Inertial Growth: the British and American Cases

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Introduction

Perhaps, one of the most astonishing experiences in economics is trying to predict the future value of a variable. This can be very useful if you are trying to determine outcomes of future scenarios and you are willing to change them in order to reach a determined objective. For instance, if you wish to control inflation, it would be very practical to determine the value of the future production level in order to establish the money supply that will be required for obtaining the desired price level.

The idea of this paper is to try to determine an adequate formalization of the gross domestic product –GDP– through a simple econometric model so that we can at least guess, in a feasible and scientific way, the growth rate for this variable in a specific period of time. Thus, it must be clear that this article is not being written without rhyme or reason because I hope to achieve a model which can be applied in several moments of world economy.

First, I will try to show, in a theoretical way, the factors which influence growth. However, I will not apply the conventional growth theory that many prominent authors like Solow, Modigliani, Barro, Sala-I-Martin and others have discussed in such a brilliant way. But, indeed, I am going to use key ideas that they expressed and that might allow me to demonstrate my thesis. The second part of

this paper will be devoted to study the empirical evidence and the applicability of my work to two different cases: United States and United Kingdom; and finally I shall, sketch a conclusion.

I. Growth Domestic Product increase Causes

When GDP is mentioned, everybody immediately begins to think in the production of final goods and services in a specific period. But why does it increase? Why can't it be fixed? One reason, like in the case of inflation, is the expectation that different agents –households and firms– have in the economy or like Delong states: "in the twentieth century we *expected* and today we expect progress. We assume that each generation will live between half again and twice as well in material terms as its parents' generation. We find it hard to imagine what it would be like to live in a society not experiencing rapid material progress" (Bradford, 2000, 3).

This means that they are always taking in to account the growth of the economy in the near past, more specifically in the last quarter or recent quarters because they believe that that result or results indicate the possible turn that the economy will take in the following three months. Schumpeter summarizes this saying: "...it [the economical system] will always be connected with the previous state of things" (Schumpeter, 1957, 30).

But why are they so interested in the past? Because they know that history and the past figures can give a valid point of view for interpreting the possible evolution of the economy. In other words: "analysts and investors seem to believe that a firm whose past growth puts it in the top tier of growth rates for several years in a row is highly likely to repeat this performance in the future" (Chan, Karceski and Lakonishok, 2001, 9).

Even more, they understand that firms, analysts, investors, and economical agents behave in a cyclic way; the problem is trying to determine the way how such cycles repeats itself and the model that best explains those cyclical changes. Another reason for looking at the past is because suppliers are worried about their merchandise stock: they do not produce because it is a fun hobby but due to the possible profit they can obtain from their products. And they are conscient that the more they sell the more they gain, but a high stock means a high storage cost that finally reduces profit. About this, Schumpeter says: "Merchandise sellers appear again as buyers, in the adequate measure, for acquiring the goods that will allow them to maintain their consumption and productive equipment for the following economical period" (Schumpeter, 1957, 31).

But why are they so interested in the supply side and not on the demand one? The answer is quite simple. They have "supplycitis", a rear disease that is caused by thinking only in producing. So their way of thinking things is that supply generates demand because this side of the market is the one that pays workers and owners of capital their share, and these agents, due to the payment,[1] obtain an income that allows them to demand goods and services and not the way around.[2]

Since I am assuming that all economic agents are rational, I can conclude, *ceteris paribus*, due to my theory and perfect information about the growth level in the last period, that if agents perceive augment in such level, the most practical thing to do will be to increase production to try to sell more taking advantage of the idea that they will buy more as a result of the increased income that they posses.[3] On the contrary, if the level of growth is diminished, they will reduce production and retrench spending through the abridgement of stocks.

In a formalized way, where Y_t^* represents long run per capita output or more precisely the per capita GDP produced in a period t, α is a constant that shows the per capita production level if there has not been any previously, β_i would be the change in the per capita output level in period t or the impact that a per capita GDP increase in the previous periods would have on today's per capita GDP; n represents the number of production periods that agents have in mind in order to establish the production level of future periods and u_t represents random effects; therefore, we could express today's per capita GDP as follows:

$$Y_t^* = \alpha + \sum_{i=1}^{n} \beta_i Y_{t-1} + u_t \qquad (1)$$

Now I must clarify that I am not stating that previous GDP is the only variable that makes output grow. No. What I am stating is that the causes of GDP growth are not wrapped in a shroud of mystery as many could think and that the main cause for the increase of production is the output in previous periods. I am aware that production depends on inputs, but this is true in an important manner in the short

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1 This is not my exclusive idea, on the contrary, a very important economist before me, said many years ago: "every supply generates its own demand." The author of such brilliant idea is John Baptiste Say.

2 This idea could be summarized: "It all began with a need, that generated production, and the latter gave demand." Remember you cannot demand without money (income), that is merely speculation.

3 But the producer will be thinking: Not for long!

run, but in long run periods, the highest weight is given to previous output. This can be demonstrated, in the short run:[4]

$$Y_t = \phi\,(Y_t^*, A_t, K_t, H_t, L_t) \tag{2}$$

Where A_t represents the technological advance, K_t is the stock of capital, H_t is the accumulated human capital and L_t is the labor stock. So I am saying that in the short run production level depends mainly of these variables that are located in period t and with lesser importance than in the long run of previous output. This idea could be expressed in a more specific way in which we are going to include capital depreciation, that is, not only for physical capital but also for human capital,

$$Y_t=\mu_1 Y_t^*+\mu_2(\xi-\rho)f(A_t)+(\psi-\delta)(\mu_3 f(K_t)+\mu_4 f(H_t))+\mu_5(\varsigma-\nu)f(L_t) \tag{3}$$

Equation in which I am also adding the difference between the growth rate of the variable and depreciation of different variables represented by the subtraction of a Greek letter that you find by pairs in every parenthesis, as well as the importance or weight that every factor has in the short run. For example, the influence of A_t in the GDP of period t is μ_2, for K_t is μ_3 and so on. The following step is to take limits towards infinity,

$$\text{Lim}_{t\to\infty} Y_t=\text{Lim}_{t\to\infty}[\mu_1 Y_t^*+\mu_2(\xi-\rho)f(A_t)+(\psi-\delta)(\mu_3 f(K_t)+\mu_4 f(H_t))+\mu_5(\varsigma-\nu)f(L_t)] \tag{4}$$

But,

$$\text{Lim}_{t\to\infty} Y_t = Y_t^* \tag{5}$$

And,

$$\text{Lim}_{t\to\infty}[\mu_1 Y_t^*+\mu_2(\xi-\rho)f(A_t)+(\psi-\delta)(\mu_3 f(K_t)+\mu_4 f(H_t))+\mu_5(\varsigma-\nu)f(L_t)] = 0 \tag{6}$$

Which agrees with the idea of a variable in the steady state, that is, that its depreciation rate equals its growth rate. Replacing equation (5) and (6) in (4) we arrive at equation (7),

$$Y_t^* = \mu_1 Y_t^* \tag{7}$$

And replacing equation (1) in (7) and understanding that since we are in the long run m_1 is equal to one since there is only one thing that influences the product in the period t then it has a weight of one hundred percent. So we can write formula (8)

$$Y_t^* = \alpha + \sum_{i=1}^{n} \beta_i Y_{t-1} + u_t \tag{8}$$

That is precisely the same as equation (1). Now in the steady state, it has to be true that

$$Y_t^* = Y_{t-1} = \ldots = Y_1 \tag{9}$$

4 From now on, all the variables will be treated in per capita terms even though this is not mentioned explicitly in the text. So when we talk about the stock of capital, for example, we are really talking about the per capita capital stock. This applies for all other variables.

Therefore, we could establish the following relation and obtain equation (10),

$$Y_t^* = Y_t = \alpha + \sum_{i=1}^{n} \beta_i Y_t + u_t$$

$$Y_t = \alpha + n\beta Y_t + u_t$$

$$Y_t - n\beta Y_t = \alpha + u_t$$

$$Y_t = \frac{\alpha + u_t}{1 - n\beta} \qquad (10)$$

What allows us to view that in the steady state the value of per capita output would be a fixed quantity (assuming that u_t is fixed in the long run). It is easy to show that all the aggregated variables would grow at the same rate as the population's rate since we are in the steady state where per capita variables do not grow. Let's proceed, then, to verify the theoretical model using econometrics.

II. British and American cases

The following is the result of two econometric models that I estimated with data that I got from different governmental statistic sites in Internet of the above mentioned countries.[5] For example, the information of GDP in USA was taken from the Bureau of Economic Analysis and for the U.K. this information was taken from StatBase. For the U.S.A and the U.K. cases, I have taken a quarterly sample of the real Gross Domestic Product. For the first case, the time series are from 1946:01 to 2001:02; for the second, the time series begins1955:01 to 2001:02.

In both cases, variables (YUSASA for the United States and YUKSA for the United Kingdom) will have the subscript *t-n* that will mean that the GDP of the country that has this notation is the quarterly growth rate of the last quarter *t-n* on corresponding quarter of previous year *t-n-1*.

The first test that I made was the Unit Root Test that would allow me to establish if the variable was stationary or not. In both cases I applied the Augmented Dickey-Fuller Test and it showed that both variables, after being seasonally adjusted, were stationary. Therefore, there is no presence of a unit root, in consecuence we can apply the Box and Jenkins methodoloy and we do not have to difference the variables. The results of these two test are presented below (Tables 1 and 2).

5 This information is in included in the appendix of this paper.

Table 1. United States: Augmented Dickey-Fuller –ADF– Test Unit Root Test

ADF Test Statistic	-7,321285	1% Critical Value*	-3,4627
		5% Critical Value	-2,8753
		10% Critical Value	-2,5740
Durbin-Watson statistic	2,005050		

* MacKinnon critical values for rejection of hypothesis of a unit root.

Table 2. United Kingdom: Augmented Dickey-Fuller –ADF– Test Unit Root Test

ADF Test Statistic	-4,529928	1% Critical Value*	-3,4678
		5% Critical Value	-2,8776
		10% Critical Value	-2,5752
Durbin-Watson statistic	2,018982		

* MacKinnon critical values for rejection of hypothesis of a unit root.

Notice that the series were seasonally adjusted with the Difference from Moving Average or Additive Method since the information is given by quarters. You will find this information plus the White Heteroscedasticity Test, Durbin Watson and other details that help understand the econometric model in Table 3. Then you will encounter the two graphs that will show the accuracy of the developed models.

Table 3. Econometric models

Country	*United States of America*	*United Kingdom*
Seasonal adjustment[a]		
Scaling factors		
1	-3,005182	0,010534
2	-3,594124	0,019423
3	6,647530	-0,019327
4	-0,048224	-0,010631

Continues...

a Through the Difference from Moving Average or Additive Method

Table 3. Econometric models (continued)

Country	*United States of America*	*United Kingdom*
Adjusted serie	Y_{USt}	Y_{UKt}
Regression[b]		
Dependent variable	Y_{USt}	Y_{UKt}
Sample, observations[c]	1948:4 to 2001:2, 211	1955:2 to 2001:2, 185
Equation	$Y_{USt} = \alpha_1 + \beta_1 Y_{USt-1} + \beta_2 Y_{USt-2} + \beta_3 Y_{USt-3}$	$Y_{UKt} = \alpha_1 + \beta_1 Y_{UKt-1}$
α_1	1066,527	0,558784
Standard error	183,7715	0,141691
T-statistic	5,803551	3,943683
Probability	0,0000	0,0001
β_1	1,144805	0,773510
Standard error	0,058708	0,044737
T-statistic	19,49982	17,29023
Probability	0,0000	0,0000
β_2	-0,226977	
Standard error	0,095279	
T-statistic	-2,382247	
Probability	0,0181	
β_3	-0,224552	
Standard error	0,066552	
T-statistic	-3,374108	
Probability	0,0009	
R-squared	0,785051	0,602117
Adjusted R-squared	0,781936	0,599943
Standard error of regression	1289,548	1,409817
Sum squared residual	3,44E+08	363,7279
Log Likelihood	-1808,569	-325,0383
Durbin-Watson statistic	2,025806	1,981036
Mean dependent variable	3498,757	2,428544
Standard deviation[d]	2761,504	2,228957

Continues...

b Method: Least Squares with Newey-West HAC Standard Errors & Covariance

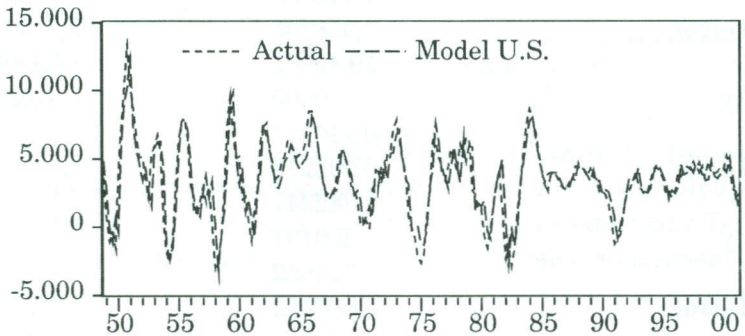
c After Adjusting Endpoints

d Dependant variable

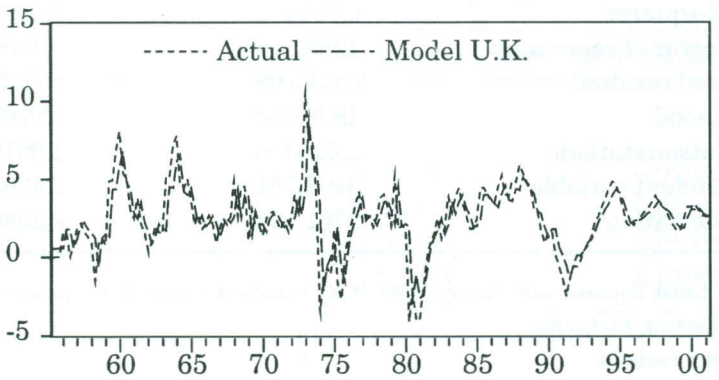
Table 3. Econometric models (continued)

Country	*United States of America*	*United Kingdom*
Akaike Information Criterion	17,18075	3,535549
Schwarz Criterion	17,24429	3,570363
F-Statistic	252,0071	342,4664
Probability (F-statistic)	0,000000	0,000000
White Heteroscedasticity Test		
F-Statistic [Probability]	1,556603 [0,161523]	0,582506 [0,559535]
Obs*R-squared [Probability]	9,237192 [0,160671]	1,176684 [0,555247]

Graph 1. United States: Regression versus actual growth domestic product



Graph 2. United Kingdom: Regression versus actual growth domestic product



For the American case, I used an autoregressive model of order three –AR(3)– in the British case an AR(1) was used. Both are estimated through the least square method using the Newey-West HAC Standard Errors & Covariance option that corrects the heteroscedasticity that the model presented. Also, it is proven that the regression has no heteroscedasticity through the White Test; the results are presented in the Econometric Model Table. The probability of the White Test is higher than 0.1 in both cases what allows us to conclude that the model has no heteroscedasticity. Remember, the variables (Y_{USA} and Y_{UK}) are stationary and non-seasonal, two necessary requirements for assuring an adequate regression. Also, the model does not present autocorrelation since, in both cases, the Durbin Watson statistics are very near to two. The value of all coefficients is shown in the table and, according to p-value, they are all statistically significant.

It can also be deduced that the relation between the growth domestic product –GDP– with one lag is positive giving us the idea that in both countries economical agents increase their current production if the GDP rose in the last quarter. But, in the American case there exists a negative relation between today's output and the output lagged two and three periods, then agents think that they should not increase their production if the GDP has risen in the second and third quarters before the current one. This could be explained through the idea of Clément Juglar, who said: "the cause of recession is growth." This is logical in the moment that production is highly big, because in order to increase such stock, the economy would have to produce a lot more, what is difficult given the different constraints.

Conclusion

It is clear that the idea of inertial growth is feasible in countries like the United States and Great Britain. The theory that I have mentioned at the beginning of this paper is totally logical with the empirical evidence that I have shown in this paper, at least for the two cases where this theory has been applied. Hence, today's GDP is related with tomorrow's GDP then policymakers should seek a sustainable path that will allow them to obtain an adequate growth rate today but also in the future because if they search a very high growth today, they will encounter, like in the American case, a very low growth rate since expectations of different economical agents will not allow the economy to grow.

Therefore, in the moment that we begin to establish our growth rate, we must have in mind all our constraints and those should include our idea of inertial growth and, of course, the cost of growing today as a price that we will have to pay as a low growth in the future.

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Table A.1. United States: Gross domestic product increase on previous quarter. 1996 chained dollars. –Percentage–

1948 1	3,793	1961 3	2,802	1975 1	-2,653	1988 3	4,148
1948 2	4,874	1961 4	6,269	1975 2	-2,063	1988 4	3,702
1948 3	5,043	1962 1	7,501	1975 3	0,757	1989 1	4,269
1948 4	3,627	1962 2	6,666	1975 4	2,590	1989 2	3,616
1949 1	0,748	1962 3	5,975	1976 1	6,387	1989 3	3,577
1949 2	-1,082	1962 4	4,115	1976 2	6,336	1989 4	2,603
1949 3	-0,370	1963 1	3,542	1976 3	5,018	1990 1	2,636
1949 4	-1,585	1963 2	3,768	1976 4	4,564	1990 2	2,315
1950 1	3,943	1963 3	4,729	1977 1	3,385	1990 3	1,646
1950 2	7,359	1963 4	5,228	1977 2	4,378	1990 4	0,463
1950 3	10,265	1964 1	6,317	1977 3	5,754	1991 1	-1,264
1950 4	13,411	1964 2	6,198	1977 4	5,019	1991 2	-0,939
1951 1	10,121	1964 3	5,604	1978 1	4,045	1991 3	-0,513
1951 2	8,735	1964 4	5,114	1978 2	6,145	1991 4	0,851
1951 3	6,779	1965 1	5,342	1978 3	5,275	1992 1	2,291
1951 4	5,097	1965 2	5,509	1978 4	6,554	1992 2	2,674
1952 1	5,142	1965 3	6,222	1979 1	6,524	1992 3	3,213
1952 2	3,465	1965 4	8,477	1979 2	2,638	1992 4	4,013
1952 3	2,076	1966 1	8,508	1979 3	2,380	1993 1	3,028
1952 4	5,257	1966 2	7,468	1979 4	1,366	1993 2	2,693
1953 1	5,969	1966 3	5,995	1980 1	1,444	1993 3	2,352
1953 2	6,752	1966 4	4,424	1980 2	-0,687	1993 4	2,548
1953 3	5,405	1967 1	2,833	1980 3	-1,541	1994 1	3,444
1953 4	0,392	1967 2	2,381	1980 4	-0,121	1994 2	4,252

Continues...

Table A.1. United States: Gross domestic product increase on previous quarter. 1996 chained dollars. –Percentage– (Continued)

1954 1	-1,918	1967 3	2,471	1981 1	1,484	1994 3	4,364
1954 2	-2,570	1967 4	2,345	1981 2	2,872	1994 4	4,079
1954 3	-0,884	1968 1	3,475	1981 3	4,257	1995 1	3,587
1954 4	2,726	1968 2	5,323	1981 4	1,226	1995 2	2,361
1955 1	6,192	1968 3	5,303	1982 1	-2,349	1995 3	2,594
1955 2	7,728	1968 4	4,967	1982 2	-1,237	1995 4	2,155
1955 3	7,997	1969 1	4,465	1982 3	-2,861	1996 1	2,506
1955 4	6,457	1969 2	2,967	1982 4	-1,631	1996 2	3,993
1956 1	3,056	1969 3	2,840	1983 1	1,182	1996 3	3,710
1956 2	2,233	1969 4	1,921	1983 2	3,126	1996 4	4,059
1956 3	0,774	1970 1	0,230	1983 3	5,462	1997 1	4,429
1956 4	1,892	1970 2	0,177	1983 4	7,551	1997 2	4,216
1957 1	2,909	1970 3	0,471	1984 1	8,646	1997 3	4,778
1957 2	1,871	1970 4	-0,137	1984 2	7,937	1997 4	4,307
1957 3	2,979	1971 1	2,793	1984 3	6,967	1998 1	4,739
1957 4	0,258	1971 2	3,142	1984 4	5,605	1998 2	3,824
1958 1	-2,992	1971 3	3,032	1985 1	4,209	1998 3	3,796
1958 2	-2,204	1971 4	4,410	1985 2	3,276	1998 4	4,775
1958 3	-0,973	1972 1	3,568	1985 3	3,921	1999 1	4,016
1958 4	2,321	1972 2	5,361	1985 4	3,992	1999 2	3,888
1959 1	7,349	1972 3	5,594	1986 1	4,071	1999 3	4,022
1959 2	9,518	1972 4	7,162	1986 2	3,692	1999 4	4,407
1959 3	7,068	1973 1	7,780	1986 3	3,114	2000 1	4,225
1959 4	5,057	1973 2	6,424	1986 4	2,816	2000 2	5,224
1960 1	5,191	1973 3	4,964	1987 1	2,635	2000 3	4,380
1960 2	2,007	1973 4	4,025	1987 2	3,296	2000 4	2,807
1960 3	2,239	1974 1	0,660	1987 3	3,203	2001 1	2,549
1960 4	0,590	1974 2	-0,070	1987 4	4,438	2001 2	1,181
1961 1	-1,025	1974 3	-0,789	1988 1	4,367		
1961 2	1,328	1974 4	-2,146	1988 2	4,486		

Source: Bureau of Economic Analysis. "National Account Data", [statistical information on the internet], United States of America, Bureau of Economic Analysis, http://www.bea.doc.gov/bea/dn1.htm, access date: March 29th, 2002.

Table A.2. United Kingdom: Gross domestic product increase on previous quarter. 1995 chained dollars. –Percentage–

1955 1	0,0	1966 4	0,9	1978 3	4,0	1990 2	1,6
1955 2	0,0	1967 1	1,9	1978 4	3,2	1990 3	0,1
1955 3	0,0	1967 2	2,5	1979 1	2,0	1990 4	-0,6
1955 4	0,0	1967 3	2,1	1979 2	5,2	1991 1	-1,4
1956 1	1,6	1967 4	2,6	1979 3	1,8	1991 2	-2,5
1956 2	1,6	1968 1	4,9	1979 4	2,0	1991 3	-1,4
1956 3	0,0	1968 2	2,6	1980 1	1,8	1991 4	-0,6
1956 4	0,8	1968 3	4,4	1980 2	-4,1	1992 1	-0,6
1957 1	1,9	1968 4	4,5	1980 3	-2,2	1992 2	-0,2
1957 2	2,2	1969 1	1,1	1980 4	-4,1	1992 3	0,4
1957 3	1,6	1969 2	3,1	1981 1	-3,9	1992 4	0,7
1957 4	1,3	1969 3	2,0	1981 2	-1,9	1993 1	1,3
1958 1	0,9	1969 4	2,0	1981 3	-0,1	1993 2	2,2
1958 2	-1,5	1970 1	1,4	1981 4	0,9	1993 3	2,6
1958 3	0,9	1970 2	2,5	1982 1	1,5	1993 4	3,2
1958 4	1,2	1970 3	2,8	1982 2	2,5	1994 1	3,7
1959 1	0,8	1970 4	2,9	1982 3	1,2	1994 2	4,4
1959 2	4,9	1971 1	2,3	1982 4	1,9	1994 3	4,8
1959 3	4,9	1971 2	1,8	1983 1	3,9	1994 4	4,6
1959 4	6,8	1971 3	2,3	1983 2	2,9	1995 1	4,0
1960 1	8,1	1971 4	1,7	1983 3	3,8	1995 2	3,1
1960 2	5,4	1972 1	2,6	1983 4	4,4	1995 3	2,1
1960 3	5,0	1972 2	4,0	1984 1	3,4	1995 4	1,9
1960 4	3,0	1972 3	2,8	1984 2	2,8	1996 1	2,3
1961 1	2,5	1972 4	5,0	1984 3	1,8	1996 2	2,4
1961 2	3,8	1973 1	10,6	1984 4	1,8	1996 3	2,6
1961 3	2,1	1973 2	7,5	1985 1	2,4	1996 4	2,9
1961 4	1,5	1973 3	7,4	1985 2	4,4	1997 1	3,1
1962 1	0,4	1973 4	3,9	1985 3	4,4	1997 2	3,5
1962 2	1,0	1974 1	-3,5	1985 4	4,0	1997 3	3,9
1962 3	2,0	1974 2	-1,4	1986 1	3,7	1997 4	3,5

Continues...

Table A.2. United Kingdom: Gross domestic product increase on previous quarter. 1995 chained dollars. –Percentage– (Continued)

1962 4	1,6	1974 3	-0,7	1986 2	3,4	1998 1	3,2
1963 1	1,5	1974 4	-1,1	1986 3	4,5	1998 2	3,0
1963 2	5,1	1975 1	1,8	1986 4	5,2	1998 3	2,4
1963 3	5,0	1975 2	-1,7	1987 1	4,0	1998 4	2,0
1963 4	7,2	1975 3	-2,7	1987 2	3,9	1999 1	1,7
1964 1	7,8	1975 4	0,0	1987 3	4,9	1999 2	1,7
1964 2	4,7	1976 1	1,5	1987 4	4,8	1999 3	2,5
1964 3	4,4	1976 2	2,3	1988 1	5,9	1999 4	3,2
1964 4	5,0	1976 3	3,3	1988 2	5,4	2000 1	3,2
1965 1	3,6	1976 4	4,2	1988 3	4,8	2000 2	3,4
1965 2	2,1	1977 1	2,3	1988 4	4,5	2000 3	3,0
1965 3	2,7	1977 2	2,7	1989 1	3,1	2000 4	2,6
1965 4	1,8	1977 3	2,6	1989 2	2,9	2001 1	2,7
1966 1	2,1	1977 4	1,9	1989 3	1,7	2001 2	2,1
1966 2	2,7	1978 1	2,6	1989 4	0,9		
1966 3	2,1	1978 2	3,8	1990 1	1,6		

Source: Statbase. "Time Series Data", [statistical information on the internet], Great Britain, StatBase, http://www.statistics.gov.uk/statbase/TSDtimezone.asp, access date: March 29th, 2002.