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HOW HOMOGENEOUS DIVERSIFICATION IN BALANCED INVESTMENT FUNDS AFFECTS PORTFOLIO AND SYSTEMIC RISK

(L'INFLUENZA SUL RISCHIO DI PORTAFOGLIO E SUL RISCHIO SISTEMICO DELLA DIVERSIFICAZIONE OMOGENEA NEI FONDI BILANCIATI D'INVESTIMENTO)

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Abstract

The recent financial crisis highlighted the dangers of systemic risk. In this regard no common view appears to exist on the definition, measurement, and real impact of systemic risk on the financial system. This paper aims to analyze the relationship between systemic risk and portfolio diversification, highlighting the differences between heterogeneous and homogeneous diversification. Diversification is generally accepted to be the main tool for reducing idiosyncratic or portfolio-specific financial risk, however homogeneous diversification also has implications on systemic risk. Using balanced investment funds data the empirical analysis first investigates how diversification affects the two components of individual portfolio risk: (i) systematic, and (ii) idiosyncratic risk. Next an estimation procedure is implemented to examine the change in asset allocation and its impact on global systemic risk. The results suggest that funds' portfolio diversification reduces at the same time the portfolio-specific risk and increasing the likelihood of a simultaneous collapse of financial institutions - given that a systemic event occurs.

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Jel Numbers: G11, G17.

Introduction
"Every happy family is the same. Every unhappy family is miserable in its own way"
[Leo Nikolayevich Tolstoy (1877), citation, Summers (2000)].

The recent financial crisis highlighted the dangers of systemic risk, and led to academicians, as well as financial executives, to consider its implications on the functioning of the financial market. The debate on the definition of systemic risk as well as on the sources of the last turmoil is still open. For example, Schwarz (2008), while discussing systemic risk, states that "if a problem cannot be defined it cannot be solved," and Tirole (2002) argues that "two crises are never identical and each one shows own distinctive elements."
Given that the last crisis may be considered as an example of systemic crisis, our research investigates a potential root of systemic risk, namely the degree of homogeneity among market agents as consequence of their portfolio diversification strategies. The common thread of systemic risk definitions in the literature is an adverse effect on the financial system stability [Brownlees and Engle (2010); De Bandt and Hartmann (2000); Lehar (2004); De Nicolo and Kwast (2002)]. Hence, if the agents are homogeneous the likelihood that a systemic event will affects them all in the same way increases. Thus, portfolio diversification, usually considered as

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one of the most important tools for mitigating risk and implemented by financial investors to reduce portfolio risk, may increase the likelihood of a systemic crisis.[3]

The aim of this paper is to examine these two sides of the diversification process by analyzing the impact of diversification on different types of financial risk. More precisely, we investigate over the past ten years how diversification has impacted portfolio and systemic risk. The former may be decomposed in two components: i) systematic risk, which stems from the sensitivity of portfolio returns to market returns, and is usually measured through the portfolio β factor - the correlation between the portfolio and market returns; and ii) idiosyncratic risk, which depends on the specific portfolio factors and is the portion of portfolio risk not explained by market factors. In the financial literature, systematic risk is considered non-diversifiable while the latter may be reduced through an adequate portfolio diversification strategy which neutralizes the risk-components related to portfolio-specific factors [Goetzmann and Kumar, (2008); Fama and MacBeth (1973)]. Consequently, if the portfolio idiosyncratic component is reduced, the level of mutual homogeneity among market's agents increases, making them vulnerable to a simultaneous collapse when a negative systemic event occurs. Thus, starting from different conditions and expectations, market agents become homogeneous because of their portfolio diversification strategies, increasing the level of systemic risk in the financial system.

Our investigation proceeds along three consecutive steps. Firstly, portfolio systematic risk, or the *beta factor*, is estimated and analyzed. Secondly, the relationship between the idiosyncratic portfolio risk and portfolio diversification is investigated. Finally, the impact of portfolio diversification and homogeneity level of the financial system on the likelihood of a simultaneous downturn is assessed.

[3] It can be defined as a systemic event that affects a considerable number of financial institutions or markets, in a strong sense and severely impairing the general well-functioning of the financial system (De Bandt and Hartmann, 2000).

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Related literature

The debate about systemic risk is recent and the related literature is still limited. Moreover, there is not a common view on the definition of systemic risk. Many strands of research into the threats caused by systemic risk on the economic system have been developed. Nevertyheless, let us briefly review some of the available ones below. Four sych approaches are: (1) **risk** that an event affects a large number of financial institutions and markets at the same moment, (2) a domino-effect that occurs through common exposures of financial institution to a certain asset, (3) a banking default or a broader market participants' default as key factors, and (4) a negative externality involving real effects.

In the first approach, systemic risk may be thought of as the likelihood that a trigger event, such as an economic or financial shock, may have significant adverse implications on a large portion of financial institutions or markets. This strand of literature [Brownlees and Engle (2010); Kupiec and Nickerson (2004); and Dow (2000)), defines systemic risk as the risk of a simultaneous collapse of market agents acting in the financial system. Dow (2000) suggests that systemic risk produces its effects in four different ways: disruption of a payment system due to one or more banks' defaults, depression of banking asset values, general fear of losing savings (simultaneous withdrawals from banks), and reduction of national income linked to macroeconomic changes. Kupiec and Nickerson (2004) describe other potential ways of systemic risk impacting on the financial system, such as price volatility, corporate liquidity, and efficiency losses.

In the second group, we have Kaufman (1996), De Bandt and Hartmann (2000), Sheldon and Maurer (2008), Schwarcz (2008), who suggest that systemic risk acts as a domino-effect due to linkages between the financial institutions. Kaufman (1996) refers to the cumulative losses caused by an event that ignites successive

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losses along a chain of financial institutions or markets. De Bandt and Hartmann (2000) relate systemic risk to experiencing of a systemic event. This involves institution Y being severly impacted because of an initial shock that has impacted institution X even if Y was fully solvent at the beginning. This is also supported by Bartram *et al.* (2005) who show institutions with good economic fundamentals can also be indirectly affected by systemic risk in a crisis. The domino effect is explicitly defined as the likelihood that a failure of one bank triggers a chain reaction causing other banks distress through interbank loans [Sheldon and Maurer, 2008)] and as a trigger event that causes a chain of bad economic consequences [Schwarcz (2008)]. In the third approach, the banking default is the key element for defining systemic risk. Eisenberg and Noe (2001) refer to the number of waves of default needed to cause a firm's default in a closed financial system. Lehar (2004) assesses systemic risk as the probability that a certain number of banks within a time period become insolvent due to a fall in the value of their assets below that of their liabilities. This view stems from Merton's (1974) structural models where banks become insolvent, and default occurs, when the value of their assets falls below a given threshold. Considering not only a bankruptcy condition but all market participants' default, the Bank for International Settlements [BIS (1994)] defines systemic risk as the risk that a failure of a market participant to meet its contractual obligations may cause other participants to default. Such definition is shared by the U.S. Commodity Futures trading commission (2008), which describes systemic risk as the risk that a market participant's default impacts other participants due to the interlocking nature of financial markets.

In the last approach, De Nicolo and Kwast (2002) and Kambhu *et al.* (2007) describe systemic risk as a negative “externality," either through the direct linkages given by intermediaries' exposures and through a broader disruption directly affecting the financial markets. Such market failure has an impact on cost of capital,

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producing a reduction in credit provision as well as in real activity. The authors underline the fact that real effects of systemic risk constitute the main treat.

However, they distinguish systemic risk from financial crises. In De Nicolo and Kwast (2002), the magbnitudes of financial failure have to be so high as to induce real consequences such as reductions in output and employment. In Kambhu *et al.* (2007) the effect is a reduction of productive investment due to the decreasing credit provision. But in the authors' opinion the optimal level of systemic risk is not zero.

Few similar studies may be found in the literature about the relationship between diversification, portfolio, and systemic risk.

De Vries (2005) argues that diversification reduces the frequency of individual bank failure when a shock is smaller and easily borne by the system, while it increases the likelihood of a systemic failure when a stronger shock occurs. Allen *et al.* (2010) analyze systemic risk focusing on the banking sector and the interconnections among the banks looking especially to the signals perceived by investors who have to roll over their investments in the same banks. The banks are involved in a network and each bank's condition is a signal for the entire banking system. The network is the result of the diversification process of the banks who desire to share their projects with other banks to achieve a lower default probability and lower repayment to creditors.

The same process makes up a “clustered” network in which each bank holds the same portfolio, so that each bank's signal is of interest for investors. Wagner (2006) considers an economy with two banks which have to set the optimal level of diversification. Full diversification is undesirable because it reduces the risk at each individual institution but increases the risk of a systemic crisis. The bank has incentives to fully diversify because it externalizes the costs, thus increasing the likelihood of failure in other banks. The level of diversification has to be arbitrarily

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small, depending on the difference between costs of individual failure and a systemic crisis.

Diversification may increase the likelihood of a **contagion** too, exposing banks to the consequences of the failure of other banks in which the first one diversified its investments. Allenspach and Monnin (2007) test for the hypothesis that there is an empirical link between common exposures to shocks and systemic risk for the period 1993-2006. If all banks choose to diversify, they are all exposed to the same risk factors.

Considering a broader notion of systemic risk that includes the contagion of financial turmoil across different countries or regions, Schinasi and Smith (2000) relate the diversification between risky and riskless assets, especially looking to the rebalancing of portfolios among these two different classes of securities, with the contagion effect from one region, where the shock occurs, transmitted to the other region. Focusing on the Russian default of 1998, this paper shows that one shock leads the leveraged portfolio to reducte its other risky positions (in other regions, markets, industries), in according with management rules, thus discovering the implicit and potential danger within portfolio diversification.

The estimation model

The framework proposed below aims to analytically describe the relation between diversification, portfolio risk, and systemic risk through a multistep analysis that begins from the portfolio return decomposition and explanation. The goal of this model is to show how diversification activities impact different forms of financial risks to capture the net effect of diversification on portfolio and systemic risk. Many papers [Fama (1972); Becker and Hoffmann (2008); Goetzmann and Kumar (2008)] have focussed on the consequences of diversification on individual risk-taking without looking at its impact on the entire system. Another strand of literature

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[Allenspach and Monnin (2007); Allen *et al.* (2010), Wagner (2006)] attempts to assess how banking diversification affects the risk that the whole banking system will collapse. By contrast, the model below aims (i) to evaluate the impact of diversification on different components of risk for a representative agent, and (ii) to assess its consequences for the entire financial system.

Portfolio return and the β factor

Consider an economy with *i* agents, with i going from 1 to *n*. Each agent holds a portfolio composed of different asset classes (from here, we identify each agent with his own portfolio. In other words, *i* identifies at the same time the agent as well as the portfolio). Each portfolio consists of *k* asset classes (with *k* going from 1 to *m*), and each asset class has a weighting of w_k within the agent's portfolio. Thus, the portfolio is a basket of *k*-asset classes, and the relative portfolio size adds up to 1 and is described as follows: $1 = PS_{it} = \sum_{k=1}^{m} w_{itk}$, where PS_{it} is the relative size of portfolio i at time t (with t going from 0 to s), and w_{itk} is the relative weight of each k asset class in portfolio i at time t.

For the aim of this paper it is useful to refer to the strand of literature related with the traditional financial theory of market models where portfolio returns are explained by different components: i) a constant term, ii) the portion of portfolio return explained by the comovements between the portfolio and the market returns (systematic factors of portfolio return), and iii) the portion of portfolio returns not explained by either the constant term or the systematic factors, identified as idiosyncratic or specific component [Black *et al.* (1972)]:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

where, α_i is the constant term, R_{it} is the return of portfolio *i* at time *t*, and R_{mt} is the

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market return at time *t*. β_i is the factor that explains the sensitivity of the *i-th* portfolio return with respect to the return on the market, and ε_{it} is the portion of portfolio return neither explained by market return nor by the constant term. This portion is defined as the idiosyncratic component of portfolio return, the portion of portfolio return explained by portfolio specific factors.

The impact of diversification on portfolio risk

It is now interesting to investigate the relationship between the model described in equation (1) and the portfolio diversification process. In order to do this, we need to construct a diversification measure of the agents' portfolios. For this purpose, we use Herfindahl's measure of concentration and compute its complement as proposed by Woerheide and Persson (1993), Lang and Stulz (1994), Byrne and Lee (2001), and Goetzmann and Kumar (2008):

$$HI_{it} = \sum_{k=1}^{m} w^2_{itk}$$

where HI_{it} is the Herfindahl concentration measure of portfolio *i* at time *t*; that is the sum of the squared relative weights of *k* asset classes (w_{itk}). Our diversification index DIV_{it} is the complement of (H_{it}):

$$DIV_{it} = 1 - H_{it} \qquad (2)$$

We can evaluate how the portfolio diversification of the portfolio of agent *i* and the other $j \neq i$ agents' portfolios influences the portfolio risk of the *i*-th agent, focusing on the idiosyncratic components.[4] For this purpose we build a measure of idiosyncratic

[4]The latter diversification term may be computed as follows: $\overline{DIV_t} = \frac{1}{n}\sum_{i=1}^{n} DIV_{it}$. This indicator measures the average degree of diversification of the financial system at each time *t*.

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portfolio risk, based on the standard deviation of the residuals (hereby, RSD) in (1) defined as $\sigma_{it}(\varepsilon_{it})$ [Fama and MacBeth (1973)]. The analysis may be implemented using the idiosyncratic risk of portfolio i as the dependent variable, and where the independent variables are the diversification index of the *i*-th portfolio, and the average measure of other portfolios' diversification followed by a set of variables that describe the **asset allocation** choices of agent *i*:

$$\sigma_{it}(\varepsilon_{it}) = \alpha_0 + \alpha_1 DIV_{it} + \alpha_2 \overline{DIV}_t + \sum_y a_y V_{iyt} + \upsilon_{it} \quad (3)$$

where α_0 is the constant term, DIV_{it} is the diversification degree of portfolio *i* at time *t*, $\overline{DIV}_t$ is the average degree of diversification of the financial system at time *t*, and V_{iyt} represents the asset allocation variables (with *y*, going from 1 to *q*, being the number of the variables), and υ_{it} being the error term.

The relationship between diversification, asset allocation of economic agents, and systemic risk

The third and final stage of the estimation model focuses on systemic risk and its relationship with diversification. More precisely, it aims to determine how diversification influences the degree of heterogeneity of asset allocation among market agents. In fact, if systemic risk is defined as the risk that a given event produces a simultaneous collapse of all market agents and the entire system, then this condition occurs with a larger probability when the agents are similar and vulnerable to similar threats. In this case, the given event affects all agents in the same way. To measure the level of agents' heterogeneity we construct a dispersion index of portfolio asset allocation:

$$DISP_{it} = \frac{1}{m}\sum_{k=1}^{m}(w_{itk} - \overline{w_{tk}})^2 \quad (4)$$

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where $DISP_{it}$ is the dispersion index of portfolio *i* at time *t*, w_{itk} is the relative weight of *k*-th asset class at time *t* in portfolio *i*, $\overline{w_{tk}}$ is the average weight of *k*-th asset class at time *t*. $DISP_{it}$ measures the extent to which the weights of *k* asset classes in portfolio *i* are different from the average weights of the *k* asset classes in all *n* agents' portfolios for each time *t*. From this index $DISP_{it}$ it is possible to define an average value for each time *t* among all portfolios to measure the level of heterogeneity in terms of asset allocation of the financial system, also taking into account the agents' portfolio sizes as follows:

$$HET_t = \frac{1}{n}\sum_{i=1}^{n} DISP_{it} \qquad (5)$$

where HET_t is the weighted average heterogeneity index of the financial system at time *t*.

Considering the definition of systemic risk, it is worth investigating when and in what condition a simultaneous collapse occurs and what is the relationship between portfolio diversification, heterogeneity, and a market agent's simultaneous downturn indicator. As stated by Brownlees and Engle (2010), Acharya (2009), and Acharya *et al.* (2010), a systemic event may be defined as a market loss that surpasses a given threshold (TS) and systemic risk is the expected shortfall suffered by market agents when the systemic event occurs. Hence, Brownlees and Engle (2010) build an expected return estimation model that takes into account different factors in addition to market return. In particular, they measure the expected loss suffered by a portfolio when market losses surpasses TS. The sum of these expected shortfalls is considered as a proxy for systemic risk. Following this approach, it is possible to compute the simultaneous downturn (hereby, SD) rate as the portion of portfolios that record a certain shortfall when the market loss surpasses a given threshold TS:

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SD_{rate} = [Number of portfolios (R_{iz} < TS)] ÷ [Number of portfolios] (6)

where *z* is a specific period in *t* where the condition R_m<*TS* occurs. Consequently, following Brownlees and Engle's approach and relating it with the traditional market model estimation described above, we may build a return estimation model which takes into account market return, portfolio diversification, and heterogeneity, to evaluate how diversification and heterogeneity affect this simultaneous downturn rate through the aggregate funds' returns. From the simple market model in equation (1) we move to the following return estimation model:

$$R_{it} = \alpha_0 + \beta_1 R_{mt} + \beta_2 HET_t + \beta_3 DIV_{it} + \eta_{it} \quad (7)$$

where η_{it} is the error term. In this way, given a market return, it is possible to assess the impact of diversification and heterogeneity on the return of portfolios and on the average return of the whole financial system.

Descriptive findings

Data

The dataset consists of 233 balanced investments funds from November 2001 to December 2010.[5] In the dataset we have monthly variables that may be grouped in two categories: i) the main characteristics of funds; ii) variables that capture the composition and the allocation strategy of funds.

The first group of variables include i) *return*, the performance of fund *t* in a particular

[5]Data are provided by *Morningstar Italia*. The selected funds are those funds that have over 70% of non-missing observations on the asset allocation variables from 2001 to 2010. We start our analysis from the first month after the economic recession of 2001 (November 2001), according to the Federal Reserve Bank of St. Louis estimation.

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month *t*; and ii) *fund size*, which is a measure of month-end net assets of fund *i* in a given month *t*, recorded in millions of euros. The second category of variables is related to the asset allocation strategy of funds. The main variables are: asset allocation *bonds,* asset allocation *equity,* asset allocation *cash,* asset allocation *other* (AAb, AAe, AAc, and AAo respectively). They measure the monthly percentages of fund investments allocated to each one of these asset classes for different sub-asset allocations. On the equity portion of the asset allocation, the first sub-category of asset class deals with the geographic allocation: North America (Ena), United Kingdom (Euk), Eurozone (Eeuro), Emerging markets (Eem), Asian developed countries (Easia), and Japan (Ejapan). The other sub-category for asset allocation equity relates to super-sectors, whoch include many similar and homogeneous industries. The equity super-sectors are: *manufacturing, information, and services* (Eman, Einf, and Eserv respectively). Bonds constitute the second asset category for which sub-asset allocation observations are available. It is possible to separate bonds allocation into five super-sectors: *United States government, United States corporate, Non-U.S. government, Mortgage, and Cash* (Busgov, Buscorp, Bnonus, Bmortg, and Bcash respectively). These represent the portions of bond assets that are allocated to bonds of the U.S. government; U.S. private company bonds; bonds issued by public authorities outside the U.S.; bonds related to the many different kinds of mortgages that have been securitized and transformed in market bonds; and bonds with maturities of less than twelve months respectively. The last sub-asset allocation refers to the credit quality rating. For each month, the percentage of total asset allocated to bonds rated *aaa, aa, a, bbb, bb, b, below b* are available.

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Summary statistics

Looking at the fund performance measures, *returns* suggest some further considerations. For the whole sample, returns have a mean of 0.5% [Table 1, column (3)] and a skewness of -.86 [(column (5)]. The presence of fat tails is confirmed by a value of kurtosis equal to 6.84 (column 6). Extreme values in monthly returns are described by 19.02% and 20.71%, respectively [columns (1), and (2)]. Looking at asset allocation, it is quite clear that funds prefer to invest mostly in equity markets [see AAe, column (3)]. This tendency is stronger for North American funds where over half of the funds' investments are allocated to equity markets. The preferred equity market for all funds is surely the North American [see Ena, column (3)]. Asian and emerging equity markets represent a very small portion of investments [see Easia and Eem, column (3)].

Asset allocation classes Cash and Other show very high negative returns (see AAc and AAo, column (1)). This may be a signal of the aggressive short strategies of funds. However funds seem to be really risk-averse about their bonds allocations. They allocate the largest portion of their bond investments to low risk assets [see table 1, column (3), variables Ba, Baa, and Baaa]. The average percentage of aaa bonds is 45% for the whole sample. By contrast, the portion allocated to the riskiest bonds (below B) is less than 1%. Within the sub-asset classes of bond, funds mostly allocate to non-United States government and short-maturity bonds (see column (3), variables Bnonus and Bcash). There are no strong differences between North American and European funds, except for a particular bond sector, mortgages (Bmortg). The North American funds allocate one bond out of 10 to this market, the European funds only allocate one out of 200.[6] Counterintuitively, the European funds are on average larger than their North American counterparts.

[6]We define the country of origin for each fund according to the inception domicile provided by Morningstar.

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Tle 1: Summary statistics - overall sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Var/Stat	**Min**	**Max**	**mean**	**sd**	**Sk**	**kurt**	**p1**	**p10**	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**	**Obs.**
Return	-19.02	20.72	0.50	2.69	-0.86	6.84	-8.17	-2.58	-0.77	0.70	2.04	3.42	4.45	6.51	33977
Fs	0.00	37300*	1010*	1850*	5.69	54.29	0.00	30.5*	155*	485*	103*	2320*	4040*	8660*	25676
AAe	-2.96	458.23	51.72	19.49	-0.10	11.31	0.99	23.50	39.42	56.19	63.79	73.97	78.94	89.25	23194
AAb	-32.15	598.85	33.70	18.92	2.79	52.79	0.00	11.39	22.62	32.46	42.09	58.04	65.66	80.14	23191
AAc	-543.79	493.80	9.09	12.34	-0.30	433.22	-2.19	1.65	3.68	6.87	11.63	19.06	27.28	47.46	23190
AAo	-488.76	100.10	5.53	15.11	-0.17	110.85	-2.95	0.00	0.13	0.79	4.67	14.79	29.74	79.12	23194
Easia	0.00	100.00	1.55	2.52	7.77	176.34	0.00	0.00	0.00	0.76	2.19	4.13	5.91	9.84	22980
Eem	0.00	61.42	1.70	2.98	4.21	37.45	0.00	0.00	0.00	0.56	2.21	4.71	7.50	13.35	22980
Eeuro	0.00	100.00	10.22	17.01	3.32	14.88	0.00	0.00	0.78	5.99	9.73	21.50	50.33	97.44	22980
Ejapan	0.00	69.09	3.21	5.03	5.27	49.10	0.00	0.00	0.00	2.14	4.69	6.93	10.30	23.94	22980
Euk	0.00	100.00	9.55	19.93	3.40	13.88	0.00	0.00	0.83	4.07	6.65	16.27	62.78	100.00	22980
Ena	0.00	100.00	50.42	32.90	-0.08	1.67	0.00	0.30	20.96	50.74	78.85	95.35	100.00	100.00	8178
Einf	0.00	72.67	15.62	6.72	0.97	6.59	0.12	8.06	11.59	15.17	18.97	23.22	59.98	37.10	22966
Eserv	0.00	100.00	45.58	8.81	0.62	8.45	21.28	36.62	40.99	45.28	49.79	55.18	27.17	69.26	22966
Eman	0.00	100.00	38.80	9.87	0.52	5.99	15.87	27.57	33.32	38.46	43.68	49.78	54.77	69.53	22966
Bnonus	0.00	100.00	49.11	34.04	-0.30	1.56	0.00	1.20	6.91	59.56	77.84	88.93	94.96	100.00	21428
Bcash	0.00	100.00	24.51	24.00	1.38	4.48	0.00	0.00	6.86	17.61	33.98	60.28	75.80	100.00	8005
Bmortg	0.00	99.97	7.85	13.95	1.77	5.01	0.00	0.00	0.00	0.24	8.18	32.20	40.57	51.38	21428
Buscorp	0.00	100.00	17.16	19.05	1.80	6.45	0.00	0.61	3.82	10.14	24.87	41.99	56.02	88.65	21428
Busgov	0.00	99.26	7.43	13.00	2.83	13.46	0.00	0.00	0.00	1.10	10.00	23.81	32.99	62.50	21428
Ba	0.00	100.00	16.42	12.63	1.22	5.58	0.00	2.17	6.85	14.47	23.18	32.20	40.41	55.75	7125
Baa	0.00	100.00	11.25	10.62	1.61	7.15	0.00	0.00	3.03	8.70	16.40	24.23	32.10	49.91	7125
Baaa	-2.83	100.00	45.16	24.77	0.14	2.60	0.00	8.83	28.42	44.61	61.02	77.50	91.23	100.00	7125
Bb	0.00	73.00	2.98	6.90	3.60	19.02	0.00	0.00	0.00	0.00	2.19	9.50	17.74	33.72	7125
Bbb	0.00	59.78	3.44	6.55	3.04	14.34	0.00	0.00	0.00	0.54	3.77	11.04	18.19	31.10	7125
Bbbb	0.00	60.79	8.65	9.09	1.98	7.93	0.00	0.00	2.35	6.11	11.68	19.43	26.88	44.38	7125
Bub	0.00	60.80	0.88	2.80	7.52	99.28	0.00	0.00	0.00	0.00	0.20	3.02	5.18	12.96	7125

Legend: Variables (raws): **return** = fund return; **fs** = fund size; **AA** = asset allocation (**e**quity, **b**ond, **c**ash, **o**ther); **E** = sub-asset allocation equity (**Asia**, **E**merging **M**arkets, **Euro**zone, **U.K.**, **Japan**, **N**orth **A**merica, **inf**ormation, **serv**ices, **man**ufacturing); **B** = sub-asset allocation bond (**U.S. gov**ernment, **U.S. corp**orate, **non-U.S.** government, **cash**, **mortg**age, **aaa, aa, a, bbb, bb, b, u**nder **b**; Statistics (columns): **min** = minimum value; **max** = maximum value; **mean** = average value; **sd** = standard deviation; **sk** = skewness; **kurt** = kurtosis; **p(n)** = percentile; **md** = median value; **Obs** = number of observations in the sample. The values of percentiles, mean, sd, and range (except for fund size) are expressed in percentage. *=the values are expressed in millions

Source: Elaboration on Morningstar data

It is useful to focus on the differences between two different time periods: the period preceeding the recent crisis, between January 2005 and June 2007, and the period when the crisis had become visible, between July 2007 and December 2010.

It is possible to observe from Table 2 how the distribution of the returns changes between the first and the second period of our analysis. The average return is 0.65% [Table 2, column (3)] in the first period, whereas it decreases to .2% [column (10)]. The fat tails phenomenon is more pronounced in the pre-crisis sample: 6.59% versus 5.89% [columns (6) and (13) respectively]. Furthermore, volatility was greater in the second sample, which covered the post-crisis period [standard deviation was 3.21%, column (4)], than the first sample [standard deviation was 2.38%, column (11)].

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Looking at the four principal asset allocation variables, we find no significantly differences. Asset allocation *equity*, *bond*, and *cash* show a slight increase from the first to the second period, while the asset allocation *other* falls strongly falls during the last crisis [see columns (3) and (10), variables AAe, AAb, AAc, AAo respectively]. It seems obvious to think of the investors' "*flight to safety*" when the crisis took hold.

Table 2: Summary statistics - for sub-sample periods (January 2005-June 2007; July 2007-December 2010)

	Panel A : pre-crisis period (January 2005 - June 2007)							**Panel B : time period from last crisis (July 2007 - December 2010)**						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Var/Stat	**Min**	**Max**	**mean**	**Sd**	**sk**	**kurt**	**Obs**	**min**	**max**	**mean**	**Sd**	**sk**	**kurt**	**Obs**
Return	-18.25	20.72	0.65	2.38	-0.61	6.59	22816	-19.02	15.80	0.20	3.21	-0.90	5.89	11161
Fs	0	20300*	823*	1490*	5	34	16839	0	37300*	1380*	2350*	6	47	8837
AAe	-0.79	184.26	51.66	19.02	-0.51	3.57	12687	-2.96	458.23	51.78	20.06	0.33	18.79	10507
AAb	-2.25	170.79	31.65	17.34	0.78	5.88	12687	-32.15	598.85	36.18	20.40	4.24	80.64	10504
AAc	-119.21	493.80	9.79	11.35	12.79	492.09	12686	-543.79	111.18	8.24	13.38	-9.88	378.62	10504
AAo	-488.76	100.10	6.91	18.03	-0.73	96.30	12686	-165.36	94.00	3.85	10.32	2.54	45.53	10508
Easia	0.00	100.00	1.42	2.82	9.54	203.70	12517	0.00	22.78	1.71	2.08	1.86	8.18	10463
Eem	0.00	61.42	1.16	2.56	6.89	92.71	12517	0.00	33.89	2.34	3.29	2.71	14.37	10463
Eeuro	0.00	100.00	9.20	16.43	3.51	16.27	12517	0.00	100.00	11.44	17.60	3.15	13.61	10463
Ejapan	0.00	69.09	3.16	5.14	5.17	48.64	12517	0.00	61.47	3.28	4.89	5.40	49.56	10463
Euk	0.00	100.00	8.52	18.78	3.63	15.72	12517	0.00	100.00	10.79	21.16	3.16	12.15	10463
Ena	0.00	100.00	60.82	33.58	-0.51	1.89	12866	0.00	100.00	44.81	31.11	0.09	1.74	5312
Einf	0.00	72.67	15.61	7.31	0.95	6.19	12514	0.00	52.68	15.63	5.95	0.96	6.76	10452
Eserv	2.47	100.00	46.67	8.51	0.43	8.52	12514	0.00	100.00	44.26	8.98	0.90	9.05	10452
Eman	0.00	97.53	37.71	10.00	0.55	5.72	12514	0.00	100.00	40.10	9.55	0.53	6.63	10452
Bnonus	0.00	100.00	47.97	34.07	-0.25	1.59	11760	0.00	100.00	50.50	33.96	-0.35	1.54	9668
Bcash	0.00	100.00	23.70	23.45	1.43	4.77	5754	0.00	100.00	26.58	25.23	1.25	3.84	2251
Bmortg	0.00	99.97	7.42	13.64	1.88	5.54	11760	0.00	69.61	8.38	14.30	1.65	4.45	9668
Buscorp	0.00	100.00	16.09	18.91	1.91	6.77	11760	0.00	100.00	18.47	19.13	1.69	6.18	9668
Busgov	0.00	99.26	6.54	13.21	3.40	17.66	11760	0.00	84.64	8.52	12.65	2.12	8.23	9668
Ba	0.00	78.57	17.65	13.10	1.03	4.48	4658	0.00	100.00	14.09	11.35	1.66	9.37	2467
Baa	0.00	100.00	10.86	9.96	1.84	9.58	4658	0.00	61.97	11.98	11.72	1.28	4.39	2467
Baaa	0.00	100.00	44.85	24.23	0.28	2.82	4658	-2.83	100.00	45.75	25.76	-0.08	2.28	2467
Bb	0.00	73.00	2.21	6.35	4.67	29.83	4658	0.00	56.75	4.43	7.62	2.43	9.64	2467
Bbb	0.00	59.78	2.77	6.03	3.61	18.97	4658	0.00	48.91	4.71	7.27	2.37	9.90	2467
Bbbb	0.00	60.79	7.80	8.81	2.38	9.95	4658	0.00	56.60	10.26	9.37	1.42	5.65	2467
Bub	0.00	60.80	0.46	2.13	11.43	207.59	4658	0.00	55.12	1.68	3.62	5.22	52.84	2467

Source: Elaboration on Morningstar data

Estimations results

In this section we implement the estimation model with the sample previously described. The empirical analysis that follows the agent *i* described above will be proxied by the fund *i*, while the time *t* will be with a monthly frequency. As

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mentioned in the introduction, our analysis consists of three steps that aim to capture different aspects of the financial risk related with the diversified investments. The first two steps evaluate the portfolio risk, decomposed into their two fundamental components. However, the main contribution of the paper is the third step, where a return estimation model stresses the impact of agents' diversification strategies and portfolio heterogeneity on the risk of a simultaneous collapse of a number of investors. This effect is also tested by augmenting the classical market model with two additional explanatory factors, diversification and heterogeneity.

Portfolio return and the β factor

The first step in our analysis deals with the investigation of the relationship between funds' returns and market proxy returns, to estimate the β factor. We estimate the β factor in equation (1) for both sample periods and a pre-sample five-year period.[7] For the sample period, we perform a random effects panel regression as in equation (1) using the following specification:

$$R_{it} = \alpha_0 + \beta\, R_{mt} + \sum_d \alpha_d C_{idt} + \varepsilon_{it}$$

where C_{idt} are the set of control variables (with *d*, going from 1 to *g*, being the number of the controls), and ε_{it} is the error term. We check for years effect (*year dummies*), and region effect (*North America*). We also define dummies to control for the effect of the crisis (taking 1 if *t* is between July 2007 and December 2008, zero otherwise), the pre-crisis (January 2006-June 2007) and the post-crisis periods (the

[7]We use the same approach of Black *et al.* (1972) in estimating the pre-sample β. We estimate the β factor for the pre-sample period (November 1996 - October 2001) to compare with the β estimation in the sample period. We do not report the pre-sample beta estimation results because we do not rank funds by β factors.

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time periods subsequent to the crises of 2001 and 2007-2009: November 2001/April 2003, January 2009/June 2010, respectively). Other control variables are constructed to take into account the impact of fund size (*log fund size*), to control for the inception date (*inception date*; that is 1 if the fund has been incepted after the first month of the time window of analysis (November 2001), and zero otherwise), and to check for the nature of the fund (*speculative*; takes the value of 1 when the fund is speculative and zero otherwise).[8]

Table 3: Funds return and market return: the (βeta factor)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	**return**	**return**	**return**	**return**	**return**	**return**	**Return**	**return**	**return**	**return**
Global market	0.92***	0.92***	0.91***	0.92***	0.92***	0.94***	0.92***	0.94***	0.94***	0.94***
	(190)	(192.51)	(188.76)	(192.38)	(192.38)	(173.73)	(192.51)	(170.51)	(173.75)	(173.75)
North America		0.13***	0.13***	0.13***	0.13***		0.13***	0.16***	0.16***	0.16***
		(5.05)	(5.08)	(5.05)	(5.05)		(5.05)	(5.41)	(5.4)	(5.4)
Post-crises			-0.38***					-0.34***		
			(-6.32)					(-6.65)		
Pre-crisis 2007-2009				0.29***					0.3***	
				(-9.4)					(4.66)	
Crisis 2007-2009					-0.29***					-0.3***
					(-4.96)					(-4.66)
Year dummies	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Inception date						-0.01	0.01	0.00	0.01	0.01
						(-0.2)	(0.2)	(0.13)	(0.24)	(0.24)
Speculative						0.05**	0.02	0.02	0.02	0.02
						(2.18)	(0.69)	(0.7)	(0.7)	(0.7)
Log fund size						0.00	0.00	0.00	0.00	0.00
						(0.21)	(0.36)	(0.26)	(0.42)	(0.42)
Constant	0.07**	-0.03	0.17***	-0.03	-0.03	0.03	-0.10	0.08	-0.11	-0.11
	(2.4)	(-0.75)	(3.97)	(-0.74)	(-0.74)	(0.22)	(-0.67)	(0.54)	(-0.73)	(-0.73)
Observations	24272	24272	24272	24272	24272	18342	18342	18342	18342	18342
R-squared	0.65	0.65	0.65	0.65	0.65	0.67	0.67	0.67	0.67	0.67

Legend: (in parentheses: robust t statistics) p***<0.01; ** p<0.05; * p<0.1
Source: Elaboration on Morningstar data.

As Table 3 shows, the sensitivity of funds returns (return) to market returns (Global market) is close to 1 in all the estimates - (1) to (10) - suggesting high integration between the market and all financial agents. In other words, the comovements of the funds and market returns are very synchronized over time. The North America dummy is significant and positive, highlighting the overall better performance of

[8] In our dataset we define a fund speculative when the overall mean of speculative bonds (sum of the bonds below the triple B) owned by the fund over the time of the analysis is greater than the overall mean of the entire sample.

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North American funds over the past decade. The *crises* dummies show the expected sign: negative impact on funds' return for the 'post-crises' and the 'crisis' [estimates (3) and (5)], and positive impact for the 'pre-crisis.' All the results remain the same when we add the fund's characteristics [estimates (6) to (10)].

The results described above stem from a panel regression of equation (1), which returns one beta factor for all funds. However, it may be interesting to estimate different beta for each time series using the following model:

$$R_t = \alpha + \beta R_{mt} + \varepsilon_t \qquad (8)$$

where equation (8) is estimated for each fund *i*. This estimation model implies, contrary to the hypothesis of panel, that the time series are considered as mutually independent. The results show that the largest portion of all funds has a beta factor close to the the market line (β = 1). Only few funds show extreme values, less than 0.5 or more than 1.5. More precisely, 47 funds (20% of the sample) show these values, whereas eight funds out of ten have a beta factor of between .5 and 1.5. 88 funds (more than 33% of the entire sample) show a beta factor value of between 0.8 and 1.2. 89 funds can be defined *aggressive* with a beta factor of more than one. The largest portion of funds consists of *defensive* with a beta factor of less than one.[9]

The impact of portfolio diversification, portfolio asset allocation, and diversification of the other agents on portfolio risk

In this section, we evaluate the relationship between the funds' portfolio diversification strategy and the measures of idiosyncratic risk. We consider

[9] Details on this time series estimation are available from the authors upon request.

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two proxies for idiosyncratic risk: i) the standard deviation of the panel β factor combined residuals, and ii) the standard deviation of the β factor time series estimation residuals.[10] We perform the estimation of equation (3) using the following specification:

$$\sigma_{it}(\varepsilon_{it}) = \alpha_0 + \alpha_1 DIV_{it} + \alpha_2 \overline{DIV_t} + \sum_y a_y V_{iyt} + \sum_d a_d C_{idt} + \upsilon_{it}$$

where C_{idt} are the set of control variables (with *d*, going from 1 to *g*, being the number of the controls), and υ_{it} being the error term.

In the first set of regressions [Table 4, columns (1a) and (1b)] the proxy for idiosyncratic risk (RSD) - for both panel and time series model - is regressed against the funds' diversification index DIV_{it}.[11] The DIV_{it} coefficients [Diversification in table 4] are both negative and statistically significant, suggesting that diversification negatively affects idiosyncratic risk. In column (2a) and (2b), the estimation takes into account the average diversification $\overline{DIV_t}$ (Av. diversification in

[10]In computing the idiosyncratic risk as the standard deviation of residuals of equations (1) and (8) with the moving average approach we know that the wider the time window the more significant is the estimation and the higher the influence of older observations. The narrower the time window, the higher the weight of recent observations, the lower the significance of the estimates. To achieve an adequate compromise, we will use a time window of 36 six months, that is the same time window chosen by Morningstar in computing the standard deviation of portfolio returns.

[11]Performing the Dorby-Whatson-Hausman test and the Breusch-Pagan/Lagrangian multiplier test, the results suggested that we run a fixed effects panel estimation model. However, we also double checked with a random effects panel estimation model which confirmed the results in table 4.

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Table 4 - The effect of diversification and funds' asset allocation choices on idiosyncratic risk

	Idiosyncratic risk Panel estimation								Idiosyncratic risk OLS estimation							
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(8a)	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)	(8b)
Variables	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**	**RSD**
Diversification	-0.41		-0.39	-0.43	-0.38	-0.44	-0.48	-0.48	-0.28		-0.26	-0.35	-0.32	-0.36	-0.39	-0.38
	(-10.64)		(-11.64)	(-2.21)	(-2.11)	(-2.36)	(-2.52)	(-2.86)	(-10.75)		(-10.11)	(-2.28)	(-2.18)	(-2.4)	(-2.57)	(-2.8)
Average diversification		2.04	0.94	-0.02	0.82	0.06	0.31	0.96		2.00	1.11	0.55	1.18	0.61	0.79	1.28
		(25.2)	(9.33)	(-0.06)	(1.99)	(0.15)	(0.71)	(2.52)		(30.94)	(14.11)	(1.57)	(3.57)	(1.81)	(2.33)	(4.11)
EAsia				0.00	0.00	0.01	-0.01	0.00				-0.01	-0.01	0.00	-0.01	0.00
				(-0.26)	(-0.49)	(0.79)	(-0.78)	(0.36)				(-0.86)	(-1.12)	(0.02)	(-1.36)	(-0.45)
Eem				0.01	0.01	0.01	0.01	0.01				0.00	0.00	0.00	0.00	0.00
				(2.66)	(3.03)	(2.09)	(2.45)	(1.73)				(0.6)	(0.79)	(0.02)	(0.34)	(-0.48)
Eeuro				-0.01	-0.01	-0.01	-0.01	0.00				-0.02	-0.01	-0.01	-0.01	-0.01
				(-4.64)	(-4.48)	(-3.95)	(-3.34)	(-1.66)				(-7.01)	(-7)	(-6.47)	(-5.8)	(-4.58)
Ejapan				-0.04	-0.03	-0.03	-0.03	-0.02				-0.03	-0.02	-0.02	-0.02	-0.01
				(-7.59)	(-6.45)	(-7)	(-6.96)	(-5.23)				(-6.65)	(-5.49)	(-6.06)	(-6.02)	(-4.33)
Euk				0.02	0.02	0.01	0.02	0.01				0.01	0.01	0.01	0.01	0.01
				(6.13)	(6.61)	(5.5)	(6.05)	(5.4)				(6.66)	(7.12)	(6.1)	(6.59)	(6.04)
Ena				0.00	0.00	0.00	0.01	0.00				0.01	0.00	0.00	0.01	0.00
				(3.75)	(3.39)	(3.17)	(4.41)	(3.74)				(5.17)	(4.91)	(4.69)	(5.82)	(5.28)
Bmort				0.00	0.00	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00
				(-2.73)	(-2.34)	(-2.06)	(-3.21)	(-2.29)				(-2.64)	(-2.25)	(-2.05)	(-3.09)	(-2.21)
Bcash				-0.03	-0.03	-0.03	-0.03	-0.02				-0.02	-0.01	-0.01	-0.01	-0.01
				(-10.38)	(-9.71)	(-9.89)	(-9.29)	(-7.81)				(-7.03)	(-6.14)	(-6.44)	(-5.94)	(-4.24)
Post-crises					0.22			0.11					0.16			0.09
					(13.59)			(6.4)					(12.69)			(6.18)
Pre-crisis						-0.21		-0.27						-0.15		-0.19
						(-10.86)		(-13.69)						(-9.32)		(-11.53)
Crisis							-0.16	-0.21							-0.12	-0.15
							(-8.12)	(-9.78)							(-7.66)	(-8.48)
Constant	1.75	-0.19	0.99	1.82	1.01	1.80	1.55	1.02	1.48	-0.34	0.58	1.07	1.07	0.46	1.05	0.86
	(41.11)	(-2.91)	(11.56)	(4.99)	(2.93)	(5.18)	(4.35)	(3.22)	(72.65)	(-6.49)	(8.63)	(3.69)	(3.69)	(1.67)	(3.77)	(3.05)
Obs	21496	24442	21424	1239	1239	1239	1239	1239	21101	23995	21101	1239	1239	1239	1239	1239
R-squared	0.06	0.02	0.05	0.22	0.33	0.29	0.26	0.43	0.03	0.05	0.09	0.13	0.29	0.25	0.23	0.37

Legend: (in parentheses: robust t statistics) p***<0.01; ** p<0.05; * p<0.1
Source: Elaboration on Morningstar data.

Table 4) of the entire financial system. The findings may seem counterintuitive because of the positive sign of the coefficient [2.04 and 2.00, columns (2a) and (2b) respectively]. Despite that, the positive sign means that the higher the diversification of all funds the higher the idiosyncratic risk of the single fund. If we consider the two measures at the same time, the fund diversification and the average diversification of all funds, the results described above do not change [columns (3a) and (3b)].

Columns (4a) and (4b) include equity asset allocation among six different geographic regions: Asia (Easia), Emerging markets (Eem), Eurozone (Eeuro), Japan (Ejapan), U.K. (Euk), and North America (Ena). Emerging markets, U.K. and North America have a positive coefficient while Asia, Japan and Eurozone are negative. This difference may be associated with the different degrees by which

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these regions were imapcted by the recent crisis. North America and the U.K. were both severly affected by the last crises, especially their financial systems. In the U.K., a dramatic example of bank-run risk occurred during the collapse of Northern bank, while both the bursting of the Internet bubble in 2001 and the sub-prime mortgages crisis of 2007 began in U.S. before spreading to other regions of the world. The negative value for the Emerging Markets coefficient may be instead associated with the high volatility and fragility of these markets, such that an investment in these economies may be rightly assessed as strongly speculative and risky. By contrast, investments in developed Asian and Japanese markets, also physically far from the last crises centers, appear to reduce portfolio riskiness. In the same way, investments in Eurozone markets reduce idiosyncratic risk. This is probably due to the different structure of European financial system, where financial markets are less volatile and the institutional architecture appears to be more consolidated.

The other outward counterintuitive finding is the significantly negative sign for the mortgage bond coefficients [columns (4a) and (4b)]. This could be related to two factors: the good performance of the real estate market during the years preceding the crisis and the credit quality of these assets. There is no information in fact about this specific category of assets, which may be low risk. In the same vein, the cash bonds (with a maturity of lower than one year) have a negative sign; probably because short-term investments are more liquid and generally less risky.

The rest of the estimations [from column (5a) to column (8a), and from column (5b) to column (8b) respectively] seem to have a negative impact on idiosyncratic risk before and for a few months during the last crisis. The portfolio idiosyncratic risk is positive from the last crisis onwards.

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Table 5 - Short term impact of diversification and heterogeneity on funds' returns using market model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	**return**	**return**	**return**	**return**	**return**	**return**	**return**	**return**	**return**	**Return**
Global Market	0.92***	0.92***	0.92***	0.92***	0.92***	0.95***	0.95***	0.95***	0.95***	0.95***
	(179)	(179)	(175)	(179)	(179)	(163)	(163)	(160)	(163)	(163)
Diversification	-0.19*	-0.24**	-0.27**	-0.24**	-0.24**	-0.17	-0.25**	-0.27**	-0.25**	-0.25**
	(-1.67)	(-2.11)	(-2.31)	(-2.08)	(-2.08)	(-1.36)	(-2.01)	(-2.15)	(-1.96)	(-1.96)
Heterogeneity (t-6)	-0.40***	-0.40***	-0.34***	-0.40***	-0.40***	-0.42***	-0.43***	-0.38***	-0.43***	-0.43***
	(-6.31)	(-6.32)	(-5.36)	(-6.32)	(-6.32)	(-5.86)	(-5.88)	(-5.18)	(-5.87)	(-5.87)
Year dummies	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
North America		0.087***	0.088***	0.087***	0.087***		0.16***	0.16***	0.16***	0.16***
		(3.24)	(3.29)	(3.22)	(3.22)		(4.70)	(4.73)	(4.70)	(4.70)
Post-crises			-0.31***					-0.28***		
			(-6.42)					(-4.93)		
Pre-crisis				0.27***					0.27***	
				(4.32)					(3.94)	
Crisis					-0.27***					-0.27***
					(-4.32)					(-3.94)
Inception date						0.0056	0.017	0.015	0.018	0.018
						(0.18)	(0.54)	(0.47)	(0.57)	(0.57)
Speculative						0.053**	0.020	0.020	0.020	0.020
						(1.97)	(0.71)	(0.74)	(0.74)	(0.74)
Log Fund size						0.0075	0.0082	0.0078	0.0086	0.0086
						(0.97)	(1.07)	(1.01)	(1.12)	(1.12)
Constant	0.84***	0.82***	0.91***	0.81***	0.81***	0.71***	0.64***	0.74***	0.63***	0.63***
	(6.04)	(5.86)	(6.51)	(5.84)	(5.84)	(3.20)	(2.92)	(3.33)	(2.85)	(2.85)
Obs	20757	20757	20757	20757	20757	15818	15818	15818	15818	15818
R-squared	0.66	0.66	0.66	0.66	0.66	0.67	0.68	0.68	0.68	0.68

Legend: (In parentheses: robust t statistics) p***<0.01; ** p<0.05; * p<0.1
Source: Elaboration on Morningstar data.

The relationship between homogeneous diversification of economic agents and systemic risk

If we accept that systemic risk is the risk that the entire financial system experiences a simultaneous distress when a given event occurs, the term *simultaneous* plays a prominent role in this concept. Two conditions must be met for an event to impact the entire financial system at the same time: i) the event itself must be able to affect the entire system (*systemic event*) and ii) the level of similarity (or *homogeneity*) among agents and institutions must be sufficiently high. As stated in the estimation model - see equations (4) and (5) - we calculate the heterogeneity index HET_t from November 2001 to December 2010.

When we plot an overall view of the simultaneous effects of diversification on

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idiosyncratic risk, the heterogeneity level of the financial system, and the simultaneous downturn rate (not shown here),[12] we find that when diversification increases (until the beginning of the 2007 recession) the idiosyncratic risk decreases, the level of heterogeneity within the financial system falls, and the simultaneous downturn rate increases.[13] When a systemic event occurs, diversification reduces the portfolio-specific risk while increasing the likelihood of a simultaneous collapse of financial institutions. We also find that the relationship between these two factors and portfolio return is characterized by a lagged effect. This hypothesis may be tested through a return estimation model in which these two variables (considering different lags for diversification and heterogeneity at one, six, and twelve months) are taken into account as proposed in equation (7). Consequently, we run panel regression models where the dependent variable is always the monthly fund returns. Different combinations of contemporaneous and lagged variables of the heterogeneity index HET_t and the diversification index DIV_t are proposed in the estimated model.

Among all these regressions, only three models have significant values for both the diversification and heterogeneity variables. Three of them refer to short-run effects of lagged and contemporaneous heterogeneity (at time *t-6*, *t-1*, and *t*) and

[12]We need to choose a threshold (TS) of equation (6) that, if surpassed, expresses the experience of a systemic event. Following the Brownlees and Engle's approach (2010) the threshold (TS) may be fixed at -2%. In addition to Brownlees and Engle's approach, using the same threshold (2%), we assess the SD_{rate} of the number of funds that experience this loss (higher than 2%) - in the months that market loss surpasses this threshold. The indicator has its highest values during the 2007 financial crisis, and its peak corresponds to the month when Lehman Brothers' collapsed. The SD_{rate} may thus be considered a good proxy for systemic crises and to measure the risk of a simultaneous collapse of financial system given the market proxy building strategy. The market returns proxy used in this analysis is in fact constructed as a weighted average of North American and European market proxies. Moreover, the market proxy is constructed reflecting the funds asset allocation, which is balanced among different asset classes (i.e., *equity, cash, bond, other*). Hence, the market proxy is a balanced index where at least one component (*cash*) is substantially less volatile than the others. Consequently, a strong drop in this index may be considered a good signal of a systemic distress.

[13]This effect can be described with the expression "*the two faces of the same coin*."

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contemporaneous diversification on funds' returns; the other refers to the long-run effect of lagged heterogeneity (at *t-12*) and contemporaneous diversification.

Table 6 - Long term impact of diversification and heterogeneity on funds' returns using market model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	**Return**	**Return**	**Return**	**Return**	**Return**	**Return**	**return**	**return**	**Return**	**return**
Global Market	0.93***	0.93***	0.93***	0.93***	0.93***	0.97***	0.97***	0.96***	0.97***	0.97***
	(177)	(176)	(174)	(176)	(176)	(161)	(161)	(159)	(161)	(161)
Diversification	-0.18	-0.24**	-0.26**	-0.23**	-0.23**	-0.14	-0.23*	-0.24*	-0.22*	-0.22*
	(-1.47)	(-2.00)	(-2.16)	(-1.97)	(-1.97)	(-1.06)	(-1.75)	(-1.86)	(-1.70)	(-1.70)
Heterogeneity (t-12)	0.49***	0.49***	0.45***	0.49***	0.49***	0.43***	0.43***	0.39***	0.43***	0.43***
	(9.48)	(9.52)	(8.51)	(9.47)	(9.47)	(7.18)	(7.21)	(6.45)	(7.17)	(7.17)
Year Dummies	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
North America		0.098***	0.099***	0.097***	0.097***		0.16***	0.16***	0.16***	0.16***
		(3.70)	(3.73)	(3.68)	(3.68)		(4.82)	(4.84)	(4.81)	(4.81)
Post-crises			-0.25***					-0.22***		
			(-5.20)					(-3.94)		
Pre-crisis				0.25***					0.26***	
				(4.19)					(3.86)	
Crisis					-0.25***					-0.26***
					(-4.19)					(-3.86)
Inception date						0.011	0.022	0.021	0.023	0.023
						(0.38)	(0.74)	(0.68)	(0.77)	(0.77)
Speculative						0.063**	0.028	0.029	0.029	0.029
						(2.35)	(1.02)	(1.05)	(1.05)	(1.05)
Log Fund size						0.0088	0.0096	0.0092	0.010	0.010
						(1.15)	(1.25)	(1.20)	(1.31)	(1.31)
Constant	-0.63***	-0.66***	-0.43***	-0.66***	-0.66***	-0.76***	-0.82***	-0.62***	-0.83***	-0.83***
	(-5.00)	(-5.28)	(-3.27)	(-5.27)	(-5.27)	(-3.63)	(-3.92)	(-2.87)	(-3.97)	(-3.97)
Observations	20137	20137	20137	20137	20137	15272	15272	15272	15272	15272
R-squared	0.66	0.66	0.66	0.66	0.66	0.67	0.68	0.68	0.68	0.68

Legend: (In parentheses: robust t statistics) p***<0.01; ** p<0.05; * p<0.1
Source: Elaboration on Morningstar

The short-run results are shown in Table 5. Heterogeneity has a negative impact on funds' returns for all the lagged time and the contemporaneous one. Thus, the degree of similarity among portfolios' asset allocations produces a positive effect on funds' returns in the short-run. This condition is perceived as a mitigator factor for systemic risk. A different way to interpret this result is that agents feel that homogeneity generates a positive perception of their asset allocation choices.[14] Contemporaneous diversification has a negative impact on monthly funds' returns meaning that the portfolio return decreases when the portfolio diversification increases.

[14]We decide to report only results for heterogeneity at t-6 in Table 6. All other lagged measures show the same impact on fund's return.

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The long run-effect (Table 6) is characterized by the persistence in the sign for diversification but it switched to positive for heterogeneity. We can interpret this change in the sign as a change in perception of the degree of homogeneity in the asset allocation choices. In the long-run, the similarities among funds' asset allocation choices is perceived by the market as a potential risk, while in the short-run it was a mitigating factor. In other words, the increasing degree of the homogeneity in the financial system has a negative impact on the funds' returns only after a certain time lag Looking at both-short and long-run effects on diversification and heterogeneity we can conclude that agents in the market perceive asset allocation choices differently based on the lag in time. In the short-run, the market seems to appreciate the homogeneity in agents' allocation choice to reduce both portfolio and systemic risk. This homogeneity is perceived by the market as a condition that makes agents more prone to suffer the consequences of a systemic event in the long-run.

Finally, for the long-run results described above, it is possible to estimate for each fund the coefficients associated with the parameters described in equation (7) through an OLS time series estimation where the dependent variable is the single fund return. The independent variables are: the market proxy returns, the lagged heterogeneity level, and the fund diversification index. Once the coefficients have been estimated, it is possible to measure the predictive powers of the estimates through a panel t-statistic test. Over the entire time window, the model predicts returns values that are not statistically different from effective values.[15]

[15]We perform the t-test on panel data as follows:

$t = [(\bar{R}_{it} - \bar{\hat{R}}_{it})(N^2 g / 2N)^{1/2}] / \sqrt{(N-1)\sigma^2_{R_{it}} + (N-1)\sigma^2_{\hat{R}_{it}}}$, where $\bar{R}_{it}$ and $\bar{\hat{R}}_{it}$ are the cross-sectional average values of monthly effective returns and estimated returns respectively, *N* is the number of cross-sectional observations, *g* is the number of degrees of freedom, σ^2 is the relative variance.

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Concluding remarks

The recent financial crisis has highlighted systemic risk as a possible, and a very important, variable that can, and should, play a role in the decisions taken by policy-makers. This paperh investigates two aspects of agents' portfolio heterogeneity in terms of asset allocation: within a single portfolio, and across investors' portfolios. The latter may be considered one possible source of a systemic distress. The rationale behind this idea is that if agents' portfolios become more similar to each other, the likelihood of a simultaneous collapse increases.

The analysis has been implemented through a sample of investment funds over the last decade, in three steps. The first two steps relate to the impact of diversification on the two portfolio risk components, respectively: systematic and idiosyncratic. The last one focuses on the impact of portfolio diversification on systemic risk.

The findings appear to suggest that diversification, even if is confirmed to be useful for reducing portfolio specific risk, could result in an increase in the degree of homogeneity among investors. This condition increases the risk that a negative systemic event produces a simultaneous collapse. If the agents allocated their wealth to the same assets, a negative event impacts all agents in the same way and at the same time.

Our results corroborate Wagner (2006), which argues that total diversification is undesirable because while it reduces risk within an individual institution it increases the risk of a systemic crisis, and De Vries (2005), which argues that diversification reduces the frequency of failure of individual institutions when a shock is small and easily borne by the system but increases the likelihood of a systemic failure when a stronger shock occurs.

Further strands of research may follow the investigation implemented in this paper. For example, it is possible to cluster the sample by regions (i.e., North America, Europe, Asia, Emerging Markets), rank portfolios by funds' beta factors, or improving the model forecasting ability for heterogeneity, diversification, and systemic risk.

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These research proposals are beyond the scope of the paper, which may also be a warning in opposition to the recent provisions of financial authorities. Common capital adequacy rules, indeed, while increasing transparency, also encourage homogeneity in investment strategy and undertaking of risk, leading to a high concentration of risk. That means that global regulations can be dangerous because they may increase the amplitude of global credit cycles [TaxPayers' Alliance (TPA), 2010].

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