The dynamic evolution of regional Greek net fixed capital time series

by

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Abstract

This paper investigates the impact on the dynamic characteristics of the time evolution of regional Greek net fixed capital time series by the depreciation method that was used for the production of the series' data. Using annual data over the period from 1974 to 2006, Karpetis & Zikos (2014) constructed the series of net fixed capital assuming a depreciation period of 25 years, in the case of the thirteen administrative regions of Greece, using four different depreciation methods of capital. These series were used to estimate the $ARIMA(p,d,q)$ model that describes best the series' diachronic evolution. The statistical findings reveal, firstly, the affection of the pattern (monotonic or sinusoidal) of series' evolution by the used depreciation method of capital and secondly, the slow convergence of regional Greek net fixed capital towards its long run equilibrium value.

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1. Introduction

The knowledge of net fixed capital stock, both in regional and national level, is crucial for the applied economic research and the planning of economic policy, since time series of this variable can be used, either as a determinant of an economy's production function, or for investigating the significance of the convergence hypothesis, which means that it can be a useful indicator for conducting the necessary cohesion policy.

The measurement of net fixed capital, however, has always been a difficult task. The lack of statistical data concerning gross investment, made researchers construct their own series of fixed capital [Maddison (1994), Mas et al. (2000),Young & Musgrave (1980)]. The problem of course, becomes more severe in regional level, where the availability of fixed capital data series is limited. This problem could be partly solved either, by using a previously estimated production function [Dadkhah & Zahedi, (1986)] or by apportioning the national capital stock among the regions [Garofalo & Yamarik (2002)].

As for the case of Greece, annual estimations of net capital stock, in national level, are provided by Kamps (2006), for the period 1960-2001 (in constant prices of 1995) whereas, Skountzos & Mattheou (1991), estimated national gross capital stock over the period from 1950 to 1991. In addition, Georganta et al. (1994), provided sectoral estimates of manufacturing capital stock over the period from 1980 to 1991. In regional level, Melachroinos & Spence (2000), constructed annual series of net capital stock, for the thirteen administrative regions of Greece, covering the period 1980-1993.More recently, Karpetis & Zikos (2014) constructed the series of net fixed capital in the case of the thirteen administrative regions of Greece, covering the period from 1974 to 2006 and assuming a depreciation period of 25 years in the frame of the four different depreciation patterns of physical capital.

Apart from data limitations, another significant issue in the determination of net fixed capital series, is the depreciation pattern of physical capital. In general, from a macro perspective, depreciation is a significant determinant in growth models such as the Solow model, while its estimates are important in national accounts, where depreciation is needed for tax purposes [Coen (1975)]. Among the various methods of the depreciation of capital which are encountered in the economic literature, the most commonly used are, the *straight-line*, the *geometric decay*, the "*sum-of-the-years-digit*" and the "*one-hoss shay*" pattern [Coen (1975), Hulten & Wykoff (1981)].

The affection of the series of net capital, by the depreciation pattern of physical capital has been addressed in various researches [Domar (1953), Linhart (1970), Coen (1975), Young &

Musgrave (1980)], but additional problems like the determination of capital's service life [Redfren (1955), Nevin (1963), Dean & Irwin (1964)] and the value of depreciation rate [Boskin et al. (1987)] can also affect the resulting estimates of net capital stock. However until today there is not any example of how the different depreciation patterns can affect the dynamic characteristics of the time evolution of net fixed capital stock series.

Thus, using the net capital stock series of the thirteen Greek administrative regions[1], as these were estimated in Karpetis & Zikos (2014), our aim in this paper is to investigate, firstly, the effects on the dynamic characteristics of the time evolution of net capital stock by the four depreciation methods that employed in Karpetis & Zikos (2014) (namely, *straight line depreciation, double declining balance, "sum-of-the-years-digits"* & *"one-hoss-shay"*) and secondly, the velocity of convergence of Greek regional net fixed capital towards its long-run equilibrium.

The rest of the paper is organized as follows. In the second section, we analyze the depreciation methods used by Karpetis & Zikos (2014) in the production of the Greek regional net fixed capital stock time series. In the third section, we describe the followed procedure and the econometric tools utilized in order to obtain the dynamic characteristics of the series under investigation. Finally, in the last two sections we demonstrate the empirical results and the conclusions of our analysis.

2. Depreciation methods

Before proceeding to the methodology and empirical results of our analysis, we shall explain the depreciation patterns of physical capital used by Karpetis & Zikos (2014) in order to obtain their estimates of net fixed capital stock. In general, the level of a region's net capital stock can be determined mathematically through the following equation:

$$NK_{j,t} = I_{j,t} - D_{j,t} \quad \textbf{(1)}$$

where $NK_{j,t}$, is the level of net capital stock of a j region at time *t*, whereas $I_{j,t}$ and $D_{j,t}$ are the levels of gross investment and the depreciation of capital of region j at time t, respectively. In addition, the level of region's j depreciation of capital stock at time t ($D_{j,t}$) is determined as:

$$D_{j,t} = \sum_{i=1}^{n} d_i I_{j,t-i} \quad \textbf{(2)}$$

[1] [1] Eastern Macedonia and Thrace (E.M.T.), [2] Central Macedonia (C.M.), [3] Western Macedonia(W.M.), [4] Thessaly (TH.), [5] Epirus (EP.), [6] Ionian Islands (I.I.), [7] Western Greece (W.G.), [8] Central Greece (C.G.), [9] Attica (ATT.), [10] Peloponnese (PEL.), [11] Northern Aegean Islands (N.A.I.), [12] Southern Aegean Islands (S.A.I.), [13] Crete (CR).

where, d_i, is the percentage of capital's good initial productive capacity that is lost i periods after its acquisition and n, the hypothesized period of its service life.

Thus, substituting relation (2) in (1), the latter takes the following form:

$$NK_{j,t} = I_{j,t} - \sum_{i=1}^{n} d_i I_{j,t-i} \quad \textbf{(3)}$$

It is evident from the above mathematical relation, that the assumed capital's service life plays a significant role in the determination of net capital stock, an occasion that was examined in Redfern (1955) and Nevin (1963). In their analysis, Karpetis and Zikos (2014), defined exogenously the service life of physical capital at 25 years, in line with Greek tax legislation.

Alternatively, net fixed capital stock of region j at time t, could be expressed as the sum of region's gross investments at period t ($I_{j,t}$) and the part of gross investments that has not been depreciated during the last n periods ($ND_{j,t}$), thus:

$$NK_{j,t} = I_{j,t} + ND_{j,t} = I_{j,t} + \sum_{i=1}^{n} (1-d_i) I_{j,t-i} \quad \textbf{(4)}$$

Following the analysis of Coen (1975) and Linhart (1970) the four deprecation patterns of physical capital are analyzed as follows:

According to the *straight line depreciation (sld)* pattern, the productive capacity of physical capital is reduced by the same amount in each of the n periods of its service life. Namely, the depreciation follows a $d_i = 1/n$ pattern, for $i = 1, 2, ..., n$. Within the context of this method, the capital asset will have been completely depreciated until the end of the depreciation period. Thus, substituting $d_i = 1/n$ in equation (2), we obtain the level of depreciation at period t as:

$$D_{j,t}^{sld} = \sum_{i=1}^{n} d_i I_{j,t-i} = \frac{1}{n} \sum_{i=1}^{n} I_{j,t-i} \quad \textbf{(5)}$$

and consequently, after the substitution of equation (5) in (4), the level of net capital stock will be determined in the context of the following equation:

$$NK_{j,t}^{sld} = \frac{1}{n} \sum_{i=0}^{n} (n-i) I_{j,t-i} \quad \textbf{(6)}$$

In the case of the *double declining balance* (*ddb*) depreciation method, the rate of decay of physical capital is considered constant and equal to $2/n$. However, the main drawback of this method is that the capital asset is not depreciated completely at the end of its service life, which means that capital will continue to contribute in the production process beyond its assumed service life. In relation to this depreciation pattern, the rate of decay of physical capital is described by $d_i = (2/n)\,[(n-2)/n]^{i-1}$, for $i = 1, 2, ..., n$. As a matter of fact, the magnitude of the depreciation at time t, will be defined through the following relation:

$$D_{j,t}^{ddb} = \sum_{i=1}^{n} d_i I_{j,t-i} = \frac{2}{n} \sum_{i=1}^{n} \left(\frac{n-2}{n} \right)^{i-1} I_{j,t-i} \tag{7}$$

The level of net capital stock of region j and time t, will be defined after the substitution of the last equation into relation (4), and therefore will take the following form:

$$NK_{j,t}^{ddb} = \sum_{i=0}^{n-1} \left(1 - \frac{2}{n} \right)^{i} I_{j,t-i} \tag{8}$$

In terms of the "*sum-of-the-years-digits*" (*syd*) method, the depreciation pattern is set equal to $d_i = (n+1-i) \Big/ \sum_{i=1}^{n} i$ for $i = 1, 2, ..., n$. In that case, the level of depreciation at period t will be defined via the following equation:

$$D_{j,t}^{syd} = \sum_{i=1}^{n} d_i I_{j,t-i} = \frac{2}{n(n+1)} \sum_{i=1}^{n} (n+1-i) I_{j,t-i} \tag{9}$$

This pattern implies a faster depreciation of the capital asset in the earlier years of its assumed service life, compared to the later years, and thus its productive capacity will be diminished faster.

The level of net capital stock of region j at period t, after the substitution of relation (9) into (1), can be determined as follows:

$$NK_{j,t}^{syd} = I_{j,t} - \frac{2}{n(n+1)} \sum_{i=1}^{n} (n+1-i) I_{j,t-i} \tag{10}$$

or equivalently and using (4) is formed as:

$$NK_{j,t}^{syd} = \sum_{i=0}^{n} \left[I_{j,t-i} \prod_{\ell=0}^{i} (1 - d_\ell) \right] = I_{j,t} + \sum_{i=1}^{n} \left\{ I_{j,t-i} \prod_{\ell=1}^{i} \left[\frac{n(n-1) - 2(1-\ell)}{n(n+1)} \right] \right\} \tag{11}$$

where $d_0 = 0$.

Furthermore, the last of the depreciation patterns used in Karpetis & Zikos (2014) is the "*one-hoss-shay*" (*ohs*) method, in the context of which the productive capacity of the capital asset is assumed to be undiminished, since depreciation capacity does not occur until the end of its entire service life, except for the last year, in which depreciation of the asset is taking place.

According to this method, the level of depreciation of region j at period t, is defined as follows:

$$D_{j,t}^{ohs} = \sum_{i=1}^{n} d_i I_{j,t-i} \text{ ,where } d_i = \begin{cases} 0 & for\ i = 1,2,....,n\text{-}1 \\ 1 & for\ i = n \end{cases} \quad \textbf{(12)}$$

Therefore, net capital stock of j region at period t, can be obtained after the substitution of (12) in equation (4) and is equal to:

$$NK_{j,t}^{ohs} = \sum_{i=0}^{n-1} I_{j,t-i} \quad \textbf{(13)}$$

3. Methodology

In order to investigate, firstly, the affection of the dynamic characteristics of the time evolution of net capital stock by the previously analyzed depreciation patterns and secondly, the convergence of Greek regional net fixed capital, towards its long-run equilibrium, we initially estimated the appropriate *ARIMA*(*p*,*d*,*q*) models that describe best the diachronic evolution of the time series. Having estimated the coefficients of the appropriate *ARIMA* (*p*,*d*,*q*) models, we obtained the characteristic roots of the specified Autoregressive, *AR*(*p*), and Moving Average processes, *MA*(*q*), that were used in the estimation of the *ARIMA* models.

More specifically, employing the estimates of Karpetis & Zikos (2014) of Greek regional net fixed capital stock series of the period 1974-2006, as a first step, we utilized the Kwiatkowski, Phillips, Schmidt, and Shin, (1992) (*K.P.S.S.*) test of stationarity to determine the order of integration of $\{NK_{j,t}\}_{t=1974}^{2006}, j = 1,2,....,13$ sequences, for each depreciation pattern. Although, the *K.P.S.S.* test results are quite sensitive to the spectral estimation method and the bandwidth selection, we used the proposed by Kwiatkowski et al. (1992) *Bartlett* estimation technique, along with *Andrews bandwidth selection,* at a 5% level of significance, since in that case test results coincide to a larger extent than other estimation methods with the Autocorrelation coefficients diagrams (*ACF*)[2].

After the determination of the order of integration for every region and depreciation pattern, in the second step of the followed procedure, we specified the *ARIMA* (*p*,*d*,*q*) models, that describe best the time evolution of series over the period from 1974 to 2006. Using the Akaike's information criterion (*AIC*), we defined the factors *p* and *q* of Autoregressive and Moving Average processes respectively, according to the lowest *AIC* statistic, after taking into consideration the statistical significance of the estimated coefficients, among all the candidate *ARIMA* (p,d,q) models, where $p,q = 0,....,3$. The estimated series of the residuals were tested for the

[2] See **Note 1** from table 2.

presence of serial correlation and heteroskedasticity, using the Breusch – Godfrey [*BG*(*h*)] and *ARCH*(*w*) *LM* – test statistics respectively at 5% significance level. The test statistics were calculated for $h = 1$ & $w = 2$ lags in the test regression equation.

From the estimated coefficients of the *ARIMA* models in final step of our procedure we derived the characteristic roots of *AR*(*p*) and *MA*(*q*) processes to define firstly the pattern (monotonic or sinusoidal) of the diachronic evolution of our series and secondly the velocity of convergence towards their long run equilibrium value.

It is well known[3] that when the evolution of a $\{Y_t\}_{t=0}^{+\infty}$ series is described by a stochastic *AR*(*p*) model, the dynamic characteristics of the series' evolution depend on the nature and magnitude of the characteristic roots λ_j , $j = 1, 2, ..., p$, of the model.

The nature of the characteristic roots (real or conjugate complex) determines the pattern of the series time evolution. More specifically, the described by the *AR*(*p*) model will be (monotonic) sinusoidal, in the case where some of the characteristic roots are (positive real numbers) either conjugate complex or negative real numbers.

The magnitude of the characteristic roots determines the stationarity of the general solution of the stochastic difference equation described by the *AR*(*p*) model. The *AR*(*p*) model will be stationary, that is the $\{Y_t\}$ sequence will converge asymptotically to a long – run equilibrium value, when the arithmetic values of the total number of the characteristic roots (real and complex) are smaller than one in absolute value $\left(|\lambda_j| \prec 1 \ \forall \ j = 1, 2, ..., p\right)$.

In the special case of an *AR*(2) model the functional form of the encountered stochastic difference equation has as follows:

$$Y_{t+2} + a_1 Y_{t+1} + a_2 Y_t = a_0 + u_t \qquad \textbf{(14)}$$

where $a_i \in \mathbb{R}^*$, $i = 0, 1, 2$: constant coefficients & $u_t \sim N\left(0, \sigma_u^2\right)$: an identically and independently distributed error term.

The dynamic characteristics of series' $\{Y_t\}_{t=0}^{+\infty}$ diachronic evolution are defined by the nature of the difference equation's characteristic roots $\left(\lambda_j, j = 1, 2\right)$, that is the roots of the characteristic equation:

[3] See Walter Enders (1995), *Applied Econometric Time Series*, 1st edition, New York: John Wiley & Sons, ch. 1, pp. 1 – 61.

$$P(\lambda) = \lambda^2 + a_1\lambda + a_2 = 0 \quad \textbf{(15)}$$

The sign of the determinant (Δ) of the characteristic equation determines the nature of the characteristic roots:

$$\mathcal{D} = a_1^2 - 4\,a_2 \quad \textbf{(16)}$$

Three different cases arise on the basis of relation (16):

1st case, $\mathcal{D}$ > 0. When the determinant is positive definite the characteristic equation has two real and distinct roots the magnitude of which is equal to:

$$\lambda_{1,2} = \frac{-a_1 \pm \sqrt{\mathcal{D}}}{2} \quad \text{with} \quad \lambda_1 \prec \lambda_2 \quad \textbf{(17)}$$

2nd case, $\mathcal{D}$ = 0. In this case we have two real and equal characteristic roots:

$$\lambda_{1,2} = \frac{-a_1}{2} \quad \text{with} \quad \lambda_1 = \lambda_2 \quad \textbf{(18)}$$

3rd case, $\mathcal{D}$ < 0. In the case where the determinant is negative definite, the characteristic equation has two conjugate complex roots of the form:

$$\lambda_{1,2} = m \pm n\,i \quad , \quad i = \sqrt{-1} \quad \textbf{(19)}$$

where $m = -a_1/2$ & $n = \sqrt{\mathcal{D}}/2$: the real and imaginary part of the imaginary roots respectively.

In this case the diachronic evolution of $\{Y_t\}_{t=0}^{+\infty}$ sequence will be sinusoidal and its functional form will be given by the sum of the partial $\left(Y_t^p\right)$ and the complementary $\left(Y_t^c\right)$ solution of (14):

$$Y_t = Y_t^p + Y_t^c \quad \textbf{(20)}$$

The functional form of the complementary solution has as follows:

$$Y_t^c = \mathscr{A}\, R^t \cos\left(\hat{\varphi}\, t\right) \quad \textbf{(21)}$$

where $\mathscr{A} > 0$: the amplitude of oscillation, $R \in (0,1)$: the module or absolute value of the conjugate complex roots:

$$R = \sqrt{m^2 + n^2} \quad \textbf{(22)}$$

and $\hat{\varphi}$: an arc that satisfies the following relations simultaneously:

$$cos\left(\hat{\varphi}\right) = \frac{m}{R} \quad \textbf{(22.1)} \qquad \& \qquad sin\left(\hat{\varphi}\right) = \frac{n}{R} \quad \textbf{(22.2)}$$

If $\left|\lambda_j\right| \prec 1$ for j = 1,2, that is if $R \in \left(0,1\right)$, the partial solution has the following functional form:

$$Y_t^p = \frac{a_0}{1 + a_1 + a_2} + \sum_{j=1}^{2}\left[\theta_j \sum_{h=0}^{+\infty}\left(\lambda_j^h\, u_{t-h}\right)\right] \quad \textbf{(23)}$$

where $\theta_1 = \dfrac{\lambda_1}{\lambda_1 - \lambda_2}$ & $\theta_2 = -\dfrac{\lambda_2}{\lambda_1 - \lambda_2}$.

The general solution of the basic difference stochastic equation, as this is described by relation (20), will be stable if the constant coefficients a_i, i = 1, 2, satisfy the following set of necessary & sufficient stability conditions:

$$\left.\begin{array}{r} 1 + a_1 + a_2 \succ 0 \\ 1 - a_1 + a_2 \succ 0 \\ 1 - a_2 \succ 0 \end{array}\right\} \quad \textbf{(24)}$$

The satisfaction of the above stated set of stability conditions guarantees that $R \in \left(0,1\right)$. As a result Y_t will converge to Y_t^p through oscillations asymptotically. The time period ($\mathscr{P}$) over which Y_t performs a full cycle around Y_t^p is given by the following relation:

$$\mathscr{P} = \frac{2\,\pi}{\hat{\varphi}} \quad , \quad \pi \approx 3.14 \quad \textbf{(25)}$$

4. Empirical Results

In the beginning of the previous section the first step of our analysis is mentioned to involve the identification of the stationarity properties of our series. For that reason, in table 1 we present the statistical results of the *K.P.S.S.* unit root test for each of the previously analyzed depreciation methods for every administrative region.

Table 1

***K.P.S.S.* Unit Root test Results and Determination of series order of Integration**

Variable	*sld*	*ddb*	*syd*	*ohs*
$NK_{1,t}$	0.113736 $I(1)$	0.099601 $I(1)$	0.116732 $I(1)$	0.214616 $I(1)$
$NK_{2,t}$	0.43437 $I(0)$	0.448439 $I(0)$	0.43048 $I(0)$	0.143587 $I(1)$
$NK_{3,t}$	0.17601 $I(1)$	0.161802 $I(1)$	0.16251 $I(1)$	0.177842 $I(1)$
$NK_{4,t}$	0.229462 $I(0)$	0.160643 $I(0)$	0.231768 $I(0)$	0.152479 $I(1)$
$NK_{5,t}$	0.252422 $I(0)$	0.250318 $I(0)$	0.259605 $I(0)$	0.274214 $I(0)$
$NK_{6,t}$	0.397024 $I(0)$	0.410041 $I(0)$	0.39712 $I(0)$	0.376901 $I(0)$
$NK_{7,t}$	0.162564 $I(0)$	0.158447 $I(0)$	0.144767 $I(0)$	0.088861 $I(1)$
$NK_{8,t}$	0.149507 $I(0)$	0.114077 $I(0)$	0.148427 $I(0)$	0.449557 $I(0)$
$NK_{9,t}$	0.154709 $I(1)$	0.147521 $I(1)$	0.165683 $I(1)$	0.213003 $I(1)$
$NK_{10,t}$	0.306419 $I(1)$	0.264607 $I(0)$	0.398915 $I(0)$	0.449805 $I(0)$
$NK_{11,t}$	0.368181 $I(0)$	0.36594 $I(0)$	0.358779 $I(0)$	0.357312 $I(0)$
$NK_{12,t}$	0.256139 $I(0)$	0.254718 $I(0)$	0.275302 $I(0)$	0.295994 $I(0)$
$NK_{13,t}$	0.332364 $I(0)$	0.315678 $I(0)$	0.388668 $I(0)$	0.365704 $I(1)$

Note 1: The above table presents the *LM* statistic in the context of the *K.P.S.S.* unit root test using *Bartlett estimation* method along with *Andrews Bandwidth criterion* with only constant (no trend) in the test equation, at a level of significance 5%.

Note 2: $NK_{j,t,}$ reflects the variable of net fixed capital stock, for all administrative regions, j = 1, 2 , ... , 13.

Note 3: *sld, ddb, syd & ohs* indicate the four patterns of depreciation that analyzed in section 2, assuming a 25 year period for capital asset's service life.

Note 4: $I(d)$'s indicate the results of the unit root test at a level of significance 5% and the series order of *Integration* as well.

Note 5: *K.P.S.S.* critical values: 0.216 (1%), 0.146 (5%) & 0.119 (10%).

The *K.P.S.S.* unit root test reveals that the series of net fixed capital stock ($NK_{j,t}$, j = 1, …. , 13) for each depreciation pattern, are either stationary at their levels or stationary after taking their first differences. For example, in terms of the *sld* method, the series of Central Macedonia (j = 2), Thessaly (j = 4), Epirus (j = 5), Ionian Islands (j = 6), Western Greece (j = 7), Central Greece (j = 8), Northern Aegean Islands (j = 11), Southern Aegean Islands (j = 12) and Crete (j = 13), are all stationary processes (d = 0), whereas, for the remaining administrative regions, namely Eastern Macedonia and Thrace (j = 1), Western Macedonia (j = 3), Attica (j = 9) and Peloponnese (j = 10), test results indicate an integration of order 1 (d = 1).

As it can be clearly seen from table 2, the order of integration, as it was derived from the *K.P.S.S.* unit root test of each of the $NK_{j,t}$ series in relation to the four depreciation patterns, coincide in 8 out of 13 administrative regions. More specifically, the order of integration in terms of the depreciation pattern, is identical for Eastern Macedonia and Thrace (j = 1), Western Macedonia (j = 3), Epirus (j = 5), Ionian Island (j = 6), Central Greece (j = 8), Attica (j = 9), Northern Aegean Islands (j = 11) and Southern Aegean Islands (j = 12). In contrast, for the remaining administrative regions Central Macedonia (j = 2), Thessaly (j = 4), Western Greece (j = 7), Peloponnese (j = 10) and Crete (j = 13), results of order of integration are identical in three of the four depreciation methods.

In addition, it is evident that generally the results of the *ACF* correlograms compared to the *K.P.S.S.* test results coincide in most cases. For example, in terms of the *ddb* depreciation pattern, results of order of integration between the *K.P.S.S.* unit root test and the *ACF* correlograms are similar except for the series of the Eastern Macedonia and Thrace (j = 1), the Attica (j = 9) and the Northern Aegean Islands (j = 11).

After determining the order of integration in the next step of the followed procedure, we estimated the appropriate *ARIMA* (p,d,q) models for each administrative region and depreciation method, which are presented in the third column of table 3. As it can be clearly seen from that table, the employed depreciation method affects the choice of the appropriate *ARIMA* model, since discrepancies of the specified *ARIMA* models within a specific region appeared in 11 out of the 13 net fixed capital series. Exceptions are the first and the ninth administrative regions, where the employed *ARIMA* models are unaffected by the depreciation methods.

As aforementioned, the final step of our analysis involved the determination of the characteristic roots of $AR(p)$ and $MA(q)$ processes. In general, the estimated results of the $AR(p)$ and $MA(q)$ models as they are presented in table 3, indicate, firstly, the affection of the series dynamic characteristics by the employed depreciation methods and secondly, the slow convergence in most administrative regions of the series to their long-run equilibrium values.

Table 2

Comparison between *K.P.S.S.* test results and results from the *ACF* correlograms

K.P.S.S.	***sld***	***ddb***	***syd***	***ohs***	***% sim.***	***ACF***	***sld***	***ddb***	***syd***	***ohs***	***% sim.***
$NK_{1,t}$	I(1)	I(1)	I(1)	I(1)	*100*	$NK_{1,t}$	I(0)	I(0)	I(0)	I(1)	*75*
$NK_{2,t}$	I(0)	I(0)	I(0)	I(1)	*75*	$NK_{2,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{3,t}$	I(1)	I(1)	I(1)	I(1)	*100*	$NK_{3,t}$	I(1)	I(1)	I(1)	I(1)	*100*
$NK_{4,t}$	I(0)	I(0)	I(0)	I(1)	*75*	$NK_{4,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{5,t}$	I(0)	I(0)	I(0)	I(0)	*100*	$NK_{5,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{6,t}$	I(0)	I(0)	I(0)	I(0)	*100*	$NK_{6,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{7,t}$	I(0)	I(0)	I(0)	I(1)	*75*	$NK_{7,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{8,t}$	I(0)	I(0)	I(0)	I(0)	*100*	$NK_{8,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{9,t}$	I(1)	I(1)	I(1)	I(1)	*100*	$NK_{9,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{10,t}$	I(1)	I(0)	I(0)	I(0)	*75*	$NK_{10,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{11,t}$	I(0)	I(0)	I(0)	I(0)	*100*	$NK_{11,t}$	I(1)	I(1)	I(1)	I(2)	*75*
$NK_{12,t}$	I(0)	I(0)	I(0)	I(0)	*100*	$NK_{12,t}$	I(0)	I(0)	I(0)	I(0)	*100*
$NK_{13,t}$	I(0)	I(0)	I(0)	I(1)	*75*	$NK_{13,t}$	I(0)	I(0)	I(0)	I(0)	*100*

Note 1: Percentages of similarity between the *K.P.S.S.* test results and results from the *ACF* correlograms are 69.23%, 76.92%, 76.92% & 53.84% for the *sld, ddb,syd* & *ohs* respectively.
Note 2: Columns *%sim*, indicate the similarity of order of integration between the different depreciation patterns.

The detailed examination of table 3 reveals that in the cases of Eastern Macedonia and Thrace ($j = 1$), Epirus ($j = 5$) and Central Greece ($j = 8$) the pattern of the diachronic evolution is sinusoidal for each depreciation method, which means that the net capital series of that regions converge to their equilibrium values (since all characteristic roots were derived from stationary series) through oscillations. Whereas, for the Northern Aegean Islands ($j = 11$) the pattern of the diachronic evolution of the series is monotonic for each depreciation method. Subsequently, it is evident that in these cases, the dynamic characteristics of the series are unaffected by the depreciation methods.

In contrast, for the remaining regions, namely Central Macedonia ($j = 2$), Western Macedonia ($j = 3$), Thessaly ($j = 4$), Ionian Islands ($j = 6$), Western Greece (j = 7), Attica ($j = 9$), Peloponnese ($j = 10$), Southern Aegean Islands ($j = 12$) and Crete ($j = 13$) results indicate either a sinusoidal diachronic evolution of the series under consideration or a monotonic pattern of evolution within a specific region, which reveals the affection of the dynamic characteristics of the series by the employed depreciation method.

Table 3

***ARIMA* models and characteristic roots of *AR*(*p*) & *MA*(*q*) polynomials**

Variable	*Deprec. Method*	*Model*	***AR*(*p*) Characteristic Roots**					***MA*(*q*) Characteristic Roots**				
			λ_1	$\lambda_{2,3} = m \pm n\,i$		*Absolute values*		λ_1	$\lambda_{2,3} = m \pm n\,i$		*Absolute values*	
				m	***n***	$\lvert\lambda_1\rvert$	$\lvert\lambda_{2,3}\rvert$		***m***	***n***	$\lvert\lambda_1\rvert$	$\lvert\lambda_{2,3}\rvert$
$NK_{1,t}$	***sld***	*ARIMA*(2,1,2)	~	0.655320	0.438392	~	0.788437	~	0.586493	0.756964	~	0.957585
	ddb	*ARIMA* (2,1,2)	~	0.644820	0.445945	~	0.784002	~	0.588940	0.755838	~	0.958198
	syd	*ARIMA* (2,1,2)	~	0.641906	0.440788	~	0.778677	~	0.587102	0.755315	~	0.956656
	ohs	*ARIMA* (2,1,2)	~	0.769267	0.390119	~	0.862534	~	0.670553	0.675939	~	0.952121
$NK_{2,t}$	***sld***	*ARIMA*(1,0,2)	0.900730	~	~	0.900730	~	~	- 0.168952	0.733850	~	0.753047
	ddb	*ARIMA*(2,0,2)	~	0.717951	0.060776	~	0.720519	~	0.160437	0.843940	~	0.859055
	syd	*ARIMA*(2,0,2)	0.851010	0.615011	0	0.851010	0.615011	~	0.146988	0.811110	~	0.824321
	ohs	*ARIMA*(0,1,2)	~	~	~	~	~	~	- 0.191096	0.726803	~	0.751506
$NK_{3,t}$	***sld***	*ARIMA*(3,1,3)	- 0.532569	- 0.096505	0.522934	0.532569	0.531765	- 0.957958	- 0.007602	0.979812	0.957958	0.979841
	ddb	*ARIMA*(1,1,2)	0.529599	~	~	0.529599	~	~	0.355013	0.159190	~	0.389070
	syd	*ARIMA*(3,1,3)	- 0.495519	- 0.108607	0.490904	0.495519	0.502775	- 0.956785	- 0.005295	0.980485	0.956785	0.980500
	ohs	*ARIMA*(3,1,3)	- 0.567701	- 0.099815	0.313069	0.567701	0.328596	- 0.948321	- 0.201666	0.965695	0.948321	0.986527
$NK_{4,t}$	***sld***	*ARIMA*(2,0,2)	~	0.849373	0.194417	~	0.871340	~	0.416665	0.490192	~	0.643349
	ddb	*ARIMA*(2,0,2)	~	0.841227	0.209153	~	0.866838	~	0.423967	0.447460	~	0.616415
	syd	*ARIMA*(2,0,2)	~	0.841470	0.184177	~	0.861390	~	0.407178	0.481669	~	0.630713
	ohs	*ARIMA*(1,1,2)	0.758257	~	~	0.758257	~	~	0.377554	0.555961	~	0.672042
$NK_{5,t}$	***sld***	*ARIMA* (2,0,1)	~	0.925529	0.152498	~	0.938009	0.943836	~	~	0.943836	~
	ddb	*ARIMA* (2,0,1)	~	0.910136	0.164435	~	0.924871	0.942	~	~	0.942	~
	syd	*ARIMA* (2,0,1)	~	0.918138	0.162241	~	0.932362	0.942327	~	~	0.942327	~
	ohs	*ARIMA* (2,0,2)	~	0.958723	0.131642	~	0.967719	~	0.920699	0.071502	~	0.923471
$NK_{6,t}$	***sld***	*ARIMA* (1,0,0)	0.792008	~	~	0.792008	~	~	~	~	~	~
	ddb	*ARIMA* (1,0,0)	0.780782	~	~	0.780782	~	~	~	~	~	~
	syd	*ARIMA* (3,0,2)	0.791444	-0.185582	0.873429	0.791444	0.892927	~	-0.216833	0.947273	~	0.971773
	ohs	*ARIMA* (3,0,3)	0.809447	-0.834357	0.080123	0.809447	0.838195	-0.88586	-0.882884	0.132862	0.88586	0.892825

Variable	*Deprec. Method*	*Model*	***AR*(*p*) Characteristic Roots**					***MA*(*q*) Characteristic Roots**				
			λ_1	$\lambda_{2,3} = m \pm n\,i$		*Absolute values*		λ_1	$\lambda_{2,3} = m \pm n\,i$		*Absolute values*	
				m	***n***	$\lvert\lambda_1\rvert$	$\lvert\lambda_{2,3}\rvert$		***m***	***n***	$\lvert\lambda_1\rvert$	$\lvert\lambda_{2,3}\rvert$
$NK_{7,t}$	***sld***	*ARIMA* (2,0,1)	~	0.907242	0.274450	~	0.947845	0.959394	~	~	0.959394	~
	ddb	*ARIMA* (1,0,2)	0.590167	~	~	0.590167	~	~	-0.330792	0.910887	~	0.969092
	syd	*ARIMA* (2,0,1)	~	0.908799	0.267848	~	0.947448	0.968492	~	~	0.968492	~
	ohs	*ARIMA* (3,1,3)	-0.899082	0.675528	0.559347	0.899082	0.877045	-0.983896	0.680352	0.711941	0.983896	0.984753
$NK_{8,t}$	***sld***	*ARIMA* (2,0,1)	~	0.879466	0.271100	~	0.920302	0.967513	~	~	0.967513	
	ddb	*ARIMA* (3,0,2)	-0.862256	0.908305	0.263538	0.862256	0.945765	0.973776	-0.953501	0	0.973776	0.953501
	syd	*ARIMA* (2,0,1)	~	0.881222	0.279233	~	0.924404	0.956967	~	~	0.956967	
	ohs	*ARIMA* (2,0,1)	~	0.857340	0.208791	~	0.882397	0.521864	~	~	0.521864	
$NK_{9,t}$	***sld***	*ARIMA* (0,1,2)	~	~	~	~	~	~	-0.230824	0.784390	~	0.817648
	ddb	*ARIMA* (0,1,2)	~	~	~	~	~	~	-0.220445	0.798376	~	0.828251
	syd	*ARIMA* (0,1,2)	~	~	~	~	~	~	-0.220293	0.793444	~	0.823457
	ohs	*ARIMA* (0,1,2)	~	~	~	~	~	~	-0.253200	0.762425	~	0.803369
$NK_{10,t}$	***sld***	*ARIMA* (1,1,3)	0.731744	~	~	0.731744	~	-0.736015	0.758140	0.481179	0.736015	0.897948
	ddb	*ARIMA* (0,0,3)	~	~	~	~	~	-0.957712	-0.104576	0.951330	0.957712	0.95706
	syd	*ARIMA* (0,0,3)	~	~	~	~	~	-0.95469	-0.105127	0.950107	0.95469	0.955905
	ohs	*ARIMA* (1,0,3)	0.479484	~	~	0.479484	~	-0.896173	-0.050954	0.936003	0.896173	0.937389
$NK_{11,t}$	***sld***	*ARIMA* (2,0,1)	0.813104	0.710339	0	0.813104	0.710339	0.957861	~	~	0.957861	~
	ddb	*ARIMA* (2,0,1)	0.810509	0.702224	0	0.810509	0.702224	0.960665	~	~	0.960665	~
	syd	*ARIMA* (1,0,0)	0.854842	~	~	0.854842	~	~	~	~	~	~
	ohs	*ARIMA* (1,0,0)	0.872221	~	~	0.872221	~	~	~	~	~	~
$NK_{12,t}$	***sld***	*ARIMA* (2,0,1)	~	0.931324	0.151433	~	0.943555	0.999687	~	~	0.999687	~
	ddb	*ARIMA* (2,0,1)	~	0.896881	0.171762	~	0.91318	0.999956	~	~	0.999956	~
	syd	*ARIMA* (2,0,2)	0.863082	-0.650723	0	0.863082	0.650723	~	-0.638435	0.176881	~	0.662485
	ohs	*ARIMA* (1,0,2)	0.849205	~	~	0.849205	~	~	-0.185694	0.641203	~	0.66755
$NK_{13,t}$	***sld***	*ARIMA* (2,0,1)	~	0.964858	0.111763	~	0.971309	0.4918	~	~	0.4918	
	ddb	*ARIMA* (1,0,3)	0.98348	~	~	0.98348	~	-0.794637	0.109273	0.982235	0.794637	0.988294
	syd	*ARIMA* (2,0,0)	~	0.889649	0.066533	~	0.892133	~	~	~	~	~
	ohs	*ARIMA* (1,1,1)	0.977342	~	~	0.977342	~	0.57323	~	~	0.57323	~

Note 1: The characteristic roots were derived from statistically significant coefficients of the estimated *ARIMA* models (see table of Appendix A).

In addition, an important feature of the net fixed capital stock series is the slow convergence towards their equilibrium values as it is obvious from the absolute values of the characteristic roots given in the $|\lambda_1|$ and $|\lambda_{2,3}|$ columns of *AR(p)* processes of table 3. The velocity of the series' convergence is not identical in all administrative regions since in some cases such as the Western Macedonia (j = 3) convergence is quite faster than Central Greece (j = 8) for instance. However, in general the absolute values of the roots are too high, which means that the series of net fixed capital stock converge to their equilibrium values very slowly.

Moreover, in the case of the characteristic roots of the *MA*(q) processes, the impact on the residuals' pattern of diachronic evolution by the depreciation methods is less distinguishable, compared to the case of the actual values of $NK_{j,t}$ series. More specifically, in the majority of the regions [Western Macedonia (j = 3), Epirus (j = 5), Ionian Islands (j = 6), Western Greece (j = 7), Peloponnese (j = 10), Southern Aegean Islands (j = 12) and Crete (j = 13)], the pattern of the residuals' diachronic evolution is either sinusoidal, which means that their evolution is characterized by oscillations or is monotonic within a specific region. In this case, of course, the dynamic characteristics of the residuals are affected significantly by the choice of the depreciation method.

However, in the remaining regions, Eastern Macedonia & Thrace (j = 1), Central Macedonia (j = 2), Thessaly (j = 4) and Attica (j = 9) the residuals' behavior is sinusoidal whereas, for Central Greece (j = 8) and Northern Aegean Islands (j = 11) it seems that residuals' evolution is monotonic. Of course in this case, it is rather obvious that the dynamic characteristics of the residuals of the Greek net fixed capital stock series is unaffected by the depreciation methods.

As in the case of *AR*(p) processes, residuals also characterized by a slow convergence towards their equilibrium values, as it is apparent from the absolute values of the characteristic roots, which are given in the last two columns of table 3. In general, the absolute values of the characteristic roots are too high, since they approach the value of one, as in the case of the actual series, which means that the residuals of net fixed capital stock converge to their equilibrium values very slowly.

Furthermore, for a better understanding of the impact on the pattern of the diachronic evolution of the series by the employed depreciation method, we constructed table 4 in which we present the degree of the series' differentiation in terms of their evolutionary pattern on the basis of each depreciation method. As it can be clearly seen, in 7 out of 12 regions [since for Attica (j = 9) there are not characteristic roots for the actual $NK_{j,t}$ series] significant discrepancies of the series' evolutionary pattern due to the different depreciation methods of physical capital do exist. For example, the $NK_{j,t}$ series of Crete (j = 13), exhibit an oscillatory diachronic evolution for the *sld* and the *syd* depreciation methods whereas, for the *ddb* and the *ohs* depreciation methods, they follow a monotonic evolution. In contrast, only in four cases [Eastern Macedonia and Thrace (j = 1), Epirus (j = 5), Central Greece (j =8) and Northern Aegean Islands (j = 11)] the evolutionary motive is not affected by the depreciation methods since there is 100% coincidence within these regions.

In addition, the general results of the series' evolutionary pattern for each depreciation method as they are presented in the last row of table 4, indicate an oscillatory evolution in the majority of the regions, with higher percentages (61.53%) for the *sld* and *syd* methods compared to those of *ddb* and *ohs* depreciation methods (46.51%).

Table 4

Differentiation of series' evolutionary motive on the basis of the depreciation method of physical capital

		sld	***ddb***	***syd***	***ohs***	**As percentage of total**	
						Monotonic	**Oscillatory**
$NK_{1,t}$		Oscillatory	Oscillatory	Oscillatory	Oscillatory	0.0%	100.0%
$NK_{2,t}$		Monotonic	Oscillatory	Monotonic	~	50.0%	25.0%
$NK_{3,t}$		Oscillatory	Monotonic	Oscillatory	Oscillatory	25.0%	75.0%
$NK_{4,t}$		Oscillatory	Oscillatory	Oscillatory	Monotonic	25.0%	75.0%
$NK_{5,t}$		Oscillatory	Oscillatory	Oscillatory	Oscillatory	0.0%	100.0%
$NK_{6,t}$		Monotonic	Monotonic	Oscillatory	Oscillatory	50.0%	50.0%
$NK_{7,t}$		Oscillatory	Monotonic	Oscillatory	Oscillatory	25.0%	75.0%
$NK_{8,t}$		Oscillatory	Oscillatory	Oscillatory	Oscillatory	0.0%	100.0%
$NK_{9,t}$		~	~	~	~	~	~
$NK_{10,t}$		Monotonic	~	~	Monotonic	50.0%	~
$NK_{11,t}$		Monotonic	Monotonic	Monotonic	Monotonic	100.0%	0.0%
$NK_{12,t}$		Oscillatory	Oscillatory	Monotonic	Monotonic	50.0%	50.0%
$NK_{13,t}$		Oscillatory	Monotonic	Oscillatory	Monotonic	50.0%	50.0%
As percentage of total	**Oscillatory**	61.53%	46.15%	61.53%	46.15%		
	Monotonic	30.76%	38.46%	23.07%	38.46%		

5. Conclusions

In this paper we tried to investigate the impact on the dynamic characteristics of the Greek regional net fixed capital series by the four depreciation methods *(sld, ddb, syd, ohs*), that were employed in Karpetis & Zikos (2014), assuming a 25 year period of capital asset's service life. Using their estimations of net fixed capital stock series over the period from 1974 to 2006, in our followed procedure we initially estimated the appropriate *ARIMA*(*p*,*d*,*q*) models describing best the diachronic evolution of net fixed capital series and then, from the estimated *ARIMA* (*p*,*d*,*q*) coefficients we derived the characteristic roots of the actual $NK_{j,t}$ series and of their residuals as well.

The results of our analysis indicate that the choice of a specific depreciation method is possibly connected with an affection of the dynamic characteristics of the $NK_{j,t}$ series. Namely, as it was revealed from tables 3 and 4, the pattern of the diachronic evolution may vary from one depreciation method to another within a specific region. More specifically, as table 4 indicates, the evolutionary motive due to the employed depreciation method differs in 7 administrative regions, whereas in only 4 regions there was an absolute coincidence. Finally, the high absolute values of the characteristic roots indicate a slow convergence of regional net fixed capital stock series towards their equilibrium values as for the case of Greece.

Appendix A: Estimation results calculated from the regression $Y_{j,t} = c + \sum_{i=1}^{p}(a_i Y_{j,t-i}) + u_{j,t} + \sum_{i=1}^{q}(a_i u_{j,t-i})$**, where** $Y_{j,t} = \Delta^d(NK_{j,t})$ **with** $j = 1, \ldots, 13$

$Y_{j,t}$	***Deprec. Method***	$\bar{R}^2$	c	a_1	a_2	a_3	θ_1	θ_2	θ_3	AIC	JB	$ARCH(1)$	$BG(2)$
$\Delta(NK_{1,t})$	***sld***	0.358554	5.826346 (0.34780)	1.310640 (0.00000)	-0.621632 (0.00320)	~	-1.172986 (0.00000)	0.916969 (0.00000)	~	8.216276	0.462132 (0.793687)	0.068137 (0.794100)	0.127853 (0.938100)
	ddb	0.317243	4.303771 (0.45744)	1.289639 (0.00000)	-0.614660 (0.00500)	~	-1.177881 (0.00000)	0.918143 (0.00000)	~	8.179177	0.314248 (0.854598)	0.046664 (0.828974)	0.173588 (0.916866)
	syd	0.317452	5.190301 (0.38001)	1.283812 (0.00000)	-0.606338 (0.00518)	~	-1.174205 (0.00000)	0.915190 (0.00000)	~	8.206376	0.374312 (0.829314)	0.099849 (0.752010)	0.115995 (0.943652)
	ohs	0.439686	10.965183 (0.15447)	1.538535 (0.00000)	-0.743965 (0.00007)	~	-1.341106 (0.00000)	0.906534 (0.00000)	~	8.350276	0.059071 (0.970896)	0.008773 (0.925375)	0.132485 (0.935904)
$NK_{2,t}$	***sld***	0.965634	9.446792 (0.00000)	0.900730 (0.00000)	~	~	0.337904 (0.03960)	0.56708 (0.00280)	~	1.002565	0.783454 (0.675889)	0.081169 (0.775700)	2.669855 (0.263200)
	ddb	0.953067	7.012683 (0.00000)	1.435902 (0.00000)	-0.519147 (0.00620)	~	-0.320874 (0.02340)	0.737975 (0.00000)	~	9.816667	1.633468 (0.441872)	0.075307 (0.783800)	1.032589 (0.596700)
	syd	0.962187	7.990295 (0.00020)	1.466026 (0.00000)	-0.523384 (0.00950)	~	-0.293976 (0.08090)	0.679505 (0.00010)	~	9.892005	1.685301 (0.430568)	0.02631 (0.871100)	0.812641 (0.666100)
$\Delta(NK_{2,t})$	***ohs***	0.00000	3.797527 (0.00660)	~	~	~	0.382192 (0.01710)	0.564761 (0.00170)	~	1.020570	0.848569 (0.654238)	0.013925 (0.906100)	0.923130 (0.630300)
$\Delta(NK_{3,t})$	***sld***	0.633915	-5.672508 (0.00220)	-0.725578 (0.00010)	-0.385564 (0.01310)	-0.150596 (0.26580)	0.973161 (0.00000)	0.974652 (0.00000)	0.919724 (0.00000)	6.283978	0.894041 (0.639531)	0.127596 (0.720900)	6.870126 (0.032200)
	ddb	0.039114	-6.000366 (0.01870)	0.529599 (0.03340)	~	~	-0.710025 (0.02120)	0.151375 (0.42350)	~	8.088185	25.94260 (0.000002)	1.440729 (0.230000)	0.908947 (0.634800)
	syd	0.680209	-5.165959 (0.00470)	-0.712732 (0.00010)	-0.360416 (0.01570)	-0.125259 (0.33610)	0.967375 (0.00000)	0.971512 (0.00000)	0.919834 (0.00000)	6.231555	0.842629 (0.656184)	0.468552 (0.493700)	5.680326 (0.058400)
	ohs	0.663308	-6.655203 (0.00420)	-0.767332 (0.00000)	-0.221306 (0.18450)	-0.061298 (0.67930)	1.351653 (0.00000)	1.355724 (0.00000)	0.922940 (0.00000)	6.223226	0.790583 (0.673484)	0.415213 (0.519300)	0.381585 (0.826300)

$Y_{j,t}$	***Deprec. Method***	$\bar{R}^2$	c	a_1	a_2	a_3	θ_1	θ_2	θ_3	***AIC***	***JB***	***ARCH*(1)**	***BG*(2)**
$NK_{4,t}$	***sld***	0.905527	3.056464 (0.00000)	1.698746 (0.00000)	-0.759233 (0.00000)	~	-0.833329 (0.00030)	0.413898 (0.03270)	~	8.953694	0.903688 (0.636453)	0.249479 (0.617400)	2.746804 (0.253200)
	ddb	0.891967	2.643640 (0.00000)	1.682454 (0.00000)	-0.751408 (0.00000)	~	-0.847933 (0.00040)	0.379968 (0.05380)	~	8.868615	0.584397 (0.746620)	0.623081 (0.429900)	2.453162 (0.293300)
	syd	0.897553	2.872203 (0.00000)	1.682941 (0.00000)	-0.741993 (0.00000)	~	-0.814355 (0.00060)	0.397798 (0.04070)	~	8.939108	0.855950 (0.651828)	0.326774 (0.567600)	2.921483 (0.232100)
$\Delta(NK_{4,t})$	***ohs***	0.431987	6.631656 (0.58840)	0.758257 (0.00000)	~	~	-0.755109 (0.00050)	0.45164 (0.01240)	~	9.149774	1.119436 (0.571370)	0.020597 (0.885900)	3.023523 (0.220500)
$NK_{5,t}$	***sld***	0.941988	6.461525 (0.00000)	1.851059 (0.00000)	-0.879860 (0.00000)	~	-0.943836 (0.00000)	~	~	6.177263	0.372514 (0.830060)	0.848440 (0.357000)	1.600440 (0.449200)
	ddb	0.919183	5.317609 (0.00000)	1.820272 (0.00000)	-0.855386 (0.00000)	~	-0.942000 (0.00000)	~	~	6.145066	0.514272 (0.773263)	0.885930 (0.346600)	1.230136 (0.540600)
	syd	0.93681	5.942815 (0.00000)	1.836276 (0.00000)	-0.869300 (0.00000)	~	-0.942327 (0.00000)	~	~	6.191022	0.396300 (0.820247)	0.893612 (0.344500)	1.578525 (0.454200)
	ohs	0.978186	1.037104 (0.00000)	1.917446 (0.00000)	-0.936479 (0.00000)	~	-1.841397 (0.00000)	0.852799 (0.00000)	~	6.165071	0.598737 (0.741286)	1.732663 (0.188100)	4.058621 (0.131400)
$NK_{6,t}$	***sld***	0.994507	6.623426 (0.00000)	0.792008 (0.00000)	~	~	~	~	~	2.368568	7.174858 (0.027669)	0.142466 (0.705800)	0.280462 (0.869200)
	ddb	0.992413	5.892803 (0.00000)	0.780782 (0.00000)	~	~	~	~	~	2.236499	17.03623 (0.000200)	0.455779 (0.499600)	0.008426 (0.995800)
	syd	0.991354	6.647601 (0.00000)	0.420279 (0.00010)	-0.503562 (0.00000)	0.631033 (0.00000)	0.433666 (0.00000)	0.944343 (0.00000)	~	2.202765	1.014005 (0.602298)	0.128767 (0.719700)	0.648903 (0.722900)
	ohs	0.997257	9.590795 (0.00000)	-0.859267 (0.00000)	0.648164 (0.00000)	0.568694 (0.00000)	2.651628 (0.00000)	2.361359 (0.00000)	0.706151 (0.00000)	2.488390	0.183532 (0.912319)	0.174902 (0.675800)	1.833862 (0.399700)
$NK_{7,t}$	***sld***	0.879873	2.200079 (0.00000)	1.814483 (0.00000)	-0.898410 (0.00000)	~	-0.959394 (0.00000)	~	~	8.060493	2.769522 (0.250384)	2.843347 (0.091800)	0.155297 (0.925300)
	ddb	0.878010	1.953051 (0.00000)	0.590167 (0.00010)	~	~	0.661584 (0.00000)	0.939138 (0.00000)	~	8.093057	0.046614 (0.976962)	0.073240 (0.786700)	0.228700 (0.891900)
	syd	0.857678	2.068868 (0.00000)	1.817598 (0.00000)	-0.897658 (0.00000)	~	-0.968492 (0.00000)	~	~	8.052771	3.923027 (0.140645)	3.187430 (0.074200)	0.020358 (0.989900)
$\Delta(NK_{7,t})$	***ohs***	0.407755	2.242584 (0.55920)	0.451974 (0.00150)	0.445503 (0.00340)	-0.691581 (0.00000)	-0.376808 (0.00010)	-0.369052 (0.00110)	0.954121 (0.00000)	8.201791	1.079876 (0.582784)	0.000465 (0.982800)	1.750666 (0.416700)

$Y_{j,t}$	*Deprec. Method*	$\bar{R}^2$	c	a_1	a_2	a_3	θ_1	θ_2	θ_3	*AIC*	*JB*	*ARCH*(1)	*BG*(2)
$NK_{8,t}$	*sld*	0.897463	9.268767 (0.00000)	1.758931 (0.00000)	-0.846955 (0.00000)	~	-0.967513 (0.00000)	~	~	1.073717	0.722611 (0.696766)	1.905293 (0.167500)	0.000000 (1.00000)
	ddb	0.891772	8.095639 (0.00000)	0.954355 (0.00000)	0.671913 (0.00640)	-0.771263 (0.00000)	-0.020275 (0.86790)	-0.928496 (0.00000)	~	1.066130	2.389515 (0.302777)	0.024828 (0.874800)	0.093187 (0.954500)
	syd	0.882395	8.671019 (0.00000)	1.762443 (0.00000)	-0.854523 (0.00000)	~	-0.956967 (0.00000)	~	~	1.074903	0.704792 (0.703002)	2.273089 (0.131600)	0.052597 (0.974000)
	ohs	0.909273	1.254238 (0.00000)	1.714679 (0.00000)	-0.778625 (0.00000)	~	-0.521864 (0.06580)	~	~	1.121218	0.098604 (0.951854)	3.180758 (0.074500)	1.392524 (0.498400)
$\Delta(NK_{9,t})$	*sld*	0.413457	5.704192 (0.05290)	~	~	~	0.461647 (0.00450)	0.668548 (0.00020)	~	1.157658	0.096354 (0.952965)	1.01E-06 (0.999200)	0.203651 (0.903200)
	ddb	0.396883	4.648266 (0.09300)	~	~	~	0.440890 (0.00350)	0.686000 (0.00010)	~	1.146894	0.230518 (0.891135)	0.032233 (0.857500)	0.016197 (0.991900)
	syd	0.398038	5.262120 (0.06380)	~	~	~	0.440586 (0.00470)	0.678082 (0.00010)	~	1.151844	0.265718 (0.875589)	0.002397 (0.960900)	0.121723 (0.941000)
	ohs	0.432476	8.577043 (0.01320)	~	~	~	0.506400 (0.00430)	0.645402 (0.00060)	~	1.183518	0.155684 (0.925110)	0.06008 (0.806400)	1.247780 (0.535900)
$\Delta(NK_{10,t})$	*sld*	0.021784	4.945926 (0.65310)	0.731744 (0.00110)	~	~	-0.780266 (0.00280)	-0.309696 (0.24060)	0.593456 (0.00370)	9.933699	15.81677 (0.000368)	0.396140 (0.529100)	4.851412 (0.088400)
$NK_{10,t}$	*ddb*	0.746645	2.255928 (0.00000)	~	~	~	1.166864 (0.00000)	1.116272 (0.00000)	0.877230 (0.00000)	9.799585	15.17707 (0.000506)	0.005057 (0.943300)	0.176922 (0.915300)
	syd	0.764969	2.417218 (0.00000)	~	~	~	1.164944 (0.00000)	1.114482 (0.00000)	0.872353 (0.00000)	9.853221	16.94466 (0.000209)	0.001639 (0.967700)	0.458455 (0.795100)
	ohs	0.839183	3.380696 (0.00000)	0.479484 (0.01310)	~	~	0.998081 (0.00000)	0.970026 (0.00000)	0.787465 (0.00000)	1.009612	4.601379 (0.100190)	0.006355 (0.936500)	3.971273 (0.137300)
$NK_{11,t}$	*sld*	0.950123	6.026446 (0.01470)	1.523443 (0.00000)	-0.577579 (0.00030)	~	-0.957861 (0.00000)	~	~	5.506528	392.0975 (0.000000)	0.033889 (0.853900)	0.482848 (0.785500)
	ddb	0.929894	5.259114 (0.02350)	1.512733 (0.00000)	-0.569159 (0.00040)	~	-0.960665 (0.00000)	~	~	5.511038	434.3090 (0.00000)	0.019169 (0.889900)	0.487508 (0.783700)
	syd	0.964066	6.145660 (0.27310)	0.854842 (0.00000)	~	~	~	~	~	5.500097	498.9579 (0.000000)	0.028789 (0.865300)	1.537550 (0.463600)
	ohs	0.988192	5.427712 (0.44250)	0.872221 (0.00000)	~	~	~	~	~	5.625717	145.0544 (0.000000)	0.238227 (0.625500)	1.907364 (0.385300)

$Y_{j,t}$	***Deprec. Method***	$\bar{R}^2$	c	a_1	a_2	a_3	θ_1	θ_2	θ_3	***AIC***	***JB***	***ARCH*(1)**	***BG*(2)**
$NK_{12,t}$	***sld***	0.966549	2.149624 (0.00000)	1.862649 (0.00000)	-0.890297 (0.00000)	~	-0.999687 (0.00000)	~	~	3.904860	5.917430 (0.051886)	1.209591 (0.271400)	0.872213 (0.646500)
	ddb	0.958399	1.740070 (0.00000)	1.793762 (0.00000)	-0.833898 (0.00000)	~	-0.999956 (0.00000)	~	~	3.795892	7.758787 (0.020663)	0.657260 (0.417500)	0.450625 (0.798300)
	syd	0.968330	1.634019 (0.00050)	0.21236 (0.17780)	0.561627 (0.00030)	~	1.276870 (0.00000)	0.438887 (0.04830)	~	4.033646	1.707740 (0.425764)	2.435580 (0.118600)	2.321910 (0.313200)
	ohs	0.987539	2.342306 (0.00010)	0.849205 (0.00000)	~	~	0.371387 (0.03090)	0.445624 (0.01010)	~	4.507202	0.954484 (0.620492)	0.414957 (0.519500)	1.181663 (0.553900)
$NK_{13,t}$	***sld***	0.981314	8.474362 (0.11570)	1.929715 (0.00000)	-0.943441 (0.00000)	~	-0.491800 (0.02350)	~	~	5.031520	0.817982 (0.664320)	0.141466 (0.706800)	2.886468 (0.236200)
	ddb	0.976908	1.096797 (0.60530)	0.983480 (0.00000)	~	~	0.576091 (0.00020)	0.803061 (0.00000)	0.776142 (0.00000)	4.926840	0.678543 (0.712289)	0.462585 (0.496400)	0.138785 (0.933000)
	syd	0.977096	7.712628 (0.20650)	1.779297 (0.00000)	-0.795901 (0.00000)	~	~	~	~	5.048995	0.552607 (0.785583)	0.023233 (0.878900)	2.761263 (0.251400)
$\Delta(NK_{13,t})$	***ohs***	0.816238	2.721604 (0.63280)	0.977342 (0.00000)	~	~	-0.573230 (0.00400)	~	~	5.117250	5.746853 (0.056505)	0.011335 (0.915200)	3.529478 (0.171200)

***Note*:** p – values in parenthesis.

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