796	0.07036	-0.02858	33
02.$Q3$	0.02402	0.06851	0.00796	0.07036	-0.02858	33
02.$Q4$	0.02402	0.06851	0.00796	0.07036	-0.02858	33
03.$Q1$	0.02549	0.07949	0.00814	0.06986	-0.0344	31
03.$Q2$	0.02449	0.08554	0.00791	0.06907	-0.0344	32

TABLE3B−Estimation Results for Regime 1: $g_{t-1} > \hat{\gamma}$

OBS	$\hat{c}_2$	$\hat{\beta}_0^2$	SD_{c2}	$SD_{\beta 2}$	$\widehat{\gamma}$	df
01.$Q4$	-0.00639	0.23938	0.00629	0.10454	-0.02858	66
02.$Q1$	-0.00650	0.23929	0.00620	0.10452	-0.02858	67
02.$Q2$	-0.00666	0.23791	0.00615	0.10379	-0.02858	68
02.$Q3$	-0.00659	0.23741	0.00603	0.10294	-0.02858	69
02.$Q4$	-0.00701	0.23531	0.00598	0.10271	-0.02858	70
03.$Q1$	-0.00785	0.22527	0.00591	0.10237	-0.0344	73
03.$Q2$	-0.00785	0.22527	0.00591	0.10237	-0.0344	73

The residuals of the TARDI model were free of heteroskedasticity. The tests described in subsection 2.3.5. to check for remaining non-linearity was not able to reject the hypothesis of linearity. Thus a two regime TAR model is sufficient to capture the non-linear pattern in the time series under observation.

A good fit in the sample does not mean a good out-of-sample forecast, but it is worth to mentioning the superior fit of the TARDI model compared to the linear DI model. The R^2 in the former case was 0.20 against 0.10 in the latter case.

In terms of forecasting quality the ratio between the MSFE of TARDI and DI (AR) is 0.93 (0.60). Not only is the MSFE of the TARDI model is smaller than the MSFE of DI model, but also TARDI model predicted the direction more accurate than DI model, except for the 2002.Q4 and 2003:2 values. Figure 6 below, plots the actual and forecast values made by the DI and the TARDI models.

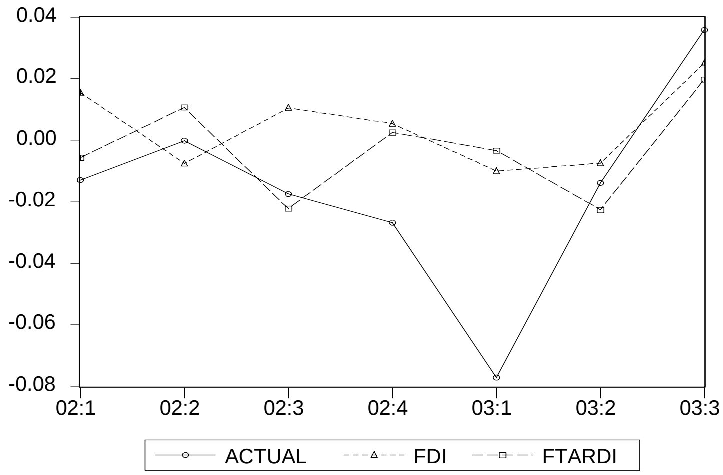


Figure 6- Actual, DI and TARDI Forecast

4.4. Markov-Switching Diffusion Index Results

Some variations of MSDI models were estimated and used to forecast. Among these, models allowing changes in both their coefficients and in the variance parameter were tried. Afterwards models allowing different intercepts with equal and different variance parameters were estimated.

When the subject is to estimate a Markov-switching (MS) model it is common to use intervention procedures such as the use of dummy variables, and the use of different variance coefficients to capture the effects of those pulses that look like outliers in the sample. The problem with that is that without an intervention procedure the MS model only captures these larger peaks, and this may cause problems with the estimation process of the mean, p and q values.

Thus, some variations of MSDI models with dummy variables such as $c_{St} = (c_0 + \tilde{c}_0 D)(1 - S_t) + (c_1 + \tilde{c}_1 D)S_t$ were also estimated and used to forecast.

Models allowing only the intercept to change with only a variance parameter and without dummy variable for the regime 0, i.e., with $\tilde{c}_0 = 0$, called here MSDI1 produced the best forecast, but weird estimation results about p and q. These results are presented in the next table.

TABLE4−Estimation Results for MSDI1: 1975.Q3 to 2001.Q4

OBS	*estimatives*	*stand.dev.*
$\hat{c}_0$	-0.01321	0.06230
$\hat{c}_1$	0.00869	0.00443
$\hat{\beta}$	0.10959	0.04705
$\hat{p}$	1	0.00001
$\hat{q}$	0	0.00002
$\hat{\sigma}^2$	0.04498	0.00307
$\tilde{c}_1$	-0.17757	0.02706
R^2	0.41	

Except for the estimates of $\hat{c}_0$ and $\hat{q}$ all the other parameter are significant at the 5% level. This model was the one which produced the best fit of the data. But the most important result in Table 4 is the estimative for $\hat{p}$. This estimative means that the Markov-switching model is a reductible one and that once it reaches an expansion stage the economy will stay there forever.

On the other hand, when forecast performance is the goal, the MSDI1 model works fine. It's MSFE ratio to the AR MSFE is only 0.53% almost equal to the TARDI model which presented a 0.60% ratio. The ratio of MSDI1's MSFE to the

MSFE of TARDI model is about 0.89%. The next Figure plots the actual and forecast values of MSD1 and TARDI models.

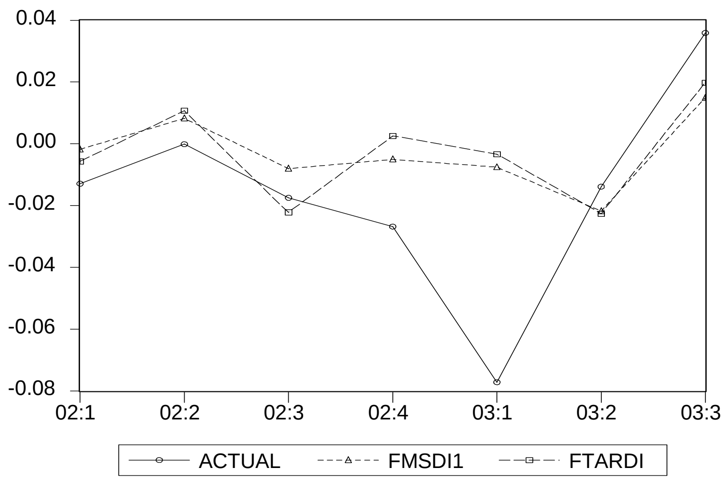


Figure 7- Actual, MSDI and TARDI Forecast

Figure 7 show that both MSDI1 and TARDI model produce similar forecasts, specially when one observes the direction of the predicted values. Another MSDI model that deserves attention is the one estimated with $\tilde{c}_0 \neq 0$ and $\tilde{c}_1 \neq 0$, and different variance parameters for each economic regime - recession and expansion. The estimation results for the first round of estimates in 2001.Q4 of this model, which will be called from now on MSDI2, are presented in Table 5.

TABLE5−Estimation Results for MSDI2: 1975.Q3 to 2001.Q4

OBS	*estimatives*	*stand.dev.*
$\hat{c}_0$	-0.01284	0.00618
$\hat{c}_1$	0.02157	0.00872
$\hat{\beta}$	0.13629	0.04105
$\hat{p}$	0.60614	0.15931
$\hat{q}$	0.33933	0.23592
$\hat{\sigma}_0^2$	0.04963	0.00429
$\hat{\sigma}_1^2$	0.01855	0.00507
$\tilde{c}_0$	-0.22899	0.02183
$\tilde{c}_1$	-0.06609	0.03740
R^2	0.29290	

Excluding $\hat{q}$, all the other estimates are statistically significant at the 5% significance level. MSDI2 models presented also a good fit to the data, but its prediction efficiency is not better than the linear DI model. The MSFE ratio between MSDI2 and AR is 0.88, meaning that this non-linear DI model improves on AR forecast, but it could not improve on any other model. Figure 8a, shows actual and forecast values from MSDI1, and AR models, while Figure 8b, shows actual and forecast values from MSDI2, and AR models.

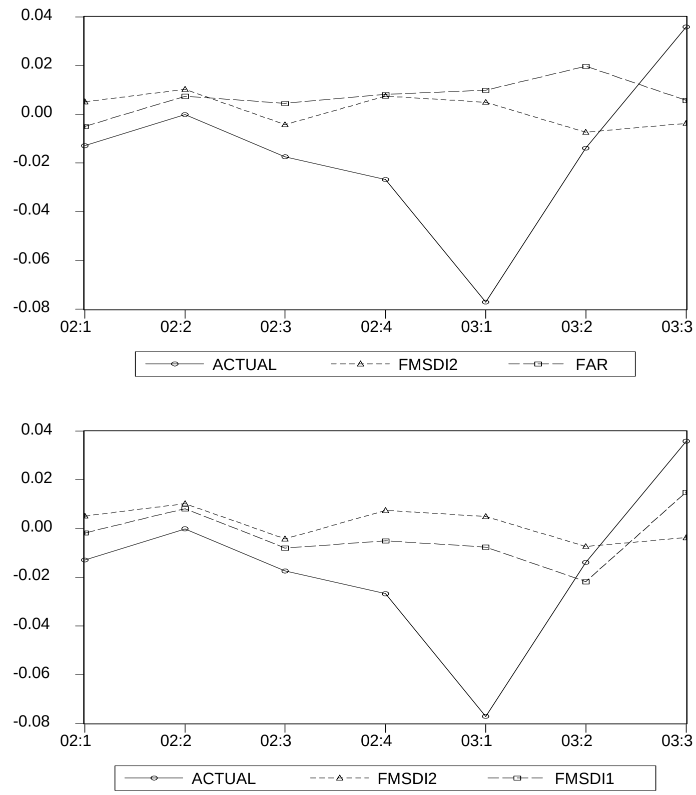


Figure 8a and 8b-Actual, AR, MSDI1, MSDI2 Forecast

CHAUVET, LIMA AND VASQUEZ (2002) proposed a Hamilton type and a Lam type Markov-switching model to estimate Brazilian business cycle and to forecast quarterly Brazilian GDP growth rate. Their result was the compared with an ARMA(1,1) and AR(3) forecasts. They found something similar to the results of this study. First, the best Markov-switching type model to forecast is not the same to estimate business cycle properties. Their best model to explain cycles was also a model that incorporated an intervention analysis and the model without this mechanism was the best to produce forecasts.

Their model estimates that in recession (expansion) the Brazilian GDP grows at an average rate of -1.4% (1.6%) per quarter. In this study, using both MRSDI1 and MRSDI2 these numbers are -1.3% and 0.87% (2.2%), respectively. In terms of duration of the economic cycle, Chauvet, Lima and Vasquez estimate a 2-3 quarters for the recession duration and 4-5 and 6-7 for the expansion duration, with two types of MS used - Hamilton's MS-AR(2) and Lam's MSG-AR(2). In this study, the MRSDI1 model is reductible, i.e., once the economy reaches an economic stage it will stay there. The duration results for the MRSDI2 model are 1-2 quarters for the recession period and 2-3 for the expansion duration phase.

Chauvet, Lima and Vaquez used their estimated Hamilton's MS-AR(4) model without any type of intervation mechanism to forecast the brazilian GDP growth rate for the period 1992:2 to 2002:2, and compared it to an ARMA[21](1,1) and AR(3). The one-step-ahead MSFE ratio amog these models was used for this purpose. Their estimated MS model improved only 2,5% upon ARMA(1,1) forecasts. In this study MRSDI1 (MRSDI2) was 47% (12%) better than a AR(1) model.

[21] They also used a AR(3) as a benchmark model. In the case of one-step-ahead forecast horizon, the ARMA(1,1) was better than AR(3) forecasts.

4.5. Intercept Corrections

Two intercept corrections (IC) techniques were tried. The first one consisted of adding the past forecast error to the actual forecast values. The second correction was to sum up the last sample error to actual forecast values. Neither of these IC approaches produced satisfactory results. Table 6a and Table 6b present pairwise comparisons between models in terms of their MSFE ratios. The first column shows the variable whose MSFE is used as the denominator of the ratio. The names with ic added mean models with the first intercept correction technique.

TABLE6a– MSFE Ratios Comparison

Denominator	Ar	Di	Tvp	Tar	Mrsdi1	Mrsdi2
Ar	1	0.65	0.81	0.60	0.53	0.88
Di	1.56	1	1.25	0.93	0.83	1.38
Tvp	1.24	0.80	1	0.74	0.66	1.09
Tar	1.67	1.07	1.35	1	0.89	1.48
Mrsdi1	1.88	1.20	1.51	1.12	1	1.66
Mrsdi2	1.13	0.73	0.91	0.67	0.60	1
Aric	0.40	0.26	0.32	0.24	0.21	0.36
Diic	0.15	0.10	0.12	0.09	0.08	0.14
Tvpic	1.03	0.66	0.83	0.62	0.55	0.91
Taric	0.62	0.40	0.50	0.37	0.33	0.55
Mrsdi1ic	1.22	0.78	0.98	0.73	0.65	1.08
Mrsdi2ic	0.90	0.57	0.72	0.53	0.47	0.79

TABLE6b– MSFE Ratios Comparison

Denominator	Aric	Diic	Tvpic	Taric	Mrsdi1ic	Mrsdi2ic
Ar	2.48	6.51	0.97	1.61	0.82	1.12
Di	3.87	10.15	1.51	2.51	1.26	1.74
Tvp	3.08	8.08	1.21	2.00	1.02	1.39
Tar	4.15	10.9	1.63	2.69	1.37	1.87
Mrsdi1	4.65	12.22	1.82	3.02	1.54	2.10
Mrsdi2	2.80	7.36	1.10	1.82	0.92	1.26
Aric	1	2.62	0.39	0.65	0.33	0.45
Diic	0.38	1	0.15	0.25	0.13	0.17
Tvpic	2.56	6.70	1	1.66	0.84	1.15
Taric	1.54	4.04	0.60	1	0.51	0.69
Mrsdi1ic	3.03	7.97	1.18	1.97	1	1.36
Mrsdi2ic	2.22	5.83	0.87	1.44	0.73	1

Table 6b shows that all the MSFE ratios of models with intercept correction are bigger than one, when compared to their respective MSFE without correction. For example, the forecast performance of TARDI with IC is 169% worse than the TARDI without IC. This value is 54%, when this same analysis is done to the MRSDI1, and so on.

4.6. Combining Forecast

The regression methods to combine forecasts, discussed in the last theoretical subsection, improved on the best individual forecast mechanism - MSDI model. As expected, the unconstrained method produced the best result in terms of smallest MSFE. The next table shows the ratio of each pooling process MFSE compared to AR, DI and MSDI models.

TABLE7– MSFE Ratios Comparison

Combining Methods\Denominator	AR	DI	MSDI
(a)	0.73	1.15	1.38
(b)	0.58	0.91	1.09
(c)	0.16	0.25	0.31
(d)	0.35	0.55	0.66
(e)	0.85	1.33	1.60

Figure 9 plots actual, MSDI and combined forecasts with method (c).

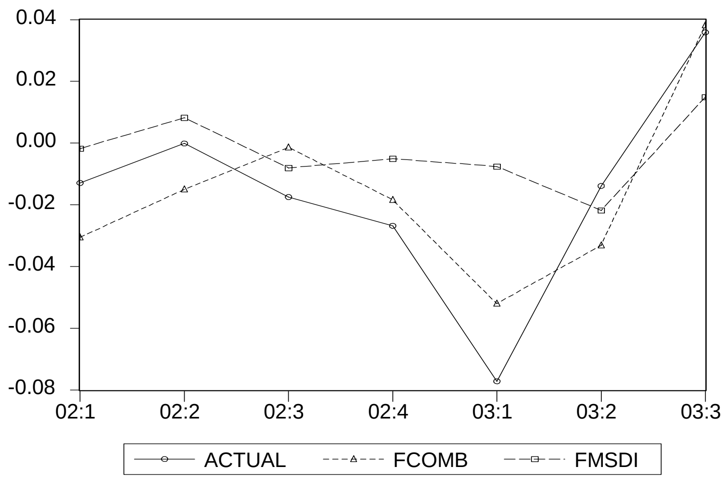


Figure 9- Actual, Combined and MSDI Forecast

The pooling technique based on the unconstrained regression (c) improves almost 84%, 75% and 69% on AR, DI and MSDI respectively. What could explain this enormous supremacy of combined forecast over individual forecast? CLEMENTS AND HENDRY (2001) shows that when there are structural breaks in the variable to be predicted, pooling is a good technique to diminish the negative effects of these breaks on individual forecasts.

The next table shows the actual, predicted and mean squared forecast errors (MSFE) and the root mean squared forecast errors[22] (RMSFE) values of selected models.

TABLE8− Actual, Predicted, MSFE and RMSFE

	Actual	**AR**	**DI**	**TARDI**
2002:1	-0.01289	-0.00504	0.01647	-0.00571
2002:2	-0.00012	0.00740	-0.00823	0.01067
2002:3	-0.01746	0.00444	0.01005	-0.02223
2002:4	-0.02682	0.00814	0.0058	0.00254
2003:1	-0.07715	0.00987	-0.00933	-0.00340
2003:2	-0.01390	0.01969	-0.00739	-0.02262
2003:3	0.03586	0.00564	0.02493	0.01974
MSFE		0.00163	0.00105	0.00098
RMSFE		0.040	0.033	0.031
	Actual	**TVPDI**	**MSDI1**	**Comb Unc**
2002:1	-0.01289	0.01649	-0.00181	-0.03053
2002:2	-0.00012	-0.00037	0.00816	-0.01502
2002:3	-0.01746	-0.00018	-0.00808	-0.00142
2002:4	-0.02682	-0.00808	-0.00507	-0.01847
2003:1	-0.07715	-0.01503	-0.00764	-0.05202
2003:2	-0.01390	-0.04049	-0.02187	-0.03312
2003:3	0.03586	-0.02000	0.01485	0.03810
MSFE		0.00131	0.00087	0.000267
RMSFE		0.036	0.030	0.016

Table 8 confirms the visual information obtained from all previous plots. As one can see, all these models are more useful to predict direction and signals instead of values. The non-linear DI models forecast direction and signals better than linear DI model, whitch is better than AR predictions. But in this type of

[22] RMSFE=$\sqrt{MSFE}$. This measure is usually used because of its property of preserving units.

comparison, the unconstrained technique of pooling forecasts is the best one. It missed only one direction (2002.Q3) and got all signals right.

4.7. New Data, New Experiment

While this study was being written, new data about Brazilian GDP, and other variables used to compute the diffusion index were released. Instead of updating the models presented before or enlarging the out-of-sample forecast period, this work used this new piece of information to answer if it is better to do *ex-ante* predictions with predicted values for F_t using the diffusion index model, or with predicted values of y_{t-1} into the AR model, to forecast the quarterly growth rate of Brazilian GDP.

The idea behind this experiment is the belief in the possibility that even in this forecasting environment, adopting a mechanism with a larger information set, which captures some of the comovement between macro variables as in the DI model, produces better forecast than a simple AR model.

In this experiment values for $\widehat{F_t}$ are estimated as before, eq(4.2), using data until 2003:Q3. The correlogram of $\widehat{F_t}$ suggest some possible ARMA models, and an AR(1) model was chosen using the Box-Jenkins methodology and Akaike information criterion. Forecast values for $\widehat{F_t}$ after 2003:Q3 until 2004:Q3, called here as $\widehat{\widehat{F}}_t$, were computed with an equation such as eq(4.3), in a dynamic way

- $\widehat{\widehat{F_t}}$ is used to forecast $\widehat{\widehat{F_{t+1}}}$, then this value is used to predict $\widehat{\widehat{F_{t+2}}}$, and so on. Then, these values of $\widehat{\widehat{F_t}}$ are used to forecast y_{t+1}.

After 2003:Q3 the DI model equations can be represented as:

$$y_{t+1} = \widehat{c} + \widehat{\beta}\widehat{\widehat{F_t}} + \epsilon_{t+1} \tag{4.1}$$

$$x_t = \Lambda F_t + e_t \tag{4.2}$$

$$\widehat{F_t} = \widehat{\alpha} + \widehat{\theta}\widehat{F_{t-1}} + \eta_t \tag{4.3}$$

Where, η_t has all the classic properties. In the case of autoregressive models to forecast y_{t+1}, the AR(1) is still the best predictor for this class of model. This is done in a dynamic way: the AR(1) model for y_t is estimated using data until 2003:Q3; then y_{t+1} is computed and used to predict y_{t+2}, which is used to forecast y_{t+3}, and so on.

The next plot shows that the DI model improves on the AR model, even when forecast values for the diffusion index are used. The MSFE ratio between DI and AR models was 30.76%.

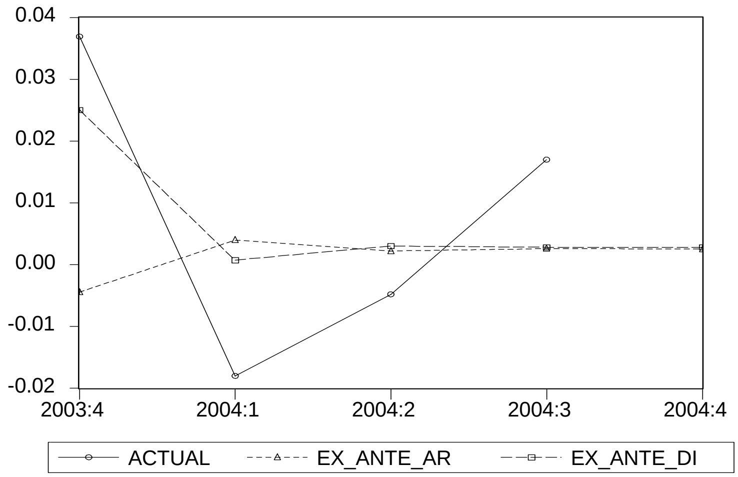


Figure 10- Actual, ex-ante DI and ex-ante AR Forecast

As expected the dynamic forecasts of AR models converge fast to a flat line. The ex-ante[23] set up for the DI model, captures almost all the changes of direction of the actual series. The only exception was the 2004:3 quarter, when the dynamic forecast seems to converge to the mean of the process.

[23]Ex-ante here means dynamic forecasts, i.e., when forecast values for the regressors were used.

5. CONCLUDING REMARKS

In order to forecast the GDP growth rate, macroeconomic theory would suggest the use of a large set of financial, monetary, and other real and nominal variables to be included in a model capable to mimic some stylized facts of business cycles, such as the comovements among a set of variables, as pointed out in the first part of this work.

From the point of view of economic forecasting practice, parsimonious models have a great advantage in terms of forecast performance compared to large econometric theory based models.

This work used linear and nonlinear diffusion index models (DI) to forecast quarterly Brazilian GDP growth rate. A DI model is basically a static representation of an unobservable dynamic factor model. Both models may be used to capture the comovements between variables and to reduce, at the same time, the number of parameters in the model used to forecast.

The most important motivation behind the choice of such a static model is that the factors may be estimated by the solution of an eigenvalue and eigenvector problem similar to the problem found in principal component technique, while the dynamic factor model is estimated by MLE.

The principal component approach allows the number of variables to be bigger than the number of observations. Besides that, it also produces a factor estimator that only needs an increasing number of cross-sections to be consistent. These important features of principal components are extremely important when one is facing a short time-series data set, as is the case in this study.

Quarterly data from 1975:1 up to 2003:3 of Brazilian GDP and another 72 macro variables, representing the external sector and the nominal and real side of the economy, were used to compute the diffusion index. The estimation period ended in 2001:4 and forecasts were made from 2002:1 to 2003:3 in a recursive environment.

The results in terms of forecast performance were very encouraging. The linear DI model with only one factor model improved 35% on an autoregressive (AR) model, when their MSFE were compared. A time varying DI model was tried and its forecast performance was better than the AR's, but not better than the simple linear DI model. This corroborates a previous result found by STOCK AND WATSON (1994). They showed that time varying parameter models are not good to forecast instability in macroeconomic time series, something that is better accomplished with recursive forecasts.

In addition, nonlinear models such as a threshold DI (TARDI) and Markov-switching DI (MSDI) model were used to forecast. This kind of model allows the parameters to change according to economic regime.

The economic regimes in this study are the economic phases of recession and expansion, and they are captured by a threshold value that splits the sample in the TARDI model or by a latent variable in the case of MSDI models. Not only did the TARDI model not only improve on the linear DI model by 7% and 40% compared to the AR, but also the test for a threshold effect against the linear model confirmed that a nonlinear pattern in the Brazilian GDP growth rate exists.

The results concerning MSDI models are dubious. On the one hand, the MSDI1 model presented the best fit to the data and improved on linear DI forecast performance around 17% and 47% compared to the AR, but its estimated transition probabilities and, thus, the duration of economic regimes are different from the results found in previous work by CHAUVET, LIMA AND VASQUEZ (2002), who have used Markov-switching models to explain the cycles to forecast Brazilian GDP growth rate in a short sample. They found two Markov-switching models, one that explains better the economic cycle and the other which forecasts better.

A similar situation happened in this work. The MSDI1 model presented a reducible Markov chain, meaning that once the economy reaches a path it stays there forever, but as said before it was the best individual mechanism to produce forecasts.

On the other hand, the MSDI2 explains the cycles better than does MSDI1, but it was not as good as MSDI1 in prediction. The MRDI2 model estimates a duration of 2-3 (1-2) quarters for the expansion (recession) phase and these results are close to the results found in CHAUVET, LIMA AND VASQUEZ (2002). They estimate duration of 4-5 and 6-7 quarters for expansion and 2-3 quarters for recession. These estimates and Figure 1 shows that Brazilian business cycles are very short. Answering this stylized fact of Brazilian economy is a good theme for future research. As to what was said in section 2 about Brazilian external economic dependency and stabilization plans implemented by Brazilian Government, one would expect that volatility should be a significant characteristic of Brazilian output, and this would produce short business cycles.

The forecast performance of MSDI2 was only 12% better than the AR model, and worse than the linear DI model. However, this result is not too bad, specially when one takes into account that the one-step-ahead forecast for 1992:2 to 2000:2 of a MS model used by Chauvet, Lima and Vasquez improved 2.5% upon an ARMA(1,1) model.

The intercept correction techniques did not work well. On the other hand, combining forecasts produced the best forecast results. Their MSFE were only 16%, 25% and 31% of the MSFE of AR, DI and MSDI1 models, respectively. One possible reason for this fact it is the presence of structural breaks in the variable to be predicted. In this case, pooling forecasts usually reach a better result than do individual ones.

It is important to remember that all these linear, non-linear and combining forecast mechanisms, used in this study, work better predicting direction, turning points and signals than values of quarterly Brazilian GDP growth rate.

Finally an *ex-ante* forecast environment was simulated with a few sample data points. The results show that it may be better to generate predictions with forecast diffusion indices than with simple dynamic ARMA models. This is another point that deserves more study, in order to produce more useful DI models to forecast, when the one-step-ahead is the desired forecast horizon, and only one lag of this index is used to forecast.

More studies using diffusion index models or other kind of indices are important because their predictions usually outperform most of time-series models, with the advantage of utilizing other exogenous variables. Smooth transitions DI models or Bayesian formulations of DI models can also be used to forecast. Another great possibility of research in this field would be those which produce the conveyance of theoretical models with the practice of forecast in the economic science.

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APPENDIX I

Assume that r is unknown and there is n $(n < k)$ common factors. Let $\underline{x_i} = (x_{i1}, ..., x_{iT})'$ $\{i = 1, ..., k\}$ to be a $(T \times 1)$ vector, $F = (F_1, ..., F_n)$ a $(T \times n)$ matrix, $P_F = F(F'F)^{-1}F'$ and λ_{it} a $(n \times 1)$ vector. Suppose that $\lambda_{it} = \lambda_{i0}$ and F is a unknown nonrandom matrix. The estimator for (λ_{i0}, F) proposed by STOCK AND WATSON (1998) minimize the following objective function:

$$V(\lambda_{10}, ..., \lambda_{k0}, F) = k^{-1} \sum_{i=1}^{k} \left(\underline{x_i} - F\lambda_{i0}\right)' \left(\underline{x_i} - F\lambda_{i0}\right) \tag{6.1}$$

Let $(\tilde{\lambda}_{i0}, \tilde{F})$ be the minimizers of $V(\lambda_{i0}, F)$, the first order condition with respect to λ_{i0} implies that

$$\tilde{\lambda}_{i0} = \left(\tilde{F}'\tilde{F}\right)^{-1} \tilde{F}'\underline{x_i} \tag{6.2}$$

Substituting (6.2) into (6.1), the result is the concentrate objective function

$$\begin{aligned} V(\tilde{\lambda}_{i0}, F) &= k^{-1} \sum_{i=1}^{k} \left(\underline{x_i} - P_F\underline{x_i}\right)' \left(\underline{x_i} - P_F\underline{x_i}\right) \\ &= k^{-1} \sum_{i=1}^{k} \underline{x_i}' \left(I_T - P_F\right) \underline{x_i} \end{aligned} \tag{6.3}$$

Considering the normalization $F'F = I_n$ and that $\sum_{i=1}^{k} e_i'e_i = tr(e'e) =$

$tr(k^{-1}\sum_{i=1}^{k}\underline{x_i}'\,(I_T - P_F)\,\underline{x_i})$, minimizing eq(6.3) is equivalent to maximizing[24]

$$tr(F'(k^{-1}\sum_{i=1}^{k}\underline{x_i x_i}')F) \text{ subject to } F'F = I_n \tag{6.4}$$

Where, $k^{-1}\sum_{i=1}^{k}\underline{x_i x_i}' = M$ is a $(T \times T)$ symmetric matrix. Thus, the optimization problem becomes,

$$Max_{F,\lambda} = \sum_{j=1}^{n} F_j' M F_j + \sum_{j=1}^{n} \lambda j(1 - F_j' F_j) \tag{6.5}$$

The first order condition to this problem is $[M - \lambda_j I_T]F_j = 0$, where is λ_j the eigenvalue of M and F_j is its associated eigenvector. Thus, $\sum_{j=1}^{n} F_j' M F_j = \sum_{j=1}^{n} \lambda j$. Adding the information that $n < T$, in order to maximize $\sum_{j=1}^{n} F_j' M F_j$ one must collect the first n largest eigenvalues and its associated eigenvectors of the $(T \times T)$ matrix $k^{-1}\sum_{i=1}^{k}\underline{x_i x_i}'$. Thus, F is just the $(T \times n)$ matrix made with these associated eigenvectors.

[24] The result $tr(ABCD) = tr(CDAB)$ was used to achieve eq(6.4)

APPENDIX II

Index of Hours Worked In Ind. Prod. of The State of Sao Paulo	*	4
Index of Industrial Production - Consumer Goods	*	4
Index of Industrial Production - Intermediate Goods	*	4
Index of Industrial Production - Capital Goods	*	4
Index of Industrial Production - Nondurable Consumer Goods	*	4
Index of Industrial Production - Durable Consumer Goods	*	4
Index of Industrial Production -Mining	*	4
Index of Industrial Production - Pharmaceuticals	*	4
Index of Industrial Production - General	*	4
Index of Industrial Production - Mechanics	*	4
Index of Ind. Production - Electrical and Communications Equip.	*	4
Index of Industrial Production -Metallurgy	*	4
Index of Industrial Production -Transport Equi.	*	4
Index of Industrial Production -Food Products	*	4
Index of Industrial Production -Paper and Cardboard	*	4
Index of Industrial Production -Plastics	*	4
Index of Industrial Production -Chemicals	*	4
Index of Industrial Production -	*	4
Index of Industrial Production -Textiles	*	4
Index of Ind. Prod.-Clothing, Footwear and Leather Goods	*	4
Capacity Utilization Rate-Industry-Capital Goods	*	7
Capacity Utilization Rate-Industry-Intermediate Goods	*	7
Capacity Utilization Rate-Industry-Material construction	*	7
Capacity Utilization Rate-Industry-Mean	*	7
Brazilian Direct Investment	**	0
Direct Investment	**	0
Foreign Direct Investment	*	0
Foreign Portfolio Investment	*	0
Portfolio Investment	*	0
Interest Rate-Bank Deposit Certificate (CDB)	*	1
Interest Rate Credit Operations to Short Term Private Capital	*	1
SELIC Interest Rate (Monetary Policy)	*	1
Loans of Financial System to Private Sector	*	3
Loans of Financial System to Private Sector-Habitation	*	3
M0-Monetary Aggregate	*	4
M1-Monetary Aggregate	*	4
Internal Debt	**	3
Federal Internal Mobiliary debt	*	3
Financial Execution of National Treasury Debt	*	3
Financial Execution of National Treasury Credit	*	3
Cost of Living Index of Sao Paulo	*	6
General Price Index Domestic Supply	*	2,6
INCC Price Index	*	2,6
Index of Nominal of The Retail Trade in Sao Paulo-Industry	*	4
Index of Employed People in Ind. Prod. of State of Sao Paulo	*	2
GDP of Brazil	*	5
Exports	*	2
Imports	*	4
Overall Balance of Payment Results	*	2
Exchange Rate (R$/US$)	*	3
International Reserve	*	2
IBOVESPA-Index of Stock Market-Brazil	***	3
Mundial Exports	*	2
Mundial Imports	*	4
Exports of Industrialized Countries	*	2
Imports of Industrialized Countries	*	4
GDP of Canada	*	6
GDP of China	*	4
GDP of Korea	*	4
GDP of Spain	*	4
GDP of France	*	4
GDP of Germany	*	2
GDP of Italy	*	6
GDP of Japan	*	6
GDP of United Kingdom	*	6
GDP of USA	*	4
USA Interest Rate-Federal Funds-3-month	*	1
USA Interest Rate-Treasury Maturities-10-years	*	1
USA Interest Rate-Treasury Maturities-3-years	*	1
USA Interest Rate-Prime-3-month	*	1
USA Interest Rate-Treasury Bills-3-month	*	1
USA Interest Rate-Treasury Bills-6-month	*	1

Figure A1-List of Series and Transformations

Where,

(*) Data from Ipeadata;

(**) Data from Central Bank of Brazil;

(***) Data from Economatica;

[0] Growth Rates;

[1]First Difference (1diff);

[2] Ln+1diff;

[3]Ln+Deflating+1diff;

[4] Ln+Seas. Adj.+1diff;

[5] Ln+deflating+seas.adj+1diff;

[6] Ln+Second Difference (2diff);

[7] $\Delta Ln(\frac{X_t}{100-X_t})$.

APPENDIX III

TABLE A3 – OLS RESULTS FOR LINEAR DI - 2002:2 UP TO 2003:Q3

```
2002.1
Valid cases:                   104      Dependent variable:                Y
Missing cases:                   0      Deletion method:                None
Total SS:                    0.328      Degrees of freedom:              102
R-squared:                   0.090      Rbar-squared:                  0.081
Residual SS:                 0.298      Std error of est:              0.054
F(1,102):                   10.108      Probability of F:              0.002

                         Standard                 Prob   Standardized  Cor with
Variable     Estimate      Error       t-value     >|t|     Estimate    Dep Var
-------------------------------------------------------------------------------
CONSTANT     0.003573    0.005307    0.673222     0.502       ---         ---
X1           0.174501    0.054887    3.179310     0.002     0.300272    0.300272

------------new period---------------------------------------------------------

2002.2
Valid cases:                   105      Dependent variable:                Y
Missing cases:                   0      Deletion method:                None
Total SS:                    0.328      Degrees of freedom:              103
R-squared:                   0.089      Rbar-squared:                  0.080
Residual SS:                 0.299      Std error of est:              0.054
F(1,103):                   10.073      Probability of F:              0.002

                         Standard                 Prob   Standardized  Cor with
Variable     Estimate      Error       t-value     >|t|     Estimate    Dep Var
-------------------------------------------------------------------------------
CONSTANT     0.003305    0.005258    0.628641     0.531       ---         ---
X1          -0.173326    0.054611   -3.173803     0.002    -0.298470   -0.298470

------------new period---------------------------------------------------------

2002.3
Valid cases:                   106      Dependent variable:                Y
Missing cases:                   0      Deletion method:                None
Total SS:                    0.329      Degrees of freedom:              104
R-squared:                   0.090      Rbar-squared:                  0.082
Residual SS:                 0.299      Std error of est:              0.054
F(1,104):                   10.321      Probability of F:              0.002

                         Standard                 Prob   Standardized  Cor with
Variable     Estimate      Error       t-value     >|t|     Estimate    Dep Var
-------------------------------------------------------------------------------
CONSTANT     0.003281    0.005208    0.629902     0.530       ---         ---
X1           0.174352    0.054271    3.212606     0.002     0.300466    0.300466
```

------------new period--

2002.4

Valid cases:	107	Dependent variable:	Y
Missing cases:	0	Deletion method:	None
Total SS:	0.329	Degrees of freedom:	105
R-squared:	0.089	Rbar-squared:	0.080
Residual SS:	0.300	Std error of est:	0.053
F(1,105):	10.212	Probability of F:	0.002

Variable	Estimate	Standard Error	t-value	Prob >|t|	Standardized Estimate	Cor with Dep Var
CONSTANT	0.002959	0.005171	0.572221	0.568	---	---
X1	0.172861	0.054092	3.195681	0.002	0.297724	0.297724

------------new period--

2003.1

Valid cases:	108	Dependent variable:	Y
Missing cases:	0	Deletion method:	None
Total SS:	0.336	Degrees of freedom:	106
R-squared:	0.085	Rbar-squared:	0.077
Residual SS:	0.307	Std error of est:	0.054
F(1,106):	9.894	Probability of F:	0.002

Variable	Estimate	Standard Error	t-value	Prob >|t|	Standardized Estimate	Cor with Dep Var
CONSTANT	0.002084	0.005179	0.402416	0.688	---	---
X1	-0.171608	0.054558	-3.145458	0.002	-0.292182	-0.292182

------------new period--

2003.2

Valid cases:	109	Dependent variable:	Y
Missing cases:	0	Deletion method:	None
Total SS:	0.336	Degrees of freedom:	107
R-squared:	0.086	Rbar-squared:	0.078
Residual SS:	0.307	Std error of est:	0.054
F(1,107):	10.074	Probability of F:	0.002

Variable	Estimate	Standard Error	t-value	Prob >|t|	Standardized Estimate	Cor with Dep Var
CONSTANT	0.001960	0.005131	0.381907	0.703	---	---
X1	-0.172235	0.054266	-3.173896	0.002	-0.293334	-0.293334

------------new period--
2003.3

Valid cases:	110	Dependent variable:	Y
Missing cases:	0	Deletion method:	None
Total SS:	0.337	Degrees of freedom:	108
R-squared:	0.084	Rbar-squared:	0.075
Residual SS:	0.309	Std error of est:	0.053
F(1,108):	9.890	Probability of F:	0.002

Variable	Estimate	Standard Error	t-value	Prob >|t|	Standardized Estimate	Cor with Dep Var
CONSTANT	0.002546	0.005101	0.499060	0.619	---	---
X1	0.171594	0.054565	3.144765	0.002	0.289635	0.289635

APPENDIX IV

TABLE A4 – FACTOR ESTIMATES: 1976.Q1 TO 2003.Q2

OBS	F1	F2	F3	F4	F5
1976:1	0,01769	-0,06515	-0,00055	-0,19829	-0,00299
1976:2	0,06478	-0,10228	0,00553	-0,0949	0,02005
1976:3	-0,05392	-0,02359	-0,00902	-0,0894	-0,0026
1976:4	0,12604	-0,02396	0,03383	-0,0404	0,06682
1977:1	-0,04491	0,02058	-0,07732	-0,12058	-0,0359
1977:2	-0,03164	0,00068	-0,04814	-0,03941	0,02604
1977:3	-0,07088	0,02772	-0,05637	-0,01711	-0,08742
1977:4	0,16044	-0,0019	-0,06138	0,07381	0,02822
1978:1	-0,03031	-0,03592	-0,07857	-0,12369	-0,01632
1978:2	-0,0155	-0,07592	-0,09758	-0,123	-0,02442
1978:3	-0,02492	0,00446	-0,08411	-0,00336	-0,04479
1978:4	0,13842	-0,12731	-0,1279	-0,04399	0,01897
1979:1	-0,044	-0,02765	-0,10747	-0,10798	-0,0293
1979:2	-0,00106	-0,04765	-0,02497	-0,10064	0,05473
1979:3	-0,07341	-0,06465	-0,09892	-0,13905	0,08545
1979:4	0,14164	-0,16142	-0,18989	0,0269	-0,04402
1980:1	0,0524	-0,13796	-0,20004	-0,11202	0,00238
1980:2	0,01695	0,03994	0,26798	-0,14036	0,06425
1980:3	0,05168	0,01687	0,10122	-0,00415	0,01479
1980:4	-0,02777	-0,07165	-0,35141	0,22867	-0,23482
1981:1	-0,16323	0,0056	-0,13985	0,02339	-0,11913
1981:2	-0,07181	0,10815	-0,07925	0,10415	-0,05288
1981:3	-0,08247	0,09358	-0,07713	0,10752	-0,12632
1981:4	0,01854	0,1193	0,20209	-0,12054	0,15195
1982:1	0,12015	-0,01457	0,03865	0,0586	-0,12094
1982:2	-0,02528	0,04648	0,04003	0,03866	-0,10998
1982:3	-0,02563	0,10306	0,23862	-0,0061	-0,04427
1982:4	-0,06673	0,15423	0,22118	-0,06247	0,02626
1983:1	-0,01455	0,04334	0,01564	0,03954	-0,005
1983:2	-0,08489	-0,00322	-0,02877	0,00866	-0,10108
1983:3	-0,01691	-0,01813	-0,09404	0,11619	-0,07232
1983:4	0,03227	-0,03848	0,00748	-0,05535	-0,01953
1984:1	-0,07536	-0,03853	-0,06231	-0,04655	0,03445
1984:2	0,09901	-0,02131	-0,12769	0,05112	-0,10032
1984:3	-0,02572	0,0048	0,01467	0,06299	-0,06549
1984:4	0,09946	0,03651	0,18627	-0,00782	0,03633
1985:1	-0,00321	0,00679	0,09486	0,0261	-0,06187
1985:2	-0,04183	0,02742	0,03499	-0,06947	0,04474
1985:3	0,13599	-0,03905	0,04942	-0,03235	0,07113
1985:4	0,07484	-0,06951	0,00242	-0,07467	0,09341
1986:1	-0,12921	-0,01911	0,09492	-0,09464	0,05674
1986:2	0,17327	0,08254	0,03246	-0,12747	0,1029
1986:3	0,13908	-0,03661	0,07352	-0,0795	-0,01633
1986:4	-0,05419	-0,06877	0,08202	-0,08296	-0,07358
1987:1	-0,05833	-0,08549	-0,02032	0,06511	0,04107
1987:2	-0,07451	-0,10296	-0,07291	0,11073	0,03108
1987:3	0,00282	0,11981	-0,1288	-0,02273	0,06872

1987:4	-0,03471	-0,11764	-0,02214	-0,0913	0,10383
1988:1	0,02917	-0,03072	0,07928	0,08435	0,00323
1988:2	-0,03438	-0,04344	-0,06568	0,03504	-0,00308
1988:3	-0,04729	-0,01531	-0,02714	0,15991	-0,06147
1988:4	-0,06654	-0,09768	-0,03225	0,05609	0,13834
1989:1	-0,06371	0,05286	-0,11165	0,03351	0,03749
1989:2	0,21503	-0,07279	0,02751	0,00618	0,07435
1989:3	-0,07003	-0,14128	0,16651	0,15014	-0,03279
1989:4	-0,11473	-0,08668	0,07711	0,12786	0,17917
1990:1	-0,25345	-0,22372	-0,00049	0,22511	0,33082
1990:2	0,03503	0,57921	-0,3379	-0,06855	0,29333
1990:3	0,11551	-0,19098	0,07378	-0,03454	0,02431
1990:4	-0,31693	-0,05668	0,02745	-0,12529	0,0681
1991:1	-0,01112	0,19232	0,07159	0,21659	0,21474
1991:2	0,2301	0,00585	0,07065	0,0944	-0,11679
1991:3	-0,0082	-0,05082	0,06983	0,0371	0,0346
1991:4	-0,31389	-0,01792	0,07077	-0,02565	0,00977
1992:1	0,0711	0,10173	0,00244	0,17996	0,20174
1992:2	0,07049	0,00794	0,02032	0,08092	0,04638
1992:3	-0,03211	-0,05359	0,04595	-0,02475	0,14788
1992:4	-0,00384	0,04192	0,02619	0,16715	-0,03359
1993:1	0,15881	-0,0038	0,10975	0,22933	-0,01215
1993:2	-0,04523	-0,09546	0,04548	0,04218	0,07192
1993:3	-0,0666	-0,04883	0,04391	0,12538	0,03408
1993:4	0,03294	-0,02356	0,00879	0,19468	0,16379
1994:1	0,04172	-0,0668	-0,00957	0,21747	0,11368
1994:2	-0,07001	-0,13649	-0,09827	0,07048	0,15363
1994:3	0,12364	0,09238	-0,18727	-0,21914	0,21514
1994:4	0,14104	-0,09608	-0,03925	-0,06978	-0,02519
1995:1	0,02343	-0,0842	-0,02079	-0,1035	0,00451
1995:2	-0,18351	-0,04465	0,05082	-0,13626	-0,00655
1995:3	-0,14471	0,18836	-0,0565	0,04435	-0,08131
1995:4	0,0456	0,07015	0,01925	-0,02732	-0,02189
1996:1	0,02504	0,01308	0,03939	-0,0319	-0,06561
1996:2	-0,03751	0,03945	-0,03532	0,01557	-0,10794
1996:3	0,09047	-0,00002	-0,01587	-0,02596	-0,00395
1996:4	0,01272	-0,03432	0,05948	-0,08659	-0,13915
1997:1	-0,01366	0,10958	-0,01303	0,03319	-0,02672
1997:2	0,04586	-0,05807	-0,00848	-0,06188	-0,03105
1997:3	0,05009	0,01966	0,02172	-0,04057	-0,06537
1997:4	-0,17286	0,05551	0,0165	-0,09314	-0,13601
1998:1	0,10027	0,11227	0,02927	0,11782	-0,03081
1998:2	-0,02278	0,03784	0,0083	-0,03584	-0,07863
1998:3	-0,02529	0,01933	0,03625	-0,07204	-0,09806
1998:4	-0,13414	0,11698	0,02688	-0,06087	-0,06628
1999:1	0,08492	0,06775	0,02272	0,09374	-0,09698
1999:2	-0,02251	0,0278	-0,02713	0,00887	-0,06614
1999:3	0,00973	-0,02593	-0,04874	-0,07081	0,01733
1999:4	0,03771	-0,04203	-0,03826	-0,0939	-0,06628
2000:1	0,01232	-0,04313	-0,04175	-0,03073	-0,02377
2000:2	0,03143	-0,02174	0,01203	-0,06132	-0,1354
2000:3	-0,02312	-0,00033	0,00209	-0,0756	0,01426

2000:4	0,08005	0,04828	0,05812	0,00295	-0,13462
2001:1	0,0445	0,00576	0,08977	-0,04028	0,02803
2001:2	-0,12013	0,15193	0,11505	0,03109	-0,1968
2001:3	-0,05113	0,14396	0,05225	0,02488	-0,01878
2001:4	0,00339	0,12706	0,12699	0,05404	-0,10819

OBS	F1	F2	F3	F4	F5
1976:1	-0,01853	-0,0636	-0,0008	0,18548	0,00532
1976:2	-0,06486	-0,10175	0,00261	0,09827	-0,02244
1976:3	0,05346	-0,02297	-0,00884	0,08784	0,00272
1976:4	-0,12604	-0,02364	0,03339	0,04569	-0,06826
1977:1	0,04472	0,02274	-0,07594	0,11538	0,03693
1977:2	0,0313	0,00234	-0,04774	0,04254	-0,02758
1977:3	0,06988	0,02849	-0,05515	0,0136	0,0882
1977:4	-0,16052	-0,00052	-0,06139	-0,06988	-0,02841
1978:1	0,02979	-0,03296	-0,07856	0,11646	0,01736
1978:2	0,01508	-0,07219	-0,09818	0,12007	0,02461
1978:3	0,02442	0,00628	-0,08383	0,00317	0,04449
1978:4	-0,1381	-0,12305	-0,13127	0,05056	-0,02194
1979:1	0,04357	-0,02436	-0,10736	0,10029	0,0302
1979:2	0,00081	-0,04565	-0,0252	0,10038	-0,05478
1979:3	0,07292	-0,06011	-0,09855	0,13253	-0,08457
1979:4	-0,14136	-0,15689	-0,19521	-0,01873	0,03951
1980:1	-0,05234	-0,13175	-0,20302	0,10827	-0,00327
1980:2	-0,01759	0,03403	0,26963	0,13478	-0,06249
1980:3	-0,05219	0,01472	0,10225	0,00138	-0,01266
1980:4	0,02692	-0,06576	-0,35454	-0,2262	0,23273
1981:1	0,16219	0,00842	-0,13863	-0,03057	0,1212
1981:2	0,07112	0,1088	-0,07598	-0,10369	0,05449
1981:3	0,08158	0,09414	-0,07454	-0,10995	0,12843
1981:4	-0,01876	0,11599	0,20634	0,12236	-0,15092
1982:1	-0,12054	-0,01702	0,03702	-0,05855	0,12136
1982:2	0,02419	0,04419	0,0411	-0,04024	0,11124
1982:3	0,02462	0,09653	0,24127	0,00598	0,0459
1982:4	0,06574	0,14906	0,22613	0,05881	-0,02331
1983:1	0,01403	0,0427	0,01696	-0,03878	0,0054
1983:2	0,08385	-0,00335	-0,02873	-0,00888	0,10117
1983:3	0,0158	-0,01671	-0,09409	-0,11955	0,07382
1983:4	-0,03277	-0,03832	0,00715	0,0539	0,02012
1984:1	0,07493	-0,03588	-0,06238	0,04453	-0,03436
1984:2	-0,09959	-0,01914	-0,12889	-0,0492	0,09927
1984:3	0,02471	0,00335	0,01451	-0,06505	0,06608
1984:4	-0,1	0,03185	0,18712	0,00942	-0,03583
1985:1	0,00203	0,0037	0,0952	-0,03225	0,06404
1985:2	0,0415	0,02744	0,0365	0,07173	-0,04506
1985:3	-0,13633	-0,03971	0,04863	0,03044	-0,07087
1985:4	-0,07512	-0,06816	0,00117	0,07237	-0,09381
1986:1	0,12838	-0,02087	0,09507	0,08857	-0,05686
1986:2	-0,17339	0,08314	0,03506	0,12315	-0,10201
1986:3	-0,13933	-0,03815	0,07228	0,07914	0,0159
1986:4	0,05321	-0,07089	0,08013	0,07919	0,07349
1987:1	0,05789	-0,0846	-0,02186	-0,06345	-0,04113
1987:2	0,0734	-0,1006	-0,07432	-0,11164	-0,0298

1987:3	-0,00303	0,12371	-0,12513	0,02479	-0,06925
1987:4	0,03453	-0,11527	-0,02387	0,08941	-0,10404
1988:1	-0,02995	-0,03294	0,07876	-0,0851	-0,00197
1988:2	0,03393	-0,04133	-0,06637	-0,02781	0,00215
1988:3	0,04584	-0,01604	-0,02751	-0,16203	0,06272
1988:4	0,06587	-0,096	-0,03385	-0,05633	-0,13916
1989:1	0,06287	0,05595	-0,1091	-0,04026	-0,03549
1989:2	-0,21537	-0,0731	0,02584	-0,01003	-0,07375
1989:3	0,06813	-0,14645	0,16292	-0,15073	0,03389
1989:4	0,11325	-0,088	0,07624	-0,12984	-0,1783
1990:1	0,25185	-0,22308	-0,00362	-0,23541	-0,32955
1990:2	-0,03471	0,59113	-0,32073	0,05722	-0,28957
1990:3	-0,11629	-0,19193	0,06864	0,03506	-0,02571
1990:4	0,31632	-0,05621	0,02729	0,12705	-0,07023
1991:1	0,00976	0,19072	0,07781	-0,22164	-0,21072
1991:2	-0,23098	0,00215	0,06953	-0,0944	0,11717
1991:3	0,00731	-0,05262	0,06862	-0,04044	-0,03422
1991:4	0,31242	-0,01912	0,07196	0,02619	-0,00924
1992:1	-0,0717	0,10253	0,00603	-0,17745	-0,2005
1992:2	-0,07097	0,00743	0,02074	-0,07987	-0,04593
1992:3	0,03162	-0,05307	0,046	0,02239	-0,14704
1992:4	0,00235	0,03957	0,02739	-0,17229	0,03544
1993:1	-0,16002	-0,00822	0,10902	-0,23104	0,01438
1993:2	0,0442	-0,09614	0,04374	-0,04467	-0,07155
1993:3	0,0652	-0,05053	0,04299	-0,12536	-0,03388
1993:4	-0,03387	-0,02411	0,00901	-0,19762	-0,16297
1994:1	-0,04299	-0,06644	-0,01088	-0,21594	-0,11311
1994:2	0,0691	-0,13295	-0,1005	-0,0759	-0,15367
1994:3	-0,1235	0,10042	-0,18379	0,20849	-0,21524
1994:4	-0,14124	-0,09464	-0,04192	0,06774	0,02434
1995:1	-0,02359	-0,0826	-0,02297	0,10689	-0,00628
1995:2	0,18298	-0,04457	0,05039	0,13569	0,0059
1995:3	0,14358	0,18954	-0,05041	-0,04726	0,08469
1995:4	-0,04567	0,06962	0,02113	0,0255	0,02271
1996:1	-0,02546	0,01214	0,03914	0,03811	0,0645
1996:2	0,03676	0,0396	-0,03433	-0,01746	0,10865
1996:3	-0,09058	0,00064	-0,0157	0,02583	0,00413
1996:4	-0,01331	-0,0363	0,05814	0,08537	0,13927
1997:1	0,0127	0,10952	-0,01033	-0,0341	0,02693
1997:2	-0,04621	-0,05722	-0,00977	0,05921	0,03102
1997:3	-0,05035	0,01889	0,02176	0,04363	0,06458
1997:4	0,17174	0,05496	0,01852	0,08554	0,13818
1998:1	-0,10041	0,10997	0,03112	-0,10618	0,02923
1998:2	0,0222	0,03747	0,0093	0,03206	0,07965
1998:3	0,02481	0,01845	0,03702	0,06838	0,09941
1998:4	0,13374	0,11634	0,03023	0,06027	0,06741
1999:1	-0,08514	0,0653	0,02328	-0,0839	0,0951
1999:2	0,02177	0,02822	-0,02632	-0,00993	0,06687
1999:3	-0,00975	-0,0235	-0,04909	0,07411	-0,01859
1999:4	-0,03842	-0,04076	-0,03891	0,0834	0,06798
2000:1	-0,01252	-0,04189	-0,04276	0,03401	0,02248
2000:2	-0,03205	-0,02249	0,01083	0,06046	0,13519

2000:3	0,02287	0,00064	0,00248	0,0744	-0,0144
2000:4	-0,08065	0,04565	0,05819	-0,00036	0,13443
2001:1	-0,04508	0,00386	0,09004	0,0405	-0,02861
2001:2	0,11911	0,14717	0,11804	-0,03098	0,19812
2001:3	0,0509	0,14208	0,05598	-0,02087	0,0193
2001:4	-0,00437	0,12284	0,13025	-0,06192	0,11294
2002:1	-0,07432	-0,01563	0,02611	0,00511	0,06532
OBS	F1	F2	F3	F4	F5
1976:1	0,01824	-0,06321	-0,00194	-0,16847	-0,03392
1976:2	0,06426	-0,1004	0,00091	-0,09692	0,01316
1976:3	-0,05335	-0,02276	-0,00945	-0,08347	-0,01267
1976:4	0,12544	-0,02327	0,03355	-0,05138	0,06526
1977:1	-0,04524	0,02478	-0,07495	-0,09851	-0,05653
1977:2	-0,03157	0,00395	-0,04685	-0,04385	0,02377
1977:3	-0,07022	0,02864	-0,05504	0,00077	-0,09294
1977:4	0,16015	0,00019	-0,06077	0,06478	0,03659
1978:1	-0,03	-0,03027	-0,07901	-0,10975	-0,03141
1978:2	-0,0155	-0,06881	-0,09937	-0,11337	-0,03765
1978:3	-0,025	0,00837	-0,0838	0,00595	-0,04683
1978:4	0,13784	-0,1188	-0,13434	-0,05456	0,02062
1979:1	-0,0439	-0,02116	-0,10801	-0,08808	-0,04589
1979:2	-0,0006	-0,04413	-0,02567	-0,10579	0,04632
1979:3	-0,07234	-0,05664	-0,09878	-0,14041	0,07226
1979:4	0,1408	-0,15141	-0,1998	0,01781	-0,03174
1980:1	0,05209	-0,12575	-0,20587	-0,1006	-0,01166
1980:2	0,01721	0,02766	0,27122	-0,13029	0,04277
1980:3	0,05151	0,01184	0,10458	0,00251	0,00864
1980:4	-0,02839	-0,05902	-0,35848	0,24463	-0,20879
1981:1	-0,16306	0,01116	-0,13921	0,0447	-0,12082
1981:2	-0,07135	0,10893	-0,07231	0,10315	-0,04129
1981:3	-0,08267	0,09468	-0,07177	0,12281	-0,11787
1981:4	0,01864	0,11214	0,21155	-0,12664	0,13445
1982:1	0,11941	-0,01971	0,03583	0,0777	-0,12161
1982:2	-0,02493	0,04183	0,04157	0,05519	-0,11039
1982:3	-0,02532	0,08973	0,24429	0,00237	-0,04893
1982:4	-0,06581	0,14318	0,22997	-0,06152	0,01815
1983:1	-0,01422	0,04161	0,01805	0,0376	0,00017
1983:2	-0,0846	-0,00345	-0,02858	0,02137	-0,10209
1983:3	-0,01631	-0,01569	-0,09453	0,12428	-0,06206
1983:4	0,03248	-0,03835	0,00643	-0,05471	-0,02223
1984:1	-0,07533	-0,03367	-0,06262	-0,03888	0,02455
1984:2	0,09896	-0,01682	-0,12931	0,05584	-0,09313
1984:3	-0,02541	0,00167	0,01374	0,07714	-0,0636
1984:4	0,0996	0,02677	0,18817	-0,01205	0,03431
1985:1	-0,00276	0,00001	0,09454	0,0461	-0,06746
1985:2	-0,04145	0,02718	0,03776	-0,07942	0,04143
1985:3	0,13604	-0,04084	0,04811	-0,03019	0,06344
1985:4	0,07503	-0,06686	-0,00059	-0,07945	0,08593
1986:1	-0,12847	-0,02315	0,09354	-0,08485	0,04266
1986:2	0,17347	0,083	0,03744	-0,12197	0,08291
1986:3	0,13891	-0,03973	0,07106	-0,07218	-0,02643
1986:4	-0,05337	-0,07297	0,07695	-0,06956	-0,08221

1987:1	-0,05822	-0,08365	-0,02401	0,0593	0,04594
1987:2	-0,07365	-0,09892	-0,07444	0,0947	0,04917
1987:3	0,00295	0,12744	-0,12119	-0,02731	0,06484
1987:4	-0,03463	-0,11302	-0,02637	-0,09731	0,09535
1988:1	0,02944	-0,03566	0,0775	0,08357	0,01005
1988:2	-0,0345	-0,03932	-0,06638	0,02747	0,00113
1988:3	-0,04667	-0,01726	-0,02831	0,167	-0,04757
1988:4	-0,06604	-0,0946	-0,03678	0,04593	0,14275
1989:1	-0,0635	0,05866	-0,10784	0,04236	0,0348
1989:2	0,21493	-0,07396	0,02425	0,0044	0,07238
1989:3	-0,06897	-0,15203	0,15781	0,1549	-0,02095
1989:4	-0,11338	-0,09013	0,07409	0,11307	0,18955
1990:1	-0,25246	-0,22293	-0,00977	0,21282	0,34259
1990:2	0,03505	0,60234	-0,30394	-0,0735	0,27825
1990:3	0,116	-0,19312	0,06351	-0,03678	0,02256
1990:4	-0,31579	-0,05552	0,02628	-0,14336	0,06647
1991:1	-0,01018	0,18801	0,08302	0,20721	0,22617
1991:2	0,22972	-0,00164	0,0691	0,10901	-0,11156
1991:3	-0,00781	-0,05456	0,06609	0,04661	0,03191
1991:4	-0,31229	-0,02043	0,07201	-0,03742	0,01435
1992:1	0,07131	0,1022	0,01024	0,1596	0,21582
1992:2	0,07031	0,00672	0,02081	0,07326	0,0544
1992:3	-0,03172	-0,05309	0,04495	-0,0339	0,14294
1992:4	-0,00316	0,03707	0,02765	0,16922	-0,01681
1993:1	0,1593	-0,01343	0,10792	0,23016	0,00632
1993:2	-0,04443	-0,09701	0,04075	0,03659	0,07629
1993:3	-0,06587	-0,05267	0,04124	0,12079	0,04543
1993:4	0,03336	-0,02513	0,00795	0,17941	0,18208
1994:1	0,04238	-0,0668	-0,01243	0,2058	0,13225
1994:2	-0,06944	-0,1297	-0,10347	0,06036	0,16072
1994:3	0,1236	0,1083	-0,18062	-0,21103	0,18327
1994:4	0,14105	-0,0932	-0,04504	-0,06465	-0,03077
1995:1	0,02376	-0,08077	-0,02517	-0,1098	-0,0012
1995:2	-0,18294	-0,04411	0,04887	-0,13858	-0,01492
1995:3	-0,14378	0,18996	-0,04523	0,05328	-0,08002
1995:4	0,04539	0,06899	0,02228	-0,0237	-0,02551
1996:1	0,02512	0,01176	0,03925	-0,02902	-0,0684
1996:2	-0,03751	0,03972	-0,03302	0,02645	-0,10683
1996:3	0,09045	0,00097	-0,01537	-0,02718	-0,00574
1996:4	0,0129	-0,03776	0,05612	-0,07217	-0,14659
1997:1	-0,01288	0,1088	-0,00735	0,03884	-0,02554
1997:2	0,04586	-0,05647	-0,01093	-0,06123	-0,03316
1997:3	0,04988	0,01838	0,0218	-0,03526	-0,06923
1997:4	-0,17187	0,05443	0,01926	-0,07408	-0,14528
1998:1	0,10001	0,10795	0,03378	0,10664	-0,01692
1998:2	-0,02238	0,03679	0,01032	-0,02797	-0,08086
1998:3	-0,02513	0,01758	0,03674	-0,06192	-0,10343
1998:4	-0,13404	0,1162	0,03284	-0,04899	-0,07586
1999:1	0,08513	0,06287	0,02487	0,08112	-0,07786
1999:2	-0,02204	0,02833	-0,02505	0,01476	-0,06568
1999:3	0,01005	-0,02096	-0,04972	-0,08288	0,01686
1999:4	0,03812	-0,03977	-0,03976	-0,07327	-0,07774

2000:1	0,01228	-0,0406	-0,04367	-0,03345	-0,02436
2000:2	0,03209	-0,02301	0,00982	-0,05415	-0,13496
2000:3	-0,02255	0,00157	0,00184	-0,0819	0,01094
2000:4	0,08005	0,04301	0,05906	0,01609	-0,13508
2001:1	0,04495	0,00202	0,08993	-0,04625	0,02694
2001:2	-0,11969	0,14254	0,12191	0,05028	-0,19524
2001:3	-0,05073	0,14061	0,05919	0,0144	-0,01231
2001:4	0,00321	0,11817	0,13373	0,0852	-0,11641
2002:1	0,07379	-0,01701	0,02542	-0,00299	-0,06389
2002:2	-0,06634	-0,00953	-0,03647	-0,12899	0,03093

OBS	F1	F2	F3	F4	F5
1976:1	0,01806	0,06365	-0,00058	0,16388	-0,05108
1976:2	0,06386	0,10109	0,00246	0,09889	0,00811
1976:3	-0,05346	0,02281	-0,00877	0,08075	-0,02087
1976:4	0,12528	0,02336	0,03305	0,05779	0,06543
1977:1	-0,04546	-0,0222	-0,07655	0,09489	-0,06128
1977:2	-0,03188	-0,00231	-0,04746	0,04599	0,02191
1977:3	-0,07024	-0,02757	-0,05486	-0,00825	-0,09375
1977:4	0,15993	0,00227	-0,06137	-0,0613	0,04365
1978:1	-0,03023	0,03304	-0,07936	0,10716	-0,03876
1978:2	-0,01595	0,07154	-0,09764	0,1106	-0,04524
1978:3	-0,02517	-0,00573	-0,08421	-0,00866	-0,0438
1978:4	0,13752	0,12229	-0,13054	0,05419	0,0138
1979:1	-0,04412	0,02434	-0,10796	0,08296	-0,05506
1979:2	-0,00076	0,04523	-0,02529	0,10796	0,03768
1979:3	-0,07276	0,05908	-0,09777	0,14299	0,05793
1979:4	0,14041	0,15677	-0,19501	-0,02159	-0,03306
1980:1	0,05171	0,13165	-0,20292	0,09737	-0,02159
1980:2	0,01717	-0,03434	0,26883	0,13387	0,03176
1980:3	0,05133	-0,01406	0,10342	-0,00073	0,01132
1980:4	-0,02855	0,06738	-0,35209	-0,26395	-0,20008
1981:1	-0,16341	-0,00738	-0,13947	-0,05206	-0,11458
1981:2	-0,07162	-0,106	-0,07622	-0,10225	-0,02484
1981:3	-0,08289	-0,09231	-0,07387	-0,12889	-0,10336
1981:4	0,01875	-0,11689	0,20601	0,13907	0,13268
1982:1	0,11942	0,01888	0,03682	-0,08714	-0,11778
1982:2	-0,02494	-0,04258	0,04058	-0,06106	-0,10239
1982:3	-0,02528	-0,09568	0,24097	-0,00156	-0,04184
1982:4	-0,06566	-0,14785	0,22329	0,06775	0,02358
1983:1	-0,01417	-0,04192	0,01698	-0,03788	0,0026
1983:2	-0,0847	0,00414	-0,02831	-0,02695	-0,09505
1983:3	-0,01644	0,01821	-0,09324	-0,12915	-0,05351
1983:4	0,03217	0,03897	0,00589	0,05568	-0,01943
1984:1	-0,07531	0,03521	-0,06132	0,0382	0,01737
1984:2	0,09864	0,0214	-0,12944	-0,05979	-0,08284
1984:3	-0,02541	-0,00186	0,01378	-0,08149	-0,05842
1984:4	0,09958	-0,03059	0,18555	0,01744	0,03864
1985:1	-0,00268	-0,00215	0,09452	-0,05034	-0,06609
1985:2	-0,0416	-0,02705	0,03509	0,08532	0,04215
1985:3	0,13589	0,04037	0,0478	0,03476	0,0601
1985:4	0,07467	0,06755	-0,00019	0,08474	0,07761
1986:1	-0,12836	0,02026	0,09458	0,08316	0,02165

1986:2	0,17348	-0,08261	0,03294	0,12776	0,07205
1986:3	0,13868	0,03834	0,07085	0,07132	-0,03038
1986:4	-0,05346	0,07083	0,07898	0,06277	-0,09189
1987:1	-0,05841	0,08459	-0,02116	-0,05637	0,04785
1987:2	-0,07403	0,10124	-0,072	-0,08963	0,06219
1987:3	0,00284	-0,12287	-0,12695	0,03461	0,06972
1987:4	-0,03504	0,11404	-0,02453	0,10363	0,08766
1988:1	0,0294	0,03373	0,07852	-0,08288	0,01424
1988:2	-0,0349	0,04166	-0,06613	-0,02333	0,01465
1988:3	-0,04676	0,01856	-0,02756	-0,16885	-0,03261
1988:4	-0,06643	0,0959	-0,03527	-0,03608	0,14346
1989:1	-0,0637	-0,05517	-0,11006	-0,04	0,03548
1989:2	0,21463	0,0743	0,02461	0,00069	0,07135
1989:3	-0,06908	0,14868	0,16119	-0,15208	-0,00231
1989:4	-0,11367	0,08917	0,0749	-0,09754	0,19926
1990:1	-0,2528	0,22163	-0,00231	-0,19763	0,33223
1990:2	0,03524	-0,59292	-0,32306	0,09021	0,26492
1990:3	0,11576	0,19174	0,06764	0,0391	0,0209
1990:4	-0,31621	0,05547	0,02543	0,15193	0,06352
1991:1	-0,01011	-0,1889	0,07624	-0,19007	0,23741
1991:2	0,22978	0,00048	0,06857	-0,11453	-0,09896
1991:3	-0,00795	0,05253	0,06905	-0,04729	0,02384
1991:4	-0,31247	0,02009	0,06902	0,04684	0,03199
1992:1	0,07092	-0,09958	0,0035	-0,13668	0,24092
1992:2	0,06999	-0,00573	0,01827	-0,06466	0,06748
1992:3	-0,03188	0,05249	0,04483	0,04397	0,1393
1992:4	-0,00347	-0,03659	0,02514	-0,16585	0,00153
1993:1	0,15917	0,01175	0,10759	-0,22646	0,02585
1993:2	-0,04457	0,09564	0,04312	-0,0323	0,07529
1993:3	-0,06597	0,0528	0,04126	-0,11422	0,05872
1993:4	0,033	0,02646	0,0062	-0,16297	0,20018
1994:1	0,04223	0,06793	-0,01141	-0,19426	0,15076
1994:2	-0,06991	0,1331	-0,10104	-0,05061	0,15833
1994:3	0,12349	-0,10333	-0,1847	0,2158	0,14602
1994:4	0,14069	0,09432	-0,04305	0,0607	-0,03929
1995:1	0,02344	0,08202	-0,02453	0,11145	-0,00514
1995:2	-0,18306	0,0425	0,04975	0,13701	-0,02671
1995:3	-0,14371	-0,18788	-0,05096	-0,05554	-0,06845
1995:4	0,04519	-0,06894	0,01944	0,02278	-0,0271
1996:1	0,02517	-0,01281	0,03858	0,02547	-0,06613
1996:2	-0,03765	-0,03838	-0,03434	-0,03223	-0,10154
1996:3	0,09021	0,00023	-0,01659	0,02786	-0,00573
1996:4	0,01289	0,03616	0,05706	0,06237	-0,14989
1997:1	-0,01283	-0,10814	-0,01052	-0,04048	-0,02351
1997:2	0,04552	0,05757	-0,01058	0,06061	-0,03549
1997:3	0,0498	-0,01844	0,02069	0,03194	-0,06822
1997:4	-0,17187	-0,05511	0,01823	0,06289	-0,15288
1998:1	0,10002	-0,10817	0,02979	-0,10388	0,00069
1998:2	-0,02245	-0,03665	0,00921	0,02228	-0,08383
1998:3	-0,02534	-0,01803	0,03542	0,05658	-0,10449
1998:4	-0,13374	-0,1172	0,02976	0,04284	-0,07983
1999:1	0,08498	-0,06254	0,02202	-0,08076	-0,05918

OBS	F1	F2	F3	F4	F5
1999:2	-0,02218	-0,02747	-0,02549	-0,01935	-0,0644
1999:3	0,00999	0,02274	-0,05003	0,08396	0,01129
1999:4	0,03809	0,04012	-0,03674	0,06109	-0,09772
2000:1	0,01189	0,04278	-0,04482	0,03641	-0,01715
2000:2	0,03218	0,02199	0,0124	0,04044	-0,14643
2000:3	-0,02267	-0,00101	0,00043	0,08258	0,0034
2000:4	0,08033	-0,04481	0,05903	-0,02689	-0,13464
2001:1	0,04452	-0,00294	0,08708	0,05392	0,03185
2001:2	-0,11925	-0,14658	0,12004	-0,06516	-0,19381
2001:3	-0,05069	-0,14118	0,05393	-0,01211	-0,00533
2001:4	0,00374	-0,12303	0,13356	-0,10005	-0,12303
2002:1	0,07328	0,01875	0,02175	0,00939	-0,0436
2002:2	-0,0663	0,0102	-0,0364	0,12953	0,02029
2002:3	0,03834	-0,00684	-0,00973	0,15549	0,0804
1976:1	-0,01865	-0,06107	-0,00107	-0,14609	-0,04529
1976:2	-0,06368	-0,10153	-0,00234	-0,10194	0,00893
1976:3	0,05228	-0,02185	0,00829	-0,07421	-0,01955
1976:4	-0,12571	-0,02409	-0,03324	-0,05698	0,06458
1977:1	0,04477	0,02414	0,07509	-0,08702	-0,05767
1977:2	0,03116	0,00274	0,04743	-0,04799	0,0214
1977:3	0,0692	0,02841	0,05468	0,00808	-0,09308
1977:4	-0,16026	-0,0021	0,0613	0,06317	0,04181
1978:1	0,0299	-0,03178	0,07872	-0,0988	-0,03541
1978:2	0,01591	-0,07123	0,09736	-0,11186	-0,04469
1978:3	0,02464	0,00588	0,08419	0,00618	-0,04334
1978:4	-0,13769	-0,12196	0,13016	-0,05013	0,01292
1979:1	0,04376	-0,02295	0,10716	-0,07423	-0,05135
1979:2	0,00007	-0,04521	0,02529	-0,10444	0,0381
1979:3	0,07262	-0,0576	0,09682	-0,13639	0,06052
1979:4	-0,14057	-0,15662	0,19513	0,02385	-0,03383
1980:1	-0,05151	-0,1305	0,2022	-0,08933	-0,01803
1980:2	-0,01792	0,03464	-0,26914	-0,13048	0,03403
1980:3	-0,05196	0,01474	-0,10373	0,00424	0,01192
1980:4	0,02775	-0,06581	0,35274	0,26344	-0,20313
1981:1	0,16268	0,00862	0,1391	0,05045	-0,11382
1981:2	0,07031	0,10777	0,07602	0,10355	-0,02686
1981:3	0,08128	0,09467	0,07366	0,13501	-0,10472
1981:4	-0,01972	0,11714	-0,20742	-0,13645	0,13361
1982:1	-0,11969	-0,01866	-0,0363	0,08761	-0,11742
1982:2	0,02395	0,04275	-0,04051	0,05731	-0,10278
1982:3	0,02395	0,09652	-0,24135	0,0023	-0,04271
1982:4	0,06459	0,149	-0,22381	-0,06321	0,02305
1983:1	0,0135	0,04197	-0,01713	0,03665	0,00195
1983:2	0,08387	-0,00336	0,02809	0,02243	-0,09499
1983:3	0,01568	-0,01803	0,09357	0,12712	-0,05414
1983:4	-0,03303	-0,03801	-0,00607	-0,04937	-0,01917
1984:1	0,07517	-0,03451	0,06065	-0,03834	0,01876
1984:2	-0,09929	-0,02194	0,12992	0,05678	-0,08319
1984:3	0,02472	0,00274	-0,01359	0,08163	-0,05847
1984:4	-0,10065	0,03069	-0,18538	-0,01383	0,03799
1985:1	0,00186	0,00308	-0,09465	0,05123	-0,06505

1985:2	0,04073	0,02716	-0,03552	-0,08467	0,0419
1985:3	-0,13581	-0,03999	-0,04809	-0,03214	0,06163
1985:4	-0,07473	-0,06745	0,00003	-0,07908	0,07883
1986:1	0,12696	-0,01768	-0,09511	-0,07105	0,02393
1986:2	-0,17354	0,08172	-0,03322	-0,12558	0,07467
1986:3	-0,13891	-0,03874	-0,07093	-0,06947	-0,02907
1986:4	0,05259	-0,06963	-0,07901	-0,05296	-0,09105
1987:1	0,05892	-0,08551	0,02061	0,04517	0,04661
1987:2	0,07323	-0,09886	0,07189	0,09602	0,06038
1987:3	-0,00382	0,123	0,12652	-0,03577	0,07004
1987:4	0,0348	-0,11254	0,02389	-0,09662	0,08859
1988:1	-0,02981	-0,03386	-0,07839	0,08057	0,01297
1988:2	0,03458	-0,04068	0,06541	0,02174	0,01164
1988:3	0,04545	-0,01698	0,02759	0,17225	-0,03378
1988:4	0,06605	-0,09496	0,03484	0,03625	0,14292
1989:1	0,06284	0,05709	0,10962	0,04505	0,03642
1989:2	-0,21452	-0,07429	-0,02453	0,00429	0,07288
1989:3	0,06821	-0,14779	-0,16136	0,1522	-0,00384
1989:4	0,11247	-0,08691	-0,0755	0,10369	0,19829
1990:1	0,252	-0,21685	0,00077	0,21576	0,33354
1990:2	-0,03653	0,59262	0,32259	-0,08999	0,26646
1990:3	-0,11515	-0,1923	-0,06735	-0,04072	0,02139
1990:4	0,31533	-0,05299	-0,02628	-0,14877	0,06346
1991:1	0,00811	0,19107	-0,07698	0,19844	0,2349
1991:2	-0,23009	-0,00118	-0,0679	0,11183	-0,09883
1991:3	0,00707	-0,0508	-0,06977	0,05471	0,02386
1991:4	0,31153	-0,01968	-0,06922	-0,05462	0,03093
1992:1	-0,07156	0,09995	-0,00397	0,13344	0,2387
1992:2	-0,07063	0,00632	-0,01836	0,06336	0,06599
1992:3	0,03159	-0,05144	-0,04559	-0,03984	0,13977
1992:4	0,00223	0,03761	-0,02476	0,16544	0,00055
1993:1	-0,15988	-0,01143	-0,10688	0,22539	0,02337
1993:2	0,04414	-0,09421	-0,04341	0,03786	0,07501
1993:3	0,06471	-0,05182	-0,04141	0,11288	0,05751
1993:4	-0,03373	-0,02541	-0,00613	0,16485	0,19949
1994:1	-0,04248	-0,06799	0,01139	0,18911	0,14806
1994:2	0,06886	-0,12987	0,10028	0,0647	0,15994
1994:3	-0,12331	0,10339	0,18471	-0,20822	0,15151
1994:4	-0,1407	-0,09495	0,04374	-0,05877	-0,0383
1995:1	-0,02287	-0,08238	0,02462	-0,11484	-0,00531
1995:2	0,1825	-0,0412	-0,05012	-0,13218	-0,0271
1995:3	0,14284	0,18869	0,05056	0,05059	-0,07021
1995:4	-0,04599	0,06999	-0,01936	-0,01786	-0,02718
1996:1	-0,02542	0,01165	-0,03835	-0,03411	-0,0678
1996:2	0,03682	0,0389	0,03456	0,03106	-0,10204
1996:3	-0,09024	-0,00054	0,0167	-0,02982	-0,00545
1996:4	-0,01352	-0,03569	-0,05676	-0,05911	-0,14949
1997:1	0,01207	0,10773	0,011	0,03603	-0,02414
1997:2	-0,04564	-0,05743	0,01064	-0,06038	-0,03492
1997:3	-0,05026	0,01845	-0,02075	-0,03271	-0,06856
1997:4	0,17084	0,05611	-0,01789	-0,05962	-0,15185
1998:1	-0,10064	0,10655	-0,0293	0,09108	-0,00297

1998:2	0,02181	0,03713	-0,00896	-0,021	-0,08346
1998:3	0,02489	0,01822	-0,03524	-0,05593	-0,10465
1998:4	0,13307	0,11791	-0,02999	-0,04257	-0,07991
1999:1	-0,08565	0,06125	-0,02146	0,06792	-0,06257
1999:2	0,02135	0,02765	0,0257	0,01913	-0,06477
1999:3	-0,00998	-0,02366	0,05032	-0,08668	0,00978
1999:4	-0,03911	-0,03916	0,03678	-0,0505	-0,09375
2000:1	-0,01133	-0,04336	0,04494	-0,04778	-0,01789
2000:2	-0,03304	-0,02186	-0,01193	-0,03669	-0,14655
2000:3	0,02254	0,00015	0,00015	-0,08407	0,00281
2000:4	-0,08169	0,04554	-0,05888	0,03133	-0,13423
2001:1	-0,04406	0,0011	-0,0868	-0,06816	0,03132
2001:2	0,11782	0,14766	-0,11987	0,06546	-0,19498
2001:3	0,04946	0,1406	-0,05366	0,0083	-0,00812
2001:4	-0,00512	0,12494	-0,13357	0,11262	-0,12194
2002:1	-0,0724	-0,02158	-0,02076	-0,03371	-0,04551
2002:2	0,06567	-0,01013	0,03576	-0,12984	0,02049
2002:3	-0,0385	0,00625	0,00972	-0,15449	0,07976
2002:4	-0,01802	0,05633	-0,07466	0,08957	-0,11536

OBS	F1	F2	F3	F4	F5
1976:1	-0,01952	0,06122	0,00182	0,14308	-0,0468
1976:2	-0,06405	0,10165	0,00327	0,10251	0,00662
1976:3	0,05182	0,02218	-0,00814	0,07379	-0,02161
1976:4	-0,12562	0,02373	0,03387	0,05889	0,06366
1977:1	0,04391	-0,023	-0,07555	0,08359	-0,05772
1977:2	0,03078	-0,00201	-0,04767	0,04907	0,01976
1977:3	0,06863	-0,02724	-0,05529	-0,01041	-0,09267
1977:4	-0,16045	0,00253	-0,06097	-0,06156	0,04261
1978:1	0,02906	0,0327	-0,07856	0,09667	-0,03646
1978:2	0,01526	0,07248	-0,09688	0,11137	-0,04716
1978:3	0,02417	-0,00456	-0,08463	-0,00762	-0,04291
1978:4	-0,13793	0,12287	-0,12834	0,0523	0,01105
1979:1	0,04278	0,02437	-0,10729	0,07111	-0,05145
1979:2	-0,0006	0,0461	-0,02532	0,10391	0,03693
1979:3	0,07195	0,05859	-0,09639	0,1377	0,05745
1979:4	-0,14127	0,15873	-0,19349	-0,02361	-0,03382
1980:1	-0,05264	0,13278	-0,20106	0,08742	-0,01873
1980:2	-0,01814	-0,03701	0,26871	0,13012	0,03154
1980:3	-0,05215	-0,0159	0,10362	-0,0042	0,01206
1980:4	0,0274	0,06884	-0,35193	-0,26368	-0,20016
1981:1	0,16131	-0,00632	-0,14002	-0,05486	-0,11162
1981:2	0,06973	-0,10658	-0,07735	-0,10408	-0,02532
1981:3	0,08067	-0,09354	-0,07489	-0,13675	-0,10281
1981:4	-0,01993	-0,11845	0,20612	0,13664	0,13263
1982:1	-0,12033	0,01863	0,03623	-0,09051	-0,11556
1982:2	0,02364	-0,04245	0,03969	-0,06013	-0,10135
1982:3	0,0238	-0,09811	0,24013	-0,00395	-0,04212
1982:4	0,06402	-0,15047	0,22191	0,06226	0,02238
1983:1	0,01274	-0,04077	0,01588	-0,0385	0,00411
1983:2	0,08314	0,00444	-0,0287	-0,02598	-0,09369
1983:3	0,01501	0,01954	-0,09388	-0,12939	-0,05098
1983:4	-0,03345	0,03799	0,00613	0,04859	-0,02026

1984:1	0,07424	0,03578	-0,06072	0,03745	0,01882
1984:2	-0,09981	0,02337	-0,12955	-0,05906	-0,08159
1984:3	0,02396	-0,00238	0,01302	-0,08328	-0,0574
1984:4	-0,10053	-0,03264	0,18509	0,01496	0,03746
1985:1	0,00109	-0,00329	0,09438	-0,05348	-0,06381
1985:2	0,0404	-0,02668	0,03482	0,08464	0,04136
1985:3	-0,13628	0,03945	0,04857	0,03321	0,06064
1985:4	-0,07503	0,06718	0,00065	0,08101	0,07695
1986:1	0,12651	0,01674	0,09499	0,07355	0,02058
1986:2	-0,17397	-0,08179	0,03262	0,12581	0,07295
1986:3	-0,13917	0,03815	0,07136	0,06812	-0,02986
1986:4	0,05246	0,0686	0,07959	0,05276	-0,09314
1987:1	0,05784	0,087	-0,02004	-0,04639	0,04959
1987:2	0,07293	0,09935	-0,07126	-0,09407	0,06155
1987:3	-0,00432	-0,12152	-0,12791	0,03541	0,07069
1987:4	0,03424	0,1126	-0,02295	0,09912	0,08602
1988:1	-0,0301	0,03333	0,0784	-0,08015	0,01439
1988:2	0,03371	0,04214	-0,06543	-0,02255	0,01297
1988:3	0,04479	0,01762	-0,02794	-0,17353	-0,03053
1988:4	0,06521	0,0956	-0,03461	-0,03391	0,14347
1989:1	0,06219	-0,05594	-0,11031	-0,04358	0,03658
1989:2	-0,21484	0,07357	0,02533	-0,00325	0,07288
1989:3	0,0674	0,14704	0,16199	-0,154	-0,00021
1989:4	0,11169	0,08667	0,07556	-0,10038	0,20022
1990:1	0,25091	0,21717	-0,00013	-0,20863	0,33699
1990:2	-0,03764	-0,5891	-0,32886	0,09368	0,26397
1990:3	-0,11561	0,19169	0,06913	0,04071	0,0207
1990:4	0,31419	0,05443	0,02566	0,14855	0,06165
1991:1	0,00759	-0,19167	0,07458	-0,19334	0,23673
1991:2	-0,23048	0,00101	0,06773	-0,11568	-0,09546
1991:3	0,00672	0,05027	0,07051	-0,05251	0,02354
1991:4	0,31034	0,02117	0,06761	0,05023	0,0334
1992:1	-0,07187	-0,09985	0,00262	-0,13013	0,24194
1992:2	-0,07116	-0,00649	0,01828	-0,0624	0,06723
1992:3	0,03098	0,05125	0,04566	0,04176	0,13949
1992:4	0,00162	-0,03746	0,02406	-0,16601	0,00363
1993:1	-0,16003	0,01042	0,10683	-0,22488	0,02731
1993:2	0,04359	0,09389	0,0439	-0,03611	0,07543
1993:3	0,06374	0,05209	0,04119	-0,11295	0,05979
1993:4	-0,03442	0,02567	0,0057	-0,16234	0,20352
1994:1	-0,04306	0,06845	-0,01138	-0,18728	0,15207
1994:2	0,06805	0,13081	-0,09957	-0,0609	0,16052
1994:3	-0,12365	-0,10287	-0,18524	0,21358	0,14532
1994:4	-0,14107	0,09515	-0,04275	0,05869	-0,04017
1995:1	-0,0232	0,08271	-0,02385	0,11527	-0,00746
1995:2	0,18221	0,04081	0,05043	0,13328	-0,03062
1995:3	0,14243	-0,1874	-0,05287	-0,05268	-0,06851
1995:4	-0,04608	-0,07023	0,01883	0,01818	-0,02791
1996:1	-0,02565	-0,01168	0,03803	0,03249	-0,06839
1996:2	0,03636	-0,03833	-0,03507	-0,03319	-0,10134
1996:3	-0,09055	0,00094	-0,01672	0,02929	-0,00545
1996:4	-0,01382	0,03539	0,05704	0,0561	-0,15065

1997:1	0,01178	-0,10727	-0,01235	-0,03638	-0,02359
1997:2	-0,04612	0,05756	-0,00989	0,06	-0,03638
1997:3	-0,05045	-0,01846	0,02059	0,03164	-0,06906
1997:4	0,17032	-0,05545	0,01668	0,05634	-0,15285
1998:1	-0,10057	-0,10662	0,02811	-0,09096	-0,00118
1998:2	0,02145	-0,03695	0,00856	0,01976	-0,08419
1998:3	0,02449	-0,01814	0,03482	0,05426	-0,10589
1998:4	0,13268	-0,11744	0,02819	0,04006	-0,0796
1999:1	-0,08624	-0,05971	0,02003	-0,07111	-0,05981
1999:2	0,02118	-0,02747	-0,02578	-0,01974	-0,06471
1999:3	-0,01034	0,02439	-0,05018	0,08744	0,00813
1999:4	-0,03932	0,0392	-0,03615	0,04987	-0,09585
2000:1	-0,01159	0,04372	-0,04471	0,04752	-0,01855
2000:2	-0,03336	0,02198	0,01205	0,03495	-0,14818
2000:3	0,0222	-0,00016	-0,00023	0,08495	0,00065
2000:4	-0,08191	-0,04575	0,05843	-0,03382	-0,13378
2001:1	-0,04431	-0,00133	0,08674	0,06806	0,03053
2001:2	0,11739	-0,148	0,1179	-0,06873	-0,19473
2001:3	0,04919	-0,14041	0,05199	-0,00874	-0,00766
2001:4	-0,00515	-0,12626	0,13227	-0,11432	-0,12046
2002:1	-0,07275	0,02206	0,02052	0,03077	-0,04416
2002:2	0,06529	0,011	-0,03593	0,1302	0,0186
2002:3	-0,03869	-0,00601	-0,00955	0,15657	0,07665
2002:4	-0,01795	-0,05696	0,07431	-0,09	-0,11477
2003:1	0,06605	0,06044	-0,01514	0,12187	-0,0012

OBS	F1	F2	F3	F4	F5
1976:1	0,01843	-0,06058	-0,00382	0,14177	-0,04631
1976:2	0,06281	-0,10027	-0,00596	0,10124	0,00609
1976:3	-0,05315	-0,02194	0,00776	0,07216	-0,02127
1976:4	0,12373	-0,02226	-0,03546	0,05955	0,0631
1977:1	-0,04491	0,02172	0,07546	0,0827	-0,05707
1977:2	-0,03197	0,00165	0,04745	0,04824	0,01995
1977:3	-0,0698	0,02686	0,05563	-0,01198	-0,09159
1977:4	0,15803	-0,00184	0,05929	-0,06201	0,04357
1978:1	-0,02906	-0,03407	0,07807	0,09611	-0,03682
1978:2	-0,01556	-0,0737	0,09539	0,11051	-0,0476
1978:3	-0,02502	0,00375	0,08441	-0,00874	-0,042
1978:4	0,13615	-0,12322	0,12477	0,05092	0,01078
1979:1	-0,04294	-0,0261	0,10669	0,06968	-0,05115
1979:2	0,00082	-0,04665	0,02504	0,10485	0,03665
1979:3	-0,07205	-0,06002	0,09555	0,13715	0,05722
1979:4	0,14016	-0,15984	0,18937	-0,02574	-0,03367
1980:1	0,05238	-0,13501	0,19784	0,08572	-0,01803
1980:2	0,01524	0,04205	-0,26867	0,1293	0,03115
1980:3	0,05028	0,01821	-0,10425	-0,00372	0,0129
1980:4	-0,02787	-0,0735	0,34975	-0,2675	-0,19814
1981:1	-0,15986	0,00266	0,14123	-0,05509	-0,11093
1981:2	-0,07078	0,10494	0,07922	-0,10382	-0,02444
1981:3	-0,08167	0,09187	0,07601	-0,13724	-0,10136
1981:4	0,01757	0,12193	-0,20465	0,13932	0,13237
1982:1	0,1175	-0,01633	-0,03793	-0,09305	-0,11415
1982:2	-0,02516	0,0434	-0,03924	-0,0612	-0,10038

1982:3	-0,02596	0,10162	-0,2387	-0,00267	-0,04258
1982:4	-0,06586	0,15294	-0,21873	0,06396	0,02112
1983:1	-0,01407	0,04121	-0,01537	-0,0379	0,00475
1983:2	-0,08287	-0,00544	0,02924	-0,02622	-0,09284
1983:3	-0,01529	-0,02067	0,09336	-0,12985	-0,04928
1983:4	0,03233	-0,03733	-0,00716	0,04803	-0,02088
1984:1	-0,07452	-0,03697	0,06017	0,03739	0,01959
1984:2	0,09889	-0,02443	0,12817	-0,06053	-0,08137
1984:3	-0,0258	0,00365	-0,01356	-0,08563	-0,05583
1984:4	0,09795	0,03657	-0,18531	0,01537	0,03687
1985:1	-0,00256	0,00521	-0,09464	-0,05419	-0,06282
1985:2	-0,04118	0,02656	-0,03402	0,08615	0,03986
1985:3	0,13336	-0,03633	-0,05086	0,03161	0,06156
1985:4	0,07362	-0,06601	-0,00256	0,08036	0,07625
1986:1	-0,12845	-0,01506	-0,09516	0,0717	0,0206
1986:2	0,17075	0,08431	-0,03283	0,12503	0,07279
1986:3	0,13681	-0,03527	-0,07342	0,0663	-0,02991
1986:4	-0,05383	-0,06709	-0,08126	0,05042	-0,09383
1987:1	-0,058	-0,08781	0,01902	-0,04484	0,0501
1987:2	-0,07156	-0,10131	0,07032	-0,09176	0,0613
1987:3	0,00309	0,11986	0,12964	0,03607	0,07077
1987:4	-0,03437	-0,11295	0,02114	0,09977	0,08525
1988:1	0,02819	-0,03124	-0,07935	-0,08053	0,01499
1988:2	-0,03331	-0,04404	0,06509	-0,02006	0,01182
1988:3	-0,0459	-0,01773	0,02725	-0,17418	-0,02881
1988:4	-0,06579	-0,09552	0,03319	-0,03351	0,14417
1989:1	-0,06347	0,05441	0,11085	-0,04392	0,03726
1989:2	0,21204	-0,07053	-0,02843	-0,0048	0,07312
1989:3	-0,06856	-0,14448	-0,16448	-0,15396	0,00119
1989:4	-0,11273	-0,08545	-0,07691	-0,09866	0,20119
1990:1	-0,25036	-0,21789	-0,00281	-0,20617	0,34095
1990:2	0,03446	0,5849	0,33774	0,09561	0,26185
1990:3	0,11435	-0,18891	-0,07312	0,03961	0,02059
1990:4	-0,31228	-0,05705	-0,02394	0,15118	0,0585
1991:1	-0,01008	0,19333	-0,07196	-0,19066	0,23991
1991:2	0,22715	0,00283	-0,06989	-0,11797	-0,09427
1991:3	-0,00956	-0,04785	-0,07267	-0,05394	0,02463
1991:4	-0,30776	-0,02348	-0,06488	0,05377	0,03125
1992:1	0,06918	0,10093	-0,00233	-0,1276	0,24232
1992:2	0,0693	0,00776	-0,01879	-0,06173	0,06687
1992:3	-0,03182	-0,05058	-0,04629	0,04327	0,13905
1992:4	-0,003	0,03835	-0,02374	-0,16622	0,00407
1993:1	0,15689	-0,00651	-0,10857	-0,22552	0,02906
1993:2	-0,04418	-0,09276	-0,04541	-0,03578	0,07542
1993:3	-0,06479	-0,05151	-0,04171	-0,11233	0,06038
1993:4	0,03365	-0,0249	-0,00625	-0,1598	0,20366
1994:1	0,04138	-0,06716	0,00935	-0,18612	0,15413
1994:2	-0,06808	-0,13202	0,09708	-0,06051	0,16134
1994:3	0,12102	0,10255	0,18523	0,21133	0,14452
1994:4	0,13954	-0,09368	0,04015	0,05605	-0,04053
1995:1	0,02283	-0,08274	0,02252	0,11488	-0,00896
1995:2	-0,18131	-0,04194	-0,04947	0,13394	-0,03313

1995:3	-0,14264	0,18483	0,05707	-0,05113	-0,06865
1995:4	0,04446	0,07078	-0,01793	0,01782	-0,02879
1996:1	0,02423	0,01316	-0,03804	0,03138	-0,06801
1996:2	-0,03657	0,03728	0,03577	-0,03358	-0,10172
1996:3	0,08911	-0,00031	0,01609	0,02893	-0,0058
1996:4	0,01346	-0,0345	-0,05731	0,05473	-0,15187
1997:1	-0,01348	0,10776	0,01371	-0,03734	-0,02251
1997:2	0,04563	-0,05757	0,00873	0,05954	-0,0379
1997:3	0,04873	0,01939	-0,02089	0,03061	-0,06942
1997:4	-0,16986	0,05416	-0,01457	0,05537	-0,15408
1998:1	0,09777	0,10861	-0,02706	-0,09116	-0,00045
1998:2	-0,02218	0,03666	-0,00786	0,01906	-0,08509
1998:3	-0,0253	0,0183	-0,03436	0,05359	-0,10716
1998:4	-0,13273	0,11621	-0,02513	0,04091	-0,08043
1999:1	0,08413	0,06122	-0,01973	-0,07125	-0,06003
1999:2	-0,02165	0,02699	0,02619	-0,02004	-0,06447
1999:3	0,01052	-0,02572	0,05028	0,08827	0,00615
1999:4	0,0373	-0,0383	0,03419	0,04605	-0,09471
2000:1	0,01089	-0,04391	0,04391	0,04709	-0,01967
2000:2	0,0319	-0,02102	-0,01285	0,03254	-0,14898
2000:3	-0,02213	-0,00042	0,00106	0,08486	-0,00131
2000:4	0,07914	0,04786	-0,05876	-0,03596	-0,1328
2001:1	0,04269	0,00363	-0,087	0,06793	0,0291
2001:2	-0,11906	0,14923	-0,1154	-0,07056	-0,19429
2001:3	-0,04991	0,14015	-0,04879	-0,00737	-0,00907
2001:4	0,00287	0,1286	-0,13085	-0,1151	-0,11757
2002:1	0,07174	-0,02097	-0,02111	0,03087	-0,04611
2002:2	-0,06545	-0,01201	0,03619	0,13069	0,01769
2002:3	0,03846	0,00537	0,01023	0,15776	0,07302
2002:4	0,01536	0,0591	-0,07437	-0,0919	-0,11259
2003:1	-0,06558	-0,06099	0,01519	0,12222	-0,00339
2003:2	-0,05558	0,03648	-0,0268	0,03318	-0,01216