Labour Gap, Output Gap and Inflation by Economic Sector: The case of Greece and the Peloponnese Region (2000-2007)

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Labour Gap, Output Gap and Inflation by Economic Sector: The case of Greece and the Peloponnese Region (2000-2007)

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ABSTRACT: The present paper estimates potential labour and labour gap as well as potential output and output gap using a Cobb Douglas production function and a Hodrick-Prescott filter. We investigate Greece as well as the Peloponnese Region in Greece by sector of economic activity (2000-2007), with the aid of the Non Accelerating Wage Inflation Rate of Unemployment (N.A.W.R.U.) concept. The results support the idea that both Greece and the Peloponnese seem to be working over the economy's capabilities a fact which was empirically found to lead to inflationary pressure. Thus, the empirical results of this paper suggest that output gap explains a considerable part of inflation in the Greek economy. In fact, it takes approximately two (2) years for the output gap to cause inflationary pressures in the Greek Economy. Clearly, future research on the subject would be of great interest.

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I. Introduction

In recent years, economic policy has placed increasing emphasis on production gap even though it cannot be observed directly and its measurement is difficult (Slevin, 2001). When total labour and total output is well below the potential of the (regional) economy (so called potential labour and potential output, respectively, associated with a desirable level to be achieved) then a negative gap exists. In simple terms, current labour/production is below what the economy could normally sustain. In this situation there is spare labour/production capacity in the economy. The implication is that the rate of inflation is likely to fall because inflationary pressure is falling. When actual labour/production lies well above potential labour/production, there is a positive labour/production gap, meaning that inflation pressures will be rising. The labour gap is unlikely to persist over the long-run, as it is supposed that there will tend to be a wage and price adjustment process to restore equilibrium, where demand and supply are equal (Slevin, 2001). This often happens to a region at the end of a period of sustained economic growth, well above the long-term average growth of national output (Riley, 1999).

The purpose of the present paper is to assist decision makers to implement certain regional policies effectively. More precisely, a key question is related to the level of actual labour and actual output and their deviation from potential labour and potential output respectively, in Greece and its region of the Peloponnese. Over the period 2000-2007 many structural changes took place in Greece, such as the 2004 Olympic Games, the European Monetary Union (EMU) membership, inflows of European Union (EU) funds. The Peloponnese region was selected because it is one of the most developed regions in Greece with considerable economic activity in most of sectors of economic activity. Obviously, the identification of poorly performing sectors of economic activity within the Greek and the Pelopponese economies, respectively, could have significant implications for policy makers in the country. Consequently, the topic of this paper is important and timely given the current position of Greece at the periphery of the E.U.

The paper is organized as follows: in Sections II some stylized facts concerning Greece and the Peloponnese Economies, respectively, are briefly presented; in Sections IV and V the methodological framework and the empirical results relatively are discussed. Finally Section VI concludes the paper.

II. The Greek and the Peloponnese Economies: Brief Overview

Agriculture was the driving force behind the Greek economy. During the first half of the 20th century, the economy depended on the export of agricultural products and had a performing shipping industry. Also, remittance sent home from Greeks working abroad was a major source of income. Natural resources are limited and there are some deposits only in the case of nonferrous metals. Fossil fuels are in short supply, expect for lignite, whereas oil production is limited. The country became more industrialized after World War II and the government policies were conducive for industrialization, while foreign aid grew considerably. Also, the country's great heritage is well preserved and tourism has become a booming industry, especially after the 2004 Olympic Games.

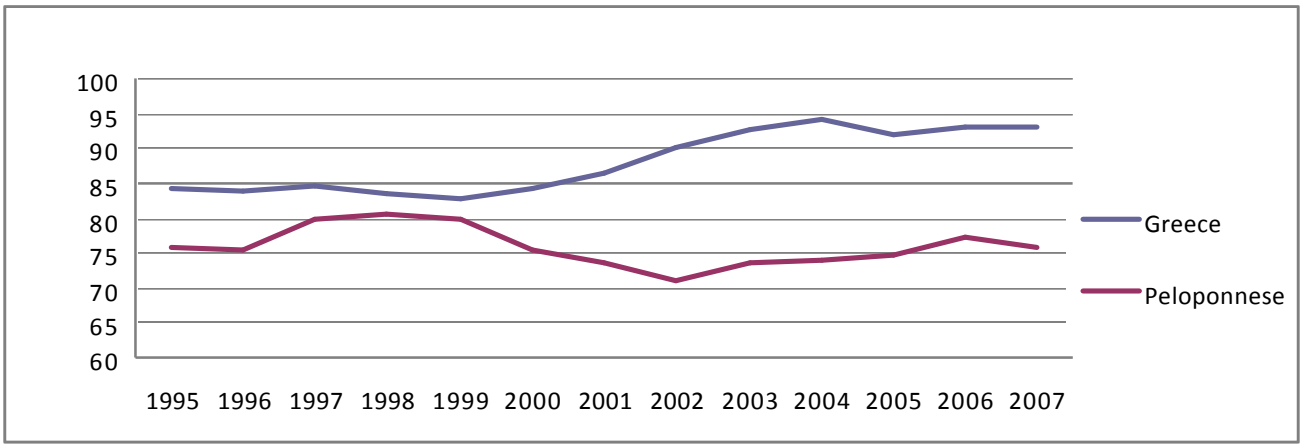
The Greek economy performed poorly from about 1970 to 1995, during which it was the poorest in the E.U. Part of the explanation lies with the collapse of macroeconomic policy that took the form of large fiscal deficits and high inflation rates. Also, reduced rates of capital formation, the shock of entry in the E.U. and the presence of structural rigidities are regarded as contributors to the economic slowdown. But the deteriorating performance is also attributed to the country's poor economic institutions, such as competitiveness of its tradable goods (Bosworth and Kollintzas, 2001).

Now, Greece has a mixed capitalist economy with a strong participation of the public area. The country became a full member of the E.U. in 1981 and its economy has improved over the last decades in the run-up to its entry into the Economic and Monetary Union (E.M.U.) in 2001 as a result of a major effort to reverse the macroeconomic situation. More precisely, the public deficit was cut from 16% of G.D.P. in 1990 to 1.8% in 1999, while inflation was reduced from 20% in 1990 to about 3% in 2000. These improvements lead to the acceleration in the growth of G.D.P until 2007.

The gradual slowdown had begun to emerge in Greece by early 2008. The combination of the global crisis with the macroeconomic imbalances and structural problems of the Greek economy, such as high fiscal deficits and debt, declining competitiveness, significantly affected the economy and inflated the cost of government borrowing. More specifically at the end of 2008 and early 2009, the growth of Greek economy stood at negative rates, more than initially expected. Today's situation in Greece is characterized by negative growth rates (-4,2%), high unemployment (12,1%), relatively high inflation rates (5%). The fiscal deficit at the end of 2009 was the highest in the euro area (15.4% of GDP or 36.2 billion €) and the debt reached a high 126.8% of GDP or 298 billion € (M.o.F. 2010). In 2010, as a result of this situation, Greece received a bail-out package by the EU / IMF.

As far as the Peloponnese region is concerned, its population density is 38.3 inhabitants per km ², ranking among the sparsely populated regions of the EU-27 (the average population density of the EU-27 is 113 inhabitants per km²). Over the period 2004-2008 the population of the Peloponnese region decreased by 0.24% (Eurostat 2010). In Figure 1 we can see the Purchasing Power Parities per inhabitant (%) of the EU average for Greece and Peloponnese. We observe a significant gap in the per capita GDP when compared to the EU-27 average.

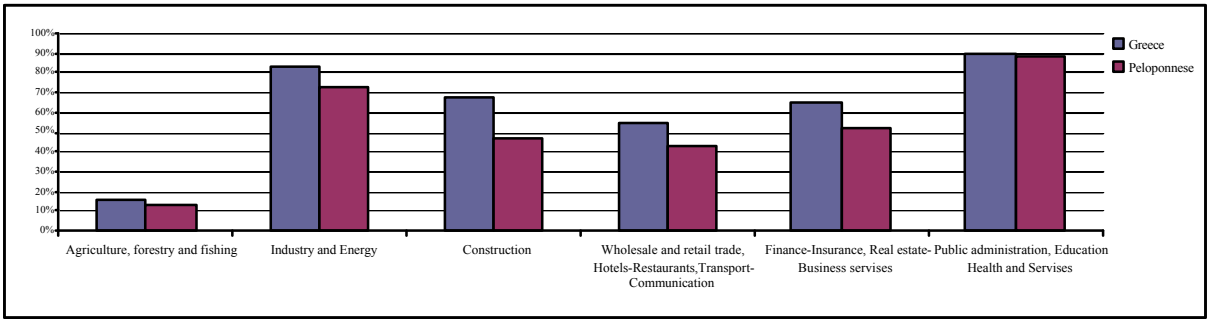
Fig. 1: *Purchasing Power Parities per inhabitant in percentage of the EU average for Greece and Peloponnese*



Source: *Eurostat, Stat extracts*

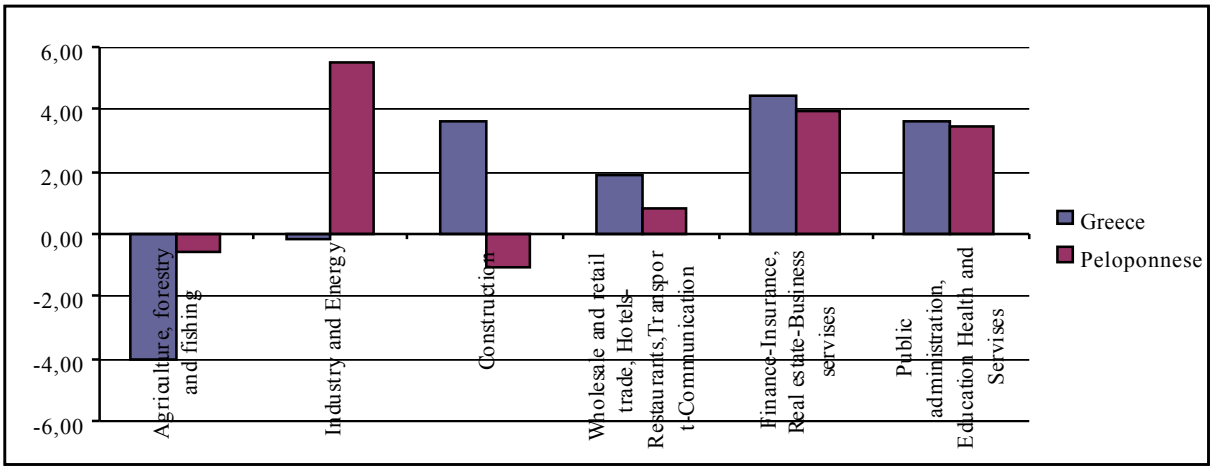
The region's employment by sector of economic activity (2000-2008) differs from the country's employment. More specifically, changes in employment by sector of economic activity, in the period 2000-2007, are presented in figures 2 and 3. The largest proportion of employees in the Peloponnese belong to sectors 2 (industry and energy) and 6 (public administration and social services), while the smallest is found for sectors 1 (primary sector) and 4 (wholesale and retail etc.). As far as the employment rate (2000 to 2007) of the Peloponnese region is concerned, we observe a significant decline in sectors 1 (primary sector) and 3 (construction sector).

Fig. 2: *Employees (%) by sector of economic activity for Greece and Peloponnese for 2007*



Source: *Eurostat, Stat extracts*

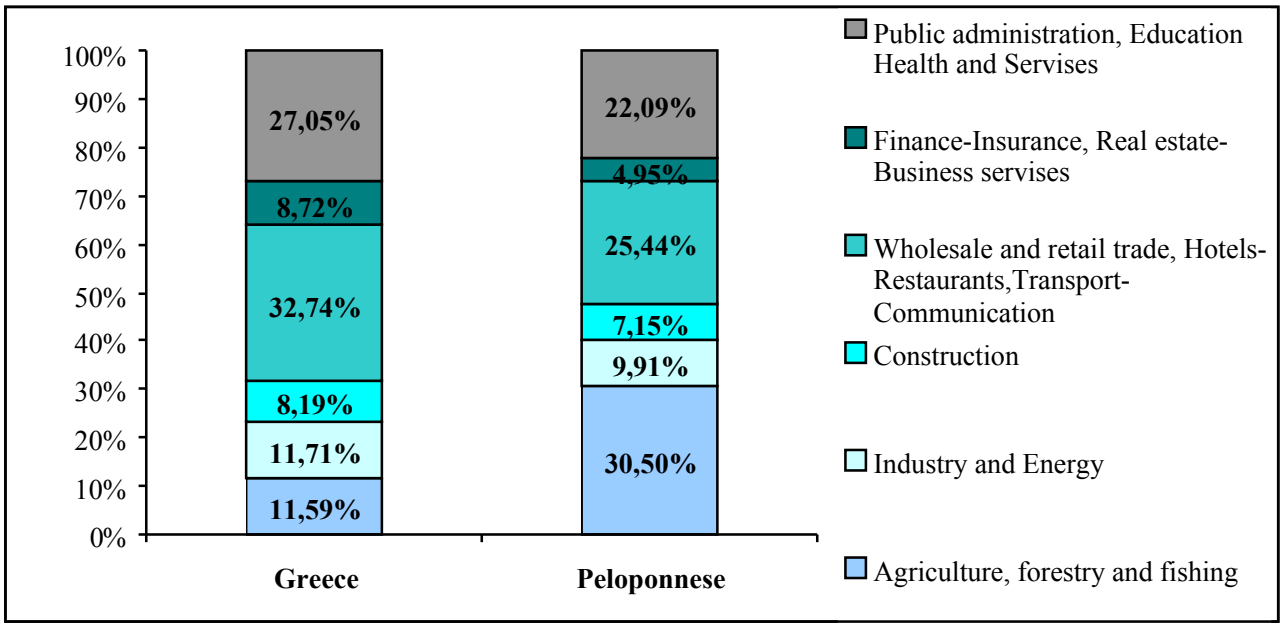
Fig. 3: *Average Annual Employment Growth Rate 2000-2007 (%) by sector of economic activity*



Source: *Eurostat, Stat extracts*

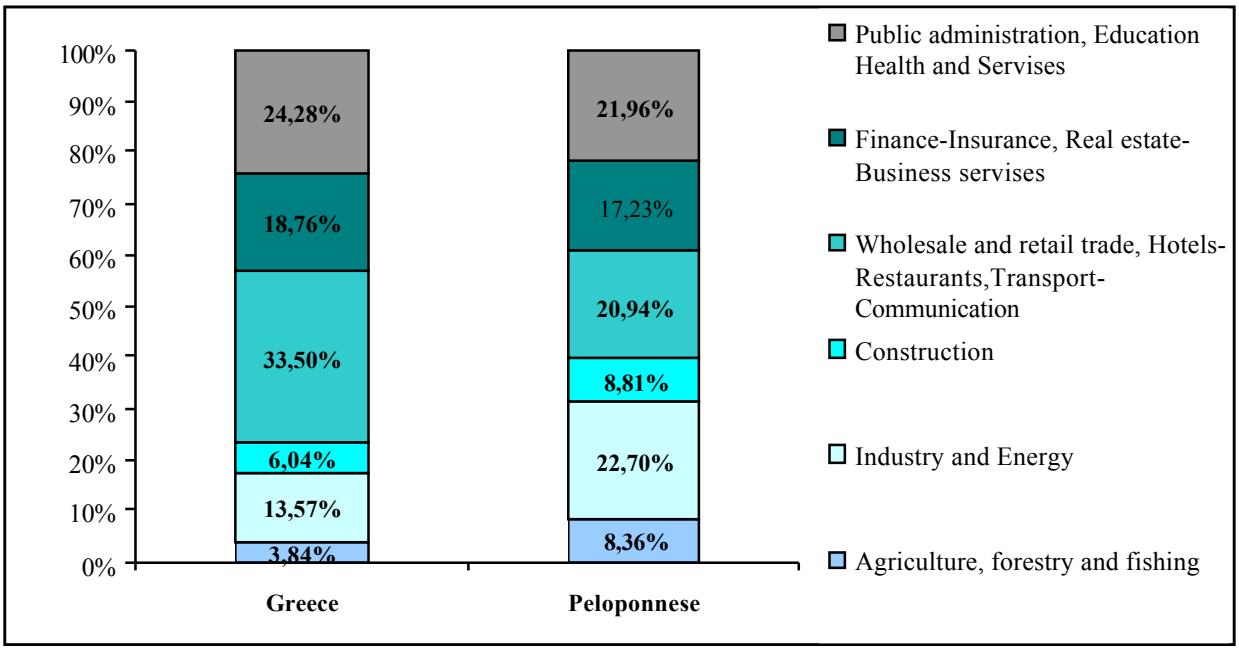
From figures 4 and 5 below, we can see the employment and Gross Value Added (GVA) for Greece and the Peloponnese, respectively. Regarding employment we have a similar picture for sectors 2 (industry and energy), 3 (construction), 5 (finance, insurance etc.) and 6 (public administration and social services). However, for the Peloponnese, the employment's proportion in the primary sector is higher in contrast to the country, while the country's rates regarding sector 4 (wholesale and retail, etc.) is significantly higher than region's.

Fig. 4: *Distribution of employment (2007)*



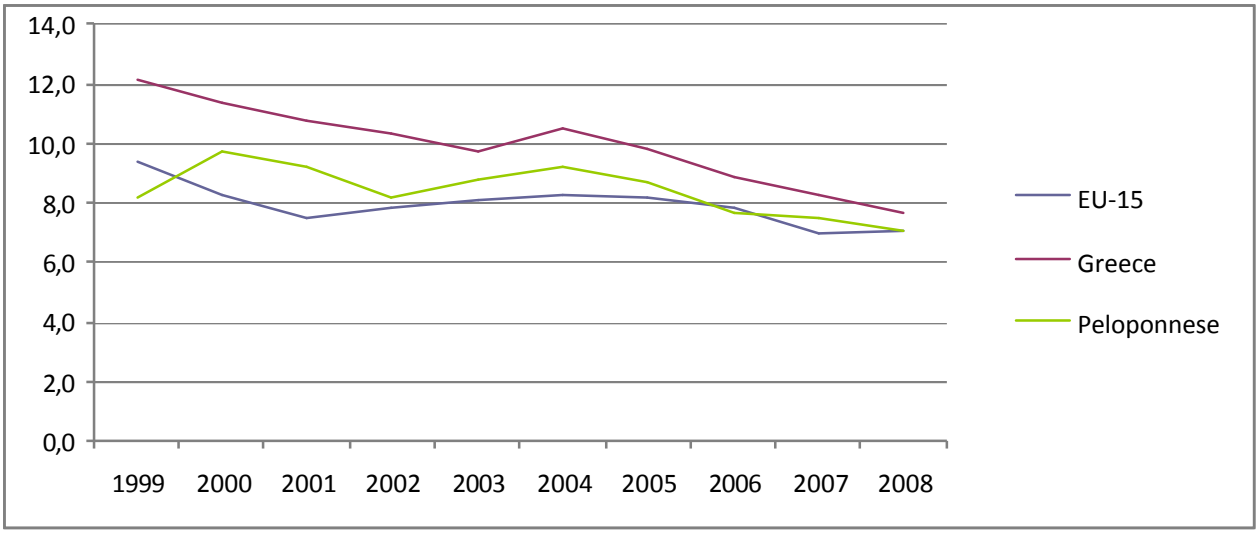
Source: *Eurostat, Stat extracts*

Fig. 5: *Distribution of GVA (2007)*



Source: *Eurostat, Stat extracts*

Fig. 6: *Unemployment Rates (2000-2008)*



Source: *Eurostat, Stat extracts*

We can see that the Peloponnese's economy is mainly based on sectors 1 (primary) and 2 (industry and energy). Meanwhile, sectors of private and public services (5 and 6 respectively) are important with regards to GVA and employment. Eventually, despite that the unemployment rate in the Peloponnese is quite lower than the country's rates (see figure 6), it seems that both economies face the same structural problems.

III. Methodological Framework

Potential output may be described as a measure of aggregate supply of the regional economy. It represents the highest sustainable level of output that can be produced using available resources and technology. This implies optimal use of labour, capital and technology, without putting sustained upward pressure on inflation. The actual level of output produced in an economy is determined by the demand. The output gap is the difference between actual and potential output. The output gap is also referred to as spare capacity. The gap is positive when actual output exceeds the economy's potential and negative when actual output is below potential output. A positive gap is associated with excess demand in the economy, which may lead to inflationary pressures. On the other hand, when the gap is negative, this indicates that potential output exceeds demand. Potential output is often referred to as the output level consistent with stable inflation and full employment (see, among others, Kenny 1996). In other words, potential output is usually associated with a desirable level of output.

Potential output is an unobservable variable and, thus, cannot be estimated directly. It can, however, be estimated with the aid of several statistical and theoretical methods. Statistical methods eliminate cyclical fluctuations from the actual output time series. The statistical methods include the time trend approach and the Hodrick-Prescott (HP) filter approach. To apply statistical methods, no other additional variables than actual output are needed. This is the reason why statistical methods are widespread (see, for instance, Claus, 2003).

On the other hand, statistical methods have several drawbacks, such as low estimation and forecasting efficiency, particularly when made over longer horizons (Stikuts, 2003). Also, the application of these methods requires relatively extensive time series. The most essential drawback of this approach, however, is that substantial changes in the economic structure due to which the level of potential output may change are not taken into account (Stikuts, 2003).

Because of the several drawbacks of the statistical methods, the analysis based on the production function is used as an alternative method for measuring potential output. The most widely applied structural method is the estimation of the production function in the form of the Cobb-Douglas (CD) production function. Potential output thus estimated takes into account the changes in the economic structure.

General research on labour and output gap started with Okun (1962) and has been abundant ever since (for instance, see Kuttner, 1994). Roughly speaking, there exist two broadly used methods for the estimation of potential output: The HP-filter and the production function. For a review see Bolt and van Els (2000). For a brief presentation of some less popular techniques see Slevin (2001).

The linear, two-sided HP-filter approach is a simple and widely used method by which the long-term trend of a (macroeconomic) series is obtained using only observable, i.e. actual, data. The trend is obtained by minimizing the fluctuations of the actual data around it, i.e. by minimizing the following function:

$$\sum [\ln y(t) - \ln y^*(t)]^2 - \lambda \sum [[\ln y^*(t-1) - \ln y^*(t)] - [\ln y^*(t) - \ln y^*(t-1)]]^2$$

where y^* is the long-term trend of the variable y and the coefficient λ determines the smoothness of the long-term (output) trend, expressing the potential output in this case.

The HP-filter approach has two positive features (Stikuts 2003): First, the obtained trend is influenced by shocks. Second, it is simple to measure. However, the HP-filter alone produces a good result only when data on a relatively stable economic environment are used. In this case, the HP-filter along with the relevant production function estimation has to be used.[1]

We will estimate a production function where real G.D.P. is some function of capital, labour and technology. Practically, its most important advantage lies in the possibility to account explicitly for different sources of growth (Billmeier 2004). The production function is then estimated when the capital stock is being fully utilized and the labour force is fully employed. This method has been used by various researchers (see Artus 1977, Giorno et *al.* 1995, De Masi 1997, Bolt and van Els 2000, Senhadji 2000, Slevin 2001, etc.) HP filter smoothing techniques have been used in the production function approach to filter technical progress and potential employment (Giorno et *al.* 1995, Bolt and van Els 2000, Fagan et *al.* 2001).

The most widely used production function is the Cobb-Douglas (CD). The CD is written as follows (Stikuts 2003, Billmeier 2004):

$$Y_t = A_t L_t^{\alpha} K_t^{1-\alpha} \quad (1)$$

where Y_t denotes output at constant prices, K_t denotes capital stock at constant prices, L_t denotes the number of the employed persons, A_t characterizes the Total Factor Productivity (T.F.P.) and α is the elasticity of production factors.

After dividing by the number of employed persons and taking *logs* equation (1) yields a linearised form, which eliminates the possible multicolinearity problem of the explanatory variables and provides us with the estimate of the (1-α) coefficient using Ordinary Least Squares (O.L.S.):

$$\ln\left(\frac{Y_t}{L_t}\right) = \ln A_t + (1-\alpha) \ln\left(\frac{K_t}{L_t}\right) \quad (2)$$

[1] For overviews of the HP filtering method shortcomings see Harvey and Jaeger (1993), King and Rebelo (1993), Cogley and Nason (1995) and Billmeier (2004).

Potential output Y^*_t is derived by inserting the potential values of the production factors. In other words:

$$Y^*_t = A^*_t L^{*\alpha}_t K^{*1-\alpha}_t \quad (3)$$

Where * denotes the potential value of the production factor.

The next step is to measure the potential value of production factors. The actual value of capital stock is used as a substitution for its potential value, as capital stock cannot fluctuate substantially, and it is assumed that the capital stock available is always used at its potential. Thus, we have that:

$$K^*_t = K_t \quad (4)$$

The Total Factor Productivity A^*_t is partly estimated by the production function as the residual of equation (2), and the potential level is determined by the HP-filter to obtain a smooth time series. Consequently:

$$A^*_t = A_{st} \quad (5)$$

where A_{st} is the HP-filtered residuals time series of equation (2) characterising T.F.P.

Potential labour input is estimated using the NAWRU (non-accelerating wage-inflation rate of unemployment) concept. The NAWRU is the unemployment rate at which wage inflation is constant. Several studies show that the equilibrium unemployment rate changes over time, but it generally follows the actual unemployment rate (Layard *et al.* 1991).

Elmeskov's (1993), method is used in this paper to construct a time varying N.A.W.R.U. This approach has also been utilized by various researchers, for example see Bolt and van Els (2000) and Slevin (2001). It is based on an equation, which relates the changes in unemployment with those in wage inflation:

$$u_t - \text{N.A.W.R.U}_t = \lambda \Delta^2 w_t, \lambda < 0 \quad (6)$$

where u_t is the actual unemployment rate, N.A.W.R.U_t is the (natural) unemployment rate, which has no effect on wage inflation and w_t is the average gross wage. Δ is the first difference, Δ^2 is the second difference and Δ^3 is the third difference operator.

Taking left and right first differences of equation (8) leads to an equation for λ:

$$\lambda = \frac{\Delta u_t}{\Delta^3 w_t}, \Delta^3 w_t \neq 0 \quad (7)$$

inserting the latter (9) into equation (8) we get:

$$N.A.W.R.U_t = u_t - \frac{\Delta u_t}{\Delta^3 w_t} \Delta^2 w_t \quad (8)$$

Equation (8) implies that the N.A.W.R.U. is equal to the actual unemployment rate, which is adjusted by unemployment rate changes and wage inflation relationship. The resulting series is then smoothed to eliminate erratic movements using the HP filter. Consequently, potential employment is calculated as follows:

$$L^*_t = L_{st} [1\text{-}NAWRU_{st}] \quad (9)$$

where L_{st} is the HP-filtered labour time series and $N.A.W.R.U_{st}$ is the HP-filtered NAWRU time series.

Labour Gap is then calculated as follows:

$$L_{gap} = (L_t - L^*_t)/ L^*_t \quad (10)$$

where L_t is the actual labour time series.

Substitution of the potential values of the production factors obtained from equations (4), (5), and (9) into equation (3) yields the time series of the potential output.

Output Gap is then calculated as follows:

$$Q_{gap} = (Q_t - Q^*_t)/ Q^*_t \quad (11)$$

where Q_t is the actual output time series.

The productivity-of-labour (l) gap is calculated as follows:

$$l_{gap} = [(Q_t/ L_t) - (Q^*_t/ L^*_t)]/(Q^*_t/ L^*_t) \quad (12)$$

Finally, regarding the relationship between output gap and inflation, the main idea is to express the inflation of any given year t - through e.g. the Consumer Price Index (CPI_t) - as a function f of the lagged Output Gap ($Qgap_{t-i}$). In mathematical terms: $CPI_t = f(Qgap_{t-i})$, i =1, 2,…, n. The f function is usually specified as a linear function. As for the optimal value of lags i, it can be selected by using one of the standard methods, for example the R^2 maximization criterion , according to which one should select the value of i, that optimizes its value implying the strongest correlation between inflation and the output gap.

The regional data come from the National Accounts of the National Statistical Service of Greece and Eurostat, are on an annual basis and cover the period 2000-2007 when data are available, by sector of economic activity and by total economic activity, as well.

The values required for the application of the methodology are: output, employment, wages, unemployment, and gross fixed capital formation. Finally, the capital stock was calculated using the method of Perpetual-Inventory.

More precisely, the time series on actual labour comes from the National Accounts concerning the reported six (6) sectors of economic activity (Table 1, below).

Table 1: *Classification of sectors of economic activity*

1	Agriculture, forestry and fishing
2	Industry and Energy
3	Construction
4	Wholesale and retail trade, Hotels-Restaurants,Transport-Communication
5	Finance-Insurance, Real estate-Business services
6	Public administration, Education Health and Servises

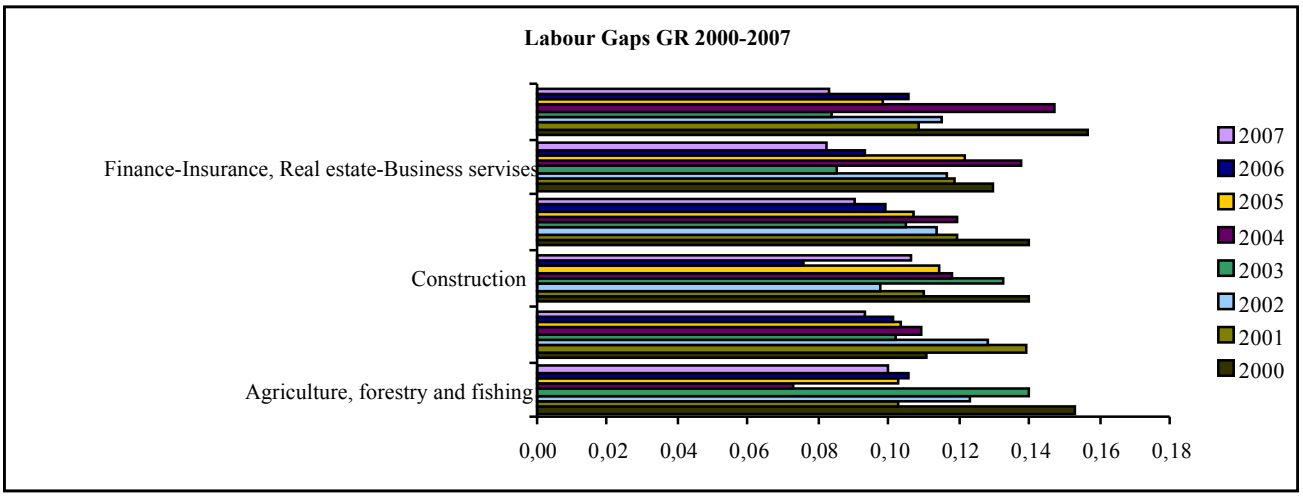
Source: *Eurostat*

IV. Empirical Analysis

The empirical results show that in the time period 2000-2007 both the Greek country and the region of Peloponnese seem to be operating, with very few exceptions, at levels which are higher than their respective capacities, especially in terms of employment. This also implies that the actual output levels achieved are, mostly, higher than the ones that would not cause inflationary pressures.

Specifically, regarding the employment gap created in the country, we see that for the period 2000-2007 in all sectors (see figure 7), the economy operates at levels well above its potential. Specifically, in 2000 in all sectors we observe a higher actual output by the potential. The sectoral analysis shows a similar picture of the potential employment of almost all sectors (e.g.: industry and energy, wholesale and retail etc.) with minor differences and exceptions (e.g.: public administration and social services).

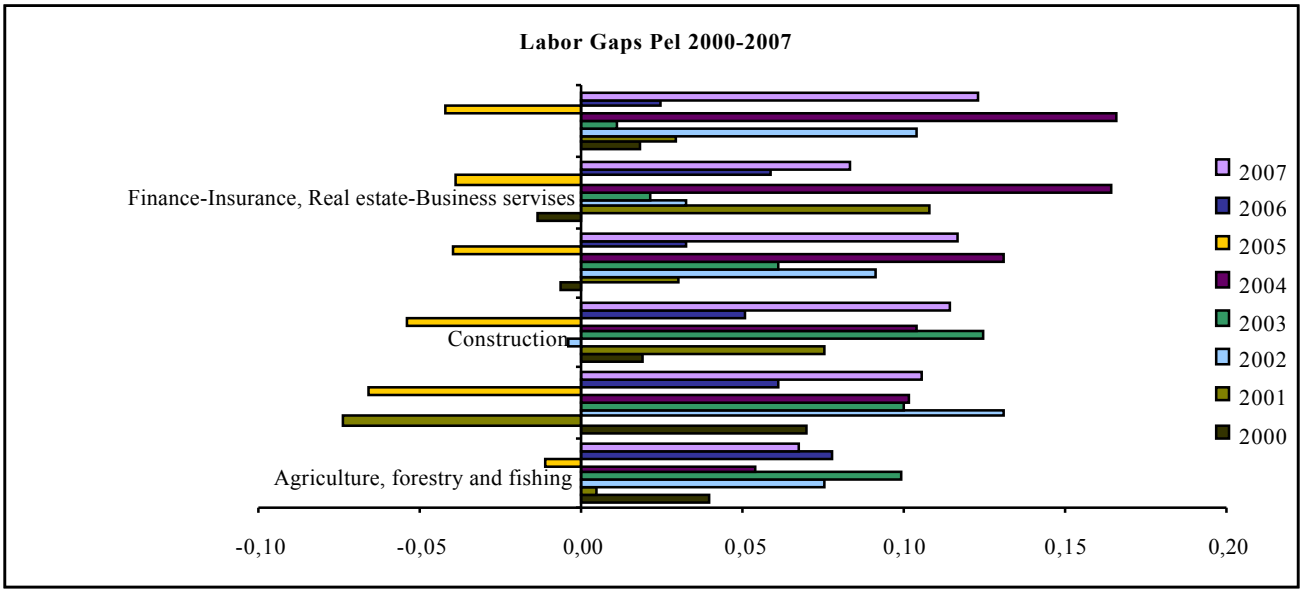
Fig. 7: *Labour Gaps for Greece, 2000-2007*



Source: *Authors' elaboration*

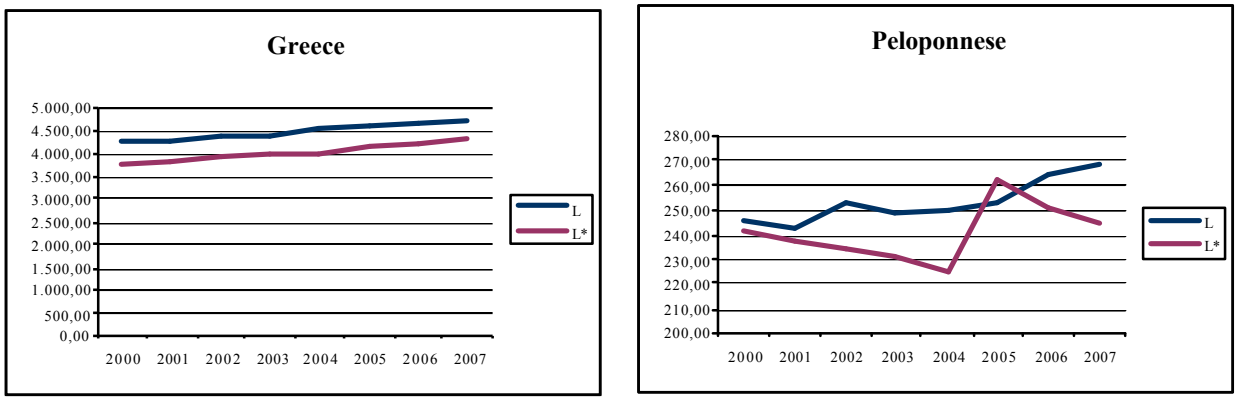
From figure 8 we can see that the Peloponnese region seems almost permanently to be functioning at employment levels that are higher than its potential. This means, the employment levels were higher than those that would not create inflationary pressures. This is associated with less unemployment than the total unemployment in the country as shown in figure 7. In figure 8 we can see that the gap in employment is always positive, except for 2005 and some individual sectors. Almost all sectors are operating at levels higher than the potential level of employment.

Fig. 8: *Labour Gaps for Peloponnese, 2000-2007*



Source: *Authors' elaboration*

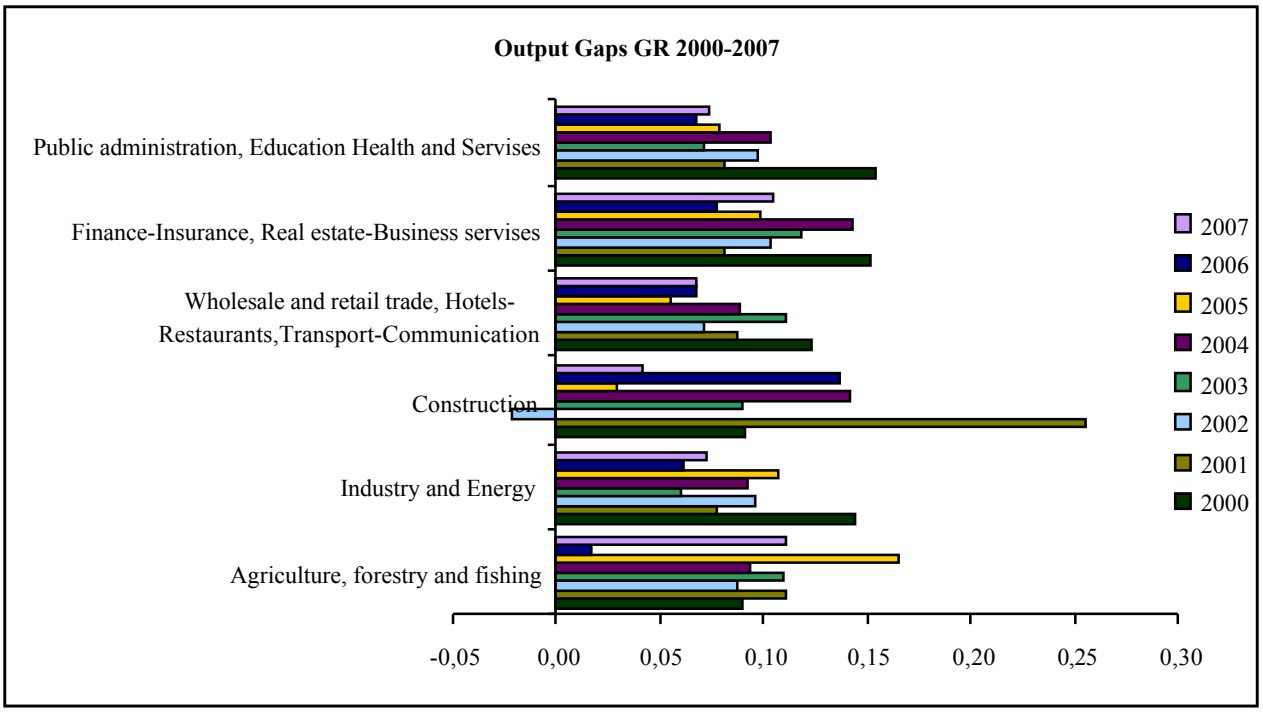
Fig. 9: *Actual and Potential Labour for Greece and Peloponnese, 2000-2007*



Source: *Authors' elaboration*

Almost the same conclusions are in force concerning the pure output gaps for the country (2000-2007). The economy is operating at higher levels of output (production) than the potential in almost all sectors (see figure 10). This implies that the Greek economy operates at levels higher than those that would not create inflationary pressures. Thus, the Greek economy faces serious problems of inflationary pressures and hence competitiveness.

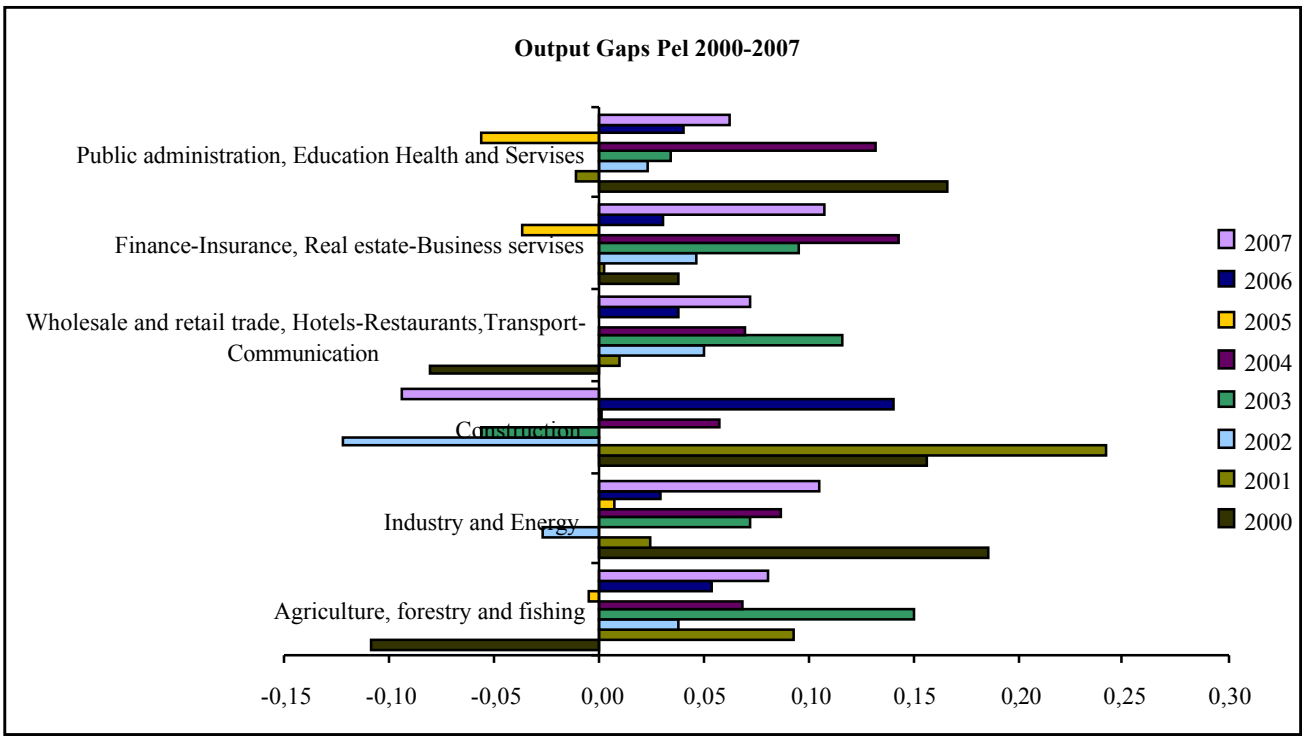
Fig. 10: *Output Gaps for Greece, 2000-2007*



Source: *Authors' elaboration*

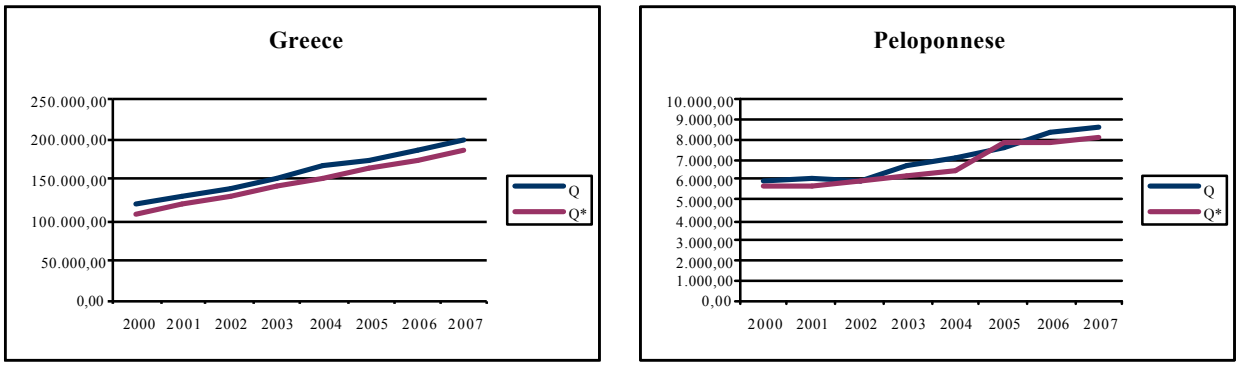
In figure 11 we can see that the Peloponnese region operates at levels of output (production) higher than the potential ones, except for the year 2005. From the analysis of particular sectors we can see that, although in general the actual production is higher than the potential, the sectoral analysis reveals some interesting differences. Specifically, the sector of Construction experiences for several years, production levels below its potential. A similar picture is to be found in the the sector of public administration, and social services. By contrast, the sectors of Agriculture etc. and Finance, insurance etc. have relatively higher positive output gap from the average of the regional economy.

Fig. 11: *Output Gaps for Peloponnese, 2000-2007*



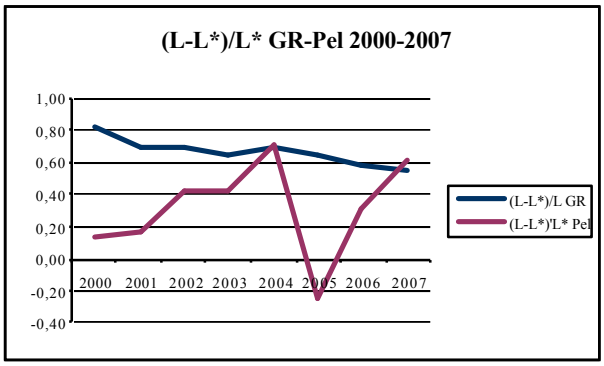
Source: *Authors' elaboration*

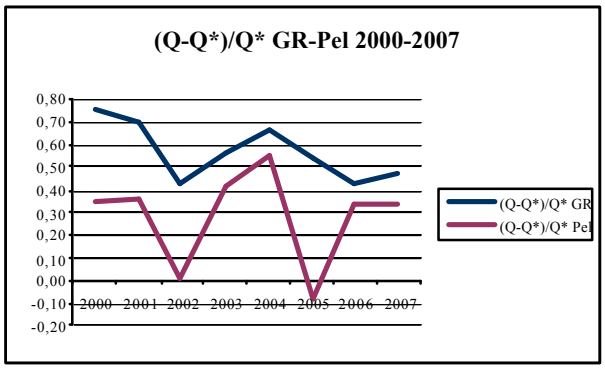
Fig. 12: *Actual and Potential Production for Greece and Peloponnese, 2000-2007*



Source: *Authors' elaboration*

Fig. 13: *Total Labour & Output Gaps for Greece and Peloponnese, 2000-2007*





Source: *Authors' elaboration*

As far as the country's labour productivity is concerned almost all sectors of economic activity for the period 2000-2007 faced negative productivities (see Figure 14). More specifically, concerning labour productivity gaps of sectors 2 (industry and energy), 3 (construction), 3 (wholesale and retail, etc.) and 6 (public administration and social services) these seem to be quite high. There are small differences in sectors 1 (primary sector), 3 (construction) and 5 (finance, insurance, etc.).

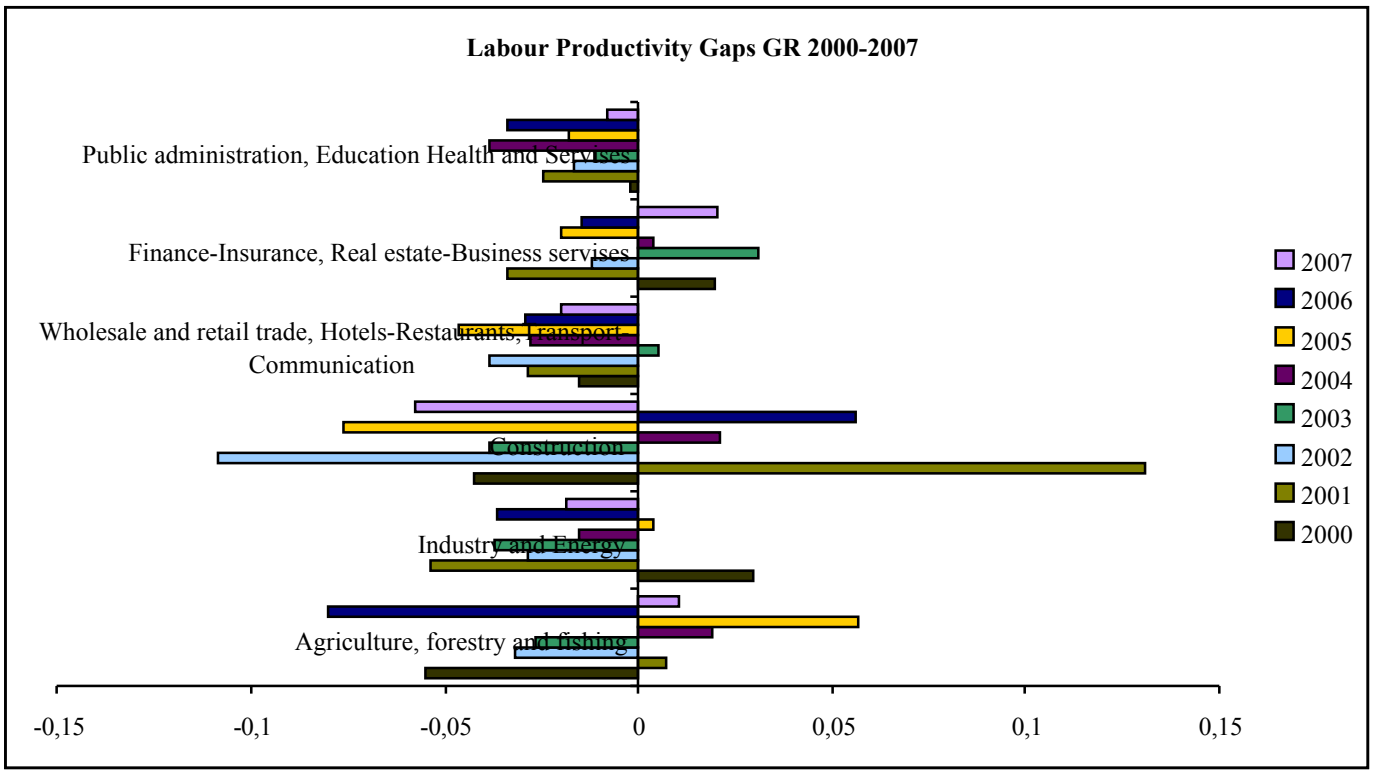
The labour productivity gaps for the Peloponnese show a similar behaviour (see Figure 15). There are significant gaps in all sectors, however there are considerable differentiations over time in the 2000-2007 time span.

Finally, regarding the productivity-of-labour gap, we observe that for the great majority of economic sectors in Greece and years the actual productivity of labour seems to be lower than its potential level, a fact which implies that *given the number of the employed persons*, the output produced per labourer is lower than its potential value.

Quite different results are found for the Peloponnese region. In spite the fact that labour productivity gaps remain noteworthy for Peloponnese as well as Greece, there are some sectors of economic activity with positive productivities in certain years (2000-2001), such as sector 2, sector 3 and 6.

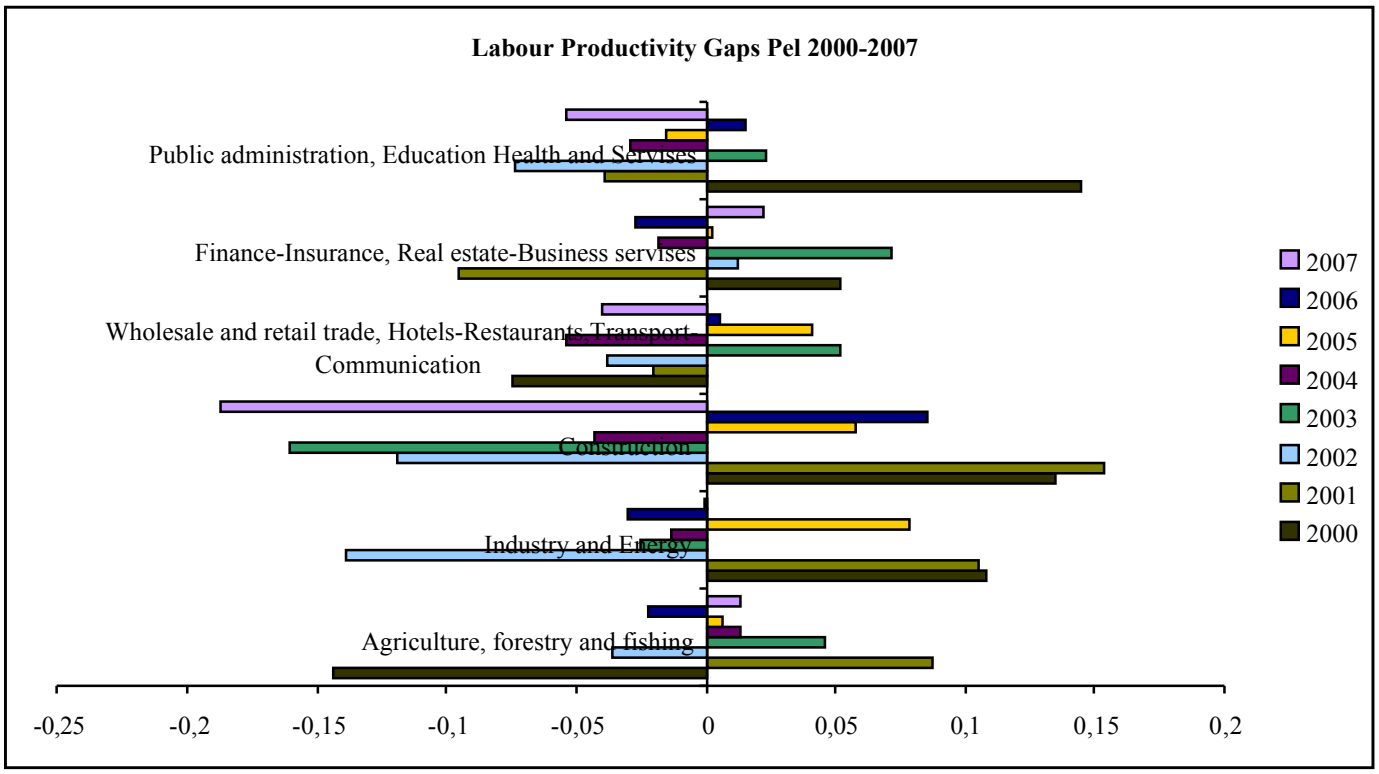
This situation is partly due to the economic conjecture (Olympic Games of 2004, E.U. funding, etc) which enables the various economic sectors to continue to operate at low (labour) productivity levels. However, as soon as this situation ceases to exist the various sectors will not be able to operate at such low levels and their productive capacities, as well as their production technology, will have to be re-examined.

Fig. 14: *Labour Productivity Gaps for Greece, 2000-2007*



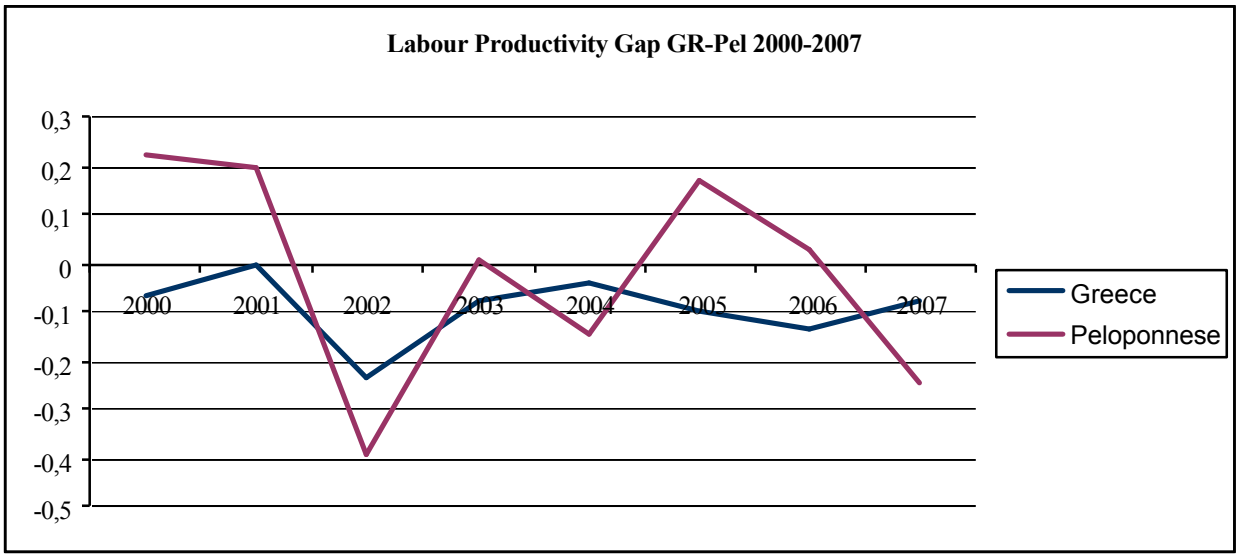
Source: *Authors' elaboration*

Fig. 15: *Labour Productivity Gaps for Peloponnese, 2000-2007*



Source: *Authors' elaboration*

Fig. 16: *Total Labour Productivity Gaps for Greece and Peloponnese, 2000-2007*



Source: *Authors' elaboration*

As mentioned earlier, a positive output gap is assumed to be associated with inflationary pressures in the Greek economy.

Table 2: R^2 *results for:* $\text{CPI}_t = f(\text{Qgap}_{t-i})$, $i = 1, 2, \ldots, n$, *f:* linear

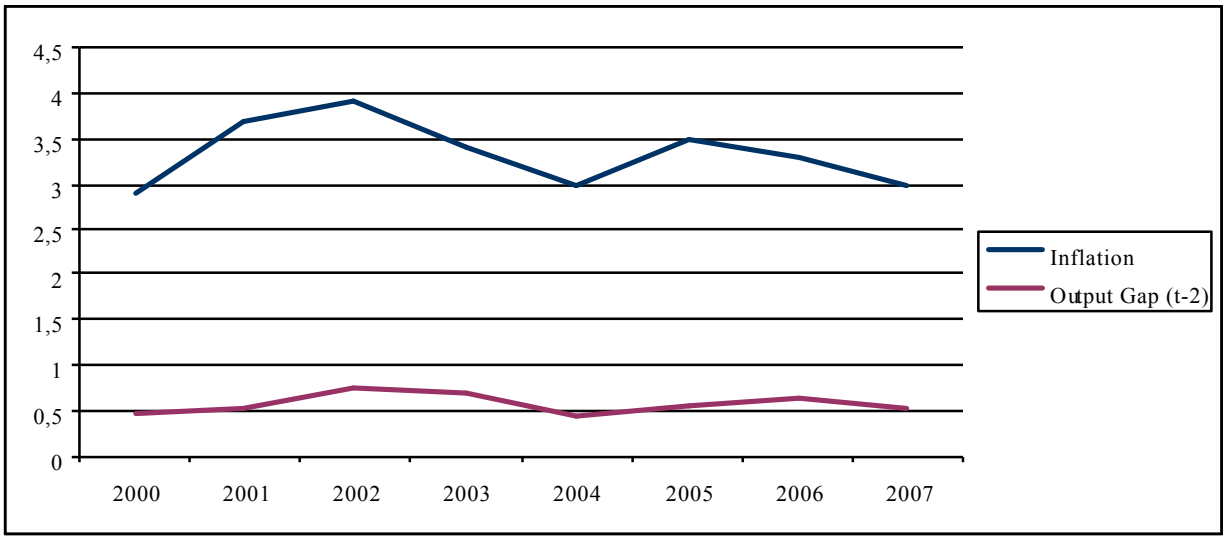
Time Lag	**t**	**t-1**	**t-2**	**t-3**
$\mathbf{R^2}$	0.13	0.46	0.50	0.15

Source: *Authors' elaboration*

As can be inferred from Table 2 the highest value of R^2 is equal to 50% and is found for a lag of two (2) years, meaning that output gap takes two (2) years approximately to be transformed into inflation. Consequently, the results indicate that there is a sufficiently strong relationship between Consumer Price Index (CPI) and the output gap.

From figure 17, which depicts the CPI_t and the two (2) year lagged output gap (Qgap_{t-2}), one can easily infer that they follow a very similar pattern consistent with our finding of a sufficiently strong relationship between them.

Fig. 17: *Inflation rate and Output Gap for Greece (lag = 2 years)*



Source: *Authors' elaboration*

Since the relevant CPI data for the Peloponnese region are not available, a similar relationship between output gap and inflation cannot be established for the regional economy. Obviously, a correlation between the *regional* output gap and the *country's* inflation (CPI) rate would not be appropriate as the prevalent economic conditions in the region, whose contribution to the country's GDP is just 4.98%, are not expected to approximate the totality of the Greek economy with any reasonable accuracy.

V. Conclusion

In this paper we estimated potential labour/output and labour/output gap, by sector of economic activity, in Greece and the Peloponnese Region, respectively, in an attempt to investigate whether they are operating at levels over their capacity, which in turns could be blamed for inflationary pressures. The results show that most sectors do operate over the economy's respective capacity and are responsible for creating inflationary pressures. Finally, regarding the relationship between inflation and output gap, we found that it takes approximately two (2) years for the output gap to be transformed into inflation.

It is well known, that in periods of expansion, the economy can function above the levels of the corresponding trend line (M.o.F. 1998), that is to say the real magnitudes are larger than the corresponding potential ones. The opposite is in force in periods of recession. In this context, and given the expansion of the two economies, our findings are not surprising.

Thus, when the activities connected to the expansion of the economy are completed, and the employment level reaches its potential value, then the unemployment rate will probably increase. This finding seems to be consistent with the most recent evidence regarding the Greek economy, as a whole. More precisely, the unemployment rate for the recent years, i.e. after 2007, has increased considerably when compared to its prior values, apparently signifying the end of a long period of economic expansion related, among other things, with the 2004 Olympic Games and the EU funding. Conclusively, we believe that future and more extended research on the subject would be of great interest, including the estimation of the labour and output gap for other crucial regions within Greece as well as with the E.U. territory, as a whole.

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