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Advancing family business research through modeling nonlinear relationships: Comparing PLS-SEM and multiple regression

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ABSTRACT

While nonlinear relationships play an important role in explaining distinct family business behaviors and outcomes, researchers rarely consider them in their theoretical and statistical models. To address this concern, this article introduces partial least squares structural equation modeling (PLS-SEM) as a suitable means for estimating nonlinear effects in latent variable models and describes its advantages vis-à-vis multiple (sum scores) regression. We conceptually compare and empirically illustrate the two methods by means of a family business research model. Based on our discussions, we provide family business researchers with a checklist of best practice recommendations when applying PLS-SEM. The article adds new methodological instruments to the family business researchers' toolbox that enable them to explain and explore the mutual and often nonlinear interactions between family and business. Thereby, this research contributes to more rigorous and meaningful family business science.

1. Introduction

The academic field of family business focuses on understanding and disentangling the effects between family and business at individual, group, and organizational levels of analysis. To investigate the mutual effects between family and business, prior research has mostly relied on linear reasoning to theorize how family involvement in key positions (such as ownership, governance, and management) affects organizational outcomes; typically by applying the logic of "the more/less family involvement, the better/worse (Cabeza-García, Sacristán-Navarro, & Gómez-Ansón, 2017; Santiago et al., 2019). However, in the way other research fields have evolved to account for nonlinear relationships, such as the "too much of a good thing is a bad thing" phenomenon in psychology (Grant & Schwartz, 2011) and management (Pierce & Aguinis, 2011), among other fields, it is unrealistic to assume that the relationship between family and business always follows a linear trend.

To overcome this limitation, family business scholars have applied theoretical and methodological approaches to explore the reciprocal impact of family involvement and business at the individual, group, and organizational levels beyond linear relationships. For example, Sciascia, Mazzola, Astrachan, and Pieper (2012) treated the relationship between family ownership and international entrepreneurship as curvilinear, forming an inverted U-shaped relation. Similarly, Cho, Miller, and Lee (2018) have shown family involvement can threaten firm survival beyond a certain level of family ownership. Finally, Herrero and Hughes (2019) provided empirical support for an inverted U-shaped relationship between family social capital and financial performance.

To improve our understanding of the state-of-the-art in methodological applications of modeling nonlinear relationships in family business research, we conducted a literature review focusing on articles investigating the mutual nonlinear relationship between family influence and firm behavior as well as performance. Our results revealed that researchers have dedicated most of their attention to nonlinear effects the family can have on business, but so far have largely ignored the nonlinear impact the business might have on the family. Methodologically, the existing studies investigating nonlinear relationships in family business seem to suffer from two main limitations. First, there is a lack of research testing the nonlinear relationships of unobservable (latent) variables that feature prominently in the field, such as socioemotional wealth (Berrone, Cruz, & Gomez-Mejia, 2012), family-oriented goals

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(Basco, 2017), and family social capital (Carr, Cole, Ring, & Blettner, 2011). This finding is surprising, since family business researchers have increasingly acknowledged that a deeper understanding of the family and business systems within the field's scope requires taking into account the perceptions, attitudes, and intentions of those involved (Pearson & Lumpkin, 2011).

Modeling such abstract concepts requires the specification of latent variables and their relationships in structural equation models (Wilson et al., 2014). However, the few studies that do test nonlinear effects between latent variables (e.g., Hatak, Kautonen, Fink, & Kansikas, 2016) rely on multiple regression analyses that use unit-weighted indicator variables of construct measures (i.e., sum scores regression), thereby neglecting the effect of measurement error (e.g., Cole & Preacher, 2014; Hair, Hult, Ringle, Sarstedt, & Thiele, 2017; Yuan, Wen, & Tang, 2020). This is problematic because measurement error—if not accounted for—can produce a combination of under- and over-estimation in the relationships between constructs in a larger nomological network. Furthermore, we observed that there is no standard convention for evaluating a nonlinear relationship's relevance by means of post-estimate analyses. This is problematic since a nonlinear effect can be significant, but not relevant (i.e., low effect size, negligible changes in the R^2 and/or negligible improvement in the out-of-sample prediction compared to the linear model).

To address these concerns, our research describes and illustrates the use of partial least squares structural equation modeling (PLS-SEM), which has recently gained considerable traction in family business research and other management fields (Hair, Sarstedt, Pieper, & Ringle, 2012), as evidenced by the numerous applications of this method (Binz Astrachan, Patel, & Wanzenried, 2014; Hair et al., 2020; Sarstedt, Ringle, Smith, Reams, & Hair, 2014). One of PLS-SEM's key features is that it relies on composites of observed variables to represent latent variables, which facilitates the estimation of different forms of nonlinear model relationships (Rigdon, Ringle, & Sarstedt, 2010). After presenting the results of our review of nonlinear relationships in family business research, we therefore discuss the efficacy of PLS-SEM vis-à-vis sum scores regression in the estimation of nonlinear effects in latent variable models. We then outline the key evaluation steps relevant in a PLS-SEM context and illustrate the method's use by extending Basco's (2013) study on the impact of family management involvement on family-oriented strategic decision making, and, finally, on firm and family economic-centered performance, assuming nonlinear relationships. More specifically, we test the nonlinear relationships between family-oriented strategic decision making and two outcome dimensions (i.e., firm and family economic-centered performance) using PLS-SEM and compare the results to those produced by sum scores regression.

This article contributes to the current family business literature by challenging the prevailing logic of linear relationships to explain the mutual effects between family and business. Our contribution is also methodological in nature, explaining how to test nonlinear relationships when latent variables are an integral part of the proposed theoretical model. This aspect is important for advancing family business research because many of the models, which often include nonlinear relationships, also involve concepts that cannot be directly observed, such as succession intention, socioemotional wealth, family-oriented goals, and transgenerational entrepreneurship, among others. Our article thus facilitates the development of more accurate and realistic research models that do not assume the reciprocal effects between family and business are necessarily always positive or negative, but can have different slopes, depending on the level of the latent variables involved.

The overarching aim of our article is to encourage researchers to extend their theoretical reasoning beyond the prevailing "the more/less, the better/worse" mantra that still dominates the family business field. Our recommendation for family business scholars is to further explore the mutual relationship between family and business by avoiding positions that hypothesize only positive or negative relationships among variables. In this line, the theoretical reasoning of family impact on business or the business impact on family should explore and develop ambidextrous and paradoxical arguments (e.g., Ingram, Lewis, Barton, & Gartner, 2016; Zellweger, 2014). By doing so, family business scholars will gain a more realistic perspective of the phenomenon under study and, consequently, develop more practical implications for business families, business/family consultants, and policy makers. Additionally, we call on scholars to routinely test for potential nonlinear effects in their latent variable models as a type of robustness check.

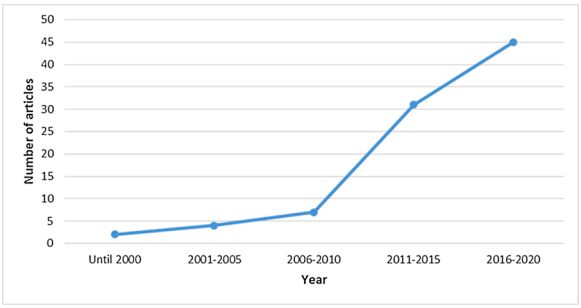

Fig. 1. Number of articles on nonlinear relationships published in peer-reviewed academic journals across time.

2. Review of nonlinear relationships in family business research

To gain an understanding of the current research landscape, we applied a systematic literature review approach for a critical analysis of models that include nonlinear relationships in family business studies. We used the Business Source Complete (EBSCO), Scopus, and Web of Science databases for our search and applied the following keywords for titles and abstracts to capture different types of nonlinear relationships: "nonlinear" OR "curvilinear" OR "U-shaped" OR "inverted U-shaped" OR "J-shaped", "S-shaped" OR "monotonic" in combination with "family firms", "family business", "family-owned business", "business family", and the single word "family." We constrained our search to articles in peer reviewed journals that were published before or during December 2020.

After removing duplicates and conceptual articles, those that did not explicitly test nonlinear relationships and did not address the central concepts of the mutual effect between family and firm, we obtained a final sample of 89 articles (Table A1). Fig. 1 shows the number of identified studies across time. The absolute number of articles that use nonlinear relationships has increased substantially during the last ten years (i.e., 76 of the 89 retrieved articles, or 85.4%). This finding confirms the growing importance of nonlinear reasoning when analyzing, both theoretically and empirically, the reciprocal effect of family on business. When evaluating the concrete types of nonlinear effects, we found the most common approach is the use of a quadratic term to create U or inverted U-shaped relationships (83 out of 89 articles, or 93.3%), while the remaining ones considered a cubic term (5 out of 89 articles, or 5.62%).

We then analyzed the articles in terms of the independent variables used to capture nonlinear relationship in each retrieved article.[1] Following Basco's (2013) classification, the selected independent variables were classified into two different approaches (Chua, Chrisman, & Sharma, 1999). The *demographic approach* focuses on the family

[1] Because we did not find articles capturing the nonlinear impact of the business on the family, from here on we focus on the family impact on the business. This observation, which stems from our literature review, can be viewed as a limitation of current research practice. Family business scholars have the opportunity to expand their study beyond the classical family impact on the firm in order to better understand the relationship from the other perspective (i.e., the ways in which business impacts the family).

involvement in the firm's observable characteristics, assuming the family involvement variables are proxies for what happens in the firm. The *essence approach*, which is behavioral in nature, measures the actual behavior—usually through latent variables, measured with multi-item scales—to capture what happens in the firm. Table A1 shows this classification in the columns "demographic variable/s to capture nonlinear relationships" and "essence variables to capture nonlinear relationships". Additionally, the column "other variables to capture nonlinear relationships" contains non-family variables that effect business outcomes (e.g., product diversification).

Our review shows that researchers have focused mainly on theorizing about and empirically testing nonlinear relationships by using demographic variables as proxies for family effects on business. The most common demographic variables for testing nonlinear relationships are: family participation in ownership (e.g., percentage of family ownership; Praet, 2013), followed by family participation in management (e.g., percentage of family members in top management positions; Ferramosca & Allegrini, 2018), and family participation in governance (e.g., percentage of family members on the board of directors; Basco, Campopiano, Calabrò, & Kraus, 2019).

While efforts to move the theoretical debate away from the traditional "the more/less, the better/worse" logic by incorporating nonlinear reasoning are laudable, the main limitation of the existing research stream is its implicit assumption that the demographic features of family involvement are reliable proxies for family firm behavior. Only a handful of research articles (4 of 89 articles, or 4.49%) consider latent variables in their testing of nonlinear relationships to overcome this limitation. Herrero and Hughes (2019), specifically, measure the curvilinear relationship between family social capital and firm performance, while Duréndez and Madrid-Guijarro (2018) focus on family culture's curvilinear effect on earnings. In addition, Rousseau, Kellermanns, Zellweger, and Beck (2018) estimate the curvilinear effect of relationship conflict and owners' valuation of their family firm. Finally, Hatak et al. (2016) consider the curvilinear moderating effect of the owner family's commitment to the firm in the relationship between innovativeness and firm performance. To estimate the nonlinear effects, however, these groups of authors compute composites (sum scores) of the corresponding construct measures, thereby attaching equal weights to each indicator—a problematic practice, as we explain in the next section.

Finally, we analyzed all the retrieved articles based on the information used to test the validity and meaningfulness of the nonlinear relationships (Lind & Mehlum, 2010). For example, a nonlinear effect could be significant but not relevant because of its low effect size, negligible changes in R^2 in comparison with a linear model, or the nonlinear model's improvement in explanatory power. Our review indicated only 17 of the 89 articles (19.10%) (e.g., Basco & Voordeckers, 2015; Bauweraerts & Colot, 2017; Pittino et al., 2020) report corresponding statistics to validate the nonlinear model's relevance (e.g., in terms of the f^2 effect size).

In summary, we conclude that family business scholars have started extending their theoretical arguments from a linear reasoning of the relationship between family and business to considering more complex nonlinear relationships. This is a positive development for the field, and we laud the efforts undertaken in this regard. But the nonlinear theoretical and empirical approach has been applied mainly to the family's effect on the firm, opening important research opportunities to explore the nonlinear nature of the firm's effect on the family. There are, however, several methodological limitations to note as well: (1) an overuse of demographic variables as proxies for firm behavior to test nonlinear relationships; (2) a lack of the use of latent variables to capture behavioral aspects to theorize and test nonlinear relationships; (3) the tendency to compute composites of latent variables giving equal weights to each indicator; and (4) lack of post-estimation analyses to validate the nonlinear relationships' relevance.

Our review suggests that opportunities for further development remain, despite the methodological improvements that family business scholars have made in terms of testing nonlinear relationships. We recommend, more specifically, that family business scholars routinely consider nonlinear relationships between latent variables, which capture the perceptions, attitudes, and intentions of the stakeholders in family businesses. In doing so, researchers should refrain from using sum scores regressions that attach equal weights to indicators of a multi-item measure. Instead, the PLS-SEM method should be used since it accounts for measurement errors and readily facilitates estimation of nonlinear effects. In the following sections, we discuss the communalities and differences between sum scores regression and PLS-SEM for estimating nonlinear effects in latent variable models.

3. Methods for estimating nonlinear models

Our literature review results confirm that relatively few authors consider nonlinear effects in models which include latent variables that capture behavioral aspects of family impact on business or vice versa. The few studies that include latent variables specify composites of multi-item scales (typically sum scores) as input for regression analyses (i.e., sum scores regression). While common, this practice is problematic because it ignores the attenuating effect of measurement error inherent in this approach. Numerous studies have shown that the failure to correct measurement errors can produce a combination of under- and over-estimation regarding the relationships between constructs in a larger nomological network (e.g., Cole & Preacher, 2014; Hair et al., 2017; Yuan et al., 2020). Conversely, PLS-SEM allows measurement error in the analyses to be reduced (Cook & Forzani, 2020; Henseler et al., 2014). The weighting procedure executed by PLS-SEM is particularly advantageous when differences between the indicator weights in a measurement model are pronounced. Conversely, when the PLS-SEM-based indicator weights are very similar, differences to sum scores regression estimates are limited (Hair et al., 2017). These results occur when indicators are highly correlated, which is associated with high internal consistency reliability values in reflective measurement models. Nevertheless, in many situations PLS-SEM's indicator weighting produces smaller biases in measurement and structural model estimates (Hair et al., 2017) and also offers concrete guidance to family business practitioners on ways in which to prioritize their management activities (Albers, 2010). That is, rather than considering all aspects covered by the indicator weights as equally important, as in sum scores regression, PLS-SEM weights the indicators individually, depending on their explanatory power in downstream model relationships (e.g., Jöreskog & Wold, 1982; Wold, 1982).

When using sum scores regressions, researchers run piecewise analyses in which each endogenous construct in the model is regressed on its immediate antecedent constructs. As a consequence, the regression estimates do not consider the larger nomological network of relationships hypothesized by the researcher. PLS-SEM also runs (partial) regressions, but the parameter estimation follows an iterative process that considers the entire model structure; that is, the model estimates in one part of the model depend on the model estimates in another part of the model (Sarstedt, Hair, Nitzl, Ringle, & Howard, 2020).[2] In addition, while the results from sum scores regression and PLS-SEM may not diverge much in small models with few constructs and a limited number of (partial) regressions, the more complex the nomological network, the greater the potential differences.

To analyze nonlinear relationships, both sum scores regression and PLS-SEM rely on a polynomial regression model of the form (Wold,

[2] Yet, PLS-SEM is a limited information approach that—unlike covariance-based SEM methods—does not estimate all model parameters simultaneously on the grounds of a single optimization criterion (Tenenhaus, 2008). However, Hwang and Cho (2020) have recently introduced a variant of the original PLS-SEM algorithm that considers a global optimization criterion.

1982):

$$Y_1 = \sum_{i=1}^{h} p_i Y_2^1 + e_1, \quad (1)$$

where Y_1 represents the endogenous construct, and Y_2 the predictor construct in a model with path coefficients p_i and an error term e_1. The model in Equation (1) corresponds to a general linear regression model with the predictor raised to the power of i (i = 1,…,h), where h represents the polynomial degree (Rigdon et al., 2010). In respect of $h = 1$, Equation (1) describes a linear relationship (i.e., Y_1=p_1Y_2+e_1), whereas polynomial degrees larger than 1 determine different types of nonlinear functions. With a higher h value, the nonlinear function becomes more complex and can take different forms of nonlinear relationships, since the number of the function turning points (i.e., h-1) also increases. For example, in respect of $h = 2$, the polynomial forms a quadratic expression; in respect of $h = 3$ a cubic expression; and in respect of $h = 4$ a quartic expression. Higher polynomials are typically considered problematic because the resulting functions tend to overfit the data with adverse consequences for the generalizability of the results (Bilger & Manning, 2015). Although these models describe nonlinear relationships between Y_1 and Y_2, the PLS path model is still considered linear, since it is linear in its path coefficients (i.e., $p_1, p_2,\ldots, p_i$) rather than, for instance,p_1^2; see Chapter 7 in Sarstedt and Mooi (2019). The following equation shows a model with a quadratic effect:

$$Y_1 = p_1 Y_2 + p_2 Y_2^2 + e_1, \quad (2)$$

where p_1 and p_2 are the path coefficients of the linear, and quadratic relationships between Y_1 and Y_2. Y_2^2 introduce a quadratic effect referred to as an interaction term describing the interplay of the predictor construct with itself (i.e., Y_2..Y_2). A quadratic effect can therefore be regarded as a special case of moderation analysis where a third variable influences the strength, or even the direction, of the relationship between the constructs in the structural model (Li, 2018). A quadratic effect differs, however, from a standard moderation set up in that the third variable corresponds to the predictor construct and self-moderates the relationship between Y_1 and Y_2. That is, the linear relationship between Y_1 and Y_2 changes in size, depending on the values of Y_2.

While the statistical model described in Equation (2) is equivalent for sum scores regression and PLS-SEM, the methods differ in terms of the inputs used for the analyses. In sum scores regression, Y_2 and Y_1 are derived from summing the construct measures, whereas PLS-SEM assigns differential indicator weights for computing the scores of all constructs involved. This difference has important implications for the creation of the interaction term. In sum scores regression, the interaction term's computation is straightforward since the constructs are represented by single-item measures in Equation (2). In PLS-SEM, however, multiple indicators are used to compute the interaction term. While researchers can compute cross-products of Y_2 to operationalizeY_2^2, research has shown that Chin, Marcolin, and Newsted's (2003) two-stage approach is more appropriate for operationalizing the interaction term (Becker, Ringle, & Sarstedt, 2018). In the first stage of their approach, the model is estimated with Y_1, but without the interaction term Y_2^2. The PLS-SEM results include the Y_1 construct scores, which allow for Y_2^2 to be computed. The second stage adds the interaction term as the single-item construct Y_2^2 to the model, for which the researcher computes the final results. PLS-SEM software packages, such as SmartPLS (Ringle, Wende, & Becker, 2015) and SEMinR (Ray, Danks, & Velasquez Estrada, 2021), automatically support the generation of a quadratic effect and the computation of its results by means of the two-stage approach.

Both sum scores regression and PLS-SEM require the researcher to explicitly hypothesize and model the nonlinear relationship as in Equation (2). This step requires careful theoretical reasoning of the expected shape within a variable's given data range. However, researchers have also proposed means to explore whether or not nonlinear relations better represent the data patterns. In a regression-based context, researchers frequently use the general-to-specific approach (Hoover & Perez, 1999), in which the researcher simplifies an initially general model that adequately characterizes the empirical evidence within his or her theoretical framework. In other words, the researcher creates a very general, deliberately over-parameterized, model, which is then progressively simplified through a sequence of tests, motivated by theory or statistical inference (e.g., using model selection criteria; Burnham & Anderson, 2002). Such an over-parameterized model may include additional interaction terms that map nonlinear relationships.

The analysis can also be automated in a specification search where the algorithm explores different polynomial forms in an effort to optimize a target criterion, such as changes in the model's F-value. Forms of specification searches have also been proposed in a PLS-SEM context. For example, the WarpPLS software (Kock, 2020) fits a set of functions to represent the observed data patterns in the best possible way. Researchers have also combined PLS-SEM with artificial neural networks to explore the PLS path model's predictive power while accounting for nonlinearities between the constructs (Abbasi, Tiew, Tang, Goh, & Thurasamy, 2021; Sharma, Dwivedi, Arya, & Siddiqui, 2021; Sohaib, Hussain, Asif, Ahmad, & Mazzara, 2020). Researchers typically use the latent variable scores from a PLS-SEM analysis as input for a feed-forward backpropagation multilayer training algorithm to train the network. This approach, however, introduces a contradiction in the analysis. While the artificial neural network captures nonlinear associations among the constructs, their scores were derived in a linear fashion.[3] Research has not offered any simulation evidence that this blending of linear and nonlinear approaches adequately accounts for nonlinearities among the constructs. Apart from the above, models resulting from such (nonlinear) specification searches often capitalize on the idiosyncrasies of the sample data (e.g., Green, Thompson, & Babyak, 1998). The analysis may yield models with higher explanatory power, but these models easily overfit the data and therefore do not generalize well to other settings (Sarstedt & Danks, 2021). Hence, specification searches to disclose nonlinearities—which are, to a certain degree, always present in the data—should be considered with caution when working with models that have been designed to offer causal explanations.

4. Evaluating nonlinear effects in PLS-SEM

Considering PLS-SEM's advantages for estimating latent variable models with nonlinear effects, we briefly outline the key analysis steps when using the method in the family business research context. Most of PLS-SEM's standard measurement and structural model evaluation criteria also apply when estimating nonlinear models. When the constructs are measured reflectively, their measurement models must meet all relevant criteria in terms of its internal consistency reliability, convergent validity, and discriminant validity. Similarly, formative measurement models need to be evaluated with regard to their collinearity, convergent validity, and the significance and relevance of the indicator weights (Hair, Risher, Sarstedt, & Ringle, 2019; Hair, Hult, Ringle, & Sarstedt, 2022; Hair, Howard, & Nitzl, 2020). There is, however, no such requirement for the interaction term, as this construct only serves as an auxiliary measurement designed to model the quadratic effect. Analogous to the interaction term in a standard moderator analysis, the interaction term's measurement model does not, therefore, have to be assessed (Hair, Sarstedt, Ringle, & Gudergan, 2018). Similarly, in the two-stage approach, the evaluation criteria only apply to the

[3] Similarly, combinations of PLS-SEM with asymmetric approaches to data analysis, such as the fuzzy-set qualitative comparative analysis (Rasoolimanesh, Ringle, Sarstedt, & Olya, 2021) and the necessary condition analysis (Richter, Schubring, Hauff, Ringle, & Sarstedt, 2020), allow capturing nonlinearities in the model.

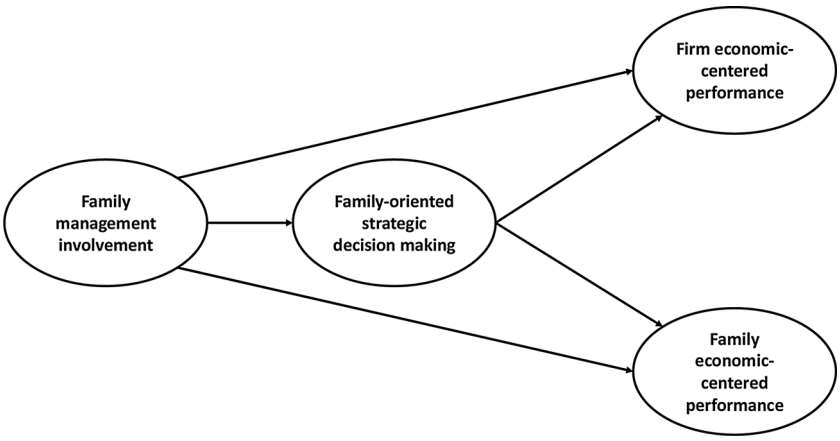

Fig. 2. Family business research model.

first stage, but not to the second since the latter only involves single-item constructs.

To assess the quadratic effect's statistical significance, researchers should run the bootstrapping procedure; for example, based on 10,000 bootstrap subsamples, the percentile approach, and the "no sign changes" option (Hair et al., 2022; Streukens & Leroi-Werelds, 2016). In case of a significant nonlinear effect, researchers should report the f^2 effect size to indicate the interaction term's impact on the endogenous construct's R^2—especially in analyses with large samples sizes, where even very small coefficients can become significant. While standard guidelines suggest f^2 values of 0.02, 0.15, and 0.35, respectively, represent small, medium, and large effect sizes, Aguinis, Beaty, Boik, and Pierce (2005) have shown the average effect size in moderation assessments is only 0.009. Against this background, Kenny (2018) proposes that 0.005, 0.01, and 0.025 constitute more realistic standards for, respectively, small, medium, and large effect sizes, but also points out that even these values are optimistic, given Aguinis et al.'s (2005) review. Hair et al. (2018) provide guidelines for establishing reliability and validity of construct measures in PLS path models involving nonlinear relationships.

Researchers should also compare the more complex nonlinear model with the more parsimonious linear variant using model selection criteria, which are well-known from the regression literature. Sharma, Sarstedt, Shmueli, Kim, and Thiele (2019) and Sharma, Shmueli, Sarstedt, Danks, and Ray (2018) recently compared the efficacy of various metrics for model comparison tasks and found Schwarz's (1978) BIC and Geweke and Meese's (1981) GM perform well in selecting a parsimonious model that fits the data well and has a good predictive power. As the BIC is easier to compute, extant literature recommends focusing on this criterion (Hair et al., 2022). If this analysis suggests the linear model achieves a better balance between model complexity and fit in terms of raw BIC values or BIC-based Akaike weights (Danks, Sharma, & Sarstedt, 2020), researchers should discard the nonlinear model and interpret the more parsimonious (linear) variant.

In summary, when analyzing nonlinear effects, family business researchers should consider the following rules of thumb (Hair et al., 2018):

- Establish your expectations of the nonlinear relationships a priori on the basis of theoretical considerations, or on a previous analysis of the relationships between the latent variables by means of scatterplots. Consider testing routinely for potential nonlinear effects as a type of robustness check (Sarstedt et al., 2019). Keep in mind that linear effects often offer reasonable approximations of nonlinear effects.
- Use the two-stage approach to create the nonlinear term.
- Create the quadratic term, or any other nonlinear effect, on the basis of standardized data.
- Evaluate if the nonlinear effects are significant by using the 95% percentile confidence intervals obtained from bootstrapping (i.e., by using 10,000 subsamples)—assuming a 5% significance level.
- Assess the relevance of significant nonlinear effects based on the f^2 effects size. Outcomes higher than 0.005, 0.01, and 0.025, respectively, constitute small, medium, and large f^2 effect sizes.
- Use the BIC to substantiate that the more complex nonlinear model achieves a better tradeoff between model complexity and fit compared to the nonlinear counterpart.

In the next section, we illustrate how family business researchers can conduct a nonlinear relationship analysis in PLS-SEM by following these guidelines and contrast the results with those produced by sum scores regression.

5. Empirical application

5.1. Model and data

To illustrate the computation of nonlinear effects in PLS-SEM, we extend Basco's (2013) study on the impact of family involvement in management on family-oriented strategic decision making, and on firm and family economic-centered performance (Fig. 2). Using data from 567 Spanish family firms, Basco's (2013) model estimation, using covariance-based SEM, supports the model's fit. The model estimation shows that family involvement has a positive, direct impact on family-oriented strategic decision making, and indirect effects on firm and family economic-centered performance. However, family involvement in management does not impact the two performance constructs directly and significantly ($p < 0.05$).

We extend this study by estimating the model using PLS-SEM, which follows a different measurement philosophy, by relying on composites, rather than on common factors, to represent the conceptual variables of interest in the statistical model (Rhemtulla, van Bork, & Borsboom, 2020; Rigdon, Sarstedt, & Ringle, 2017; Sarstedt, Hair, Ringle, Thiele, & Gudergan, 2016). Our primary concern is to test for a possible nonlinear relationship between family-oriented strategic decision making and the two performance constructs; that is, firm and family economic-centered performance. However, we theoretically expect that family influence on strategic decision making will show a convex function (positive exponential effect) in terms of family economic-centered performance, but not necessarily with firm economic-centered performance. Our rationale to justify this nonlinear relationship is that, when strategic decision making recognizes family needs and expectations, the dominant coalition would create the conditions to accelerate the family

Table 1
PLS-SEM results of the structural model

Path coefficients	Original model	Nonlinear model PLS-SEM	Nonlinear model sum scores regression
Family management involvement → Family-oriented strategic decision making	0.237 [0.158; 0.319]	0.237 [0.161; 0.315]	0.234 [0.157; 0.309]
Family management involvement → Firm economic-centered performance	0.014 [-0.078; 0.100]	0.007 [-0.08; 0.097]	0.005 [-0.079; 0.089]
Family management involvement → Family economic-centered performance	−0.063 [-0.143; 0.016]	−0.073 [-0.157; 0.003]	−0.074 [-0.149; 0.005]
Family-oriented strategic decision making → Firm economic-centered performance	0.165 [0.089; 0.261]	0.244 [0.146; 0.350]	0.243 [0.133; 0.343]
Family-oriented strategic decision making → Family economic-centered performance	0.324 [0.260; 0.404]	0.449 [0.371; 0.541]	0.446 [0.357; 0.529]
Family management involvement → Family-oriented strategic decision making → Firm economic-centered performance	0.077 [0.050; 0.113]	0.058 [0.031; 0.094]	0.057 [0.029; 0.091]
Family management involvement → Family-oriented strategic decision making → Family economic-centered performance	0.039 [0.020; 0.068]	0.106 [0.071; 0.151]	0.104 [0.066; 0.146]
Family-oriented strategic decision making^2 → Firm economic-centered performance	-	0.102 [0.036; 0.168]	0.108 [0.042; 0.170]
Family-oriented strategic decision making^2 → Family economic-centered performance	-	0.163 [0.102; 0.222]	0.167 [0.108; 0.226]
R^2			
Family-oriented strategic decision making	0.056	0.056	0.055
Firm economic-centered performance	0.029	0.046	0.045
Family economic-centered performance	0.099	0.142	0.140
BIC			
Firm economic-centered performance	1.534	−2.140	−1.993
Family economic-centered performance	−41.386	−62.790	−61.195

Note: 95% bootstrap confidence intervals (percentile approach, 10,000 subsamples) in brackets.

economic-centered performance achievement. Basing our reasoning on institutional logics (Thornton, Ocasio, & Lounsbury, 2012), we argue that the family influence on strategic decision making shifts a firm's focus of attention toward both business-oriented and family-oriented goals. The focus of attention on family-oriented goals directs resources and develops familiness learning mechanisms (Barros-Contreras, Basco, Martín-Cruz, & Hernangómez, 2021), making family involvement in the business more efficient and, consequently, accelerating the achievement of family economic-centered performance.

Our application draws on Basco's (2013) data and uses the same measurement model setup as in the original study. To estimate the model, we applied SmartPLS 3 (Ringle et al., 2015) with default algorithm settings, using bootstrapping with 10,000 subsamples (Streukens & Leroi-Werelds, 2016). We followed the guidelines by Hair, Howard, and Nitzl (2020) to assess the PLS-SEM results. In the following section, we report the results of the evaluation of the measurement models, followed by the structural model assessment.

5.2. Results

We first estimated the original model and subsequently extended it by adding quadratic effects for the two relationships from family-oriented strategic decision making to firm economic-centered performance and to family economic-centered performance. Analyzing the measurement models, we found support for the measures' reliability and validity (Table A2). More specifically, all the construct measures yielded high levels of internal consistency reliability, as evidenced by Cronbach's alpha, the composite reliability ρ_c, and the ρ_A values above 0.7 (Hair et al., 2020; Sarstedt, Ringle, & Hair, 2017). The convergent validity was supported, since all the average variance extracted values were larger than 0.5. Finally, for the discriminant validity assessment, using the Henseler, Ringle, and Sarstedt (2015) heterotrait-monotrait ratio of the correlations (Table A3) showed that all the values were significantly lower than the conservative threshold of 0.85 (Franke & Sarstedt, 2019; Hair et al., 2022).

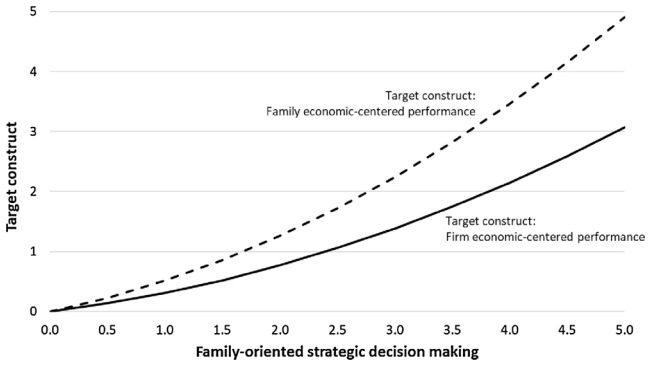

Fig. 3. Quadratic effects plot.

Analyzing the structural model (Table 1), we found the model's explanatory power was low, as evidenced by R^2 values of less than 0.1 with respect to all three endogenous constructs. However, running Shmueli, Ray, Velasquez Estrada, and Chatla's (2016) $PLS_{predict}$ procedure on the data indicated the model's predictive power was intermediate, since two of the four indicators in the firm and the family economic-centered performance produced lower RMSE values in the PLS-SEM analysis than in the naïve linear benchmark model (Binz Astrachan et al., 2014; Henseler et al., 2014; Sarstedt et al., 2016; Shmueli et al., 2019). The structural model estimates produced the same findings as Basco's (2013) analysis. More specifically, all the direct and indirect effects were significant ($p < 0.05$), except for the family management involvement's direct relationships with the firm and the family economic-centered performance. The structural model relationships were generally lower than in Basco (2013), which is expected when contrasting PLS-SEM with covariance-based SEM (Binz Astrachan et al., 2014; Henseler et al., 2014; Sarstedt et al., 2016).

Next, following the aforementioned logic we extended the original model with two nonlinear (quadratic) effects between the family-oriented strategic decision making and the two performance constructs (i.e., the firm and the family economic-centered performance). To do so, we added a quadratic interaction term for each relationship, and adopted the two-stage approach for model estimation, using the SmartPLS 3 software (Ringle et al., 2015). The PLS-SEM results showed that linear effects of family-oriented strategic decision-making increased from 0.165 (firm economic-centered performance) and 0.324 (family economic-centered performance) to 0.244 and 0.449, respectively (Table 1). In addition, the analysis showed the interaction terms had significant ($p < 0.05$) positive direct effects on firm economic-centered performance (0.102) and on family economic-centered performance (0.163). An increase in family-oriented strategic decision making by one standard deviation unit therefore increased the relationship with firm economic-centered performance by 0.102 (i.e., from 0.244 to 0.346). Similarly, the relationship between family-oriented strategic decision making and family economic-centered performance changed by 0.163 (i.e., from 0.449 to 0.612). These results suggest the relationship between family-oriented strategic decision making and the two

performance constructs increases exponentially for higher levels of family-oriented strategic decision making.

To illustrate the nonlinear relationships, we derived the unstandardized path coefficients from the analysis, and plotted the construct values according to their indicators' scale levels (1 to 5, with higher values indicating higher degrees of family-oriented strategic decision making and performance) using spreadsheet software.[4] The illustration in Fig. 3 confirms our anticipated result that an increase in family-oriented strategic decision making has a positive exponential effect on family economic-centered performance.

We next assessed the relevance of the nonlinear relationships. With f^2 effect sizes of 0.017 (firm economic-centered performance) and 0.050 (family economic-centered performance), the effects can be considered moderate and strong, respectively.

Comparing the models in terms of the BIC values of their two performance constructs, we found that the nonlinear model had a higher model fit (Sharma et al., 2018). More specifically, the nonlinear model produced lower BIC values for both family economic-centered performance (-62.790) and firm economic-centered performance (-2.140) than those in the original model (-41.386 and 1.534) (Table 1). These results support the relevance of the nonlinear relationships and suggest the nonlinear model balances model complexity and fit better than the linear model specification (Sharma et al., 2018).

Finally, we estimated the nonlinear model using sum scores regressions in which each indicator is weighted equally in its measurement model. Table 1 shows the estimates produced by sum scores regression largely correspond to the PLS-SEM-based estimates. This result is not surprising, considering the model's limited complexity and the small ranges of indicator loading estimates in PLS-SEM for family economic-centered performance (range = 0.138), family-oriented strategic decision making (range = 0.104), and firm economic-centered performance (range = 0.076). Nevertheless, comparing the results on the grounds of BIC, we find that sum scores regression produces higher values (family economic-centered performance: -61.195; firm economic-centered performance: -1.993), thereby indicating the PLS-SEM estimates offer a better fit. But with models that include formative measurement whose indicators do not correlate highly, greater differences between PLS-SEM and sum scores regression can be expected.

6. Conclusion

Our literature review of nonlinear relationships in the field of family business demonstrated that an increasing number of studies acknowledges the commonly implied "the more/less, the better/worse" reasoning does not apply universally when theorizing and testing the reciprocal effect between family and business (e.g., Boling, Pieper, & Covin, 2016; Calabrò, Campopiano, & Basco, 2017; Herrero & Hughes, 2019). While there is evidence of an increasing interest in moving the theoretical reasoning from linear to nonlinear relationships, prior research largely focused on demographic variables and single-item proxies, such as family involvement in a firms' ownership, governance, and management, to test for mainly curvilinear relationships (one type of nonlinear relationship). Testing nonlinear relationships among latent variables that capture behavioral aspects of the family firm and business families is not common in the family business field, and in the few articles using latent variables, authors convert them into sum scores composites of multi-item scales to be used as input in regression analyses, thereby ignoring the attenuating effect of measurement error inherent in the items.

One potential reason for the dearth of research testing nonlinear relationships in latent variable models is the methodological challenges of estimating complex nonlinear relationships. Our article addresses this concern by closing this methodological gap and offering family business researchers guidelines for specifying, estimating, and evaluating nonlinear relationships in their models through PLS-SEM. In doing so, our overarching aim is to encourage family business researchers to theoretically re-direct their investigations toward nonlinear reasoning. Our call for considering nonlinearities aligns with the current evidence that family firms attempt to adjust and balance both the family and business needs (Elsbach & Pieper, 2019), emotions (Labaki & D'Allura, 2021), and goals (Basco, 2017), which justifies a shift from "either/or" reasoning to "both/and" reasoning for an improved understanding of the reciprocal effect between family and business at individual, group, and organizational levels of analysis (e.g., Hayward, Hunt, & Miller, 2021; Ingram et al., 2016).

From an academic perspective, modeling nonlinear relationships between latent variables could help to challenge mainstream theories from management, finance, psychology, and strategic management fields. For instance, the too-much-of-a-good-thing (Pierce & Aguinis, 2011) effect in family-oriented business goals and/or the perception of their achievement, which act as a bounded rationality frame for family business managers, could trigger stewardship or agency behavior among family members and shift a firm's strategic behaviors (Williams, Pieper, Kellermanns, & Astrachan, 2018). In a world where social aspects are as important as economic aspects informing how non-economic goals affect firm behavior, it is relevant for the inverse knowledge contribution of the family business field to mainstream research to gain external legitimacy and recognition as a research field (Perez Rodriguez & Basco, 2011). Eventually, since the current evolution of the family business field focuses on abstract concepts measured by latent variables, such as "familiness" to capture the effect of the family on the firm (Frank, Kessler, Rusch, Suess–Reyes, & Weismeier–Sammer, 2017), and "enterpriseness" of business families to analyze the effect in the opposite direction (Frank, Suess-Reyes, Fuetsch, & Kessler, 2019), nonlinear modeling of these constructs could help refine the current attempts to develop family business theories. This step is particularly necessary for the development of family business knowledge, since the family business field attempts to explore, analyze, and, eventually, predict how the family affects the way an organization is owned, governed, and managed, and how the organization, in turn, affects the way a business family works via the interpersonal relationships among its members. Consequently, non-nonlinear reasoning could help researchers approach the phenomenon from a perspective that better reflects reality.

Finally, from a practitioner's perspective, nonlinear theoretical reasoning could develop a more realistic explanation of the mutual relationship between family and business in terms of behavior and outcomes at individual, group, and organizational levels. Such an explanation could, consequently, be used to develop useful knowledge to inform decision making within business families and among practitioners. In other words, if researchers were able to explain in which area of the organization the level of family participation in the firm changes into a negative factor, and when this change happens, applied knowledge could serve as a functional guide for these businesses to own, govern, and manage their family firms. For instance, it is well documented that family involvement in business imposes the organization's family-oriented goals (Williams, Pieper, Kellermanns, & Astrachan, 2019) alongside the traditional business-oriented goals on the business decisions made. However, understanding the implications of family and business-oriented goals for a family business is a research path that has only been explored to a very limited extent. While a linear theorizing approach would try to answer whether family-oriented goals are good or bad for family firm success, a nonlinear theorizing approach would focus on the threshold where a good (bad) factor, such as family-oriented goals, results in a bad (good) outcome for family business success. An increase in applied theories or practical implications gleaned from the current theoretical knowledge is not a trivial consequence, since building strong connections between academia and practice could further develop the family business field's legitimacy.

[4] The associated Excel file can be downloaded from the Downloads section at https://www.pls-sem.net/.

Table 2
Selected questions related to some salient constructs in the field of family business research.

Constructs	Research questions
Family-oriented goals (FoG) and socio-emotional wealth (SEW)	**Firm domain:** • Do FoG and SEW affect family firm latent dimensions (such as psychological ownership, entrepreneurial orientation, strategic behavior, corporate social responsibility, preferential family member treatment, and succession intention, among others)? Are these relationships nonlinear? • Do FoG and SEW affect family firm performance (e.g., economic, financial, and non-economic performance)? Are these relationships nonlinear? Is there a threshold where the good (bad) of FoG or SEW turns into bad (good) for family firm performance? **Family domain** • Do FoG and SEW affect family psychosocial and transactional dimensions? Are these relationships nonlinear? • Do FoG and SEW affect family wellbeing? Are these relationships nonlinear? Is there a threshold where the good (bad) of FoG or SEW turns into bad (good) for family wellbeing?
Family aspirations (FA), positive family climate (PFC), and identification with family firm (IFF)	**Firm domain** • Do family firm latent dimensions which capture organizational behavioral aspects (such as psychological ownership, entrepreneurial orientation, strategic behavior, corporate social responsibility, preferential family member treatment, and succession intention, among others) affect FA, PFC, and IFF? Are these relationships nonlinear? • Do past firm performance achievements affect FA, PFC, and IFF? Are these relationships nonlinear? **Family domain** • Do FA, PFC, and IFF affect family psychosocial and transactional dimensions? Are these relationships nonlinear? • Do FA, PFC, and IFF affect family wellbeing? Are these relationships nonlinear? Is there a threshold where the good (bad) of FA, PFC, or IFF turns into bad (good) for family wellbeing?
Familiness, family social capital, and family human capital	**Firm domain** • Do familiness affect family firm latent dimensions (such as psychological ownership, entrepreneurial orientation, strategic behavior, corporate social responsibility, preferential family member treatment, and succession intention, among others)? Are these relationships nonlinear? • Do familiness dimensions affect family firm performance (e.g., economic, financial, and non-economic performance)? Are these relationships nonlinear? Is there a threshold where the good (bad) of familienss turns into bad (good) for family firm performance? **Family domain** • Do familiness dimensions affect family psychosocial and transactional dimensions? Are these relationships nonlinear? • Do familiness dimensions affect family wellbeing? Are these relationships nonlinear? Is there a threshold where the good (bad) of familienss turns into bad (good) for family wellbeing?
Family firm image (FFI) and family firm reputation (FFR)	**Firm domain** • Do FFI and FFR affect family firm latent dimensions (such as psychological ownership, entrepreneurial orientation, strategic behavior, corporate social responsibility, preferential family member treatment, and succession intention, among others)? Are these relationships nonlinear? • Does FFI and FFR affect family firm performance (e.g., economic, financial, and non-economic performance)? Are these relationships nonlinear? Is there a threshold where the good (bad) of FFI or FFR turns into bad (good) for family firm performance? **Family domain** • Do FFI and FFR affect family psychosocial and transactional dimensions? Are these relationships nonlinear? • Do FFI and FFR affect family wellbeing? Are these relationships nonlinear? Is there a threshold where the good (bad) of FFI and FFR turns into bad (good) for family wellbeing?

In light of the above, we encourage family business researchers to theoretically and empirically explore nonlinear relationships when analyzing latent variable models. This recommendation is even more important for developing solid family business theories or challenging existing theories when latent dimensions capture specificities of the family in business (such as family-oriented goals) or business in family (such as family aspirations). Table 2 contains some of the most salient constructs related to family in business and business in family, and their potential nonlinear relationships with other constructs, including firm performance and family wellbeing. For instance, while empirical evidence has shown that the dimensions of socioemotional wealth affect firm entrepreneurial orientation (Hernández-Perlines, Moreno-García, & Yáñez-Araque, 2019), it is implausible these relationships follow a "the more the better" logic. More specifically, assuming, for instance, that emotional attachment of family members always boosts firm entrepreneurial orientation is certainly questionable. It is reasonable to assume that emotional attachment has a positive effect on entrepreneurial orientation at moderate levels of emotional attachment because emotions can encourage communication, define common goals, and facilitate fast decision all of which are important characteristics for developing an entrepreneurial orientation. However, high levels of emotional attachment can have a negative effect because it creates family-centric behavior (Kellermanns, Eddleston, & Zellweger, 2012). Following this logic, there should be a threshold where the positive effect of having family members with emotional attachment triggers negative effects. That is, high levels of emotional attachment instead of boosting firm entrepreneurial orientation may create conservative strategic postures in family firms.

Table A1
Retrieved articles with nonlinear relationships

#	Authors (year)	Journal	Sample/country	Demographic variable/s to capture nonlinear relationships	Essence variables to capture nonlinear relationships	Other variables to capture nonlinear relationships	Type of nonlinear relationship	Yes/no: Further information to evaluate the nonlinear relationship / Type of analysis
1	Acero and Alcalde (2016)	Review Management Science	Family and non-family firms / Spain			Ownership concentration	Curvilinear relationship	No Feasible generalized least squares
2	Acquaah (2011)	European Management Journal	Family and non-family firms / Ghana			Networking relationships with government political leaders bureaucratic officials, and community leaders	Curvilinear relationship	No Pooled time series
3	Almodóvar, Verbeke, and Rodríguez-Ruiz (2016)	Journal of Leadership & Organizational Studies	Family firms / Spain				Cubic relationship	No Tobit Panel
4	Amin & Liu (2020)	International Review of Financial Analysis	Family and non-family firms / Singapore			Proportion of control rights owned by the 10 largest controlling shareholder	Curvilinear relationship	No GMM regression
5	Anderson & Reeb (2003)	Journal of Finance	Family firms / USA	Family ownership		Educational level R&D Staff	Curvilinear relationship	No Fixed effect models
6	Arosa, Iturralde, & Maseda (2010)	Journal of Family Business Strategy	Family and Non-Family Firms / Spain	Family ownership concentration Ownership concentration			Curvilinear relationship	No Regression
7	Arregle et al. (2015)	Entrepreneurship Theory and Practice	Entrepreneurial ventures / US, China, Russia, and France	Family percentage in business advice Family percentage emotional support Family percentage in business resource network			Curvilinear relationship	No Regression
8	Bacci, Cirillo, Mussolino, and Terzani (2018)	Small Business Economics	Family firms / Italy	Family equity dispersion			Curvilinear relationship	No Panel regression fixed effect
9	Barkema and Penning (1998)	Organizational Studies	Family and Non-family firms / Netherlands	Shares held by executive's families			Curvilinear relationship	No Regression
10	Basco, Campopiano, Calabrò, & Kraus (2019)	Journal of Small Business Management	Family firms / Spain	Proportion of family members in the board Ratio of executive family directors			Curvilinear relationship	Yes, Sasabuchi test Regression
11	Basco & Voordeckers (2015)	Journal of Management & Organization	Family firms / Spain			Ratio of outside board members	Curvilinear relationship	Yes, Sasabuchi test Regression
12	Bauweraerts & Colot (2017)	Journal of Business Research	Family firms / Belgium	Family involvement in the board			Curvilinear relationship	Yes, F-test, Sasabuchi test and Filler approach Regression
13	Bauweraerts, Diaz-Moriana, & Arzubiaga (2020)	European Management Review	Family firms / Belgium	Family Management			Curvilinear Relationship	No 2SLS regression
14	Binacci, Peruffo, Oriani, & Minichilli (2016)	Corporate Governance	Family firms / Italian			Non-family managers size Non-family managers organizational tenure diversity	Curvilinear relationship	No Regression
15	Bjuggren, Duggal & Giang (2012)	Journal of Small Business & Entrepreneurship	Family and non-family firms / Sweden			Balance of voting power	Curvilinear relationship	No Regression
16	Boling, Pieper, & Covin (2015)	Entrepreneurship Theory and Practice	Family and non-Family firms / USA			CEO tenure	Curvilinear relationship	No Regression
17	Calabrò, Campopiano, & Basco (2017)	Journal of Family Business Management	Family firms / Germany	Size of the family owner group			Curvilinear relationship	Yes, Sasabuchi test Regression

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Table A1 (*continued*)

#	Authors (year)	Journal	Sample/country	Demographic variable/s to capture nonlinear relationships	Essence variables to capture nonlinear relationships	Other variables to capture nonlinear relationships	Type of nonlinear relationship	Yes/no: Further information to evaluate the nonlinear relationship / Type of analysis
18	Carrasco-Hernández & Jiménez-Jiménez (2016)	European Journal of Family Business	Family and non-family firms / Spain	Family involvement in ownership Family involvement in management			Curvilinear relationship	No Regression
19	Catuogno, Arena, Cirillo, & Pennacchio (2018)	Journal of Family Business Strategy	Family firms / Italy	Family Ownership			Curvilinear relationship	No Multinomial logit regression
20	Che and Langli (2015)	Journal of Business Finance & Accounting	Family firms / Norway	Family ownership			Curvilinear relationship	Yes, several robustness check Regression with piecewise linear specification
21	Che and Zhang (2017)	Journal of Management and Governance	Family firms /Norway	Family CEO Ownership			Curvilinear relationship	Yes, Regression with piecewise linear specification *and* quadratic terms
22	Chirico & Bau (2014)	Journal of Small Business Management	Family firms / Switzerland	Family involvement on TMT			Curvilinear relationship	Yes, F-test Regression
23	Chirico et al. (2020)	Entrepreneurship Theory and Practice	Family firms / Italy	Family ownership			Curvilinear relationship	Yes, Wald test, Sasabuchi test Zero-Inflated Negative Binomial Regression
24	Cho, Miller, & Lee (2018)	Journal of Family Business Strategy	Family firms / Korea	Family ownership			Curvilinear relationship	Yes, test slop at both side of the inflection point Cox Proportional Hazzard Analysis
25	Davis & Harveston, (1999)	Family Business Review	Family firms / USA	Generation			n.s.	No Descriptive statistics
26	De Massis, Chirico, Kotlar, & Naldi (2014)	Family Business Review	Family firms / Switzerland			Firm age	Cubic relationship	No Hierarchical Analysis
27	De Massis, Kotlar, Campopiano, & Cassia (2013)	Journal of Family Business Strategy	Family firms / Italy	Family involvement in TMT Family ownership Family Ownership dispersion			Curvilinear relationship	No Regression
28	De Massis, Kotlar, Campopiano, & Cassia (2015)	Journal of Small Business Management	Family firms / Italy	Family ownership Family ratio in top management team			Curvilinear relationship	No Regression
29	Dehlen, Zellweger, Kammerlander, and Halter (2014)	Journal of Business Venturing	/ Germany, Switzerland, and Austria			Level of screening (the effort made by the incumbent before transfer the firm)	Curvilinear relationship	No Logit regression
30	Delbufalo, Poggesi, & Borra (2016)	Journal of Management Development	Family firms / Italy			Product diversification Geographic diversification	Curvilinear relationship	No Fixed-effect Panel Data Regression
31	Ding and Wu (2014)	Journal of Business Ethics	Family and non-family firms / USA			Firm age	Curvilinear relationship	No Logistic regression
32	Duran & Ortiz (2019)	Entrepreneurship Theory and Practice	Family firms / Chile	Number of families			Curvilinear relationship	Yes, test slop at both side of the inflection point Pooled Regression
33								No

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Table A1 (*continued*)

#	Authors (year)	Journal	Sample/country	Demographic variable/s to capture nonlinear relationships	Essence variables to capture nonlinear relationships	Other variables to capture nonlinear relationships	Type of nonlinear relationship	Yes/no: Further information to evaluate the nonlinear relationship / Type of analysis
	Duréndez & Madrid-Guijarro (2018)	Journal of Family Business Strategy	Family firms / Spain		Family influence: Power, culture, and experience		Curvilinear relationship	Regression
34	Ernst, Kraus, and Matser (2012)	International Journal of Entrepreneurship and Innovation Management	Family firms / Netherlands			Firm age	Curvilinear relationship	No Regression
35	Ferramosca and Allegrini (2018)	Journal of Family Business Strategy	Family firms / Italy	Number of family members involved in C-suite roles			Curvilinear relationship	Yes, change in the R-squared, goodness of fit Random-effect Panel Data regression
36	Gallucci and D'Amato (2013)	International Journal of Wine Business Research	Family firm and non-family firms / Italy	Family power (presence of family members in the ownership and the board of directors)			Curvilinear relationship	No Panel Regression
37	Gupta and Nashier (2017)	Quarterly Journal of Finance and Accounting	Family and non-family firms / India	Family ownership		Non-family promoter ownership	Curvilinear relationship	No Feasible generalized least squares
38	Graafland (2020)	Journal of Cleaner Production	Family firms / 12 European countries	Family involvement in management			Curvilinear relationship	No Structural Equation Modelling
39	Hatak, Kautonen, Fink, & Kansikas (2016)	Technological Forecasting & Social Change	Family firms / Finland		Family commitment		Curvilinear relationship	No Regression
40	Hernández-Trasobares & Galve-Górriz (2020)	Thunderbird International Business Review	Family and non-family business groups / Spain	Family ownership concentration			Curvilinear relationship	No Panel data regression model
41	Herrero & Hughes (2019)	Journal of Family Business Strategy	Family firms / Spain		Family social capital		Curvilinear relationship	Yes, Sasabuchi test and Fieller approach Hierarchical Regression Analysis
42	Huang, Chen, Xu, Lu, & Ka-Chai (2020)	Administrative Science Quarterly	Family firms / China and Taiwan	Child-successors' Wellingness Child-successors' Capacity			Curvilinear relationship	Yes, test slop at both side of the inflection point Hierarchical Linear regression
43	Jara, López-Iturriaga, and Torres (2021)	Journal of Business Research	Family controlled firms / Chile			Cash flow rights of the ultimate shareholder Different between voting rights and cash flow rights	Curvilinear relationship	No GMM regression
44	Jara, Pinto-Gutiérrez, and Núñez (2018)	Emerging Markets Finance & Trade	Family and non-family firms / Chile			Excess control rights	Curvilinear relationship	No 2SLS regression
45	Kabbach de Castro, Aguilera, and Crespí-Cladera (2016)	Family Business Review	Family firms / UK, Spain and Germany	Family ownership			Curvilinear relationship	Yes, Fieller approach Zero-Inflated Binomial Regression
46	Kammerlander, Patzelt, Behrens, & Röhm (2020)	Family Business Review	Family firms / Germany	Family involvement in TMT			Curvilinear relationship	No Regression
47	Kim, Kim, and Lee (2008)	Organizational Science	Family and non-family firms / Korea			Financial slack	Curvilinear relationship	No Generalized least squares
48	Kowalewski, Talavera, & Stetsyuk (2010)	Family Business Review	Family and non-family firms / Poland	Family share			Curvilinear relationship	No Two-Step Generalized Method of

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Table A1 (*continued*)

#	Authors (year)	Journal	Sample/country	Demographic variable/s to capture nonlinear relationships	Essence variables to capture nonlinear relationships	Other variables to capture nonlinear relationships	Type of nonlinear relationship	Yes/no: Further information to evaluate the nonlinear relationship / Type of analysis
								Moment Estimates
49	Labelle, Hafsi, Francoeur, & Ben Amar (2018)	Journal of Business Ethics	Family and non-family firms / Countries belonging to AECD and five Asian countries	Family control (voting rights)			Curvilinear relationship	No Regression
50	Laffranchini & Braun (2014)	Journal of Family Business Management	Family and Non-Family Firms / Italy			Available Slack resources	Curvilinear relationship	No Feasible generalized least square
51	Liang, Wang, & Cui (2013)	Family Business Review	Family firms / China	Family involvement in management Family ownership			Curvilinear relationship	No Logistic regression
52	Lo, Ting, Kweh, and Yang (2016)	International Review of Financial Analysis	Family and non-family firms / Taiwan			Ultimate owner's control	Curvilinear relationship	No Pooled regression
53	Lozano, Martínez, & Pindado (2016)	International Business Review	Family and non-family firms / 16 European countries			Ownership concentration	Curvilinear relationship	No GMM regression
54	Luo, Wan, Cai, & Liu (2013)	Management and Organization Review	Family firms / China			Contest for control	Curvilinear relationship	No Feasible generalized least squares
55	Maseda, Iturralde, Aparicio, Boulkeroua, & Cooper (2019)	European Journal of Management and Business Economics	Family firms / Spain	Family ownership in the board			Cubic relationship	No Regression
56	Maseda, Iturralde, and Arosa (2015)	Journal of Small Business Management	Family firms / Spain			Ratio of nonemployee directors	Curvilinear relationship	No Regression
57	Mazzola, Sciascia, and Kellermanns (2013)	Journal of Business Research	Family firms / Italy	Family involvement in ownership Family involvement in the board of directors Family involvement in management			Curvilinear relationship	No Regression
58	Mbanyele (2020)	Cogent Economics & Finance	Family and non-family firms / Italy			Ownership concentration	Curvilinear relationship	No Fixed effects regression
59	Memili, Fang, Chrisman, and De Massis (2015)	Small Business Economics	Family and non-family firms / USA	Family SME prevalence (in an economy) Family ownership			Curvilinear relationship	No Fixed effect regression
60	Memili, Misra, Chrisman, and Welsh (2017)	International Journal of Management and Enterprise Development	Family firms / USA	Family management			Curvilinear relationship	No Tobit fixed effects Panel data
61	Miller, Amore, Le Breton-Miller, Minichilli, & Quarato (2018)	Journal of Family Business Strategy	Family firms / Italy			Conformity index	Curvilinear relationship	No Pooled regression
62	Minichilli, Corbetta, & MacMillan (2010)	Journal of Business Studies	Family firms / Italy	Top Management Team family ratio			Curvilinear relationship	No Hierarchical multiple regression
63	Mitter, Duller, Feldbauer-durstmüller, and Kraus (2014)	Review Management Science	Family firms / Austria	Family influence (ownership, management, and governance)			Curvilinear relationship	No Binary logistic regression
64	Naldi, Chirico, Kellermanns, and Campopiano (2015)	Family Business Review	Family firms / Sweden	Family member advisors			Curvilinear relationship	Yes, Sasabuchi test and Fieller approach Regression

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Table A1 (*continued*)

#	Authors (year)	Journal	Sample/country	Demographic variable/s to capture nonlinear relationships	Essence variables to capture nonlinear relationships	Other variables to capture nonlinear relationships	Type of nonlinear relationship	Yes/no: Further information to evaluate the nonlinear relationship / Type of analysis
65	Pattanayak (2010)	Asia Pacific Journal of Economic & Business	Family and non-family firms / India	Share of the founding family/ insider/promoter			Curvilinear relationship	No Fixed effects regression
66	Pindado, Requejo, & de la Torre (2014)	Journal of Empirical Finance	Family non-family firms / Western Europe			Ownership concentration	Curvilinear relationship	No GMM regression
67	Pittino et al. (2020)	Journal of Family Business Strategy	Adult Population / Mexico			Household size	Curvilinear relationship	Yes, Sasabuchi test and Fieller approach Logistic regression
68	Poutziouris, Savva, and Hadjielias (2015)	Journal of Family Business Strategy	Family and Non Family firms / UK	Family ownership			Curvilinear relationship	No Two-way fixed effects model
69	Praet (2013)	Journal of Family Business Strategy	Family firms / Belgium	Family ownership			Curvilinear relationship	No Logistic regression
70	Razzaque, Ali, & Mather (2020)	Pacific Basin Finance Journal	Family and Non-Family firms / Bangladesh	Family ownership			Curvilinear relationship	No Panel data regression
71	Rousseau, Kellermanns, Zellweger, & Beck (2018)	Family Business Review	Family firms / Germany		Relationship conflict in family firm		Curvilinear relationship	No Hierarchical regression
72	Sánchez-Marín, Pemartín, and Monreal-Pérez (2020)	Review of Managerial Science	Family firms / Spain	Family involvement in management			Curvilinear relationship	No Random effect Tobit regression
73	Santulli, Torchia, Calabrò, & Gallucci (2019)	Journal of International Entrepreneurship	Family firms / Germany	Family ownership concentration			Curvilinear relationship	No Tobit regression
74	Schulze, Lubatkin, and Dino (2003)	Academy of Management Journal	Family firms / USA			Balance of voting power	Curvilinear relationship	No Polynomial regression
75	Sciascia and Mazzola (2008)	Family Business Review	Family firms / Italy	Family Involvement in Ownership Family Involvement in Management			Curvilinear relationship	No Regression
76	Sciascia, Mazzola, Astrachan, and Pieper (2012)	Small Business Economics	Family firms / USA	Family Ownership			Curvilinear relationship	No Ordinal regression
77	Sciascia, Mazzola, Astrachan, and Pieper (2013)	Journal of Small Business Management	Family firms / USA	Family ownership Family involvement in the board of directors			Curvilinear relationship	No Regression
78	Sciascia, Mazzola, & Chirico (2013)	Entrepreneurship Theory and Practice	Family firms / Switzerland	Generational involvement			Curvilinear relationship	Yes, F-test Two-stage least squares
79	Sikarwar & Gupta (2019)	Journal of Economic Studies	Family and non-family firms / India	Family ownership			Cubic relationship	No Cross-sectional regression
80	Srivastava and Bhatia (2020)	Global Business Review	Family and non-family firms / India	Family ownership			Curvilinear relationship	No Panel data regression
81	Terlaak, Kim, & Roh (2018)	Journal of Business Ethics	Business groups / South Korea	Family ownership			Curvilinear relationship	No Logistic regression
82	Ting, Lo, & Kweh, (2020)	International review of Finance	Family and non-family firms			Ownership concentration	Curvilinear relationship	No 2SLS regression
83	Wang (2006)	Journal of Accounting Research	Family and non-family firms /USA	Family ownership			Curvilinear relationship	No Regressions
84	Yang and Danes (2015)	Entrepreneurship Research Journal	Entrepreneurs / USA			Business demand	Curvilinear relationship	No Regression
85	Yeh, Lee, & Woidtke (2001)	International Review of Finance	/ Taiwan	Excess family control			n.s.	No Piecewise Linear Regression
86	Yeoh and Hooy (2020)	Asia Pacific Journal of Management				CEO age		No GMM regression

(*continued on next page*)

Table A1 (*continued*)

#	Authors (year)	Journal	Sample/country	Demographic variable/s to capture nonlinear relationships	Essence variables to capture nonlinear relationships	Other variables to capture nonlinear relationships	Type of nonlinear relationship	Yes/no: Further information to evaluate the nonlinear relationship / Type of analysis
			Family and non-family firms / Malaysia				Curvilinear and cubic relationship	
87	Zahra, Hayton, Salvato (2004)	Entrepreneurship Theory and Practice	Family and non-family firms / USA			Individual orientation	Curvilinear relationship	No Regression
88	Zhang, Venus, and Wang (2012)	Journal of Family Business Strategy	Family firms / China	Family Ownership			Curvilinear relationship	No Regression
89	Zona (2015)	Small Business Economics	Family firms / Italy	Balance of voting power			Curvilinear relationship	No Regression

n.s. = not specified

Table A2
Measurement model evaluation results

Construct	Cronbach's alpha	Composite reliability ρ_A	Composite reliability ρ_c	Average variance extracted (AVE)
Family-oriented strategic decision making	0.877	0.893	0.914	0.639
Firm economic-centered performance	0.722	0.835	0.881	0.649
Family economic-centered performance	0.711	0.729	0.821	0.535

Table A3
HTMT values

	Family management involvement	Family-oriented strategic decision making	Firm economic-centered performance	Family economic-centered performance
Family management involvement				
Family-oriented strategic decision making	0.248 [0.167; 0.333]			
Firm economic-centered performance	0.055 [0.028; 0.139]	0.191 [0.106; 0.295]		
Family economic-centered performance	0.067 [0.035; 0.134]	0.380 [0.285; 0.480]	0.607 [0.505; 0.694]	

Note: 95% (one-sided) bootstrap confidence intervals (percentile approach, 10,000 subsamples) in brackets.

Future research could further improve nonlinear analyses in PLS-SEM. One direction would be to develop extensions of the original PLS-SEM algorithm to facilitate exploring whether certain nonlinear relationships, can be confirmed in the same way over time, as theoretically assumed. Furthermore, it may be interesting to shed more light on mediation and moderation in the context of nonlinear effects. For example, it would be worthwhile to explore whether the concepts known from conditional process models (Sarstedt et al., 2020), such as the index of moderated mediation (Hayes, 2015), can readily be transferred to cases where the interaction term represents a self-moderation. Recent research has proposed using the cross-validated predictive ability test (CVPAT; Liengaard et al., 2021) to assess whether an alternative PLS path model offers significantly better out-of-sample predictive power than a benchmark or an established model. Since the current implementation of the CVPAT is confined to comparing different forms of linear models, future research should extend its capabilities to accommodate models with nonlinear relationships. In particular, extensions of CVPAT should allow researchers to assess whether a nonlinear model offers predictive capabilities that significantly exceed those of a more parsimonious linear model. Establishing a nonlinear model's superior predictive power would not only give evidence for its practical utility (Hair & Sarstedt, 2021; Sarstedt & Danks, 2021), but would also provide theoretical support as "it remains true that if we can predict successfully on the basis of a certain explanation, we have a good reason, and perhaps the best sort of reason, for accepting the explanation" (Kaplan, 1964, p. 350). As such, an extended predictive ability test would help to advance theoretical reasoning of nonlinear effects in family business research.

Appendix

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