# Can portfolio diversification increase systemic risk? evidence from the U.S and European mutual funds market

Dicembrino, Claudio and Scandizzo, Pasquale Lucio

University of Rome 'Tor Vergata'

30 November 2011

# Can Portfolio Diversification increase Systemic Risk? Evidence from the U.S and European Mutual Funds Market[1]

**Pasquale Lucio Scandizzo**

*CEIS, University of Rome "Tor Vergata"*

**Claudio Dicembrino**

*CEIS, University of Rome "Tor Vergata" and ENEL SpA*

## Abstract

This paper tests the hypothesis that portfolio diversification can increase the threat of systemic financial risk. The paper provides first a theoretical rationale for the possibility that systemic risk may be increased by the proliferation of financial instruments that lead operators to hold increasingly similar portfolios. Secondly, the paper tests the hypothesis that diversification may result in increasing systematic risk, by analyzing the portfolio dynamics of some of the major world open funds.

**JEL classification**: G01, G11, G32

[1] The views expressed in this article are solely those of the authors and do not involve the institutions of affiliation. All other usual disclaimers apply. Corresponding author: Claudio Dicembrino (dicembrino@economia.uniroma2.it).

**Keywords:** *Systemic Risk, Portfolio Diversification, Mutual Funds, CAPM*

# Introduction

This paper contributes to the growing literature on the link between portfolio diversification and its implications on the question of systemic risk. We first show that the introduction of any contingent claim, whose value is correlated with the value of the assets owned by a population of heterogeneous agents, causes an improvement of the agents' expected utility. At the same time, such an introduction will increase overall systemic risk. These effects are due to the cumulative interaction of two distinct, but closely related factors:

(i) The gain obtained from diversifying one's portfolio, thus reducing risk exposure through risk sharing;

(ii) The gain obtained through risk shifting from higher to lower risk-aversion agents.

We test the hypothesis on the negative relationship between diversification and systemic risk by estimating a simultaneous equation model on a panel of the 266 largest mutual funds (based on size). In particular, we use 162 funds to analyze the US market and 64 funds for the European area, exchanged in the market between January 2003 and March 2010. The plan of the paper is as follows. In section 1, we review the basic concepts and some of the recent literature on systemic risk. In section 2, we look in particular at the relationship between diversification and systemic risk. In Section 3, we develop a theoretical model that captures the essence of this relationship, by analyzing the effects on both diversification and systemic risks of the issuance of an additional security. In section 4 we describe the data set. In Section 5 we present the econometric analysis and the results obtained. In the last section we discuss some conclusive remarks.

# 1. On the Meaning and the Measure of Systemic Risk

In the context of analysis of financial instability, an active debate has emerged around how to define both a *systemic event*, a *systemic risk*, and their effects. Despite the considerable amount of literature on the topic, no shared consensus exists about the meaning, features and policy implications of these concepts. Highlighting the complexity of these issues, Alan Greenspan (1995), as chair of the Federal Reserve System (FED), has underlined that "*the very definition of systemic risk is somewhat unsettled*".

Macro-level analyses of systemic risk can be found in several works of the past two decades. Kaufman et al. (2003) refer to systemic risk as the risk or the probability of collapse in an entire financial system. Bartholomew et al. (1995) examine, within the systemic risk spreading mechanism, its effect not only on the domestic economy, but also on the entire international banking, financial, or economic system. Mishkin (1995) focuses on the investment repercussions of such an important event. Allen and Gale (2000) analyze the cause-effect process through which macro-shocks can spark contagion episodes and bank runs. Bordo et al. (1998) define systemic risk as a situation where "*shocks to one part of the financial system lead to shocks elsewhere, in turn impinging on the stability of the real economy*" (pp. 31). In their exhaustive review of the literature, De Bandt and Hartmann (2002) offer a similar view of a systemic event, saying that it takes place when a shock affects "*a considerable number of financial institutions or markets in a strong sense" (p.11).* De Nicolò and Kwast (2002), and Dow (2000), define systemic risk as a mechanism that, at the same time of the shock, affects the entire financial system, while Lehar (2005) says that "*a systemic crisis can be defined as an event in which a considerable number of financial institutions default simultaneously*".

The search of the micro foundations of systemic risk across shock-transmissions and spillover effects on the entire financial system has given rise to a different strand of literature. The following contributions emphasize causation mechanisms requiring close and direct connections among several institutions and different markets. Kaufman (1995) underlines the fact that systemic risk is the probability that cumulative losses originate from an event that, through a contagion effect, involves a chain of institutions belonging to a market. The Board of Governors of the FED (2001) provides a definition whereby systemic risk jeopardizes the solvency capacity of institutions[2]. Kambhu et al. (2007) define systemic risk as a situation where financial shocks "*have the potential to lead to substantial, adverse effects on the real economy, e.g., a reduction in productive investment due to the reduction in credit provision or a destabilization of economic activity*". This contribution has stressed the transmission of financial events to the real economy, as the key feature distinguishing a systemic event from a purely financial event. The contagion effect indiscriminately affects more or less the entire universe reflecting a general loss of confidence in all the units (solvent and insolvent) involved in the system. Referring not only to bankruptcy but also to the default of all market participants, the G-10 "Report on Financial Consolidation" (2001) defines systemic risk as: "*…a risk that an event will trigger a loss of confidence in a substantial portion of the financial system that is serious enough to have adverse consequences for the real economy*". In Bartram et al. (2005), systemic risk affects the unexposed institutions not otherwise involved by a crisis given its economic fundamentals.

---

[2] "*Private large-dollar payments network were unable or unwilling to settle its net debt position. (…) Serious repercussions could, as a result, spread to other participants in the private network, to other depository institutions not participating in the network, and to the nonfinancial economy generally*".

Overall, we can conclude that despite the vast literature on systemic risk, a clear and shared view of the concepts underlying this term has not emerged. Nevertheless, in the attempt to provide a general and unambiguous definition of systemic risk, both at a macro and micro level, three principal aspects must be recognized:

1. Impact on a "substantial portion" of the financial system;
2. Spillovers from one institution to many others;
3. Strong and adverse macroeconomic effects.

Turning again to the literature, we have carried out a review of systemic risk measures, according to two broad categories of indicators:

a) Traditional macroeconomic indicators of financial soundness and stability;

b) Indicators of interdependencies among financial institutions through the analysis of the financial institution's assets.

The first group of measures relies on bank capital ratios and bank liabilities to show that aggregate macroeconomic indicators can provide a valid and useful instrument to predict systemic financial threats. Through the study of macroeconomic fundamentals, Gonzalez-Hermosillo et al. (1997), Gorton (1998) and Gonzalez-Hermosillo (1999) demonstrate how macro analysis can be appropriately used to estimate systemic risk. More recently, Bhansali et al. (2008) derive a "*systemic credit risk*" variable from aggregate index credit derivatives, finding that this measure of systemic risk roughly doubles during the 2007-2009 financial crisis as compared to May 2005. De Nicolò and Lucchetta (2009) use a dynamic factor model to work out joint forecasts of indicators of systemic real risk and systemic financial risk, and then elaborate stress-tests of these indicators as impulse responses to structurally identifiable shocks.

The second group of measures quantifies the linkages among financial institutions as well as exposures among banks that through their business can influence each other in situations of financial distress. A more recent contribution is given by Lehar (2005), assessing the probability that a certain number of banks within a specific arc of time go bankrupt due to reduced asset value vis a vis a critical and well-defined liability value. Adrian and Brunnermeier (2009) define CoVaR as the VaR of financial institutions conditional on other institutions that experience, at the same time, financial distress. De Nicolò and Lucchetta (2009) investigate the transmission channels and contagion effects of certain shocks between the macroeconomy, the financial markets and the intermediaries. Huang et al. (2010) use as a proxy of systemic risk, the price of insuring a dozen of the major U.S banks against financial turmoil on the basis of both ex-ante bank default probabilities and forecasted asset-returns correlations.

The IMF (2009) surveys four different methods to assess interlinkages among financial institutions:

- The *network approach*, where the interbank market spreads the transmission of financial stress through the banking system (Allen et al. (2010));
- The *co-risk model*, (or co-movement risk model) whereby the probability default of one institution is directly linked to the default risk of another institution (Adrian et al. (2009, p.5)), de Vries et al. (2001), Longin and Solnik (2001) and Chan-Lau (2004);
- The *distress dependence matrix* based on the probability of default of banks' pairs, taking into account a panel of financial institutions Goodhart and Segoviano (2009);
- The *default intensity model* based on the estimate of the probability of default of financial institutions Giesecke and Bacho (2009)).

Among other contributions that are worth mentioning, Bartram et al. (2005) propose three different approaches to estimate systemic risk by observing market reaction to global financial shocks for a subset of banks that are not directly exposed to the shock[3]. Capuano (2008) develops a framework to derive a market-based measure of probability of default, defined as the probability that the value of the underlying asset will fall below a given threshold. Using a VaR approach, Acharya et al. (2010), define systemic risk as the likelihood of experiencing cumulative losses in financial system that exceed the predicted by VaR model.

## 2. Systemic Risk and Portfolio Diversification

Recalling the 2008 financial crises, characterized by a conglomerate of interrelated financial services and multi-sector institutions, a vibrant discussion has emerged regarding the causes of the recent financial system collapse. In this debate, many financial actors have been analyzing the roots of this phenomenon: on one side, many address as micro-drivers of this turmoil the *financialization* of the real economy (e.g. mortgage-backed securities (MBS)); others, on the other side, highlight as macro-drivers the lack of an efficient macro-prudential banking system (e.g. timely mechanisms able to prevent contagion and spread). In this current framework, Rodrìgez-Moreno et al. (2010)

[3] Bertrand et al. (2005) argue that in efficient capital markets, negative information (as 9/11) will affect bank performances that are exposed to the events in question. Unexposed banks will be unaffected by these effects.

argue that academic research has widely investigated both idiosyncratic and systematic risk, ignoring the fundamental importance of systemic risk and its implications on the financial markets. This concept is also clearly expressed in Masera et al. (2010), stating "*it is now clear that supervisory authorities, policy makers and political authorities must look, beyond idiosyncratic risk, also at the systemic risk to the broader financial system that certain very large financial firms (Systemically Important Financial Institutions – SIFIs) pose".*

Further, what appears to have been less investigated in the relevant literature are the potential effects of portfolio diversification on systemic risk. While the benefits of diversification at a microeconomic level (in portfolio choices theory) have been thoroughly examined in the economic literature (Allan and Gale, 2005; Freixas et al., 2005; and Wagner and Marsh, 2006), the macroeconomic side of the link between diversification and systemic risk remains complex, multi-faceted, and not yet completely explored (Lo, 2008). In this regard, two different views, outlining both the negative and positive effects of the relationship between diversification and systemic risk, have been characterizing this more controversial strand of the literature. Although portfolio diversification reduces risks at each individual institution, from the prospective of the entire financial system, it only reallocates these individual risks (Wagner, 2009). As argued in de Vries (2005) "*…while diversification reduces the frequency of individual bank failures, since smaller shocks can be easily borne by the system, at the same time diversification makes the bank sector prone to systemic breakdowns in case of very large (non-macro) shocks, which otherwise would only have isolated impact*". Indeed, there is not any evidence to date, which would indicate that portfolio diversification reduces the threat of systemic risk. Further diversification leads to sharing risks across institutions involved in contributing to make these positions similar to each other, with the effect of facilitating financial contagion due to interlinked relationships among financial institutions. Nevertheless, it is crucial to include in these causes even the large financial conglomerates and the increasing presence of derivative instruments in the international financial system. In particular, derivative products have been indicated as both a responsible mechanism and perverse interaction of risk spreading and transferring from the banking to the insurance sector and vice versa (e.g. Originate-to-Distribute Model in banking and OTC derivatives).

In this regard, risk transfers between insurers and the banking sector represent a widely used diversification instrument, allowing banks to transform liquid liabilities of depositors into illiquid assets (loans) (de Vries 2010). Furthermore, and in particular during the last decade, there are many contributions sustaining the contention that diversification has negative effects on the financial system, including De Young and Roland (2001), Stiroh (2004, 2006), Acharya et al. (2006), and Hirtle et al. (2007). In particular, Stiroh and Rumble (2006) find that benefits stemming from diversification can be completely undermined by the volatility effect of new exposures introduced into a portfolio. Sanya et al. (2010) offers different kinds of mechanisms that can be detected to analyze the negative impact (or reduced benefits) of portfolio diversification on systemic risk. The first, discussed in Froot and Stein (1998) and Cebenyoyan and Strahan (2004), indicates that gains obtained from portfolio diversification will be limited if the banks (managing the portfolio) do not have a risk efficient portfolio. The second argues that diversification can play a negative role when banks expand their business into industries, with difficulties emerging from loan-monitoring activities. Wegner (2006) emphasizes the role of diversification as an incentive for taking greater and new risks in the international financial markets. De Vries (2010) states that "*diversification lowers the risk of isolated shocks for a financial entity, but may simultaneously increase the systemic risk".* Recently, Allen et al. (2010) claim that the spread of credit default swaps and other credit derivative products, loan sales and collateralized loan obligations, has increased and improved the possibility for banks, mutual funds and financial institutions to diversify risk. But this possibility has, according to Allen et al. (2010) "*also led to more overlap and more similarities among their portfolios. This has increased the probability that the failure of one institution is likely to coincide with the failure of other similar institutions"* (p.6).

Conversely, there is an opposing strand of the relevant economic literature which sustains the positive effects of diversification, first, from an efficiency gain point of view (Berger et al. (1999), Estrella (2002)), and second, in increasing bank stability (Grossman (1994), Wheelock (1995), Berger et al. (1999), Reichart and Wall (2000), Campa and Kedia (2002), and Baele et al. (2007)).

## 3. The model

Consider an economy formed by n agents. Each agent is endowed with a certain amount of wealth, whose rate of return varies stochastically from one agent to the other. The satisfaction of the *i-th* agent is measured by expected utility $EU_i(y_i)$, where $E$ is the expectation operator, $U_i(.)$ denotes a well behaved utility function and $y_i$ is stochastic income. By projecting orthogonally the agent's stochastic individual income $y_i$ onto the stochastic total agents' income $y=\sum_i y_i$, we can write the following identity:

(1) $y_i - \mu_i = \beta_i(y-\mu) + v_i$

where $\sum_i v_i = 0$ $Ev_i = 0$, $Cov(v_i, y) = 0$, $Ey_i = \mu_i$; $\frac{1}{n}\sum_i \mu_i = \mu$; and $\sum_i \beta_i = n$.

Equation (1) decomposes individual risk into a systemic, diversifiable component, correlated with total agents' revenue, and into an independent, idiosyncratic component.

The variance of individual income, assuming no correlation between diversifiable and idiosyncratic risk is:

(1bis) $Var(y_i) = \beta_i^2 \sigma_y^2 + \sigma_i^2$

By diversifying, each operator can bring her $\beta_i$ to unity, thus bringing her portfolio to coincide with the market portfolio, which by definition is the most diversified, being an average of all portfolios, thereby achieving a minimum variance (i.e. the variance of the most diversified portfolio).

The distribution function (d.f.) of total revenue is $F(y)$ and its support is the compact interval $[0, y_{\max}]$, while the d.f. of the idiosyncratic component is $G(v_i)$ over the support $[v_{i\min}, v_{i\max}]$.

Assume now that a derivative is introduced. In our context a derivative is defined as a contingent claim whose value depends on one of the assets, i.e. income sources in the market, more specifically, we will assume it depends on the average return of all other assets. The derivative price $p(y)$ is assumed to be distributed with mean $Ep$, variance $\sigma_p^2$ and covariance $\sigma_{ip}$ with each agent's income. The derivative corresponds to a contract between a issuer (i.e. a short holder) and a buyer ( a long holder), whereby each party promises to pay the other a premium in different states of the world.

The i-th agent is confronted with the problem of choosing an optimal number of units of the derivative to hold long (i.e. to purchase) or short (i.e. to issue), so that total income for each agent will be equal in each state of nature to the solution of the following maximization problem:

(2) $\underset{q_i}{Max}\, EU_i(x_i)$ , $x_i = y_i + q_i p$ ; $i = 1,2...n$

where $q_i$ denotes the number of units of the security in terms of shares of the promised (random) payoff $p$, and is positive or negative according to whether the security is bought or sold by the ith agent.

Using (1) and the related assumptions, the expected utility in (2) can be written as follows:

(3) $$EU_i(x_i) = \int_{v_{i\min}}^{v_{i\max}} \int_{0}^{y_{\max}} U_i(\mu_i + \beta_i(y-\mu) + v_i + q_i p(y)) dF(y) dG(v_i)$$

$$= \int_{0}^{y_{\max}} V_i(m_i + \beta_i(y-\mu) + q_i p(y)) dF(y)$$

where $m_i = \mu_i - \beta_i \mu$ and $V_i(.)$ is the indirect utility function defined as:

(4) $$V_i(m_i) = \int_{v_{i\min}}^{v_{i\max}} U(m_i + v_i) dG(v_i) \text{ for all } \mu_i$$

As shown by Kihlstrom, Romer and Williams (1981), the indirect utility function in (4) is well behaved, i.e. it is increasing and concave in its arguments.

In order to show that the introduction of the security increases the income of the *i-th* subject, it is sufficient to show that the problem in (2) has a solution with a non zero value for the security in question. The first order condition is obtained differentiating (3) w.r.t. $q_i$:

(6) $$\frac{dEV_i}{dq_i} = \int_{0}^{y_{\max}} (V_i' p(y)) dF(y) = E(V_i' p) = 0,$$

where primes indicate derivatives, while the second order condition requires:

(7) $$\frac{d^2 EV_i}{dq_i^2} = E(V_i'' p^2) < 0,$$

which is always satisfied for a concave utility function. Applying the definition of covariance to (6), we obtain:

(8) $$EV_i' Ey + Cov(V_i' p(y)) = 0$$

Differentiating totally with respect to the parameters yields:

(9) $$EV_i' dEp + [E(V_i'' p)Ep + Cov(V_i'' p^2)]dq_i + [E(V_i'' py)Ep + Cov(V_i'' py)]d\beta_i = 0$$

which, by applying again the definition of covariance, can be also be written as:

(10) $$EV_i' dEp + E(V_i'' p^2) dq_i + E(V_i'' p^2 y) d\beta_i = 0$$

Since $\theta_i = -\frac{E(V_i^{''} p^2)}{EV_i^{'}} \geq 0$ and $\psi_i = \frac{E(V_i^{''} p^2 y)}{EV_i^{'}} \geq 0$ are both positive measures of risk aversion, solving (10) for $dq_i$ yields:

$$(11) \quad dq_i = \frac{dEp}{\theta_i} + \frac{\psi_i}{\theta_i} d\beta_i$$

Equation (11) establishes the fact that any increase in the expected pay off and/or in the beta will increase long positions while it will reduce short positions in the derivative asset. In a stable market equilibrium, we must have $\sum_{i=1}^{n} dq_i = 0$, which implies:

$$(12) \quad dEp = -\Theta d\beta$$

where $\Theta = n(\sum_{i=1}^{m} \frac{1}{\theta_i})^{-1}$ and $d\beta = \frac{1}{n}\sum_{i=1}^{n} \frac{\psi_i}{\theta_i} \beta_i$ .

Substituting (12) into (11) yields the equilibrium relationship:

$$(13) \quad dq_i = \frac{\psi_i}{\theta_i} d\beta_i - \frac{\Theta}{\theta_i} d\beta$$

Expression (13) establishes the dependence of the quantities traded of the security on the difference between the individual incentive to diversify (through his beta and risk aversion) and the incentive to shift risk to or from more risk averse traders.

Expression (13) can be integrated, assuming that the utility function parameters are constant. A simpler way to proceed, however, is to expand $V_i^{'}$ in (8) according to the Mac Laurin's formula:

$$(14) \quad V_i^{'} = V_{i0}^{'} + V_{i0}^{''}(m_{i0} + \beta_i y + q_i p(y)) + \frac{1}{2} V_{i\alpha}^{'''}(m_{i0} + \beta_i y + q_i p(y))^2$$

where the subscripts $0$ and $\alpha$ denote the fact that the derivatives of the utility function are measured, respectively, at the origin and at $\alpha(y_i + q_i p)$ , with $0 \leq \alpha \leq 1$.

Substituting into (8), and assuming that all moments higher than two of the joint distribution of $y$ and $p$ are zero, yields:

$$(15) \quad Ep - \phi_i(\beta_i\sigma_{yp} + q_i\sigma_p^2) = 0$$

where $\phi_i = -\frac{V_{i0}^{''}}{EV_i^{'}}$ is a measure of absolute risk aversion and coincides with the Pratt coefficient for the family of constant risk aversion utility functions (CARA).

Solving (15) for $q_i$, we obtain:

$$(16) \quad q_i = \frac{Ep}{\phi_i\sigma_p^2} - \beta_i\frac{\sigma_{yp}}{\sigma_p^2}$$

Expression (16) shows that a solution to the maximization problem is the result of two factors of agents' heterogeneity: (i) the degree of risk aversion and, (ii) the correlation between the security payoff and the agent income. However, in order for the solutions for the different agents to be mutually compatible, the determination of the expected payoff $Ep$ should be competitively determined, i.e. $\sum_i q_i = 0$, so that :

$$(17) \quad Ep = \Phi\sigma_{yp}$$

where $\Phi = n(\sum_i \frac{1}{\phi_i})^{-1}$ is the harmonic average of the individual risk aversion coefficients and I have used the property : $\sum_{i=1}^{n}\beta_i = n$.

Substituting (17) into (16) yields:

$$(18) \quad q_i = (\frac{\Phi}{\phi_i} - \beta_i)\beta = (\frac{\Phi - \phi_i\beta_i}{\phi_i})\beta$$

where $\beta = \frac{\sigma_{yp}}{\sigma_p^2}$ and

$$Var\sum(q_i p(y)) = [\sum_i^n (\frac{\Phi - \phi_i\beta_i}{\phi_i})\beta)]^2 \sum_j (\sigma_p^2 + 2\sigma_{jp})$$

In conclusion, each agent will be able to improve her expected utility by diversifying into a short or long position on an additional contingent claim, depending on two effects: (i) the difference between average and individual demand for diversification (the beta) and, (ii) the difference between average and individual risk aversion. The equilibrium level of long and short positions will be independent from the expected level of the pay off, but will depend only on its variance. For example, in the special case of a derivative that acts as an insurance (e.g. a put option) and pays to long holders $p = R - y$ when $y \leq R$ and $p = -c$ otherwise, we have that $\sigma_p^2 = \sigma_y^2 F(R)$ and $\sigma_{yp} = -\sigma_y^2 F(R)$, so that $\beta = -1$ and :

$$(19) \quad q_i = (\beta_i - \frac{\Phi}{\phi_i})$$

and

$$(20) x_i = \mu_i + \beta_i (y - \mu) + v_i + (\frac{\Phi - \phi_i \beta_i}{\phi_i}) \beta \ p(y)$$

so that : $Var(x_i) = \beta_i^2 \sigma_y^2 + \sigma_i^2 + (\frac{\Phi - \phi_i \beta_i}{\phi_i})^2 \beta^2 (\sigma_p^2 + \sum_j 2\sigma_{jp})$ .

Note that the introduction of the security has improved expected income of each agent, it has further diversified her portfolio, but, at the same time, has introduced a new source of variance (and, implicitly, risk), into the system. This new form of risk can be defined as “systemic”, because it depends on the correlation between the yield of the derivative and the income of all agents in the system. In other words, a shock on the price of the derivative is transmitted to all agents.

From equation (20), we can derive a modified version of the well known CAPM model, by subtracting from both sides the risk free rate of return *r*:

$$(21) x_i - r_f = (\mu_i - \beta_i \mu) + \beta_i (y - r_f) + v_i + (\frac{\Phi - \phi_i \beta_i}{\phi_i}) \beta \ p(y)$$

# 4. Dataset

As noted in section 2, several methodologies have been implemented to measure systemic risk, based on different motivations and goals: we choose the correlation among mutual funds showing lower performances compared to the average level returns (threshold value) as a proxy of systemic risk (*Syst_rsk*). The choice of this approach is not novel in the literature (De Nicolo and Kwast (2002)), its advantage being that correlations among funds’ returns are considered as a *forward-looking* variable much more suitable than balance sheets or company financial indicators to capture systemic failures and the associated costs. Furthermore, the correlation between returns of different funds reflect fund values. Following the approach by Chan et al. (2004), we thus estimate this variable through a pairwise correlation approach between the return of the *i-th* and the *j-th* fund:

$$Cov\left[R_{i,t}R_{j,t}\right]=\frac{\beta_i\beta_j\sigma_\lambda^2}{\sqrt{\beta_i^2\sigma_\lambda^2+\sigma_{\varepsilon,i}^2}\sqrt{\beta_j^2\sigma_\lambda^2+\sigma_{\varepsilon,i}^2}} \tag{23}$$

As discussed above, we propose the systemic risk variable as the *pairwise correlation* within the subset of funds having lower than average performance:

$$R_{ij,t}=x_{ij,t}-\bar{x}_{ij} \qquad if \qquad x_{it,t}<\bar{x}_{ij}$$

$$R_{ij,t}=0 \qquad otherwise$$

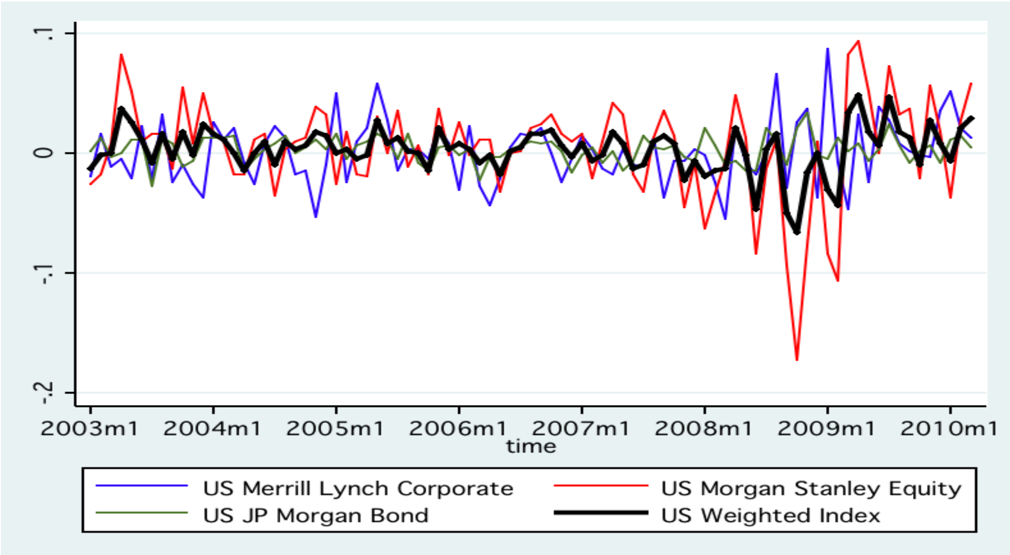
We analyze a panel of the 226 largest mutual funds (based on size) from the Morningstar database[4]. The U.S. market is analyzed through 162 funds and through 64 funds for the European area, exchanged in the market between January 2003 and March 2010, thereby amounting to 19.662 monthly observations. We chose as the risk-free rate for the U.S market the 3-Months Treasury Bills from the Federal Reserve Bank of Saint Louis (FED of Saint Louis) database. For the European market, we use the 3-Months German government bond from the Bloomberg database. Through a *Return Based Style Analysis* (*RBSA*), we create a return weighted index able to capture the equity stocks, government bonds and corporate fund performances. *Bond*, *equity* and *cash* compose the *n*-segments of any fund in the *n-th* portfolio.

In order to build up these two proxies (for both the U.S and European market) we consider:

- the *U.S and European Morgan Stanley (MSCI)* index for government bonds;
- the *U.S and European J.P Morgan (JPM EMBI)* index for the stock exchange;
- the U.S and European *Merry Lynch (ML-Corporate)* index for the corporate sector.

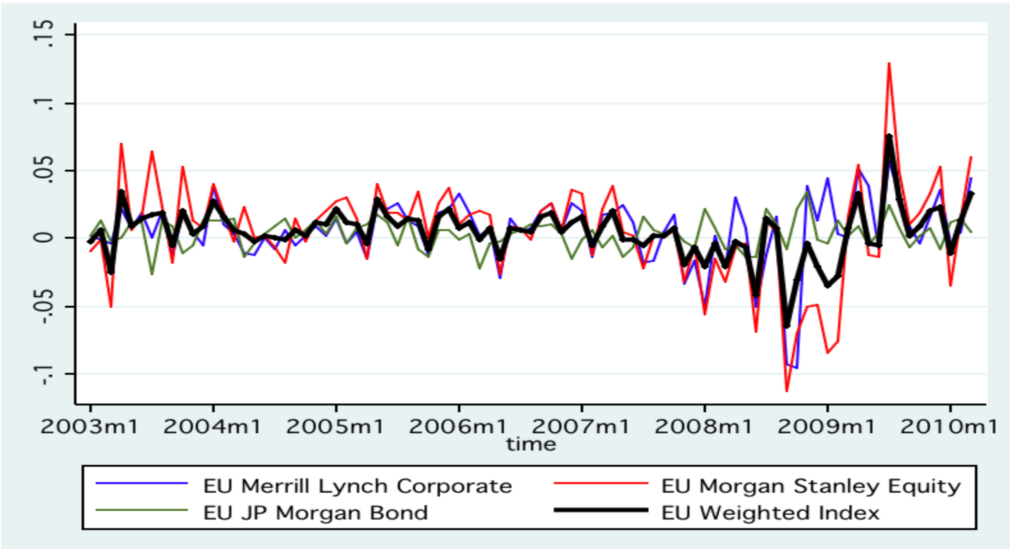
[4] The largest funds are chosen by size. Having our database comprised of 226 mutual funds exchanged in *n* different countries, we divide these mutual funds into three wide macro-areas of affiliation. **Europe** = Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom. **North America** = United States, Canada and Mexico.

Figure 1: US market performances




Source: Authors' elaborations on Bloomberg database. The "weighted" index is the market index created on the other three index performances.

Figure 2: EU market performances




Source: Authors' elaborations on Bloomberg database. The "weighted" index is the market index created on the other three index performances.

The *Libor-OIS* (*Overnight Interest Swap*) (*Libor_Ois*) for the American market, and the *spread Euribor-Ois* (*Euribor_Ois)* for the European market are considered as proxies for banks' soundness and as a reliable indicator of the stability of the banking system[5]. The *diversification*

[5] The importance of this spread is asserted both by Alan Greenspan "*Libor-OIS remains a barometer of fears of bank insolvency*" and the Vice President of the FED of St. Louis, D.L. Thornton "*the term Libor-OIS spread is assumed to be*

*index* (*DIV*) has been measured as the difference from each portfolio , in terms of asset allocation, and an equally diversified portfolio. The variable *Beta Market* (*ßmkt)* is the difference between the return weighted index previously mentioned and the risk free rate (see above); while the Excess Return (*Exc_Ret*) is the difference between the mutual fund returns and the risk free rate (see above) , for both the U.S and European markets. The *Consumer price index growth rate* (*Cpi*) for the U.S and the *Harmonised Index of Consumer Prices* (*HICP*)[6] for Europe represent the two variables accounting for inflation. The 2007, 2008 and 2009 (*D07, D08, D09*) dummy variables take into account the years where the last crisis created increased turbulence in the financial markets. A detailed list of the variables used in the empirical analysis is presented in Table 1.

## 5. The Estimation Strategy and the Empirical Results

We estimate a simultaneous equation model, based on the classical CAPM formulation augmented by a variable that represents the contribution that diversification through derivatives makes to systemic risk. In Tables 2 and 3, we show the result of the CAPM estimates in the two markets (U.S and Europe). In particular, using the CAPM specification presented in Fama et al. (2004), we regress individual (fund) excess returns on market returns, the diversification index and a series of dummy variables. In both markets, we find a positive relation between Beta and excess returns. Although the two markets show a significant difference in their Beta coefficients, (approximately 1.16 in the U.S and around 0.86 in the European market) no sizeable variation appears in intra-market differences (the U.S market beta ranges between 1.14 and 1.17 while the European market beta varies between 0.84 and almost 0.89). In the U.S and European market, the diversification variable shows a positive and a high significant coefficient, while the systemic risk variable negatively impacts the excess returns (dependent variable).

Once we examined the CAPM analysis, in order to assess the impact of the diversification strategy on systemic risk, we specify a model in which the market excess returns and the indicators of systemic risk are simultaneously determined and depend on a series of key variables that, according to the literature, play a fundamental role both in influencing the beta market and as a possible factor impacting systemic risk. The model is estimated by using two stage least squares. The first equation is given by:

---

*a measure of the health of banks because it reflects what banks believe is the risk of default associated with lending to other banks".*

[6] Consumer price inflation in the Euro area is measured by the Harmonised Index of Consumer Prices (HICP). The HICP is compiled by Eurostat and the national statistical institutes in accordance with harmonised statistical methods (http://www.ecb.int/stats/prices/hicp/html/index.en.html).

(22a) - U.S. Market:

$$Mkt\_Beta_{i,t} = Sist\_rsk_{i,t} + Fcorr_{i,t} + Cpi_{i,t} + Libor\_Ois_{i,t} + D08_i + D09_i + u_t$$

(22b) - European Market:

$$Mkt\_Beta_{i,t} = Sist\_rsk_{i,t} + Fcorr_{i,t} + HICP_{i,t} + Euribor\_Ois_{i,t} + D08_i + D09_i + u_t$$

Equations (22a-b) test the hypothesis that systemic risk variable has a negative impact on the market performances. In addition to the dependent variable *Mkt_Beta,* measured as the market monthly excess return, the independent variables are: the systemic index measured as *the fund correlations* (without any return threshold); *the consumer price index growth rate* (for the American market) and the *Harmonised Index of Consumer Prices* (for the European market); the *spread Libor-Ois* (*Libor_Ois*) for the American market; the *spread Euribor-Ois* (*Euribor_Ois)* for the European market as proxies of bank sector soundness; and the 2007, 2008 and 2009 dummy variables on the *Market Beta* variable (*Mkt_Beta*), (defined as difference between market performance, created through the RBSA, and the risk free rate).

As tables 4-5 show, an increase in the correlation of mutual funds' returns (*Fcorr*) has a negative and significant impact on market excess returns (*Mkt_Beta*). This effect is strongly significant in both the U.S and EU markets. These findings clearly emerge from the tests applied through the first hypothesis in any specification of the 22a-b models. The Libor (Euribor)-OIS spread represents the unsecured interest rate at which banks lend money to other banks which must satisfy certain criteria for creditworthiness. Libor and Euribor are not entirely credit risk-free, because they reflect both liquidity risk and the bank's default risk over the following months. The OIS represents the average of the overnight interest rates expected until maturity, so the Libor (Euribor) – OIS reflects both the liquidity and default risks over the next months. Then, during the period where the stock markets register a strong performance, this spread should be subjected to a reduction. In this context, our results confirm the negative relationship between market performance and the Libor (Euribor) – OIS spread indicator. The Cpi and Hicp negative coefficients support the strand of the literature that predicts a negative relationship between inflation and stock performances in the short run.

In the second equation of the simultaneous model, (23a-b) we aim to test the second hypothesis, *i.e.* that an increase in the similarities of the diversification strategies of each fund can increase the threat of systemic risk. In this case the dependent variable is the *systemic risk,* while the independent variables are the three *dummy variables* for 2007-2008-2009, the *fundsize* and the *Cpi/Hicp growth rate* on the *systemic risk* variable.

(23a) - U.S. Market:

$$Sist\_rsk_{i,t} = Mkt\_Beta_{i,t} + Fcorr_{i,t} + Cpi_{i,t} + Libor\_Ois_{i,t} + Div_{i,t} + Fsize_{i,t} + D07_{i} + D08_{i} + D09_{i} + u_{t}$$

(23b) - European Market:

$$Sist\_rsk_{i,t} = Mkt\_Beta_{i,t} + Fcorr_{i,t} + HICP_{i,t} + Euribor\_Ois_{i,t} + Div_{i,t} + Fsize_{i,t} + D07_{i} + D08_{i} + D09_{i} + u_{t}$$

The results of the empirical analysis are contained in table 4 for the U.S market, and table 5 for the European market. In general all these variables show a high level of significance, although the diversification index variable is weakly significant at 10%. The strategy in the asset allocation investment choices is captured by the diversification index (*Div*) variable. This index explains how portfolio diversification can increase the threat of systemic risk as dependent variable. The similarities in fund returns for each portfolio are instead represented by the *Fcorr* that also shows a positive and significant coefficient. This suggests that an increase of the correlation among fund returns can be interpreted as a warning for a distress situation in the financial system. As already explained in the first stage, in periods when the stock markets register good performances, this measure is subjected to a reduction, conversely in periods of turmoil this spread should increase so as to capture the market risks. In the estimate of the second equation, we thus find that an incrase of this spread leads to an increase of the threat of systemic risk. Further in both specifications (model 23a-b) we find a positive relation between the dummy variables, the *Fund size* and the *CPI* (for the American market) or the *Hicp* (for the European market) and the systemic risk variable. The *Market Beta* variable has a negative effect on systemic risk, suggesting that deteriorating market performance reverberates negatively on systemic risk.

## 6. Concluding Remarks

The theoretical and empirical motivation of this analysis is the ongoing debate which posits that derivative driven financial diversification, often interpreted by professionals and academics as a fundamental benefit of investment financial strategies, can be undesirable and a driver of excessive instability. Our results provide insight into the connection between portfolio diversification strategies and the impact on systemic risk. In this regard, we have developed a model where the *i-th* agent diversification strategy interacts with the *j-th* agent diversification strategy, through the mutual purchase and sale of derivatives, thus increasing agents' interdependence, the probability of contagion from a systemic event and, ultimately, systemic risk. The basic reason for this result is that derivatives provide an insidious instrument of diversification. While they appeal to risk managers because of their capacity, as contingent claims, to provide insurance to individual investors, at the same time, they create a separate source of portfolio volatility which may be increasingly difficult to further diversify.

Some of the implications of the theoretical model have been tested through a simultaneous equations model, where we have hypothesized that systemic risk may increase the need to further diversify and, at the same time, further diversification, by increasing portfolio similarities, can boost systemic risk. Both hypothesis appear to be corroborated by our econometric tests, which show significant and mutual substantial impacts of the signs implied by the model, between diversification and systemic risk variables.

Our findings can be summarized as follows: from the point of view of the individual agent, the portfolio diversification strategy represents a valuable instrument of portfolio management. However, from the point of view of the financial system, when such a diversification is pursued through a proliferation of derivative securities, the increase in similarities and mutual interdependence among financial agents may result in an increase in aggregate risk. Such an increase has systemic nature since it is based on the loss of a diversified ensemble of financial agents as a key source of systemic resilience.

# List of tables

**Table 1a: Complete list of variables used in the empirical analysis**

| Variable | Sample | Frequency | Source | Acronym |
|---|---|---|---|---|
| Market Beta | Jan '03-Mar '10 | monthly | Authors elaborations on Morningstar and Bloomberg data | *Mkt_Beta* |
| Excess Return | Jan '03-Mar '10 | monthly | Authors elaborations on Morningstar and Bloomberg data | *Exc_ret* |
| Fund correlation | Jan '03-Mar '10 | monthly | Author elaborations on Morningstar data | *Fcorr* |
| Systemic risk | Jan '03-Mar '10 | monthly | Author elaborations on Morningstar data | *Syst_risk* |
| Spread Euribor OIS | Jan '03-Mar '10 | monthly | Bloomberg | *Euribor_Ois* |
| Spread Libor OIS | Jan '03-Mar '10 | monthly | FED St. Louis database | *Libor_Ois* |
| Consumer Price Index | Jan '03-Mar '10 | monthly | Bureau of Labor Statistics | *Cpi* |
| Harmonized Index of Consumer Prices | Jan '03-Mar '10 | monthly | ECB statistics | *HICP* |
| Fund Size | Jan '03-Mar '10 | monthly | Morningstar | *Fsize* |
| Dummy 2007 | Jan '03-Mar '10 | monthly | Dummy variable | *D07* |
| Dummy 2008 | Jan '03-Mar '10 | monthly | Dummy variable | *D08* |
| Dummy 2009 | Jan '03-Mar '10 | monthly | Dummy variable | *D09* |
| Diversification Index | Jan '03-Mar '10 | monthly | Author elaborations on Morningstar data | *Div* |

Source: Author's elaborations

**Table 1b: Summary statistics of variables**

| | min | p1 | p10 | p25 | p50 | p75 | p90 | p99 | max | mean | sd | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mkt_Beta_US | -0.66 | -0.66 | -0.18 | -0.08 | 0.01 | 0.13 | 0.24 | 0.49 | 0.93 | 0.02 | 0.19 | 16502 |
| Mkt_Beta_EU | -0.65 | -0.65 | -0.22 | -0.05 | 0.03 | 0.13 | 0.20 | 0.75 | 0.89 | 0.05 | 0.18 | 3160 |
| Fcorr_US | -0.76 | -0.58 | -0.32 | -0.30 | 0.14 | 0.19 | 0.38 | 0.55 | 0.93 | 0.03 | 0.71 | 14456 |
| Fcorr_EU | -0.82 | -0.74 | -0.41 | -0.19 | 0.09 | 0.23 | 0.34 | 0.59 | 0.87 | 0.01 | 0.41 | 3160 |
| Sist_rsk_US | -0.05 | -0.04 | -0.01 | 0.00 | 0.02 | 0.21 | 0.32 | 0.49 | 0.67 | 0.04 | 185.89 | 11225 |
| Sist_rst_EU | -0.03 | -0.04 | -4.39 | 0.00 | 0.21 | 0.32 | 0.39 | 0.44 | 0.75 | 0.03 | 185.89 | 2770 |
| Exc_ret_US | -0.65 | -0.65 | -0.15 | -0.06 | 0.04 | 0.16 | 0.25 | 0.49 | 0.49 | 0.04 | 0.19 | 16502 |
| Exc_ret_EU | -0.64 | -0.64 | -0.20 | -0.03 | 0.07 | 0.15 | 0.22 | 0.75 | 0.75 | 0.05 | 0.18 | 3160 |
| Rend_WI_US | -1.25 | -0.39 | -0.13 | -0.03 | 0.21 | 0.26 | 0.31 | 0.48 | 0.61 | 0.25 | 0.09 | 16502 |
| Rend_WI_EU | -1.31 | -0.63 | -0.28 | -0.17 | 0.10 | 0.15 | 0.21 | 0.30 | 0.58 | 0.13 | 0.13 | 3160 |
| Cpi | -2.00 | -2.00 | -0.10 | 2.00 | 2.90 | 3.01 | 3.90 | 5.17 | 6.01 | 3.01 | 1.87 | 16502 |
| Hicp | -1.76 | -1.88 | -0.10 | 1.50 | 2.80 | 3.60 | 4.20 | 5.50 | 5.50 | 2.55 | 1.56 | 3160 |
| DIV_US | 1.49 | 11.86 | 26.90 | 33.26 | 38.57 | 44.72 | 53.20 | 68.60 | 214.61 | 39.26 | 11.06 | 10171 |
| DIV_EU | 1.07 | 8.85 | 24.63 | 30.87 | 39.55 | 50.31 | 60.06 | 117.67 | 808.19 | 42.30 | 24.59 | 2770 |
| libor_OIS | 0.04 | 0.04 | 0.08 | 0.09 | 0.12 | 0.38 | 0.87 | 2.39 | 2.39 | 0.33 | 0.45 | 16502 |
| euribor_OIS | 0.04 | 0.04 | 0.05 | 0.06 | 0.07 | 0.45 | 0.79 | 1.86 | 1.86 | 0.29 | 0.37 | 3160 |
| Fsize_US | 0.02 | 0.02 | 0.10 | 0.27 | 0.57 | 1.17 | 2.49 | 10.62 | 37.31 | 2.34 | 2.05 | 16502 |
| Fsize_EU | 0.01 | 0.01 | 0.13 | 0.29 | 0.63 | 1.56 | 2.86 | 13.54 | 29.32 | 1.96 | 1.73 | 3160 |

Source: Author's elaborations

**Table 1c: Variables, unit of measurement and explanation**

| | | |
|---|---|---|
| *Mkt_Beta* | Percentage | Difference between market index weighted performances and the risk free rate |
| *Exc_ret* | Percentage | Difference between fund returns and the risk free rate |
| *Fcorr* | Percentage | Correlation between funds' returns |
| *Sist_risk* | Percentage | Correlation between funds' returns performing below the average value |
| *Return_WI* | Percentage | Market Weighted Index performance based on the Return Based Style Analysis |
| *Cpi* | Percentage | Consumer Price Index (US market) |
| *Hicp* | Percentage | Harmonized Index of Consumer Prices (EU market) |
| *DIV* | Percentage | Diversification index obtained by the sum of the square differences between portfolio composition (in terms of asset allocation) and a portfolio equally diversified |
| *libor_OIS* | Percentage | Libor-OIS monthly spread |
| *euribor_OIS* | Percentage | Euribor-OIS monthly spread |
| *Fsize* | Billion of dollars | Fund Size |

Source: Author's elaborations

**Table 2: CAPM model (U.S. market)**

| | | | | | |
|---|---|---|---|---|---|
| Mkt_Beta_US | 1.174*** | 1.177*** | 1.178*** | 1.150*** | 1.147*** |
| | (148.00) | (141.25) | (140.85) | (128.89) | (126.16) |
| Syst_Risk | -0.395*** | -0.366*** | -0.361*** | -0.260*** | -0.264*** |
| | (5.01) | (4.51) | (4.44) | (3.17) | (3.22) |
| DIV_US | | 0.046*** | 0.044*** | 0.047*** | 0.047*** |
| | | (3.22) | (3.09) | (3.31) | (3.31) |
| Dummy 2007 | | | 0.009** | | |
| | | | (2.01) | | |
| Dummy 2008 | | | | -0.039*** | -0.038*** |
| | | | | (8.10) | (7.92) |
| Dummy 2009 | | | | | 0.008 |
| | | | | | (1.61) |
| Constant | 0.016*** | -0.003 | -0.003 | 0.003 | 0.002 |
| | (10.73) | (0.44) | (0.55) | (0.50) | (0.32) |
| Observations | 11225 | 10171 | 10171 | 10171 | 10171 |
| R-squared | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 |

Absolute value of t statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%
Source: Author’s elaborations

**Table 3: CAPM model (EU market)**

| | | | | | |
|---|---|---|---|---|---|
| Mkt_Beta_EU | 0.882*** | 0.876*** | 0.875*** | 0.861*** | 0.841*** |
| | (49.98) | (47.13) | (46.93) | (41.56) | (40.17) |
| Syst_Risk | -0.352* | -0.383* | -0.388** | -0.333* | -0.354* |
| | (1.83) | (1.95) | (1.97) | (1.68) | (1.79) |
| DIV_EU | | 0.026*** | 0.026*** | 0.028*** | 0.024*** |
| | | (2.12) | (2.11) | (2.23) | (1.95) |
| Dummy 2007 | | | -0.006 | | |
| | | | (0.67) | | |
| Dummy 2008 | | | | -0.018* | -0.010 |
| | | | | (1.69) | (0.89) |
| Dummy 2009 | | | | | 0.051*** |
| | | | | | (5.29) |
| Constant | -0.002 | -0.015** | -0.014** | -0.012* | -0.023*** |
| | (0.56) | (2.32) | (2.05) | (1.84) | (3.24) |
| Observations | 3160 | 2770 | 2770 | 2770 | 2770 |
| R-squared | 0.45 | 0.45 | 0.45 | 0.45 | 0.46 |

Absolute value of t statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%
Source: Author’s elaborations

**Table 4: Simultaneous equations model (U.S. market)**

| | | | | |
|---|---|---|---|---|
| | ***First equation: Dependent variable = Market Beta*** | | | |
| Systemic Risk | -0.003*** | -0.004*** | -0.001*** | -0.001*** |
| | (8.46) | (7.67) | (10.35) | (14.49) |
| Fcorr_US | -0.069*** | -0.023*** | -0.029*** | -0.076*** |
| | (7.91) | (2.77) | (10.93) | (20.31) |
| Dummy 2008 | 0.187*** | 0.276*** | 0.052*** | 0.027** |
| | (4.90) | (10.10) | (5.81) | (2.53) |
| Cpi growth rate | -0.031*** | | | |
| | (7.22) | | | |
| Spread Libor-OIS | | -0.072** | -0.156*** | |
| | | (2.31) | (22.43) | |
| Dummy 2009 | | 0.174*** | 0.169*** | 0.150*** |
| | | (8.54) | (27.60) | (19.14) |
| Constant | 0.136*** | 0.042*** | 0.052*** | 0.034*** |
| | (11.11) | (4.83) | (20.53) | (11.23) |
| | ***Second Equation: Dep. Var. = Systemic Risk*** | | | |
| Fcorr_US | 16.419*** | | | 37.284** |
| | (4.94) | | | (2.49) |
| DIV_US | 0.029* | 0. 030* | 0.065* | 0.029* |
| | (1.27) | (1.18) | (0.73) | (1.56) |
| Market Beta | -1.286*** | -1.431*** | -1.882*** | -1.688*** |
| | (4.86) | (5.26) | (7.23) | (3.70) |
| Dummy 2008 | 49.519*** | 71.096*** | 38.621*** | 79.826*** |
| | (6.36) | (7.37) | (5.97) | (2.62) |
| Spread Libor-OIS | 36.970*** | | | 38.436*** |
| | (4.95) | | | (4.56) |
| Dummy 2007 | | 5.180*** | | |
| | | (3.43) | | |
| Dummy 2009 | | 45.340*** | 117.786*** | |
| | | (5.65) | (16.25) | |
| Cpi growth rate | | 5.951*** | 28.373*** | 94.066*** |
| | | (2.86) | (15.82) | (4.06) |
| Found Size | | | 7.938*** | 12.238*** |
| | | | (9.39) | (9.68) |
| Constant | -2.464 | -15.204** | -88.685*** | - |
| | (0.75) | (2.43) | (11.46) | (4.13) |
| Observations | 10168 | 10168 | 10168 | 10168 |
| R-Square | 0.141 | 0.153 | 0.156 | 0.147 |

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

**Table 5: Simultaneous equations model (European market)**

| | | | | |
|---|---|---|---|---|
| | ***First equation: Dependent variable = Market Beta*** | | | |
| Systemic Risk | -1.481* | -1.754* | -0.909*** | -2.909* |
| | (1.64) | (1.44) | (2.71) | (1.19) |
| Fcorr_EU | -0.117* | -0.133* | -0.311*** | -0.04*** |
| | (1.65) | (11.61) | (2.78) | (1.18) |
| Dummy 2008 | 0.205*** | 0.074*** | 0.087*** | 0.196*** |
| | (12.95) | (12.11) | (4.05) | (4.92) |
| HICP growth rate | -0.024*** | | -0.025*** | |
| | (7.55) | | (7.30) | |
| Constant | 0.189*** | 0.051*** | 0.108*** | 0.047*** |
| | (3.99) | (0.78) | (14.73) | (6.13) |
| | ***Second equation: Dependent variable = Systemic risk*** | | | |
| Fcorr_EU | 0.079*** | 0.076*** | 2.311*** | 0.246 |
| | (12.06) | (1.40) | (2.78) | (9.83) |
| DIV_EU | 0.003* | 0.015* | 0.008* | 0.002* |
| | (1.26) | (0.35) | (0.37) | (0.12) |
| Beta_EU | -0.241*** | -0.241*** | | -0.231*** |
| | (5.47) | (3.75) | | (3.77) |
| Dummy 2007 | 0.007* | 0.012* | | |
| | (0.96) | (1.42) | | |
| Dummy 2008 | 0.106*** | 0.209*** | -0.217*** | 0.057*** |
| | (9.65) | (6.03) | (4.77) | (5.31) |
| EU spread | 0.062*** | 0.038*** | 0.063*** | 0.018* |
| | (6.42) | (3.25) | (3.24) | (1.40) |
| Dummy 2009 | | 0.058*** | | 0.044 |
| | | (3.75) | | (1.20) |
| Exc return EU | | | -0.137*** | |
| | | | (32.11) | |
| Found Size | | | | -0.000 |
| | | | | (0.04) |
| Constant | -0.052*** | -0.051 | -0.373*** | -0.115 |
| | (9.45) | (7.06) | (4.17) | (0.89) |
| Observations | 4484 | 4484 | 4484 | 4484 |
| R-Square | 0.112 | 0.116 | 0.123 | 0.119 |

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

## Bibliography


Acharya, V., I. Hasan, and A. Saunders. "Should banks be diversified? Evidence from individual bank loan portfolios". *Journal of Business*, 79(3):1355-1412, (2006).

Acharya, V., Pedersen, L., Heje, P.T., and Richardson, M. P., "Measuring Systemic Risk", *FRB of Cleveland Working Paper No. 10-02*. Available at SSRN: http://ssrn.com/abstract=1595075 (2010).

Adrian, T., and Brunnermeier, M, K., "CoVaR", *FRB of New York Staff Report No. 348*. Available at SSRN: http://ssrn.com/abstract=1269446 (2009).

Allen, F., Gale, D., "Financial contagion", *Journal of Political Economy*, (2000) 108, 1 - 33.

Allen, F., and Gale, D., "Systemic risk and regulation". *Wharton Financial Institutions Center Working Paper No. 95-24*, (2005).

Allen, F., Babus, A., Carletti, E., "Financial Connections and Systemic Risk" European University Institute (EUI) Working Papers, ECO 2010/30 (2010).

Baele, L., De Jonghe, O., and Vennet, R. V., "Does the stock market value bank diversification?" Journal of Banking and Finance, 31, (2007).

Bartram, S. M., Brown, G. W., and Hund J. E. "Estimating Systemic Risk in the International Financial System", *FDIC Center for Financial Research Working Paper* No. (2005).

Bartholomew, P., and Whalen, G., "Fundamentals of Systemic Risk" In *Research in Financial Services: Banking, Financial Markets, and Systemic Risk, vol.7, edited by George G. Kaufman, 3 – 17.* Greenwhich, Conn.: JAI (1995).

Berger, N., Demsetz, R., and Strahan, E., "The consolidation of financial services industry: Causes, consequences, and implications for the future". *Journal of Banking and Finance*, (23) pp. 135-194, (1999).

Bhansali, V., Gingrich, R., and Longstaff, F., "Systemic Credit Risk: What is the Market Telling Us?", *Financial Analysts Journal* 64, (4) pp. 16–24 (2008).

Bordo, D., Mizrach, M.B., and J. Schwartz, A. "Real versus pseudo-international systemic risk: Some lessons from history". *Review of Pacific Basin Financial Markets and Policies*, (1) pp. 31-58 (1998).

Campa, J.M., and Kedia S., "Explaining the diversification discount". *Journal of Finance*, 57 pp. 1731-1762, (2002).

Capuano, C., "The option-ipod. The probability of default implied by option prices based on entropy". *IMF Working Paper* 08/194, 2008.

Cebenoyan S., Strahan P.E., "Risk management, capital structure and lending at banks".

*Journal of  Banking and Finance* (28) pp.19 – 43 (2004).

Chan-Lau, J. A., Mathieson, D. J., and Yao, J.Y., "Extreme contagion in equity markets". *IMF staff  paper*, 51(2) pp. 386-408 (2004).

De Young, R., and Roland, K.R.,  "Product mix and earnings volatility at commercial banks: Evidence from a degree of total leverage model". *Journal of Financial Intermediation*, 10 pp. 54-84, (2001).

De Vries, G.C., "Systemic risk & diversification across Euroepan banks and issuers", *Beyond the financial crisis: systemic risk, spill over and regulation*, (2010).

De Vries, G.C., Hartmann, P., and Straetmans, S., "Asset market linkages in crisis periods". *C.E.P.R. Discussion Papers*, (2001).

De Vries, C, G., "The simple economics of bank fragility". *Journal of Banking and Finance*, 29(4) pp. 803-825, (2005).

De Nicolo, G., Kwast, M.L., "Systemic Risk and Financial Consolidation: Are They Related?" *Journal of Banking and Finance*, Volume 26, Number 5, pp. 861-880 (2002)

De Nicolo, G., and Lucchetta, M., "Systemic Risk and the Macroeconomy," *FRB NBER Research Conference on Quantifying Systemic Risk* (2009).

De Bandt, O. and Hartmann P., "Systemic Risk: A Survey" Nov. *European Central Bank* (2000).

Dow. J., "What is systemic risk? moral hazard, initial shocks, and Propagation". *Monetary and Economic Studies*, pp 1-24, (2000).

Estrella, A., "Securitization and the Efficacy of Monetary Policy". *Economic Policy Review*, Vol. 8, No. 1. Available at SSRN: http://ssrn.com/abstract=831926 (2002).

Fama, E, F., French, K.R., "The Capital Asset Pricing Model: Theory and Evidence", *Journal of Economic Perspectives* (2004), pp 25-46, N.3 (18).

Federal Reserve System Board of Governors. Technical report. n.2, (2001).

Freixas, X., Lòrànth, G.,  and Morrison, A., "Regulating financial conglomerates". *Oxford Financial Research Center Working Paper* no. 2005-FE-03, (2005).

Froot, K. A., & Stein, J. C., "Risk management, capital budgeting, and capital structure policy for financial institutions: an integrated approach" *Journal of Financial Economics*, Elsevier, vol. 47 (1), pp. 55-82, (1998).

Giesecke, K., and Bacho, K., "Risk Analysis of Collateralized Debt Obligations", Working Paper (Palo Alto, California: Stanford University) Available at: www.stanford.edu/dept/MSandE/people/faculty/giesecke/riskanalysis.pdf (2009).

Gonzlez-Hermosillo, B., Pazarbasioglu, C., and Billings, R., "Banking System Fragility:

Likelihood Versus Timing of Failure. An Application to the Mexican Financial Crisis," *IMF staff paper* 44,3, 295–314 (1997).

Gonzalez-Hermosillo, B., "Determinants of Ex-ante Banking System Distress: A Macro-Micro Empirical Exploration of Some Recent Episodes" *IMF Working Paper*, WP/99/33 (1999).

Goodhart, C., and Segoviano, M., "Banking Stability Measures", *IMF Working Paper* (2009).

Gorton, G., "Banking Panics and Business Cycles," *Oxford Economic Papers*, 40, 751–781 (1998).

Greenspan, A., "Remarks at a conference on risk measurement and systemic risk". *Board of Governors of the Federal Reserve System*, Washington, D.C., 1995.

Group of Ten (G-10). "Report on consolidation in the financial sector". Basel, (2001).

Grossman, S. R., "The shoe that didn't drop: Explaning banking stability during the great depression". *Journal of Economic History*, 54(3) pp. 654-692, (1994).

Hirtle, J., and Stiroh, K.J., The return to retail and the performance of US banks. *Journal of Banking and Finance*, (21) 1101-1133, (2007).

Huang, X., Zhou, H., and Zhu, H., "Assessing the Systemic Risk of a Heterogeneous Portfolio of Banks during the Recent Financial Crisis". 22nd Australasian Finance and Banking Conference 2009, Available at SSRN: http://ssrn.com/abstract=1459946 (2010).

Kambhu, J., Schuermann, T., Stiroh, K.J., "Hedge Funds, Financial Intermediation, and Systemic Risk", *Federal Reserve Bank of New York Staff Reports no. 291* (2007).

Kaufman, G.,"Comment on systemic risk". *Research in Financial Services*, (1995).

Kaufman, G. G., and Scott, K. E., "What is Systemic Risk and Do Bank Regulators Retard or Contribute to it?", *Independent Review* 7, 371-391 (2003).

IMF, "Responding to the financial crisis and measuring systemic risk". *Technical report, International Monetary Fund*, (2009).

Lehar, A., "Measuring systemic risk: A risk management approach*" Journal of Banking and Finance* (2005).

Lo, W. A., "Hedge Funds, Systemic Risk, and the Financial Crisis of 2007-2008", *Written testimony prepared for the U.S House of Representatives Committee on Oversight and Government Reform*. Hearing on Hedge Funds (2008).

Longin, F., and Solnik, B., "Extreme correlation of international equity markets". *Journal of Finance*, 56(2): 649-676 (2001).

Kihlstrom, R., Romer, D., and Williams, S., "Risk Aversion with Random Initial Wealth", *Econometrica* (49) pp. 911-20 (1981).

Masera, R., Maino, R., Mazzoli, G., "Reform of the Risk Capital Standard (RCS) and

Systemically Important Financial Institutions (SIFIs)" in *Reform of the Risk Capital Standard (Rcs) and Systemically Important Financial Institutions (SIFIs),* Bancaria Editrice (2010).

Mishkin, F., (1995) "Comment on systemic risk", in G. Kaufman ed. *Research in Financial Services Private and Public Policy: Banking, Financial Markets and Systemic Risk. Greenwich, Connecticut: JAI Press Inc., 7*, pages 31-45 (1995).

Reichart, A.K., and Wall, L. D. "The potential for portfolio diversification in financial services". *Federal Reserve Bank of Atlanta Economic Review*, Third Quarter:31-51, (2000).

Rodriguez-Moreno, M., and Pena Sanchez de Rivera, J.I., "Systemic risk measures: the simpler the better". *Open Access publications from Universidad Carlos III de Madrid*., (2010).

Sanya, S., and Wolfe, S., "Can banks in emerging economies benefit from revenue diversification". *Journal of Financial Services Resources* (2010).

Stiroh, K., and Rumble, A., "The dark side of diversification: The case of us financial holding companies". *Journal of Banking and Finance*, 30 - 2132-2161, (2006).

Stiroh, K.J., "Do community banks benefit from diversification?" *Journal of Financial Services Resources*, 25 pp. 135-160, (2004).

Stiroh, K.J., "A portfolio view of banking with interest and noninterest activities". *Journal of Money Credit Bank*, 38(5): pp. 1351–1361, (2006).

Wagner, W., "Diversification at financial institutions and systemic crises". *Journal of Financial Intermendiation*, (19) pp. 373-386 (2009).

Wheelock, D.C., "Regulation, market structure, and the bank failures of the great depression". *Federal Reserve Bank of Saint Louis Review*, 27-38, (1995).