The Impact of UCITS IV Directive on European Mutual Funds Performance

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Abstract

In this paper, we examine the impact of the UCITS IV Directive on the performance of European mutual funds. In a sample of 1435 equity funds from December 2001 to December 2013, we empirically investigate the effects of the economies of scale on the relation between size and performance. Using panel regressions with multilevel models, we find that European funds appear to benefit from gains related to size and to not encounter diseconomies of scale. The post-UCITS IV period appears to be a new regime with a significant quadratic and positive convex relationship between size and performance. This observation clearly indicates that there is a premium for the largest funds because it is precisely the expected objective pursued by the Directive. Nonetheless, specific characteristics of the European fund family structure burden performance. Despite the intention of regulators to provide a costless and favorable environment, European fund families are highly diversified and composed of a large number of small-sized members and thus achieve overall positive spillover effects.

Keywords: Performance evaluation, European funds, Economy of scale, UCITS IV

JEL Codes: G11, G23

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1 Introduction

The objective of this paper is to examine the impact of the UCITS IV Directive[1] on the dynamics of European mutual funds. Since its launch in 1985, the introduction of UCITS Directives has deeply modified the universe of investment funds in Europe. The main purpose is the development of an integrated market and the strengthening of the competitiveness of European funds through improved coordination between regulators and through reinforced investor protection. Thus, UCITS IV Directive is one of the most important bases. UCITS IV Directive differs from the three previous Directives by enabling more cost effective notification procedures and by introducing a framework for merging funds. More specifically, the directive should produce benefits for both investors and managers. For investors, it is expected to provide greater liquidity, more transparency and more effective management of risks. For managers, with the simplified European passport and the accelerated procedure, it is expected to create cross-border distribution opportunities. The directive enables access to a larger range of strategies and sophisticated or non–sophisticated funds. The directive also provides a greater opportunity for structuring funds. Indeed, since UCITS IV Directive entered into force, managers have had the opportunity to adopt different types of structures per their own strategies and constraints such as the following: a single or conventional strategy fund structure, an umbrella fund structure or a Master and Feeder structure. Further innovations can be added at different levels such as merging funds, depositary, "prime broker", administrators, managers, management companies.

All these developments tend to make the management process more flexible and to render the promotion and the cross-border distribution of European funds more fluid. The costs of engagement for investors should be reduced. The merging of funds should be accelerated within the European Union. Moreover, these developments will encourage the development of a much larger average fund size, conducive to a large and integrated European market with harmonized regulation. Thus, the central hypothesis of our study is based on the following: the UCITS IV Directive significantly changes the universe of investment funds in Europe by increasing the average size of funds while facilitating the emergence of economies of scale. Ultimately, this evolution enhances the ability of managers to generate higher risk-adjusted returns. Therefore, to test this hypothesis, in accordance with the equilibrium of the mutual fund industry approach developed by Berk and Green (2004) and Chen et al. (2004), we introduce the concept of the diseconomy of scale in an active management portfolio.

[1] Undertakings for the Collective Investment in Transferable Securities, adopted in 2011

From this perspective, we use trans-logarithmic models to test the existing change in the form and the strength of the relation between European fund size and performance before and after the UCITS IV Directive adoption. Moreover, as the source of economies of scale can be located at the fund family level, we run panel regressions using multilevel models to identify the family-specific characteristics that can explain the time-varying change in the size and performance relationship. Multilevel models have two main advantages. On the one hand, the models allow us to test all our hypotheses as a single block. On the other hand, the models enable us to decompose and to distinguish the portion of variance shared by all funds in the family and the variance of the fund member. In our model, we consider the fund performance as a quadratic function of the lagged fund size in which conventional control variables related to fund specific characteristics (flows, age, management fees, and redemption fees) and variables related to family-specific characteristics are added. For the family-specific variables, we run tests with dummy variables and use various Herfindahl-Hirschmann concentration indexes that can provide information on the extent of the diversification and specialization of the fund families.

Our empirical analysis relies on the Lipper-Reuters and Eurofidai databases. We extract the UCITS European fund data from the Lipper-Reuters database. Our dataset covers 1435 UCITS equity funds. We extract monthly data from 2001 through 2013. Our family-level data are based on over 30000 funds that are part of the fund families considered. We use the Eurofidai indices database to extract the European factor benchmarks: market returns (RM), factor mimicking portfolios for size (Small minus Big, SMB), book-to-market equity (High minus Low, HML) and one-year momentum in stock returns (MOM).

Generally, the hypothesis related to the existence of the UCITS IV effect is not rejected by the data. We find significant performance improvements dependent upon the UCITS IV period. The risk-adjusted performances measured by alpha coefficients are more significant and superior after the UCITS IV adoption than in previous periods. We find that European funds appear to benefit from gains related to size and to not encounter diseconomies of scale. Nonetheless, specific characteristics of the European fund family structure burden performance. Despite the intention of regulators to provide a costless and favorable environment, European fund families are highly diversified and consist of a large number of small-sized members that achieve overall positive spillover effects.

The remainder of this paper is organized as follows. Section 2 discusses the theoretical backgrounds, presents the empirical issues and summarizes our testable hypotheses. Section

3 describes the data used in this study. Section 4 presents the methodology used for the tests based on trans-logarithmic models and multilevel models. Section 5 presents the results; Section 6 concludes the paper.

2 Theoretical backgrounds and Testable Hypotheses Development

UCITS IV Directives can impact the performance of European mutual funds by following two main paths at the fund level and at the fund family level. For both, the theoretical backgrounds and the empirical issues rely on the expected improvement in the fund managers' performance to address the increasing size and to benefit from the potential economies of scale.

2.1 Theoretical Background

The seminal work of Berk and Green (2004) introduces the decreasing returns of scale in the rational model of active portfolio management to explain the persistence of performance. The researcher's paper provides a clear scope to understand the relation between size and performance. The researchers show that performance decreases with size. On the one hand, when funds are new and small, active managers should be able to generate positive and persistent alpha. On the other hand, investors should react positively to past returns by offering new money to funds with positive past returns; this increases their size. Consequently, this increase reduces the efficiency of the active management, prompting managers to switch to passive strategies, which are less costly to implement. Thus, the returns decrease proportional to the inflows. This mechanism is repeated so that the proportion of the active strategies decline in favor of those that are passive. Ultimately, when the optimal size is achieved, a fund becomes totally dedicated to non-persistent passive strategies. In sum, in a rational and competitive market for capital investment, Berk and Green (2004) demonstrate that a portion of the risk-adjusted performance is persistent only for the short-term until funds achieve their optimal size. A fund's underperformance is valid only for funds that have achieved their optimal size. Managers cannot perform better than the market; they still have additional transaction costs that reduce their returns.

In accordance with Dangl et al. (2008), we present a model that explicitly relates alpha to the decreasing returns to scale:

$$\alpha_i = \theta_i w_i \epsilon_i - \gamma A_i w_i^2 \epsilon_i^2 = w_i \epsilon_i (\theta_i - \gamma A_i\, w_i \epsilon_i) \qquad (1)$$

Where α_i is the Jensen's alpha coefficient; Jensen, θ_i is the manager's active skill (exogenous and unobservable); w_i is the portfolio weight dedicated to an active strategy, and $(1 - w_i)$ is the portfolio weight dedicated to a passive strategy; ϵ_i is a normally distributed noise representing the fund-specific risk; γ is a constant corresponding to the diseconomy of scale, and A_i is the fund size.

From equation (1), we propose following relation:

- $\frac{\delta \alpha_i}{\delta \theta_i} = w_i \epsilon_i = \sigma_i > 0$. For the same proportion of assets dedicated to an active strategy, a skillful manager will generate a superior alpha.
- $\frac{\delta \alpha_i}{\delta A_i} = -\gamma\, w_i^2 \epsilon_i^2 = -\gamma\, \sigma_i^2 < 0$. For additional net asset unity, the alpha decreases with the proportion w_i dedicated to the active strategy and the constant γ.
- $\frac{\delta^2 \alpha_i}{\delta^2 \sigma_i^2} = -2\gamma\, A_i < 0$. The marginal effect of a specific risk rise decreases faster for larger funds.
- $\frac{\delta^2 \alpha_i}{\delta A_i \delta \sigma_i} = -2\sigma_i^2$. The larger the fund is, the smaller the risk-taking effect on the alpha is.

The alpha is an increasing function of a manager's skill that allows management to dedicate a larger proportion of the fund to active management. Alpha is a decreasing function of a size whose magnitude depends on the constant decreasing returns to scale. All things being equal, a highly skilled manager can manage a larger fund than a less talented one. This finding is the fundamental result of the fund performance evaluation conducted by Berk and Green (2004) and Dangl et al. (2008). The fund size is a fundamental observable parameter to estimate the manager's skill. Therefore, it is possible to define the optimal size of a fund, i.e., the size beyond which returns cannot be predictable. The perfect capital mobility assumption implies that investors systematically transfer money from poorly performing funds to the best performing funds. Investors respond positively to α_i, which they cannot perfectly either observe or predict. Investors should state beliefs based on past returns and assume that a manager's active skill is normally distributed $\theta \sim N\,(a_i; v_i)$. Under this constraint, managers are assumed to maximize the following function:

$$\underset{c_i,\sigma_i}{Max}\; c_i\,(1-F)\,A_i \quad (2)$$

Where F represents fixed costs. Therefore, managers maximize their revenues under the constraint of the compatibility of their incentives with those of investors:

$$c_i = a_i \sigma_i - \gamma A_i \sigma_i^2 \quad (3)$$

In addition, the following are feasibility constraints: $c_i > 0$; $\sigma_i > 0$; $A_i > 0$.

To solve this program, we express equation 3 as a function of A_i (fund size). The result is substituted into equation 2 and is derived as a function of c_i. Thus, the return is maximized when:

$$\frac{c_i}{\sigma_i} = \frac{a_i}{2} \quad (4)$$

This equation allows us to define the optimal size of the fund:

$$A_i = \frac{a_i^2}{4\gamma c_i} \quad (5)$$

On the one hand, Equation 5 shows that the optimal size of a fund is a positive and quadratic function of the investor's belief on manager's active skill a_i. This result is consistent with studies that address the performance and investment flows. The hypotheses on the distribution function of the belief θ_i play a central role, particularly through the impact of fund stars and marketing strategies conducted by fund families. On the other hand, the optimal size of a fund is a negative function of fees and the constant term γ. Once one releases the assumption that γ is an exogenous constant and realizes it is a random variable, it is possible to assume that the funds that effectively reduce the diseconomies of scale are the best performing funds. At the same time, one can assume that those funds succeed in obtaining the largest market share. Indeed, we can rely on this ascertainment to the UCITS IV Directive objective: the key investor information document should facilitate a performance evaluation (positive effect on a_i), and the European fund passport must rationalize fund promotion and distribution and then should facilitate economies of scale (negative effect on γ). Therefore, the challenge becomes one of identifying the determinants of γ, i.e., the main sources of the diseconomies of scale. This identification will allow us to understand specifically how the UCITS IV Directive may improve fund performance.

2.2 The sources of economies of scale

In the literature on fund performance evaluation, many studies have highlighted the potential sources of decreasing returns of scale. Gruber (1996) stated that the objective of active management is mainly to have "good ideas" of investment, but the value of these "good ideas" progressively deteriorate once they are diffused in a relatively efficient market. The researcher explained fund underperformance and concluded that skillful managers are those whom permanently find "good ideas". Therefore, the issues of decreasing returns of scale connected the research kernel and the detection of the best investment opportunities.

Recently, Pastor and Stambaugh (2015) showed that the extent of the diseconomies of scale is not constant. The extent mainly varies depending on the active management size compared with the size of passive management in the fund industry. When the share of active management is small, due to less competition, it is easier for managers to find suitable investment opportunities. Investors respond positively by increasing investment flows to their destinations; this automatically increases the size of the active management compared with the overall fund industry. Through this mechanism, the difficulty to find other investment opportunities, and thus the extent of the diseconomies of scale, increases as the competition intensifies among managers and reduces the superior "stock" opportunities. Consequently, this behavior deteriorates fund performance at the same pace as the growth of active management in the industry. This mechanism can extend to fund families as coordinated entities. Massa (1998) attempts to explain the growth of the fund industry. The researcher shows that there is an excessive quantity of funds on the market, much more than what is justified solely by the investors' need for diversification. Khorana and Servaes (1999, 2012) indicate that the launching of new funds by families is in response to differentiation strategies that strive to segment the fund market. This segmentation leads to a reduction in competition by narrowing prices and thus performance. Massa (2003) and Gaspar et al. (2007) show that fund families perform arbitrage among « proliferation fund strategies » and show an improvement in the performance of existing funds. Particularly, families that dominate the market favor the cross-fund subsidization of certain funds. The objective of these cross-fund subsidization strategies is to facilitate spillover effects for fund stars. The status of fund stars will benefit other, less prestigious fund members (Del Guercio et al., 2014, Wilcox, 2003, Nanda et al., 2004, 2009, Kacperczyk et al., 2005, 2008).

It was largely shown that investors are more sensitive and overreact to strong performance than for poor performance (Sirri and Tufano, 1998). This convex relation between performance and flows impacts the competition in the fund market. This relation encourages fund families to adopt spillover strategies. Therefore, this relation does not penalize funds that display poor performance (Capon et al., 1998, Barber et al., 2000). Herein, the UCITS IV Directive requirements, which include the key investor information document and the European fund passport, are advantageous to large fund families. Let us recall that the objective is to rationalize European fund offers by dividing the industry around a few large fund families. This industry concentration reinforces the power and the control of the fund industry by large families. Thus, this concentration would reduce the competitive intensity for those with certain organizational characteristics and governance structures. Thus, these entities can more efficiently manage the effects of economies of scale.

Chen et al. (2004) investigate the impact of liquidity, hierarchy and transaction costs. The researchers show that fund families adopt organizational structures that allow them to optimize their information systems and to manage common skills. More recently, Chen et al. (2013) show that internal members of a fund family display better performance than external funds that are promoted by the same management company. The researchers explain these results by stating that internal funds share technologies and use the same governance model to coordinate managers. For fund families associated with bank companies, Massa et al. (2008) show that the banks' lending activities impact the asset choice and allocation of their fund managers. The researchers conclude that the sharing of information and technologies is not limited to the asset management activity. Fund members of large families share more large common skills such as ideas, information systems, processes, technologies, trading desks, legal counselors, outside experts, macroeconomic anticipations and microeconomic opinion (Brown and Yu, 2014).

2.3 Testable hypotheses development

In accordance with Berk and Green (2004), the relation between size and the manager's ability to generate positive alpha depends on the following conditions:

- Alpha decreases with inflows (increasing the size of the fund). There is an active management skill that is subject to a decreasing scale of returns.
- Alpha is not directly observable by investors. Investors can observe fund size and age.
- There is perfect mobility of capital; fund size can increase until performance becomes unpredictable.

It appears that UCITS IV Directives should facilitate the first and third conditions. The KIID and all the requirements striving for transparency are used to facilitate the perfect mobility of capital. The UCITS passport attempts to generate economies of scale by allowing structure choices for funds grouping. Consequently, this behavior should steadily increase the fund size. Nevertheless, all these additional resources can have contradictory impacts on performance. On the one hand, managers can enhance their diversification scope, but they must also confront increasing transaction and hierarchy costs. On the other hand, there are expectations regarding synergy (sharing commons skills, costs reductions, etc.) due to the adoption of an UCITS structure. Therefore, performance can increase or decrease depending on the dominant effects. Herein, this finding is a central point of our study. The issue is to investigate whether the UCITS IV Directive fully realizes its objective. Therefore, one main question arises. Have European funds displayed economies of scale since the adoption of the UCITS IV Directive? This question leads to our two main testable hypotheses:

H1: Due to the existence of economies of scale, European funds display better performance in the period after the adoption of the UCITS IV Directive than in prior periods.

H2: The strength of the economies of scale depends on the main characteristics of European fund families.

To test these hypotheses, we act in accordance with the equilibrium of mutual fund industry approach developed by Berk and Green (2004) and Chen et al. (2004), which permits a test of the existence of positive and persistent alpha by considering that the "performance generation process" is subject to costs related to fund size.

3 Data and descriptive statistics

3.1 Database sources

Our study uses two main sources: Lipper-Reuters and Eurofidai indices databases. We extract UCITS European funds data from Lipper-Reuters database. Our dataset covers 1435 UCITS Equity funds. We extract monthly data from 2001 through 2013. Our family-level information is based on over 30000 funds that are considered part of fund families. For all funds, we collect data related to the net asset value (TNA), the size (at fund and family level), the age, the management and redemption fees, and the Lipper classification category (at fund and family level). To address the usual biases, our database includes live, dead, new and merged funds covering all sample periods. We use the Eurofidai indices database to extract European factor benchmarks: market returns (RM, MSCI Europe), 1-month Euribor (RF, risk free rate), factor mimicking portfolios for size (Small minus Big, SMB), book-to-market equity (High minus Low, HML) and one-year momentum in stock returns (MOM). For all our empirical tests, we split our sample into 4 sub-periods:

- P1: Before crisis - from December 2001 to September 2007
- P2: During crisis – from September 2007 to February 2009
- P3: After crisis – from March 2009 to June 2011
- P4: After UCITS IV – from July 2011 to December 2013.

3.2 Summary statistics for European fund size by period

Hereafter, certain summary statistics relate to our dataset. Table 1 reports the summary statistics related to the fund size per period. The table indicates that the number of funds has doubled between 2001 through 2013, from 738 to 1400. The year 2007-08 related to the crisis period has not impeded this development but basically impacted the fund values. From 2001 to 2007, the total asset outstanding that grew by 2.5 times nearly disappears until it returns to its original value, approximately 200 billion €, in March 2008. The funds' total net assets increased by approximately 50 percent and achieved 241 billion € at the end of 2013.

Table 1: Descriptive statistics for European fund size by period

	12.2001-09.2007 Before crisis (P1)		10.2007 - 02.2009 During Crisis (P2)		03.2009 - 06.2011 After Crisis (P3)		07.2011 - 12.2013 After UCITS IV (P4)	
	Number	*Total TNA*	*Number*	*Total TNA*	*Number*	*Total TNA*	*Number*	*Total TNA*
Mean	1 055	284 037	1 494	341 923	1 517	275 324	1 399	281 187
Median	1 042	233 949	1 504	348 335	1 529	279 107	1 403	268 802
Standard deviation	180	109 486	58	93 128	44	25 713	25	37 794
Plage	648	364 135	174	287 616	138	105 896	102	130 778
Minimum	738	150 423	1 391	202 262	1 435	201 804	1 336	237 349
Maximum	1 386	514 558	1 565	489 878	1 573	307 700	1 438	368 127
Fund number (Average)	**1059**		**1500**		**1530**		**1399**	
At the beginning	*738*		*1409*		*1553*		*1430*	
At the end		*1391*		*1554*		*1435*		*1336*
Overall TNA (M €)								
At the beginning	198 254		489 878		201 804		288 021	
At the end		482 611		202 262		297 406		241 898

Notes: This tables presents the evolution of European fund size from December 2001 and December 2013. TNA x1000

Figure 1 : The evolution of European fund size from 2001 through 2013

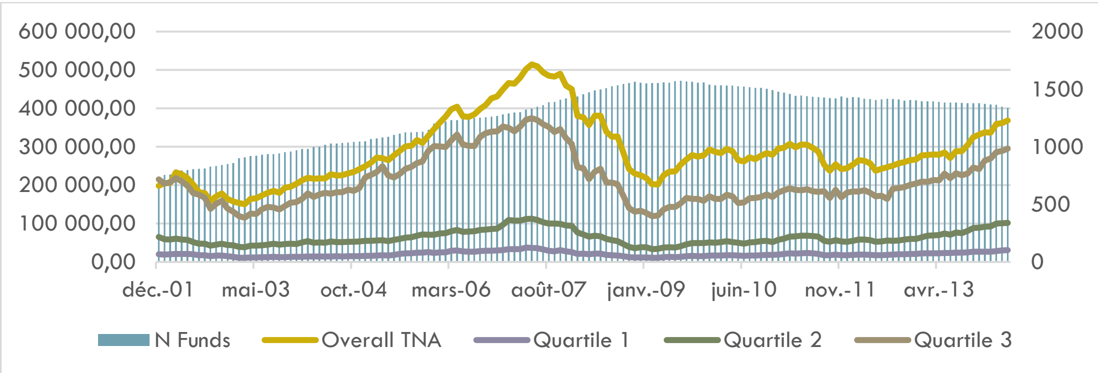

Table 2: Descriptive statistics for European fund size by quartile

	12.2001- 09.2007 Before crisis (P1)			10.2007 - 02.2009 During crisis (P2)			03.2009 - 06.2011 After crisis (P3)			07.2011 - 12.2013 After UCITS IV (P4)		
	Q1	***Q2***	***Q3***	***Q1***	***Q2***	***Q3***	***Q1***	***Q2***	***Q3***	***Q1***	***Q2***	***Q3***
Mean	20,73	64,85	231,95	18,55	61,23	211,92	17,24	52,07	166,47	21,99	68,56	210,80
Median	19,05	57,35	216,74	18,31	60,07	207,09	16,72	51,36	166,84	21,08	62,15	202,48
Standard deviation	7,43	21,01	79,48	5,94	21,49	69,93	3,32	9,49	16,94	3,80	15,70	36,94
Plage	26,52	74,26	259,41	19,44	66,02	226,74	12,34	34,23	70,77	13,28	49,13	131,44
Minimum	10,93	38,38	115,20	11,13	33,34	119,23	11,24	34,36	121,05	17,33	52,40	164,12
Maximum	37,45	112,64	374,61	30,57	99,36	345,98	23,57	68,60	191,82	30,62	101,53	295,55

Notes: This table presents descriptive statistics related to the evolution of European fund size from December 2001 to December 2013 by quartile.

Figure 1 illustrates this evolution. This contrasting trend probably can be explained in part by the post-financial crisis upward trend and the reversion to mean effect. This trend also suggests that the UCITS IV Directive may have played an important role. Indeed, the UCITS IV Directive appears to play a catalytic role in the creation and structuring of funds; it also appears to stabilize fund production. Table 2 provides an indication of the dynamics of the European fund size by period and by quartile. We observe differences between small-sized funds (Q1 and Q2) and large- sized funds (Q3). Mainly, fund size standard deviations and range values steadily decrease with time for all funds but more significantly for large funds. Once again, this result opens the debate about the role of the UCITS IV Directive. Indeed, in addition to the possible cyclical effect, this result may indicate an improvement in size and in the economies of scale management by fund managers.

3.3 Fund characteristic variables and fund family instruments

In our tests, we use three groups of variables. The first group includes the usual fund specific instruments such as lagged fund size, flow, age, management and redemption fees. The second group of variables is composed of family-specific instruments that provide information regarding their organizational structure such as Fund family size (LogFamSize), the Number of member funds in the family (LogNFam), a dummy variable indicating fund families with large Fund members at a maximum of 20 (Large_20) and a dummy variable indicating fund families with large equity fund members (a maximum of 20, EQ_Large). The third group of variables consists of specific instruments used to assess the potential sources of the economies of scale through the extent of geographic diversification and/or the degree of specialization of the fund families. Thus, we calculate the 5 Herfindahl–Hirschmann Concentrations, as follows:

- The family concentration depending on a fund member's weight (TNA) within the family (HHI_TNA_F). A value close to 1 indicates the presence of « fund stars », that is, a small number of members with a greater contribution to the family. A value close to 0 indicates balanced contributions for each fund within the family.
- The family concentration dependent on the Lipper class size (HHI_TNA_LC). This variable measures the family degree of specialization according to the size of the different asset classes of all the funds in the family. A value close to 1 indicates a highly specialized family, which implies superior expertise and understanding of resources related to the asset

classes considered. A value close to 0 indicates that the family is diversified in terms of asset class allocation.

- The family concentration depending on the number of asset classes (HHI_N_LC). This variable measures the diversity of the product range covered by the family. A value close to 1 indicates a specialized family that promotes a limited range of fund classes. A value close to 0 indicates that family covers a large range of fund classes.
- The family concentration depending on fund members' domicile (HHI_D). This variable measures the geographical presence of the family. A value close to 1 indicates a reduced number of domicile locations. A value close to 0 indicates a more extensive geographic network.
- The family concentration depending on an Equity fund members' domicile (EQ_HHI_D). This variable measures the geographical presence of the family for the only Equity fund members. A value close to 1 (0) indicates a large Equity funds less (more) extensive equity funds' domicile.

Table3: Summary statistics for fund family characteristics

Label	Variable	12.2001-09.2007 Before crisis (P1)		10.2007-02.2009 During crisis (P2)		03.2009-6.2011 After crisis (P3)		07.2011-12.2013 After UCITS (P4)	
		Mean	Std	Mean	Std	Mean	Std	Mean	Std
Number of fund members	N_Fam	56	116	61	132	58	126	52	108
Family fund size (M€)	FamSize	9 188	21 878	8 523	21 279	8 208	20 642	8 149	19 871
Number of Equity fund members	N Fam EQ	17	25	18	27	16	25	14	22
Family up to 20 members	Large 20	0,476	-	0,477	-	0,485	-	0,474	-
Family up to 20 Equity fund members	EQ Large 20	0,273	-	0,258	-	0,232	-	0,195	-
Concentration index depending on fund size	HHI_TNA_F	0,213	0,214	0,228	0,223	0,228	0,226	0,234	0,233
Concentration index depending on Lipper class numbers	HHI_N_LC	0,178	0,186	0,179	0,188	0,186	0,199	0,189	0,202
Concentration index depending on Lipper class size	HHI_TNA_LC	0,281	0,218	0,301	0,226	0,297	0,23	0,296	0,234
Concentration index depending on the number of fund domicile	HHI_D	0,845	0,228	0,843	0,231	0,852	0,227	0,866	0,221
Concentration index depending on the number of Equity fund domicile	EQ_HHI_D	0,874	0,214	0,869	0,22	0,875	0,217	0,884	0,213

Notes: This table reports summary statistics related to fund family variables estimated for 4 periods from December 2001 to December 2013

Table 3 above reports the descriptive statistics related to fund characteristic variables and fund family instruments. This table reveals specific properties regarding European equity funds in our dataset. First, we do not observe important differences in evolution for the 4 periods considered. This finding suggests that the UCITS IV Directives adoption, contrary to what is expected, has no major effect on the structure and the size of European funds. Second, European fund families consist of groups composed of a large number of members. Generally, families are composed of 56 members with an average size of approximately 9 billion €.

Standard deviations of fund numbers within families are generally superior to 100. This finding indicates that funds in our dataset comprise the two extremes. Many individual funds and families can have more than 100 members. Generally, approximately 48 percent of families have more than 20 funds. In addition, 27 percent are composed of a maximum of 20 equity funds. In terms of asset classes, families are significantly diversified. The concentration index, depending on the size of fund members, is approximately 22 percent. The Herfindahl-Hirschmann indexes for the number and the size of the Lipper class, are approximately 18 percent and 29 percent, respectively. Conversely, the concentration indexes are high for the domiciliation level for all funds and for only equity funds, approximately 85 percent and 87 percent, respectively.

4 The dynamics of European funds size and performance: tests using Multi level models

In accordance with Chen et al. (2004), we examine the existence of a significant relation between European fund size and performance for 4 periods from 2001 through 2013. These exploratory empirical investigations are based on our two main hypotheses.

H1a - On the existence of UCITS IV effects: The risk-adjusted performances for the period after the UCITS IV adoption (P4) are superior to those of the prior periods (P1, P2 and P3).

H2a - On the existence of economies of scale: For the period after the UCITS IV adoption (P4), large funds improve their performance more than prior periods and small funds.

Thus, we refer to the three standard performance models to estimate the risk-adjusted performance. Notably, we use a non-conventional and innovative methodology, i.e., a multilevel regression model, to test our two hypotheses.

4.1 Performance Models

In all our tests, we consecutively use three standard performance evaluation models: the 1-factor CAPM, the Fama-French 3-factors and the 4-factors Carhart benchmark models.

- 1-factor CAPM model: $R_{i,t} = \alpha_i + \beta_{0,i} RM_t + \varepsilon_{i,t}$ *(7)*
- 3-factors Fama-French model: $R_{i,t} = \alpha_i + \beta_{0,i} RM_t + \beta_{1,i} SMB_t + \beta_{2,i} HML_t + \varepsilon_{i,t}$ *(8)*
- 4-factors Carhart model: $R_{i,t} = \alpha_i + \beta_{0,i} RM_t + \beta_{1,i} SMB_t + \beta_{2,i} HML_t + \beta_{3,i} MOM_t + \varepsilon_{i,t}$ *(9)*

These three models permit the estimation of Jensen's alpha coefficients, which represent the risk-adjusted performance considering the heterogeneity of the fund-related styles. Thus, different risk factors are considered: the only market risk (RM) for the one factor model, the factor mimicking portfolios for size (Small minus Big, SMB), the book-to-market equity (High minus Low, HML) for the 3- factors Fama-French model and the added one-year momentum in stock returns (MOM) for the 4-factors Carhart model. The summary statistics related to these factors are reported in Appendix 1.

4.2 Multilevel Regression Methodology

As we indicate in Section 2, the economies of scale can mainly be observed at the fund family level. Indeed, the fund family structure and the governance appears to be the level on which transaction and hierarchy cost reduction benefits occur. At the family level, gains from sharing common skills and hard and soft information can be substantial. However, all models and previous tests are based on the strong hypothesis that funds use the same technologies, and competition occurs between funds. By definition, OLS regressions suppose the independence of observations and ignore that funds are often neither independent nor isolated. These funds belong to fund families that have many resources. Multilevel models permit the consideration of this nested nature of the fund industry by separating the common variance shared by funds belonging to the same families from the total fund variance (Goldstein, 1986, Snijder and Bosker, 1999). By definition, this approach allows the modeling of the heterogeneity of microeconomic units when these units belong to groups that are themselves heterogeneous and in competition. Thus, multilevel models appear to be more powerful and to strengthen our tests of the existence of UCITS IV and economies of scale effects.

Multilevel regression models combine fixed and random effects and explicitly consider the hierarchical structure of observations. The objective is to decompose the total variance for each level of interest. In our investigation, we consider three levels of variance: (1) Intra-variance, which explains the growth of fund size, (2) Inter-fund variance, which models the performance differences between funds and (3) Inter-fund family variance, which explains the heterogeneity between fund families. The challenge is to address the decomposition of the dynamic relationship between the risk-adjusted performance of funds and the size in one block. Specifically, we test the following relationship:

$$\alpha_{i,j,t} = \beta_{0,j} + \beta_1 LogTNA_{i,j,t-1} + \beta_2 \left(LogTNA_{i,j,t-1}\right)^2 + \sum_{K=3}^{K=4} \beta_k Period + \sum_{L=5}^{L=6} \beta_L Period * LogTNA_{i,j,t-1} + \sum_{M=7}^{M=8} \beta_M Period * \left(LogTNA_{i,j,t-1}\right)^2 + \sum_{N=9}^{N=12} \beta_N Ctrl_{i,j,t} + \epsilon_{i,j,t} \quad (10)$$

This relation explains the risk-adjusted performance $\alpha_{i,j,t}$ of fund i belonging to fund family j measured for month t as a quadratic relation with the size $LogTNA_{i,j,t-1}$ *and* $LogTNA_{i,j,t-1}{}^2$ to which interaction effects with different periods and fund characteristic instruments are added. In this relation, we introduce the random effects that allow the consideration of unobserved heterogeneity, which indicates the membership of a fund in a family. This specification tests whether a fund belonging to a family explains the differences in performance vis-à-vis funds belonging to other families. Specifically, we introduce random effects on the constant term (intercept) in the model. We vary this constant term depending on fund families assuming that it follows a normal distribution as follows[2]:

$$\beta_{0,j} \sim N\ (\delta_{00}, \sigma_0^2) \qquad (11)$$

Where σ_0^2 represents the estimated inter-group variance that must be explained by the fund family characteristic variables:

$$\beta_{0,j} = \delta_{00} + \sum_{F=13}^{F=16} \delta_{0F} * (Family)_{j,t} + u_0 \qquad (12)$$

We address the problems related to the existence autocorrelation of residuals by an autoregressive maximum order 1 process:

$$\epsilon_{i,j,t} = \rho\epsilon_{i,j,t-1} + v_{i,j,t} \quad where\ \ |\rho| < 1\ follow\ an\ AR(1)\ process$$

$$v_{i,j,t} \sim N\left(0,\ \sigma_v^2\right) \text{ and } \sigma_\epsilon^2 = \frac{\sigma_v^2}{1-\rho^2} \qquad (13)$$

Substituting these equations into the overall model, we obtain the following multilevel model with a random constant term (family level) and individual errors (fund level) auto-correlated to a maximum order 1:

$$\alpha_{i,j,t} = \delta_{00} + \beta_1 LogTNA_{i,j,t-1} + \beta_2\left(LogTNA_{i,j,t-1}\right)^2 + \sum_{K=3}^{K=4}\beta_k Period + \sum_{L=5}^{L=6}\beta_L Period * LogTNA_{i,j,t-1} + \sum_{M=7}^{M=8}\beta_M Period * \left(LogTNA_{i,j,t-1}\right)^2 + \sum_{N=9}^{N=12}\beta_N Ctrl_{i,j,t} + \sum_{F=13}^{F=16}\delta_{0F} * \left(Family_{j,t}\right) + u_0 + \rho\epsilon_{i,j,t-1} + v_{i,j,t} \quad (14)$$

This model is composed of two main components. The fixed component of the model can be considered as a classical cross-sectional OLS. The random component of the model $\left(u_0 + \rho\epsilon_{i,j,t-1} + v_{i,j,t}\right)$ estimates the inter-family variance u_0, the intra-fund variance $\rho\epsilon_{i,j,t-1}$

[2] In our study, we performed testing on models with various random effects depending on the constant term and depending to the size (LogTNA and LogTNA^2). The objective was to examine whether fund families explain the fund members size and performance relationship: $\begin{pmatrix}\beta_{0,j}\\ \beta_{1,j}\\ \beta_{2,j}\end{pmatrix} \sim N\begin{pmatrix}\delta_{00} & \sigma_0^2\\ \delta_{10}\ , & \sigma_1^2\\ \delta_{20} & \sigma_2^2\end{pmatrix}$. The results are inconclusive and not reported here.

and the residual $v_{i,j,t}$, /which should be i.i.d. and homoscedastic. This specification allows us to perform extensive tests on the existence and the shape of the relationship between size and performance not only at the fund level but also at the family level. Three sets of tests can be performed.

The first set is related to the existence of the "fund family effect":

- *T1:* $\sigma_0 \neq 0$ *. It tests whether the variance of the random constant term in the model is significantly different from zero (Wald Z-test). The objective is to determine if the fund family has a direct effect on fund member performance.*

A second set of tests is related to the shape of the relationship of size and performance:

- *T2:* $\beta_1 = 0; \beta_2 = 0$*. There is no relation between size and performance.*
- *T3:* $\beta_1 < 0; \beta_2 = 0$*. There is a linear and negative relation between size and performance consistent with the theoretical background.*
- *T4: It tests whether there is a quadratic relation between size and performance that can be*
    - *Positive concave:* $\beta_1 > 0; \beta_2 < 0$ *and negative concave :* $\beta_1 < 0; \beta_2 > 0$
    - *Positive convex :* $\beta_1 > 0; \beta_2 > 0$ *and negative convex :* $\beta_1 < 0; \beta_2 < 0$

A third set of tests is related to the existence of UCITS IV effects and the presence of economies of scale:

- *T5:* $\beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8 \neq 0$.

In our investigation, we test three different specification models to avoid the presence of multi-collinearity between family-specific variables[3]. The first model is a standard model that includes family level variables such as the size of the family (logFamSize). The expected sign of the estimated coefficient is positive, thus showing that a family should have important resources that it effectively manages to benefit from the economies of scale. The second model is based on the number of funds offered by the family irrespective of the overall size. This model should explain the effects of sharing information between managers within fund families with a relatively diversified profile. Three family-level variables are integrated here: the concentration index depending on the Lipper class number (HHI_N_LC), Large fund family (Large_20), and the concentration index depending on the domicile number (HHI_D). The third model is based on fund family financial resources, calculated from the TNA with a focus

[3] The correlation matrix between different variables and instruments is presented in Appendix 2.

on equity funds. Three family characteristic variables are used in this model: the concentration index depending on the domiciliation of equity funds (HHI_D_EQ), the concentration index depending on the weight of the fund's Lipper class compared to all family Lipper classes (HHI_TNA_LC) and Large Equity Families (EQ_Large 20).

5 Empirical results

For each of the three specifications, we perform all tests for the three different periods as a single block to consider one of the main advantages of the methodology. We use monthly rolling alphas estimated using the three different benchmark factors models: the 1-factor CAPM, the 3-factors Fama-French and the 4-factors Carhart. The alpha coefficients are monthly estimated over 36-month rolling periods[4]. For our multilevel regressions, we use the restricted maximum likelihood estimator (REML). In the line of studies using financial data series including crisis periods, we exclude the period P2 from all our tests. Indeed, this period poses convergence problems for estimators due to the high volatility and the high correlations between the data series. Thus, we perform panel regressions directly on our three defined periods P1, P3 and P4. We use the period P4 corresponding to the UCITS IV Directive adoption as the reference. To limit the impact of outliers on our estimations, we exclude 2.5% to 2.5% at the right and left of the fund's size distribution.

Table 6 hereafter reports the overall results for our estimates. These results necessitate four main sets of comments.

5.1 On the existence of decreasing returns of scale.

Referring to the seminal works of Berk and Green (2004) and Chen et al. (2004), the size and performance relationship is negative. As more investment funds grow, instances of lower performance will increase (Pollet & Wilson, 2008, Stein, 2002). Therefore, there are diseconomies of scale related to the existence of liquidity constraints and the increased hierarchy costs. Empirically, the answers to the shape of the size and performance relationship are mixed. Various studies have concluded that there is a significant relation with two types of shape: a negative and linear relationship and a quadratic and concave relationship.[5] These two forms of relationships are consistent with the theoretical assumptions. Moreover, the quadratic and concave relationship allows us to identify the optimal size from which performance decreases.

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[4] Appendix 3 shows the time series of the average alphas. These figures allow us to confirm the consistency between defined sub-periods and the time-varying changes in the dynamic of European fund performances.
[5] See Bodson (2011) for an extensive review of literature.

Globally, all our tests validate the hypothesis of a quadratic relationship between the size and performance.[6] Constant terms (intercept) β_0 are statistically significant and vary from -2.8 percent to -4.65 percent, except for the 4-factors Carhart estimation in the period P1. β_1 and β_2 coefficients related to the size and performance dynamics and associated to LogTNA and $(\text{LogTNA})^2$ are statistically significant, except for β_1 for the 1-factor CAPM estimation in the period P1. The signs of β_1 (negative) and β_2 (positive) related to the reference period (P4) indicate a quadratic and positive convex relationship. For P1 and P3, the results are in accordance with previous studies. The coefficients $\beta_5\ et\ \beta_6$ associated to LogTNA are positive and $\beta_7\ et\ \beta_8$ associated to LogTNA^2 are negative. This result indicates a quadratic and positive concave relationship. This contrasting result shows that the post-UCITS IV period appears to represent a new regime in the relation between the size and performance of European funds. The funds appear to benefit from gains related to size and to not confront the diseconomies of scale.

[6] An explanation, including a reading and commentary of the results, is displayed in Table 6. The main coefficients correspond to those of reference value (period P4), denoted REF. To obtain coefficients related to the other period, one must add to the REF coefficient terms provided by the interaction effects. For example, for the constant term (column 1), REF indicated -0.034759; therefore, the constant term for P1 is -0.032722 (=-0.034759 + 0.002038). Refer to Appendix 4 for an aggregate table of coefficients associated with the relationship size – Performance;

Table 6 : Multilevel regression results on the size–performance relationship

		Model 1			Model 2			Model 3		
		CAPM	**Fama - French**	**Carhart**	**CAPM**	**Fama - French**	**Carhart**	**CAPM**	**Fama - French**	**Carhart**
		RANDOM EFFECTS								
Constant term variance (σ_0^2)		0,000005 ***	0,000007 ***	0,000006 ***	0,000006 ***	0,000007 ***	0,000004 ***	0,000007 ***	0,000008 ***	0,000005 ***
AR(1)		0,988800 ***	0,990200 ***	0,988500 ***	0,988500 ***	0,990200 ***	0,988900 ***	0,988300 ***	0,990100 ***	0,988800 ***
Residuals (ε)		0,000121 ***	0,000150 ***	0,000153 ***	0,000153 ***	0,000149 ***	0,000122 ***	0,000151 ***	0,000148 ***	0,000120 ***
Constant term (β_0)	**Coefficients**	-0,034759 ***	-0,039941 ***	-0,038818 ***	-0,031657 ***	-0,036483 ***	-0,036179 ***	-0,029955 ***	-0,034902 ***	-0,034078 ***
	Std error	*0,001221*	*0,001315*	*0,001385*	*0,001137*	*0,001229*	*0,001291*	*0,001125*	*0,001216*	*0,001277*
P1 (β_3)	**Coefficients**	0,002038 *	0,002849 **	0,001936 (NS)	0,002019 *	0,002881 **	0,001923 (NS)	0,001897 *	0,002743 **	0,001789 (NS)
	Std error	*0,001135*	*0,001180*	*0,001286*	*0,001135*	*0,001180*	*0,001286*	*0,001135*	*0,001180*	*0,001286*
P3 (β_4)	**Coefficients**	-0,005593 ***	-0,006562 ***	-0,007307 ***	-0,005595 ***	-0,006556 ***	-0,007304 ***	-0,005605 ***	-0,006570 ***	-0,007320 ***
	Std error	*0,000753*	*0,000784*	*0,000858*	*0,000753*	*0,000784*	*0,000858*	*0,000753*	*0,000784*	*0,000858*
P4	**Coefficients**	REF	REF	REF	REF	REF	REF	REF	REF	REF
	Std error									
LogTNA (β_1)	**Coefficients**	-0,001140 ***	-0,001398 ***	-0,001631 ***	-0,001140 ***	-0,001398 ***	-0,001630 ***	-0,001152 ***	-0,001409 ***	-0,001643 ***
	Std error	*0,000361*	*0,000377*	*0,000412*	*0,000362*	*0,000377*	*0,000412*	*0,000361*	*0,000377*	*0,000412*
(LogTNA)² (β_2)	**Coefficients**	0,000384 ***	0,000344 ***	0,000364 ***	0,000389 ***	0,000348 ***	0,000368 ***	0,000392 ***	0,000352 ***	0,000371 ***
	Std error	*0,000093*	*0,000097*	*0,000106*	*0,000093*	*0,000097*	*0,000106*	*0,000093*	*0,000097*	*0,000106*
LogTNA*P1 (β_5)	**Coefficients**	0,000246 (NS)	0,001292 **	0,001363 **	0,000273 (NS)	0,001315 **	0,001389 **	0,000252 (NS)	0,001299 **	0,001368 **
	Std error	*0,000571*	*0,000594*	*0,000649*	*0,000572*	*0,000594*	*0,000649*	*0,000571*	*0,000594*	*0,000649*
LogTNA *P3 (β_6)	**Coefficients**	0,001860 ***	0,002220 ***	0,002472 ***	0,001870 ***	0,002228 ***	0,002480 ***	0,001866 ***	0,002226 ***	0,002479 ***
	Std error	*0,000384*	*0,000400*	*0,000438*	*0,000384*	*0,000400*	*0,000438*	*0,000384*	*0,000400*	*0,000438*
LogTNA*P4	**Coefficients**	REF	REF	0,000000	REF	REF	REF	REF	REF	REF
	Std error									
(LogTNA)² *P1 - (β_7)	**Coefficients**	-0,000161 (NS)	-0,000390 **	-0,000324 *	-0,000164 (NS)	-0,000393 **	-0,000327 *	-0,000162 (NS)	-0,000391 **	-0,000325 *
	Std error	*0,000147*	*0,000153*	*0,000167*	*0,000147*	*0,000153*	*0,000167*	*0,000147*	*0,000153*	*0,000167*
(LogTNA)² *P3 - (β_8)	**Coefficients**	-0,000400 ***	-0,000478 ***	-0,000529 ***	-0,000402 ***	-0,000480 ***	-0,000531 ***	-0,000402 ***	-0,000480 ***	-0,000531 ***
	Std error	*0,000095*	*0,000099*	*0,000109*	*0,000095*	*0,000099*	*0,000109*	*0,000095*	*0,000099*	*0,000109*
(LogTNA)²*P4	**Coefficients**	REF	REF	REF	REF	REF	REF	REF	REF	REF
	Std error									

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$; NS : Non-Significant

Table 6 : Multilevel regression results on the size–performance relationship (continued)

FIXED EFFECTS										
		Model 1			Model 2			Model 3		
		CAPM	Fama - French	Carhart	CAPM	Fama - French	Carhart	CAPM	Fama - French	Carhart
Flow (t-1)	**Coefficients**	-0,000019 ***	-0,000028 ***	-0,000012 **	-0,000019 ***	-0,000028 ***	-0,000012 **	-0,000019 ***	-0,000028 ***	-0,000012 **
	Std error	*0,000009*	*0,000010*	*0,000010*	*0,000009*	*0,000009*	*0,000010*	*0,000009*	*0,000009*	*0,000010*
Management fees	**Coefficients**	-0,000655 **	-0,000866 ***	-0,000785 ***	-0,000729 **	-0,000934 ***	-0,000865 ***	-0,000670 **	-0,000882 ***	-0,000800 **
	Std error	*0,000300*	*0,000338*	*0,000336*	*0,000297*	*0,000337*	*0,000334*	*0,000297*	*0,000336*	*0,000333*
Redemption fees	**Coefficients**	0,000554 **	0,000724 **	0,000718 **	0,000520 **	0,000697 **	0,000690 **	0,000542 **	0,000714 **	0,000709 **
	Std error	*0,000251*	*0,000284*	*0,000281*	*0,000249*	*0,000282*	*0,000279*	*0,000249*	*0,000282*	*0,000279*
log(age) (t-1)	**Coefficients**	0,007571 ***	0,009875 ***	0,009559 ***	0,007676 ***	0,010011 ***	0,009666 ***	0,007489 ***	0,009821 ***	0,009465 ***
	Std error	*0,000320*	*0,000348*	*0,000360*	*0,000318*	*0,000347*	*0,000359*	*0,000318*	*0,000347*	*0,000358*
		Model 1			**Model 2**			**Model 3**		
		CAPM	**Fama - French**	**Carhart**	**CAPM**	**Fama - French**	**Carhart**	**CAPM**	**Fama - French**	**Carhart**
HHI_D_EQ (t-1)	**Coefficients**							-0,000358 (NS)	-0,000631 (NS)	-0,000202 (NS)
	Std error							*0,000390*	*0,000411*	*0,000444*
HHI_N_LC (t-1)	**Coefficients**				0,001056 *	0,001079 (NS)	0,000912 (NS)			
	Std error				*0,000625*	*0,000657*	*0,000715*			
LogFamSize(t-1)	**Coefficients**	0,000420 ***	0,000439 ***	0,000421 ***						
	Std error	*0,000075*	*0,000081*	*0,000086*						
Large_20 (t-1)	**Coefficients**				0,000042 (NS)	0,000060 (NS)	0,000109 (NS)			
	Std error				*0,000138*	*0,000144*	*0,000157*			
HHI_TNA_LC (t-1)	**Coefficients**							-0,003508 ***	-0,003301 ***	-0,003546 ***
	Std error							*0,000484*	*0,000507*	*0,000551*
EQ_Large_20 (t-1)	**Coefficients**							-0,000249 **	-0,000226 **	-0,000297 **
	Std error							*0,000102*	*0,000107*	*0,000117*
HHI_D (t-1)	**Coefficients**				-0,000064 (NS)	-0,000471 (NS)	0,000509 (NS)			
	Std error				*0,000459*	*0,000484*	*0,000520*			

* p < 0.1 ** p < 0.05 *** p < 0.01; NS : Non-Significant

Note: This table presents cross sectional OLS for the following multilevel regression model: $\alpha_{i,j,t} = \delta_{00} + \beta_1 \mathrm{LogTNA}_{i,j,t-1} + \beta_2 (\mathrm{LogTNA}_{i,j,t-1})^2 + \sum_{K=3}^{K=4} \beta_k \mathrm{Period} + \sum_{L=5}^{L=6} \beta_L \mathrm{Period} * \mathrm{LogTNA}_{i,j,t-1} + \sum_{M=7}^{M=8} \beta_M \mathrm{Period} * (\mathrm{LogTNA}_{i,j,t-1})^2 + \sum_{N=9}^{N=12} \beta_N \mathrm{Ctrl}_{i,j,t} + \sum_{F=13}^{F=16} \delta_{0F} * (\mathrm{Family}_{j,t}) + u_0 + \rho\epsilon_{i,j,t-1} + v_{i,j,t}$, where $\alpha_{i,j,t}$ is estimated from the three standard benchmark evaluation models: CAPM, 3-factors Fama-French and 4-factors Carhart. The regression uses specific standard variables such as the fund size, flow, age, management and redemption fees. Three different specification models are tested to address the presence of multi-collinearity between family-specific variables. Model 1 is a standard model based on the overall size of the fund family (logFamSize). The model 2 is based on three fund family concentration indexes depending on the number of: Lipper class (HHI_N_LC), large fund family (Large_20), and domicile (HHI_D). Model 3 is based on three fund family concentration indexes calculated from the TNA with a focus on equity funds and depending on: the domiciliation of equity funds (HHI_D_EQ), the weight of the fund Lipper class compared to all family Lipper classes (HHI_TNA_LC) and the presence of Large Equity Families (EQ_Large 20).

5.2 On the existence of UCITS IV effects

The existence of UCITS IV effects can be observed through $\beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8$ coefficients. As previously indicated, all coefficients are statistically significant, except for β_3 and β_5 estimated in period P1 with the 4-factors Carhart and the 1-factor CAPM models, respectively. Estimations made with the 3-factors Fama-French model are clean; therefore, we will refer to it in all our comments. The hypothesis of the existence of UCITS IV effects is not rejected by the data with multilevel estimation.

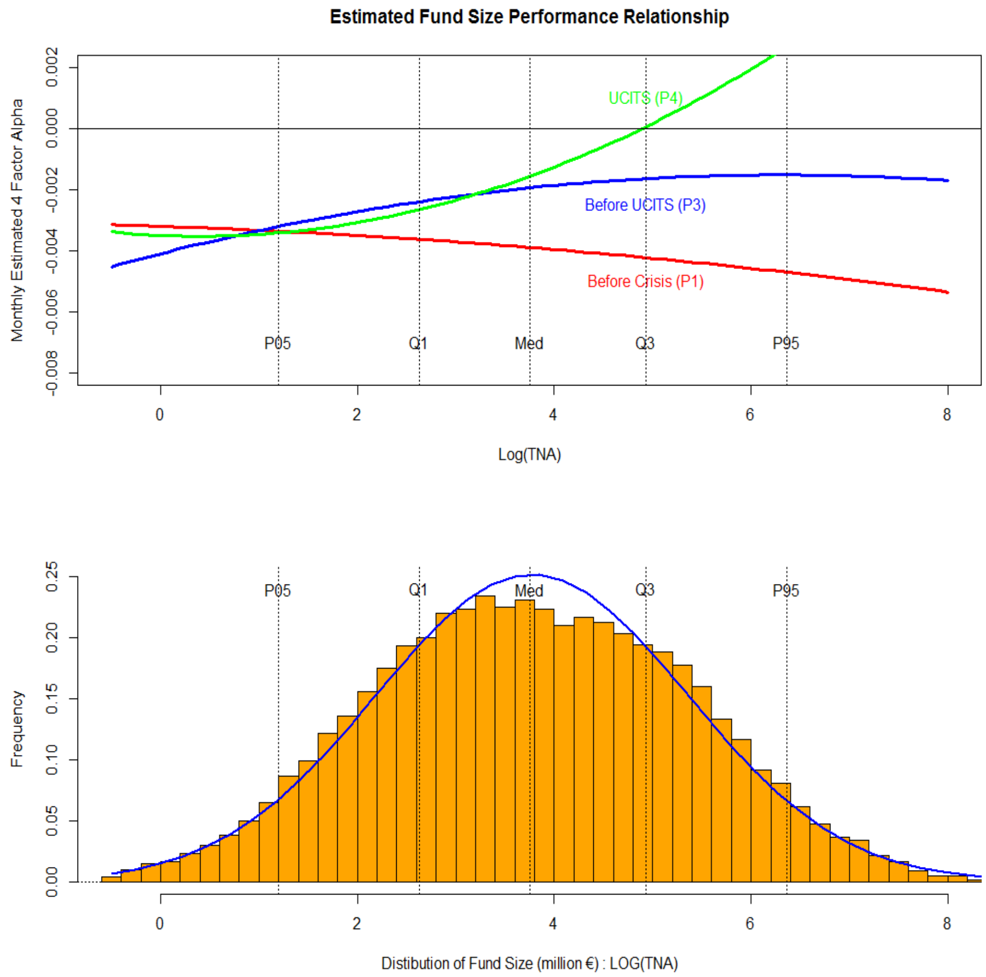

Figure 2 : Size and performance simulation based on model 3 estimated coefficients

Beyond the significance of all coefficients, figure 2 below provides a clear view of these results. Figure 2 relates the size and performance for the three periods considered to a projection of the distribution of the size of the funds in our sample and highlights two major observations. On the one hand, the performance associated with period P4 is substantially greater than the two other periods, mainly for large funds, to a maximum of the median. On the other hand, the performance dynamic is growing with the size for period P4 while it decreases for the two other periods. These results appear to confirm the issues of Pastor and Stambaugh's (2011, 2015) theoretical model, which states that economies of scale vary according to market conditions. Periods P1 and P4 both occur following a period of financial crisis (dot.com for P1 and subprime for P4), while period P3 corresponds to a market upward trend. The Pastor and Stambaugh model shows that the extent of the diseconomies of scale depends on the overall size of the active management industry. The larger this industry is, the greater the competition between funds is. This behavior reduces the investment opportunities and ultimately degrades performance. As a reaction, investors transfer their capital to fund passive management; this consequently decreases the size of the active management industry and reduces the magnitude of the diseconomies of scale. Thus, the post-subprime crisis, here period P3, corresponds to a situation where the active management industry is at its lowest level. Thus, competition between active managers is very low, justifying the concave relationship. Conversely, the P1 and P4 periods correspond to market upward periods. Therefore, consistent with the literature, the overall size of the active management industry increased during these periods, which, in turn, increased the competition and the extent of the diseconomies of scale to the point where the size and performance relationship becomes negative. The difference between P1 and P4 corresponds mainly to the extent of the diseconomies of scale. Whereas P1 is nearly linear and negative, the convex form for P4 clearly indicates that there is a premium for the largest funds. This finding is precisely the objective pursued by the UCITS IV Directive.

5.3 On the potential sources of economies of scale and the fund family effects

Theoretically, the economies of scale may exist at the fund family level. Many studies have shown this positive relationship between the fund family size and the performance of individual fund members. On the one hand, fund members of large families can take advantage of greater resources in research and expertise, sharing transaction and credit costs (Chen et al., 2004), Ferreira, 2013). On the other hand, large fund families can organize themselves to smooth the performance of fund members by transferring performance from high fee funds to low fee funds. To this behavior, we can add that large families are committed to creating fund stars that generate capital inflows for itself and for other fund family members (Nanda et al., 2004, Massa, 2008).

In our study, two parts in Table 6 allow us to determine the existence of the fund family effects and the potential sources of these economies of scale. The tests related to the existence of "fund family effect" are reported at the top of table 6 (random effects). We observed that the variance of the constant term is significantly different from zero, ($\sigma_0 \neq 0$) at 1% level. This finding indicates that fund families explain and have a direct effect of the performance variation of its fund members. More importantly, the tests on variables related to the fund family characteristics and associated with our three models provide a clear indication of the extent of the fund family effects.

Our standard model (model 1) that includes lagged fund family size (logFamSize) as a control variable is conclusive and validates the theoretical assumptions. All estimated coefficients with the three performance models are positive and highly significant. These results confirm the Chen et al. (2004) and Ferreira (2013) issues, which stated that family size has positive effects on fund members' performance. Thus, families that manage their resources efficiently can benefit their members by generating substantial economies of scale.

For model 2 based on the number of funds offered by the family irrespective of the overall size, none of the three control variables considered display significant coefficients, except for the CAPM model, which does so at the 10% level. The first variable (concentration index depending on the number of Lipper class, HHI_N_LC) displays a positive and significant coefficient only with the CAPM estimation. This result indicates that a family with a high concentration of asset classes has positive effects on fund members' performance. This result is consistent with previous theoretical assumptions, which state that a high concentration implies effective resource controls and superior expertise in these classes. This finding logically allows economies of scale. However, this result must be nuanced since it is limited to the CAPM model estimation. This observation suggests further investigations to better understand all the impacts considering the heterogeneity of the styles and the strategies. The second control variable (Large fund family, Large_20) is non-significant. This variable indicates that belonging to a very large fund family does not necessarily provide an additional performance benefit, particularly when the family is highly diversified. For the third control variable (concentration index depending on the number of domicile (HHI_D), we expected a negative and significant effect to the extent that it is a major component of the UCITS IV Directive. Indeed, by reducing the number of domiciles, the European passport would reduce the costs for the internationalization of fund families. This internationalization would allow families, especially the largest, access to investment opportunities by reducing the costs; this should positively impact the performance. However, our tests show that all the estimated coefficients are not statistically significant. These results indicate that there is no direct relation between fund performance and the number of fund domiciles.

Model 3, which is based on fund family resources and is focused on equity, provides the most conclusive results. Two of the three considered fund family characteristic variables show significant coefficients. The first variable (concentration index depending on the domiciliation of equity funds, HHI_D_EQ) display non-significant estimated coefficients. Regarding model 2, we observe no direct relation between the fund performance and the number of equity fund domiciles. Fund domiciliation does not appear to be a main determinant of benefits from either economies or diseconomies of scale. This finding probably explains why the average level of concentration by domicile (see above Table 3) remained constant before and after the UCITS IV Directive despite the broadening of the notification procedure through the creation of a European passport.

The second variable (concentration index depending on the weight of the fund Lipper class compared to all family Lipper classes, HHI_TNA_LC) displays negative and significant coefficients for all benchmark model estimations. This result indicates to the fund family that a high concentration in the allocation of financial resources has negative effects on the performance of its members. In theory, belonging to a family may induce positive spillover effects once the organization promotes the sharing of information and resources. The belonging can have negative spillover effects if the hierarchy costs increase, and the organization spurs more competition between managers and causes cannibalization between funds. With regard to our findings, the result of a negative effect can be easily explained. As we observed in our descriptive statistics (see Table 3), the European fund families have specific characteristics. On the one hand, these fund families have a very high number of members, with an average of more than 50, with standard deviations of as much as 100. On the other hand, these fund families display low concentration indexes depending on the Lipper class: approximately 19 percent if one refers to the number of Lipper classes; approximately 30 percent if one refers to the size of Lipper classes. Thus, European fund families are highly diversified. This diversification can probably be beneficial as it helps to seek many investment opportunities. Nevertheless, in return, the diversification requires a more appropriate organization to effectively share information and resources and to thus benefit from positive common skills effects. This finding does not appear to apply to the European funds in our study. Herein, the negative sign simply indicates the existence of significant hierarchy costs that burden the performance. The third variable (Large Equity Families, EQ_Large 20) displays negative and significant coefficients for all estimations. We have the same comments as for the earlier variable. Indeed, we are in the presence of the diseconomies of scale phenomenon. Overall, the strong specialization of the family in Equity fund induces negative spillover effects.

5.4 On the standard control variables

The estimated coefficients of our four control variables necessitate short comments. All coefficients are significant for all estimations. Estimated coefficients associated to the lagged flows are negative, which is consistent with the main empirical studies. By definition, flows mechanically increase the fund size, which, in turn, increases the liquidity and hierarchy costs. More interestingly, management fees have a negative effect. The more expensive the fund is, the lower its performance is, and vice versa. This result is consistent with recent literature based on the Gil-Bazo and Ruiz (2009) agency model. Similarly, the redemption fees have positive effects on performance. This finding illustrates that funds with high back load fees are also the most stable; this reduces agency costs between investors and fund managers (Chordia, 1996). Finally, the coefficient associated with age is positive, which is paradoxical. We can argue that this effect is related to the outperformance of the largest funds, which accordingly are not the youngest.

6 Conclusion

Since its launch in 1985, the UCITS Directive has gradually changed the universe of fund investment in Europe. The main purpose is the development of an integrated market and strengthening the competitiveness of European funds through improved coordination between regulators and reinforced investors protection. With the adoption of the UCITS IV Directive in 2011, a large step was taken. By enabling more cost effective notification procedures and by introducing a framework for merging funds, the UCITS IV Directive tends to encourage the development of a much larger average fund size; this is conducive to a large, fluid and integrated European market with harmonized regulation.

In this paper, we study the impact of the UCITS IV Directive (Undertakings for the Collective Investment in Transferable Securities, adopted in 2011) on the dynamics of European mutual funds. Our central hypothesis is based on the premise that the UCITS IV Directive should benefit both managers and investors by facilitating the emergence of economies of scale. From this central point, we derive two testable hypotheses regarding the existence of UCITS IV effects and the emergence of economies of scale. Therefore, in accordance with the equilibrium of mutual fund industry approach developed by Berk and Green (2004) and Chen et al. (2004), we introduce the concept of the diseconomy of scale in an active management portfolio. This approach provides methodologies to test the relationship between size and performance and to identify the potential sources of economies of scale. In a sample of 1435 European Equity funds from December 2001 to December 2013, we successively perform two main empirical investigations. From the first set of tests based on the portfolio approach, the hypothesis of the existence of UCITS IV effects is not rejected by data. As observed with descriptive statistics, the performance after the UCITS IV is significantly superior to those of previous periods. Nonetheless, the results related to the existence of economies of scale are mixed. Despite noticing a reversion in performance order for small and large fund portfolios, the differences between them are excessively small for more relevant comments. Our second set of tests with the trans-logarithmic model and multilevel panel regression methods provides more interesting results.

First, regarding the existence of UCITS effects and economies of scale, all our tests validate the hypothesis of a quadratic relationship between size and performance. European equity funds display a quadratic and positive concave form before UCITS IV and a quadratic and positive convex form after. These contrasting results appear to show that the post-UCITS IV period represents a new regime in the relation between size and performance for European funds. The performance is increasing with the size, while it decreases for the two previous periods. The funds appear to benefit from gains related to size and to not confront the diseconomies of scale. The convex form clearly indicates that there is a premium to the largest funds. This finding is precisely the objective pursued by the UCITS IV Directive.

Second, the potential sources and the extent of the economies of scale must be nuanced by results from the family-specific characteristic variables under consideration. In accordance with Chen et al. (2004) and Ferreira (2013), we find that family size has positive and highly significant effects on European fund performance. Surprisingly, none of the variables related to the number of funds offered by a family; the dummy variable indicates a large family (as many as 20 members), and the domicile numbers are particularly non-significant. We expected negative effects. However, we simply observe an absence of a significant relation between these variables and fund performance. This observation suggests certain extensions of our tests and specification models with other family-specific characteristics and additional variables. The last two variables related to fund family financial resources provide certain relevant insights. As expected, large families with a high number of equity fund members display negative and significant spillover effects on fund performance. Similarly, a family that is broadly diversified in its capital allocation among Lipper classes does not provide positive common skill effects to its members. The negative and highly significant coefficient signs simply indicate the existence of hierarchy costs and the presence of diseconomies of scale. Herein, as observed in the descriptive statistics, the family-specific characteristics of a European fund with a high number of members and broad diversification burden the performance.

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8 Appendix

- Appendix 1: Summary statistics of benchmark factors
- Appendix 2: Correlation matrix among all variables
- Appendix 3: Estimated marginal mean of alphas by quartile
- Appendix 4: Aggregate estimated coefficients for Size - Performance with multilevel regression

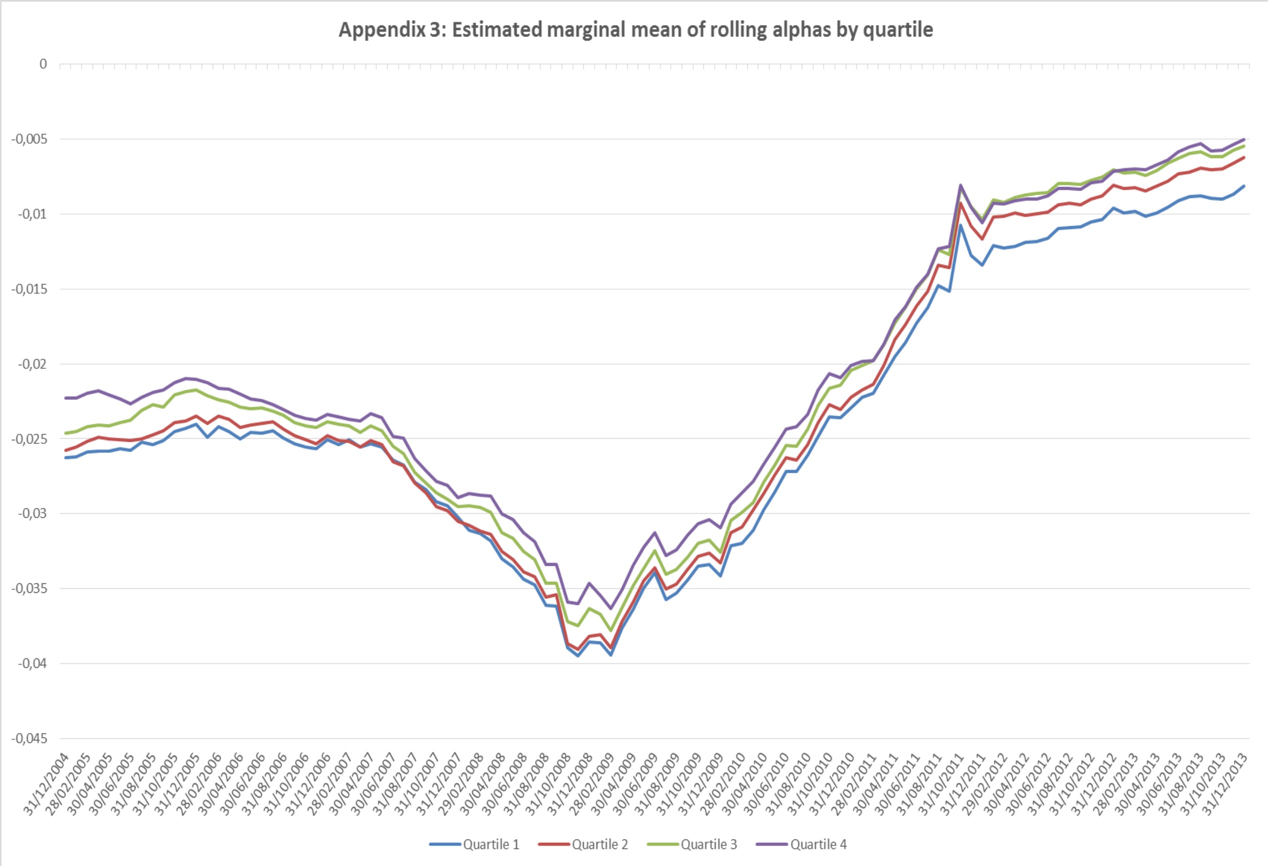
Appendix 1 Summary statistics of benchmark factors

Factors	Mean return*	Std dev.*	Cross-correlation			
			Mkt-RF	*SMB*	*HML*	*MOM*
Market	0,366	16,060	1,000			
SMB	1,040	3,612	0,102	1,000		
HML	1,332	1,955	-0,245	0,438	1,000	
MOM	1,629	2,419	-0,253	0,035	-0,073	1,000

Annualized, in %

Appendix 2 : Correlation matrix among all variables

Variables	alpha_1f	alpha_3f	alpha_4f	LogTNA	(LogTNA)²	flows (t-1)	management fees	redemption fees	log(age) (t-1)	LogNfam	LogFamSize	HHITNAF	HHINLC	HHITNA LipperC	Large 20	HHIDEQ	HHID	EQNFam	EQ Large 20
alpha_1f	1,000																		
alpha_3f	0,963	1,000																	
alpha_4f	0,952	0,989	1,000																
LogTNA	0,090	0,100	0,099	1,000															
(LogTNA)²	0,071	0,081	0,079	0,939	1,000														
flows (t-1)	0,003	0,002	0,002	-0,002	-0,002	1,000													
Management fees	-0,024	-0,027	-0,024	-0,001	-0,016	-0,005	1,000												
Redemption fees	-0,001	0,001	0,001	-0,054	-0,059	-0,001	-0,043	1,000											
log(age) (t-1)	0,151	0,142	0,140	0,210	0,214	-0,002	0,061	-0,071	1,000										
LogNfam	-0,046	-0,035	-0,030	0,164	0,156	-0,004	-0,004	-0,008	0,087	1,000									
LogFamSize	-0,045	-0,034	-0,030	0,163	0,156	-0,004	-0,003	-0,008	0,088	1,000	1,000								
HHITNAF	0,020	0,011	0,009	-0,189	-0,169	0,002	0,028	0,028	-0,148	-0,752	-0,751	1,000							
HHINLC	-0,017	-0,022	-0,023	-0,176	-0,161	0,006	0,017	0,070	-0,121	-0,505	-0,504	0,685	1,000						
HHITNA LipperC	-0,030	-0,039	-0,039	-0,219	-0,201	0,005	0,060	0,007	-0,145	-0,525	-0,523	0,822	0,702	1,000					
Large 20	0,006	0,014	0,016	0,185	0,172	-0,005	-0,017	-0,011	0,131	0,754	0,753	-0,687	-0,510	-0,533	1,000				
HHIDEQ	0,006	-0,001	0,000	-0,136	-0,121	0,002	0,041	-0,010	-0,068	-0,541	-0,540	0,387	0,317	0,473	-0,403	1,000			
HHID	0,009	0,004	0,005	-0,150	-0,136	0,002	0,048	-0,006	-0,074	-0,542	-0,542	0,402	0,342	0,496	-0,406	0,934	1,000		
EQNFam	-0,102	-0,096	-0,090	0,142	0,152	-0,002	-0,015	-0,018	0,045	0,822	0,822	-0,465	-0,280	-0,308	0,443	-0,456	-0,484	1,000	
EQ Large 20	-0,030	-0,026	-0,028	0,227	0,229	-0,003	-0,029	-0,019	0,095	0,767	0,767	-0,540	-0,379	-0,396	0,620	-0,507	-0,490	0,651	1,000



Appendix 4: Aggregate estimated coefficients for Size - Performance with multilevel regression

FIXED EFFECTS		Model 1			Model 2			Model 3		
		CAPM	Fama - French	Carhart	CAPM	Fama - French	Carhart	CAPM	Fama - French	Carhart
P1	Constant term	-0,03272 *	-0,03709 **	-0,03688 NS	-0,02964 *	-0,03360 **	-0,03426 NS	-0,02806 *	-0,03216 **	-0,03229 NS
	logTNA	-0,00089 NS	-0,00011 **	-0,00027 **	-0,00087 NS	-0,00008 **	-0,00024 **	-0,00090 NS	-0,00011 **	-0,00027 **
	logTNA²	0,00022 NS	-0,00005 **	0,00004 *	0,00022 NS	-0,00004 **	0,00004 *	0,00023 NS	-0,00004 **	0,00005 *
P3	Constant term	-0,04035 ***	-0,04650 ***	-0,04612 ***	-0,03725 ***	-0,04304 ***	-0,04348 ***	-0,03556 ***	-0,04147 ***	-0,04140 ***
	logTNA	0,00072 ***	0,00082 ***	0,00084 ***	0,00073 ***	0,00083 ***	0,00085 ***	0,00071 ***	0,00082 ***	0,00084 ***
	logTNA²	-0,00002 ***	-0,00013 ***	-0,00017 ***	-0,00001 ***	-0,00013 ***	-0,00016 ***	-0,00001 ***	-0,00013 ***	-0,00016 ***
P4	Constant term	-0,03476 ***	-0,03994 ***	-0,03882 ***	-0,03166 ***	-0,03648 ***	-0,03618 ***	-0,02996 ***	-0,03490 ***	-0,03408 ***
	logTNA	-0,00114 ***	-0,00140 ***	-0,00163 ***	-0,00114 ***	-0,00140 ***	-0,00163 ***	-0,00115 ***	-0,00141 ***	-0,00164 ***
	logTNA²	0,00038 ***	0,00034 ***	0,00036 ***	0,00039 ***	0,00035 ***	0,00037 ***	0,00039 ***	0,00035 ***	0,00037 ***