



Evaluation of the Diachronic Performance of the OECD Macroeconomic Forecasts for Greece

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Abstract

A variety of standard forecasting accuracy criteria and one suggestion are applied to evaluate the OECD's macroeconomic forecasts for Greece for the aggregate demand and output, the GDP implicit price deflator, the investment, the imports and the exports of goods and services. Every year and half-year the OECD provides projections for these variables published in the OECD Economic Outlook. Because these projections are used extensively by governmental and nongovernmental organizations, it is useful to examine their accuracy. Among some 'traditional' forecasting performance criteria another forecasting criterion is suggested in order to take into account the diachronic adjustment process between the forecasts supplied by OECD and the actual data the last 27 years. According to our results, irrespective of how accurate are the OECD's forecasts, there is certainly much room for further improvement. As predictors of direction the OECD's six-month ahead forecasts should be considered valuable; this cannot be said for forecasts which look ahead a year and 18 months.

Keywords: OECD Forecasts Accuracy, Greek Economy, Diachronic Adjustment Speed, Distributed Lags model, Monte Carlo Experiments.

JEL Classification: E17, E37, F17, F47

1. Introduction

Since 1967 the Organisation for Economic Co-operation and Development (OECD) has published semi-annual forecasts of economic activity in its seven largest member countries Canada, France, Germany, Italy, Japan, the UK and the USA. These forecasts, the last years extended to include all country members of the Organisation, covering the major components of demand and output, inflation and the balance of payments. According to Llewellyn J. and Arai H.,(1984) the OECD aims to "produce an integrated set of internationally consistent country forecasts, taking into account the linkages between economies". Across the years the forecasting methods employed by the OECD have evolved from the systematic but relative informal "pooling or confronting" of member country forecasts first dubious by Mc Mahon (1965) to a current large INTERLINK system of formal macroeconomic models which ensures consistency in forecasting world trade flows, capital flows and domestic economic developments. Llewellyn J. and Arai H.,(1984) explain the structure of INTERLINK and how the system is used for forecasting. OECD forecasting techniques are usually summarised in the Technical Appendix to each issue in the OECD Economic Outlook. Details of relevant research appear from time to time in the OECD Economics and Statistics Department's Working Papers and Occasional Studies, for example: Richardson P. (1988), Artis M.J (1988), Ballis B, (1989), Barrionuevo M, (1993) and Koutsogeorgopoulou V, (2000).

The OECD publishes its forecasts twice a year in the June/July and December issues of OECD Economic Outlook making available one-two and three step ahead forecasts. The forecasts cover the current and the next calendar years. Although a lot of attention has been paid to analyse the performance of these one-two and three step ahead OECD forecasts using standard forecasting performance measures¹ little has been done to analyse the diachronic relationships between these forecasts and the actual data. Well used forecasts error measures, such as the mean square forecasts error and other 'traditional' forecasting criteria, do not provide always a reliable basis for forecasts evaluation and comparison of forecasting methods. For empirical evidence on this, see Armstrong S. and Collopy F. (1992).

¹ Ash K., Smyth J. and Heravi S. M., 1990, 1991, Ballis B., 1989, Holden K. and Peel D.A., 1985, 1990, Holden K., Peel D.A. and Sandhu B., 1987, Llewellyn J. and Arai H., 1984. Richardson P., 1988, Smyth J., 1983, Smyth J. and Ash J., 1981, Artis, J. 1997, Barrionuevo, M., 1993, DeMasi, P. 1996, Kreinin, M. 2000, Koutsogeorgopoulou V. 2000 and Vuchelen, J. and Gutierrez, M. 2005.

In this paper using Greek data we analyse the diachronic relationship between the actual data and the one-, two- and three-step OECD forecasts, henceforth denoted by F_{1t} , F_{2t} and F_{3t} respectively, for seven macroeconomic variables namely: aggregate demand and output, GDP Implicit Price Deflator, investment, imports and exports of goods and services, all at 1995 constant prices. The assessment provided here differs in approach from earlier assessments, but its purpose is similar. Among some 'traditional' forecasting performance measures, a polynomial distributed lags model (Almon S. 1965), is used to measure the diachronic adjustment process between the actual data and the forecasts supplied by OECD the last 27 years. Some Monte Carlo results are applied in order to prove that the suggested forecasting evaluation criterion is additional to the 'standard' or 'traditional' forecasting evaluation criteria.

For the case of Greece until to date, we have not seen studies of this kind² for studding the forecasting performance of the OECD forecasts. In a lot of studies the analysis of the OECD forecasts performance for the Greek economy, is only a part of a panel of countries and usually refer to a few economic magnitudes using some standards forecast performance measures and tests. Exception are the studies of Tserkezos Dik., 1996 α,β , 1997 and 1998, were the diachronic speed of adjustment of the OECD forecasts to the actual data is used as an additional forecasting evaluation criterion. Although these studies use a different sample period, appears to indicate that there is still much room for forecasting improvement.

This paper is organised as follows: In section 2 the available data and the suggested forecasts evaluation criterion with some Monte Carlo experiments are discussed in some detail. The empirical results are presented and discussed in section 3. Conclusions and some thoughts for further research are given in section 4.

2. Data and Forecasting Performance Measures.

The OECD publishes annual forecasts for the ensuing eighteen months (Three half-years). Thus we evaluate one, two and three step ahead forecasts,

² One exception is the work of Christodoulakis and Mamatzakis (2008). These authors assess whether there exist asymmetries in the loss preference of the EUR Commission's GDP growth forecasts from 1969 to 2004 for 12 countries including Greece as well. The evidence further reveals that the Commission forecasting exercise could be subject to caveat.

labelling F_{1t} , F_{2t} and F_{3t} respectively. In each case let F_{jt} , $j=1,2,3$ be the forecasted time series and A_t ($t=1,2,\dots,T$) be the time series of corresponding outcomes. To give a picture of the available data, in figure 1 we present the one-two- and three-step ahead OECD forecasts and the actual percentage changes of the Greek Total Domestic Demand at 1995 constant market prices during the period 1980-2006.

Actual Total Domestic Demand.

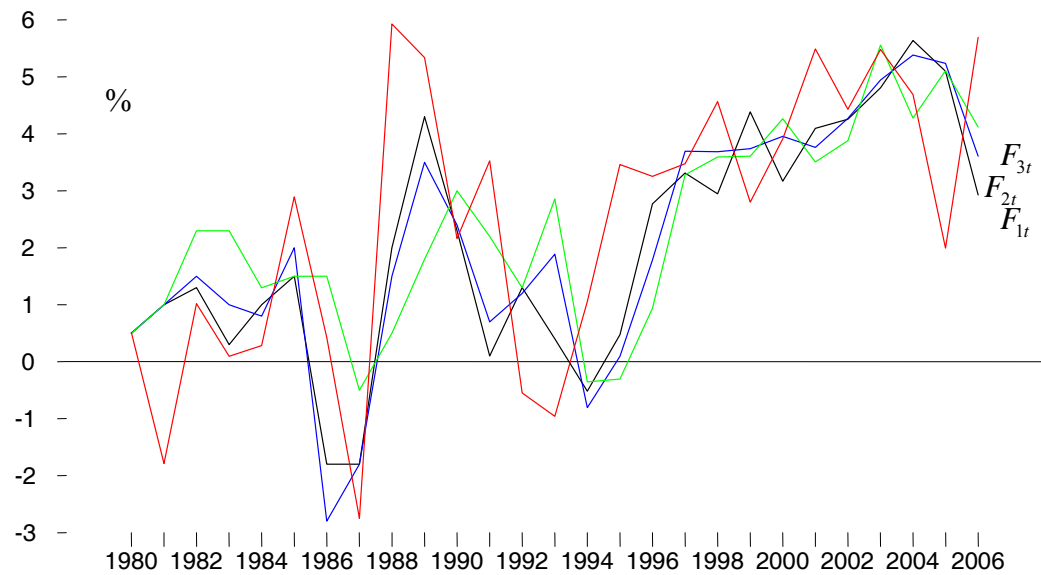


Figure 1. One-, two- and three-step ahead OECD forecasts and the actual percentage changes of the Greek Total Domestic Demand at 1995 constant prices.

In a lot of studies concerning the evaluation of forecasts, traditional measures such as : the Mean Forecast Error , the Mean Absolute Error ,the Root Mean Square Error, the Theil's 1966 Inequality Measure, the Bias Proportion of MSE , the Variance Proportion of MSE and the Covariance Proportion of MSE , are in the first line in the empirical part of the analysis. These well known forecasts error criteria do not provide always a reliable basis for evaluation of forecasts and comparison of different forecasting methods. For empirical evidence on this, see Armstrong S. and Collopy F. (1992). In this paper we suggest another forecasting performance criterion, the Average Lag Reactions or the Diachronic Speed of Adjustment coefficients , in order to measure the adjustment process between the actual data (A_t) and the three OECD's forecasts (F_{jt} , $j=1,2,3$). To measure this diachronic adjustment process a Polynomial Distributed Lags model¹ (Almon S.,1965) is used between the forecasts (F_{jt} , $j=1,2,3$) and the actual data (A_t):

$$F_{jt} = \gamma_j + \sum_{i=0}^{s_j} \beta_{ji} A_{t-i} + \varepsilon_{jt} \quad (1)$$

$$\beta_{ji} = f_j(z) = a_{0j} + a_{1j}z + a_{2j}z^2 + \dots + a_{r_j}z^{r_j} \quad (2)$$

$t=1980, \dots, 2006. \quad z = 0, 1, 2, 3, \dots, s_j \quad j = 1, 2, 3$

where:

¹ The choice of this quite old fashion but still useful polynomial distributed lags model instead of a more general ARDL (Autoregressive Distributed Lags Model), it is well known that imposes strong and some times incorrect restrictions on the lagged response of the OECD forecasted to the actual data. This choice was necessary mainly due to data availability. We must clarify that we use the specification (1) and (2) not to identify any possible causality effects between the actual data and the OECD forecasts. From theoretical reasons there are not feedback causality effects, although someone could comply that there is a sort of causality running from the actual data to the forecasts. We simply use the above polynomial distributed lags specification to schedule the diachronic relationship between the actual data and the OECD forecasts.

A_t : Actual data

F_{jt} : One-, two- and three-step ahead OECD forecasts (F_{1t} , F_{2t} and F_{3t}) for each variable.

$\gamma_j, \beta_{ji}, s_j, r_j$ and $a_{m,j}$ for $j = 1, 2, 3$ OECD forecasts,

$i = 0, 1, 2, \dots, s_j$ and $m_j = 0, 1, 2, \dots, r_j$: parameters under estimation.

The estimation procedure of the parameters of the specification (1)-(2) is presented in the Appendix. Having available estimates of the parameters β_{ji}, s_j, r_j for $j = 1, 2, 3$ (Forecasts), we may estimate the average lag reactions or the Diachronic Speed of Adjustment coefficients of the OECD forecasts to the actual data as follows:

$$\text{Diachronic Speed of Adjustment coefficients: } \hat{\lambda}_j = \frac{\sum_{i=1}^{\hat{s}_j} i \hat{\beta}_{ji}}{\sum_{i=1}^{\hat{s}_j} \hat{\beta}_{ji}} \quad (3)$$

with

$j = 1, 2, 3$ (Number of OECD's Forecasts)

$s_{j=1,2,3}$: Number of Distributed Lags

and $\hat{\beta}_{ji}$ are the least squares estimates of the parameters β_{ji} .

Good forecasts adjustment to the actual data except that : $\lambda_1 < \lambda_2 < \lambda_3$,

requires a value of $\hat{\lambda}_{kj}$ (for $j = 1, 2, 3$ and $k = 1, 2, \dots, 7$) close to zero. If

$\hat{\lambda}_{kj}$ is getting greater than zero the adjustment process of the forecasts to the actual data is getting slower.

Some Monte Carlo Experiments

In order to 'prove' that the suggested forecasting evaluation criterion works additional with similar 'traditional' forecasting evaluation measurements we conducted a Monte Carlo experiment. Our experiment is based on the following stochastic equations:

The actual data x_t were generated applying the following autoregressive processes:

$$x_t = \tau x_{t-1} + (\sqrt{(1-\tau)^2})w_t$$

(4)

$$w_t \approx NID(.25)$$

(5)

The values of the parameter τ in the relation (4) were chosen to give different autoregressive characteristics on the data generating processes of the exogenous variables ($\tau_1 = .1$ $\tau_2 = .5$ $\tau_3 = .98$).

The forecasted fx_t data were obtained using the stochastic formula²:

$$fx_t = (1-\lambda)(x_t - fx_{t-1}) + fx_{t-1} + \xi_t \quad (6)$$

$$\xi_t \approx NID(.25) \quad (7)$$

$$0 \leq \lambda \leq 1 \quad (8)$$

For different (randomly selected) values of $0 \leq \lambda \leq 1$ and $0 \leq \tau \leq 1$ we generate through the relation (4) the actual data and analogous forecasts using the relation (6). In each of the 10000 iterations we evaluate the actual and the forecasts using some of the well known 'traditional' forecasting evaluation criteria. Some of the results of this experiment are presented in Figure 2, where we present the frequency distributions of four of the traditional forecasting evaluation criteria at different values of the adjustment coefficient $0 \leq \lambda \leq 1$ and with $\tau = .5$ ³. It is clear that the 'traditional' forecasting criteria are invariant

² According to the formula (4) the forecasts fx_t and the actual data x_t are related with a partial adjustment process as : $(fx_t - fx_{t-1}) = (1-\lambda)(x_t - fx_{t-1}) + \xi_t$, with

$$\xi_t \approx NID(.25)$$

³ More simulation results are available by request.

with the diachronic adjusted process between the actual and the forecasts. These results constitute another reason to use the diachronic adjusted coefficients in addition with the traditional forecasting evaluation criteria.

3. The Empirical Results

We analyse the OECD forecasts for the seven macroeconomic variables⁴ as they presented on Table 1. Some empirical results based on 'standard' forecasts evaluation measures (Theil H. 1961 and 1966) are presented in the first five columns on Table 1 among with the estimated Diachronic Speed of Adjustment coefficients. The Diachronic Speed of Adjustment coefficients estimates on Table 1, are revealing and give more information about the diachronic characteristics of the OECD's forecasting ability.

About the Diachronic Speed of Adjustment coefficients, we may conclude that only in three of the seven macroeconomic variable cases we may observe that: $\lambda_1 < \lambda_2 < \lambda_3$. About 90% of the cases we observe that: $\lambda_2 > \lambda_1$ and quite disappointing we observe that four times out of seven $\lambda_2 > \lambda_3$.

In addition according to the results of Table 1 the variable with the most drastic improvement of the OECD forecasts to outcomes and the lower Diachronic Speed of Adjustment coefficients is the GDP Implicit Price Deflator. Other economic time series, such as the Gross Fixed Capital Formation and Exports of Goods and Services have also improved quite rapidly the F_{1t} , F_{2t} and F_{3t} forecasts to the outcomes although their Diachronic Speed of Adjustment coefficients are not that low compared with analogous Diachronic Speed of Adjustment coefficients of other variables of Table 1. Gross Domestic Product (GDP) at Market Prices and Private Consumption has only a partial forecasting improvement from F_{3t} directly to F_{1t} forecasts. Quite disappointed is the improvement of the F_{1t} , F_{2t} and F_{3t} forecasts to outcomes in the case of the variable of Imports of Goods and Services and the Total Domestic Demand.

⁴ For space reasons we do not present and analyse analogous results based on standard forecast encompassing tests (Granger C.W.J., and Newbold P. 1985, Diebold, F. X. and Mariano, R. S. 1995 and Harvey, D. I., Leybourne, S. J. and Newbold, P. 1997).

Frequency Distributions of Forecasting Criteria for Different Adjustment Coefficients

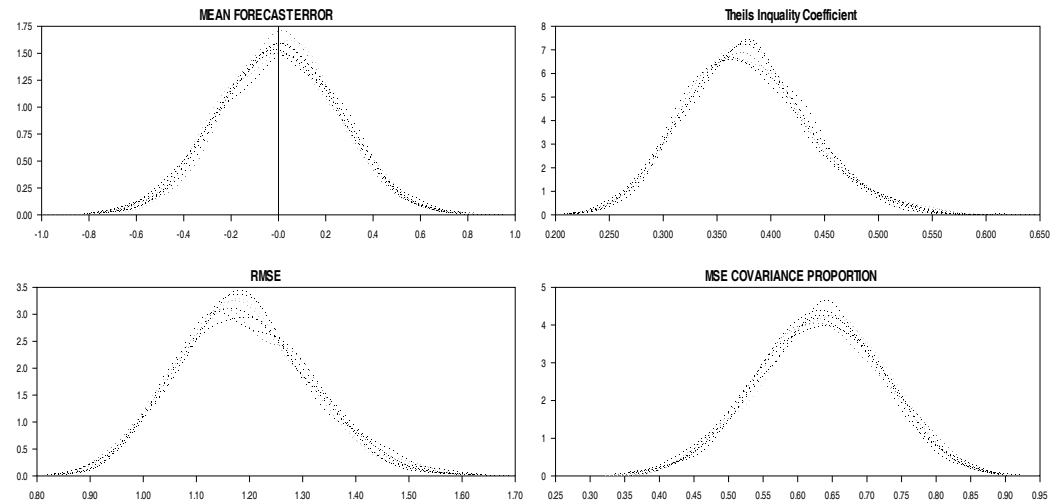


Figure 2. Frequency Distributions of ‘traditional’ forecasting performance criteria with different forecasts adjustment coefficients $0 \leq \lambda \leq 1$ and $\tau=.5$.

Comparing the results of columns (1-5) and the columns (6-7) of Table 1, we may conclude that there are not serious contradictions between the 'traditional' forecasting measurements and the suggested measurement of the diachronic speed of adjustment of the forecasts and the actual data. The estimated Speed of Adjustment coefficients are substitutive to the results of the first five columns of Table 1 where we analyze the OECD forecasting performance using 'standard' forecasting performance criteria. For example the variable of Imports of Goods and Services which has the worst forecasting accuracy according to the traditional forecasting evaluation criteria of Table 1, according to our results this variable has a quite high Diachronic Speed of Adjustment coefficient and improves the forecasts F_{1t} , F_{2t} and F_{3t} to the outcomes, a result which is on the line with the results of Table 1 and especially with the Bias, the Variance and the Covariance Proportion of the Mean Square Error (MSE) in the three last columns of Table 1.

Table 1. ‘Standard’ and the Diachronic Speed of Adjustment coefficients forecasting evaluation measurements between the actual data and the OECD forecasts.

| Variable | RMSE | U ₆₆ | U ^B | U ^V | U ^c | Diachronic Speed of Adjusted coefficients: $\hat{\lambda}_j = \frac{\sum_{i=1}^{\hat{s}_j} i \hat{\beta}_{ji}}{\sum_{i=1}^{\hat{s}_j} \hat{\beta}_{ji}}$ | Comparisons of the Diachronic Speed of Adjusted coefficients |
|--|---------|-----------------|----------------|----------------|----------------|---|--|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1. Private Consumption. | | | | | | | |
| One Step Ahead Forecasts | 2.09421 | 0.35033 | 0.04786 | 0.00194 | 0.95020 | 1.95182 | $\lambda_1 < \lambda_2 > \lambda_3$ |
| Two Step Ahead Forecasts | 2.06346 | 0.34885 | 0.10958 | 0.00076 | 0.88966 | 2.25789 | |
| Three Step Ahead Forecasts | 2.08215 | 0.34534 | 0.08125 | 0.00385 | 0.91490 | 2.19898 | |
| 2. Gross Fixed Capital Formation. | | | | | | | |
| One Step Ahead Forecasts | 6.94239 | 0.60293 | 0.00215 | 0.50392 | 0.49393 | 1.83465 | $\lambda_1 < \lambda_2 < \lambda_3$ |
| Two Step Ahead Forecasts | 7.11284 | 0.62864 | 0.00005 | 0.61351 | 0.38644 | 2.05679 | |
| Three Step Ahead Forecasts | 7.33804 | 0.63621 | 0.00571 | 0.65143 | 0.34286 | 2.61664 | |
| 3. Total Domestic Demand. | | | | | | | |
| One Step Ahead Forecasts | 1.77322 | 0.28163 | 0.04098 | 0.04859 | 0.91042 | 2.39198 | $\lambda_1 > \lambda_2 > \lambda_3$ |
| Two Step Ahead Forecasts | 1.90770 | 0.29936 | 0.02569 | 0.03109 | 0.94322 | 2.37225 | |
| Three Step Ahead Forecasts | 2.12942 | 0.33802 | 0.00145 | 0.11740 | 0.88115 | 2.29754 | |
| 4. Exports of Goods and Services. | | | | | | | |
| One Step Ahead Forecasts | 6.36545 | 0.54935 | 0.21887 | 0.16206 | 0.61907 | 5.12122 | $\lambda_1 < \lambda_2 < \lambda_3$ |
| Two Step Ahead Forecasts | 6.22826 | 0.53981 | 0.24372 | 0.16435 | 0.59193 | 5.22511 | |
| Three Step Ahead Forecasts | 5.89020 | 0.51939 | 0.22864 | 0.29988 | 0.47149 | 5.77387 | |

Table 1(Continue).

| <i>5. Imports of Goods and Services.</i> | RMSE | U ₆₆ | U ^B | U ^V | U ^C | Diachronic Speed of Adjusted coefficients $\hat{\lambda}_j = \frac{\sum_{i=1}^{\hat{s}_j} i \hat{\beta}_{ji}}{\sum_{i=1}^{\hat{s}_j} \hat{\beta}_{ji}}$ | Comparisons of the Diachronic Speed of Adjusted coefficients |
|--|---------|-----------------|----------------|----------------|----------------|--|--|
| One Step Ahead Forecasts | 7.21472 | 0.56542 | 0.06692 | 0.55935 | 0.37373 | 3.05679 | $\lambda_1 < \lambda_2 > \lambda_3$ |
| Two Step Ahead Forecasts | 7.20932 | 0.55444 | 0.05706 | 0.50397 | 0.43898 | 3.43837 | |
| Three Step Ahead Forecasts | 7.24645 | 0.56563 | 0.06656 | 0.52626 | 0.40718 | 3.25038 | |
| <i>6. GDP at Market Prices.</i> | | | | | | | |
| One Step Ahead Forecasts | 1.34913 | 0.23086 | 0.00324 | 0.11228 | 0.88448 | 1.17949 | $\lambda_1 < \lambda_2 > \lambda_3$ |
| Two Step Ahead Forecasts | 1.64461 | 0.28264 | 0.00089 | 0.07722 | 0.92189 | 2.19996 | |
| Three Step Ahead Forecasts | 1.90149 | 0.31599 | 0.03350 | 0.07997 | 0.88653 | 2.03262 | |
| <i>7. GDP Implicit Price Deflator.</i> | | | | | | | |
| One Step Ahead Forecasts | 1.48952 | 0.04147 | 0.00801 | 0.01742 | 0.97456 | 0.751125 | $\lambda_1 < \lambda_2 < \lambda_3$ |
| Two Step Ahead Forecasts | 2.88652 | 0.08231 | 0.09015 | 0.07698 | 0.83287 | 0.931157 | |
| Three Step Ahead Forecasts | 3.84716 | 0.10992 | 0.08375 | 0.14844 | 0.76781 | 1.37365 | |

Source: Our Estimates (RMSE: Root Mean Square Error, U₆₆: Theil's 1966 Inequality Measure, U^B: Bias Proportion of MSE; U^V: Variance Proportion of MSE; U^C: Covariance Proportion of MSE). All estimates are statistical significant at the 1% significance level. Estimates of the parameters of the model, the degree of the polynomial and the number of distributed lags were obtained using the Akaike (1973) selections criterion: $Akaike = -2 \log L/T + 2K/T$ where L is the Loglikelihood function of (1), T is the number of the available observations and K is the number of the regressors.

Lastly, a further confirmation of the quantitative performance of the OECD forecasts is provided by estimating the geometric mean of the Diachronic Speed of Adjusted coefficients of the seven economic series, as follows:

Geometric Mean of the Diachronic Speed of Adjusted coefficients:

$$GM_{j=1,2,3} = \prod_{i=1}^{k=7} (\hat{\lambda}_{ij})^{1/k} \quad (9)$$

Using the estimates of the diachronic adjusted coefficients on the Table 1 the Geometric Means of the Diachronic Speed of Adjusted coefficients (GM_j) of the OECD's forecasts are: 1.98986, 2.31798 and 2.49850 for the one-, two- and three-step ahead OECD forecasts (F_{1t} , F_{2t} and F_{3t}) respectively. These geometric means of the Diachronic Speed of Adjusted coefficients are very high compared with the lowest Diachronic Speed of Adjusted coefficients of the GDP Implicit Price Deflator and the highest Diachronic Speed of Adjusted coefficients of Exports of Goods and Services.

Independently of how low or high are the Diachronic Speed of Adjusted coefficients $\hat{\lambda}_{(k=1,2,\dots,7)(j=1,2,3)}$, our results confirm that the OECD forecasts on the average adjust better to the real data when the forecast period is decreased. Especially, on the basis of the Geometric Mean Diachronic Speed of Adjusted coefficients, we may conclude that on the average the quickest adjustment of forecasts to outcomes is presented in the one step ahead forecast. Following this step are the two and three step ahead forecasts respectively.

The above results in relation with the 'traditional' forecasting evaluation criteria confirms: first the slow forecasting adjustment of the OECD forecasts, second the inability of the forecasting methods OECD uses to rapidly incorporate a large part of the most recent information about the actual values of the economic data and final that there is certainly much room for further improvement in the future minimizing the distance of the Geometric Mean Diachronic Speed of Adjusted coefficients from the lowest Diachronic Speed of Adjusted coefficients of the GDP implicit price deflator.

4. Conclusions.

Efforts by the OECD to provide forecasts of crucial variables are clearly warranted. The analysis of the diachronic behaviour of the OECD one- two and three step forecasts F_{1t} , F_{2t} and F_{3t} in relation to the attained sizes is interesting and revealing. Using data of the period 1980 – 2006 for the seven important macro economic variables of the Greek economy we verified the potentials of the OECD to improve on the average its forecasts as the size decreases of the foreseeable period, and at the same time we located those economic time series which the forecasts of OECD are not greater effective. We refer to the case of the Imports of Goods and Services and the Total Expenditure of the Economy, in which, according to our results, the Diachronic Speed of Adjustment coefficients of the adaptations F_{1t} , F_{2t} and F_{3t} do not decrease as the forecast period is decreased.

Independently of the ability of the OECD forecasts to adjust on the average better to the real data when the forecast period is decreased, the Diachronic Speed of Adjusted coefficients $\hat{\lambda}_{(k=1,2,\dots,7)(j=1,2,3)}$ are still very high confirming that there is certainly room for further quantitative improvement. The geometric mean Diachronic Speed of Adjusted coefficients are also very high compared with the lowest Diachronic Speed of Adjusted coefficients of the GDP Implicit Price Deflator and the highest Diachronic Speed of Adjusted coefficients of Exports of Goods and Services. All the above in relation with the ‘traditional’ forecasting measurements confirms the slow forecasting adjustment of the OECD forecasts to the actual outcomes and at the same time the inability of the forecasting methods it uses to rapidly incorporate a large part of the most recent information about the actual values of the economic data.

Finally comparing these results with analogous results based mainly on ‘standard’ forecasting criteria, we may conclude that on the average there are not contradictions. The methodology of testing the diachronic behaviour of the OECD macroeconomic forecasts for Greece, could become even more effective if we use more complicated dynamic models, if we take into account possible improvements in the quality of these forecasts and of course to compare the results of Table 1 with the analogous results for OECD forecasts for other countries. Lastly, one of our immediate objectives is to compare the forecasts of the OECD concerning the Greek economy with the analogous forecasts of various organizations as the International Monetary Found (IMF), the EUR

Commission's forecasts and the forecasts of the Greek Ministry of National Economy.

Appendix.

In order to estimate efficiently the parameters of the specification (1) and (2), we followed an iterative process suggested by Sirley Almon (1965) and extended by Pagan A. (1978), Pagano M., and Hartley M. (1981) and Andrews D., and Fair R., (1992), to minimize the sums:

$$\min_{\hat{\alpha}_{mj}, \hat{\gamma}_j, \hat{r}_j, \hat{s}_j, \hat{\beta}_{ji}} \sum_{t=1+s_j}^T (F_{jt} - \hat{\gamma}_j - \sum_{i=0}^{\hat{s}_j} \hat{\beta}_{ji} A_{t-i})^2 \quad (10)$$

$$\text{Subject to: } \hat{\beta}_{ji} = \sum_{m=0}^{\hat{r}_j} \hat{a}_{mj} z^m \quad (11)$$

with $j = 1, 2, 3$ $i = 0, 1, 2, \dots, s_j$ $m = 0, 1, 2, 3, \dots, r_j$

Having estimates of the parameters $\hat{\alpha}_{ji=1,2,\dots,r_j}, \hat{\gamma}_j, \hat{r}_j, \hat{s}_j$ we may obtain estimates of the parameters $\hat{\beta}_{ji}$ for $j = 1, 2, 3$ (Forecasts) using the relations $\hat{\beta}_{ji} = \hat{a}_{0j} + \hat{a}_{1j} z + \hat{a}_{2j} z^2 + \dots + \hat{a}_{r_j} z^{\hat{r}_j}$. The choice of the appropriate lags distributions and the order of the polynomial has been made using the well known Akaike Information Criterion (Akaike, 1973) and Bayesian Information Criterion (Schwarz, 1978):

$$Akaike = -2 \log L / T + 2K / T \quad (12)$$

$$Schwartz = -2 \log L / T + \log(T)(N) / T \quad (13)$$

where L is the Loglikelihood function of (1), T is the number of the available observations and K is the number of the regressors.

More information about this minimization procedure is available by request, although some very interesting references can be found in Almon S.(1965), Harvey, G. (1981) Maddala G (1977) and Pindyck S. and Rubinfeld D. (1981). The application of a Seemingly Unrelated Regression System (SURE) technique to take into account the possible information's contained in variance-covariance matrix of the disturbance terms of the one-, two- and three-

step ahead OECD forecasts (F_{1t} , F_{2t} and F_{3t}) for each variable, did not improve scientifically our results.

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