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Assessing the Impact of Fair-Value Accounting on Financial Statement Analysis: A Data Envelopment Analysis Approach

The historical-cost and prudence principles have guided accounting for financial investments and tangible fixed assets in many jurisdictions around the globe. This situation might change as a consequence of the increasing number of countries adopting International Financial Reporting Standards (IFRS), which, to some extent, permit accounting on a fair-value basis. It is unclear how such a change would affect the analysis of financial statements and to what extent it could modify analysts' perceptions of companies' condition and performance. This paper attempts to shed some light on this issue by restating the financial investments and tangible fixed assets of a sample of 85 Spanish insurance companies, applying fair value instead of historical-cost-based valuations and by simulating analyst perception of these companies' efficiency and profitability for both sets of data using data envelopment analysis (DEA). We find that the numbers on the face of the financial statements change considerably and observe that the magnitude of these changes varies between companies and classes of assets. However, only in a few cases does a change in the valuation basis lead to a relevant change in DEA scores; within our sample, the overall assessment of companies with regard to efficiency and profitability remains largely the same under both valuation bases. These findings seem to indicate that a change from historical-cost to fair-value accounting could alter analyst perceptions of a limited number of companies but likely will not have a major impact on the appraisal of the majority of them.

Key words: DEA; Fair value; Financial statement analysis; Historical cost; IFRS; Insurance companies.

While historical costs are typically perceived as being more objective and reliable than fair value, the literature on fair value indicates that it might provide more

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relevant information to investors and creditors (e.g., Magnolio, 1986; Harris and Ohlson, 1987; Barth, 1994; Barth *et al*., 1996; Barth and Clinch, 1998; Dietrich *et al*., 2001; Carroll *et al*., 2003; Kanagaretnam *et al*., 2009; Wier 2009). Although the conclusions of this line of research are not definitive at this point, we believe that there is more evidence in support of the hypothesis that fair values are more value-relevant than historical costs, in the sense of indicating a stronger association with stock market indicators. An important limitation of the research design of these studies, however, is that they can only be applied to quoted firms on the stock market, leaving one to wonder whether the results can be generalized to smaller, closely held enterprises. Another unanswered question is whether the alleged informational benefits of fair-value accounting can actually be perceived by the users of financial statements, who typically extract quantitative information from the financial statements through some form of ratio analysis.

In an effort to contribute to the filling of this gap, this paper addresses the question of whether a change from historical cost to fair value affects the analysis of financial statements and, particularly, to which extent it modifies users' (or analysts') perceptions of a firm's efficiency and profitability, without using stock market data. If it is true that the two valuation methods convey different information, one might expect that analyst perceptions about a company will be different depending on whether the company uses one method or the other. However, financial statements are normally not analysed in isolation but rather in relation to some kind of reference point, frequently the financial statements of other companies. From this perspective, analysing *different information* might not necessarily imply arriving at *different conclusions*, if the information *has changed for all companies* that are being analysed. What seems to matter is whether something is being revealed by the use of fair value instead of historical costs, which leads users to position a company differently *relative to its peers*.

In order to shed some light on the issue, we consider that the reasoning of financial statement analysts, however complex it may be in practice, in the end boils down to ordering companies from 'best' to 'worst', with respect to an overall criterion. This overall criterion can be understood as the summary or simultaneous assessment of a series of ratios that link different financial statement items. Ratio analysis has several well-known problems (McLeay and Trigueiros, 2002), such as the determination of optimal or threshold values, the subjectivity inherent in the selection of specific ratios in the analysis, or the difficulty of interpreting contradictory ratios. However, the value of fundamental analysis is not only supported by its extensive use in practice but also by empirical research, such as by Ou and Penman (1989), Abarbanell and Bushee (1998) or Soliman (2008), who present evidence that accounting-based signals can be used to predict abnormal returns. Soliman, in particular, found associations between the ratios used in a DuPont analysis and stock returns as well as analyst forecast revisions.

For the purpose of this paper, we think of financial statement analysis as the mapping of multiple financial-statement items into a one-dimensional rank order. We simulate this mapping process with data envelopment analysis (DEA), a non-parametric, linear-programming-based technique that turns any number of variables

into one overall score, relative to best-in-class observations. Specifically, we perform DEA analysis on financial statement items commonly used in a DuPont analysis (profitability, asset-turnover and profit-margin ratios), and contrast the scores obtained using historical costs with those using fair values for the same sample of firms.

Our empirical sample consists of 85 insurance companies, for which we obtained the annual reports for the year 2003. These firms were selected because they comprise one of the few industries in which both fair-value- and historical-cost-based valuations of several types of assets are available. According to the sector-specific regulation in Spain, financial investments and land and buildings have to be shown at historical cost on the balance sheet, while the market value of these items must be disclosed in the notes to the financial statements.[1] A second reason to concentrate on insurance companies is the high proportion of tangible and financial investments these firms usually have on their balance sheets. As these assets are likely to exhibit considerable divergence between their fair value and historical cost measures, the effects on financial statements of using one valuation base over the other should be more clearly observable.

Our results show that the accounting numbers displayed on the face of the financial statements change considerably when financial investments and tangible fixed assets are accounted for at fair value instead of at historical cost, while the magnitude of these changes varies significantly between companies and types of assets. However, in most cases the change from historical cost to fair value leads to no material change in DEA scores; consequently, the overall rank order of the companies in our sample with regard to efficiency and profitability remains largely the same under both valuation bases. Nevertheless, the assessment of a few of the companies changes radically, in some cases for the better and in others for the worse. A change from historical cost to fair value—as per adoption of IFRS, for example—could therefore be expected to alter analyst perceptions of a limited number of companies but not to have a major impact on the appraisal of the majority of them.

Apart from providing additional insights to the value-relevance literature, these findings are relevant to financial statement analysts, preparers and regulators. The dispersion in revaluations under fair value discourages the idea that analysts could make their own adjustments to convert financial statements from a historical-cost to

[1] In Spain, current regulation focuses on a detailed and rigorous system of calculation of the commitments of the entity (requiring 'technical provisions') and provides guidelines about the investments with which such commitments can be covered ('assets suitable for the coverage of technical provisions'). The regulation provides a limited list of assets that might be used to cover the technical provisions, particularly including real estate and financial investments. Given the importance of appropriate coverage, a high percentage of these assets must be financial and tangible investments (real estate). Finally, the regulation also refers to the valuation of these assets, indicating that they should be marked to market (market quotation in the case of financial investments and professional appraisal for real estate). This valuation rule essentially corresponds with the concept of fair value as used in IFRS.

Information about the assets used for the coverage of technical provisions has to be reported on two levels: on the one hand, in the balance sheet, where assets are registered and valued in accordance with criteria of the Spanish Accounting Plan (normally at acquisition cost), and, on the other hand, in the notes to the financial statements, in a paragraph explaining the coverage of provisions, where the same assets are valued at their fair value.

a fair-value basis, or vice versa, without having detailed knowledge about the firm's assets; using an average adjustment factor would clearly lead to very imprecise results. Analysts will only be able to truly compare companies if they all use the same valuation basis, which will only occur if regulators decide to impose only one of the available options. The fact that the valuation basis seems to make little difference to the assessment of the majority of companies is not an argument for leaving measurement choices to account preparers. For those companies that have nothing to win or lose, it seems rational to opt for the accounting policy that is least expensive to implement, but for the few of them for whom it does make a difference it would be very tempting to make the choice opportunistically.

BACKGROUND

Fair Value

Several approaches have been followed in the literature to explore the properties of fair values. Some studies investigate companies' motivations to revalue (Jaggi and Tsui, 2001; Nichols and Buerger, 2002; Rodríguez and Navarro, 2007; Barlev *et al*., 2007). The findings in this area suggest that managers revalue assets in order to improve their borrowing capacity or their access to financial markets. From this perspective the fair value of assets is used as a signal to financial statement users and to overcome information asymmetry problems. By revaluing, a firm is signalling its growth potential and providing more assurance for creditors. Another finding from this literature is that firms bearing more political costs (large firms) revalue in order to lower their reported return on assets.

The majority of empirical studies contrasting fair value and historical cost have attempted to determine whether financial statements prepared on one valuation basis have a higher explanatory power for companies' market capitalization and profitability than the other. These studies typically examine the degree of statistical relationship between the book and market value of companies under the two valuation methods, equating higher correlations with 'better' information. For example, Magnolio (1986) and Harris and Ohlson (1987) observed that fair values explained the market value of oil and gas companies significantly better than historical costs. Also Barth (1994), Barth *et al*. (1996), and Barth and Clinch (1998) found that the fair value of assets in a sample of U.S. banks was significantly more correlated with stock prices than their historical cost. On the other hand, neither Nelson (1996) nor Khuarama and Kim (2003) detected significant differences in the same sector, except for a sub-sample of large banks.

Using a similar approach, the information content of specific types of assets has also been analysed. Eccher *et al*. (1996), for example, found that information on the fair value of financial investments had higher explanatory power of market-to-book ratios over and above the information already contained in historical costs, although it only accounted for a modest portion of the variation. Barth and Clinch (1998) found information about revaluations of tangible fixed assets, intangibles and financial investments all to be value-relevant. Wier (2009) studied firms operating in the gold industry, and found that finished goods inventory of gold is more value relevant

when marked to market than when carried at cost. Kanagaretnam *et al.* (2009) analysed the value relevance of the components of comprehensive income for Canadian firms, and found that the change in the fair value of available-for-sale investments had significant explanatory power for firm value.

Some authors have also studied the correlation between the revaluation of assets and company profitability in subsequent periods. For example, Easton *et al.* (1993) found a weak relationship between revaluations of fixed assets and book profit and a strong relationship between asset revaluations and the evolution of stock prices, while Barth and Clinch (1998) and Aboody *et al.* (1999) found strong evidence in both cases.

In summary, there seems to be more support for the hypothesis that fair values have incremental explanatory power compared to historical costs than against it, but findings cannot be considered conclusive.

Applications of Data Envelopment Analysis to Financial Statement Analysis and the Insurance Industry

DEA has not been applied extensively yet in the context of financial statement analysis, in spite of the fact that it avoids many of the problems usually encountered with parametric methods, like the difficulty to determine the functional form or statistical distribution of ratios. Pioneering work was undertaken by Smith (1990), who discusses the strengths and weaknesses of DEA applied to financial statement analysis. Other authors in the management-science and operations-research literature, like Thanassoulis *et al.* (1996), Berger and Humphrey (1997), and Feroz *et al.* (2003), have suggested that DEA might be superior to traditional financial ratios analysis or at least complement it. Alam and Sickles (1998) found that changes in technical efficiency scores calculated with DEA explain stock market returns, and therefore concluded that a link exists between a firm's market value and how efficiently it uses its resources. Nevertheless, we have identified only one article in an accounting journal using a DEA model for the analysis of financial statements (Halkos and Salamouris, 2004), which concludes that this technique can be used as a complement or substitute for simple ratio analysis of banks.

In the context of the insurance industry, research using DEA is less scarce but has been directed mostly at two different issues. The first issue is how insurers balance maintaining solvency and achieving other objectives (McCabe and Witt, 1980; Brockett *et al.*, 2004), while the second concerns the efficiency with which these companies use inputs in the process of generating output (Fecher *et al.*, 1993; Chen, 1999; Cummins *et al.*, 1999a; Cummins *et al.*, 1999b; Fukuyama 1999; Noulas *et al.*, 2001; Worthington and Hurley, 2002; Mahlberg and Url, 2003; Cummins *et al.*, 2004; Pestaña *et al.*, 2005). Financial statement analysis, in turn, has been primarily seen as an instrument for solvency vigilance (Willenborg, 1996; Brockett *et al.*, 2004).

RESEARCH HYPOTHESES

Our research centres around two main issues. In the first place, we address the question as to what extent the use of fair values instead of historical costs has an

impact on the face of financial statements, and whether it would be possible for analysts to estimate fair values from historical-cost information by making adjustments to the latter, based, for example, on industry averages. Secondly, we attempt to determine whether the differences between historical costs and fair values have material implications for the conclusions drawn from financial statement analysis. These issues are addressed in the following two broad hypotheses, which we shall refine later on.

H1: The relationship between the fair value and historical cost of assets depends on asset-specific and company-specific circumstances.

H2: Conclusions drawn from the analysis of financial statements based on historical costs are different from those based on fair values.

If either of these hypotheses can be falsified, the alleged benefits of fair-value accounting would not be supported; if analysts themselves can convert historical-cost data into fair values, or the analysis of historical-cost- and fair-value-based financial statements leads to the same conclusions, financial statement users would be just as well off with either of the two valuation bases.

Different types of assets are obtained by firms in different markets and under varying conditions and moments of time. Therefore, we expect that there will be differences in revaluation rates between firms. On the other hand, industry-specific similarities exist across firms with regard to the management and life cycles of assets. Taking into account that differences between historical costs and fair values are likely to be larger if assets are older, we therefore expect the revaluation rates also to be systematically different for different types of assets. Furthermore, determining the fair value of certain assets will be a more or less difficult task depending on the information available about their market value. For assets that are traded on efficient secondary markets—as is the case for many financial investments that are quoted on a stock market, for example—reliable market values can be known. On average, companies should thus show relatively similar rates of revaluation for such assets. In the case of assets for which such secondary markets do not exist, however, the estimation of fair values is subject to management's discretion (Dietrich *et al*., 2001) and will largely depend on the specific procedures used in each particular company. This suggests that, in these cases, revaluations are more subjective and exposed to larger errors. Consequently, we expect that different types of assets will show different levels of variability in revaluation rates.

We hence refine H1 with the following three sub-hypotheses:

H1.1: For a given type of asset, different companies show different rates of revaluation.

H1.2: The average rate of revaluation of different types of assets is different.

H1.3: The variability of the rate of revaluation of different types of assets is different.

Regarding our second main hypothesis, the impact on financial statement analysts' perceptions of using fair value instead of historical cost, two views are possible. On the one hand, if the information content of financial statements depends on the valuation base used and the specific numbers shown for a company's assets, it seems logical to

think that the analysis of financial statements with different valuation bases should also lead to different conclusions. In particular, one would expect that, *ceteris paribus*, a company that switches to fair values seems less efficient than when it reported historical cost, since it appears to be using more assets to obtain the same output.

On the other hand, if all companies change from one valuation basis to the other, the conclusions about one particular company in comparison to its industry might remain unchanged. That is, although the information content of financial statements might be different when using fair values instead of historical costs, this does not necessarily imply a revision of the perception of a company compared to its industry, when the change from one valuation base to the other affects all companies in a similar way, or when the change only affects a small amount compared to the value of other financial statement items.

To contrast these competing views, the following sub-hypotheses are formulated:

H2.1: When a firm changes from historical cost to fair value, the perception of this company's efficiency will change.

H2.2: When all firms in an industry change from historical cost to fair value, the perception of the companies' efficiency relative to each other changes.

H2.3: When only one firm changes from historical cost to fair value, and all other firms in the industry continue valuing their assets at historical cost, the perception of the relative efficiency of that company will be negatively affected.

METHODOLOGY

Overview

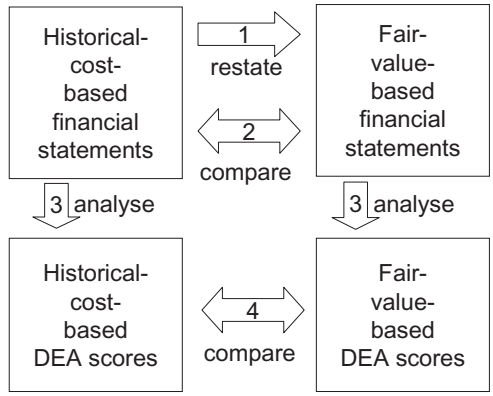
Our research methodology proceeds along the following four steps (also see Figure 1):

1. We obtained the annual reports of a sample of Spanish insurance companies. We collected information about revenues, expenses and assets from the balance sheets and income statements, which had all been prepared on a historical-cost basis. Fair values were retrieved from the notes to the financial statements for the following three types of assets: (a) land and buildings, (b) financial investments in associated and group companies and (c) other financial investments.[2] We then restated the original financial statements, using the information about the fair values. Thus, two sets of data for each company were obtained: one based on historical costs only, and one based on fair values.
2. In order to contrast hypotheses H1.1, H1.2 and H1.3, we calculated the means and standard deviations for the revaluation rates for each type of asset for which we had both the fair value and historical cost, and inspected the differences in the rates between companies and between types of assets. The differences between

[2] In the insurance industry these three types of assets make up about 80% of the total balance sheet. For all other assets, mostly short-term receivables, the difference between historical costs and fair values can be assumed to be immaterial.

FIGURE 1

SUMMARY OF THE RESEARCH METHODOLOGY



companies were assessed by analysing the standard deviation for the revaluation rate for each type of asset, while for the differences in revaluation rates between types of assets we used a Wilcoxon test.

3. To obtain a summary measure for the conclusions drawn from the analysis of the two sets of financial statements, we concentrated on profitability, asset-turnover and profit-margin ratios, and then simulated the process of mapping the multiple financial statement items related to these ratios into a one-dimensional score with data envelopment analysis.
4. To contrast hypothesis H2.1, a pair-wise comparison was performed of the historical-cost- and fair-value-based DEA scores obtained in Step 3. To contrast hypotheses H2.2 and H2.3 we determined the correlation between the two sets of DEA scores, and checked whether the differences in these scores were statistically significant. Finally, we inspected the differences in the ranking of the companies according to their DEA scores, obtained under both valuation bases.

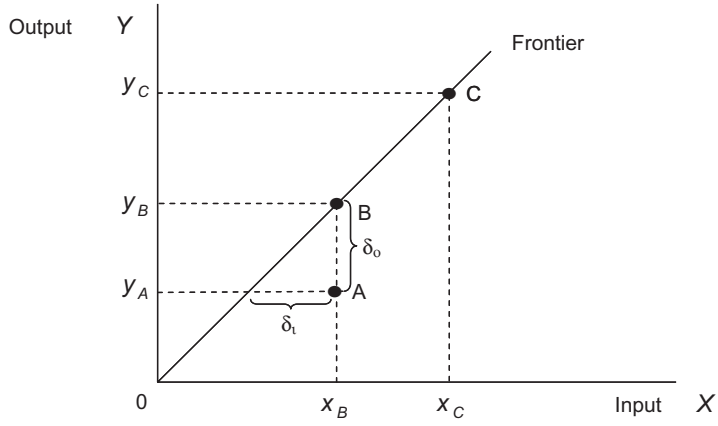
Data Envelopment Analysis

Based on Farrell's work (1957), DEA is a non-parametric, linear-programming-based technique developed by Charnes *et al*. (1978) and further extended by Banker *et al*. (1984). It converts multiple input and output measures for a set of decision-making units into a single comprehensive measure of efficiency. DEA models identify a frontier of best-in-class units that are used to measure the relative efficiency of remaining units in terms of their distance from that frontier. This logic is illustrated in Figure 2, for the simplest case of a set of companies that use a single type of input (X) to obtain a single type of output (Y).

Points B and C in Figure 2 represent the most efficient firms in the set of observations, since there are no other firms that obtain more output with the same or

FIGURE 2

FRONTIER ANALYSIS



fewer inputs, or any that use fewer inputs to obtain the same or higher output. The curve connecting the origin with B and C is referred to as the efficient frontier and it shows the interpolation of the most efficient combinations of inputs and output. Firm A is said to be inefficient because it uses the same quantity of input as Firm B but obtains less output. For A to become fully efficient, it should either improve its level of output by δ_o, or reduce the level of inputs by δ_i.

One possible measure of Firm A's inefficiency is:

$$\alpha = \frac{y_B / x_B}{y_A / x_B} = \frac{y_B}{y_A} > 1,$$

where α can be interpreted as the factor by which Firm A's output should be increased in order to become fully efficient. The lower α, the more efficient the company is. Alternatively, a factor can be calculated that indicates by how much inputs should be reduced to become fully efficient. A DEA model that expresses inefficiencies in the first approach is referred to as output-oriented, whereas it is said to be input-oriented if it uses the second approach.

If the efficient frontier is forced to have a constant slope, as depicted in Figure 2, an increase in inputs is associated with an equivalent increase in output, thus implying a constant returns-to-scale assumption. On the other hand, if the model allows the frontier to have different slopes between the observations, a variable returns-to-scale assumption is made. Given that it was our aim to simulate ratio analysis, and ratios are typically characterized by the fact that they do not take into account any scale effects, we opted for a constant returns-to-scale model.[3] Considering that under

[3] Although we believe that constant returns to scale is closest in logic to standard ratio analysis, we replicated all our analyses using results obtained from a variable-returns-to-scale DEA model, which yielded no substantial differences in findings.

constant returns-to-scale, input and output oriented models will provide equivalent results, we arbitrarily chose an output orientation.

The general DEA model allows for the evaluation of the efficiency of decision-making units using any number of inputs and output. Using an output orientation and constant returns-to-scale, it can be formulated in the following way:

$$
\begin{aligned}
&Max\ \alpha_s \\
&\sum_{k=1}^{K} z_k \cdot y_m^k \geq \alpha_s y_m^s \qquad m = 1, \ldots, \mathrm{M} \\
&\sum_{k=1}^{K} z_{\mathrm{k}} \cdot\ x_n^k \leq \boldsymbol{x}_n^s \qquad n = 1, \ldots, \mathrm{N} \\
&z_k \geq 0 \qquad k = 1, \ldots, \mathrm{K}
\end{aligned}
$$

where α_s = efficiency score of unit *s*. It adopts values greater than or equal to 1;
α = 1 indicates that the unit is on the efficient frontier;
k = units analysed;
m = types of output obtained;
n = types of inputs used;
y_m^k = amount of output *m* obtained by unit *k*;
x_n^k = amount of input *n* used by unit *k*; and
z = an intensity vector with weights assigned to each unit that serves as a reference to determine the relative level of inefficiency, with z_k being the weight given to unit *k*.

Input and Output Variables

In our case, the DEA model consisted of five inputs and one output (see Table 1). We wanted the model to be interpretable as the summary or simultaneous analysis of asset turnover (revenues / assets), profit margin ([revenues – expenses] / revenues), and profitability ratios ([revenue – expenses] / assets), as is common in a DuPont analysis. These ratios lead analysts to rank companies higher if they achieve more revenues, incur fewer expenses and use fewer assets, and *vice versa*. Therefore revenues were chosen as the output variable (to be maximized) and assets and expenses as inputs (to be minimized) for the DEA model. Since our concern was with the different valuation bases of assets and we expected that not all assets would

TABLE 1

INPUT AND OUTPUT VARIABLES USED IN DEA MODELS

Inputs	Output
Total expenses	Total revenues
Land and buildings	
Financial investments in associated and group companies	
Other financial investments	
Other assets	

behave in a similar way, we distinguished four different types in our analysis: land and buildings, financial investments in associated and group companies, other financial investments, and other assets. The last type was defined as total assets minus land and buildings, and all financial investments. It should be observed that changes in asset valuation affect profitability and asset turnover under this approach, but not profit margin.[4]

Although it was not our primary concern, our choice of variables is consistent with the view that companies use resources (measured in accounting as assets and expenses) to produce output (measured in accounting as revenues). Revenues have been used as an output variable in DEA models assessing efficiency in other industries (for example, by Zhang *et al*., 2001, and Chen and Ali, 2003, who study manufacturing firms), but they are somewhat controversial in the context of insurance. For example, Worthington and Hurley (2002), in their analysis of the cost efficiency of general insurers, used net premium income as an output, but also included 'invested assets' as an output variable to cater to the fact that insurers' profits come, to a considerable extent, from their role as financial intermediaries. In our view, investments are used (therefore, an input) to produce investment income (part of the output), while premiums (another part of the output) are generated by sacrificing commercial, general and administrative resources (which are expensed) using the infrastructure provided by the companies' other assets.

The DEA literature shows an even wider variety of approaches regarding the choice of input variables. Accounting-based variables that have been used as inputs include, among others: personnel expenses, costs of materials, and investments (Hill and Kalirajan, 1993); operating expenses and fixed assets (Piesse and Thirtle, 2000); total expenses, fixed assets, and current assets (Worthington, 1998); and labour expenses, expenses on information technology, expenses on other physical capital, and expenses on financial capital (Worthington and Hurley, 2002). As has been pointed out, we hoped to gain insights by disaggregating total assets into subcategories, but we did not expect that doing the same for total expenses would be helpful for our purposes.

An implicit, underlying assumption of the basic DEA model is that all inputs are equally desirable. This means DEA assumes that it is equally acceptable to consume any type of input. In our specific case, however, to use assets worth one euro or to spend one euro on expenses cannot be reasonably considered as equally desirable. Therefore, we imposed weight restrictions on the DEA program (Allen *et al*., 1997), such that it preferred a euro invested in assets between 8.3 and 12.5 times more than

[4] In our model, we do not adjust the profit margin reported by the companies in our sample, although strictly speaking, and depending on the specific accounting principles applied, revenues and expenses might be affected by the revaluation of assets through additional depreciation charges and/or gains/losses from marking to market. The practical significance of this potential misstatement of total revenues and expenses does not appear to be very big, however. Under IFRS, for example, most revaluation gains and losses of the assets considered here would be directly recognized in owners' equity and not flow through the income statement, whereas we have estimated the potential additional depreciation charges to be in the order of 0.1% of total expenses.

a euro spent on expenses. These weights can be interpreted as assuming that the cost of capital for holding the assets was between 8% (= 1/12.5) and 12% (= 1/8.3) per year. Although reasonably realistic for the period and industry in which our data were collected, these percentages are arbitrarily chosen. To make sure that this choice did not bias our findings, we repeated the analysis under other assumptions (with percentages ranging between 5% and 20%); every time very similar results were obtained.

Analysis of DEA Scores

DEA scores were calculated valuing the input variables for all companies in our sample at their historical costs, and then these calculations were repeated using the fair values of the assets. By comparing the results from the two calculations, the relative impact of an industry-wide change from historical costs to fair values can be evaluated.

Hypothesis H2.1 states that the perception of a company's efficiency changes when that company changes from historical cost to fair value. Taking the DEA scores as an indicator of the perception of a company's efficiency, we contrast this hypothesis with a pair-wise comparison of the scores obtained by each company for the two valuation bases. We do so with a parametric test (Student's *t* of the logs of the DEA scores), following Banker and Natarajan (2004), and a non-parametric test (Wilcoxon's sign-rank).

Hypothesis H2.2 says that the perception of the companies' efficiency relative to each other changes when all firms in an industry change from historical cost to fair value. As is common in the DEA literature (see Joro and Viitala, 2004, for example), the similarity between the sets of DEA scores was explored with Spearman's rank-order correlation coefficient. We inspected the ordinal ranking of the companies obtained under both valuation bases further, counting the number of companies that occupied a different rank position and the number of positions they climbed up or down when changing from historical costs to fair values. The overall difference in the rankings was assessed with Spearman's footrule distance and Kendall's tau distance.

Hypothesis H2.3 says that the perception of the relative efficiency of a company will be negatively affected when that firm changes from historical costs to fair values, while all other firms in the industry continue valuing their assets at historical costs. We modelled this setting by adapting the initial DEA program, running it with the fair-value-based observations but imposing the frontier to be constructed with the historical-cost-based observations.

This second program can be formally specified in the following way:

$$
\begin{aligned}
&Max\ \beta_s \\
&\sum_{k=1}^{K} z_k \cdot y_m^k \geq \beta_s y_m^s && m = 1, \ldots, \mathrm{M} \\
&\sum_{k=1}^{K} z_{\mathrm{k}} \cdot x_{nCost}^k \leq x_{nFV}^s && n = 1, \ldots, \mathrm{N} \\
&z_k \geq 0 && k = 1, \ldots, \mathrm{K}
\end{aligned}
$$

where this time β is the DEA score, with respect to the historical-cost frontier,[5] and the sub-indices indicate historical-cost- ('Cost') and fair-value- ('FV') based input variables.

Following Banker and Natarajan (2004) again, we analysed the differences in the logs of the DEA scores with a Student's *t*, and complemented this analysis once more with a Wilcoxon's signed-rank test. Furthermore, we inspected company by company the impact of the change in valuation base on their position in the ordinal industry ranking. To test whether the change in the valuation base leads to significant changes in this ranking, another Wilcoxon test was carried out.

SAMPLE SELECTION AND DESCRIPTION OF VARIABLES

In the first place, the companies for our sample were selected according to their activity and legal form. Only insurance firms registered as public limited companies were considered (240 out of 351 firms), since firms with other legal forms, such as mutual firms, are subject to different regulations and their functioning was expected to be different. This expectation was based on Cummins *et al*. (2004), who found that Spanish stocks and mutuals operate on different production, cost, and revenue frontiers, and thus employ distinct technologies. About half of the remaining firms were randomly selected for further inspection, and their annual reports for the year 2003 were analysed in detail. Of the inspected companies, 23 did not own any of the assets that could be valued differently with historical cost and fair value (land and buildings or financial investments), and three were extreme outliers. Our final sample consisted of 85 companies.

Although the companies in the sample only represent 24% of the total number of entities in the industry, they represent approximately half of the total in terms of the other indicators, such as assets (47%), employees (51%), total investment (47%), total premiums (52%), life insurance premiums (49%) and non-life insurance premiums (54%). The size of the companies in the sample is thus higher than average in the industry, in terms of assets, employees and premiums.

With regard to the activities carried out by the companies in the sample, it can be pointed out that 18% only commercialize life insurance policies, and 44% only non-life insurance, while the remaining 38% offer both types of insurance.

Table 2 shows descriptive statistics for the variables used in our DEA models. According to the Kolmogorov–Smirnoff test, none of these variables follows a normal distribution, thus suggesting that non-parametric techniques are more appropriate for their statistical analysis. Investments as a percentage of total assets are high, but this is common in the industry, since insurance companies need investments to cover their commitments.

[5] The historical-cost frontier was obtained with the optimization program using the historical-cost data, and therefore was exactly the same for all firms in this second optimization.

TABLE 2

INPUT AND OUTPUT VARIABLES USED IN DEA MODELS (IN € '000)

	Mean	Standard deviation	Maximum	Minimum	Kolmogorov–Smirnov (sig.)
Output					
Total revenues	294,457	410,642	2,298,211	1,925.857	0.000
Inputs					
Total expenses	283,742	397,667	2,226,146	1,839.391	0.000
Assets at historical cost:					
Land and buildings	19,940	33,438	189,691	20.862	0.000
Financial investments in group and associated companies	53,040	106,427	681,575	0.060	0.000
Other financial investments	630,782	1,268,154	9,283,977	241.303	0.000
Other assets	201,668	300,285	1,659,211	338.790	0.000
Assets at fair value:					
Land and buildings	38,889	70,976	383,683	20.862	0.000
Financial investments in group and associated companies	59,639	115,348	684,448	0.136	0.000
Other financial investments	676,723	1,359,694	9,922,663	241.303	0.000
Other assets	201,668	300,305	1,659,211	338.790	0.000

TABLE 3

REVALUATION RATES OF DIFFERENT GROUPS OF ASSETS WHEN CHANGING FROM HISTORICAL COST TO FAIR VALUE

	Mean revaluation rate	Standard deviation	Wilcoxon test (sig.)		
			(1)	(2)	(3)
(1) Land and buildings	+88.5%	112.4%	—		
(2) Financial investments in group and associated companies	+332.4%	2,352.8%	.004	—	
(3) Other financial investments	+6.6%	7.6%	.000	.010	—

EMPIRICAL RESULTS

Results Relating to Hypothesis 1—Relationship Between the Fair Value and Historical Cost of Assets

Table 3 shows the average revaluation rate of the assets of the companies in our sample, when fair values are used as the valuation basis instead of historical costs. It should be observed that these rates are calculated on a company-by-company basis, and therefore different from the rates that would result from using the sample-wide averages for fair values and historical costs reported in Table 2.

The three types of assets analysed all show increases in value. Rates are particularly high for land and buildings, and financial investments in group and associated companies. Nevertheless, since these assets only make up a part of each company's resources, the increase in total assets when changing from historical cost to fair values is on average only 9.8%.

The variation between the firms in the sample is very high, as evidenced by the standard deviation, indicating that different companies show different rates of revaluation, as expected by hypothesis H1.1. On average, financial investments in group and associated companies have the highest increases, followed by land and buildings and, finally, the other financial investments. The Wilcoxon test detects significant differences between the revaluation rates for these three types of assets, which is in accordance with hypothesis H1.2. Finally, from the differences in standard deviation we can conclude that the variability in the revaluation rates is different for different types of assets, as suggested by hypothesis H1.3.

Taking into account that the numbers based on historical-cost valuations tend to capture decreases in market value and no increases, it is not surprising that on average assets are valued higher under fair value. It is more interesting to observe the high variation between companies and types of assets. Apart from the possible dissimilarity between entities in the way of managing assets, an explanation of these differences might be that the chance of experiencing a revaluation depends on the age of the assets. From the three types of assets analysed, 'other financial investments' typically experience the fastest turnover and, therefore, at the balance sheet date in most of the companies these investments will have been relatively recently acquired, while investments in group and associated companies usually will be rather long-term in nature. Land and buildings, finally, occupy an intermediate position in this regard.

Altogether, these findings imply that it is not very likely that the users of financial statements could estimate fair values from historical-cost data with reasonable accuracy. That is, analysts cannot convert historical-cost data into fair values in the absence of further asset- and company-specific information.

Results Relating to Hypothesis 2—Impact of the Change From Historical Costs to Fair Values on Financial Statement Analysis

With regard to the implications of the differences in the book values under historical cost and fair value for the analysis of financial statements, a benchmark was obtained by running our DEA model on the historical-cost-based observations. The model was then run again using the fair-value-based observations (reflecting the case where the whole industry changes its valuation base), and a third time using once more the fair-value observations but now taking the historical-cost-based frontier as the reference point (reflecting the case where individual companies change their valuation base but the industry as a whole continues to use historical costs). Table 4 contains summary statistics for the DEA scores obtained with these three calculations.

When assets are valued on a historical-cost basis, the average DEA score is 127.9%, while the least efficient company shows a level of 189.1%. Since we use an output-oriented analysis, this means that, for example, the company with the score of

TABLE 4

DEA SCORES OBTAINED USING THE HISTORICAL-COST AND FAIR-VALUE DATA SETS

	Number of firms	Mean score	Standard deviation	Maximum score	Minimum score
Score with historical cost	85	127.9%	19.8%	189.1%	100.0%
Score with fair value	85	129.2%	21.7%	205.3%	100.0%
Score with fair value (compared to cost frontier)	85	130.3%	21.9%	207.2%	100.7%

189.1% would need to improve its output (in this case, revenues) by 89.1% to become fully efficient. On the other hand, when assets are valued at fair value, the average efficiency score is 129.2% and the least efficient company attains a score of 205.3%. In the third version of our model where the fair-value data are compared to the cost-based frontier, finally, the average score increases slightly further to 130.3%, and the maximum to 207.2%.

Figure 3 shows for each company the relationship between its DEA score obtained when using historical costs and when using fair value. Firms that are below the diagonal had better scores when they were based on fair values, while firms above the diagonal obtained better scores when they were based on historical costs. For the setting where we consider that all firms change from historical costs to fair values (Panel A in Figure 3), one entity obtains exactly the same score under both valuation bases, and therefore appears equally efficient in both cases. Fifty-two firms obtain a higher score when their assets are valued at fair value, which means that these firms, on a fair-value base, appear to be further away from the frontier than when using historical cost. The remaining 32 firms show a decrease in their score, indicating that under a fair-value base they appear to be closer to the frontier. For the setting where we consider that only one firm at a time changes from historical costs to fair values (Panel B in Figure 3), all firms obtain a higher DEA score when their assets are valued at fair value, thus suggesting worse performance.

Figure 4 shows the position of each firm when ranked from best to worst DEA score in the different scenarios studied. In the graph in Panel A, the X-axis indicates the position of each company in the industry rank order when historical costs are used, while the Y-axis shows what will be its position when all companies in the industry switch to fair values. Firms above the diagonal lose positions and firms below it gain positions when fair values are used instead of historical costs. For example, Firm A is in the 27th position when DEA efficiency is assessed with historical costs and in the 35th position when it is assessed with fair values, while Firm B would climb from position 68 to position 65. The dashed lines indicate the levels at which firms would gain or lose ten positions. It can be seen that all firms are between the dashed lines, thus gaining or losing fewer than ten positions. Figure 5 complements the previous graph by showing the frequency with which a certain number of positions is gained and lost.

FIGURE 3

DEA SCORES OBTAINED USING THE HISTORICAL-COST AND FAIR-VALUE DATA SETS

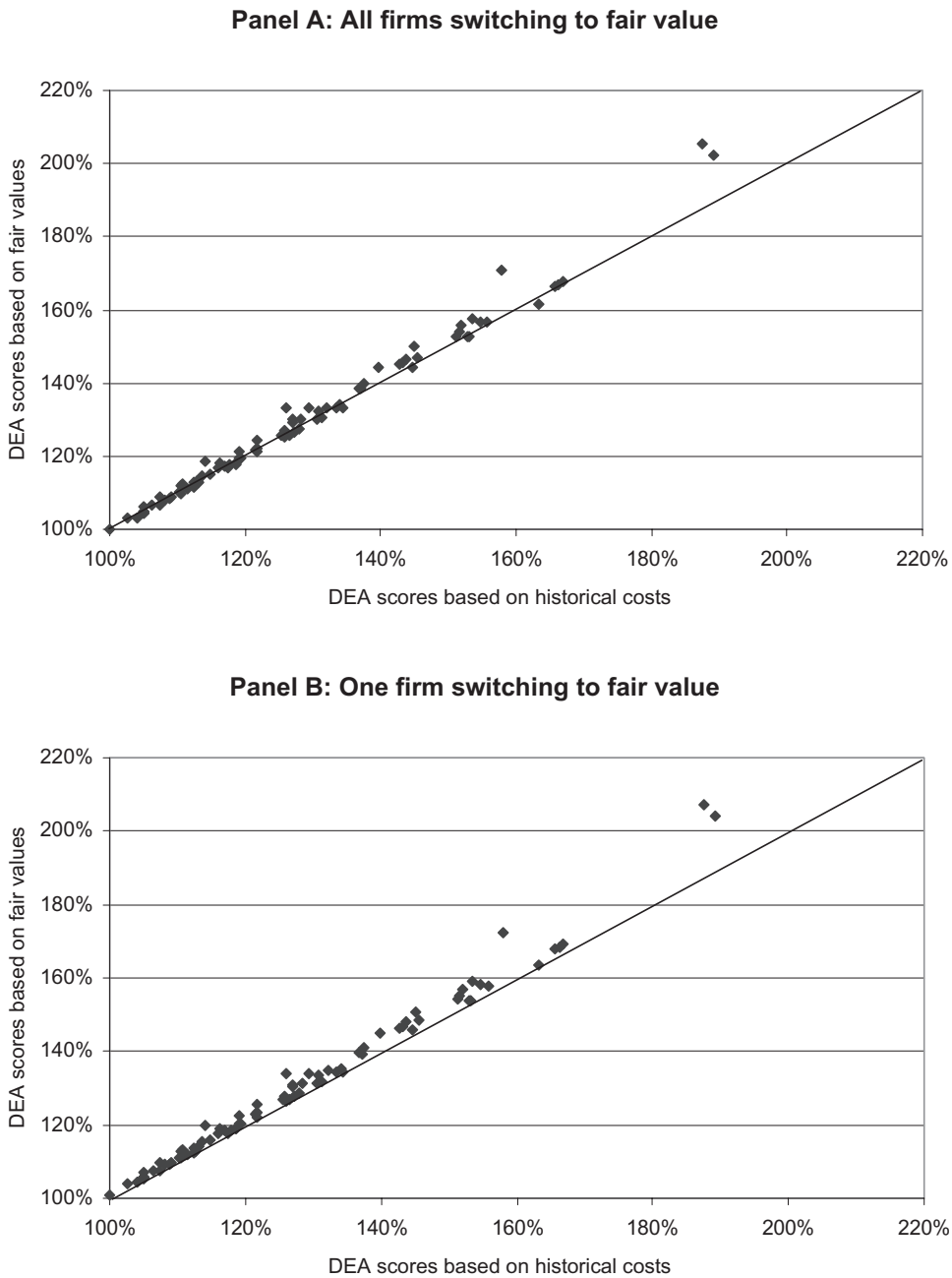
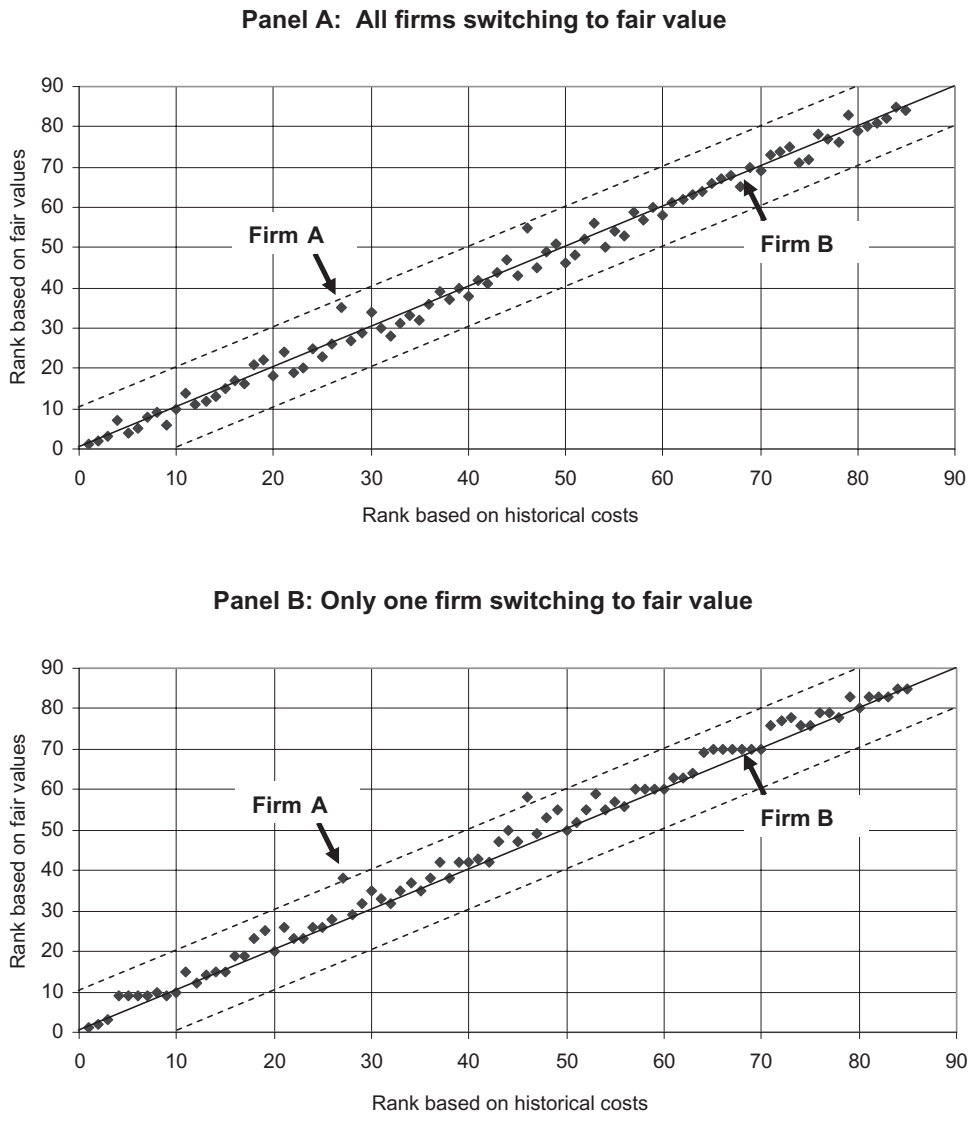


FIGURE 4

POSITION IN INDUSTRY RANKING USING HISTORICAL COST AND FAIR VALUE

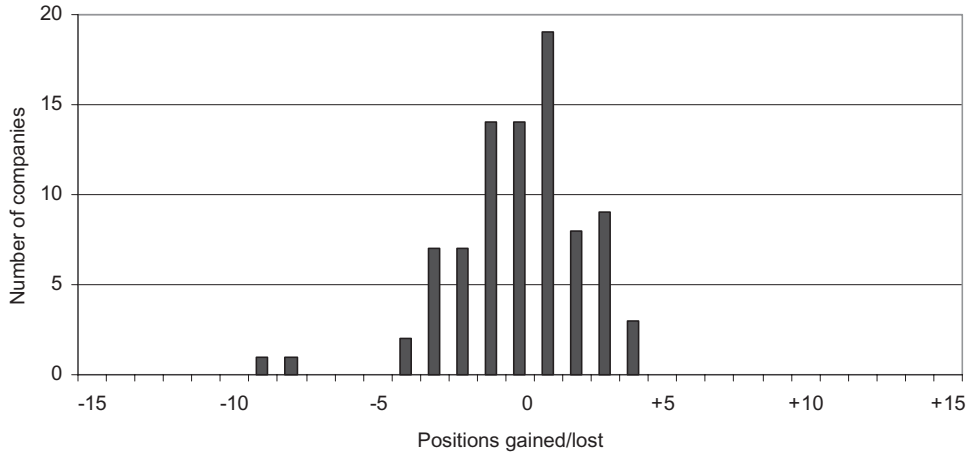


The second panel in Figures 4 and 5 show the impact on the ordinal ranking when only one firm changes to fair values and all others remain with historical costs. For the particular case of Firm A, for example, it can be seen that if this company were the only one in the industry that switched from historic costs to fair values, it would

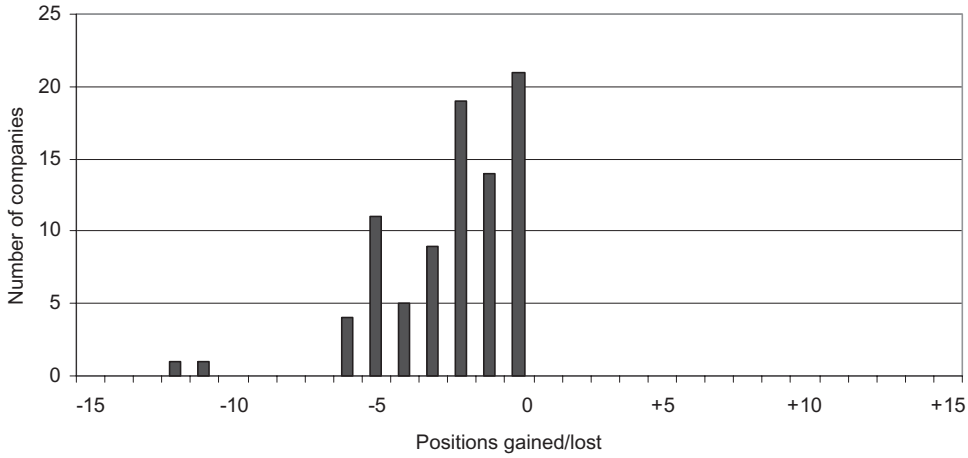
FIGURE 5

NUMBER OF POSITIONS IN THE INDUSTRY RANKING GAINED OR LOST WHEN CHANGING VALUATION BASE

Panel A: All firms switching to fair values



Panel B: Only one firm switching to fair values



fall from the 27th position to the 38th. Firm B, on the other hand, would only fall from position 68 to position 70.

With regard to the statistical significance of the results reported above, the following was found. For the setting where we consider that all firms change from

historical costs to fair values, Student's t (p = .000) and Wilcoxon's signed-rank test (p = .000) indicate that the differences from a pair-wise comparison of the logs of the DEA scores for each company are significant. This is in accordance with hypothesis H2.1, which says that the perception of a company's efficiency will change when it changes from historical cost to fair value. On the other hand, there is a strong correlation between the scores obtained under both valuation bases (Spearman correlation coefficient of 0.995, with p = .000), and also the changes in the ordinal ranking are only modest, as is evidenced by a Spearman's foot distance of 0.041 and Kendall's tau distance of 0.046; this provides evidence against hypothesis H2.2, which says that the perception of the companies' efficiency relative to each other changes when all firms in an industry change from historical cost to fair value.

For the setting where we consider that only one firm changes from historical costs to fair values, the differences from the pair-wise comparison of the log of the DEA scores for each company are significant, according to Student's t (p = .000) and Wilcoxon's signed-rank test (p = .000). Concerning the ordinal ranking, with many firms losing and no firm gaining positions, the impact of the switch from historical costs to fair values is on average negative, for which the Wilcoxon's paired test provides a very significant result (p = .000). Apart from providing additional evidence in favour of hypothesis H2.1, this supports hypothesis H2.3, which says that the perception of the relative efficiency of a company will be *negatively* affected, when it is the only one that changes from historical cost to fair value, and all other firms in the industry continue valuing their assets at historical cost.

SUMMARY AND CONCLUSIONS

In many jurisdictions the introduction of IFRS is leading to the modification of the valuation basis of certain assets. The consequences of these changes for accounting-based performance indicators and the analysis of financial statements are uncertain. In this paper we have studied the financial statement impact of using fair value instead of historical-cost measurements for the valuation of investments and analysed its effect on the efficiency and profitability of a sample of Spanish insurance companies.

Using data from annual reports for 2003, we compared the historical cost and fair value of the following asset classes: (a) land and buildings, (b) financial investments in associated and group companies and (c) other financial investments. The reasoning of financial analysts, who have to interpret several ratios simultaneously to arrive at an overall conclusion regarding the efficiency and profitability of companies, was simulated using data envelopment analysis (DEA). Specifically, DEA efficiency scores were calculated with models that consider expenses and assets employed as inputs and revenues as output; this can be interpreted as the simultaneous analysis of profitability, asset-turnover and profit-margin ratios, as in a basic DuPont analysis.

We found that the valuation base has a substantial effect on the book value of the assets analysed, and that differences between historical costs and fair values vary significantly across different asset classes and companies. We further found that the use of fair value instead of historical-cost measurements affects the relative efficiency scores calculated with the DEA models (and, by extension, the values of

financial ratios in general), but also note that for the majority of the sampled companies this did not imply a material change in their overall assessment when they were compared to their industry peers. This result was obtained both when we considered that all firms in the industry adopted fair values and when we assumed that only one firm changed its valuation base while all others remained with historical cost.

Our findings add to the debate on the relevance and utility of fair values vs historical costs in decision-making contexts. Although we cannot affirm that the information content of one valuation method is superior to the other—or in other words, we cannot say which method is 'better'—we can confirm that historical-cost information is different from data based on fair values. However, this difference only seems to matter in relatively few cases. This might partly explain the contradictory and statistically weak findings of previous research that grounds its conclusions on sample means; that is, perhaps the superior information content for a part of the companies in the samples of those other studies was largely averaged out by the rest of the observations.

Apart from providing additional insights to the value-relevance literature, our findings are also of interest for financial statement analysts, preparers and regulators. The dispersion in revaluations under fair value discourages the idea that users could make their own adjustments to convert financial statements from a historical-cost to a fair-value basis, or vice versa, without having detailed knowledge about the firm's assets; thus, using an average adjustment factor can clearly lead to very imprecise results. Analysts will therefore only be able to compare companies properly when they all use the same valuation basis, which will only occur if regulators decide to impose one of the options on all entities. This observation is particularly pertinent in the context of the criticisms of current IFRS for allowing multiple measurement options in several standards. The fact that the valuation basis seems to make little difference for the assessment of the majority of companies is not an argument to leave the choice to the preparers. For those companies that have nothing to gain or lose, it seems rational to opt for the accounting policy that is least costly to implement, but for those few for whom it does make a difference it would be very tempting to make the choice opportunistically.

This study has several limitations. In the first place, we do not actually perform financial statement analysis but only simulate the process of ratio analysis. Furthermore, we assume that analysts interpret financial statement data rather naively and mechanically, not making any distinctions depending on whether balance sheet data were prepared with historical costs or fair values, or taking into account any other type of information than the assets, expenses and revenues modelled here. Real-life financial statement analysis could therefore very well lead to different conclusions than do our models. Nevertheless, the reasoning of analysts, however complex it may be in practice, in the end boils down to ordering companies from 'best' to 'worst', and DEA might be a relatively practical way of simulating this.

Still, more research on these issues is needed to take our findings from the level of insights to facts. Among other things, it would be interesting to see an empirical validation of our approximation of analyst reasoning, or the use of different input

and output variables in other model-based approaches. Ideally, future research should also address the question of what causes the differences in company efficiency scores, and whether these factors are different when the assessment is based on historical costs or fair values.

One of the strengths of our approach is at the same time a limitation. DEA is a non-parametric technique, and for some of our findings we could not calculate a degree of statistical significance. As a consequence, we could not strictly test all of our hypotheses, leaving some issues at the level of subjective interpretation. For example, it is a matter of opinion exactly how many companies should change their position in an industry ranking for fair value accounting to make a material impact on it.

A final limitation of this study is that it only refers to insurance companies. Balance sheets in this sector show a larger number of assets which are subject to revaluations than do many other industries. Applying our methodology to other industries might, therefore, detect smaller effects than we found here.

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