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INPUT–OUTPUT MODELLING OF LABOUR PRODUCTIVITY AND THE WORKING TIME IN GREECE

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Abstract: In Greece, the total annual working hours per employer are significantly over the average EU level placing the country in the first position in EU-15. A key question related to this situation is the calculation of the diffusion effects in terms of productivity in the Greek economy, if the final demand for some industry changes. To do this, we apply a methodology for calculating labour productivity change by sector of economic activity in an input – output framework. More specifically, through this analysis, the change in final demand is translated into the levels of working time of each sector and the levels of intermediates that are purchased by each sector to produce that output. The input-output tables and the working time data for our applications are provided by the National Statistical Service of Greece and the Statistical Office of the European Communities. So, we investigate the change in the sectoral productivity that will be generated if a change in the final demand takes place, whereas the working time is cut down to the average EU-15 level. The results suggest that a decrease of the annual working time in Greece will cause a significant increase in the gross labour productivity of the various sectors. We believe that the results of the paper could be utilized for the feedback of the policy formulation procedure and could contribute to the efficient allocation of labour. The lack of comparability in methodology and time period hampers multi-country analyses.

Keywords: input - output analysis, labour productivity, sectors, working time, Greece.

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1. Introduction

Labour Productivity growth is usually analysed in the framework of Total Factor Productivity (TFP) growth, building on the seminal contribution of Solow (1957). However, Hart (1996), based on Jorgenson and Griliches (1967) and Griliches (1990), stressed the fact that most results can be derived from other approaches, including the input-output framework.

In this context, our approach is consistent with the input–output tradition focusing on changes in labour productivity close to the spirit of Prakash and Balakrishnan (2005) and Greenhalgh and Gegory (1988). Also, the analysis is based on gross output which is appropriate at the sectoral level (Jorgenson et al. 1987). Our approach emphasises on a single country, i.e. Greece, with the various sectors encompassing the whole economy and recognises the fact that labour productivity proceeds at varying rates in different sectors.

The approach will be able to identify the sectors of economic activity where labour productivity growth is particularly strong in case of an increase in an industry's final demand. However, our objective is also to examine the changes needed in labour productivity if the working hours in Greece are cut down to the average European Union (EU) level. More precisely, the present paper attempts to answer the following questions:

(a) *A change in an industry's final demand, what change in the level of labour productivity by sector will generate in case the amount of labour remains constant?*

(b) *A change in an industry's final demand, what change in the level of labour productivity by sector will require in case the amount of labour is cut down to EU levels?*

The paper is organised as follows: section 2 provides some sytlised facts about the Greek economy, section 3 key sets out the methodological framework, section 4 presents the empirical results and section 5 concludes the paper.

2. Stylized facts about Greece

In 1998, total employment in Greece was equal to 3.976 millions, while labour force was equal to 4.446 millions implying an unemployment rate of 11%, which is considered as very high in the E.U. The active population (aged 15-64) was equal to 6.936 millions indicating an employment ratio of 64.1%. Finally, the total population of the country was 10.835 millions implying an active population percentage of 64%. At this point it is interesting to note that the unemployment rate and the employment ratio have increased significantly compared with their 1988 values (8% and 61.8% respectively). Meanwhile, the active population rate remained unchanged and equal to 64%.

The measurement of productivity changes for the Greek economy is of great interest since real Gross Domestic Product (G.D.P.) growth in Greece, in 1999, exceeded the E.U. average for the fourth consecutive year (European Commission, 2000: 30), placing Greece first among E.U. countries with an average annual growth rate in current prices of 11.8% (2.3% in 1995 market prices) over the 1991-2000 period (European Commission, 2000: 172).

Furthermore, during the period 1993–2001, while an increase in production and productivity was observed, we also noted an increase in unemployment and a decrease in competitiveness, a thing that gives credit to the view that the Greek economy is belatedly

entering into a phase, which for most of the economies of the E.U. member states has already ended. More specifically, Greek labour productivity continues, along with Spain and Luxembourg, to hover at around 50% of the equivalent E.U. average. In 1996, labour productivity in Greece remained at very low levels and stood at around 66% of the E.U. average, while in 2001 labour productivity in the Greek economy reached 88% of the average E.U. value (Labour Insitute, 2001).

The Greek economy performed poorly from about 1970 to 1995. 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).

However, 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. 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 led to the acceleration in growth of G.D.P. Major challenges remaining include the reduction of unemployment and restructuring of the economy.

Greece is also the most easterly country within Western Europe, and the gradual enlargement of the E.U. to the East will create a new allocation of resources and factors such as know-how and productivity will play a decisive role for competitiveness.

Obviously, the identification of poorly performing sectors of economic activity within the Greek economy could have significant implications for policy makers. Consequently, the topic of this paper is important and timely given the position of Greece at the periphery of the E.U. To this end, we investigate the case of Greece for the years 1999–2000, when data are available.

3. Methodology

Gross labour productivity by sector *i* is calculated by the formula:

$$\pi_i = \frac{X_i}{L_i} \quad (1)$$

where:

π_i is the gross productivity of labour by sector

X_i is the gross output by sector

L_i is the total employment by sector

Consequently, the sector wise row vector of gross labour productivity (Π) is equal to:

$$\Pi = X^T \hat{L}^{-1} \quad (2)$$

where:

X is the row vector of gross outputs

L is the row vector of employment

T denotes transposition and ^ denotes the diagonal matrix.

Also, the input coefficients matrix is obtained as follows:

$$A = Z \hat{X}^{-1} \quad (3)$$

where:

Z is the matrix of intermediate deliveries.

In the input–output approach, the balance equations can be written as:

$$X = AX + Y \quad (4)$$

Solving the balance equation for X, we obtain:

$$X = (I - A)^{-1} Y \quad (5)$$

where:

$(I - A)^{-1}$ denotes the Leontief inverse and

Y is the row vector of final demand.

Substituting (5) into (2) we get:

$$\Pi = Y^T \left[(I-A)^{-1}\right]^T \hat{L}^{-1} \quad (6)$$

In this framework, the growth rate of sectoral productivity is:

$$G_{\Pi} = \Delta \Pi \ \hat{\Pi}^{-1} \quad (7)$$

where:

G_{Π} is the vector of gross labour productivity growth rates

$\Delta \Pi$ is the row vector of change in sectoral gross labour productivity

$\hat{\Pi}^{-1}$ is a diagonal matrix of initial levels of sectoral gross labour productivity

Consequently:

$$G_{\Pi} = (Y'^T - Y^T)\left[(I-A)^{-1}\right]^T \hat{L}^{-1} \ \hat{\Pi}^{-1} \quad (8)$$

$$G_{\Pi} = (Y'^T - Y^T)\left[(I-A)^{-1}\right]^T \hat{X}^{-1} \quad (9)$$

where Y' is the new vector of final demand under the assumption that sectoral employment and production technology remain unchanged.

The methodological framework presented can have significant and measurable policy implications for Greece. For example, our findings can be used to pinpoint the sectors which face the largest labour productivity changes, in case the Greek government decides to create extra final demand for the output of some industries.

In case, the greek government wishes to satisfy final demand of year 2000 while keeping employment down to the 1999 levels, what changes in labour productivity will be required at the sectoral level (scenario I)? This question will be answered by means of the methodological framework presented above. More precisely, equation (9) is used to determine the labour productivity change needed, where Y' expresses final demand of year 2000, and Y express final demand of year 1999.

Furthermore, if the Greek government wishes to reach the final demand levels of year 2000 but, meanwhile, it wishes to cut down sectoral employment to the EU levels, what productivity changes, at the sectoral level, would then be required (scenario II)? This question will also be answered by means of the methodology presented above. However, equation (6) is then used twice to determine the two labour productivity levels, respectively, i.e. those of years 1999 and 2000, and its growth rate is then calculated numerically.[1]

4. Empirical Analysis

In this section, we investigate empirically the case of the Greek economy for the years 1999 and 2000 based on the methodological framework presented in the previous section. The domestic input-output table for the Greek economy for year 2000 is not published

[1] As we can see, equation (9) cannot be utilized, since its analytical derivation is based on the assumption that sectoral employment (and production technology) remains constant, an assumption which does not hold, in the case under investigation.

and is, thus, estimated using the Schintke and Staglin (1988) methodology. It is used for both years, under the assumption that production technology for the Greek economy remains unchanged. The figures on employment and output are obtained from the National Statistical Service of Greece and the Statistical Office of the European Communities. It should be noted that the sector wise vector of EU average employment level is used for year 2000. For the industry classification, which is not identical to the classification used by O.E.C.D., see Table 2 (Appendix). Table 3 (Appendix) presents the average working hours per week for Greece and the EU-15 average.

This section presents the empirical results for the Greek economy. Table 1 presents the labour productivity changes for the Greek case for both scenarios.

Table 1

Figure 1 illustrates graphically the changes needed for both scenarios for years 1999-2000.

Figure 1

With one exception, as illustrated in Table 1, gross labour productivity has increased over the years 1999-2000, indicating that more gross output per employee is produced in 2000, than in 1999 (see column "Actual Change"). This means that productivity changes are positive.

In case the Greek government wishes to satisfy final demand of year 2000 by keeping employment down to 1999 levels, in an attempt to increase gross labour productivity gradually, the productivity changes are also positive because more gross output per employee will be produced in 2000, than in 1999 (see "Scenario I"). However, we notice that the actual changes in productivity and changes considered in the 1st scenario follow a quite similar pattern among the industries. This is due to the fact that employment levels at the sectoral level between 1999 and 2000 are very close and follow similar patterns, whereas the Leontief inverse matrix employed is the same.

Furthermore, we notice that in case the Greek government decides to cut down sectoral employment to EU levels in 2000 this requires a considerable increase in gross labour productivity, on average equal to about 47% among industries. Consequently, reaching final demand levels of year 2000, while adjusting to EU working hours, requires greater effort than reaching year 2000 demand levels and keeping employment constant. This is obviously due to the fact that EU working hours, at the sectoral level, are significantly over the respective sectoral levels in Greece.

We can see that the industries that are more affected by the adjustment to EU working hour levels belong to the industrial sectors. More precisely, the industries that face the highest increases in gross labour productivity are the "Petroleum and coal products" (No. 7), "Iron and steel, non-ferrous metals" (No. 10), and "Transport, storage and communication" (No. 17) industries. Similarly, the industries that require the lowest increases in gross labour productivity are the "agriculture, forestry and fishing" (No. 1), "mining" (No. 2) and "construction" (No.14) industries.

5. Conclusion

To sum up, the methodology presented in this paper calculates the change in the level of gross labour productivity by sector of economic activity that will be generated in case of a change in an industry's final demand. From the empirical analysis we found that gross labour productivity has increased over the time period 1999-2000, indicating that more gross output per employee is produced in 2000, than in 1999.

An important conclusion that can be drawn from this paper is that the gross labour productivity would have to increase considerably in case the Greek government decided to adjust sectoral employment to EU levels over the 1999-2000 time period, while keeping technology constant. However, it should be noted that while employment (in terms of working hours) cut down hovers around 23% among sectors, the implied increase in labour productivity is equal to about 47%.

Although some European countries report increasing labour productivity, the lack of comparability in methodology and time period hampers multi-country analyses of productivity change. The measurement of labour productivity change in an input-output framework for other European countries is of great interest and could be a good example for future investigation.

Appendix

Table 2

Table 3

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Tables

Table 1: *Gross Labour Productivity Changes (1999-2000)*

Industry	Change (%) in gross labour productivity (Actual Change)	Change (%) in gross labour productivity (Scenario I)	Change (%) in gross labour productivity (Scenario II)
1	8.17	4.92	22.83
2	2.71	8.65	26.66
3	2.55	3.00	36.92
4	4.20	3.69	33.72
5	13.95	6.29	48.44
6	14.42	8.34	56.46
7	60.29	43.08	98.58
8	10.56	8.09	45.62
9	12.72	7.47	47.65
10	23.64	12.83	68.53
11	7.81	8.18	44.50
12	15.01	13.54	58.33
13	12.02	5.96	42.50
14	3.41	8.19	29.63
15	4.81	6.55	50.89
16	7.39	9.31	55.21
17	23.95	24.21	61.85
18	5.21	13.26	36.05
19	-1.77	0.30	38.09
20	10.06	11.86	37.64
21	8.90	9.14	50.36
Average:	*11.90*	*10.33*	*47.16*

Table 2: *Industry Classification*

Industry	Description	I.S.I.C. rev.2
1	Agriculture, forestry and fishing	1
2	Mining	2
3	Food, Beverages and Tobacco	31
4	Textiles, apparel and leather	32
5	Wood products and furniture	33
6	Paper, paper products and printing	34
7	Petroleum and coal products	353+354
8	Industrial chemicals, Rubber and Plastic Products	351+352–3522+355+356
9	Non-metallic mineral products	36
10	Iron and steel, non-ferrous metals	371+372
11	Metal products	381
12	Shipbuilding and other transport, motor vehicles, aircraft, electrical apparatus, non electrical apparatus, professional goods, other manufacturing	382–3825+383+3832+3841+3842+ 3844+3849+3843+3845+385+39
13	Electricity, gas and water	4
14	Construction	5
15	Wholesale and retail trade	61
16	Hotels and restaurants	62
17	Transport, storage and communication	71+72
18	Finance and insurance	81
19	Real estate and business services	82
20	National defense and public administration	-
21	Communication, social and personal services	9

Table 3: *Average working hours for year 2000 (Greece & EU-15)*

Industry	Greece	EU-15	Difference (%)
1	1941.60	1709.91	-11.93%
2	2164.29	1755.03	-18.91%
3	2220.48	1663.13	-25.10%
4	2159.89	1683.03	-22.08%
5	2223.94	1707.26	-23.23%
6	2198.73	1607.97	-26.87%
7	2141.69	1728.80	-19.28%
8	2169.42	1647.14	-24.07%
9	2221.21	1695.62	-23.66%
10	2235.57	1640.11	-26.64%
11	2235.57	1668.06	-25.39%
12	2215.34	1609.17	-27.36%
13	2066.51	1624.56	-21.39%
14	2161.85	1724.69	-20.22%
15	2235.78	1552.97	-30.54%
16	2206.47	1526.63	-30.81%
17	2226.83	1705.37	-23.42%
18	2108.06	1630.25	-22.67%
19	2176.30	1548.10	-28.87%
20	1834.11	1466.69	-20.03%
21	2007.81	1454.15	-27.58%

Figures

Figure 1: *Gross Labour Productivity Changes Chart (1999-2000)*