"MOVING MEDIAN"
A METHOD OF AUTOCORRELATION SOLUTION

by Eleftherios Giovanis*

*Graduate from the University of Thessaly, department of Economics

Candidate for the Master program of Economics in the University of Macedonia, Department of Economics

Researcher in statistical and econometrics projects in corporation with the of Economic Chamber of Serres in Greece www.eves.gr

Mail address: 10 Alexandrou Panagouli, e-mail: giovanis@freemail.gr

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ELEFTHERIOS GIOVANIS

ABSTRACT

In econometric theory an important problem of estimation is the appearance of autocorrelation and of course the solution of it so that we will be able get off the problem of the autocorrelation from the old model ant to conduct to a new econometric model to forecast the prises in the future as always something like that can be possible.

Key words: basic econometrics, moving median, autocorrelation solution, method of Durbin in two steps , repetitive method of Cochrane – Orcutt
Jel classification: c40

INTRODUCTION

This work is constituted by the first chapter in which we will present the methodology in its theoretical form and in the second chapter, where is analyzed the repetitive method of moving median for the solution of autocorrelation. This method does not constitute an original discovery, after it is based exclusively on the estimate of ρ with the method of two steps of Durbin[1] in combination with the repetitive method of Cochrane – Orcutt[2]. Consequently it constitutes an alternative method of exemption of model from the problem of autocorrelation. We will examine three very simple econometric models, as it is not interest for us the study of the econometric model, but the existence of autocorrelation and the solution of it. The first model receives the private consumption of United States America as dependent variable and the personal disposable income as independent variable. The second model examines once again the private consumption and the income, but this time concerns the Greek economy and more specific the rural sector. The third and the last model examines the demanding quantity of fertilizers as dependent variable and the price of fertilizers as independent variable. The demanding quantity concerns the quantity that demand the farmers. These sizes concern once again the Greek rural sector.

1. J. Durbin, «Estimation of parameters in Time-series Regression models», Journal of the Royal Statistical society, ser. B, vol.22, pp 139-153.
2.Guzarati N. Damodar, "Basic Econometrics", McGraw - Hill International Editions, Economic Series, Third Edition, New York 1995, pages 430-433.

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CHAPTER ONE: MOVING MEDIAN- A THEORETICAL APPROACH

The methodology, as it was also reported just previous is based exclusively on the estimate of ρ with the method of two steps of Durbin (Kintis 1982) in combination with the repetitive method of Cochrane - Orcutt. (Guzarati, 1995). The first step that we make is receive the ρ. Let's suppose that we have the following econometric model.

$$\mathbf{Y_t = b_o + b_1 X_t \qquad (1)}$$

We suppose that model (1) presents autocorrelation. In order to find the ρ we are taking first the moving median. If the data concern four-month periods, then we will take the moving median of four periods, after the one year is constituted by four four-month periods. If the data concern share, then it is obvious that we will take the moving median of five periods. If the data concern years then we can take the moving median of four or the five or even seven periods , a subject that is a matter of empiric and is also based on the chance. Let's take the moving median of four periods for equation (1) The model it ill be:

$$\mathbf{\Delta Y_t = b_o + b_1 \Delta X_t + b_2 \Delta Y_{t-1} + b_3 \Delta X_{t-1} \quad (2)}$$

ΔY_t = moving median of variable Y
ΔX_t = moving median of variable X
ΔY_{t-1} = moving median of variable Y with a time lag
ΔX_{t-1} = moving median of variable X with a time lag

Consequently the ρ results from the factor of variable ΔY_{t-1} , that is concretely factor b_2 Next step is henceforth to find the new variables. For factor Y we have:

$$Y^{\wedge} = \Delta Y_t + \varrho * \Delta Y_{t-1} \text{ and } \quad X^{\wedge} = \Delta X_t + \varrho * \Delta X_{t-1}$$

, where symbol * express the multiplication

Because the new variables Y^ and X^ have lost the first price we have to find the first price with the following transformation:

$$Y_1\sqrt{1-\rho^2} \quad \text{και} \quad X_1\sqrt{1-\rho^2}$$

, where Y_1 is the first price of variable ΔY_t of model (2) and no variable Yt of model (1). Similarly for variable X_1. This transformation is known as Prais-Winsten transformation.

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3. Guzarati N. Damodar, "**Basic Econometrics**", McGraw - Hill International Editions, Economic Series, Third Edition, New York 1995, pages 427-428.

The new model will be the following:

$$\mathbf{Y_t\hat{} = b_o + b_1X_t\hat{}} \qquad \mathbf{(3)}$$

Until now the process concerned the method of two steps of Durbin. Now we run the new regression (3) and if the model presents again autocorrelation, then we are taking again the moving median not of variables of equation (1), but the moving median of variables of the new equation (3). This precisely is the point that concerns the repetitive method Cochrane - Orcutt (Kaskarelis 2000). Finally we achieve to exempt the model from the existence of autocorrelation and we wish to forecast for a period after (Christou 2001). The new model will be:

$$\mathbf{Y_t\hat{} = b_o\hat{} + b_1X_t\hat{}} \qquad \mathbf{(4)}$$

where constant term $b_0\hat{}$ results from the fraction $\frac{bo}{1-\rho}$, while b_1 remains the same. Let's suppose now that our data are thirty and we want to make the forecasting for the period 31.

$$\mathbf{Y_t\hat{} = b_o\hat{} + b_1X_t\hat{} + \varepsilon_\tau\hat{}} \quad \mathbf{(5)} \quad \mathbf{, where\ \varepsilon_{31}\hat{} = \varrho * \varepsilon_{30}}$$

$$\mathbf{,but\ \varepsilon_{30}\hat{} = Y_{30}\hat{} - b_o\hat{} - b_1X_{30}\hat{}\ ,}$$

Consequently the forecast for the variable Y will be:

$$\mathbf{Y_{31}\hat{} = b_o\hat{} + b_1X_{31}\hat{} + \varrho * \varepsilon_{30}\hat{}}$$

where for period 31 we know the price for variable X, after it is the independent variable, or with other words is the variable of means and we want to see how much it will affect the variable of objective Y in period 31[4].

4. Halkos Em. George, Academic lessons the period that I was a student in the fourth semester in February - June 2001, University of Thessaly, Department of Economic Sciences.

CHAPTER TWO: MOVING MEDIAN- SOME EMPIRICAL APPROACHES

2. 1 Model of consumption and income in the economy of United States America.

2.1.1. The method of two steps of Durbin

In this part we will analyze the equation of demand for the United States America. We will analyze the model and we will exempt it from the autocorrelation with the method of two steps of Durbin, with the repetitive method Cochrane - Orcutt and finally with the repetitive method of moving median that we propose in this work. The data concern the time period 1981-1990. The data are separated in four-month periods. (Table 1, Annex). The equation is:

$$PCE = b_o + b_1 PDI \qquad (1)$$

,where PCE = personal consumer expenditure
PDI = personal disposable income

The regression equation is

LnPCE = - 1,63 + 1,19 LnPDI

Predictor	Coef	SE Coef	T	P
Constant	-1,6254	0,1765	-9,21	0,000
C7	1,18989	0,02190	54,33	0,000

S = 0,01132 R-Sq = 98,7% R-Sq(adj) = 98,7%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0,37843	0,37843	2951,22	0,000
Residual Error	38	0,00487	0,00013		
Total	39	0,38330			

Durbin-Watson statistic = 1,04

We preferred the logarithmic model, as it is statistically more significant (Guzarati 1995), so for the variables separately - t statistic-, as in the total, statistical F(Papadimitriou 1989). The price DW is 1,04 and is smaller than the prices 1.246 and 1.344 which are the prices dL and dU respectively for k=40 and in level of statistical significance 0.01, as in level 0.05 is dL and dU 1.442 and 1.544 respectively. As becomes comprehensible price DW that resulted from the above regression it falls in the region where is rejected the hypothesis H_0 = does not exist autocorrelation, and the model presents positive autocorrelation. (Guzarati D., 1995). Moreover the price 1,19, that is also the bent and as is the MPC- the marginal propensity to consumption- is erroneous, according to the economist Keynes, after if the disposable income

increases at one unit , then the consumption will be increased more than a unit, at 1,19. The MPC should oscillate between the zero and the unit. (Keynes M. John, 2001). Afterwards we will apply the method of two steps of Durbin. We run the following regression in order to find the ρ.

$$\mathbf{LnPCE_t = b_o + b_1\, LnPDI_t + b_2\, LnPCE_{t-1} + b_3\, LnPDI_{t-1}}$$

,where PCE_{t-1} = personal consumer expenditure with a time lag
PDI_{t-1} = personal disposable income with a time lag

The regression equation is

$$\mathbf{LnPCE = - 0{,}112 + 0{,}165\, LnPDI + 0{,}873\, LnPCE_{t-1} - 0{,}025\, LnPDI_{t-1}}$$

Predictor	Coef	SE Coef	T	P
Constant	-0,1121	0,2130	-0,53	0,602
PDI	0,1650	0,1387	1,19	0,242
PCE_1	0,8734	0,1075	8,13	0,000
PDI_1	-0,0252	0,1339	-0,19	0,852

S = 0,006471 R-Sq = 99,6% R-Sq(adj) = 99,6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	0,35894	0,11965	2857,19	0,000
Residual Error	35	0,00147	0,00004		
Total	38	0,36041			

Durbin-Watson statistic = 1,81

The ϱ is the parameter of variable $LnPCE_{t-1}$, which is 0,873. Then we obtain the new variables LnPCE^ and LnPDI^, where

$LnPCE^ = LnPCE + \varrho^* LnPCE_{t-1}$

$LnPDI^ = LnPDI + \varrho^* LnPDI_{t-1}$ (Table 2, appendix)

Because the first prices will be missing we will find them with the Prais-Winsten transformation

The regression equation is

$$\mathbf{PCE^ = 0{,}00675 + 0{,}983\, PDI^}$$

Predictor	Coef	SE Coef	T	P
Constant	0,006748	0,004113	1,64	0,109
PDI^	0,982563	0,003470	283,17	0,000

S = 0,009703 R-Sq = 100,0% R-Sq(adj) = 100,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	7,5490	7,5490	80187,22	0,000
Residual Error	38	0,0036	0,0001		
Total	39	7,5526			

Durbin-Watson statistic = 2,40

If we see the tables of DW we will realise that the model was exempted from the autocorrelation. Also the model is statistically very significant as it appears from t-statistics and F- statistic as the interpretation of model is very important after R-Sq (adj) is equal with 100,0%. Next step is to make forecast for the period 1991-1. As we reported in the first chapter the parameter b_1, the inclination remains the same, but what changes is parameter b_0, which is the constant term. The new factor b_0 ^ is equal with the fraction $\frac{bo}{1-\rho}$. Consequently we have $\frac{0,00675}{1-0,873} = 0,053$.

Hence the new model which will be estimated is the following:

$$\mathbf{LnPCE^{\wedge} = 0,053 + 0,983\ LnPDI^{\wedge}}$$

The forecast for period 1991-1 has the following steps

1º PCE^ = 0,053 + 0,983 PDI^ + ε_{τ}^ , where $\varepsilon_{1991\text{-}1}$^ = ϱ* $\varepsilon_{1990\text{-}4}$

2º $\varepsilon_{1990\text{-}4}$ = PCE^$_{1990\text{-}4}$ - 0,053 + 0,983 PDI^$_{1990\text{-}4}$ = 3251,8 – 0,053 – 0,983*3529,5 = -217,753.

3o The forecasting for PCE^ of period 1991-1 is:

PCE^$_{1991\text{-}1}$ = 0,053 + 0,983 PDI^ + ε_{τ}^$_{1991\text{-}1}$ => PCE^$_{1991\text{-}1}$ = 0,053 + 0,983* 3514,8 + 0,873*(-217,53) = 3265,2

The actual price is 3241,1, while the predicted price is ,according to the method of two steps of Durbin ,3265,2, which means that the forecasting is not reliable.

2.1.2. The repetitive method of Cochrane – Orcutt

In this part we will analyze the model of consumption that we just analysed in the part 2.1.1., but now the analysis will be with the repetitive method Cochrane - Orcutt. First step is to find the ρ. This results if we run the regression

$$PCE = b_o + b_1 PDI \qquad (1)$$

and take the residues. After we have made this process we will run the following regression:

$$U_t = b_o + b_1 U_{t-1}$$

Factor b_1 of the the variable U_{t-1} is the ρ, where variable U_t are the residues which resulted from equation (1) and the variable U_{t-1} are the residues with a time lag.

The regression equation is

$$\mathbf{U_t = - 0,00014 + 0,480\ U_{t-1}}$$

Predictor	Coef	SE Coef	T	P
Constant	-0,000145	0,001614	-0,09	0,929
U_{t-1}	0,4805	0,1453	3,31	0,002

S = 0,01008 R-Sq = 22,8% R-Sq(adj) = 20,7%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0,0011106	0,0011106	10,93	0,002
Residual Error	37	0,0037583	0,0001016		
Total	38	0,0048689			

Durbin-Watson statistic = 1,98

Hence the ρ is equal with 0,480. As with the method of two steps of Durbin we will calculate with the precisely same way the new variables PCE^ and PDI^ as well as the first missing prices. The new variables are presented in table 3 in the Appendix.

The regression equation is

$$\mathbf{LnPCE^{\wedge} = 0,0140 + 0,982\ LnPDI^{\wedge} \quad (2)}$$

Predictor	Coef	SE Coef	T	P
Constant	0,013955	0,005900	2,37	0,023
PDI	0,982058	0,002512	390,98	0,000

S = 0,01071 R-Sq = 100,0% R-Sq(adj) = 100,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	17,535	17,535	152869,23	0,000
Residual Error	38	0,004	0,000		
Total	39	17,539			

Durbin-Watson statistic = 2,24

Consequently from price DW we conclude that the model was exempted from the autocorrelation. We are proceeding now to the forecast once again for period 1991-1 The new model that will be estimated will be:

$$\mathbf{LnPCE\hat{} = 0{,}027 + 0{,}982\ LnPDI\hat{}}$$

, as $\frac{bo}{1-\rho} = \frac{0{,}014}{1-0{,}48} = 0{,}027$

The forecasting for the period 1991-1 has the following steps.

1º $\mathbf{PCE\hat{} = 0{,}0140 + 0{,}982\ PDI\hat{} + \varepsilon_{\tau}\hat{}}$ **, where** $\varepsilon_{1991\text{-}1}\hat{} = \rho * \varepsilon_{1990\text{-}4}$

2º $\varepsilon_{1990\text{-}4} = PCE\hat{}_{1990\text{-}4} - 0{,}027 + 0{,}982\ PDI\hat{}_{1990\text{-}4} = 3251{,}8 - 0{,}027 - 0{,}982 * 3529{,}5 = -214{,}1.$

3o The forecasting for PCE^ of period 1991-1 is:

$PCE\hat{}_{1991\text{-}1} = 0{,}0140 + 0{,}982\ PDI\hat{} + \varepsilon_{\tau}\hat{}_{1991\text{-}1} \Rightarrow PCE\hat{}_{1991\text{-}1} = 0{,}027 + 0{,}982 * 3514{,}8 + 0{,}528 * (-214{,}1) = 3338{,}5.$

And with this method the forecast is not reliable.

2.1.3. The repetitive method of moving median.

In this part we will see once again the model of consumption in the ecomy of U.S.A. with the repetitive method of moving median. First step is to find the ρ running the regression (2) of the first chapter.

$$\mathbf{Ln\Delta Y_t = b_o + b_1 Ln\Delta X_t + b_2 Ln\Delta Y_{t-1} + b_3 Ln\Delta X_{t-1} \quad (2)}$$

,where Ln= the logarithm and Δ= the moving median

The ρ is the parameter b_2 of the variable $Ln\Delta Y_{t-1}$. In the table 1 are presented the four-monthly data. For this reason we will take the moving median term of four periods, where in the case in this case there are the four four-monthly periods. When we say that we will take the moving median of four periods we mean the following: For 1982-1 we take the median term on periods 1981-1/ 1981-4, which price is (n + 1) /2, where n = the observations which in the case are 4-monthly. The price is between the 2nd and in the 3rd period (n + 1) /2 = (4+1) /2 = 5/2= 2.5. The price that will result from the mean of the second and the third price is the new price that we will take. For period 1981-2 we will have the median of periods 1981-2/1982-1, and with the same way we find all the others.. (Table 4,appendix).

The regression equation is

$$\mathbf{Ln\Delta PCE_t = 0{,}006 + 0{,}225\, Ln\Delta PDI_t + 0{,}958\, Ln\Delta PCE_{t-1} - 0{,}183\, Ln\Delta PDI_{t-1}}$$

Predictor	Coef	SE Coef	T	P
Constant	0,0062	0,1662	0,04	0,971
$Ln\Delta X_t$	0,2250	0,1247	1,81	0,081
$Ln\Delta Y_{t-1}$	0,95755	0,07968	12,02	0,000
$Ln\Delta X_{t-1}$	-0,1831	0,1263	-1,45	0,157

S = 0,004238 R-Sq = 99,8% R-Sq(adj) = 99,8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	0,286193	0,095398	5311,46	0,000
Residual Error	31	0,000557	0,000018		
Total	34	0,286750			

Durbin-Watson statistic = 0,96

The ρ is the price of parameter of the variable $Ln\Delta PCE_{t-1}$ and is equal with 0,958. Now we take the new variables LnPCE^ and LnPDI^

, where $LnPCE^{\wedge} = LnPCE + \varrho^* LnPCE_{t-1}$

$LnPDI^{\wedge} = LnPDI + \varrho^* LnPDI_{t-1}$ (Table 5, appendix)

Because the first prices are missing we will find them ,as we reported above, with the transformation Prais-Winsten.

The regression equation is

$$\mathbf{PCE\hat{} = 0{,}00374 + 0{,}981\ PDI\hat{}}$$

Predictor	Coef	SE Coef	T	P
Constant	0,003742	0,001669	2,24	0,032
PDI	0,980594	0,003272	299,65	0,000

S = 0,006245 R-Sq = 100,0% R-Sq(adj) = 100,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	3,5020	3,5020	89790,53	0,000
Residual Error	34	0,0013	0,0000		
Total	35	3,5033			

Durbin-Watson statistic = 1,60

The new model is:

$$\mathbf{LnPCE\hat{} = 0{,}089 + 0{,}981\ LnPDI\hat{}}$$

, where $\frac{bo}{1-\rho} = \frac{0{,}00374}{1-0{,}52} = 0{,}089$

The forecasting for period 1991-1 has the following steps.

1º $\mathbf{PCE\hat{} = 0{,}089 + 0{,}981\ PDI\hat{} + \varepsilon_\tau\hat{}}$ **, where** $\mathbf{\varepsilon_{1991\text{-}1}\hat{} = \varrho^* \varepsilon_{1990\text{-}4}}$

2º $\mathbf{\varepsilon_{1990\text{-}4} = PCE\hat{}_{1990\text{-}4} - 0{,}089 + 0{,}981\ PDI\hat{}_{1990\text{-}4} = 3251{,}8 - 0{,}089 - 0{,}981*3529{,}5 = -210{,}72.}$

3o The forecasting for PCE^ of period 1991-1 is:

$\mathbf{PCE\hat{}_{1991\text{-}1} = 0{,}089 + 0{,}981\ PDI\hat{} + \varepsilon_\tau\hat{}_{1991\text{-}1}}$ **=>** $\mathbf{PCE\hat{}_{1991\text{-}1} = 0{,}089 + 0{,}981* 3514{,}8 + 0{,}958*(-210{,}72) = 3246{,}2.}$

The actual price is 3241,1, while the predicted is according to the repetitive method of moving median is 3246,2, which means that the forecasting is much more reliable in this case in relation with the other two methods that we saw previously.

2. 2 Model of consumption and income in the Rural economy of Greece

2.2.1 The method of two steps of Durbin

In this part we will analyze the same model that we analyzed and previously, only that this time we will receive the consumption and the income of Greek economy and concretely the rural sector for the period 1960-1994 and will make the forecasting for the year of 1995. The data are presented in table 6.

```
The regression equation is
```

PCE = - 1878 + 0,956 PDI

```
Predictor        Coef     SE Coef          T        P
Constant      -1878,3       654,6      -2,87    0,007
PDI           0,95647     0,01163      82,22    0,000

S = 876,6       R-Sq = 99,5%     R-Sq(adj) = 99,5%

Analysis of Variance

Source            DF          SS          MS         F        P
Regression         1  5195174279  5195174279   6760,59    0,000
Residual Error    34    26127303      768450
Total             35  5221301582

Durbin-Watson statistic = 0,9
```

This time we obtained the linear and no the logarthmic model. We observe that it exists positive autocorrelation. Hence it will be supposed that we solve the problem of autocorrelation. Afterwards we will apply the method of two steps of Durbin. We run the following regression in order to find the ρ.

$$PCE_t = b_o + b_1 PDI_t + b_2 PCE_{t-1} + b_3 PDI_{t-1}$$

,where PCE_{t-1} = the personal consumer expenditure with a time lag
PDI_{t-1} = the personal disposable income with a time lag

```
The regression equation is
```

PCE = - 1024 + 0,970 PDI + 0,524 PCE_1 - 0,513 PDI_1

```
Predictor        Coef     SE Coef          T        P
Constant      -1023,9       699,9      -1,46    0,154
PDI           0,96986     0,02415      40,16    0,000
PCE_1          0,5242      0,1546       3,39    0,002
PDI_1         -0,5129      0,1507      -3,40    0,002

S = 782,1       R-Sq = 99,6%     R-Sq(adj) = 99,5%
```

```
Analysis of Variance

Source            DF          SS          MS         F        P
Regression         3  4400467475  1466822492   2397,94    0,000
Residual Error    31    18962770      611702
Total             34  4419430246

Durbin-Watson statistic = 2,02
```

The ϱ is the parameter of variable $LnPCE_{t-1}$, which is 0,524. Then we obtain the new variables LnPCE^ and LnPDI^, where

$LnPCE^ = LnPCE + \varrho^* LnPCE_{t-1}$

$LnPDI^ = LnPDI + \varrho^* LnPDI_{t-1}$ (Table 7, appendix)

```
The regression equation is
```

PCE^ = - 1194 + 0,967 PDI^

```
Predictor        Coef     SE Coef          T        P
Constant      -1194,1       528,0      -2,26    0,030
PDI^          0,96652     0,01910      50,61    0,000

S = 752,2       R-Sq = 98,7%     R-Sq(adj) = 98,7%

Analysis of Variance

Source            DF          SS          MS         F        P
Regression         1  1448826548  1448826548   2560,91    0,000
Residual Error    34    19235395      565747
Total             35  1468061942

Durbin-Watson statistic = 2,08
```

The final model is:

LnPCE^ = 0,089 + 0,967 LnPDI^

, where $\frac{bo}{1-\rho} = \frac{-1194}{1-0,524} = -2508$

1º PCE^ = -2508 + 0,967 PDI^ + ε_τ^ , where ε_{1995}^ = ϱ* ε_{1994}

2º ε_{1994} = PCE^$_{1994}$ - (-2508) + 0,967 PDI^$_{1994}$ = 52911 – (-2508) – 0,967*58548 = -1196,916.

3o The forecasting for PCE^ of period 1995 is:

PCE^$_{1995}$ = -2508 + 0,967 PDI^ + ε_τ^$_{1995}$ => PCE^$_{1995}$ = -2508 + 0,967* 58646 + 0,524*(-1196,916) = 53575,6.

The actual price is 53570 while the predicted is according to the method of two steps is 53575,6, which means that the forecasting is vey reliable.

2.2.2. The repetitive method of Cochrane - Orcutt

We are proceeding now to the method of Cochrane - Orcutt. As we saw previously, we will regress once again the equation of consumption for the Greek rural sector, in order to obtain the residues and to run the regression of residues.

The regression equation is

$$U_t = -16 + 0{,}519\ U_{t-1}$$

Predictor	Coef	SE Coef	T	P
Constant	-16,0	128,8	-0,12	0,902
U_{t-1}	0,5189	0,1503	3,45	0,002

S = 761,8 R-Sq = 26,5% R-Sq(adj) = 24,3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	6920989	6920989	11,92	0,002
Residual Error	33	19153353	580405		
Total	34	26074342			

Durbin-Watson statistic = 2,07

The ρ is equal with 0,519. I'll take the new variables PCE^ and PDI^ (Table 8,appendix).

The regression equation is

$$PCE = 36239 + 1{,}07\ PDI$$

Predictor	Coef	SE Coef	T	P
Constant	36239	1354	26,76	0,000
PDI	-1,0747	0,1867	-5,76	0,000

S = 8082 R-Sq = 49,4% R-Sq(adj) = 47,9%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	2164627228	2164627228	33,14	0,000
Residual Error	34	2220741697	65315932		
Total	35	4385368925			

Durbin-Watson statistic = 0,42

We observe from the statistical DW that it still exists positive autocorrelation. We retake the new variables (table 9, appendix) with the same process.

The regression equation is

$$U_t = -169 + 0{,}782\ U_{t-1}$$

Predictor	Coef	SE Coef	T	P
Constant	-169,4	842,5	-0,20	0,842
U_{t-1}	0,7822	0,1058	7,39	0,000

S = 4984 R-Sq = 62,4% R-Sq(adj) = 61,2%

```
Analysis of Variance

Source            DF          SS          MS         F        P
Regression         1  1358296115  1358296115     54,68    0,000
Residual Error    33   819732620    24840382
Total             34  2178028736

Durbin-Watson statistic = 1,24


The regression equation is
```

PCE = 8407+0,732 PDI

```
Predictor        Coef     SE Coef          T        P
Constant       8407,4       803,7      10,46    0,000
PDI          -0,73234     0,08496      -8,62    0,000

S = 4817        R-Sq = 68,6%     R-Sq(adj) = 67,7%

Analysis of Variance

Source            DF          SS          MS         F        P
Regression         1  1723964389  1723964389     74,30    0,000
Residual Error    34   788865744    23201934
Total             35  2512830133

Durbin-Watson statistic = 2,34
```

The autocorrelation was solved and the final model is:

PCE = 38564,22+0,732 PDI

$$\text{, where } \frac{bo}{1-\rho} = \frac{38564{,}22}{1-0{,}782} = 38564{,}22$$

The forecasting for period 1995 is:

1º PCE^ = 38564,22 + 0,732 PDI^ + ε_τ^ , where ε_{1995}^ = ρ* ε_{1994}

2º ε_{1994} = PCE^$_{1994}$ - 38564,22 + 0,732 PDI^$_{1994}$ = 52911 – 38564,22 – 0,732*58548 = -28510,3.

3o The forecasting for variable PCE^ of period 1995 is:

PCE^$_{1995}$ = 38564,22 + 0,732 PDI^ + ε_τ^$_{1995}$ => PCE^$_{1995}$ = 38564,22 + 0,732* 58646 + 0,782*(-28510,3) =59197,8.

The actual price is 53570, while the predicted according to the repetitive method of Cochrane - Orcutt it is 59197,8

2.2.3. The repetitive method of moving median.

As we saw in the part 2.1.3 the methodology of the moving median we will run once again the equation (2) that we saw in the first chapter and is the following:

$$\Delta Y_t = b_o + b_1 \Delta X_t + b_2 \Delta Y_{t-1} + b_3 \Delta X_{t-1} \qquad (2)$$

The difference is that in that case we examine the variables that we just analysed in th precedents two chapters. In the part 2.1.3 we took the moving median of four periods, because the data was concerning four-monthly periods. In our case where we examine in th specific part the data are annual (table 6, appendix). However we will prefer to take the moving median of four periods, four years. The process is acquaintance. The moving medians of variables PCE and PDI are presented in the table 10, appendix. So in order to find the ρ we have:

The regression equation is

$$PCE = -789 + 0{,}919\ PDI + 0{,}728\ PCE_{t-1} - 0{,}654\ PDI_{t-1}$$

Predictor	Coef	SE Coef	T	P
Constant	-788,9	548,9	-1,44	0,163
PDI	0,91949	0,02993	30,72	0,000
PCE_1	0,7281	0,1230	5,92	0,000
PDI_1	-0,6541	0,1215	-5,38	0,000

S = 492,4 R-Sq = 99,8% R-Sq(adj) = 99,8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	3319763901	1106587967	4563,38	0,000
Residual Error	26	6304821	242493		
Total	29	3326068722			

Durbin-Watson statistic = 1,25

Hence the ρ is equal with 0,758. With the known process we are finding the variable PCE^ and PDI^ (table 11, appendix).

The regression equation is

$$PCE^{\wedge} = -362 + 0{,}946\ PDI^{\wedge}$$

Predictor	Coef	SE Coef	T	P
Constant	-362,3	408,3	-0,89	0,382
PDI	0,94576	0,02437	38,81	0,000

S = 491,3 R-Sq = 98,1% R-Sq(adj) = 98,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	363494795	363494795	1506,07	0,000
Residual Error	29	6999232	241353		
Total	30	370494027			

Durbin-Watson statistic = 1,26

The statistic DW is 1,26 and it is bigger than the price 1.133 and a litlle smaller than the price 1.263 , which are the prices dL and dU respectively for k=30 and in level of statistical significance 0.01, as in level 0.05 are dL and dU 1.352 and 1.489 respectively. As becomes comprehensible statistic DW that resulted from the above regression it falls in the region where is rejected the the hypothesis H_0= does not exist autocorrelation, and the model presents positive autocorrelation in level 0.05, while in level 0.01 it is unknown if we have autocorrelation or not. For this reason we will run again the last model in order to to calculate the ρ and then to create once again the new variables PCE^ and PDI^. We should notice that at the repetition we do not take again the moving median of the new variables, but we run the model:

$$\mathbf{PCE_t = b_o + b_1\, PDI_t + b_2\, PCE_{t-1} + b_3\, PDI_{t-1}}$$

So we apply the method of Durbin. The only transformation that we are doing is when we are taking the moving median of the initial actual variables. The new variables PCE^ and PDI^ are presented in table 12, in the appendix: The equation is:

$$\mathbf{PCE = 26 + 0{,}920\ PDI}$$

Predictor	Coef	SE Coef	T	P
Constant	26,5	231,6	0,11	0,910
PDI	0,92046	0,02172	42,38	0,000

S = 448,9 R-Sq = 98,4% R-Sq(adj) = 98,4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	361933288	361933288	1796,07	0,000
Residual Error	29	5843913	201514		
Total	30	367777201			

Durbin-Watson statistic = 1,55

The final model is:

$$\mathbf{PCE = 43{,}26 + 0{,}920\ PDI}$$

, where $\dfrac{bo}{1-\rho} = \dfrac{26}{1-0{,}399} = 43{,}26$

The forecasting for period 1995 is:

1º $\mathbf{PCE^{\wedge} = 43{,}26 + 0{,}920\ PDI^{\wedge} + \varepsilon_{\tau}^{\wedge}}$ **, where** $\mathbf{\varepsilon_{1995}^{\wedge} = \varrho * \varepsilon_{1994}}$

2º $\mathbf{\varepsilon_{1994} = PCE^{\wedge}_{1994} - 43{,}26 + 0{,}920\ PDI^{\wedge}_{1994} = 52911 - 43{,}26 - 0{,}920*58548 = -996{,}42.}$

3o The forecasting for variable PCE^ of period 1995 is:

$PCE^{\wedge}_{1995}$ = 43,26 + 0,920 PDI^ + $\varepsilon_{\tau}{}^{\wedge}_{1995}$ => $PCE^{\wedge}_{1995}$ = 43,26 + 0,920* 58646 + 0,339*(-996,42) =53659,8.

The actual price is 53570, while the predicted price according to the repetitive method of moving median is 53659,8. Consequently, we observe that with the this method the divergence in that case is almost 89 , with the method of Durbin is almost 5, while with the method Cochrane - Orcutt is almost 6.000. Hence, in the previous case the method that we propose was the most optimal. In that case it could be best, but the method of Durbin is more reliable by a little, as the method of Cochrane – Orcutt loses its reliability.

2. 3 Model of price and demanding quantity of fertilizers in the Greek rural sector

2.3.1 The method of two steps of Durbin

In the last part we will see the price and the demanding quantity of fertilizers in the Greek rural sector. The data are annual and are concerning the period 1960-1993. (Table 13, appendix). The forecasting will become for the year of 1993. The method of Durbin is:

```
The regression equation is
```

$$Q = 534 + 0{,}322\ P$$

```
Predictor        Coef     SE Coef          T        P
Constant       534,11       25,18      21,21    0,000
P              0,3224      0,1098       2,94    0,010

S = 62,92       R-Sq = 35,0%     R-Sq(adj) = 30,9%

Analysis of Variance

Source            DF          SS          MS          F        P
Regression         1       34111       34111       8,62    0,010
Residual Error    16       63348        3959
Total             17       97459

Durbin-Watson statistic = 1,00
```

, where Q = the demanding quantity of fertilizers
P =the price of the fertilizers.

What makes us impression is that when the price is increased then the demanding quantity is also increased, while according to the law of demand it would be supposed that the demanding quantity must to decreased, so it would be supposed that must exist reverse or negative relation between the price and the demanding quantity. However the reality does not always going according to the theory. In our case because the production is increased each year and when is increased the demand for more fertilizers, explains that even though the increase of price of fertilizers may conduct initially to the decreasing of the demanding quantity, but the increasing of the production, that can be owed either in the subsidies either in favourable meteorological circumstances, was perhaps been greater than the increasing of the price, therefore the demanding quantity for fertilizers final was increased. We observe that exists positive autocorrelation. Hence it will be supposed that we must solve the problem of autocorrelation. Afterwards we will apply the method of two steps of Durbin. We run the following regression in order to find the ρ.

$$Q_t = b_o + b_1 P_t + b_2 Q_{t-1} + b_3 P_{t-1}$$

, where Q = the demanding quantity of fertilizers with a time lag
P =the price of the fertilizers with a time lag

The regression equation is

$$\mathbf{Q = 315 - 0{,}720\ P + 0{,}424\ Q_{t-1} + 1{,}08\ P_{t-1}}$$

Predictor	Coef	SE Coef	T	P
Constant	314,9	113,6	2,77	0,016
P	-0,7202	0,5437	-1,32	0,208
Q_{t-1}	0,4244	0,2184	1,94	0,074
P_{t-1}	1,0755	0,7097	1,52	0,154

S = 49,01 R-Sq = 56,5% R-Sq(adj) = 46,5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	40549	13516	5,63	0,011
Residual Error	13	31228	2402		
Total	16	71778			

Durbin-Watson statistic = 2,56

The ρ is the price of the parameter of the variable Q_{t-1} and is equal with 0,424. Now we take the new variables Q^ and P^, where

$Q^ = Q + \varrho * Q_{t-1}$

$P^ = P + \varrho * P_{t-1}$ (Table 14, Appendix)

After we found the new variables we run the following model:

$$\mathbf{Q^ = b_0 + b_1\ P^}$$

The regression equation is

$$\mathbf{Q^ = 341 + 0{,}115\ P^}$$

Predictor	Coef	SE Coef	T	P
Constant	340,79	19,69	17,31	0,000
P^	0,1151	0,1315	0,88	0,395

S = 50,37 R-Sq = 4,6% R-Sq(adj) = 0,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1942	1942	0,77	0,395
Residual Error	16	40593	2537		
Total	17	42536			

Durbin-Watson statistic = 2,03

The final model is:

$$\mathbf{Q^{\wedge} = 592 + 0{,}115P^{\wedge}}$$

, where $\frac{bo}{1-\rho} = \frac{341}{1-0{,}424} = 592$

The forecasting for period 1993 is:

1º $\mathbf{Q^{\wedge} = 592 + 0{,}115\ PDI^{\wedge} + \varepsilon_{\tau}^{\wedge}}$ **, where** $\mathbf{\varepsilon_{1993}^{\wedge} = \varrho * \varepsilon_{1992}}$

2º $\mathbf{\varepsilon_{1992} = Q^{\wedge}_{1992} - 592 - 0{,}115\ P^{\wedge}_{1992} = 628 - 592 - 0{,}115*549{,}3 = -27{,}17.}$

3o The forecasting for the variable Q^of the period 1993 is:

$\mathbf{Q^{\wedge}_{1993} = 592 + 0{,}115\ P^{\wedge} + \varepsilon_{\tau}^{\wedge}{}_{1993}}$ **=>** $\mathbf{Q^{\wedge}_{1993} = 592 + 0{,}115*\ 549{,}8 + 0{,}424*(-27{,}17) = 644{,}75}$

We seeing that in that case the forecasting demanding quantity is 644,75, as the actual is 509. Afterwards, in the model the variable P is statistically insignificant, as it can be seemed from the t-statistic.

2.3.2. The repetitive method Cochrane – Orcutt

In this section we will analyse the method of Cochrane - Orcutt. As we saw previously we regress once again the equation of the demanding quantity of fertilizers for the Greek rural sector, in order to take the residues and to run the regression of residues.

The regression equation is

$$\mathbf{Ut = 4{,}6 + 0{,}386\ Ut\_1}$$

Predictor	Coef	SE Coef	T	P
Constant	4,62	12,89	0,36	0,725
Ut_1	0,3864	0,2237	1,73	0,105

S = 52,93 R-Sq = 16,6% R-Sq(adj) = 11,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	8362	8362	2,98	0,105
Residual Error	15	42031	2802		
Total	16	50393			

Durbin-Watson statistic = 1,76

The ϱ is equal with 0,386. The new variables Q^ and R^ are presented in the table 15 in the apppendix.

The regression equation is

Q = 359 + 0,139 P

Predictor	Coef	SE Coef	T	P
Constant	358,82	19,56	18,34	0,000
P	0,1386	0,1248	1,11	0,283

S = 49,87 R-Sq = 7,2% R-Sq(adj) = 1,4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	3068	3068	1,23	0,283
Residual Error	16	39795	2487		
Total	17	42862			

Durbin-Watson statistic = 1,98

We observe that the autocorrelation was solved. And in this case variable P is statistically insignificant. The final model that will be estimated is the following:

Q^ = 584,7 + 0,139P^

, where $\frac{bo}{1-\rho} = \frac{359}{1-0,386} = 592$

The forecasting for period 1993 is:

1º **Q^ = 584,7 + 0,139 PDI^ + ε_τ^ , where ε_{1993}^ = ϱ* ε_{1992}**

2º **ε_{1992} = Q^$_{1992}$ - 584,7 + 0,139 P^$_{1992}$ = 628 – 584,7 – 0,139*549,3 = -33.**

3o The forecasting for the variable Q^of the period 1993 is:

Q^$_{1993}$ = 584,7 + 0,139 P^ + ε_τ^$_{1993}$ => Q^$_{1993}$ = 584,7 + 0,139* 549,8 + 0,386*(-33) = 648,38.

And with the method of Cochrane - Orcutt the forecasting is not reliable.

2.3.3. The repetitive method of moving median.

As we saw in the part 2.1.3 the methodology of moving median that we will run once again is the equation (2) that we saw in the first chapter and this is below:

$$\Delta Y_t = b_o + b_1 \Delta X_t + b_2 \Delta Y_{t-1} + b_3 \Delta X_{t-1} \qquad (2)$$

The difference is that in that case we examine the variables that we just saw in the precedents two parts (2.3.1. and 2.3.2). In the department 2.1.3 we took the moving median of four periods, as the data are concerning four-month periods. In that case where we examine in this part the data are annual (table 13, appendix). However we will prefer to take also the moving median of four periods, four years. The process is the known. The moving medians of variables PCE and PDI are presented in the table 10,appendix. Consequently in order to find the ρ we have

The regression equation is

$$\Delta Q = 190 - 2{,}59\,\Delta P + 0{,}701\,\Delta Q\_1 + 2{,}94\,\Delta P\_1$$

Predictor	Coef	SE Coef	T	P
Constant	189,6	106,8	1,78	0,109
P	-2,5900	0,9295	-2,79	0,021
Q_1	0,7006	0,2090	3,35	0,009
P_1	2,9440	0,9658	3,05	0,014

S = 26,30 R-Sq = 80,7% R-Sq(adj) = 74,2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	25969,9	8656,6	12,51	0,001
Residual Error	9	6225,8	691,8		
Total	12	32195,7			

Durbin-Watson statistic = 2,43

Hence the ρ is equal with 0,701. With the known process we are finding the variables Q^ and P^ (table 16, appendix).

$$Q\hat{} = 216 - 0{,}230\,P\hat{}$$

Predictor	Coef	SE Coef	T	P
Constant	216,23	35,28	6,13	0,000
P^	-0,2302	0,5376	-0,43	0,676

S = 56,12 R-Sq = 1,5% R-Sq(adj) = 0,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	577	577	0,18	0,676
Residual Error	12	37798	3150		
Total	13	38376			

Durbin-Watson statistic = 1,24

The final model:

$$\mathbf{Q=722-0,230\ P}$$

, where $\frac{bo}{1-\rho} = \frac{216}{1-0,701} = 722$

The forecasting for period 1993 is:

1º $\mathbf{Q^{\wedge} = 722 - 0,230\ PDI^{\wedge} + \varepsilon_{\tau}^{\wedge}}$ **, where** $\mathbf{\varepsilon_{1993}^{\wedge} = \varrho * \varepsilon_{1992}}$

2º $\mathbf{\varepsilon_{1992} = Q^{\wedge}_{1992} - 722 - (-0,230)\ P^{\wedge}_{1992} = 628 - 722 + 0,230*549,3 = 32,4.}$

3o The forecasting for the variable Q^of the period 1993 is:

$\mathbf{Q^{\wedge}_{1993} = 722 - 0,230\ P^{\wedge} + \varepsilon_{\tau}^{\wedge}{}_{1993}}$ **=>** $\mathbf{Q^{\wedge}_{1993} = 722 - 0,230*\ 549,8 + 0,701*(32,4) = 617.}$

The actual price is 509, while the predicted according to the repetitive method of moving median is 617. Consequently, we observe that with this method the divergence ,in the case that we just now examined , is smaller in combination with the method of Durbin and with the method Cochrane – Orcutt . Also the sign of the variable P is negative, which means that agrees with the Law of demand. So the model is more reliable than the other two. However the forecasting and with this method is unreliable.

CONCLUSSIONS

In this project we suggest a new method of autocorrelation solution. This is the repetitive method of moving median. From the empirical approaches we concluded that the repetitive method of moving median can lead us to more reliable results than the others methods do. Of course this method is a empirical method and we have to test it in many applications to see if can hold a long time of application under different circumstances.

REFERENCES

1. Christou George (2001) " Introduction in the Econometrics", Volume B, Publications Gutenberg, Athens 2001.

2. Guzarati N. Damodar (1995) "Basic Econometrics", McGraw - Hill International Editions, Economic Series, Third Edition, New York

3. Kaskarelis Alkiv.John (2000) "Eleven Courses of econometrics", 2nd Publication Revised, Gutenberg, Athens 2000.

4. Kintis A. Andreas, (1982) "Econometrics", Volume A, Publications Gutenberg, Athens.

5. Papadimitriou John (1989), Statistics Copy 2, "Inductive statistics", Publications Observer Thessaloniki,.

APPENDIX

TABLE 1

YEAR	PCE	PDI	YEAR	PCE	PDI
1981-1	2475,5	2783,7	1986-1	2922,4	3227,5
1981-2	2476,1	2776,7	1986-2	2947,9	3281,4
1981-3	2487,4	2814,1	1986-3	2993,7	3272,6
1981-4	2468,6	2808,8	1986-4	3012,5	3266,2
1982-1	2484	2795	1987-1	3011,5	3295,2
1982-2	2488,9	2824,8	1987-2	3046,8	3241,7
1982-3	2502,5	2829	1987-3	3075,8	3285,7
1982-4	2539,3	2832,6	1987-4	3074,6	3335,8
1983-1	2556,5	2843,6	1988-1	3128,2	3380,1
1983-2	2604	2867	1988-2	3147,8	3386,3
1983-3	2639	2903	1988-3	3170,6	3407,5
1983-4	2678,2	2960,6	1988-4	3202,9	3443,1
1984-1	2703,8	3033,2	1989-1	3200,9	3473,9
1984-2	2741,1	3065,9	1989-2	3208,6	3450,9
1984-3	2754,6	3102,7	1989-3	3241,1	3466,9
1984-4	2784,8	3118,5	1989-4	3241,6	3493
1985-1	2824,9	3123,6	1990-1	3258,8	3531,4
1985-2	2849,7	3189,6	1990-2	3258,6	3545,3
1985-3	2893,3	3156,5	1990-3	3281,2	3547
1985-4	2895,3	3178,7	1990-4	3251,8	3529,5

TABLE 2

YEAR	LnPCE^	LnPDI^	YEAR	LnPCE^	LnPDI^
1981-1	3,80000	3,86000	1986-1	1,02161	1,03939
1981-2	0,99265	1,00479	1986-2	1,02217	1,04265
1981-3	0,99699	1,02036	1986-3	1,03000	1,02551
1981-4	0,98543	1,00680	1986-4	1,02280	1,02590
1982-1	0,99827	1,00352	1987-1	1,01700	1,03645
1982-2	0,99481	1,01843	1987-2	1,02895	1,01236
1982-3	0,99854	1,01065	1987-3	1,02825	1,04013
1982-4	1,00838	1,01063	1987-4	1,01959	1,04349
1983-1	1,00239	1,01339	1988-1	1,03721	1,04348
1983-2	1,01490	1,01820	1988-2	1,02837	1,03379
1983-3	1,01218	1,02353	1988-3	1,03013	1,03843
1983-4	1,01527	1,03228	1988-4	1,03397	1,04338
1984-1	1,01191	1,03936	1989-1	1,02450	1,04321
1984-2	1,01731	1,02893	1989-2	1,02744	1,02879
1984-3	1,01026	1,03150	1989-3	1,03542	1,03922
1984-4	1,01687	1,02616	1989-4	1,02678	1,04268
1985-1	1,02165	1,02336	1990-1	1,03194	1,04706
1985-2	1,01791	1,04285	1990-2	1,02726	1,04145
1985-3	1,02547	1,01416	1990-3	1,03422	1,03850
1985-4	1,01290	1,03028	1990-4	1,01919	1,03313

TABLE 3

YEAR	LnPCE^	LnPDI^	YEAR	LnPCE^	LnPDI^
1981-1	6,85000	6,96000	1986-1	4,15416	4,20863
1981-2	4,06363	4,12188	1986-2	4,15837	4,21788
1981-3	4,06806	4,13647	1986-3	4,16962	4,20725
1981-4	4,05829	4,12816	1986-4	4,16848	4,20658
1982-1	4,06815	4,12414	1987-1	4,16514	4,21636
1982-2	4,06714	4,13711	1987-2	4,17695	4,19575
1982-3	4,07164	4,13351	1987-3	4,18083	4,21709
1982-4	4,08362	4,13406	1987-4	4,17590	4,22575
1983-1	4,08337	4,13733	1988-1	4,19337	4,23168
1983-2	4,09853	4,14366	1988-2	4,19132	4,22718
1983-3	4,10305	4,15221	1988-3	4,19554	4,23254
1983-4	4,11139	4,16587	1988-4	4,20221	4,23994
1984-1	4,11382	4,18066	1989-1	4,19672	4,24385
1984-2	4,12296	4,17976	1989-2	4,19942	4,23293
1984-3	4,12129	4,18654	1989-3	4,20834	4,24075
1984-4	4,12984	4,18589	1989-4	4,20366	4,24603
1985-1	4,13890	4,18509	1990-1	4,20888	4,25336
1985-2	4,14078	4,20521	1990-2	4,20628	4,25204
1985-3	4,15177	4,18475	1990-3	4,21322	4,25064
1985-4	4,14517	4,19676	1990-4	4,20090	4,24546

TABLE 4

YEAR	LnΔPCE^	LnΔPDI^	YEAR	LnΔPCE^	LnΔPDI^
1981-1			1986-1	7,96256	8,062435
1981-2			1986-2	7,970495	8,060725
1981-3			1986-3	7,9755	8,071845
1981-4			1986-4	7,984505	8,087745
1982-1	7,816715	7,93571	1987-1	7,99656	8,094685
1982-2	7,8152	7,941455	1987-2	8,0074	8,09236
1982-3	7,81452	7,93805	1987-3	8,01036	8,0958
1982-4	7,818615	7,94089	1987-4	8,01602	8,092035
1983-1	7,822325	7,946935	1988-1	8,026585	8,09059
1983-2	7,832345	7,948315	1988-2	8,031125	8,1049
1983-3	7,843015	7,95089	1988-3	8,03957	8,119065
1983-4	7,855595	7,956925	1988-4	8,051335	8,126575
1984-1	7,87148	7,96726	1989-1	8,05807	8,13061
1984-2	7,88553	7,983325	1989-2	8,066745	8,13893
1984-3	7,897655	8,00526	1989-3	8,0715	8,14858
1984-4	7,90926	8,022735	1989-4	8,07239	8,14971
1985-1	7,91857	8,034065	1990-1	8,07863	8,148705
1985-2	7,92648	8,04257	1990-2	8,083745	8,15477
1985-3	7,93908	8,045925	1990-3	8,086465	8,163985
1985-4	7,9506	8,057195	1990-4	8,08908	8,171415

TABLE 5

YEAR	LnΔPCE^	LnΔPDI^	YEAR	LnΔPCE^	LnΔPDI^
1981-1			1986-1	0,34589	0,34364
1981-2			1986-2	0,34236	0,33691
1981-3			1986-3	0,33977	0,34967
1981-4			1986-4	0,34398	0,35492
1982-1	2,24000	2,28000	1987-1	0,34740	0,34663
1982-2	0,32679	0,33904	1987-2	0,34670	0,33765
1982-3	0,32756	0,33014	1987-3	0,33927	0,34332
1982-4	0,33230	0,33624	1987-4	0,34210	0,33626
1983-1	0,33209	0,33956	1988-1	0,34724	0,33842
1983-2	0,33856	0,33515	1988-2	0,34166	0,35411
1983-3	0,33963	0,33640	1988-3	0,34575	0,35457
1983-4	0,34199	0,33997	1988-4	0,34943	0,34851
1984-1	0,34582	0,34453	1989-1	0,34489	0,34535
1984-2	0,34465	0,35069	1989-2	0,34711	0,34981
1984-3	0,34332	0,35723	1989-3	0,34356	0,35149
1984-4	0,34331	0,35370	1989-4	0,33989	0,34337
1985-1	0,34150	0,34828	1990-1	0,34528	0,34128
1985-2	0,34049	0,34594	1990-2	0,34442	0,34831
1985-3	0,34551	0,34114	1990-3	0,34224	0,35172
1985-4	0,34496	0,34920	1990-4	0,34225	0,35032

TABLE 6

YEAR	PCE	PDI	YEAR	PCE	PDI
1960	22662	25420	1978	61486	66271
1	28954	31488	9	56603	61840
2	28793,5	30882,5	1980	63785,6	67897,6
3	32668,6	35130,6	1	62616,2	66475,2
4	34482,3	37868,3	2	67362	71064
5	38525,8	42554,8	3	60334	63824
6	39966,8	43278,8	4	64152	69140
7	39413	43585	5	64785	69861
8	35431	40292	6	55831	58646
9	38231	42802	7	56579	58750
1970	41300	45355	8	60876	65317
1	44496	49000	9	63000,8	67667,8
2	50428	55244	1990	53562	58535
3	62580	68271	1	62628	67319
4	57184	61546	2	53250	59017
5	54678	59702	3	50504	55376
6	59663	64601	4	52911	58548
7	47705	53362	5	53570	58646

TABLE 7

YEAR	PCE^	PDI^	YEAR	PCE^	PDI^
1960	19285,4	21632,4	1978	36488,6	38309,3
1	17079,1	18167,9	9	24384,3	27114,0
2	13621,6	14382,8	1980	34125,6	35493,4
3	17580,8	18948,2	1	29192,5	30896,9
4	17364,0	19459,9	2	34551,1	36231,0
5	20457,1	22711,8	3	25036,3	26586,5
6	19779,3	20980,1	4	32537,0	35696,2
7	18470,4	20906,9	5	31169,4	33631,6
8	14778,6	17453,5	6	21883,7	22038,8
9	19665,2	21689,0	7	27323,6	28019,5
1970	21267,0	22926,8	8	31228,6	34532,0
1	22854,8	25234,0	9	31101,8	33441,7
2	27112,1	29568,0	1990	20549,6	23077,1
3	36155,7	39323,1	1	34561,5	36646,7
4	24392,1	25772,0	2	20432,9	23741,8
5	24713,6	27451,9	3	22601,0	24451,1
6	31011,7	33317,2	4	26446,9	29531,0
7	16441,6	19511,1	5		

TABLE 8

YEAR	PCE^	PDI^	YEAR	PCE^	PDI^
1960	19353,3	21708,7	1978	28767,4	10614,4
1	13797,9	4974,9	9	48830,5	-7280,7
2	21884,4	-1959,5	1980	38891,8	3398,5
3	19669,1	2920,2	1	48634,7	-4342,0
4	23656,7	1227,1	2	44684,2	1730,4
5	23865,1	3058,2	3	54368,2	-10295,8
6	28260,4	-1105,9	4	43447,3	2571,6
7	30380,7	-1554,8	5	47975,1	-2252,0
8	31742,9	-5167,2	6	53427,4	-14219,0
9	25224,8	777,4	7	41650,1	-2417,8
1970	27193,4	712,5	8	40371,4	4040,8
1	29438,4	1694,7	9	44734,2	-457,8
2	30424,8	4137,0	1990	52335,6	-12042,5
3	31663,2	10651,5	1	35624,6	6267,0
4	49920,5	-9660,7	2	52023,3	-11196,7
5	44357,6	-4490,5	3	41520,1	-6178,7
6	38582,9	2331,8	4	36778,1	790,8
7	16441,6	19511,1	5		

TABLE 9

YEAR	PCE^	PDI^	YEAR	PCE^	PDI^
1960	12057,1	13524,5	1978	-11216,1	21575,6
1	-1336,4	-12001,3	9	26334,4	-15581,1
2	11094,4	-5849,9	1980	706,3	9092,0
3	2555,5	4452,5	1	18221,3	-6999,6
4	8275,5	-1056,5	2	6651,9	5125,8
5	5365,5	2098,6	3	19425,1	-11648,9
6	9597,9	-3497,3	4	931,4	10622,8
7	8281,1	-690,0	5	13999,3	-4263,0
8	7985,2	-3951,3	6	15910,8	-12457,9
9	401,8	4818,2	7	-130,1	8701,5
1970	7467,7	104,6	8	7801,0	5931,5
1	8173,1	1137,5	9	13163,8	-3617,7
2	7404,0	2811,7	1990	17353,4	-11684,5
3	7871,0	7416,4	1	-5301,8	15684,2
4	25159,9	-17990,1	2	24164,9	-16097,5
5	5319,8	3064,2	3	837,9	2577,1
6	3895,2	5843,4	4	4309,4	5622,6
7	20958,0	-15840,3	5		

TABLE 10

YEAR	PCE	PDI	YEAR	PCE	PDI
1960			1978	57170,5	62151,5
1			9	53684	58981,5
2			1980	54595,5	59816,5
3			1	59044,5	64055,5
4	28873,75	31185,25	2	60194,3	64868,8
5	30731,05	33006,55	3	63200,9	67186,4
6	33575,45	36499,45	4	64989,1	68769,6
7	36504,05	40211,55	5	63848	67444
8	39246,3	42916,8	6	62243	66482
9	39689,9	43431,9	7	64468,5	69500,5
1970	37422	41938,5	8	60308	64253,5
1	36831	41547	9	56205	58698
2	39765,5	44078,5	1990	58727,5	62033,5
3	42898	47177,5	1	61938,4	66492,4
4	47462	52122	2	58281,4	63101,4
5	56504	61757,5	3	58095	62927
6	59882	64908,5	4	57939	63168
7	55931	60624	5	51877	57196,5

TABLE 11

YEAR	PCE^	PDI^	YEAR	PCE^	PDI^
1960			1978	16452,7	18017,2
1			9	12063,9	13735,2
2			1980	15513,5	16878,0
3			1	19299,0	20509,1
4	19778,5	21361,9	2	17209,9	18236,4
5	9711,0	10303,7	3	19379,4	19961,9
6	11203,2	12470,7	4	18978,8	19857,9
7	12061,1	13640,0	5	16535,9	17379,7
8	12671,4	13642,8	6	15761,7	17382,8
9	11118,6	12188,5	7	19155,6	21101,6
1970	8527,8	10320,1	8	13374,9	13657,1
1	9587,8	11015,8	9	12300,8	11921,5
2	12952,5	13832,3	1990	17810,3	19301,4
3	13948,7	15088,4	1	19184,8	21332,0
4	16232,3	17776,8	2	13190,2	14694,9
5	21951,7	23812,7	3	15666,1	16989,2
6	18747,1	19949,0	4	15645,8	17357,1
7	12336,9	13370,6	5	16452,7	18017,2

TABLE 12

YEAR	PCE^	PDI^	YEAR	PCE^	PDI^
1960			1978	11530,3	12682,4
1			9	5499,2	6546,3
2			1980	10700,1	11397,6
3			1	13109,1	13774,8
4	18136,8	19588,9	2	9509,6	10053,3
5	1819,3	1780,3	3	12512,7	12685,6
6	7328,6	8359,5	4	11246,4	11893,1
7	7591,0	8664,1	5	8963,4	9456,4
8	7859,0	8200,5	6	9163,8	10448,3
9	6062,7	6745,0	7	12866,7	14165,9
1970	4091,4	5456,9	8	5731,8	5237,6
1	6185,2	6898,1	9	6964,2	6472,3
2	9127,0	9437,0	1990	12902,3	14544,7
3	8780,7	9569,3	1	12078,5	13630,8
4	10666,7	11756,5	2	5535,5	6183,5
5	15475,0	16719,7	3	10403,2	11125,9
6	9988,4	10447,8	4	9395,0	10578,5
7	4856,8	5410,9	5	11530,3	12682,4

TABLE 13

ΕΤΗ	ΖΗΤΟΥΜΕΝΗ ΠΟΣΟΤΗΤΑ ΛΙΠΑΣΜΑΤΩΝ	ΤΙΜΗ ΛΙΠΑΣΜΑΤΩΝ
1975	438,1	45,3
1976	482,3	53,2
1977	505,3	55,5
1978	582,5	56,7
1979	581	68,1
1980	526	100
1981	527	111,2
1982	590,7	111,2
1983	640,2	149,4
1984	611,2	153,1
1985	709,9	165,3
1986	665,8	195,5
1987	555,4	233,7
1988	648,8	275,2
1989	649,5	275,4
1990	695,3	319,2
1991	652,1	417,5
1992	628	549,3
1993	509	549,8

TABLE 14

YEARS	Q^	P^
1975	396,480	41,000
1976	296,546	33,993
1977	300,805	32,943
1978	368,253	33,168
1979	334,020	44,059
1980	279,656	71,126
1981	303,976	68,800
1982	367,252	64,051
1983	389,743	102,251
1984	339,755	89,754
1985	450,751	100,386
1986	364,802	125,413
1987	273,101	150,808
1988	413,310	176,111
1989	374,409	158,715
1990	419,912	202,430
1991	357,293	282,159
1992	351,510	372,280
1993		

TABLE 15

YEARS	ΔQ^	ΔP^
1975		
1976		
1977		
1978		
1979	493,80	54,35
1980	543,90	56,10
1981	581,75	62,40
1982	553,50	84,05
1983	526,50	105,60
1984	558,85	111,20
1985	615,45	130,30
1986	625,70	151,25
1987	660,55	159,20
1988	687,85	180,40
1989	610,60	214,60
1990	602,10	254,45
1991	649,15	275,30
1992	672,40	297,30
1993		

TABLE 16

YEARS	Q^	P^
1975	403,900	41,760
1976	313,193	35,714
1977	319,132	34,965
1978	387,454	35,277
1979	356,155	46,214
1980	301,734	73,713
1981	323,964	72,600
1982	387,278	68,277
1983	412,190	106,477
1984	364,083	95,432
1985	473,977	106,203
1986	391,779	131,694
1987	298,401	158,237
1988	434,416	184,992
1989	399,063	169,173
1990	444,593	212,896
1991	383,714	294,289
1992	376,289	388,145
1993		