

Family Involvement- Firm Performance Link: Winning Configurations Revealed by Set- theoretic Methods*

Implicación familiar y rentabilidad de la
empresa: configuraciones ganadoras reveladas
a través de métodos basados en la teoría de
conjuntos



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54



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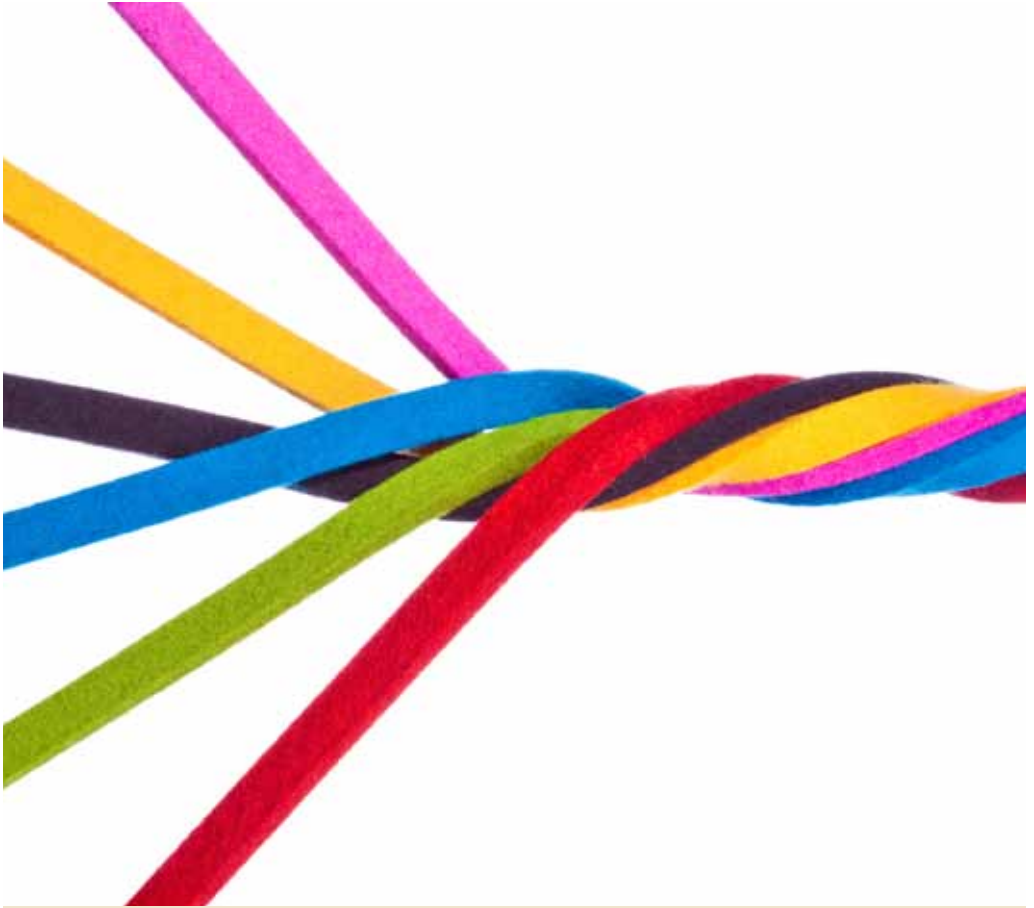
I. FAMILY INVOLVEMENT IN BUSINESS AND PERFORMANCE

Does family involvement in business (FIB) help or hinder a firm's financial performance (FP)? Significant scholarly time and efforts have been devoted to understanding the nature of this relationship. But, findings are mixed ranging from positive, neutral, to negative, regardless of whether market- or accounting-based measures of firm performance (FP) are used (e.g., Miller, Miller, Lester & Cannella, 2007; Rutherford, Kuratko & Holt, 2008).

Positive findings that reveal family firms outperform non-family firms are explained in two ways. First, concentrated ownership alleviates the conflict of interest between owners and managers reducing agency costs (e.g., Berle & Means, 1932; McConaughy, Matthews & Fialko, 2001). Second, competitive advantages are gained through the long-term perspective that family involvement in management encourages (e.g., Anderson & Reeb, 2003; Chami & Fullenkamp, 1997).

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EXECUTIVE SUMMARY

Prior empirical research has found positive, negative and neutral relationships between family involvement in business and firm performance. These inconsistent findings may be partly explained by the different levels of family involvement. Family firms are not homogeneous entities; there are family-owned, family-governed and family-managed firms. These variations lead to different configurations based on the components of family involvement which can be captured by using set-theoretic methods. Applying this method to an international sample of 6,611 firms, we identify seven configurations in firms that lead to superior financial performance.

RESUMEN DEL ARTÍCULO

Diversos estudios empíricos han encontrado una relación positiva, negativa y neutra entre la implicación familiar en la empresa y la rentabilidad de la compañía. La inconsistencia de los resultados obtenidos puede estar motivada por los diferentes niveles de implicación familiar. Las empresas familiares no son entidades homogéneas sino que, en realidad, hay empresas propiedad de la familia, gobernadas por la familia o gestionadas por ella. Todas estas variaciones dan lugar a diferentes configuraciones basadas en los componentes de implicación familiar y que pueden ser estudiadas empíricamente empleando métodos basados en la teoría de conjuntos (fs/QCA). Utilizando esta metodología con una muestra internacional de 6.611 empresas identificamos siete configuraciones que conducen a una rentabilidad superior.

When family firms underperform in comparison to their non-family counterparts, entrenchment, nepotism and lack of professional management are stated to be culprits (Lansberg, Perrow & Rogolsky, 1988). A second type of agency conflict appears in family-owned firms when large family shareholders use their controlling position in the firm to extract private benefits at the expense of small shareholders (e.g., Villalonga & Amit, 2006).

Neutral findings are said to be contingent upon a number of firm-specific features. And, this evidence is mounting. For example, while performance was found inversely related to family ownership level in non-dual firms where CEO and Board chairman roles are separated,

no such relationship was found in dual firms (Braun & Sharma, 2007).

In privately held firms, while family involvement in ownership (FIO) had no effects on performance, a negative effect of family involvement in management (FIM) with firm performance was revealed (Sciascia & Mazzola, 2008).

How might one reconcile these conflicting empirical results between FIB and FP? While different perspectives might be used to address this question, in this article we focus on the ill-defined concept of FIB and related methodological challenges for researchers. Family business scholars tend to use different approaches to define and measure FIB. While

some studies use dichotomous categorizations of FIB (e.g., whether family ownership in a firm exceeds the 5% threshold), others adopt continuum measures such as the F-PEC scale developed by Klein, Astrachan and Smyrnios (2005) that aims to capture the outcome variables of power, experience and culture in the family enterprise due to the FIB. Thus, at this stage of the literature, different empirical definitions of FIB based on ownership, governance, management or succession criteria are in use leading to contradictory results. This is further complicated by differences in first and later generation firms, and in firms operating under different legal structures and institutions.

In this paper, we seek to investigate the FIB-FP in a novel manner. First, we do not measure FIB as a dichotomous or continuum variable but as a typology. That is, we argue that there are several types of family firm with varied components of family involvement and each of them may have different impact on FP. Second, we examine whether there exists a positive, negative or neutral relationship between each type or 'set' of family firms and FP, taking into account

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the complementarities and interactions existing between the different components of family involvement. We use a novel method not yet adopted in family business studies - fuzzy sets/qualitative comparative analysis (fs/QCA). This method enables us to investigate the effect of simultaneous occurrence of multiple variables in family firms (referred to as configurations) on FP, rather than measuring the affect of individual components such as family ownership or management on FP.

2. COMPONENTS OF FAMILY INVOLVEMENT IN BUSINESS

Since the inception of scientific research on family enterprises, scholars have used Venn diagrams and other pictorial depictions to describe and understand the nature of family and business overlaps in these hybrid identity firms (see Sharma & Nordqvist, 2008 for a review of these models). For example, Davis (1982) developed a model of three overlapping circles each depicting family membership, ownership and managerial roles. This simple yet elegant model laid the foundation for future extensions such as the addition of changes in each circle over time (e.g., Gersick *et al.*, 1997). Sharma & Nordqvist (2008) presented a typology of 72 different categories of family firms based on the extent of family involvement in ownership and management of the firm. In addition to ownership and management, family involvement in governance and its plans for trans-generational continuity or succession are often added as two other integral components likely to influence FP (e.g., Handler, 1989).

KEY WORDS

Family firms; set-theoretic methods; firm performance; ownership; corporate governance

PALABRAS CLAVE

Empresa familiar; métodos basados en la teoría de conjuntos; rentabilidad; propiedad; gobierno corporativo

Table 1. Possible family firm configurations

	FAMILY INVOLVEMENT IN			IS THIS A FAMILY FIRM?
	OWNERSHIP	GOVERNANCE	MANAGEMENT	
1	Yes	Yes	Yes	Yes
2	Yes	Yes	No	?
3	Yes	No	Yes	?
4	Yes	No	No	?
5	No	Yes	Yes	?
6	No	Yes	No	?
7	No	No	Yes	?
8	No	No	No	No

However, although theoretical developments elaborate rich categories of family firms, in practice, researchers tend to use dichotomous or continuous measures of FIB. Lack of a robust method for dealing with complex configurations has been a stumbling block. To illustrate the complexity of possible categories of family firms, if we simply consider the role of family involvement in firm's ownership, management, and governance, there are eight (2^3) possible configurations as depicted in **Table 1**.

Which of the eight combinations qualify as a family firm? Are each of these similarly related to FP? Although it is easy to agree that the 1st category is a family firm and the 8th is not, the other six combinations are less obvious. The number of configurations and complexity further increases when additional integral variables such as succession are included. In short, it is obvious that the specific operational definition of family firm used in an empirical study is likely to influence the findings. For the same set of firms, different definitions used may even reverse the results of the relationship between FIB – FP. We suggest that if we can use all possible categories of firms based on all factors related to family involvement in business that have been considered as integral in previous research, the margin of error can be significantly reduced and confidence in obtained results can be improved. Given the lack of consensus in the field about which factors account for firm performance, in this exploratory study, we consider four factors – ownership, management, governance, and succession – to empirically determine the possible combinations between these factors that lead to superior FP. This approach should lead to a more nuanced understanding of the relationship between FIB and FP that is likely to benefit both the scholarly and managerial communities.

3. SET-THEORETIC METHODS APPLIED TO FAMILY FIRMS

Qualitative Comparative Analysis (QCA) is a methodology for assessing combinations of causal conditions that lead to an outcome (Ragin, 2008). Developed in late 80s by Charles Ragin, this method is gaining momentum in social science research. The underlying logic used in this method is that if a large majority of members with a given combination of conditions satisfy an outcome, then it is considered sufficient for the outcome to be present in that set of members. For example, in this study, if a large majority of family firms with a particular mix of family's involvement in ownership, management, gover-

nance, and succession, are found to have superior firm performance, then that configuration is considered to be a winning configuration. There can be several winning configurations however, as we will later find.

To apply this method, the researcher starts with a phenomenon to be explained, called the outcome – FP in our case. Then, the possible conditions that may have an influence on that phenomenon are listed – ownership, management, governance, and succession in this study. Next, each item (family firm) is assessed on the extent to which it satisfies the outcome and each of the causal conditions. A combination of qualitative reasoning and quantitative techniques is used to assess whether a family firm belongs to a specific set or not.

If the number of possible established causal conditions is k , then there are 2^k possible combinations of causal conditions, also called configurations. In this study, we use five causal conditions – ownership, management, succession, and two dimensions of governance. Thus, there are 32 (2^5) possible configurations. Each family firm in the sample can belong to only one of these 32 configurations. In other words, each configuration is associated with a subset of family firms. If the majority of firms with a particular configuration of family's involvement in ownership, management, governance, and succession, lead to high firm performance, then that is a winning configuration.

Because this method works with proportions in any set, it allows for the individuals' conditions of membership to be relaxed both regarding causal factors and the outcome. This enables the usage of *degrees* of membership. For example, a family firm with 100% ownership is considered to be a full member of the set, another firm with zero family ownership is considered fully outside the set. Firms with 50-100% ownership are considered more in than out, while the reverse is true for firms with less than 50% ownership. Maximum ambiguity lies with 50% ownership – a case that requires qualitative judgment. This generalization is known as fuzzy set analysis (fs/QCA²). Given the peculiarities of this method, the winning configurations identified in this study indicate likely combinations of FIB that lead to high FB rather than a guarantee that if a firm adopts those combinations it will surely achieve high performance. However, this method helps bring more clarity to the likely winning configurations than we have had thus far.



3.1. Sample

We use a dataset of 6,611 publicly listed and major unlisted companies from 46 countries using the OSIRIS database (Bureau Van Dijk)³. The full OSIRIS database for the year 2005 has about 19,000 publicly listed and major unlisted/delisted companies from around the world. In this study, we include non-financial firms with complete data on the variables of interest. Excluded were financial and insurance firms that lacked ownership data and other firms with inconsistencies in balance sheets such as negative values in positive-defined accounts.

3.2. Measures of the components of family involvement

The set-theoretic analysis with fs/QCA requires transformation of variables into sets that are calibrated regarding *full membership*, the *cross-over point* of maximum ambiguity and *full non-membership* for every variable of interest. These values are qualitative anchors to determine which cases belong to each of the sets analyzed. Below, we briefly share how the calibration was carried out for each variable (also see **Table 2**).

Five basic components of family involvement were used in this study: family ownership, family management (CEO), succession, and two components of governance – family board and chairman. *Family ownership* is computed by adding all shares owned by family members with same surnames. Firms with 1% or lower family ownership are considered a non-members or non-family firms, 5% is the crossover point, and 25% or higher ownership is considered high family involvement in ownership⁴.

Family board captures the family presence on the board of directors. It is computed as the ratio of family directors to total board directors. In its definition of family firms, the European Group of Owner-Managed and Family Enterprises (GEEF) requires that there be at least one family member on the board. Hence, we use the lowest percentage (1% threshold for full non-membership) in order to leave out of the set those firms with no presence of family members on the board. For the crossover point, we take the same 5% used for our first variable and a threshold of 10% is used for full-membership or family dominated board.

Chairman carries the value of 1 when a family member is the chairman of the board of directors. Otherwise, it is set to 0. Similarly, *CEO* takes the value of 1 when a family member is the *CEO* of the company

and 0 otherwise. For *Succession*, a threshold of 30 years is used to create a proxy measure. If a company is less than 30 years of age it is considered to be in first generation taking a value of 0. Firms more than 30 years in age take the value of 1 that assumes a succession has been completed.

3.3. Performance and control variables

Industry adjusted Return on equity (ROE) is used to measure FP. In addition to controlling for industry effects, this allows for comparisons with previous research as ROE is one of the most frequently used performance measures in the literature (Rutherford *et al.*, 2008). Following Fiss (2010), 20, 50, 80 percentiles are used to transform the original ROEs into a fuzzy set. For example, firms in the top 20% of the distribution have full membership in the set, thereby considered as superior performers. Those in the bottom 20% are considered low performers and 50% is the crossover point used.

Table 2. Descriptive statistics and set calibration (fuzzy and crisp sets)

	DESCRIPTIVE STATISTICS			MEMBERSHIP CRITERIA		
	N. OBS.	MEAN	ST. DEV.	FULL MEMBERSHIP	CROSSOVER POINT	FULL NON-MEMBERSHIP
OWNERSHIP						
Family Ownership	6,611	8.86%	17.4	25%	5%	1%
GOVERNANCE						
Family Board	6,611	6.30%	13.17	10%	5%	1%
Family Chairman ¹	6,611	16.02%	-	Crisp set (1,0)		
MANAGEMENT						
Family CEO ¹	6,611	16.44%	-	Crisp set (1,0)		
SUCCESSION						
Succession ¹	6,611	11.25%	-	Crisp set (1,0)		
Anglo-Saxon ¹	6,611	42.23%	-	Crisp set (1,0)		
Size (Log assets)	6,611	12.94	2.03	14.71	12.76	11.17
ROE adjusted	6,611	0.02	0.21	0.09	0.01	-0.07

¹ Dummy variables – Family member Chairman, Family member CEO, Succession (firm over 30 years of age) or Anglo-Saxon firms take the value of 1, others are valued as 0

Two additional control variables used in this study are firm size and legal system. Small family firms are distinguished from large by taking the log of a firm's assets and using 20, 50, 80 percentiles of distribution to create fuzzy sets using similar logic as done for ROE. For legal systems in which the firms operate, we distinguish between firms operating in Anglo-Saxon (value of 1) and non-Anglo-Saxon (value of 0) systems.

4. RESULTS AND FINDINGS

Table 3 depicts all the possible combinations using the five components of family involvement in business. It is interesting to note that although theoretically there are 32 (2^5) possible configurations, empirically in this sample, only 24 are found with at least one observation. Furthermore, this number drops down to 11 when we consider combinations with at least 1% of cases in the sample (66 firms). While null sets reduce complexity of the typology, they also reveal the more popular or perhaps pragmatic categories. For example, almost all of the non-family owned firms have little family involvement in board or management. On the other hand, family owned firms both young and old seem to follow several different pathways in terms of the mode of family involvement in management and governance. Almost 35% of family owned firms (691) retain both governance and managerial control of the enterprise, regardless of whether they are in first or later generation of leadership.

Table 4 shows the fuzzy set analysis results. In addition to the five components of family involvement in business, this analysis includes two additional variables - company size and legal tradition that are likely to influence FP. Thus, the number of theoretical configurations increases to 128 (2^7). **Table 4** shows the seven winning configurations that lead to superior industry adjusted ROE. Full circles in this Table indicate the presence of a condition, crossed-out circles suggest its absence, and a blank space means that this condition is not binding in that particular configuration. This is the case, for example, of family ownership in configuration 1A.

The high overall solution consistency⁵ of .84 indicates that the set-subset connections found are strong and well-supported by the data. However, the overall solution coverage of .039 is low, indicating that although the relationships found are consistent, they apply only to a reduced number of firms in the sample. This suggests the possibility of other causal factors of FP beyond the FIB considered in this study.

Table 3. Typology of family firms found in the sample¹

COMPONENTS OF FAMILY INVOLVEMENT IN BUSINESS ²					IN THE SAMPLE	
OWNERSHIP	GOVERNANCE		MANAGEMENT	SUCCESSION	FIRMS #	%
FAMILY OWNERSHIP	FAMILY BOARD	FAMILY CHAIRMAN	FAMILY CEO	SUCCESSION		
N 4,616 (69.82%)	N 4,596 (69.52%)	N 4,596 (69.52%)	N	N	4,570	69.13%
			4,596 (69.52%)	Y	26	0.39%
			-	N	-	-
		Y -	N	N	-	-
			-	Y	-	-
			Y	N	-	-
	Y 20 (0.30%)	N 9 (0.14%)	N	N	5	0.08%
			6 (0.09%)	Y	1	0.02%
			Y	N	1	0.02%
			3 (0.05%)	Y	2	0.03%
		Y 11 (0.16%)	N	N	2	0.03%
			2 (0.03%)	Y	-	-
			Y	N	7	0.11%
			9 (0.13%)	Y	2	0.03%
Y 1,995 (30.18%)	N 197 (2.97%)	N 168 (2.51%)	N	N	97	1.47%
			167 (2.50%)	Y	70	1.06%
			Y	N	-	-
		Y 29 (0.46%)	N	N	1	0.02%
			23 (0.37%)	Y	14	0.21%
			Y	N	9	0.14%
	Y 1,798 (27.21%)	N 780 (11.80%)	N	N	4	0.06%
			6 (0.09%)	Y	2	0.03%
			N	N	258	3.90%
			405 (6.13%)	Y	147	2.22%
		Y 1,018 (15.41%)	Y	N	259	3.92%
			375 (5.67%)	Y	116	1.75%
			N	N	214	3.24%
			327 (4.95%)	Y	113	1.71%
Y 691 (10.46%)	N	N	440	6.66%		
	691 (10.46%)	Y	251	3.80%		

¹ For the sake of simplicity, all the sets are represented in this table as "crisp sets" (Y/N). However, it is important to note that only chairman, CEO and succession are truly crisp sets while Family Ownership and Family Board are fuzzy sets where each firm has a different degree of membership to that set from 0 (fully out) to 1 (fully in).

² Y = "Yes" when the component is above the cross-over point. / N = "No" when the component is below the cross-over point.

Shades areas indicate categories with over 1% (66) firms in the sample.

Table 4. Seven winning configurations with high industry-adjusted ROE¹

	ANGLO-SAXON FIRMS				NON-ANGLO SAXON FIRMS		ANGLO & NON-ANGLO FIRMS
	1A	2A	3A	4A	5N	6N	7AN
	1 ST GEN. LARGE FIRMS WITH FAMILY CEO	2 ND OR LATER GEN FIRMS WITH FAMILY CHAIRMAN	2 ND OR LATER GEN LARGE FIRMS WITH FAMILY CHAIRMAN	2 ND OR LATER GEN LARGE FIRMS WITH FAMILY BOARD	1 ST GEN FAMILY OWNED AND MANAGED FIRMS	1 ST GEN LARGE FAMILY OWNED AND MANAGED FIRMS	1 ST GEN FAMILY OWNED FIRMS
Family ownership		⊗	⊗	⊗	●	●	●
Family Board	⊗	⊗	⊗	●	⊗	⊗	⊗
Family Chairman	⊗	●	●		⊗		⊗
Family CEO	●	⊗		⊗	●	●	
Succession	⊗	●	●	●	⊗	⊗	⊗
Large Size	●		●	●		●	●
Consistency	.920	.948	.930	.898	.926	.894	.838
Raw Coverage	.001	.001	.001	.003	.001	.001	.035
Overall Solution Consistency .844							
Overall Solution Coverage .039							

¹ ● Presence of conditions
⊗ Absence of conditions
A: Anglo-Saxon
N: Non Anglo-Saxon
AN: Either A or N

Seven configurations indicate superior industry-adjusted ROE confirming that different pathways can lead to the same desired outcome. Four of these are in the Anglo-Saxon category (1A-4A), two in the non-Anglo-Saxon category (5N and 6N) and one compatible with any legal tradition (7AN).

Our first superior performing firms are **large young Anglo-Saxon firms** (1A). Family involvement in these firms is limited to the CEO position. However, this family leadership position is balanced by minimal family involvement in governance as the board chairman is a non-family member and the family holds less than 5% of board positions. Such firms may or may not be family owned.

With some exceptions, high performing **large older Anglo-Saxon firms** (3A and 4A) tend to have family more involved in governance roles while leaving the management of the firm to non-family profes-

sionals. **Smaller older Anglo-Saxon non-family owned firms (2A)** also do well under non-family management though family is often involved in governance of the firm. **Non Anglo-Saxon family owned and managed first generation firms** perform well with independence of governance from family (5N, 6N). **Family owned large first generation firms** outperform when governance is in non-family hands (6N, 7AN).

Going beyond the specific configurations, **Table 4** reveals some interesting regularities. First, in general, larger firms tend to outperform smaller firms in terms of industry-adjusted ROE. Nevertheless, the smaller firms can be highly profitable as well, when management is separated from governance (2A, 5N). Second, in terms of legal tradition, our analysis suggests different configurations can lead to high performance in both Anglo-Saxon (1A-4A) and non-Anglo-Saxon countries (5N-6N). Indeed, the hybrid configuration (7AN) has the highest coverage (.35) providing larger confidence in these findings.

Third, family CEO and succession seem to work as substitutes for each other; firms with family CEO and no succession (1A, 5N, 6N) seem to perform above the median; but so do firms with no family CEO that are in the second generation (2A, 4A). This pattern of substitution between family CEO and generation has been observed previously by other researchers. For example, Villalonga and Amit (2006) and Pérez-González (2006) found that, first generation family CEOs create value but when descendants serve as CEOs, firm value is destroyed. However, 3A suggests these findings are not universally applicable as large second generation firms can do well under duality of a family CEO and a family Chairman, as long as family does not dominate the Board.

Finally, our results provide some evidence that firms with family CEO and non-family chairman (1A, 5N), and vice-versa (2A), tend to perform better than firms where family members occupy both roles (CEO duality). However, configurations 3A and 6N evidence that this result does not hold in all configurations.

Overall, these results confirm that there are several equally effective pathways that family firms can choose to achieve high performance. However, these pathways can only be revealed and explained in terms of configurations. The analysis demonstrates that the impact of each individual component on FP is contingent on all the other components and, hence, this finding should be taken into account in

future research. In addition, it makes clear that it is the combination of factors rather than individual components that explain firm performance.

5. MANAGERIAL IMPLICATIONS AND CONCLUSION

Does family involvement in business (FIB) foster, hinder, or have no effect at all on firm performance (FP)? In this article, we address the FIB-FP relationship by empirical testing the configurational approach that has long been theoretically suggested in the literature (e.g., Sharma & Nordqvist, 2008). Thus, the primary contribution of this study is to introduce a new technique – fuzzy set analysis (fs/QCA) into family business studies and for the first time reveal the empirically supported configurations of family involvement in business that lead to superior performance.

This study confirms that the components of FIB do not exert an impact on industry-adjusted ROE in isolation. Instead, these components are related each other and to FP in a complex way. Therefore, it is the configurations as a whole, and not the individual components, that lead to high industry-adjusted ROE. Although some of these winning configurations are revealed in this study, others might be discovered in subsequent research as additional relevant variables such as business life-cycle, firm strategy, financial structure and other firm-specific features that may affect FP are considered.

Results of this study suggests that in general, a mix of family and non-family involvement in ownership, management, and governance works better across size, generation and legal traditions. When family ownership and management are high, governance must be independent. Otherwise, family must stay involved in governance. But, generalities veil a number of intricate and powerful specificities as indicated by the winning combinations presented in **Table 4**.

While it won't come as a surprise to managers that each firm – family or non-family – is unique in its own peculiar way. Thus, caution must be exerted when blindly transplanting the 'best practices' that worked for one firm to another. However, this study reveals that some combinations of family involvement in business seem to work better than others as shown in **Table 4**. For instance, a question that frequently challenges family firm owners - what is the bottom line impact of naming a family CEO? The answer, as often found in management, is it all depends. Family CEOs lead to high performance in large Anglo-Saxon firms when there are no family members on the board of

directors (1A) or in non Anglo-Saxon family owned firms when the governance is in non-family hands (5N and 6N). By contrast, a family CEO has, potentially, a negative performance effect in Anglo-Saxon non-family owned firms (2A and 4A). Although there are no straight forward answers, the set-theoretic methods used in this study, bring managers and researchers closer to understanding what combinations work better than others.

This study also joins the growing consensus on the diversity and heterogeneity of family enterprises by differentiating between family-controlled, family-governed and family-managed firms. Keeping this distinction in mind is important both for managers as they think of adopting the 'best practices' from one firm to the another, and for scholars to systematically select their research samples and elucidate the scope of their research findings. It is our hope our introduction of the set-theoretic methods in family firm studies will be the 'first stone' in a long and well used pathway of research.

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NOTES

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1. Contact author: IESE Business School, Universidad de Navarra. Camino del Cerro del Águila, 3. 28023 Madrid, España.
 2. For more technical discussion of this method, please refer to Ragin (2008). And, for an application of this method in family firm study, please see García-Castro & Casasola (2011).
 3. <http://www.bvdep.com/en/osiris.html>
 4. While we describe the threshold point, full and no-membership for family involvement in ownership and board (Table 2), in this exploratory study for the sake of simplicity, we use crisp sets with 0 and 1 values in Table 3. All firms with values lower than the threshold point are converted to 0 and others to 1.
 5. The *consistency* assesses the degree to which cases sharing a given condition or a combination of conditions display the outcome in question. That is, consistency indicates how closely a perfect subset relation is approximated. Consistency values ranges from 0 to 1, where 1 indicates a perfect subset relation.
- The *coverage* assesses the degree to which a cause or a causal combination "accounts for" instances of an outcome. The coverage can be thought of as a measure similar to R-square in regression models, allowing the researcher to evaluate the empirical relevance of the solutions found.

The calculation of fuzzy set-theoretic consistency and coverage is done as follows:

$$\text{Consistency } (X_i \leq Y_i) = \sum [\min (X_i, Y_i)] / \sum (X_i)$$

$$\text{Coverage } (X_i \leq Y_i) = \sum [\min (X_i, Y_i)] / \sum (Y_i)$$

where X_i is the degree of membership of individual i in configuration X and Y_i is its degree of membership in outcome Y .

In this study, both consistency and coverage are set to 0.75. The solutions are depicted at the bottom of Table 4.