OWNERSHIP AS A DETERMINING FACTOR IN THE EVOLUTION OF EFFICIENCY

Nuria Fernández Conejero

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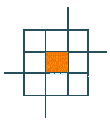

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ABSTRACT

Taking into consideration the privatisation policy that has emerged in recent decades, significant researches have been carried out to compare the efficiency of public and private companies. However, there is a drop regarding the evolution of these companies over the years. In view of this, the present research tries to deal with the analysis of efficiency from a dynamic perspective, and to evaluate the process of changes occurring between the starting point (1990) and the finishing point (1998).

The methodology is Indexes of Malmquist. Empirical data show that privatised enterprises have improved its technical efficiency more than private enterprises. Public enterprises are the firms that have improved least in this way.

Finally a complementary analysis considers if determinant factors, such exports, R&D., presence of workers contracted, or human c Indexepital contribute to improve the efficiency.

PALABRAS CLAVE: privatisation, efficiency, Indexes of Malmquist

RESUMEN

En los últimos años se han realizado significativas investigaciones con el objetivo de comparar la eficiencia de empresas públicas y privadas, como consecuencia, de la política de la privatización que ha emergido en décadas recientes.

Sin embargo los análisis encargados de evaluar la evolución de la eficiencia en las distintas categorías de empresas resultan notablemente menores. Como consecuencia, el presente trabajo intenta afrontar el estudio de la eficiencia desde una perspectiva dinámica, y evaluar el proceso de los cambios que ocurren entre el punto de partida (1990) y el punto final (1998). La metodología empleada gira en torno a los Índices de Malmquist. Los datos empíricos demuestran que las empresas privatizadas han mejorado su eficiencia técnica más que las entidades privadas. Las empresas públicas, por su parte, son las firmas que han mejorado peor comportamiento han tenido en este contexto.

Finalmente se plantea un análisis complementario en el que se trata de determinar en qué medida contribuyen a esta evolución factores como la I+D. las exportaciones, la presencia de trabajadores contratados en la plantilla, el capital humano, etc.

PALABRAS CLAVE: Privatizaciones, eficiencia, indices de Malmquist

ÍNDICE

1. INTRODUCTION

Taking into consideration the privatisation policy that has emerged in recent decades, significant researches have been carried out to compare the efficiency of public and private companies. The general conclusions of such researches have established that private companies are more efficient than public companies within competitive frameworks, although this is not unanimous. However, there is a drop regarding the evolution of these companies over the years. In view of this, the present research tries to deal with the analysis of efficiency from a dynamic perspective, and to evaluate the process of changes occurring between the starting point (1990) and the finishing point (1998).

The use of static efficiency indexes, for the purpose of establishing the evolution of productivity over the years, is clearly inefficient in fulfilling this purpose (Cuadras, Fernández and Rosés (2002), given that if we compared these indicators at different moments, we would be relating the efficiency of each company with the limit established for each of the periods, so the possible technological evolution would be obviated. Alternatively, another way to analyse this evolution is to take into consideration the growth rate of total or global factor productivity, and its decomposition. This allows us to determine the extent to which such growth is due to the technical progress or only to the production efficiency of the company, as well as the influence of the variable returns to scale (Orea, 2001)[1]. The so-called **Malmquist indexes**, based on the distance functions[2], are an appropriate instrument for the measurement of these variations. More particularly, the Malmquist indices show the evolution of total factor productivity in a specific period of time, based on the information included in a data panel.

Consequently, these indices provide the necessary tools to answer the following questions: Is the evolution of efficiency over the years less favourable in public companies than in private companies? Does efficiency improves to a larger extent in the case of privatised companies? Does the uneven evolution depend on business strategy factors?

2. THEORETICAL APPROACH

Caves, Christensen and Diwert (1982) were the first authors to use the concept of distance function within the framework of the Malmquist index, which was initially defined in the context of the consumer

[1] In Álvarez Pinilla (2001).

[2] According to the OECD (2001), the input-oriented distance function is based on the consideration that the inefficiency is related to the reduction that can be made in the use of the inputs, considering the possibilities of production to reach a specific output level. Moreover, Zofío (2001a) develops the consideration of distance functions in the Malmquist indices.

theory. These authors established the differences in productivity included in the Malmquist index, as well as the differences in the minimum volume of necessary inputs to reach a specific product (input-oriented) or the differences in the maximum product that can be obtained based on specific amounts of factors (output-oriented)[3].

As stated by Coelli, Prasada and Batesse (2000) and Pastor (1995)[4], this instrument has the advantage of not presuming that the analysed decision units are efficient, unlike the Törnquist indices, which consider that these do not present inefficiency in production[5], so any advance in the total factor productivity is attributed to technical progress. Such an advantage of the Malmquist indices, jointly with the fact that price information is not necessary, becomes specially interesting when the analysis is focused on or includes, as is the case, public organizations or companies (in which the purpose of their activities is not necessarily the maximisation of profits). Moreover, it is worth mentioning that it allows the decomposition of the productivity index into technological advances or changes in the production efficiency, the latter aspect being the core objective of this research. From a different perspective, bearing in mind that it is a non-parametric method, it is neither necessary to specify a functional form nor to make suppositions of distribution for the error term.

All these considerations are supported by the growing use of this kind of indices, as proven by their inclusion in the productivity measurement manual published by the OECD in the year 2001 (OECD, 2001).

The calculation of Malmquist indices can be carried out on the basis of different approaches. The option initially chosen herein is the one based on the original definition by Caves, Christiansen and Diewert (1982), taken up again by Färe, Grosskopf, Norris and Zhang (1994) [6], as established by Coelli, Prasada and Batesse (2000). These authors suggest a method to calculate the indices based on the Data Envelopment Analysis (DEA), which will become the axis of the present research. However, some innovations are introduced: On the one hand, an input-orientation has been chosen, and on the other hand, we will widen this initial approach to introduce a more detailed decomposition of it, considering from a productive perspective the possibility that the efficient companies could not be operating in the optimum production scale[7], and therefore the existence of variable returns to scale is proposed.

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[3] Pastor Monsálvez (1995)

[4] Berg, Førsund and Jansen (1992) allowed for the first time the presence of inefficient units when combining the distance function with the efficiency measures of Farrel, and it is in fact measured as the inverse of it. Within a parametric environment, Nixhimizu, M. and Page, J. (1982) take the credit for considering the presence of inefficiency for the first time.

[5] However, there is a relationship between the Malmquist index and the Törnquvst index: "Caves et al. (1982) prove that under certain general conditions, the geometric mean of two of the Malmquist productivity indices equals the quotient of the Törnquvst output and input indices, whose calculation only requires the input, output and price data observed, with no need of estimates" (Pastor, 1995).

[6] Caves, Christiansen, and Diewert (1982) offer a definition of the Malmquist indices that is subsequently reintroduced by Färe, Grosskopf, Norris and Zhang (1994), as stated by Coelli, Prasada and Batesse (2000); Zofío (2001b) or Grosskopf (2003).

[7] Zofío, J.L. (2001a)

According to Zofío(2001), and Quirós and Picazo (2001), the definition of the Malmquist indices can be made in the following terms: The starting point is a group of production possibilities, S^t:

$$S^t = \left\{ \left(x^t, y^t \right) \middle| \, x^t \text{can introduce } y^t \right\}, \qquad t = 1,...,T$$

where: x^t = I*nputs* vector in t.

y^t = O*utputs* vector in t.

Assuming that such a group complies with the requirements set up by Shephard (1970), we can establish an input distance function, whose inverse represents a measure of technical efficiency.

$$D_i^t\left(x_i^t, y_i^t\right) = \sup_{\theta}\left\{\theta > 0 : \left(x_i^t / \theta, y_i^t\right) \in S^T\right\}$$

This function takes values ranging between zero and one. Thus, when a decision unit is efficient, its distance function will be one, and if it is inefficient, its value will be lower than one and the higher its inefficiency level is, the nearer to zero it will be. In that case, and as a factor-oriented radial indicator, we could conclude that it is possible to reduce the use of inputs in the proportion included between the value of the distance function and one.

The so-defined distance functions constitute the foundations to create the Malmquist productivity indices.

$$M_i^t\left(x_i^t, y_i^t, x_i^{t+1}, y_i^{t+1}\right) = \frac{D_i^t\left(x_i^t, y_i^t\right)}{D_i^t\left(x_i^{t+1}, y_i^{t+1}\right)}$$

where $D_i^t\left(x_i^t, y_i^t\right)$ represents the distance function of the company i during the period t (taking the technology of the period t as a reference), taking values between zero and one. On the other hand, $D_i^t\left(x_i^{t+1}, y_i^{t+1}\right)$ is the distance function establishing a comparison of productivity of the company i during the period t+1, with respect to the technology of the period t, that is to say, the proportional variation that should occur in the input vector in t+1 to be over the frontier in t.

An index higher than 1 indicates that the total factor productivity has grown from period t to period t+1; values lower than 1 imply a decrease with respect to the most efficient units; and, finally, when the index takes value 1, it means a stable situation.

Likewise, this index can be calculated taking technology in t rather than technology in t+1 as a reference. Choosing one basis or the other implies, particularly in the cases where technological change occurs quite fast, important changes in the results. That is the reason why Färe, Grosskopf, Norris and Zhang (1994) suggest the calculation of an index as the

geometric mean of the previous two, therefore correcting the possible biases introduced by the election of a base or reference technology.

This index can also be expressed as follows:

$$M_i^t\left(x_i^t, y_i^t, x_i^{t+1}, y_i^{t+1}\right) = \frac{D_i^t\left(x_i^{t+1}, y_i^{t+1}\right)}{D_i^{t+1}\left(x_i^{t+1}, y_i^{t+1}\right)} \cdot \frac{D_i^{t+1}\left(x_i^{t+1}, y_i^{t+1}\right)}{D_i^t\left(x_i^t, y_i^t\right)} = TC_i^{t,t+1}\left(x_i^{t+1}, y_i^{t+1}\right) \cdot TEC_i^{t,t+1}\left(x_i^t, y_i^t, x_i^{t+1}, y_i^{t+1}\right) =$$

$$= \text{Technological Change} * \text{Productive Efficiency Change.}$$

That is to say, we decompose the Malmquist index, that measures the total factor productivity change, into two elements: The first one ($TC_i^{t,t+1}\left(x_i^{t+1}, y_i^{t+1}\right)$) indicates the change occurred between the periods and t+1 in the "technological level", which would allow "to obtain a higher quantity of products without modifying the quantity of applied factors"[8] (it graphically corresponds to a displacement of the frontier function). Whereas, $TEC_i^{t,t+1}\left(x_i^t, y_i^t, x_i^{t+1}, y_i^{t+1}\right)$ shows the variation undergone by the productive efficiency of the company, that is to say, if this is close to the best possible behaviours within the observed sample, i.e. to the frontier (also known as *catching up process*), as a result of its specific capacity, or on the contrary it moves away from it or keeps the same distance. Like in the general case of the Malmquist index, when these factors take a value that is higher, equal or lower than one, this indicates an increase, a decrease or a stagnation respectively in the specific aspect.

This component includes the evolution of technical or productive efficiency and the technological change with a great precision when there are **constant returns to scale**. However, in the case where the sample presents **variable returns to scale**, these elements will show different meanings: *Productive efficiency* can be decomposed into two elements: *pure technical efficiency* and *scale efficiency*. And what we could call "*technological change when there are constant returns*", which corresponds to the variation in the productivity of those companies being efficient during the two periods under consideration[9]. Thus, as the observation of the sample indicates that decision-making units present variable returns to scale, as is this case, this element should be incorporated into the research.

Nevertheless, the consideration of the existence of variable returns to scale in the Malmquist indices has been subject to an important controversy in the economic literature. In fact, authors such as Coelli, Prasada and Batesse (2000) are uncertain that these are exactly measuring the total factor productivity change when non-constant returns to scale are considered; it would not correspond to a productivity index, because this would not verify, from an axiomatic approach, the property of homogeneity –proportionality. However, the recent advances in this field allow for the development of distance functions that take the existence of such returns into consideration when data indicates so, while the Malmquist index does

[8] Quirós and Picazo (2001).
[9] Given that they are technically efficient, the increase in productivity is only due to the change occurred in the technological level from one period to the other.

not lose representativeness. In fact, Grosskpf (2003) concludes that there is not any problem in considering variable returns to scale, provided that the interpretation of results is in keeping with the criterion used for its calculation. This way, it is necessary to pay special attention to the interpretation of the so-called "scale efficiency change", as well as the concept of technological change, due to the fact that the different alternatives imply different meanings.

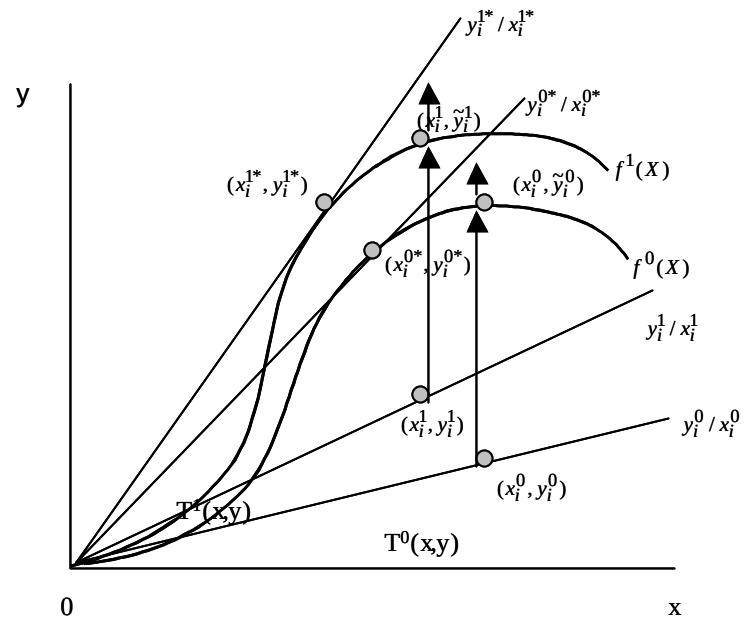
Particularly, as we pointed out previously, the following analysis focuses on the decomposition of the Malmquist index suggested by Färe, Grosskopf, Norris and Zhang -FGNZ- (1994) and subsequently developed by Färe, Grosskopg and Lovell (1994), actually the "most popular decomposition" of the same. Within this framework, the component related to the input from the changes in the operation scale to the variations in productivity, refers to the change experienced by the efficiency of the production scale, this being the result of the comparison of the scale efficiency in the two periods considered. That is to say that it compares the productivity obtained by the assessed company in the efficient frontier, considering its scale of operations, with the one obtained in the most efficient production scale that obtained the maximum productivity observed, therefore determining its change from one period to the following one. From an analytical point of view, this change in the scale efficiency can be calculated as the quotient between the returns to scale and the technical change with respect to the optimum production scale.

What we have called "technical change" corresponds to the technological boost incorporated by the efficient companies in the periods considered or the change in potential productivity, which Grosskopf (2003) defined as "change in the maximum average product between t and t+1". In this case, any change undertaken in the total factor productivity corresponds completely to the technological process, since it is not due to any improvement in productive efficiency (which is equal to 1 in all cases), and this is the aspect included in the expression "technological change" suggested by FGNZ (1994).

In graphical terms, this interpretation is shown in figure 1, where we assume there is only one output (y) and only one input (x). If we try to evaluate the change that has taken place in the total factor productivity from period *0* to period *1*, what we are doing is comparing the situation (x_i^0, y_i^0) with (x_i^1, y_i^1). The change undertaken can be decomposed, as previously seen, into various elements: On the one hand, what we have called "technical change", which corresponds to the displacement occurred in the frontier of the group of production possibilities considering constant scale returns, for the efficient decision-making units. The evolution of technical efficiency refers to the comparison between the distance existing between $\left(x_i^0, y_i^0\right)$ and $\left(x_i^0, \tilde{y}_i^0\right)$ and between $\left(x_i^1, y_i^1\right)$ and $\left(x_i^1, \tilde{y}_i^1\right)$. Whereas the comparison between the distances between $\left(x_i^0, \tilde{y}_i^0\right)$ and y_i^{0*} / x_i^{0*}, and between $\left(x_i^1, \tilde{y}_i^1\right)$ and y_i^{1*} / x_i^{1*} corresponds to the change produced in the scale efficiency.

FIGURE 1

TFP change



Source: Zofío, J.L. (2001)

We cannot ignore the fact that the state of the question does not end with this suggestion by FGNZ. Zofío (2001b) reviewed the related literature in order to make his own suggestion to establish a clear relationship between the decompositions of the Malmquist index suggested so far.

Among the most recent contributions, this author highlights the one made by Färe, Grosskpf, Norris and Zhang, referred to herein, and the one established by Ray and Desli (1997): The main characteristic of this last suggestion is that it is based on variable returns to scale. On the basis of this assumption, the productivity index is divided into the following components: the evolution of the technological change (considering variable returns to scale, unlike the suggestion made by FGNZ, which refers only to the technological change undertaken by the efficient companies), the change in pure technical efficiency and the contribution of the returns to scale to the productivity change (again there is a difference with respect to the previous proposal). Initially, Ray and Desli (1997) call this factor "scale efficiency change". However, this conception was directly subject to review by Färe, Grosskopg and Norris (1997), since it does not constitute a change of it under the same terms as the ones established for the technical change and the pure technical efficiency. This is the reason why the interpretations carried out refer to such a change as the contribution of the returns to scale to the total factor productivity change.

The last contribution of Zofío consist of the development of a relationship between the decompositions carried out by FGNZ (1994) and Ray and Desli (1997), in such a way that as from the suggested decomposition, all the previous components can be derived.

The rejection of the decomposition by Ray and Desli is mainly due to the fact that the essential aims of this subject matter are not related to the technological change, although some remarks have been made in this respect, but to the productive efficiency of companies that, as it has been established, constitutes the only objective of companies that cannot be obviated by public companies, regardless that other purposes of economic politics must be added as well as the decomposition in the pure technical efficiency change and the scale efficiency.

And finally, the most recent proposal surpasses the intentions of the present piece of research, so that considering the complexity of the proposal and the contribution of information that is not so important for the interests of this study, its application to subsequent researches has been postponed.

In this context, the **working hypothesis** to be contrasted is whether **there are differences in the evolution of total or global factor productivity depending on the fact that the company is private or has any share in public capital**. Moreover, in the case that the answer is affirmative, we must determine **the extent to which productive efficiency and its components (pure technical efficiency and scale efficiency) have an influence on this uneven behaviour**.

3. EMPIRICAL ANALYSIS

3.1. Calculation and decomposition of the Malmquist Indices.

The data used to answer these questions corresponds to the following variables: EMPLOYMENT, CAPITAL (CAPITAL GOODS)[10] and PRODUCTION after the deduction of the price effect, for the years 1990 and 1998.

Using the computer program DEAP, we can calculate the Malmquist indices, which show us the evolution of total factor productivity during the nineties in the companies included in the *Encuesta sobre Estrategias Empresariales*, ESEE (Survey on Business Strategies) that have maintained their participation in it during the period[11], taking into consideration the existence of variable returns to scale among them and with an input orientation. According to this approach, the index can be decomposed into three elements:

Change in TFP = "Technological change" * Pure technical efficiency change* Scale efficiency change

Table 1 shows a summary of the results obtained, including the means of each of the categories considered, as well as the statistical significance of

[10] Martín-Marcos and Suárez (1997).
[11] It is worth noticing that the calculation of Malmquist indices requires a complete or balanced data panel.

the difference of means among the categories. Hence, the sample has been structured into two groups: on the one hand, those companies whose capital or a part of whose capital is in public hands (*public companies*) –with a total of 18 companies, 2.33 percent of the sample–, and on the other hand, the *private companies* –representing the remaining 97.67 percent–. In the case of the latter, an interesting subgroup has also been considered, *privatised companies*, whose distinctive feature is that these were public in 1990 whereas by 1998 they had became privately owned –a total of 1.32 percent of the private companies–. Consequently, a residual subgroup was made up of those companies that could be called "traditional" private companies (including those companies that were completely in private hands in 1990 and still were in 1998).

The simple observation of these results[12] leads us to suggest that in a context in which all the groups have increased their productivity level, the evolution of the total factor productivity in public companies has been less favourable (with a growth of 47.7 percent for the period) than in the total of the sample (59.6 percent). In turn, the average Malmquist index for the group is slightly below the private companies, although very close, considering the importance of this kind of entities included in the sample (with a growth of 58.4 percent). And finally, the privatised companies, which have developed the most, have undergone a productivity growth of 175.5 percent. Furthermore, the variability within the group tends to grow, as the improvement of the group is higher.

The analysis carried out by Laurin and Bozec (2001) also considers the change in apparent productivity of the factors between 1981 and 1991 in the Canadian railway sector. They state similarly that such productivity undergoes a higher growth in private companies, and when a public company is privatised, its positive evolution is above the one undergone by its competitor.

[12] Similar treatment to the one carried out by Pedraja, Salinas and Salinas (2002).

TABLE 1

TFP evolution and descomposición. Malmquist Index.

	PTF Change	Technical Change	Productive Efficiency Change	Pure Technical Efficiency Change	Scale Efficiency Change
Public Enterprises	1,447 (0,703)	2,202 (0,311)	0,686 (0,381)	0,667 (0,430)	1,147 (0,379)
Private Enterprises	1,584 (1,102)	1,831 (0,320)	0,880 (0,682)	0,900 (0,439)	1,022 (0,477)
Privatised Enterprises	2,755 (1,421)	2,189 (0,169)	1,275 (0,703)	1,410 (0,650)	0,892 (0,196)
Total	1,596 (1,106)	1,844 (0,325)	0,881 (0,678)	0,901 (0,446)	1,023 (0,473)
ANOVA public-private **F-statistic** **P-value**	0,334 0,564		1,520 0,219	5,114 0,024	1,270 0,260
ANOVA private-privatised **F-statistic** **P-value**	11,050 0,01		3,314 0,069	13,322 0,000	0,734 0,392

Source: Own elaboration.

However, in view of the data, we cannot state that this is a significant difference[13]. In fact, the specification of an analysis of means differentiation, where the change undergone in the total factor productivity is the dependent variable –always bearing in mind the questions set out previously regarding its representativeness– and the ownership (public or private) is the factor, leads us to conclude that such a significance does not exist, so the ownership does not result as a conditioning element of the evolution of this productivity. In contrast, comparing the privatised companies with those that are strictly private, we can see that they have

[13] Against the analysis carried out by Pedraja, Salinas and Salinas (2002), we try to verify here that the differences observed in the average values estimated by categories are significant from the statistical point of view.

developed in a different way as a consequence of their condition (the ANOVA analysis is interesting in this respect).

This more favourable evolution can be the consequence of eliminating the characteristic elements of public companies (diversity of objectives and variation of these over time, "light" budgetary stringencies, concatenated agency relationships, etc.), which makes them concentrate their efforts on improving their productivity and become competitive. At the same time, they correct the differences of levels with respect to private companies, as it has been proven by the non-parametric analysis carried out at an aggregated level, and grouping them as goods of final or intermediate consumption and capital goods, with limited exceptions[14]. These results with an intermediate aggregation level also become corroborated by means of the application of the same information of econometric analyses[15].

In order to determine the extent to which the productive efficiency is responsible for this differential behaviour, we can turn to the decomposition of the Malmquist index (table 1), and to the successive analyses of difference of means carried out for each of the components, taking as a factor the consideration that the company has been privatised during the nineties (1990-1998) or has maintained its private ownership throughout the decade. However, in this context, we must take into consideration that, regarding what we have called "technological change", it has no sense to compare the evolution in the private and in the public context, as it actually refers to the technological boost occurred in the reference efficient companies or leading companies, which can be public or private, regardless of the ownership of the company in question. Nevertheless, if we stop to determine which are the efficient companies and their ownership (obtained in the comparative efficiency analysis in public, private and privatised companies from a static perspective by means of the non-parametric analysis DEA), we can observe that all are private entities. In other words, the guidelines related to technical change are characterised by private companies, which indicate that public companies are clearly a step behind when compared with them. We shall have the opportunity to stress this point later on.

From this perspective, productive efficiency represents as the essential explanatory factor of the differences observed in the uneven evolution of privatised companies and those maintaining their private ownership throughout the decade. More specifically, this is due to pure technical efficiency, where the difference between both categories of companies reaches 0.506. In fact, the evolution of scale efficiency during this wide period has led to an increase in private companies, against a decrease in the case of privatised ones, although it is not significant.

In conclusion, privatised companies present a more favourable evolution in terms of productivity than private companies, which is also statistically important, and occurs despite the fact that they

[14] Conclusions in the analyses by sectors cannot be generalised for certain. However, in most of the cases, when it is observed that public companies have a higher level of productive efficiency than private companies, it usually exists only one company fulfilling this condition, so we could question its representativeness.

[15] Appendix 4 includes the results obtained with the parametric methodology of panel data.

are far from the optimum production scale, thanks to the significant improvement in the allocation of resources, and considering their size.

Although from an aggregated perspective, the ownership (public or private company) does not imply a condition in the evolution of global factor productivity, one of its components, pure technical efficiency, does.

Regarding *pure technical efficiency*, the significant difference of means is shown as favourable to private companies. In other words, public companies have undergone a worse evolution as regards the allocation of resources, due to their size and technological level. The explanatory reasons of this behaviour are related to the characteristics of the public companies, that is to say, the diversity of objectives and the change of these over time, "concatenated" agency relationships, the greater influence exercised by the interest groups, "light" budgetary stringencies, etc.

We can break down there change into two periods: 1990-1994 and 1994-1998. In most cases (table 2) changes are more important in second period.

Private enterprises have the best conduct in the first stage, when Spanish economy is in a crisis period. However, there are the privatised enterprises that behave in the best way between 1994 and 1998 (years of growth). The firms privatised between 1994 and 1998, the 50%, however had a better behaviour before its privatisation (table 3).

TABLE 2
TFP evolution and descomposition in 1990-1994 and 1994-1998. Malmquist Index.

		Public enterprises	Privatised enterprises	Private enterprises
1990-1994	Productive Efficiency Change	0,986	0,680	1,073
	Pure Technical Efficiency Change	1,166	1,062	1,262
	Scale Efficiency Change	0,975	0,752	0,945
	TFP Change	0,980	0,797	1,085
1994-1998	Productive Efficiency Change	1,003	1,225	1,991
	Pure Technical Efficiency Change	0,770	1,660	1,130
	Scale Efficiency Change	1,642	1,184	1,241
	TFP Change	2,139	2,518	2,227

Source: Own elaboration.

TABLE 3

Technical Efficiency Change in Public Enterprises

Enterprise	Technical Efficiency Change	
	1990-1994	1994-1998
34	1,097	2,27
445	1,084	0,597
1156	3,439	0,69
1220	0,746	1,922
1309	2,573	0,805
1703	1,098	1,166
1714	0,483	2,792
1730	1,744	0,46
2053	4,909	0,182
2063	0,335	5,716

Source: Own elaboration.

We have already mentioned that the technological change was not a specific analysis of the present analysis, although the global analysis of the sample has allowed us to anticipate that the companies leading the technical change are private. However, we can take a step forward and, based on the analysis of Malmquist indices as have been herein defined, we can establish whether there is a difference of means among public and private companies.

From a point of view, we can expect private companies to have superiority, if we take into consideration that their only purpose is to maximise profits, and that R&D investment and technological change are some of the elements on which the competitiveness of companies, regions and countries to a large extent is based. Consequently, private companies should be those experiencing a more significant growth at a technological level.

However, there are also arguments leading us to believe that the public sector is the most dynamic sector in this respect. Therefore, regarding the technological change, it is interpreted as the result of R&D investment carried out by the company (on the contrary, the existing diversity of technology becomes apparent as improvements in productive efficiency,

and not as a technical change)[16]. This is worth noticing given that research and development activities can be classified as a *public asset*, to the extent that they fulfil the established requirements: on the one hand, these are joint-offer assets, R&D results can be applied with a minimum cost once it has been materialised and the available offer in the market does not decrease as the number of users consuming the total volume offered increases; and on the other hand, their exclusion due to the price seems to be difficult, unless there is protection by the public sector (for example, via the patent system). This consideration as a public asset would lead us to conclude that the private sector tends to underinvest in such activities. Awareness of this reality by the economic authorities often makes public companies play a facilitating role in this task, reaching the leading position regarding R&D in the business system, and, consequently, the technical change boost within this should be superior to the private sector's (this fact is clear after the observation of data from the ESEE, where expenditure on R&D in relation to the volume of production represents 2.6% in public companies, against 0.69% in private companies).

In order to contrast empirically which of these arguments is in keeping with the behaviour of the companies comprising our sample, we divide it into two groups: public and private companies (differentiating the privatised companies), including in these sub-samples a decision-making unit corresponding to the average company; and then, we calculate independent Malmquist indices for each of them. This is the method we use to obtain the average technical change experienced by the efficient public companies on the one hand, and the technical change experienced by the efficient private companies on the other.

The results gained, shown in table 4, reveal that, on average terms, efficient private companies corresponding to the one representing this category are those with the highest growing rhythm, and particularly the privatised companies within this group. Consequently, the theory that private companies whose main purpose is the maximisation of profits have undergone a higher growth in technology is becoming stronger. More specifically within this group, privatised companies resulted in being the most dynamic ones. However, if we observe the investment effort carried out by ones and the others, we can see that public companies allocate a considerably higher percentage of their turnover to research and development (2.5 percent against 0.69 percent of private companies: table 3).

[16] Maudos, Pastor, Serrano (2000).

TABLE 4.

Technological Change

	Technological change
Public Enterprise	0,939
Private Enterprise	2,003
Privatised Enterprise	3,687

Source: Own elaboration.

In other words, as public companies make a greater effort in R&D, the entities leading the technological change in the Spanish manufacturing industry are those of private ownership, and specially those that previously were of public condition, as stated by Martín and Velázquez (1993), we must bear in mind the differences between research and development, and innovation.

3.2. Second Stage analysis.

On the basis of the conclusions reached so far, we could consider whether the differential behaviour between public and private companies can be related to the uneven business strategy they follow[17]. In this context, mainly according to Melle (1999), we can set out a new hypothesis: **the different evolution of public and private companies is a consequence, at least partially, of the differences existing in aspects like export, level of competitiveness perceived by the companies, R&D investment, to which we referred to previously, human capital, contracting of employees, or the externalisation of services (related to the organising flexibility of the firm), or the productive sector in which the company operates, so that all these variables have a significant influence on the changing level occurred in productivity and its different components**[18].

Table 5 shows, on average for the year 1998, the behaviour of efficient companies, public companies and the group of private companies related to these items, so that we can compare the different behaviours.

[17] This is a similar approach to the one carried out for the case of export and non-export companies in the research developed by De Jorge and Suárez (2004).

[18] Pedraja, Salinas and Salinas (2002) carried out a similar study considering the influence of human capital and public productive capital over the evolution of the productivity of private productive factors.

TABLE 5

Efficient Company Features (1998).

	Empresa eficiente	Empresa pública	Empresa privada
Cuota de mercado	19,11	41	14,15
Competencia	4,6	2,25	3,7
Gastos en I+D	0,53	2,5	0,69
Exportaciones	34,06	42,54	19,86
Personal eventual	2,43	7,11	16,94
Capital humano	20,23	13,81	10,14
Servicios exteriores	10,98	15,77	14,48
Tamaño (total personal)	2401,00	1007,88	205,13

Source: Own elaboration.

In order to contrast this hypothesis, we set out an exercise structured in two stages: Firstly, we try to determine whether there is any difference of means that is statistically significant in the variables of public and private companies. Now, by means of the *tobit* analysis, we will determine if these are determining variables in the evolution of the company's efficiency.

The ANOVA analysis shows that the values of all variables, except for the external services, are different depending on whether the company is public or private. Therefore, it is considered that each of these categories has a different business strategy, defined under these terms, by means of which we try to explain the uneven evolution of its productivity throughout the nineties.

Considering these relationships, we estimate a *tobit* censored regression model. The dependent variable will be productive efficiency, technical efficiency and scale efficiency respectively. Given that this variation is between zero and one in the event that the company is far from the most efficient companies, equals one if its relative situation is maintained, and is higher than one in the case of improvement, we have a variable that always maintains higher-than-zero values.

In this sense, the results of the *tobit* regression (included in table 4) reveal that in the determining of the technical efficiency evolution, only the variables contracting of temporary employees and external services are representative, both showing a negative influence; on the other hand, the variables having a positive influence on the change of scale efficiency are: human capital, export turnover and contracting of temporary employees, with a 95-percent confidence level.

On the contrary, for the most general case of productive efficiency, the afore-mentioned variables are not significant for its evolution in either of the cases. These relationships are kept in the event of not considering the ownership factor[19].

[19] See Appendix 5.

TABLE 6.

Tobit regresión results.

	Malmquist Index	Productive Efficiency Change	Pure Technical Efficiency Change	Scale Efficiency Change
Ownership	-0,427 (0,141)	-0,232 (0,201)	-0,179 (0,125)	-0,042 (0,728)
Market quota	0,003 (0,198)	-0,0004 (0,767)	-0,0007 (0,413)	-0,0002 (0,836)
Competitiveness	-0,004 (0,877)	-0,004 (0,772)	0,006 (0,562)	-0,018 (0,065)
R&D expenses	-0,003 (0,880)	-0,008 (0,581)	0,0001 (0,168)	-0,018 (0,056)
Employees training	0,010 (0,011)	0,004 (0,097)	-0,124 (0,168)	0,004 (0,019)
Exports	0,006 (0,001)	0,008 (0,442)	0,0003 (0,676)	0,001 (0,034)
Temporary contracts	-0,002 (0,431)	-0,0003 (0,838)	-0,0003 (0,000)	0,005 (0,000)
External services	-0,007 (0,215)	-0,005 (0,124)	-0,005 (0,022)	0,0001 (0,975)
Constant	1,499 (0,000)	0,942 (0,000)	1,049 (0,000)	0,919 (0,000)
Pseudo R^2	*0,0116*	*0,0047*	*0,029*	*0,0468*

Source: Owned elaborated.

Likewise, the trends are maintained only if we include in the model dummy variables representing the activity sector in which the decision unit operates (so that they take value 1 when the company belongs to the sector, and value 0 in the opposite case). More precisely, 19 sectorial dummies are considered (20 activity branches in which the manufacturing

industry is structured[20], except for one -Beverages- in order to avoid multicollinearity, thus what we measure in practice with the coefficient of these variables is the influence of the sector with respect to the one omitted. The result reveals a limited influence of the sector in determining efficiency, although the explicative charge of the model is slightly increased, according to the information contributed by the pseudo R2.

Before rejecting the relationship between the changes undertaken in the efficiency levels and the strategy variables already defined, the Spearman Rank Correlation Test allows us to contribute more information to try and establish whether there is a correlation, and in which sense among the different strategy variables and the changes in productivity and efficiency.

In general, if we observe the Spearman correlation tests (table 7) we can conclude that the level of dependence of the changes occurred not only at the levels of scale efficiency, but also of technical and productive efficiency, and at the level of global productivity with respect to the variables included is relatively reduced. However, in many cases, the application of the test leads us to reject the null hypothesis that the indices are independent of the variables evaluated: Therefore, we can state that the *change in technical efficiency* is not independent of:

- R&D expenses, as a negative correlation between both elements exists. This would indicate that the higher the technical efficiency change is, the lower the R&D investment. Considering that the improvement in technical efficiency is interpreted as the catching-up process, i.e. the result of the diffusion process of the existing technology (and not the technological change in a strict sense, which would include the result of the research and development investment), the sign of this correlation seems to be logical. The companies investing lower amounts in R&D are those "copying" to a large extent the available technology and this allows them to improve their technical efficiency. Likewise, this inverse relationship is reflected in the coefficient of the *tobit* regression, although it is not significant in this case.

[20] The ESEE decomposes the manufacturing activity into 20 productive sectors or activity branches: Meat industry; Food and tobacco production; Beverages; Textile and clothes; Leather and shoes; Wood industry; Paper industry; Edition and graphic arts; Chemical products; Rubber and plastic products; Mineral non-metallic products; Ferrous and non-ferrous metals; Metallic products; Farming and industrial machinery; Office machinery; Electrical machinery and material; Motor vehicles; Other transport material; Furniture industry and Other manufacturing industries. On the other hand, these sectors can also be grouped into three categories: final consumer goods, intermediate consumer goods and capital goods.

TABLE 7

Spearman Correlation Test

	Malmquist Index	Productive Efficiency Change	Pure Technical Efficiency Change	Scale Efficiency Change
Market quota	0,1684 (0,0000)	0,0100 (0,7908)	-0,0688 (0,0665)	0,1162 (0,0019)
Competitiveness	-0,0143 (0,6919)	-0,0081 (0,8230)	0,0467 (0,1959)	-0,0833 (0,0207)
R&D expenses	0,1431 (0,0001)	-0,0605 (0,0934)	-0,1756 (0,0000)	0,1957 (0,0000)
Employees training	0,1461 (0,0000)	0,0270 (0,4535)	-0,0469 (0,1927)	0,1283 (0,0004)
Exports	0,2679 (0,0000)	0,0554 (0,1204)	-0,1307 (0,0008)	0,2282 (0,0000)
Temporary contracts	0,0058 (0,8721)	0,0304 (0,2736)	0,1763 (0,0000)	0,1833 (0,0000)
External services	0,3152 (0,0000)	-0,0175 (0,7264)	-0,2488 (0,0000)	0,3520 (0,0000)

Source: Own elaboration.

- The percentage of exports over turnover. In this case, the negative relationship between the level of exports and the change undertaken in technical efficiency, proven not only in the Spearman coefficient, but also in the *tobit* analysis (although it is not significant in the latter), does not seem to be so evident. In fact, efficient companies, on average, sell 34 percent of their products to foreign markets. However, public companies register a higher percentage, which could partly explain their trajectory being worse, always on average terms when a specific limit is surpassed. Nevertheless, private companies (in keeping with the tradition of the Spanish businesspeople) show a much more reduced trend towards export, only near to 20 percent of their turnover.

- The consideration of the influence of human capital in the change of technical efficiency provides controversial results,

given that between both variables there is a negative correlation included in the Spearman test (not significant and questionable from a theoretical perspective), whereas the influence included in the censored regression is positive (although it is neither significant). In both cases, apart from not being significant, the relationship shown is very reduced, in fact the lowest among the variables considered. Therefore, the investment in human capital has an influence on some higher levels of efficiency, but its contribution to the evolution of the same is neither univocal nor definitive.

- The contracting of temporary employees as a percentage of the total (negative relationship established not only by the Spearman rank coefficient, but also by the regression analysis, where it is statistically significant). The higher the percentage corresponding to the temporary contracts over the total of the staff is, the lower the change produced in technical efficiency. That is to say, the argument supporting that the establishment of long-term relationships between the employee and the company increases its level of efficiency becomes more important. This relationship can reflect a higher investment in human capital carried out by the employee him/herself or by the company, before the improvement expectations in his/her position, which would contribute to clarify the allocation of human capital to the evolution of technical efficiency.

- A verification of this event is found in the comparison between the data of efficient and non-efficient companies, either private or public (table 3). Against 2.43 percent represented in the technically efficient companies, public companies reach 7.2 percent, which is even higher in private companies, reaching 16.94 percent. This data is only the reflection of a reality of Spanish economy, which has just perceived a notable increase in the number of labour contracts in recent years, considerably drifting from the parameter of European mean and generating an increasing social concern. In fact, the most recent labour market reforms have tried to tackle this instability.

- And the contracting of external services that, as well as the previous one, is significant in the *tobit* regression (likewise, with a negative correlation). The higher flexibility in the organisation of production reflected in a higher contracting of services outside is negatively related to the change that occurred in the level of technical efficiency. On average, efficient companies present an externalisation (calculated by means of the percentage implied by the contracting of external services over the total turnover) of almost 11 percent, whereas private companies reach 14.5 percent and public companies, partly explaining again their lower technical efficiency, reach 15.75 percent. As is set out in the annual analysis, we must take these results with caution, as they represent a wide range of tertiary activities within the group of externalised services, although the existence of this negative relationship could be justified by means of the vertical integration. The control of several production levels of the decision-making unit allows the

adjustment of decisions regarding the final objectives of the company to a larger extent, which could contribute to a higher increase of its technical efficiency.

On its part, the *scale efficiency change* shows a significant dependence of all estimated variables on the Spearman coefficient, while those variables depending on the *tobit* analysis increase in number.

- A positive correlation with respect to the market quota is observed. Thus, the higher the market quota, the higher the efficiency level. In other words, those companies with a higher market power have been those whose size has approached closest to the optimum production scale. This is possibly the main reason that public companies are those experiencing a higher improvement in their scale efficiency, given that (as shown in table 3) such companies show a higher market quota (41 percent, in fact almost three times the one of private companies), although they are far from the parameter of efficient companies (with an average market quota of 19.11 percent).

- On the other hand, such a quota is positively correlated to the company size, which at the same time is considerably larger for public companies'.

- On the contrary, when companies observe that the number of competitors with a significant market quota is high, the improvement produced in their scale efficiency tends to be worse. A priori, we can register a negative relationship between the variable market quota and the number of competitors: when the number of competitors with a significant market quota increases, their own quota tends to be lower, thus provoking a lower trend towards the improvement in scale efficiency[21]. This influence is also included in the regression analysis, where the coefficient is lower than zero and is very near to statistical significance. We could conclude that the competitiveness perceived by producers does not press towards the improvement in scale efficiency. This is due to the fact that, on average, the size of efficient companies is larger than the mean, and the presence of more competitors in the market and the distribution of the same make this size smaller, which makes the improvement of scale efficiency more difficult. In this sense, public companies, which are larger than private companies and have a lower number of recognised significant competitors, also on average terms, are more biased to improve their scale position.

- R&D expenses show, in turn, a positive relationship with scale efficiency (not only in the regression but also in the Spearman coefficient). In other words, we can observe that, when a

[21] Although this correlation for the sample considered is true, it is not significant.

company invests in research and development, it tends to approach its optimum level of production scale faster.

- The training of employees is also an influential element in the change undertaken in scale efficiency; in fact, it contributes to it approaching the optimum size of production.

- And finally, a higher flexibility of the company, expressed in terms of percentage representing temporary contracts of the staff, as well as the contracting of external services, represents a positive influence on the improvement of the scale level, as it is also reflected by the estimated equation (with statistical significance). We can conclude that, the more flexible the company is, the more easily it will be able to adapt itself to the economic events and consequently, to adapt its size to the optimum. In this sense, sales in external markets allow a more flexible adaptation, influencing on it positively.

Concerning what occurs regarding the *evolution of productive efficiency* (considering constant returns to scale), where we cannot reject that it is independent of all the variables considered, the *total factor productivity change* (with the clarifications established regarding its representativeness due to the consideration of technical change representing the one occurred in the event of existence of constant returns to scale) presents a significant correlation with respect to virtually all variables (with the only exceptions of competence -probably due to the definition of this variable, as relevant competence level recognised by the companies- and the temporary employees).

4. CONCLUSIONS

Private companies present a more favourable evolution than public companies (or, more specifically, a smaller step backwards) in their technical efficiency, which is statistically significant. This uneven behaviour can be due, among other factors, to elements related to their business strategy. The positive effects generated by the lower R&D expenses constitute proof of this, bearing in mind that, as a counterpart, we understand that private companies are applying technologies that are already available in the market, the lower volume of exports, and the contracting of external services, though the higher number of temporary contracts exerts an opposite effect.

It is worth noticing that differential increase of total factor productivity, despite of this not being statistically significant, is favourable for private companies, unlike what occurs in the improvement in terms of scale efficiency, which favours public companies as a consequence of the positive effects generated by a higher market quota, the lower level of competence recognised by the companies, the higher volume of R&D expenses, the percentage superiority of exports, as well as the higher level of external services contracted.

Privatised companies present a more favourable evolution in terms of productivity than private companies, which is also statistically important, and occurs despite the fact that they are far from the optimum production scale, thanks to the significant improvement in the allocation of resources, and considering their size.

5. REFERENCES

ÁLVAREZ PINILLA, A. (coord.) (2001): La medición de la eficiencia y la productividad. Ediciones Pirámide. Madrid.

CAVES, D.W. , CHRISTIANSEN, L.R. Y DIEWERT, W.E. (1982): "The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity", *Econometrica*, 50, pp. 1393-1414.

COELLI, T.; PRASADA RAO, D.S. Y BATTESE, G.E. (2000): *An Introduction to Efficiency and Productivity Analysis*. Kluwer Academic Publishers. London.

CUADRAS-MORATÓ, X., FERNÁNDEZ CASTRO, A.S. Y ROSÉS, J.R. (2002): "Productividad, competencia e innovación en la banca privada española (1900-1914)", *Revista de Historia Económica*, Año XX, Otoño-Invierno 2002, nº3, pp. 543-575.

FÄRE, R., GROSSKOPF, S., NORRIS, M. Y ZHANG, Z. (1994): "Productivity Growth, Technical Progress, and Efficiency Changes in Industrialised Countries", *American Economic Review*, 84, pp. 66-83.

FÄRE, R.S., GROSSKOPF, B. Y LOVELL, C.A.K. (1994): *Production Frontiers*. Londres. Cambridge University Press.

GROSSKOPF, S. (2003): "Some remarks on productivity and its decompositions", *Journal of Productivity Analysis*, 20, pp. 459-474.

LAURIN, C. Y BOZEC, Y. (2001): "Privatization y Productivity Improvement: The Case of Canadian National", *Transportation Research, Part E: Logistic and Transportation Review*, 37, 5, pp. 355-3745.

MARTÍN-MARCOS, A. y SUÁREZ, C. (1997): "El stock de capital para las empresas de la Encuesta Sobre Estrategias Empresariales", *Documento interno*. Programa de Investigaciones Económicas. Fundación Empresa Pública.

MAUDOS, J., PASTOR, J.M. y SERRANO, L. (1998): "Convergencia en las regiones españolas: cambio técnico, eficiencia y productividad", *Revista Española de Economía*, vol. 15, nº 2, pp. 235-264.

MELLE HERNÁNDEZ, M (1999): "Algunos resultados efectivos de las privatizaciones en España: Una primera aproximación", *Economía Industria*, n.330, pp.141-158.

NIXHIMIZU, M. Y PAGE, J. (1982): "Total Factor Productivity Growth, Technological Progress and Technical Efficiency Change: Dimensions of Productivity Change in Yugoslavia", *Economic Journal*, n.92, pp. 920-936

OECD (2001): "Recent privatisation trends", *Financial Market Trends*, 79, pp.43-65.

PASTOR MONSÁLVEZ, J.M. (1995): "Eficiencia, cambio productivo y cambio técnico en los bancos y cajas de ahorro españolas: un análisis de la frontera no paramétrico", *Revista Española de Economía*, Vol. 12, nº 1, pp. 35-73.

PEDRAJA, F., SALINAS, M.M. Y SALINAS, J. (2002): "Efectos del capital público y del capital humano sobre la productividad de las regiones españolas*", Papeles de Economía Española*, nº 93, pp. 135-147.

QUIRÓS, C. Y PICAZO, A.J. (2001): "Liberalización, eficiencia y cambio técnico en las telecomunicaciones", *Revista de Economía Aplicada*, n. 25 (vol.IX), pp. 77-113.

RAY, S. Y DESLI, E. (1997): "Productivity Growth, Technical Progress and Efficiency Change in Indusrialized Countries. Comment", American Economic Review, 87 (5), pp. 1033-1039.

SHEPHARD, L.M. (1970): *Theory of Cost and Production Functions*. Princeton University Press. Priceton. New Jersey.

ZOFÍO, J.L. (2001): "Malmquist Productivity Index Decompositions: A Unifying Framework", Departamento de Análisis Económico. Universidad Autónoma de Madrid. Mimeo.