The Contribution of the Publicly Funded RD Capital to Productivity Growth and an application to the Greek food and beverages industry

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Abstract

This paper follows the dual cost function methodology and develops a theoretical specification that assesses the contribution of public R&D capital to the productivity growth. The empirical application focuses on Greek food and beverages industry. For this purpose it employs a micro-aggregated annual data set over the period 1976-2002. The regression analysis shows that publicly funded R&D capital is a productive input as 8.7 percent and 7.3 percent of the total factor productivity growth in the food industry and in the beverages industry respectively is attributed to the publicly funded R&D capital. The relationship between publicly funded R&D and private purchased inputs is also examined.

Keywords: Public R&D; Productivity Growth; Rate of return.
JEL Classification: L6; O32; O38.

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1. Introduction

The starting point of the literature on the measurement of the returns to R&D can be traced back to the pioneering work of Griliches (1958), exploring the social returns to the research at the hybrid corn. Since Griliches, a plethora of papers has emerged, providing further measurements of the returns to R&D. In the literature two are the main approaches of estimating those returns: (i) the production function method that includes R&D as an input of production, and (ii) the market value method regressing firm's market value on R&D. According to the first approach, as developed by Griliches (1958), a Cobb-Douglas production function is used augmented with the "knowledge" capital so as to estimate the productivity of R&D (see also Griliches & Jorgenson, 1967; and for a review Mairesse & Sassenou, 1991). The second approach stems also from the work of Griliches (1981) and is based on the financial market assessment of the value of the firm (see Hall, 1993; Blundell *el al.*, 1999 and Hall & Oriani, 2006). Along the lines of the market value approach there exists also an alternative approach that relies on Tobin's Q model as described in Hayashi & Inoue (1991), where the firm's market value is a function of different forms of capital, that are differentiated into tangible and non tangible. Overall, most of the above studies present results of positive returns to R&D, though some variation exists across various approaches and samples. Nevertheless, as often the case with empirical studies criticism is not absent, mainly emphasising the econometric problems associated with the estimation of the returns to R&D (see Griliches & Mairesse, 1996).

Despite the numerous studies on the returns to R&D, the impact of publicly funded R&D on private sector performance has received considerably less attention compared to the effects of privately funded R&D, with the exception of Nadiri & Mamouneas (1996) that report evidence of a productive public R&D capital. However, in recent years the public debate over the issue of raising public R&D expenditure has gathered significant momentum, especially within the European Union that has set ambitious targets of increasing R&D expenditure above 3 percent of GDP by 2010.

The new found scope for raising R&D expenditure in EU has triggered new empirical studies, though no silver bullet has been discovered as yet, and no definite answer to the exact impact stemming out of R&D, in terms of the magnitude and less often in terms of the sign, has been brought forward. David *el al.* (2000) in a review of the literature argue that R&D expenditure asserts some positive impact on the underlying production procedure, though the evidence is ambivalent with respect to the exact magnitude. Also, in a recent paper, Bonte (2004) provides evidence that R&D is enhancing productivity growth in the case of the German industry, though it is the privately funded R&D that is mainly driving this impact, whilst the publicly funded R&D bears a less clear impact on productivity growth. However, earlier studies such as Lichtenberg (1988), Grilliches (1986) and Grilliches & Lichtenberg (1984) report little or no evidence of a productive R&D capital.

This paper is an attempt to fill a gap in the literature by providing a theoretical framework that allows the investigation of the impact of publicly funded R&D capital on the industrial productivity growth for the Greek economy that has not been investigated. To this end, I follow the productivity approach along the lines proposed by Griliches and use as a starting point the theoretical specification of the rate of productivity growth, namely the Solow residual, which I then modify within a dual cost function framework. The dual cost function specification is flexible and allows the disentangling of the impact of publicly funded R&D on productivity growth. Then, an assessment of the specific channels, both direct and indirect, through which this effect operates is provided. The data set of the empirical application is derived from the Greek food and beverages industry. Nadiri & Mamouneas (1996) show that R&D capital benefits the capital intensive industries more. Thus, the choice of using data from the food and beverages industry is justified as it is one among the most capital intensive Greek industries. Thus, some positive spill over stemming out of public R&D capital might be observed.

The next section discusses the theoretical framework, based on a cost function with publicly funded R&D as an unpaid input of production. The data set is then reported in section 3. Section 4 provides the empirical model and findings, while the last section offers a short summary and some concluding remarks with some brief policy implications.

2. A Theoretical Framework

Many questions were raised concerning the econometric issues of estimating a production function (see for a review Griliches & Mairesse, 1997) but also the often reported implausibly high returns to R&D (see David *el al.*, 2000; Nadiri & Mamouneas, 1996). A way to address these issues is to opt for a flexible functional form, like the dual cost function. The cost function framework allows to deal with the possible endogeneity problem of output, as the main objective of the representative firm is to minimize the total cost given the level of output, the input prices, the quasi fixed inputs, and, in particular for the purpose of the present paper, the input of public R&D capital.

Thus, the starting point of our analysis is a variable cost function, G, given the level of output, the prices of variable inputs, and the stocks of quasi fixed inputs:

$$G = G(\mathbf{x}, P, Y, t) \qquad (1)$$

where **x** is a vector of quasi-fixed inputs (private capital = K, and public R&D capital = R&D), P is the vector of the input prices for labour, P_L, and intermediate inputs P_M, Y is the output and t is a time trend.

Notice that total cost is given by $C = G + P_K K + P_{R\&D} R\&D$ or equivalently $C = G + P_K K$, as the representative firm does not pay for publicly funded R&D capital, while it receives the spill over effects, if any. In this way, both the private capital and the public R&D capital may affect the cost curve over the long run. Note that the usual homogeneity conditions apply to fixed inputs as scale effects depend upon them (see Morrison & Schwartz, 1996)

In detail, the firm solves the following variable cost minimization problem:

$$C(\mathbf{x}, P, Y, t) = \min_{x_i} \{ \sum_{i=1}^{n} P_i X_i : F(\mathbf{x}, L, M, Y, t) = 0 \} \qquad (2)$$

where X_i is the quantity of purchased inputs (L and M) while P_i is the price of the purchased inputs (L and M).

Given equation (2) the productivity growth can be derived, using similar methodology to Ohta (1974). Ohta was the first to show that there exists equivalence between the primal and the dual measure of productivity growth. In detail, logarithmically differentiating the right hand side of equation (2) with respect to t gives:

$$\frac{dC}{dt}(\sum_i P_i X_i) = \sum_i S_{Xi}\dot{X}_i + \sum_i S_{Pi}\dot{P}_i \qquad (3)$$

where S_{Xi}=dlnC/dlnX_i and S_{Pi}=dlnC/dlnP_i is the cost elasticity with respect to private inputs and input payments respectively, and dots above variables indicate derivatives with respect to time.

Next, logarithmically differentiating the left hand side of equation (2) with respect to t gives:

$$\frac{dC}{dt}(x,P,Y,t) = \sum_i S_{Pi}\dot{P}_i + \varepsilon_{CY}\dot{Y} + \eta_K\dot{K} - \eta_{R\&D}\dot{R\&D} + \varepsilon_{Ct} \qquad (4)$$

where ε_{CY}=dlnC/dlnY is the cost elasticity of output, η_K=dlnC/dlnK is the cost elasticity of private capital and $\eta_{R\&D}$=dlnC/dlnR&D is the *"shadow share"* of public R&D capital, as no market price is linked to the derived services. Lastly, ε_{Ct} is the elasticity of cost with respect to the time trend.

By substituting equations (3) into (4) we get:

$$\sum_i S_{Xi}\dot{X}_i = \varepsilon_{CY}\dot{Y} + \eta_K\dot{K} - \eta_{R\&D}\dot{R\&D} + \varepsilon_{Ct} \qquad (5)$$

Then, by multiplying both sides of equation (5) by minus one and by adding $\dot{Y}$ to both sides it gives:

$$\dot{Y} - \sum_i S_{Xi}\dot{X}_i = \dot{Y} - \varepsilon_{CY}\dot{Y} - \eta_K\dot{K} + \eta_{R\&D}\dot{R\&D} - \varepsilon_{Ct} \qquad (6)$$

Note that the left hand side of equation 6 is the primal index number measure of productivity growth, which is the Solow residual, $\dot{TFP} = \varepsilon_{CY}\dot{Y} - \sum_{i=1}^{n} S_i\dot{X}$. Also, it is common in the literature (see Nadiri & Mamouneas, 1996) to assume constant returns to scale, that is the elasticity of cost with respect to output is 1, ε_{CY} =1. However, this assumption is too restrictive as it is not generally valid (Morrison & Schwartz, 1996). In this paper we do not assume constant returns to scale, that is $\varepsilon_{CY} \neq 1$, then the elasticity of total cost with respect to output is given from:

$$\varepsilon_{CY} = \frac{Y}{C}\frac{dC}{dY} = \varepsilon^{L}_{CY} - \eta_{K}\,\varepsilon_{KY} - \eta_{R\&D}\,\varepsilon_{R\&DY}, \qquad (7)$$

, where ε^{L}_{CY} is the long run elasticity of cost with respect to output, ε_{KY} and $\varepsilon_{R\&DY}$ are the long run elasticities of the demand for private capital and public R&D capital with respect to output respectively.

Combining equations (6) and (7) with the primal-index-number measure of productivity growth gives:

$$\dot{TFP} = -\varepsilon_{Ct} - (\varepsilon^{L}_{CY} - 1)\,\dot{Y} + \eta_{CK}\,\varepsilon_{KY}\,\dot{Y} - \eta_{CK}\,\dot{K} + \eta_{R\&D}\,R\dot{\&}D - \eta_{R\&D}\,\varepsilon_{R\&DY}\,\dot{Y} \qquad (8)$$

Equation 8 decomposes productivity growth into the impact of technical change, of scale economies, of fixity of private capital, and of the contribution of public R&D capital. The latter is the sum of two components: (i) the direct effect of R&D through the share weight on R&D growth and (ii) the indirect effect through the share weights on output growth.

3. The data set for the food and beverages industry

In the empirical application of the productivity growth decomposition I opt for the food and beverages Greek industry. The food and beverages industry, together with the chemical industry, is among the most important industries of the Greek manufacturing, exhibiting strong dynamism. This dynamism is reflected by its performance, measured by the industrial production index, that reached 105.6 in 2006 (100 in 2000), 7.5 units above the equivalent index for total manufacturing. Moreover, in the last five years the food and beverages industry captures the biggest share in the industrial production, 25%, while it covers slightly above 25% of the total investment in manufacturing. In addition, the food and beverages sector is far more profitable than any other sector of the Greek manufacturing with a net profit growth of 7 percent in 2004. Most firms in the sector are capital intensive and exhibit a higher degree of technological advancement than firms in other sectors of manufacturing such as Tobacco, Furniture and Paper, underlying their competitiveness as depicted also by their high export share, capturing 18% of the total manufacturing exports. The food and beverages industry has also the higher number of entries. The competitiveness of the sector is further evident by the high ratio of value added to gross value, above 41%, the highest in Greek manufacturing. Thus, investigating the impact of public R&D capital on the productivity growth in the food and beverages industry is of interest.

The time series for labour, intermediate inputs, private capital stock and gross output have been collected from various issues of the Annual Industrial Survey of Greece published by the National Statistical Office of Greece over the period 1976-2002.[1]

The labour input is defined as number of employees in industrial units with more than twenty employees.[2] The price of labour is derived by dividing the total labour cost by the number of employees. Total labour cost is the sum of wages and salaries paid to employees. Intermediate inputs are also derived from the Annual Industrial Survey, and cover mostly expenditure on energy.

The time series of private capital stock include equipment, structures and inventories. The depreciable assets of private capital stock like equipment and structures are estimated using the perpetual inventory method. The stock of capital is a weighted sum of all past investment. The efficiency of an asset is assumed to decline monotonically with age and it is approximated by a rectangular hyperbola. The underlying assumption is that the flow of the derived services from capital stock affects the cost structure of Greek manufacturing industries. These services are assumed to be a constant proportion of private capital stock. The price of private capital stock is measured as $P_K = i_t (r_t+\delta_t)$, where i_t is the asset price or investment deflator, r_t is the rate of return or opportunity cost of investment, and δ_t is the economic depreciation rate. The series of private capital stock and its price are

[1] In addition to this data source, whenever was necessary, our data set was cross checked with time series available from the Monthly Statistical Bulletin of Bank of Greece, the Ministry's of National Economy Net Capital Stocks Publications, and the Centre of Planning and Economic Research (ΚΕΠΕ).

[2] In the Annual Industrial Survey those industries are mentioned as *'large scale manufacturing'*.

obtained from the Greek Annual Industrial Survey, the Ministry of National Economy and the Centre of Planning and Economic Performance (ΚΕΠΕ).

The time series of publicly funded R&D capital is obtained from OECD Main Science and Technology Indicators, various issues, and the Greek Ministry of National Economy and refers to public expenditure on R&D as presented in the government's annual budget. The public capital stock in R&D is constructed using the perpetual inventory method, where a 10 percent constant depreciation rate is chosen, following studies such as Bernstein & Nadiri (1991).

An important issue that emerges is the choice of the depreciation rate of the R&D capital. Most research in the literature is carried out assuming a constant depreciation rate that varies between 10 and 15 percent as proposed by the work of Griliches. However recently, Hall (2007) pinpointed the limitations of using a constant depreciation rate to construct R&D capital. The author provides evidence of the shortcomings of assuming constant depreciation rate on the measurement of returns to R&D using three different regressions: output on R&D intensity, output on R&D, and firm's market value on R&D. The results of the first regression show serious downward bias. In contrast, the estimations using the production function and the market value approach suffer little from this problem, though Hall demonstrates that in a second stage it is necessary to derive depreciation rates in order to accurate measure the returns to R&D. A striking finding of Hall's paper is that the last two approaches do not give similar depreciation rates.

An additional issue that is worth mentioning regards the need to differentiate between two categories of R&D spending; basic R&D vs. applied R&D. Nelson (2004) emphasises the crucial role of the government in providing the framework to support an open science environment. In his own words *"…the allocation of scientific resources should not be guided by anticipation of particular practical payoffs, but rather by the informed judgments of scientists regarding the most important problems to work on"*. Based on this, he argues that public funding is imperative to research if the goal is to advance science. However, to the best of my knowledge there is no record in Greece for differentiating the R&D spending into basic and applied.

Lastly, the gross output represents the output variable given that the total cost function includes labour and intermediates as private purchased inputs of production. All variables are expressed in constant terms.

4. The translog cost function and the empirical results

Prior to the calculation of the productivity growth as given by equation 8, it is necessary to estimate the underlying variable dual cost function that is equation 1. In the present analysis I opt for the flexible functional form of the translog cost specification introduced by Christensen *el al.* (1971):

$$\ln G = \alpha_0 + \sum_i \alpha_i \ln P_i + a_Y \ln Y + \alpha_{R\&D} \ln R\&D + \alpha_K \ln K + \alpha_t t + \frac{1}{2}\sum_i \sum_l \beta_{il} \ln P_i \ln P_l + \frac{1}{2}\beta_{R\&DR\&D} \ln R\&D^2 + \frac{1}{2}\beta_{KK} \ln K^2 + \frac{1}{2}\beta_{YY} \ln Y^2 + \frac{1}{2}\beta_{tt} t^2 + \sum_i \beta_{iY} \ln P_i \ln Y_j + \sum_i \beta_{it} \ln P_i t + \sum_i \beta_{R\&Di} \ln P_i \ln R\&D + \sum_i \beta_{iK} \ln P_i \ln K + \beta_{R\&DK} \ln K \ln R\&D + \beta_{R\&DY} \ln Y \ln R\&D + \beta_{YK} \ln Y \ln K + \beta_{Yt} \ln Y\, t + \beta_{R\&Dt} \ln R\&D\, t + \beta_{Kt} \ln K\, t, \quad (9)$$

where symmetry implies that $\alpha_{il} = \alpha_{li}$. In addition, a well-behaved cost function such as equation (9) must exhibit homogeneity of degree one in the prices of private purchased inputs of production, P_L, and P_M.

Applying Shephard's Lemma, the cost-minimising shares for the private purchased inputs (L and M) as well as the elasticity of cost with respect to output and public R&D capital are derived. This study focus on the cost share of publicly funded R&D capital given as:

$$\eta_{R\&D}=\alpha_{R\&D}+\beta_{R\&Dt}t+\beta_{LR\&D}\ln P_L+\beta_{MR\&D}\ln P_M+\beta_{R\&DY}\ln Y+\beta_{R\&DK}\ln K+\alpha_{R\&DR\&D}\ln R\&D \quad (10)$$

Equation (10) is the '*shadow share*' of public R&D capital, which is an implicit measure of the productive effect, if any exists.

The selected system of equations consists of the total cost function and the labour share while the estimation method is the seemingly unrelated regressions (SUR). This method is chosen because it employs more information, and thus it is more efficient than a single equation estimation by OLS. However, the SUR method is sensitive to which cost share equation is excluded from the sum of the cost share equations. Recall that the sum of the cost shares of private purchased inputs is equal to one, and thus because of the emerged singularity problem only n-1 cost share equations can be estimated. To overcome this difficulty, I apply the iterated seemingly unrelated regression method (ISUR), which ensures that the parameter estimates of the system approximate those obtained by using maximum likelihood method, and thus they are invariant to the choice of the excluded cost share equation (see Judge, 1980). The overall efficiency of the estimation is further enhanced by imposing optimisation behaviour among industries, linear homogeneity, and symmetry.

In addition, to estimate the cost function and the labour share equation I use a panel of the food and beverages industries. The main advantage of using a panel date set series is the achieved sample variability that results to efficient estimations, whereas estimations using single industry data often suffer from multicollinearity. Inter-industry differences are then captured using industry dummies on the constant and the coefficients of private purchased inputs, as well as on the effects of quasi fixed inputs, that is private capital and publicly funded R&D. Having two different industries in our sample the usual normalisation is applied with respect to the food industry.

The estimated results show that cost function satisfies the monotonicity and concavity conditions for all observations in the sample period, but two. The translog cost function is monotonically non-decreasing and concave in the price of labour and of intermediate inputs, non-decreasing in output, and non-increasing and convex in publicly funded R&D[3]. In addition, specification tests show good fit and no evidence of serial correlation.

[3] Strict monotonicity is satisfied since the fitted shares for labour and intermediates inputs are all positive. In addition, for strict quasi-concavity is satisfied as the mat9rix of substitution elasticities is found to be negative semidifinite. In order to test for strict quasi-concavity I proceed with the eigenvalues of the above matrix and its LDL factorisation using TSP 4.4.

<< Table 1 about here>>

The sign and the magnitude of the parameter estimate of $\alpha_{R\&D}$ is of interest as it captures the spill over bias effect of publicly funded R&D on variable cost. The reported results show that a one percent increase in publicly funded R&D induces on average a downwards bias effect on variable cost of 0.17 percent, indicating that publicly funded R&D asserts a cost-saving bias effect on food and beverages industry. As a way forward and in order to explore further the effects of publicly funded R&D on total cost I estimate the elasticity of cost with respect to publicly funded R&D, that is the '*shadow share'* of publicly financed R&D ($\eta_{R\&D}$). Table 2 reports the parameter estimates of $\eta_{R\&D}$ (see first column) for both the food and beverages industry. The results show that the average *'shadow share'* of publicly funded R&D on food and beverages industry over the whole sample period is 0.37 percent and 0.43 percent respectively. However, note that in the 1980s the elasticity of cost with respect to publicly funded R&D in food and beverages industry sharply declined compared to the 1970s, whereas it recovered thereafter in the 1990s. It is no coincidence that during the 1980s public expenditure in R&D was dramatically curbed. Nevertheless, the *"shadow shares"* of publicly funded R&D imply a positive productivity effect. One could interpret these results as providing evidence of an under-provision of public funded R&D, in particular during the 1980s.

<< Table 2: about here>>

Note that despite the importance of the food and beverages industrial production for the Greek economy due to the disaggregation of the data used here, one would not expect to observe reverse causality from the industrial production to the R&D investment, as this sector holds little power to influence the overall ceiling or mix of the government's spending. Moreover, the anecdotal evidence in the Greek case concerning the process of setting the amount of the public R&D investment shows that it is decided within a heavily centralised budgetary process and it is essentially treated as a residual. This means that the public R&D investment has been often curtailed in periods characterised by fiscal imbalances, as it is evident in the eighties.

In addition, Table 2 reports the impact of R&D on labour. Moreover, the total impact is the sum of the productivity effect of publicly funded R&D ($\eta_{R\&D}$) and the ratio of the *"input bias*" effect of publicly funded R&D over the share of labour in total cost ($\frac{\beta_{LR\&D}}{S_L}$). Similar analysis is carried out for the case of intermediate input, the second variable factor within the dual cost function. A positive (negative) sign implies that R&D asserts a positive (negative) bias impact on inputs. The results report negative signs (see Table 2, $\eta_{LR\&D}$), suggesting a substitute bias relationship between the public R&D capital and the labour input. This result is of some value for policy making as the Lisbon strategy of the EU is aiming at raising R&D spending as a percent of GDP and in parallel at creating new jobs. Based on the present findings public R&D capital appears not to benefit labour intensive firms, despite being overall a productive input. On the other hand, Table 2 presents results that show a complementary relationship between public R&D capital and intermediate inputs as $\eta_{MR\&D}$ takes positive values. This finding could imply that public R&D capital benefits technologically advanced production procedures with a high value added, both being common characteristics of many firms within the food and beverages industry.

Next, Table 3 presents the effects of publicly funded R&D on productivity growth of food and beverages industry.The last column of Table 3 shows the productivity growth ($\dot{TFP}$) in the food and the beverages industry. $\dot{TFP}$ is decomposed into the contribution of public R&D capital, which is the sum of the direct effect of R&D through the share weight on R&D growth ($\eta_{R\&D}\dot{R\&D}$) and the indirect effect through the share weights on output growth ($\eta_{R\&D}\,\eta_{R\&DY}\,\dot{Y}$). Moreover, the total impact of public R&D capital on the productivity growth for the food industry presents high variability, ranging from the low value of 0.052 percent in the eighties to the high value of 0.227 percent in the nineties and early 2000s. On the other hand, the impact of public R&D capital on $\dot{TFP}$ of the beverages industry is somewhat lower than the one of the food industry over time but present less variability, ranging from 0.17 percent in the eighties to 0.2 percent in the nineties and the early 2000s. Over the whole period the total impact of R&D public capital is positive and contributes 0.18 percent and 0.17 percent in the total factor productivity growth in the food and beverages industry respectively.

<<Table 3: about here>>

It is of interest to notice that the impact of public R&D capital on productivity growth sharply declined in the 1980s, a period characterised by a dramatic curtailment on R&D expenditure, though it bounces back in the nineties. This development implies that the sector, in particular the food industry, suffered from shortages in the provision of publicly funded R&D capital, mainly during the eighties, which deterred its productivity growth performance. In the eighties public R&D expenditure was dramatically curbed to extremely low levels, less than 0.1 percent of GDP, as severe macroeconomic instabilities at the time meant that fiscal consolidation focused in less visible items of the fiscal budget. In the nineties, the negative trend of R&D spending was reversed, increasing to around 0.4 percent of GDP. Alas, this improvement was lagging behind the EU-15 average of around 1.9 percent of GDP in 2000, and the target set by the Lisbon's strategy of 3 percent of GDP. Some positive news come from recent data showing that in the period 2001-2006 the average Greek R&D spending increased, reaching an all time high of 0.6 percent of GDP. Another promising sign comes from the relatively strong performance of the patents applications. Based on the data set of patent applications to the European Patent Office the number of applications in Greece per million inhabitants more than doubled from 3002 in 1994 to 6819 in 2004. This implies that the increase in publicly funded R&D, as percent of GDP, during the late nineties and since 2000 resulted to more patents. A parametric analysis, therefore, of the link between productivity growth and R&D as reflected by the number of patents is warranted, though this will be part of future research because of the lack of an adequate data set in the present.

4. Conclusion

This paper uses a flexible dual cost function methodology to decompose productivity growth into the impact of R&D capital in the case of food and beverages industries. Two principal findings emerge from this study: first, the empirical analysis shows that publicly funded R&D capital exhibits a productive effect, though some variation over time exists. The cost elasticity with respect to publicly funded R&D capital is reported negative for both the food and the beverages industry, implying that the average short run cost function shifts downwards as public expenditure in R&D increases. Second, the R&D capital contributes to productivity growth, and thus the reduction in public R&D capital is, at least, partially responsible for the observed slowdown in productivity growth of the Greek food and beverages industry in the eighties. In particular, the total impact of publicly financed R&D on the productivity growth was positive and was rising in the seventies and during the nineties, while it declined in the eighties. The empirical findings show that over the sample period 8.7 percent and 7.3 percent of the total factor productivity growth ($\dot{TFP}$) in the food industry and in the beverages industry respectively is due to the publicly funded R&D capital. In addition, the R&D capital appears to benefit more capital intensive firms as it is found to assert a negative bias effect on employment. Abstracting from issues regarding the financing of public R&D spending, the present findings demonstrate that the reduction of public investment in R&D might have been partly responsible for the sluggish performance of the Greek food and beverages industry, especially in the eighties.

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