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Beta-convergence and sigma-convergence in corporate governance in Europe

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ABSTRACT

This paper tests for beta-convergence and sigma-convergence in the corporate governance models, using a sample of corporate governance ratings for 198 European corporations listed on the FTSE Eurofirst 300 index. A piecewise linear regression is deployed to select a model and the Poisson pseudo-maximum likelihood estimator is also applied to estimate an exponential model. It concludes that there is statistical evidence of beta- and sigma-convergence within countries and the results suggest that institutional differences between countries are statistically relevant.

1. Introduction

The aim of this paper is to present a beta-convergence and sigma-convergence approach to analyse the evolution of corporate governance models for the major European firms listed on the Eurofirst 300 index.[1]

The notion of convergence is commonly deployed in economic growth theory and is above all applied to questions bound up with trends in earnings levels and analysing whether or not regional and/or national disparities remain in effect. According to conventional neoclassical theory, lowering the barriers to trade enables greater efficiency in the allocation of resources, resulting in an increase in earnings per capita. Due to decreasing returns on factors, the growth rate of earnings per capita is greater in poorer regions and this fact would result in the long-term convergence to the same level of per-capita earnings (Fingleton et al., 1997). Barro and Sala-i-Martin (1992, 1999) have introduced greater explanatory depth into the model, based upon studying the importance of human capital, R&D and public policies on the behaviour of economies. These are the endogenous growth and human capital theories (see for example Lucas, 1988; Mankiw et al., 1992; Romer, 1986, 1990).

The motivation for the present research is to seek answers to the following questions: (i) Are companies with weaker levels of governance quality (expressed by a lower rating) able to overcome this lag? Based on the literature review, it is observed that there is no easy to be obtained; (ii) Should such convergence be proven, does it differ from country to country, that is, does it depend on the legal/institutional framework? Only by this means can we understand whether or not the cultural and political facets are relevant to convergence processes.[2] Hence, this paper makes a distinction firstly between the Anglo-Saxon model and the continental model and then between the Anglo-Saxon, Latin and Scandinavian models (see, La Porta et al., 1997).

This paper contributes to the literature in two ways. First, to the best of our knowledge, there are few empirical studies on convergence of corporate governance that apply econometric estimation techniques. Thus, our results expand on the previous results on this subject (see for example Wójcik, 2006). Second, the paper represents an attempt to apply in this scientific area the two convergence definitions developed by economic growth theorists.

The rest of this paper is organised as follows. The second section reviews the literature. Section 3 details the methodology adopted for the data analysis. Section 4 presents a discussion of the results. The last section offers some concluding remarks.

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[1] For a critical analysis of corporate governance ratings, see Daines et al. (2010).

[2] Dallas (2004, p.142) goes so far as to state: "The legal environment is arguably the most important external factor affecting individual company governance", while adding that "(…) it is important to understand both the scope of relevant written law and the effectiveness with which is enforced." (see also Djankov et al.,2002).

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2. Literature review

Studies on corporate governance identify two major trends. On the one hand, some authors consider that globalisation exerts pressure on both companies and countries to adopt a common model of corporate governance (Coffee, 1999, 2000; Hansmann and Kraakamn, 2001), furthermore discussing which model might be more efficient. On the other hand, some authors argue that a set of economic, financial, political and cultural factors places limits on the extent of this convergence process (Bebchuck and Roe, 1999; O'Sullivan, 1999).

The conceptual questions are multiple and start from the definition of the concepts involved, particularly that of corporate governance (Blair, 1995; Monks and Minow, 2011; Shleifer and Vishny, 1997). In practice, the systemic character of governance models hinders the identification and analysis of all the key features, such as the legal framework (Hopt, 2002; La Porta et al., 1998, 1999), the relative importance of the stock market (Licht, 1998), the ownership structure of listed and non-listed companies (Faccio and Lang, 2002; Ibrahimo and Barros, 2009), the structure and level of remuneration paid to senior management (Conyon and Peck, 1998; Maassen, 2002), or the relative weighting of the diverse stakeholders (Charkham and Simpson, 1999; Roe, 1994).

Regarding the evolution of governance models, the strong interrelationship between the multiple factors characterising such models means that, at least theoretically, they are able to obtain equally efficient results through different combinations of factors. Hence, this does not automatically exclude diverse models from coexisting in the future, even while resulting from the approximation of those currently existing. This is the position held by the OECD and Boutillier et al. (2002), who identify that the trends are not proceeding unilaterally towards the Anglo-Saxon model, but rather merging facets of both the Anglo-Saxon and the Continental models.

Finally, the correct definition of convergence also remains subject to some outstanding controversy even though Gilson's (2001) classification, which distinguishes between formal convergence and de facto convergence based on the adoption of shared practices, gains broad agreement.

The classification (rating) of corporate governance quality in (listed) companies is relatively recent and the emergence of this type of information is closely bound up to crises and scandals such as that of Enron in 2001. Despite the diverse scope of criticism of such measures, they are increasingly sought out by investors, given that ratings emerge as "(…) a powerful indicator of the extent to which a company is currently adding, or has the potential to add shareholder value in the future. (…) a company with good corporate governance is generally perceived as more attractive to investors than one without" (Mallin, 2009, p.73).

The ratings issued by Deminor (2003) are based upon analysis of over 300 indicators gathered from regularly published data and grouped into four categories: Rights and Duties of Shareholders, Range of Takeover Defences, Disclosure on Corporate Governance, and Board Structure and Functioning. The rating reflects the level of adoption and/or compliance with the principles of good corporate governance (Deminor Rating Standard), in accordance with a scale of 1 (more questionable practices) to 5 (best practices), resulting in an overall rating arrived at by aggregating the four aforementioned categories and hence forming an evaluation range of between 4 and 20.

Nevertheless, we should stress the limitations of applying theoretical economic growth models to the evolution of ratings-based evaluations of corporate governance models. In effect, while per-capita production levels are not capped in any way, the rating does come with a pre-established maximum value. Hence, theoretically, from a certain point, it becomes impossible to improve further. Considering the hypothesis that all companies are keen on boosting their rating, it may be expected for all companies to converge on the same value in the long term. It should also be noted that applying changes in the rating is the correct approach, given that such ratings are produced by an independent entity and with no value judgement associated with any alteration. Consequently, this allows us to analyse whether or not companies converge on a common standard and hence test our convergence hypothesis.

3. Methodology

3.1. Beta convergence and sigma convergence hypotheses

The most common methodology to analyse economic convergence was developed by Barro (1991) and Barro and Sala-i-Martin (1992) and consists of estimating the following model:

$$Z_{it} = \beta_0 + \beta_1 P_{it} + U_{it}$$

in which:

Z_{it}	per-capita income (or product) growth rate of a country or region i in period t;
P_{it}	initial level of per capita income (or product) of a country or region i in period t ($t=t_0$);
β_0,β_1	parameters to be estimated;
U_{it}	random residual.

The model generally includes a set of control variables, such as investment, capital stock, education levels and public expenditure, as well as qualitative variables that reflect the importance of the prevailing legal framework, political stability or even cultural and religious factors (Barro, 1991, 1996, 2001; Barro and McCleary, 2003; Bils and Klenow, 2000).

Should the earnings levels of different countries converge, then the estimate for β_1 should be negative corresponding to a production growth rate higher in countries/regions with lower starting levels of output. This is denominated as beta convergence, given that it is evaluated by the coefficient estimate associated with the independent variable.

Raising both conceptual and econometric questions, some authors, such as McGrattan and Schmitz (1999), focus their analysis not on evolution, but rather on the range of income dispersion at a particular point in time, due to a consideration that the concept of convergence incorporates a lower level of per-capita sectional income dispersion and that a negative estimate for β_1 does not guarantee such a decrease in dispersion. These authors thus defend convergence studies based on levels of per-capita income dispersion, thus determining estimates for standard dispersion deviation (sigma-convergence). The fact that beta-convergence is a necessary but insufficient condition for sigma-convergence has led to these two topics being analysed in parallel.

Lichtenberg (1994) demonstrated that the two convergence definitions are not equivalent. Effectively, the verification of sigma-convergence – measured by the ratio of dispersion of results observed over two different periods of time – depends not only on verifying beta-convergence, but also the coefficient of determination of his growth rate model.

3.2. Linear models in parameters and variables

The characteristics of the problem and the variables under study enable an analytical approach to corporate governance models based on linear models. The item scale runs from one to five (partial ratings); given that each company is evaluated across four items, its minimum possible rating is four against a feasible maximum of twenty. We excluded all companies that were not rated across all four components, rather studying only total company ratings (the sum of the four partial ratings) in 2000 and in 2003 (198 companies).

We may thus estimate the following model type:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + U_{it} \quad (1)$$

in which:

Y_{it} $\frac{\Delta X_i}{X_{i0}}$

ΔX_i variation in the total i company rating between period 0 and period t. In reality, we substituted the discrete growth rate with an approximate logarithmic growth rate. Some authors apply an arithmetical average as the logarithmic growth rate;

$X_{it} = X_{i0}$ total rating of company i in period 0.

The exogenous nature of X_{i0} may be justified by how ratings are issued by an independent company. The causality is justified by how such ratings processes may impact on decision-making, since decisions are taken to shape the future rating and, hence, the level of the rating growth rate. As Dallas and Patel (2004, p.6) detail: "In behavioural science as in the physical sciences, the act of measurement can have an effect on that which is being measured. Applied to the area of corporate governance, this suggests the potential for an effective governance rating system serving as a positive discipline and incentive for improvement."

Taking into consideration the importance of the legal framework to identifying the corporate governance models of societies and the classical distinction between the Anglo-Saxon model and the Continental model, we also sought to study any eventual convergence between these two groups, employing a dummy variable (Dallas, 2004; Djankov et al., 2002) for such purposes.

$$Y_{it} = \beta_0 + \beta_1 X_{i0} + \delta_1 X_{i0} QL_1 + U_{it} \quad (2)$$

in which:

Y_{it} total company i rating growth rate between period 0 (2000) and period t (2003), in a logarithmic form;

X_{i0} total company i rating in the period 0;

QL_1 dummy variable for the legal framework ($QL_1 = 1$, in the Anglo-Saxon model; $QL_1 = 0$, in the Continental model);

$\beta_0, \beta_1, \delta_1$ parameters for estimation;

U_{it} random residual.

Finally, and in order to test the importance of the La Porta et al. (1997) approach, we carried out the estimations for the following model:

$$Y_{it} = \beta_0 + \beta_1 + X_{i0} + \delta_1 X_{i0} QL_1 + \delta_2 X_{i0}\ QL_2 + \delta_3\ X_{i0}\ QL_3 + U_{it} \quad (3)$$

in which:

Y_{it} total company i rating growth rate between period 0 and period t;

X_{i0} total company i rating in the period 0;

QL_1 dummy variable for the legal framework ($QL_1 = 1$, in the Anglo-Saxon model; $QL_1 = 0$, in any other);

QL_2 dummy variable for the legal framework ($QL_2 = 1$, in the Latin model; $QL_2 = 0$, in any other);

QL_3 dummy variable for the legal framework ($QL_3 = 1$, in the Scandinavian model; $QL_3 = 0$, in any other).

Given the relationship between the ratings growth rate (Y_i) and the rating of year 2000 (X_{i0}), we might assume a non-linear relationship between the variables (carrying out the RESET test also failed to rule out this hypothesis). Hence, we applied a piecewise linear regression to this context (see Morck et al., 1988), with the objective of identifying whether or not there were statistically distinctive behaviours between companies, based on their classification into three different classes in accordance with their 2000 ratings[3]:

- Companies with a low rating (total rating below 8);
- Companies with an average rating (total rating above 7 but equal to or below 16);
- Companies with a high rating (total rating above 16).

The variables employed for this analysis were the following:

Xl_{i0} = company i rating in the year 2000, when less than 8;
= 8, when the rating is at least equal to 8.
$Xm_{i0} = 0$ when the rating of company i is below 8;
$= (\text{rating}_i - 8)$ for ratings ranging between 8 and 16, inclusive;
= 8, for ratings in excess of 16.
$Xh_{i0} = 0$, when the rating of company i is below 17;
$= (\text{rating}_i - 16)$ for ratings at least equal to 17.

Therefore, the model calculated was the following [4]:

$$Y_{it} = \beta_0 + \beta_1 Xl_{i0} + \beta_2 Xm_{i0} + \beta_3 Xh_{i0} + U_{it}. \quad (4)$$

3.3. Non-linear variable models but with linear parameters

Graphic analysis of the relationship between the dependent variable (Y_i) and the independent variable (X_{i0}) would seem to call into question the relative linearity of the parameters (and also the variables) assumed in the mentioned models. This correspondingly resulted in two complementary approaches.

The first approach involves defining a linear model for the parameters, but non-linear in terms of the variables.

$$Y_{it} = \beta_0\ + \beta_1 X_{i0} + \beta_2 X^2{}_{i0} + U_{it}. \quad (5)$$

In this model, the verification of the convergence hypothesis depends on the level of X_{i0}, being the point of inflection ($\partial Y_i / \partial X_{i0} = 0$) when $X_{i0} = -\beta_1 / 2\beta_2$.

The second approach, furthermore taking into account that the higher grades (ratings) might be expected to be more difficult to modify, incorporates analysis of the feasibility of estimating an exponential or potential model, of the type:

$$Y_{it} = \beta_0\, e^{\beta 1 Xi0} + U_{it}$$

or alternatively:

$$Y_{it} = \beta_0 X^{\beta 1}{}_{i0} + U_{it}.$$

These models, given their linear nature, may be estimated in two different ways:

(a) $lnY_{it} = ln\beta_0 + \beta_1 X_{i0} + lnU_{it}$ (a log–lin relationship, where β_1 is an estimate for the semi-elasticity and the condition for convergence $\beta_1 < 1$), or

(b) $lnY_{it} = ln\beta_0 + \beta_1\ lnX_{i0} + lnU_{it}$ (log–log relationship, where β_1 is an estimate for elasticity and the condition for convergence $\beta_1 < 0$).

However, as the growth rate is the dependent variable, its logarithmic expression excludes from the sample all companies with

[3] The sensitive analysis of the parameters of these three classes of piecewise regression and the indicators of the overall quality of the model (F statistic and Schwarz B.I.C. criterion) are available from the authors on request.

[4] The model estimated thereby enables results to be obtained for the expected values for the dependent variable $E(Y_i)$, based on the following company specifications: (a) companies with low ratings (below 8): $E(Y_i) = \beta_0 + \beta_1 \text{rating}_{i0}$; (b) companies with average ratings (between 8 and 16, inclusive): $E(Y_i) = \beta_0 + \beta_1 8 + \beta_2(\text{rating}_{i0} - 8)$; (c) companies with high ratings (above 16): $E(Y_i) = \beta_0 + \beta_1 8 + \beta_2 8 + \beta_3(\text{rating}_{i0} - 16)$.

negative trends in their overall rating over the 2000–2003 period, which might bias the study's findings. One alternative would be the replacement of the scale, substituting the originally-explained variable with a transformation that would ensure its non-negativity. This may be achieved, for example, by $ln\,(1 + lnY_i)$. Another question stems from this relationship between the random residual properties U_{it} and their logarithms (Santos Silva and Tenreyro, 2006, 2010).

To this end, we opted for an exponential model, altering the explained variable, Y_i, which was subsequently endowed with strictly positive values ($Y_i^* = Y_i - \min Y$). The explained variable Y_i^* became the difference between the total growth rate of company i between period 0 (2000) and period t (2003) (Y_i) and the minimum obtained value for this growth rate obtained across the sample under study. The specification is as follows:

$$Y_{it} = e^{\beta 0+\beta 1Xi0+\delta 1Xi0\ QL1+\delta 2Xi0\ QL2+\delta 3Xi0\ QL3} + U_{it}.$$

Applied to logarithms, we reach:

$$lnY_{it} = \beta_0 + \beta_1 X_{i0} + \delta_1 X_{i0} QL_1 + \delta_2 X_{i0}\ QL_2 + \delta_3\ X_{i0}\ QL_3 + lnU_{it}. \quad (6)$$

In order to guarantee that the methodology was applied in accordance with its theoretical assumptions, we subsequently carried out the RESET test for model specification. The estimator used was the Poisson pseudo-maximum likelihood (PPML).

4. Data and results

4.1. Beta-convergence

Table 1 summarises the models outlined in the section above and the parameters estimated, as well as the key statistics on these parameters and models.

This table presents the estimates for the regression coefficients for models (1) to (6), as well as the t-statistic, heteroscedasticity-corrected. They also display the adjusted R^2 and F statistic results. In all these regressions, the dependent variable is the company i total rating growth in the years 2000 and 2003 in logarithmic form. In model (6), we applied the PPML estimator with the dependent variable being the difference between the company i total rating growth in the years 2000 and 2003 and the minimum obtained growth rate obtained across the sample.

Eq. (1) provides the conclusion that there is a negative relationship ($\beta_1 = -0.0372$) and a statistically significant relationship (at the 1% level) between the year 2000 rating and the growth rate for the period under study. Calculating a confidence interval (CI) for β_1, with a significance level of 5%, we may therefore conclude that at this level of confidence there is, in fact, a beta process of convergence relative to the quality of governance in effect in the sample under study (CI 95% = −0.0440; −0.0304). The calculation of the confidence intervals for the beta-convergence parameter (β_1) for the respective heteroscedasticity parameters proposed by White (1980) does not alter the conclusion that all the confidence interval limits estimated remain constantly negative. As regards the global adjustment quality, this rejects the hypothesis that both parameters are null.

Eq. (2) seeks to analyse whether there are any significant differences between companies in the United Kingdom and Ireland (which are grouped under the Anglo-Saxon model of corporate governance) and the remaining companies making up the sample. As the model specified, the relationship between the expected level of growth and the rating in the year 2000 is expressed by the following relationships:

- Continental model

$$E(Y_i) = \beta_0 + \beta_1 X_{i0}.$$

- Anglo-Saxon model

$$E(Y_i) = \beta_0 + (\beta_1 + \delta_1) X_{i0}.$$

Based on the results set out in Table 1, this does not reject the hypothesis that the parameter associated with the dummy Anglo-Saxon variable is statistically significant and positive ($\delta_1 = 0.0122$). Correspondingly, we may conclude that for the same level of rating in 2000, the growth rate of continental European companies was less and hence there was no parallel approximation between the two models (when measured by rating). We thus concluded that the differential effect between the two models (measured by δ_1) is not null. Hence, we may additionally conclude that within each model, there is a process of convergence, but within the scope of which the Anglo-Saxon model not only returns higher initial rating levels, on average, for the same rating value, but also obtains a higher rate of growth, thereby enlarging the differential.

Table 1
Estimated models.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
X_{00}	−0.03719	−0.05487	−0.06217		−0.11209	−0.10269
	(−10.7676)***	(−8.6308)***	(−8.6195)***		(−5.003)***	(−7.8728)***
$X_{00}QL_1$		0.01221	0.01906			0.03125
		(4.3476)***	(4.1634)***			(3.3083)***
$X_{00}QL_2$			8.44E−03			0.01557
			(1.8525)*			(1.7726)*
$X_{00}QL_3$			9.21E−03			0.01672
			(1.7506)*			(1.7137)*
Xl				−0.10363		
				(−4.5541)***		
Xm				−0.03034		
				(−5.2738)***		
Xh				−9.62E-03		
				(−0.7685)		
X^2_{00}					3.13E-03	
					(3.6833)***	
β_0	0.6165	0.7616	0.7691	1.0905	1.0108	0.3933
	(12.5073)***	(11.2896)***	(11.3778)***	(6.4174)***	(7.4355)***	(4.2172)***
R^2_{adjust}	0.36937	0.41668	0.42596	0.41763	0.40968	
F	116.386***	71.362***	37.546***	48.091***	69.358***	
N	198	198	198	198	198	198

t-statistics in parentheses. ***,*Statistically significant at 1 % or 10%, respectively.

With regard to the variation in the growth rate (Y_i) by unit of increase in the ratings grade, the relationship is expressed as follows:

- in the Continental model

$$\frac{dY_i}{dX_{i0}} = \beta_1.$$

- in the Anglo-Saxon model

$$\frac{dY_i}{dX_{i0}} = \beta_1 + \delta_1.$$

Given that the parameter of the dummy variable associated to the Anglo-Saxon model is significant, we may conclude that for Anglo-Saxon companies the effect of the initial rating value is different to that of Continental European companies. As this parameter is positive ($\delta_1 = 0.0122$), and taking into account that these Anglo-Saxon companies recorded the highest initial ratings in 2000, the variation (decrease) in the growth rate is sharper than in European companies. So, long-term approximation between the average ratings of the two different models is not expected.

In comparative terms, for Eq. (1), the F test with the introduction of the dummy variable enables us to come out in favour of the relevance of the introduction of this variable, a conclusion also returned by analysis of the adjusted coefficient of determination, which rose from 0.3694 to 0.4167.

The purpose of Eq. (3) is to distinguish between trends in the four legal models identified by La Porta et al. (1997). In accordance with the model's definition, the estimates for the parameters take on the following interpretations: in the German model: $dY_i/d\ X_{i0} = \beta_1$; in the Anglo-Saxon model: $dY_i/d\ X_{i0} = \beta_1 + \delta_1$; in the Latin model: $dY_i/d\ X_{i0} = \beta_1 + \delta_2$; and in the Scandinavian model: $dY_i/d\ X_{i0} = \beta_1 + \delta_3$.

Analysing the estimates in Table 1, we may conclude that for the same rating level (and given that the model assumes the same order as the original), the growth rates, on average, were ranked over the period studied in the following order: in the Anglo-Saxon model ($\beta_1 + \delta_1 = -0.04311$), the Scandinavian model ($\beta_1 + \delta_3 = -0.05296$), the Latin model ($\beta_1 + \delta_2 = -0.05373$) and the German model ($\beta_1 = -0.06217$), therefore aggravating the difference existing between the Anglo-Saxon model and the continental European models. Nevertheless, given that all the values estimated for the slopes are negative, we may refer to a reduction in the internal dispersion of the ratings.

It should also be noted that for a unit increase in the rating in 2000, the decrease in the growth rates was still higher over the 2000–2003 period for the German model ($\beta_1 = -0.06217$), the Latin model ($\beta_1 + \delta_2 = -0.05373$) and the Scandinavian model ($\beta_1 + \delta_3 = -0.05296$) companies respectively.

Finally, we should note that the global model adherence is good (statistic value $F = 48.091$/adjust$R^2 = 0.426$) and Ramsey's RESET2 test for the specific shape of the functional form does not reject the null hypothesis, H_0.

Furthermore, regarding model (3), we also tested the hypothesis that there were no significant differences between the continental legal frameworks in relation to their impact on growth rates (thus, H_0:$\delta_1 = \delta_2 = \delta_3$). The F test enabled the rejection of H_0, hence the legal and institutional frameworks do hold influence over ranking trends.

Model (4), as explained above, is designed to identify differences in the rating growth rate taking into consideration the 2000 classifications, having defined three different groups in order to enable piecewise linear regression and reporting two alterations in the slope. The parameter estimates were all negative (and decreasing in the module). The model also returns a good global adherence level and there is no rejection of its functional shape when applying Ramsey's RESET2 test.

The graphic analysis of the relationship between the variables Y_i and X_{i0}, as well as the results of the Ramsey RESET2 test on Eq. (1), serve to justify study of the non-linear specification of the variables (Eq. (5)).

In Eq. (5), the results are statistically significant for all variables, reflecting a model with good global adherence and not rejecting its specific characterisation (Ramsey's RESET2 test). As $dY_i/d\ X_{i0} = \beta_1 + 2\beta_2\ X_{i0}$ and $\beta_1 = -0.11209$, $\beta_2 = 0.00313$, we may conclude that the point of inflection is obtained for rating value $X = 17.91$. Given that only 22 of the sample observations under study have a 2000 rating higher than 17 (11% of the total sample), this result in practice corresponds to assuming a declining relationship between the 2000 rating and the growth rate between 2000 and 2003 throughout the field, thereby indicating a process of beta-convergence for this group of companies.

In the case of model (6), two facets need to be taken into account. On the one hand, this model respects non-linearity in a continuous form, contrary to the case of model (4). On the other hand, this corresponds to a specification enabling a Poisson pseudo-maximum likelihood (PPML) estimation without any logarithmic application of the parameters, thus avoiding possible econometric problems (Santos Silva and Tenreyro, 2006, 2010). In order to guarantee that the model is well specified, the RESET test was carried out and returned a good level of model specification. The results display great similarity between the Latin and the Scandinavian models.

4.2. Sigma convergence

As detailed above, analysis of convergence-related questions may adopt economic growth theory focused on two distinct perspectives on the concept – beta-convergence and sigma-convergence – and their respective mutual relationships. This latter problem was initially approached theoretically by Lichtenberg (1994), with the later work of Carree and Klomp (1997) making some significant advances.

The model proposed by Lichtenberg (1994) was estimated, with the results set out in Table 2. The estimate for the parameter associated with the regressor $(1 + \pi)$ underpins the conclusion, verifying a process of beta-convergence at the global level, which, as aforementioned, is a necessary but insufficient condition for verification of sigma-convergence. The global adherence of this model is also good (adjust$R^2 = 0.575$).

This table presents the parameter estimates for the Lichtenberg (1994) model proposed for the analysis of sigma-convergence and beta-convergence between the years 2000 and 2003, relative to progress in the corporate governance models of companies, in accordance with the annual Deminor-issued governance ratings of companies listed on the FTSE Eurofirst 300 index. We also set out the t-statistic and the respective p-value statistical results.

With regard to sigma-convergence, the tests put forward by Carree and Klomp (1997) enable the rejection, in the three different alternatives, of the null hypothesis of non-convergence and returning a p-value of very close to zero (Table 3).

In summary, for the 2000–2003 period, based on the governance ratings of the 198 companies evaluated by Deminor and listed on the Eurofirst 300 index that were rated in both 2000 and 2003, the null hypothesis that there is no process of convergence at the European level is hereby rejected.

Table 2
Lichtenberg's model estimates.

Parameter	Estimate	t-student	p-value
β_0	1.1817	11.905	0.000
$(1+\pi)$	0.5816	15.103	0.000

Table 3
Sigma convergence.

Statistics (Ti)	Estimate	Significance level, $\alpha = 5\%$
T_1	1.705	$F_{(196.196)} = 1.266$
T_2	31.056	Chi squared $_{(1)} = 3.842$
T_3	6.097	$N_{(0.1)} = 1.959$

5. Concluding remarks

Based upon Deminor's governance ratings for the 198 Eurofirst 300 listed companies issued in 2000 and in 2003, our study rejects the null hypothesis that there is no process of convergence. This conclusion is similar when evaluating either beta-convergence (company rating growth rate) or sigma-convergence (the dispersion level of company ratings). The results also suggest that there is a statistically significant difference between companies in the United Kingdom and Ireland (Anglo-Saxon model) on the one hand and all other European companies (Continental model), on the other. Thus, the convergence process differs from model to model, reflecting the statistical effects of national cultures and policies. Hence, institutional factors are relevant to the convergence process. In relation to comparisons with other empirical studies that use alternative methods, we can observe that our results broadly confirm the convergence within individual countries found by Wójcik (2006). Yoshikawa and Rasheed (2009) conducted a critical review and found that convergence has become a topic of vigorous academic debate.

The results presented are robust to alternative estimation methods. However, our analysis has some limitations. In fact, this paper uses a sample of the largest listed European companies and consequently these results should be considered carefully. Non-listed or smaller companies could be studied in further research. In addition, we may address the question of whether the corporate governance ratings supplied do not suffer from endogeneity. The use of instrumental variables suggested by related literature or the lagged values of the explanatory variables could be included in a future study (see for example Börsch-Supan and Köke, 2002; Daines et al., 2010; Larcker and Rusticus, 2010). A dynamic panel data analysis using the system GMM estimator developed by Blundell and Bond (1998, 2000) is another possible direction for future research. The dynamic GMM estimator eliminates the endogeneity that occurs due to the correlation between the specific effects and explanatory variables (see for example Baltagi et al., 2009). Another limitation of the present study is the lack of other control variables, such as firm characteristics (dimension, ownership structure, and industry) or country characteristics (shareholder and creditor rights, legal enforcement, rating of accounting standards). Finally, new econometric and empirical approaches could be applied. For example, long-run convergence can be tested using fractional integration and cointegration techniques (Barros et al., 2012), and the relation between convergence and efficiency could be analysed by applying the DEA (Data Envelopment Analysis) approach and the Bayesian Varying Efficiency Distribution (VED) model (see for example Barros et al., 2011a,b).

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