Productivity and efficiency change and shareholder value: evidence from the Spanish banking sector

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PRODUCTIVITY AND EFFICIENCY CHANGE
AND SHAREHOLDER VALUE:
EVIDENCE FROM THE SPANISH BANKING SECTOR

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ABSTRACT:

Productivity change and shareholder value have been analysed in the banking sector in the last few years, although it should be noted that these two important aspects have been studied separately. In this regard, the main contribution of our study is to link these two lines of research by verifying whether those banks characterised by higher levels of efficiency and productivity change have a higher shareholder value. To measure changes in efficiency and productivity we use the Malmquist non-parametric technique, which is calculated from Data Envelopment Analysis (DEA) linear programming approach. The Malmquist total factor productivity index enables separation of the 'catching up' effect, i.e, changes over time in technical efficiency, from 'technological change', i.e., the shift of best practice frontier over time due to technological progress. Our results for a sample of listed Spanish banks in the period 2000-2004 confirm that those banks with higher efficiency and productivity changes have a higher shareholder value, even after controlling for the impact of traditional measures of performance, such as return on assets.

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PRODUCTIVITY AND EFFICIENCY CHANGE AND SHAREHOLDER VALUE: EVIDENCE FROM THE SPANISH BANKING SECTOR

I. INTRODUCTION

Given the importance of the banking sector for the whole economy in general, and for the financial system in particular, a number of studies have analysed the efficiency of this sector since the early 1990s in order to assess the impact of the structural changes to which it has been subjected such as deregulation, liberalisation, introduction of new technologies and adaptation to the European Community's directives. The main literature has focused on analysing cost efficiency, using both parametric and non-parametric methodologies (see Berger and Humphrey, 1997 and Goddard *et al*., 2001, for extensive surveys). However, a criticism of these efficiency studies relates to the fact that the empirical results may not account for both technological and efficiency change through time, that is, the analyst may end up without learning whether efficiency improves or deteriorates over time if efficiency is only measured with respect to a year-specific period (Hunter and Timme, 1991). To overcome this problem, a number of recent studies have focused on investigating productivity change, mainly by employing non-parametric methodologies such as the Malmquist Total Factor Productivity Index approach (e.g., Alam, 2001; Chaffai *et al*., 2001), which is calculated from efficiency scores based on Data Envelopment Analysis (DEA) linear programming approach. This Malmquist index technique enables separation of the 'catching up' or 'efficiency change' effect, i.e, changes over time in the technical efficiency of each decision making unit with respect to best practice frontier, from 'technological change', i.e., the shift of best practice frontier over time due to technological progress.

On the other hand, given the current importance of shareholder value maximisation as a key objective for financial institutions, another strand of recent research (e.g., Fiordelisi and Molyneux, 2006) has analysed shareholder value in European banking and its relationship with several performance indicators (such as return on assets, economic value added, etc.).

However, to the best of our knowledge, so far there is no study that links the aforementioned two lines of research focused on productivity and efficiency change and shareholder value. In this regard, the main contribution of our study is to verify whether those banks characterised by higher efficiency and productivity changes have a higher shareholder value, proxied by total shareholder return (Rappaport, 1986). This measure captures the two sources of value creation for a typical shareholder, i.e., the increase in share price during the year and the dividends received in that year.

We focus our analysis on the Spanish banking industry which, according to the Spanish Banking Association (2002), plays a prominent role in European banking based on the value of the most relevant performance ratios. Over the last two decades, the Spanish banking industry, likewise many other Western European banking systems, has experienced fascinating changes, such as deregulation, liberalisation, and technological advances, which have significantly reshaped the industry. The period under study is 2000-2004, which follows the wave of mergers and acquisitions that took place in Spain in the 1990s.

The rest of the paper is structured as follows. Section 2 describes the methodology used for measuring productivity -the Malmquist Total Factor Productivity (TFP) Index approach-. Section 3 presents the research design including the model for measuring the performance of the banks, the selection of outputs and inputs, and the data used for the empirical application. Section 4 comprises the results of the empirical study. Finally, section 5 concludes the paper.

II. MALMQUIST TOTAL FACTOR PRODUCTIVITY INDEX

Total factor productivity (TFP) measures changes in total output relative to inputs and the concept derives from the ideas of Malmquist (1953). The non-parametric Malmquist total factor productivity index, developed from Caves *et al.* (1982), has been the most commonly used measure of productivity change (see Färe *et al.*, 1997 for a survey)[1]. The Malmquist index is based on the output distance function which, following Shepard (1970) and Färe *et al.* (1994), is defined as:

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[1] Other studies measure productivity change using a parametric approach (Berger and Mester, 1999, 2001). However, Casu *et al.* (2004), in their analysis of productivity change in European banking

$$D_0^t(\,x_t\,,y_t\,) = inf\{\,\theta : (\,x_t\,,y_t\,/\,\theta\,) \in S^t\,\} \tag{1}$$

where x_t and y_t denote a vector of inputs and outputs respectively, and S^t represents the production technology for each reference period. The distance function is the reciprocal of Farrell's (1957) measure of output technical efficiency, which calculates how far an observation is from the frontier of technology.

To define the Malmquist productivity index, it is necessary to define the above distance function with respect to two different time periods. Following Färe *et al.* (1994), assuming constant returns to scale (CRS) and an output orientation, the Malmquist TFP index between period s (the base period) and period t is given by:

$$M_0(\,y_s,x_s,y_t,x_t\,) = \left[\frac{D_0^s(\,x_t,y_t\,)}{D_0^s(\,x_s,y_s\,)} \times \frac{D_0^t(\,x_t,y_t\,)}{D_0^t(\,x_s,y_s\,)}\right]^{1/2} \tag{2}$$

where the notation $[\,D_0^s(x_t,y_t)\,]$ represents the distance from the period t observation to the period s technology or efficiency frontier. The previous formulation in (2) is, in fact, a geometric mean of two TFP indices, the first evaluated with respect to period s technology and the second with respect to period t technology. A value of of M_0 greater than one will indicate a growth in productivity from period s to period t, while a value less than one will indicate a decline in productivity.

The Malmquist index formulation of productivity growth can be further broken down into the following two components:

$$M_0(\,y_s,x_s,y_t,x_t\,) = \left[\frac{D_0^t(\,x_t,y_t\,)}{D_0^s(\,x_s,y_s\,)}\right] \times \left[\frac{D_0^s(\,x_t,y_t\,)}{D_0^t(\,x_t,y_t\,)} \times \frac{D_0^s(\,x_s,y_s\,)}{D_0^t(\,x_s,y_s\,)}\right]^{1/2} \tag{3}$$

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during the period 1994-2000, conclude that both parametric and non-parametric methodologies do not yield markedly different results in terms of identifying the main components of productivity change.

The first component of productivity change is referred to as *technical efficiency change*[2], and measures the change in the efficiency of a decision making unit (DMU) relative to the best practice frontier, that is, the change in the DMU's distance to the production frontier. Thus, a value greater than 1 indicates an increase in the efficiency relative to the frontier while a value less than 1 indicates a decline in efficiency with respect to the frontier. The second component, referred to as *technological change*, is due to the variation of the production frontier between two periods, and thus reflects the improvement or deterioration of best practice DMUs. A value greater than 1 indicates technological progress while a value less than 1 means technological deterioration. The usefulness of this decomposition is that it provides information on the sources of the overall productivity change.

Following Färe *et al.* (1994), we can calculate the required distance measures involved in equation (3) for the Malmquist TFP index by using Data Envelopment Analysis (DEA)-like linear programming techniques[3], which is the method that will be followed in our empirical analysis. Under the assumption of CRS[4], the DEA model can be expressed mathematically as follows:

$$D_0^t(x_t, y_t)^{-1} = \max_{\phi, \lambda} \phi$$

s.t.

$$-\phi\, y_{it} + Y_t \lambda \geq 0$$
$$x_{it} - X_t \lambda \geq 0 \qquad\qquad (4)$$
$$\lambda \geq 0$$

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[2] A further decomposition of the 'technical efficiency change' component to take into account variable returns to scale (VRS) technology has been proposed, which distinguishes between 'scale efficiency' and 'pure technical efficiency change' (Färe *et al.*, 1994). However, this further decomposition has been subjected to a number of criticisms (see, e.g., Ray and Desli, 1997). In this regard, there seems to be consensus that the Malmquist index is correctly measured by the ratio of the CRS distance function even when the technology exhibits VRS (Casu *et al.*, 2004).

[3] DEA is a technique originally introduced by Charnes *et al.* (1978) as a reformulation of Farrell's (1957) efficiency measure to the multiple-output, multiple-input case. This technique has been usually applied to evaluate efficiency in different economic sectors, specially for financial institutions (see Berger and Humprey, 1997 for a survey).

[4] The hypothesis of constant returns to scale was subsequently modified to allow for variable returns to scale (VRS) (Banker *et al.*, 1984), which is the most commonly used specification in the 1990s, because the CRS assumption is only appropiate when all DMUs are operating at an optimal scale. The VRS approach provides technical efficiency scores that are greater than or equal to those obtained using the CRS model.

where Y_t and X_t represent the vector of outputs and inputs, respectively and λ defines the weight of each unit within the reference or 'peer' group to which is compared any particular observation in order to determine the distance to the efficient frontier[5].

III. DATA AND VARIABLES

Sample and data sources

As our dependent variable –total shareholder return- is computed from market share prices, we consider Spanish banks listed in the Madrid Stock Exchange on the five-year period 2000-2004, which follows the wave of mergers and acquisitions that took place in Spain in the 1990s. The list of the 14 quoted banks is reported in Table 1. Inputs and outputs necessary to compute efficiency and productivity measures are based on data from balance sheets and income statements collected from the website of the Spanish Securities Commission (www.cnmv.es). Regarding information on share prices and dividends, data come from Global Vantage Compustat.

Table 1. Sample Banks	
Banco Bilbao Vizcaya Argentaria, SA	Banco de Vasconia, SA
Banco de Andalucía, SA	Banco Español de Crédito, SA
Banco de Castilla, SA	Banco Guipuzcoano, SA
Banco de Crédito Balear, SA	Banco Pastor, SA
Banco de Galicia, SA	Banco Popular Español, SA
Banco de Sabadell, SA	Banco Santander Central Hispano, SA
Banco de Valencia, SA	Bankinter, SA

Input and output definition

The output and input selection becomes a crucial issue for research into cost efficiency. This is particularly true for banks as there is no agreement on appropiate inputs and outputs in this industry[6]. As Berger and Humphrey (1997) point out, although there is no perfect approach, the intermediation approach may be more appropiate for evaluating entire financial institutions because this approach is

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[5] The DEA models can take two different orientations. The first one, called *input orientation*, seeks to identify technical inefficiency as a proportional reduction in inputs usage. The second one, referred to as *output orientation*, seeks to identify technical inefficiency as a proportional increase in output production. To date, the theoretical literature is inconclusive as to the best choice among these two alternatives. These two orientations yield equal values under CRS, but not when VRS is assumed (Thanassoulis, 2001).

[6] The most debated issue regards the role of deposits. Under the production model, which views banks as service-producing organisations, deposits are considered as an output. Under the intermediation approach, banks are viewed as financial intermediaries whose primary business is to borrow funds from savers and lend those funds to customers to obtain profits. Hence, in this case deposits are regarded as inputs.

inclusive of interest expenses, which often account for one-half to two-thirds of total costs. Thus, following the empirical literature (Molyneux *et al*., 1996; Mester, 1996, Yeh, 1996), the intermediation approach is used, which views banks as mediators between the demand and supply of funds. Therefore, two banks' outputs are used in the current study: total loans (k_1) and interest income and commissions received (k_2). In the input side, three variables are selected: total deposits (k_3), interests expenses and commissions paid (k_4) and personnel and administration expenses (k_5)[7]. Table 2 shows the descriptive statistics of the outputs and inputs considered in the design of performance models.

Table 2. Summary Descriptive Statistics for outputs and inputs

		K_1	K_2	K_3	K_4	K_5
2000	Mean	28348	4752	29260	2811	1138
	Median	4805	412	4493	196	143
	St.dev.	53862	10363	56719	6547	2348
2001	Mean	30825	5076	31810	2728	1293
	Median	5547	498	4840	243	152
	St. dev.	56461	10716	60854	6022	2689
2002	Mean	30513	4277	29638	2078	1158
	Median	6340	473	5223	172	159
	St. dev.	52712	8792	54833	4533	2319
2003	Mean	33452	3527	29411	1509	1044
	Median	7754	480	5886	142	162
	St. dev.	55554	6875	52174	3171	2033
2004	Mean	49141	3730	40808	1581	1083
	Median	9866	550	6958	163	171
	St. dev.	93430	7222	82097	3312	2072

Notes: K_1 = total loans; K_2 = interests income and commissions received; K_3 = total deposits; K_4 = interests expenses and commissions paid; K_5 = personnel and administration expenses (variables are expressed in million).

IV. EMPIRICAL RESULTS

DEA efficiency scores

To get an overview of the efficiency annual measures, Table 3 summarises the results for three different models. The first one is based on the hypothesis of constant returns to scale (CRS), while the two remaining models assume the hypothesis of

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[7] To run the DEA model, personnel expenses and administration expenses have been summarised into a single variable in order to avoid an excessive number of inputs so that the proposed model can be accepted regarding the total number of variables (El-Mahgary and Ladhelma, 1995).

variable returns to scale (VRS) under a double specification (input/output orientation). A value of the DEA score equal to one means efficiency while a value less than one means inefficiency.

Table 3. DEA efficiency scores

| | Constant returns to scale | | Variable returns to scale | | | |
| | | | Output-based | | Input-based | |
Period	Mean	St. Dev.	Mean	St. Dev.	Mean	St.Dev.
2000	0.907	0.112	0.952	0.090	0.948	0.100
2001	0.934	0.083	0.973	0.045	0.972	0.047
2002	0.915	0.110	0.947	0.084	0.944	0.088
2003	0.906	0.107	0.959	0.093	0.960	0.090
2004	0.912	0.107	0.960	0.085	0.959	0.087

All models show high efficiency scores for all years, which implies that the process of mergers and acquisitions occurred in Spain during the 1990s have resulted in an improvement of the efficiency of the resulting banks. For the CRS model, the average efficiency score shows a slight improvement in the efficiency level over time (+0.5%). Regarding the VRS model, the improvement in the efficiency level over time is very similar (+ 0.8% for the output-based model and +1.1% for the input-based model). Figure 1 depicts the evolution of DEA efficiency scores over the sample period.


Figure 1. DEA efficiency Scores (2000-2004)
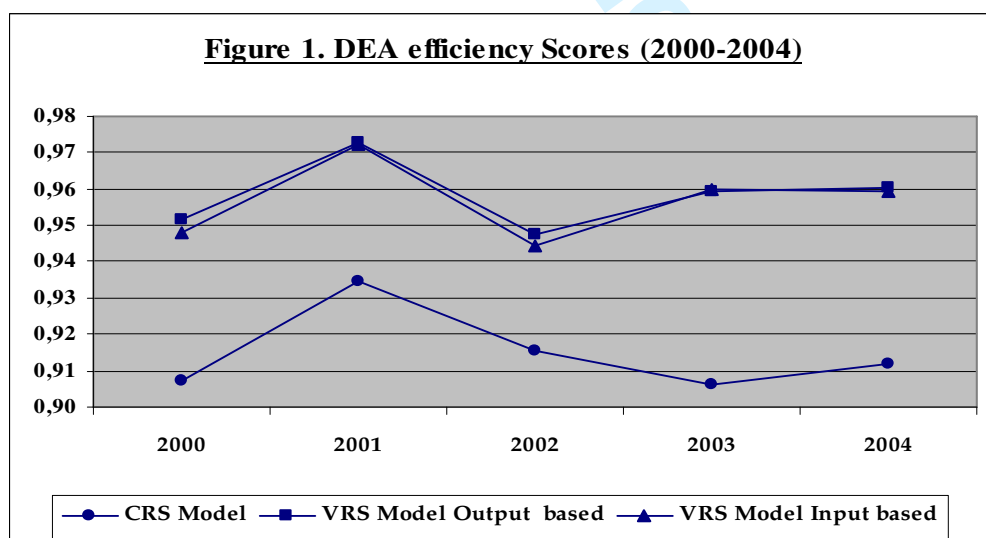
Malmquist Index estimates

The results from the efficiency measures analysis support that efficiency scores have increased slightly over our sample period. However, this trend in mean efficiency values cannot be used to infer productivity growth because they do not take into account shifts in the efficiency frontier, that is, shifts in best practice firms. Considering this issue, Malmquist total factor productivity change (TFP) is computed to evaluate productivity growth. We further decompose TFP into its two components: a) technological change (TC), or change in best practice, and b) 'catching-up' or technical efficiency change (TEC), where TFP= TC x TEC. Table 4 summarises geometric means of results for individual banks for each two-year period –also depicted in Figure 2- and the last row shows the geometric mean of the annual means for the entire period (2000-2004).

	Technical Efficiency Change	Technological Change	Total Factor Productivity Change
Table 4. Malmquist Index decomposition (summary of annual geometric means)			
Years	**(TEC)**	**(TC)**	**(TFP)**
2000/2001	1.034	0.989	1.022
2001/2002	0.976	1.049	1.024
2002/2003	0.990	1.068	1.058
2003/2004	1.006	0.981	0.987
2000/2004	**1.001**	**1.021**	**1.022**

Our results reveal a productivity growth in the sample period (+2.2%), which is almost entirely attributable to technological change (+2.1%). This finding is consistent with the results obtained by Mukherjee *et al*. (2001) for the US case and Asmild *et al*. (2004) for the Canadian case. Technical efficiency change shows almost no growth (+ 0.1%), which implies that, despite the gains achieved by best practice banks, there has been little catching-up effect on the part of the remaining banks.

Figure 2. Malmquist Index descomposition in Spanish Banks (2000-2004)
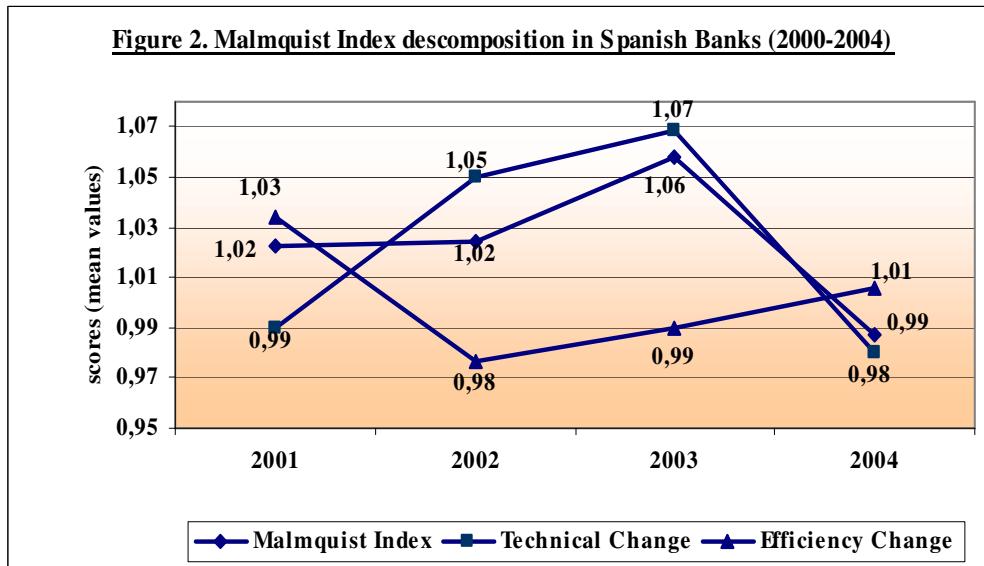
Relationship between shareholder value and change in efficiency and productivity

Our main hypothesis is that those banks characterised by a higher efficiency change and a higher total productivity change should have a higher shareholder value, proxied by total shareholder return (Rappaport, 1986). Total shareholder return (TSR) is computed for each bank as follows:

$$TSR_{it} = \frac{P_{it} - P_{it-1} + d_{it}}{P_{it-1}} \tag{5}$$

where P_{it} is price of bank i's shares at the end of year t, P_{it-1} is price of bank i's shares at the beginning of year t and d_{it} are dividends paid by bank i in year t. Therefore, TSR captures the two sources of value creation for a shareholder, i.e., the increase in share price during the year and the dividends received in that year.

To test our hypothesis, we first perform a cluster analysis in order to form two groups of banks according to their values of the technical efficiency change variable (TEC) and the total productivity change variable (TFP). Then we compute TSR for each group of banks and test whether the difference in TSR between the two groups is statistically significant.

Table 5 reports the results for the *k*-means cluster analysis, which clearly differentiates two groups of banks. The first cluster includes those banks with growth in total productivity (mean TFP= 1.077) and with an increase in efficiency with respect to best practice frontier (mean TEC= 1.028), while the second cluster groups those banks with a decline in total productivity (mean TFP= 0.906) and with a decrease in efficiency with respect to best practice frontier (mean TEC= 0.945).

As hypothesised, it can be observed in Table 5 that the TSR is higher for those banks pertaining to cluster 1 (15.56%) as compared to those pertaining to cluster 2 (4.03%), this difference been statistically significant at a 5% level (*p*-value = 0.0223). Therefore, it seems that the shareholder value creation is higher in those banks characterised by higher efficiency and productivity changes from one period to another.

Table 5. Total shareholder return differences between banks grouped according to technical efficiency change (TEC) and total productivity change (TFP) by means of a cluster analysis

Cluster 1:
Efficiency change (TEC): 1.028
Productivity change (TFP): 1.077
Cluster 2:
Efficiency change (TEC): 0.945
Productivity change (TFP): 0.906
Mean total shareholder return (TSR) for both clusters
Cluster 1: **0.1556**
Cluster 2: **0.0403**
p-value of means differences in TSR across the two clusters= **0.0223**

However, it could be the case that those banks with higher efficiency and productivity changes have higher shareholder returns just because they have higher return on assets (ROA) –which is a common accounting-based measure of banks' performance-. In order to verify whether our measures of efficiency and productivity change are significantly related to TSR after controlling for the effect of ROA we estimate for our panel data set the following three models:

$$TSR_{it} = \alpha_0 + \alpha_1 ROA_{it} + u_{it} \tag{6}$$

$$TSR_{it} = \beta_0 + \beta_1 ROA_{it} + \beta_2 TEC_{it} + u_{it} \tag{7}$$

$$TSR_{it} = \gamma_0 + \gamma_1 ROA_{it} + \gamma_2 TFP_{it} + u_{it} \tag{8}$$

where:

TSR_{it}: Total shareholder return of bank i for period t.

ROA_{it}: Return on assets of bank i for period t.

TEC: Technical efficiency change of bank i for period t.

TFP: Malmquist's total productivity change of bank i for period t.

We hypothesise that ROA, TEC and TFP should be positively and significantly associated with TSR. Table 6 shows the results from the estimation of models (6), (7) and (8). As we work with panel data, we can have two alternative specifications, i.e., the fixed effects model and the random effects model. The former assumes differences in intercepts across firms, whereas the latter assumes differences in the error term. The Hausman (1978) specification test compares the fixed versus random effects under the null hypothesis that the individual effects are uncorrelated with the other regressors in the model. If the null is rejected (i.e., there is correlation among individual effects and regressors), the random effect model produces biased estimators, so a fixed effect model is preferred. In our case, the Hausman test (1978) reveals that the random effects specification (which is estimated using Generalized Least Squares) is better than the fixed effects specification for the three models.

Table 6. Panel data estimation of models (6), (7) and (8).

Dependent variable: TSR

Model	Intercept	ROA	TEC	TFP	R^2
Model (6)	-0.006 (0.995)	11.467[**] (0.013)			0.0907
Model (7)	-0.443 (0.153)	11.389[**] (0.012)	0.435[*] (0.075)		0.1265
Model (8)	-0.554[**] (0.023)	10.745[**] (0.014)		0.541[***] (0.010)	0.1807

Notes: Figures in parentheses represent the *p*-values. TSR_{it}: Total shareholder return of bank i for period t; ROA_{it}: Return on assets of bank i for period t; TEC: Technical efficiency change of bank i for period t; TFP: Total productivity change of bank i for period t.
The results correspond to the random effects specification since the Hausman (1978) test indicates that this specification is better than the fixed effects model for the three models.
(*)Significant at the 10% level; (**)Significant at the 5% level;(***)Significant at the 1% level.

As hypothesised, ROA, technical efficiency change (TEC) and productivity change (TFP) are positively and significantly related to TSR, being the latter (TFP) the most significant variable (*p*-value = 0.010). Moreover, the two variables analysed in our study (TEC and TFP) are significantly associated with TSR, even after controlling for the effect of ROA, leading to an increase in R^2 of 3.58% and 9%, respectively with respect to model (6). Therefore, we can assert that the impact of both efficiency and productivity change on shareholder value does not stem from the fact that they are subsumed in the ROA standard measure of banks' performance. Moreover, as expected, the total productivity change variable (TFP) has a greater impact on TSR with respect to the efficiency change variable (TEC) (0.54 vs 0.43), since the former also takes into account technological change over time.

V. CONCLUSIONS

Productivity change and shareholder value have been analysed in the banking sector in the last few years. However, these two important aspects have been studied separately. In this regard, the main contribution of our study is to link these two lines of research by verifying whether those banks characterised by higher levels of

efficiency and productivity change have a higher shareholder value, proxied by total shareholder return (Rappaport, 1986). To measure changes in efficiency and productivity we use the Malmquist non-parametric technique, which is calculated from efficiency scores based on Data Envelopment Analysis (DEA) linear programming approach. This Malmquist index technique enables separation of the 'catching up' or 'efficiency change' effect, i.e, changes over time in the technical efficiency of each decision making unit with respect to best practice frontier, from 'technological change', i.e., the shift of best practice frontier over time due to technological progress.

Our results for a sample of listed Spanish banks in the period 2000-2004 confirm that those banks with higher efficiency and productivity changes have a higher shareholder value, even after controlling for the impact of traditional measures of performance, such as return on assets.

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