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Opacity, Risk, Performance and Inflows in Hedge Funds

Opacidade, Risco, Performance e Captação em Fundos Multimercados

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Resumo

O presente artigo avalia a relação entre ativos opacos e o risco, retorno e captação dos fundos multimercados. Em particular, empregou-se uma base de dados considerada única, por conter informações requeridas pelo órgão regulador brasileiro para avaliar o montante investido pelos fundos em contratos a termo, contratos futuros, swaps e opções. Foram considerados fundos direcionados tanto para investidores qualificados quanto não qualificados. Nossos resultados apontam para associação positiva entre derivativos e a variação do risco, mas negativa para a relação entre derivativos (especialmente swaps) e as medidas de desempenho mensais desses fundos. Dessa forma, o uso de derivativos esteve relacionado a um incremento de risco dos fundos (total e sistemático) sem necessariamente estar vinculado ao benefício de um maior retorno. Observou-se também que fundos multimercados que adotam operações de alavancagem com derivativos apresentam, no geral, uma menor medida de performance anual. Adicionalmente, existe evidencia de que swaps estão relacionados a captação do fundo de forma negativa (independentemente desses fundos serem direcionados a investidores qualificados ou não qualificados).

Palavras-chave: derivativos; fundos multimercados; opacidade.

Abstract

This article analyzes the relationship between opaque assets and the risks, returns and inflows of hedge funds. In particular, we use a unique dataset containing information required by a Brazilian regulator to evaluate the amount invested by funds in forward and future contracts, swaps and options in the context of qualified and non-qualified investors. Our results show a positive association between the positions in derivatives and the variations in risk and a negative association between derivatives (especially swaps) and the funds’ monthly performances. This means that the use of more derivatives is related to higher risk (total and systematic) without the benefit of higher return. Hedge funds adopting leveraged operations with derivatives also present a lower annual performance. In general, there is significant evidence that swaps are related to fund inflows in a negative way with regard to qualified and non-qualified investors.

Keywords: derivative; hedge fund; opacity.

JEL Code: G23, G20, G19.

Introduction

Opacity represents a strategy employed by agents to exploit less informed investors. An asset can be considered opaque if the information about its return volatility is incomprehensible and inaccessible for the majority of retail investors. This phenomenon is a consequence of the investor's inability to clearly visualize the portfolio's composition, which makes the understanding of the pricing of complex assets more difficult (Sato, 2014).

Brunnermeier & Oehmke (2009) defined opaque assets as those that are composed of complex cash flow structures that are difficult for investors to understand and predict, especially when the return is a function of a variety of underlying assets. In this context, derivatives are seen as complex financial tools due to their payout composition, the large quantity negotiated, the need for precise models to evaluate this market, and their low transparency level (Arora, Barak, Brunnermeier, & Ge, 2011). In line with this literature, it is reasonable to assume that when managers raise funds' holdings in derivatives, they increase the opacity level of their funds.

Opacity has attracted increasing interest in mainstream academics. A few studies have conceptually explored the opacity and the complexity of financial products (e.g., Célérier & Vallée, 2013; Brunnermeier & Oehmke, 2009; Sato, 2014). Recently, Blau, Brough and Griffith (2017) showed that the level of the inefficiency of financial companies' stock prices is higher than those of non-financial institutions. Thus, banks are considered the firms with the highest level of opacity because their balance sheets are composed of many complex assets and they have a low level of disclosure. Although the volume of banking opacity literature is increasing, no empirical study has yet been conducted in the investment fund (IF) context. One of the challenges to empirical analyses in this area is the lack of data. This constraint results from the low level of disclosure required by hedge fund regulators in certain countries, such as the U.K. and the U.S.

We contribute to the existing literature by empirically investigating the association between opacity (considered as any position in derivatives) and other relevant aspects regarding hedge funds, such as risk, performance and fund inflows. Furthermore, we compare two segments with distinct levels of information (qualified and retail investors). We innovate by using a more complete database related to the positions in derivatives taken by managers. Due to regulatory demands, Brazil has a unique data set on hedge funds' portfolio allocation. These data are compulsorily provided on a monthly basis by all hedge funds and are used in this research. Our sample is composed of monthly data on 727 Brazilian hedge funds from 2010 to 2015. Although Koski and Pontiff (1999) considered the impact of investments on options, futures and securities interest rates on funds' profitability and volatility, their data were collected through telephone interviews from December 1994 to June 1995. As a proxy to derivatives investments, Chen (2011) considered dummies that differentiated the group of users and non-users and the types of derivatives employed. Frino, Lepone and Wong (2009) and Cici and Palacios (2015) restricted their studies to the markets of the future stock index and options. In contrast, all the analyses conducted in our study are supported by a database that allows us to explore different positions in derivative markets.

This paper is composed of five sections. In addition to this introduction, the second section contains the theoretical background supporting our study. The sample and the models used in our analyses are described in the third section. In the fourth section, we present and discuss our empirical results. The fifth section concludes.

Opacity in the Context of Hedge Funds

A risk asset is opaque if its return realization could not be directly observed by investors (either because it is not published, or its formula is not clearly understood by shareholders). Thus, in this market of opaque assets, there is typical information asymmetry, provided that managers know the asset's return realization. Comparatively, in opaque funds, shareholders do not visualize the present asset return or the portfolio formed by managers, especially the amount not published that is related to risk asset purchases (Sato, 2014).

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According to Easley, O'hara and Yang (2014), hedge funds have a low portfolio disclosure level in the US, even with regulatory supervision (the *Security and Exchange Commission,* SEC). Only American funds with more than US$1 billion in net worth are required to present quarterly reports describing their operations and portfolio positions. However, this information is not disclosed to the general public. This low level of disclosure is justified by managers as a means to avoid the loss of competitive advantages since, during the portfolio release, this content would be easily accessed by competitors, thus interfering with asset purchase and sale operations. If investment funds (IFs) show their asset allocation to the market, other agents could take advantage of the fund's liquidity needs by offering low attractive taxes when managers decide to sell the asset to address outflows (Aragon, Hertzel & Shi, 2013).

With respect to the second component of opacity, Carlin, Kogan and Lowery (2013) indicated that assets' complexity makes it difficult for market participants to forecast the essential inputs required to valuate it. This fact could alter the subject's bidding strategies, decrease the assets liquidity and increase the asset's price volatility. It could also affect the asset's trade efficiency by decreasing it. According to Sato (2014), Célérier and Vallée (2013) and Arora, Barak, Brunnermeier and Ge (2011), managers can increase the opacity level of funds by holding more variable income assets (especially those with complex payout structures), which are more difficult for retail investors to understand (such as derivatives, for instance).

Due to the rapid growth and the deregulation of financial markets, several complex derivatives have been structured to support specific financial goals. Therefore, they do not have analytical formulas for their prices, particularly when there is more than one market variable associated with its payout (Dai, Wang & Lyuu, 2013).

Material and Methods

Sample

Due to regulatory issues, Brazil has a unique data set on the portfolio allocation of hedge funds. This information is (compulsorily) provided monthly by all hedge funds. This monthly reporting standard is not available in other countries with well-developed hedge fund industries, such as the United Kingdom or the United States. The data was retrieved from *Economatica* and *Quantum Axis*, which are locally based private databases. The sample period was from January 2010 (the oldest data available in those databases) to December 2015. We collected monthly information regarding the derivative component of the funds' portfolio composition, the values of the inflows, net assets, and shares and the funds' opening and closing data. The sample involves 727 Brazilian hedge funds (active and inactive) listed with the Brazilian Securities and Exchange Commission (CVM).

As this research's objective is to verify whether there is a relationship between the fund's net worth invested in opaque assets and the levels of risk, adjusted returns and inflows, only open-end funds[1] that were composed of non-exclusive[2] and non-restricted[3] shares were selected. The analysis was conducted on three segments of hedge funds. The first one refers to non-qualified investors that are characterized by investments lower than BRL 1,000,000.00 (approximately US$ 298,000) and no requirement to present a certificate of qualification. The second segment refers to qualified investors characterized by investments greater than BRL 1,000,000.00 and that require a certificate of qualification. The third segment is composed of professional investors whose investments are higher than BRL 10,000,000.00 (approximately US$ 2,980,000) and that require a professional certificate. In accordance with this qualification level, the sample is composed of 59 funds for professional investors (9.05% of the sample), 254 for qualified investors (34.28%) and 414 for retail investors (56.66%).

Sample bias treatment

We address three main biases during the sample selection of hedge funds to avoid the occurrence of spurious correlations throughout the estimation of the empirical models. To address the survivorship bias, active and inactive funds are included in the sample. In addition, since all the information must be compulsorily disclosed in Brazil, the data do not present selection bias.

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The third bias (the multi-sample period) is a consequence of the fact that each hedge fund can show distinct durations. To address it, Eling and Faust (2010) exclude funds with less than 24 months of historical returns. That same procedure was adopted here. From an initial sample of 1045 valid funds, 286 were excluded for having less than 24 months of observations, which left 759 funds for analysis. Of these, 32 were also removed because they were designated to exclusively receive other investment fund applications. Consequently, the final sample was composed of 727 hedge funds.

Since most of our sample (98.89%) is composed of funds that invest in shares of other funds, we adjust all the variables concerning the "percentage invested in derivatives by each fund of fund". In this case, the fund of a fund's net worth percentage used to purchase shares of the invested fund is multiplied by the monthly derivative positions in the portfolio of those invested funds. This result was automatically computed by the Economática Database®.

Procedures to calculate the risk and the percentage of opaque assets in which hedge funds have invested

We consider two measures of risk: the total and the systematic. The systematic risk is measured using the same procedures established in Alexander (2008). In this paper, systematic risk measures the exposition of a fund to the movement of the following risk factors: foreign currency (dollar and euro exchange rates), domestic stock index market returns (Ibovespa return and domestic Carhart (1997) factors), domestic bonds (Ima-geral, Ida-geral), the domestic commodities price index (Icb), the domestic inflation rate (Ipca) and the domestic interest rate ($\text{Cdi-over}_{m,y}$). The description of each one is offered below:

- **Ibovespa**: It is the result of a theoretical portfolio formed by assets of higher negotiability and is representative of the Brazilian stock market (Bm&FBovespa, 2016).

- **Ima-geral**: It is an index created to show the evolution of Brazilian government bonds at market prices. This index has a market coverage of approximately 97%.

- **Ida-geral**: It is an index that shows the evolution (at market prices) of the Brazilian debenture portfolio.

- **Icb**: It is the result of a theoretical portfolio formed by commodities that have future contracts negotiated in the Brazilian market. These commodities include agricultural products, livestock, forestry products, metals and energy (Bm&FBovespa, 2016).

- **Ipca**: It is the Brazilian inflation index used as a reference for economic policy that shows the price evolution of the products and services consumed by families with mensal incomes between 1 and 40 minimum wages.

- **Cdi-over**: the mean of the Interbank Loan Certificate interest rates for lending operations of one day duration.

This set of variables is similar to those explored by Bali, Brown and Caglayan (2011), but it considers their adoption to the Brazilian market, since these funds allocate their resources in one or more securities that are related to these risk factors.

According to the Brazilian regulations, all of the operations involving the negotiation of swaps, options, and forward and future contracts are defined as derivatives. All this information is extracted from the Composition and Diversification Portfolio Document (CDPD). This information is compulsorily and disclosed monthly by all the hedge funds that have been active for more than 90 days.

The percentage of opaque assets purchased by each fund (represented by derivatives) is calculated using two criteria. In the first calculation, this variable is estimated in absolute terms. It is based on the assumption that, regardless of the derivative usage to hedge or its speculative purposes, a higher absolute value results in a greater degree of portfolio opacity.

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However, as stated by Chen (2011), managers can engage in multiple operations using derivatives with the intention of hedging the fund's net worth against market risks by acting on a long or short position. Consequently, the net values obtained by the interaction of both strategies expresses how much managers invest in derivatives with the real intention of increasing the fund's risk. To model this behavior, we adopt a second criterion that uses only net values computed as the difference of the amount invested in buyers and sellers' positions in swaps, options, and future and forward contracts.

Models

The models investigate the potential associations between the opacity in hedge funds (*proxied* by the ratio of derivatives in their portfolios) and each of the four following factors (used as dependent variables): the risk of the portfolios (Model 1:M-1 and Model 2: M-2), their monthly returns (Model 3: M-3), their inflows (Model 4: M-4) and their annual performance (Model 5: M-5).

- M-1 and M-2 test whether the risk levels of hedge funds vary with the use of opaque assets (derivatives).

Based on the models proposed by Chen (2011) and Opazo, Raddatz and Schmukler (2015), the following equations characterize Models 1 and 2:

$$\frac{\sigma_{total\ i,m,y}}{\sigma_{total\ i,m-1,y}} = \beta_1\sigma_{total\ i,m-1,y} + \beta_2 Dperf_i + \beta_3 Dmang_i + \beta_4 r_{i,m,y} + \beta_5 r_{i,m-1,y} + \beta_6 \sum_{l=0}^{1} \Delta Futc_{i,m-l,y} + \beta_7 \sum_{l=0}^{1} \Delta Forwc_{i,m-l,y} + \beta_8 \sum_{l=0}^{1} \Delta Opt_{i,m-l,y} + \beta_9 \sum_{l=0}^{1} \Delta Swap_{i,m-l,y} + \beta_{10} Dleverg_i + \beta_{11} Size_{i,m,y} + \beta_{12} Age_{i,m,y} + \sum_{k=13}^{26} Rf_{i,m,y} + \beta_{27} Dcat_i + \beta_{28} Dyear_i + \epsilon_{i,m,y}$$

M-1

$$\frac{\sigma_{systematic\ i,m,y}}{\sigma_{systematic\ i,m-1,y}} = \beta_1\sigma_{systematic\ i,m-1,y} + \beta_2 Dperf_i + \beta_3 Dmang_i + \beta_4 r_{i,m,y} + \beta_5 r_{i,m-1,y} + \beta_6 \sum_{l=0}^{1} \Delta Futc_{i,m-l,y} + \beta_7 \sum_{l=0}^{1} \Delta Forwc_{i,m-l,y} + \beta_8 \sum_{l=0}^{1} \Delta Opt_{i,m-l,y} + \beta_9 \sum_{l=0}^{1} \Delta Swap_{i,m-l,y} + \beta_{10} Dleverg_i + \beta_{11} Size_{i,m,y} + \beta_{12} Age_{i,m,y} + \sum_{k=13}^{26} Rf_{i,m,y} + \beta_{27} Dcat_i + \beta_{28} Dyear_i + \epsilon_{i,m,y}$$

M-2

where:

$\frac{\sigma_{total\ i,m,y}}{\sigma_{total\ i,m-1,y}}$= variation of the fund's *i* monthly total risk, in month *m* and year *y* (Chen, 2011). This variable is calculated as:

$$\sigma_{total\ i,m,y} = \sqrt{\frac{1}{n-1}\sum_{d=1}^{n}\left(r_{i,d,m,y} - \bar{r}_{i,m,y}\right)^2} \times \sqrt{21} \quad (1)$$

The variable $r_{i,d,m,y}$ represents the return of fund *i* on day *d*, month *m* and year *y*, while $\bar{r}_{i,m,y}$ characterizes the daily mean return of fund *i* in month *m* and year *y*. We consider 21 working days in each month.

$\frac{\sigma_{systematic\ i,m,y}}{\sigma_{systematic\ i,m-1,y}}$= variation of the fund's *i* monthly systematic risk for month *m* and year *y* (as suggested by Chen, 2011).

$Dperf_i$= dummy variable that refers to performance taxes. It takes a value of 0 for funds that do not charge them and 1 otherwise.

$Dmang_i$= dummy variable that refers to the type of relationship between the fund's administrator and manager. If both belong to the same financial group, its value will be 0; otherwise, the value is 1. This relationship may affect the risk level variation since the risk of the fund may increase when the administrator does not directly supervise managers.

$\Delta Futc_{i,m,y}$ = Variation of the monthly percentage invested in future contracts by fund *i* in month *m* for year *y*, where $\Delta Futc_{i,m,y} = Futc_{i,m,y} - Futc_{i,m-1,y}$.

$\Delta Forwc_{i,m,y}$ = Variation of the monthly percentage invested in forward contracts by fund *i* in month *m* for year *y*, where $\Delta Forwc_{i,m,y} = Forwc_{i,m,y} - Forwc_{i,m-1,y}$.

$\Delta Opt_{i,m,y}$ = Variation of the monthly percentage invested in option by fund *i* in month *m* for year *y*, where $\Delta Opt_{i,m,y} = Opt_{i,m,y} - Opt_{i,m-1,y}$.

$\Delta Swap_{i,m,y}$ =Variation of the monthly percentage invested in swaps by fund *i* in month *m* for year *y*, where $\Delta Swap_{i,m,y} = Swap_{i,m,y} - Swap_{i,m-1,y}$.

$r_{i,m,y}$ = monthly percentage return obtained for each fund *i* in month *m* and year *y*.

$Dleverg_i$= dummy variable that is equal to 1 if fund *i* is allowed to adopt leverage strategies and 0 otherwise.

$Size_{i,m,y}$ = natural logarithm of the fund's net worth in month *m* for year *y*.

$Age_{i,m,y}$ = natural logarithm of the difference between the current date (or the liquidation date if the fund closes before the end of the sample) and the fund's opening date.

$Ducat_i$ = dummy variables representing each of the three Brazilian Association of Financial and Capital Market Entities (ANBIMA) classifications of funds, such as "Strategy" ($Dcat1_i$), "Allocation" ($Dcat2_i$) and "Investment abroad" ($Dcat3_i$). The "Strategy" classification includes funds in which the operations follow the strategies selected by the managers. All of them are allowed to adopt leverage strategies. The "Allocation" classification encompasses funds directed to long-term returns. Some of them can engage in leverage operations. The "Investment abroad" classification considers funds that invest more than 40% of their net worth in assets negotiated abroad. All of them are allowed to conduct leverage operations.

$Dyear_i$ = dummy variables representing each year. This variable is included to capture potentially significant annual fixed effects.

In terms of "risk factors" (i.e., the $Rf_{i,m,y}$ variable), the following variables are considered (in monthly periods), in accordance with Bali et al. (2011) and Fung and Hsieh (2001): stocks ($Ibrx\text{-}100_{m,y}$[4], $Ibovespa_{m,y}$ and Carhart (1997) factors), government bonds ($Ima\text{-}geral_{m,y}$), corporate bonds ($Ida\text{-}geral_{m,y}$), domestic interest rates ($Cdi\text{-}over_{m,y}$; $Selic\text{-}over_{m,y}$[5]), foreign currency (dollar ($Dol_{m,y}$) and euro ($Eur_{m,y}$) exchange rates), commodities prices ($Icb_{m,y}$), and inflation ($Ipca_{m,y}$).

- (M-3) tests whether investments in derivatives are related to monthly adjusted returns.

Does the strategy of increasing the fund risk really raise the shareholder's adjusted return? Since the Sharpe ratio indicates the excess of return offered by the fund by adjusting it to the incurred risk level, this ratio is selected as another response variable. However, Koenig (2004) notes that the dynamics of asset prices are modeled under the assumption that the logarithm of returns is normally distributed. Nonetheless, there is empirical evidence that these return distributions present the results in a denser manner than the normal distribution and are often asymmetric. This result can be observed in the hedge fund context mainly because these funds can negotiate nonlinear payoff assets, such as options. Consequently, we employ the adjusted Sharpe ratio, as described in Koenig (2004).

Model (M-3) can be presented as follows based on Soydemir, Smolarski and Shin (2014):

$$Dasr_{i,m,y} = \beta_1 Dasr_{i,m-1,y} + \beta_2 Dperf_i + \beta_3 Dmang_i + \beta_4 r_{i,m-1,y} + \beta_5 \sum_{l=0}^{1} \Delta Futc_{i,m-l,y} + \beta_6 \sum_{l=0}^{1} \Delta Forwc_{i,m-l,y} + \beta_7 \sum_{l=0}^{1} \Delta Opt_{i,m-l,y} + \beta_8 \sum_{l=0}^{1} \Delta Swap_{i,m-l,y} + \beta_9 Dleverg_i + \beta_{10} Size_{i,m,y} + \beta_{11} Size2_{i,m,y} + \beta_{12} Age_{i,m,y} + \beta_{13} Smb_{i,m,y} + \beta_{14} Hml_{i,m,y} + \beta_{15} Wml_{i,m,y} + \beta_{16} Premiun_{i,m,y} + \beta_{17} Mang_{\text{Fee}\, i} + \sum_{k=18}^{31} Rf_{i,m,y} + \beta_{32} Dcat_i + \beta_{33} \text{D}year_i + \epsilon_{i,m,y}$$

M-3

The additional variables included in M-3 are:

$Dasr_{i,m,y}$ = the difference between the Sharpe Adjusted Ratio for month *m* and *m-1* for fund *i* in year *y*.

$Size_{2\ i,m,y}$= the inverse of the natural logarithm of the value of fund assets in month *m* and year *y*.

$Mang_{Feei}$ = management fee charged by fund *i* (percentage of net worth).

$Smb_{i,m,y}$ = return of the low market capitalization stock portfolio minus the return of the high market capitalization stock portfolio for fund *i* in month *m* and year *y*.

$Premium_{i,m,y}$ = return of the stock market portfolio (Ibovespa) minus the return of the risk-free asset (Cdi-over) for fund *i* in month *m* and year *y*.

$Hml_{i,m,y}$ = return of a stock portfolio with a high ratio of accounting value / market value minus the return of a stock portfolio with a low ratio of accounting value / market value for each fund *i* in month *m* and year *y*.

$Wml_{i,m,y}$ = return of a winner stock portfolio less the return of a loser stock portfolio for fund *i* in month *m* and year *y*.

The "risk factors" ($Rf_{i,m,y}$ variable) are the same as those expressed in Model 1 (M-1) and Model 2 (M-2).

· M-4 tests whether investments in derivatives are related to net flows in hedge funds.

Model 4 (M-4) was proposed based on factors extracted from Sirri and Tufano (1998), Cashman, Nardari, Deli and Villupuram (2014) and Berggrun and Lizarzaburu (2015):

$$\Delta Inflows_{i,m,y} = \beta_1 \Delta Inflows_{i,m-1,y} + \beta_2 Size_{i,m-1,y} + \beta_3 Age_{i,m,y} + \beta_4 Mang_{\text{Fee}\, i} + \beta_5 Volret_{i,m-1,y} + \beta_6 r_{i,m-1,y} + \beta_7 r^2_{i,m-1,y} + \beta_8 \sum_{l=0}^{1} \Delta Futc_{i,m-l,y} + \beta_9 \sum_{l=0}^{1} \Delta Forwc_{i,m-l,y} + \beta_{10} \sum_{l=0}^{1} \Delta Opt_{i,m-l,y} + \beta_{11} \sum_{l=0}^{1} \Delta Swap_{i,m-l,y} + \beta_{12} Dleverg_i + \sum_{k=13}^{26} RF_{i,m,y} + \beta_{27} Dcat_i + \beta_{28} Dyear_i + \epsilon_{i,m,y}$$

M-4

The additional factors are presented below:

$\Delta Inflows_{\ i,m,y}$ = monthly inflow variation of fund *i* in month *m* and year *y*.

$Volret_{i,m-1,y}$= volatility of the funds' daily return multiplied by $\sqrt{21}$ in month *m-1* and year *y*.

$r_{i,m-1,y}$ = monthly percentage return obtained for fund *i* in month *m-1* and year *y*.

$r^2_{\ i,m-1,y}$ = squared monthly percentage return obtained for fund *i* in month *m-1* and year *y*. According to Berggrun and Lizarzaburu (2015), the insertion of this quadratic term enables the analyses of the possible convex relationship between the inflows and the fund performance.

As noted by Sirri and Tufano (1998), the fund flows are historically sensitive to past performance, but such dynamics are not linear. In this asymmetric relation, those with recent superior performance receive more financial resources while those with inferior performance have more outflows.

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The “risk factors” ($Rf_{i,m,y}$ variable) are the same as those expressed in Model 1 (M-1), Model 2 (M-2) and Model 3 (M-3).

· M- 5 tests whether investments in derivatives are related to annual adjusted returns.

Model 5 (M-5) is similar to Model 3 (M-3), but the main difference is that it is on an annual basis:

$$Dasr_{i,y} = \beta_1 Dasr_{i,y-1} + \beta_2 Dperf_i + \beta_3 Dmang_i + \beta_4 cmr_{i,y-1} + \beta_5 \sum_{l=0}^{1} \Delta Futc_{i,y-l} + \beta_6 \sum_{l=0}^{1} \Delta Forwc_{i,y-l} + \beta_7 \sum_{l=0}^{1} \Delta Opt_{i,y-l} + \beta_8 \sum_{l=0}^{1} \Delta Swap_{i,y-l} + \beta_9 Dleverg_i + \beta_{10} Size_{i,y} + \beta_{11} Size2_{i,y} + \beta_{12} Age_{i,y} + \beta_{13} Smb_{i,y} + \beta_{14} Hml_{i,y} + \beta_{15} Wml_{i,y} + \beta_{16} Premiun_{i,y} + \beta_{17} Mang_{\text{Fee } i} + \sum_{k=18}^{31} RF_{i,y} + \beta_{32} Dcat_i + \beta_{33} Dyear_i + \epsilon_{i,m,y}$$

M-5

where:

$Dasr_{i,y}$= the difference between the adjusted Sharpe ratio between year *y* and *y-1* for fund *i*.

$cmret_{i,y-1}$= annual return of fund *i* in year *y-1*.

$\Delta Futc_{i,y}$ = variation of the mean monthly percentage invested in future contracts by fund *i* in year *y*.

$\Delta Forwc_{i,y}$ = variation of the mean monthly percentage invested in forward contracts by fund *i* in year *y*.

$\Delta Opt_{i,y}$ = variation of the mean monthly percentage invested in options by fund *i* in year *y*.

$\Delta Swap_{i,y}$ = variation of the mean monthly percentage invested in swaps by fund *i* in year *y*.

Before estimating the econometric models, tests related to collinearity, stationarity, fixed effects (Wooldrige test) and endogeneity (Wu-Hausman test) are implemented. Then, all of the equations are calculated using the Generalized Method of Moments (GMM). The GMM estimator can simultaneously address the main problems of endogeneity that are commonly found in research with observational data. According to Blundell and Bond (1998), this method eliminates the fixed effects specific to each unit (in our case, each hedge fund) by using the first difference between the variable and its lagged value[6].

Results

Summary statistics

The summary statistics calculated for the main response variables are detailed in Table 1:

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Table 1

Summary Statistics of Dependent Variables

Investor Type	Variable	Minimum	1st Quartile	Median	Mean	3rd Quartile	Standard Deviation	Maximum
Professional	Monthly Total Risk	0.000442	0.003520	0.006742	0.012871	0.016959	0.014348	0.070795
	Monthly Sistematic Risk	0.0002785	0.002862	0.005502	0.010394	0.013238	0.012073	0.064960
	Monthly Adjusted Sharpe Ratio	-5.03	-0.55	0.18	3.46	0.99	21.47	194.6
	Monthly Inflows (in Thousands of Reais)	0	0	0	3249	298	12686	97269
Qualified	Monthly Total Risk	0.000014	0.001644	0.004853	0.009023	0.009782	0.013787	0.084308
	Monthly Sistematic Risk	0.000008	0.001307	0.003898	0.007606	0.008126	0.011958	0.073888
	Monthly Adjusted Sharpe Ratio	-8.30	-0.71	0.08	2811	1.31	21147	194932
	Monthly Inflows (in Thousands of Reais)	0	0	10	5216	1472	169250	152466
Non-Qualified	Monthly Total Risk	0.000002	0.0030042	0.006374	0.009015	0.012023	0.008747	0.046056
	Monthly Sistematic Risk	0.000072	0.002265	0.005035	0.007510	0.010006	0.007833	0.042461
	Monthly Adjusted Sharpe Ratio	-12.62	-0.88	-0.08	-0.02	0.81	2.56	10.64
	Monthly Inflows (in Thousands of Reais)	0	0	121	4198	1975	11562	74889

Note. This table reports the summary statistics for the dependent variables of Model 1 to 5 according to the investors qualification level.

Referring to the total monthly risk (measured by the standard deviation of daily returns multiplied by $\sqrt{21}$) and the systematic risk, Table 1 shows that, based on the mean and the median, the funds aimed at professional investors are riskier. Conversely, in contrast to the adjusted Sharpe ratio, by observing the quantiles and the mean, one can note that the funds directed to qualified investors offer a higher risk-adjusted return than those offered to the retail public.

Furthermore, funds for non-qualified investors exhibit higher values of inflows (based on the quantiles and the median observation). With respect to the standard deviation, in general, there is a low level of dispersion in the less qualified investors group. The same conclusion can be inferred when the risk and the adjusted Sharpe ratio

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level of dispersion are analyzed. On the other hand, for inflows, a higher dispersion is verified within the qualified investor set.

The summary statistics related to the net worth percentages invested in opaque assets (derivatives) are expressed in Table 2.

Table 2

Summary Statistics of Net Worth Percentage Invested by Hedge Funds in Opaque Assets

Investor level of Qualification	Variable (as a percentage of net Worth)	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
Professional	Future Market-Short Position	-114.70%	-0.10%	0.00%	-0.25%	0.08%	39.40%
	Future Market-Long Position	-27.76%	-0.01%	0.00%	0.65%	0.15%	49.74%
	Call Option –Sellers Position	-55.10%	-0.32%	-0.04%	-0.59%	0.00%	0.00%
	Call Option –Buyers Position	0.00%	0.00%	0.15%	0.65%	0.50%	15.32%
	Put Option –Sellers Position	-3.51%	-0.17%	-0.04%	-0.19%	0.00%	0.00%
	Put Option –Buyers Position	0.00%	0.00%	0.08%	0.34%	0.29%	13.30%
	Swap to pay	-11.81%	-0.12%	-0.01%	-0.20%	0.00%	0.00%
	Swap receivable	0.00%	0.00%	0.02%	0.67%	0.62%	11.28%
	Forward- Purchases receivables	-1.07%	0.00%	0.00%	0.31%	0.07%	61.84%
	Forward - Sales receivables	-2.61%	0.00%	0.00%	0.00%	0.56%	18.12%
Qualified	Future Market-Short Position	-105.10%	-0.02%	0.00%	1.60%	0.11%	359.10%
	Future Market-Long Position	-35.41%	0.00%	0.00%	0.79%	0.09%	177.10%
	Call Option –Sellers Position	-53.79%	-0.33%	-0.06%	-0.51%	0.00%	0.00%
	Call Option –Buyers Position	0.00%	0.00%	0.10%	0.88%	0.58%	71.64%
	Put Option –Sellers Position	-23.88%	-0.15%	-0.03%	-0.23%	0.00%	0.00%
	Put Option –Buyers Position	0.00%	0.00%	0.05%	0.35%	0.28%	33.77%
	Swap to pay	-38.05%	-0.08%	0.00%	-0.28%	0.00%	0.00%
	Swap receivable	0.00%	0.00%	0.00%	0.53%	0.17%	57.32%
	Forward – Purchases receivables	-0.58%	0.00%	0.00%	0.14%	0.00%	17.40%
	Forward - Sales receivables	-3.87%	0.00%	0.00%	1.02%	0.25%	49.62%
Non-Qualified	Future Market-Short Position	-125.40%	-0.05%	0.00%	30.76%	0.07%	186936.00%
	Future Market-Long Position	-53.58%	-0.01%	0.00%	2.31%	0.06%	1865.94%
	Call Option –Sellers Position	-58.24%	-0.18%	-0.01%	-0.46%	0.00%	0.00%
	Call Option –Buyers Position	0.00%	0.00%	0.03%	0.82%	0.35%	75.68%
	Put Option –Sellers Position	-40.64%	-0.10%	0.00%	-0.23%	0.00%	0.00%
	Put Option –Buyers Position	0.00%	0.00%	0.01%	0.34%	0.17%	76.79%
	Swap to pay	-39.86%	-0.07%	0.00%	-0.25%	0.00%	0.00%
	Swap receivable	0.00%	0.00%	0.00%	0.78%	0.06%	50.60%
	Forward – Purchases receivables	-23.13%	0.00%	0.00%	0.17%	0.00%	72.72%
	Forward - Sales receivables	-5.89%	0.00%	0.00%	0.61%	0.00%	60.27%

Note. To treat outliers' presence, as evidenced in Table 2, all the data was winsorized considering extreme values below the 1% percentile and above the 99% percentile. The negative percentages are related to: (i) values to be paid; (ii) negative adjustments of buyers or sellers

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positions; (iii) option sale operations (these transactions are registered with a negative sign in the monthly portfolio balance sheet because, despite leading to cash inflows, they may also result in potential obligations).

As shown in Table 2, net worth percentages vary considerably across the funds. In particular, for the future contract market, positions higher than 100% are allowed since the possibility of leverage is recorded in the funds' legal documentation. The managers of non-retail funds (directed to qualified and professional investors) invest more in derivatives than the other segment. This is inferred through the observation of both the first and third quartiles and the median.

Estimated models

Three sample groups are considered in our analyses: the full sample (727 hedge funds), the subsets of qualified investors (composed of the professional and qualified investors, resulting in 313 IFs) and retail investors (composed of the non-qualified investors, resulting in 414 IFs). This division is proposed because there is evidence (as shown in Table 2) that the use of derivatives occurs more often in the group of non-retail investors. Therefore, restricting our analyses only to the total sample could generate biased conclusions regarding the relationship between the fund's net worth invested in derivatives and the risks, returns and inflows of hedge funds.

The models are run according to two criteria related to the percentage of derivatives invested: assumption 1 (percentage applied in absolute terms) and assumption 2 (percentage applied in net terms). It is worth noting that four variables are involved in each assumption: the variation of the net worth percentages invested in swaps, forward contracts, future contracts and options.

For every model described in the third section, we use the dependent lagged variable as instruments, as suggested by Cameron and Trivedi (2005). They stated that the use of lagged regressors is a formal means of softening the problem of endogeneity if it is reasonable to admit a null correlation between this and the error term. Furthermore, factors that were not initially included in the model but that were considered significant instruments by the Sargan test are also employed such as the economic variables and fund specific variables. In summary, all the independent variables described in the third section could be employed as control variables or as instruments (that is, none of our independent variables is considered pre-determined or endogenous by assumption). An example is given for Model 1 (Absolute ΔDeriv), as reported in Table 3:

Table 3

Description of Model 1- Variation of monthly total risk/ Sample- Total Investors

Variable	Coefficient	p-value
Δ total risk i,m-1,y	-0,3349	0,0000
Δ total risk i,m-2,y	-0,1009	0,0000
Absolute $\Delta Deriv_{i,m,y}$	0,0020	0,0000
$ret_{i,m,y}$	-1,5283	0,0000
Ibrx-$100_{m,y}$	-0,8496	0,0000
dum2010	0,0361	0,0000
dum2011	0,0154	0,0014
dum2014	0,0353	0,0000
$Dol_{m,y}$	0,9096	0,0000
Test	**Statistics**	**p-value**
Sargan test	703,6094	0,3219
1°Autocorrelation Test	-20,2147	0,0000
2°Autocorrelation Test	1,6246	0,1043

Note. Instruments: Dcat1i ; Ima-geral m-1,y ; Ima-geral m-2,y; Δ total risk i,m-3,y; Absolute ΔDerivi,m-1,y ; Absolute ΔDerivi,m-2,y.

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For all the models, the null hypothesis is assessed at the 5% significance level. Consequently, we can infer that the linear specification of all equations is correct, and the set of instruments chosen was not correlated with the error term.

Nonetheless, as stated by Arellano and Bond (1991), the GMM consistency is strictly based on the assumption that E ($\Delta v_{it,} \Delta v_{i(t-2)}$)=0. Therefore, the existence of the serial correlation of lagged values superior to 1 (such as Δv_{it-1} and Δv_{it-2}) would indicate that the moment's conditions were not satisfied, which invalidates the estimated equation. For all the estimated equations of this study, we found evidence at the 5% significance level that the null hypothesis of zero auto correlation could not be rejected for the lagged superior levels of differenced idiosyncratic error term.

Given the above, all models expressed in Tables 4 and 5 refer to the results of M-1 to M-5, which investigate whether the use of opaque assets (characterized by derivatives) is associated with the change in the funds' level of risk (total and systematic), adjusted Sharpe ratio (in monthly and annual terms) and the inflow variation. The following results were obtained using the variation of the total amount invested in derivatives (in absolute and net terms) as the main independent variable, as expressed in Table 4:

Table 4

The Significance of the Percentage of Net Worth Invested in Derivatives

Models	Type of Derivative	Sample		
		Total Investors	**Qualified Investors**	**Non-Qualified Investors**
		Coefficient	**Coefficient**	**Coefficient**
Model 1: Variation of monthly total risk	Absolute $\Delta Deriv_{i,m,y}$	0.00202*** (0.00044)	0.01036*** (0.00216)	0.00786*** (0.00182)
	Absolute $\Delta Deriv_{i,m-1,y}$	Inserted as instrument	0.00772*** (0.00094)	0.00389*** (0.00075)
	Net $\Delta Deriv_{i,m,y}$	0.00305*** (0.00068)	0.01953*** (0.00414)	0.00943*** (0.00233)
Model 2: Variation of monthly systematic risk	Absolute $\Delta Deriv_{i,m,y}$	0.00236*** (0.00051)	0.00331*** (0.00102)	0.00710*** (0.00189)
	Absolute $\Delta Deriv_{i,m-1,y}$	Inserted as instrument	Inserted as instrument	0.00353*** (0.00080)
	Net $\Delta Deriv_{i,m,y}$	0.00366*** (0.00079)	0.00537*** (0.00156)	0.00884*** (0.00255)
	Net $\Delta Deriv_{i,m-1,y}$	Inserted as instrument	Inserted as instrument	0.00191** (0.00102)
Model 3: Variation of monthly adjusted Sharpe index	Absolute $\Delta Deriv_{i,m,y}$	0.00001*** (0.00768)	-0.02759 (0.03811)	-0.07584*** (0.02407)
	Absolute $\Delta Deriv_{i,m-1,y}$	0.00076*** (0.00683)	-0.03991 (0.04327)	Inserted as instrument
	Net $\Delta Deriv_{i,m,y}$	0.00288** (0.01176)	-0.00060 (0.01998)	-0.28557*** (0.07538)
	Net $\Delta Deriv_{i,m-1,y}$	0.01977*** (0.00992)	Inserted as instrument	Inserted as instrument

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Table 4 (Continued)

Models	**Type of Derivative**	**Sample**		
		Total Investors	**Qualified Investors**	**Non-Qualified Investors**
		Coefficient	**Coefficient**	**Coefficient**
Model 4: Variation of monthly inflow	Absolute $\Delta Deriv_{i,m,y}$	-0.00445*** (0.00268)	-0.00824 (0.00607)	-0.00355 (0.00301)
	Absolute $\Delta Deriv_{i,m-1,y}$	-0.00117*** (0.00259)	-0.00467 (0.00511)	-0.00194 (0.00303)
	Net $\Delta Deriv_{i,m,y}$	-0.00814*** (0.00413)	-0.01160 (0.00827)	-0.00490 (0.00440)
	Net $\Delta Deriv_{i,m-1,y}$	-0.00218*** (0.00392)	-0.00414 (0.00699)	-0.00315 (0.00489)
Model 5: Variation of annual adjusted Sharpe index	Absolute $\Delta Deriv_{i,m,y}$	-0.08600** (0.06071)	0.90893 (1.23275)	0.12408 (0.09192)
	Absolute $\Delta Deriv_{i,m-1,y}$	Inserted as instrument	-0.51846 (0.37928)	0.00767 (0.03027)
	Net $\Delta Deriv_{i,m,y}$	-0.03914** (0.06052)	0.43556 (0.71570)	0.14618 (0.09563)
	Net $\Delta Deriv_{i,m-1,y}$	Inserted as instrument	-0.41114 (0.30539)	0.03458 (0.03555)

Note: Table 4 considers the derivative percentage in absolute and net terms as well as the total sample and its subsets (according to the investors' qualification level). Total sample: 38.625 monthly observations/ Qualified investors sample: 15.594 monthly observations / Non-qualified investors sample: 23.031 monthly observations. Values in parentheses are the standard errors of the coefficients. ***, ** and * indicate 1%, 5% and 10% significance levels, respectively.
$\Delta Deriv_{i,m-1,y}$(absolute)= $\Delta Futc_{i,m,y}$ (absolute) + $\Delta Forwc_{i,m,y}$ (absolute)+ $\Delta Opt_{i,m,y}$ (absolute)+ $\Delta Swap_{i,m,y}$ (absolute).
$\Delta Deriv_{i,m-1,y}$(net)= $\Delta Futc_{i,m,y}$ (net) + $\Delta Forwc_{i,m,y}$ (net)+ $\Delta Opt_{i,m,y}$ (net)+ $\Delta Swap_{i,m,y}$ (net).

As seen in Table 4, the variation of the total amount invested in derivatives in (net and absolute terms) is positively related to the increase of total and systematic risk (M-1 and M-2) in both subsamples, qualified and non-qualified investors. Regarding the monthly adjusted Sharpe ratio (M-3), derivatives are significant in the subsample of retail shareholders and they are associated with this dependent variable in a negative way. For the qualified investor group, no relevant significant relationship is observed between these variables.

As for the monthly funds' inflows (M-4), we find a negative relationship between them and the ratio of derivatives in the total sample only, thus indicating that increments in the fund's net worth invested in derivatives are linked with a reduction in the new financial resources entrance inside hedge funds.

Specifically, for the annual-adjusted Sharpe ratio (M-5), only a negative association was verified between this variable and the derivatives usage level (both in net and absolute terms) inside the total sample context. The relationships between the different types of derivatives and the dependent variables expressed in Models 1 to 5 are reported in Table 5.

Table 5

The Significance of Derivatives in Absolute and Net Terms

Models	Type of Derivative	Panel A: Derivatives in Absolute Terms			Panel B: Derivatives in Net Terms		
		Total Investors	Qualified Investors	Non-Qualified Investors	Total Investors	Qualified Investors	Non-Qualified Investors
		Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Model 1: Variation of monthly total risk	$\Delta Futc_{i,m,,y}$	0.00302*** (0.00096)	0.00335* (0.00179)	0.00043 (0.00084)	0.00121 (0.00096)	0.00074 (0.00148)	0.00098 (0.00104)
	$\Delta Futc_{i,m-1,y}$	0.00577*** (0.00072)	0.00935*** (0.00112)	0.00338*** (0.00059)	0.00621*** (0.00101)	Inserted as instrument	0.00506*** (0.00101)
	$\Delta Opt_{i,m,y}$	0.02319*** (0.00198)	0.07312*** (0.00899)	0.02309*** (0.00244)	0.03584*** (0.00378)	0.02779*** (0.00469)	0.04876*** (0.00627)
	$\Delta Opt_{i,m-1,y}$	Inserted as instrument	0.00898** (0.00350)	0.00785*** (0.00257)	Inserted as instrument	Inserted as instrument	0.01319** (0.00583)
	$\Delta Swap_{i,m,y}$	0.09394*** (0.00840)	0.09417*** (0.01168)	0.11161*** (0.01178)	0.12921*** (0.01181)	0.13099*** (0.01579)	0.09731*** (0.01374)
	$\Delta Swap_{i,m-1,y}$	Inserted as instrument	-0.02684*** (0.01024)	-0.01445* (0.00738)	Inserted as instrument	Inserted as instrument	-0.03186* (0.00919)
	$\Delta Forwc_{i,m,y}$	-0.00541** (0.00235)	0.00010 (0.00328)	-0.00577* (0.00343)	-0.00330 (0.00238)	-0.00194 (0.00323)	-0.00320 (0.00326)
	$\Delta Forwc_{i,m,-1,y}$	-0.00651** (0.00268)	0.00023 (0.00423)	-0.00779** (0.00381)	-0.00738*** (0.00271)	-0.00285 (0.00406)	-0.00918** (0.00372)
Model 2: Variation of monthly systematic risk	$\Delta Futc_{i,m,,y}$	0.00342*** (0.00124)	0.00172 (0.00114)	0.00359** (0.00144)	0.00467*** (0.00185)	0.00284 (0.00206)	0.00284 (0.00183)
	$\Delta Futc_{i,m-1,y}$	0.00736*** (0.00097)	0.00816*** (0.00119)	0.00572*** (0.00107)	0.01109*** (0.00154)	0.01255*** (0.00177)	0.00707*** (0.00135)
	$\Delta Opt_{i,m,y}$	0.03007*** (0.00235)	0.02614*** (0.00347)	0.03098*** (0.00288)	0.04770*** (0.00480)	0.03295*** (0.00565)	0.05734*** (0.00755)
	$\Delta Opt_{i,m-1,y}$	Inserted as instrument	Inserted as instrument	0.01566* (0.00270)	Inserted as instrument	Inserted as instrument	0.02426* (0.00587)
	$\Delta Swap_{i,m,y}$	0.12031*** (0.00965)	0.12695*** (0.01376)	0.10325*** (0.01209)	0.16528*** (0.01425)	0.17198*** (0.01922)	0.14995*** (0.01876)
	$\Delta Swap_{i,m-1,y}$	Inserted as instrument	Inserted as instrument	Inserted as instrument	Inserted as instrument	Inserted as instrument	Inserted as instrument
	$\Delta Forwc_{i,m,y}$	-0.00901*** (0.00277)	-0.00426 (0.00355)	-0.00979** (0.00394)	-0.00583** (0.00270)	-0.00193 (0.00318)	-0.00576 (0.00382)
	$\Delta Forwc_{i,m,-1,y}$	-0.01401*** (0.00314)	Inserted as instrument	-0.01772*** (0.00425)	-0.01476*** (0.00313)	Inserted as instrument	-0.01823*** (0.00426)

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Table 5 (Continued)

		Panel A: Derivatives in Absolute Terms			Panel B: Derivatives in Net Terms		
Models	**Type of Derivative**	**Total Investors**	**Qualified Investors**	**Non-Qualified Investors**	**Total Investors**	**Qualified Investors**	**Non-Qualified Investors**
		Coefficient	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
Model 3: Variation of monthly adjusted Sharpe index	$\Delta Futc_{i,m,,y}$	0.00792 (0.01511)	-0.59931*** (0.21060)	0.09597*** (0.03536)	-0.00294 (0.02477)	-0.74148*** (0.25542)	0.45950*** (0.12399)
	$\Delta Futc_{i,m-1,y}$	-0.02299 (0.02624)	-0.52056*** (0.17066)	-0.00875 (0.03921)	-0.01982 (0.03072)	-0.42753*** (0.15216)	0.00208 (0.09543)
	$\Delta Opt_{i,m,y}$	0.09392 (0.08880)	0.72312 (0.54012)	0.06327 (0.07849)	0.42984* (0.24403)	1.46940 (1.49823)	4.84572 (3.01143)
	$\Delta Opt_{i,m-1,y}$	-0.03694 (0.06127)	-0.72617 (0.53102)	0.07090 (0.09014)	0.15874 (0.31188)	-1.19908 (1.25487)	Inserted as instrument
	$\Delta Swap_{i,m,y}$	-0.47225 (0.84264)	-8.28548*** (2.35517)	-8.91213*** (3.01661)	0.63477 (1.50920)	-10.37432*** (2.93645)	-38.30698*** (10.41963)
	$\Delta Swap_{i,m-1,y}$	0.30740 (0.90644)	Inserted as instrument	3.45548 (5.05474)	Inserted as instrument	Inserted as instrument	7.24480 (12.42171)
	$\Delta Forwc_{i,m,y}$	0.04598 (0.03820)	0.37133 (0.23778)	1.82971*** (0.68532)	0.00433 (0.03964)	0.42241* (0.24889)	-0.78115 (1.29230)
	$\Delta Forwc_{i,m,-1,y}$	0.18182*** (0.03624)	0.33133*** (0.09986)	Inserted as instrument	0.14986*** (0.02774)	0.33951*** (0.12368)	Inserted as instrument
Model 4: Variation of monthly inflow	$\Delta Futc_{i,m,,y}$	-0.00629* (0.00369)	-0.00962 (0.00845)	-0.00331 (0.00344)	-0.01006 (0.00624)	-0.01616 (0.01249)	-0.00362 (0.00570)
	$\Delta Futc_{i,m-1,y}$	-0.00423 (0.00335)	-0.00609 (0.00734)	-0.00296 (0.00373)	-0.00154 (0.00553)	-0.00400 (0.01141)	-0.00016 (0.00664)
	$\Delta Opt_{i,m,y}$	-0.00127 (0.01179)	0.00027 (0.01647)	-0.00176 (0.01576)	0.00485 (0.02145)	0.00681 (0.02634)	0.01396 (0.03161)
	$\Delta Opt_{i,m-1,y}$	-0.00021 (0.01311)	0.01027 (0.01636)	-0.01660 (0.01830)	-0.01255 (0.02358)	0.01504 (0.02137)	-0.06736 (0.04468)
	$\Delta Swap_{i,m,y}$	-0.13742*** (0.04429)	-0.18587** (0.07616)	-0.15884*** (0.04267)	-0.19410*** (0.05641)	-0.27257*** (0.10384)	-0.21287*** (0.05437)
	$\Delta Swap_{i,m-1,y}$	-0.11696*** (0.04001)	-0.13720** (0.06077)	-0.0989** (0.04821)	-0.18428*** (0.05519)	-0.24910*** (0.08404)	-0.16864** (0.06637)
	$\Delta Forwc_{i,m,y}$	0.00666 (0.01336)	0.03514 (0.02327)	-0.00548 (0.01394)	0.00877 (0.01375)	0.04051* (0.02368)	-0.00407 (0.01444)
	$\Delta Forwc_{i,m,-1,y}$	0.00168 (0.01262)	-0.00395 (0.02218)	-0.00120 (0.01295)	0.00231 (0.01277)	-0.00057 (0.02216)	0.00251 (0.01315)

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Table 5 (Continued)

Models	Type of Derivative	Panel A: Derivatives in Absolute Terms			Panel B: Derivatives in Net Terms		
		Total Investors	Qualified Investors	Non-Qualified Investors	Total Investors	Qualified Investors	Non-Qualified Investors
		Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Model 5: Variation of annual adjusted Sharpe index	$\Delta Futc_{i,m,,y}$	-0.03733 (0.02777)	-0.20777* (0.12447)	-0.02717 (0.04332)	-0.04870 (0.04445)	-0.27176 (0.18342)	-0.03376 (0.04448)
	$\Delta Futc_{i,m-1,y}$	-0.04535 (0.04212)	Inserted as instrument	-0.02683 (0.02127)	Inserted as instrument	Inserted as instrument	-0.01593 (0.01977)
	$\Delta Opt_{i,m,y}$	0.02542 (0.27223)	-0.62053 (0.78299)	0.17494 (0.12254)	0.12800 (0.84752)	-0.59857 (1.45980)	0.02540 (0.29875)
	$\Delta Opt_{i,m-1,y}$	0.12108 (0.53639)	0.52881 (1.07182)	-0.14756 (0.17492)	0.71108 (1.25211)	1.63905 (2.57866)	-0.19657 (0.44046)
	$\Delta Swap_{i,m,y}$	0.08933 (0.37816)	-0.29677 (0.93740)	0.14836 (0.23765)	-3.41472 (5.81452)	-6.76046 (14.46307)	1.32566 (2.02768)
	$\Delta Swap_{i,m-1,y}$	0.78526** (0.34938)	0.30625 (0.77147)	0.64346** (0.26706)	2.68297 (10.79229)	0.84249 (5.10273)	-0.75465 (1.57085)
	$\Delta Forwc_{i,m,y}$	-0.00927 (0.41601)	-0.23521 (0.96147)	0.32851 (0.42128)	0.53347 (0.56475)	-0.32107 (0.80117)	0.38486 (0.44457)
	$\Delta Forwc_{i,m,-1,y}$	-0.23329 (0.31265)	-0.14324 (0.72908)	-0.21621 (0.25761)	-0.50015 (0.52917)	-0.22336 (0.92787)	-0.22726 (0.27458)
	$Dleverg_i$	-15.17364** (6.68989)	-20.16407** (9.28778)	-9.48826** (3.94369)	1.88136 (1.80762)	4.65995 (4.10012)	-6.60178* (3.84115)

Note. Table 5 considers the derivatives percentage in absolute and net terms as well as the total sample and its subsets (according to investors' qualification level). Values in parentheses are the standard errors of the coefficients. ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Total sample: 38.625 monthly observations/ Qualified investors sample: 15.594 monthly observations / Non-qualified investors sample: 23.031 monthly observations.

As shown in Table 5, the absolute (Panel A) and net percentages (Panel B) invested in derivatives (particularly in swaps, options and future contracts) are significant and positively related to the total risk variation (M-1) in all the scenarios (the total sample and the set of qualified and non-qualified investors). In summary, for a significance level of 10%, it can be inferred that the use of these opaque assets is associated with higher levels of total risk in hedge funds. On the other hand, forward contracts are negatively related to total risks although the strength of their association is lower than that of the other types of derivatives.

As highlighted by Chen (2011), if the derivatives usage is intended to manage and stabilize fund risks (possibly due to career concerns), it should be associated with lower risks. Otherwise, if they are employed for speculation purposes, they can enhance fund performance through leverage and transaction costs savings. Due to leverage effects and low transaction costs, derivatives may provide a more powerful means to shift fund risks than rebalancing portfolios. In our study, we find evidence that, in general, Brazilian hedge funds managers essentially use derivatives for speculation purposes. This finding occurs because swap operations can leverage funds' positions, provided that their counterparts change the financial returns of different underlying assets related to a notional value higher than those required as margins (if any). When options are employed with leverage goals, funds become exposed to underlying assets based on notional contract values, and these are higher than both the call/put value and the paid or received margin to format the strategy. In the context of future contracts, funds that

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are engaged in buyer or seller operations can exhibit notional value expositions higher than the required margin values, which results in negative or positive variations of the net worth value per the daily adjustments suffered.

Bollen (2013) indicated that a considerable portion of a hedge fund returns' variability can be explained by common factors. When the volatility due to economic exposure is isolated, it results in the systematic risk (SR) measurement. In this paper, the following variables are employed in the SR calculation: currency (euro ($Eur_{m,y}$) and dollar ($Dol_{m,y}$)), stocks ($Ibovespa_{m,y}$ and Carhart (1997) factors), bonds ($Ima\text{-}geral_{m,y}$ and $Ida\text{-}geral_{m,y}$), commodities ($Icb_{m,y}$), inflation ($Ipca_{m,y}$), and interest ($Cdi\text{-}over_{m,y}$). This group of factors is similar to those explored by Bali et al. (2011).

As indicated in Table 5 (Panel A), the absolute percentage invested in swaps, options and future contracts is significant and positively related to the systematic risk variation (M-2). Similarly, in Table 5 (Panel B), concerning the net percentage applied in derivatives, the same relationship is found. These results suggest that derivatives are also employed to increase the total but also the systematic risk and enhance the effect of the unfavorable influence of severe market conditions on fund operations.

To investigate whether opaque asset investments are related to the additional monthly returns obtained for each risk unit incurred by hedge funds, the main results of Model 3 (M-3) are presented in Table 5. In Table 5 (Panel A), we generally observe a negative relationship between the absolute amount invested in derivatives and the adjusted returns provided by funds (the exceptions being the percentage invested in forward contracts related to the both subsample and futures contracts (in level) for the non-qualified group). Even with these exceptions, the operations with swaps (in both context, qualified and non-qualified investors) presented the highest values of negative coefficients, thus demonstrating that, despite this derivative be associated with higher risk (total and systematic), it diminishes the shareholders' returns received by the risk incurred in monthly terms. In general, the same relationship remains when this derivative is analyzed in net terms, as expressed in Table 5 (Panel B).

To determine whether higher investments in opaque assets generate higher volumes of monthly inflows, the results of Model 4 (M-4) are also explained in Table 5 (Panel A and B). As demonstrated, the percentage invested in swaps is significant, and it is negatively correlated with monthly inflows for the qualified and non-qualified investors' fund sample (in net and absolute terms). Regarding the total sample, the future contracts positions were also negatively associated with the monthly inflows variation. It may indicate that investors respond to the effect of the swaps usage assumed by managers (which increases fund's risk and decreases its monthly adjusted Sharpe ratio), thus reducing the entrance of new financial resources into these hedge funds. The negative coefficients observed for swaps (in M-4) are higher for the non-retail investor subsample, which suggests that this group of shareholders reacts to this fact more efficiently.

Model 5, which is also represented in Table 5, examines whether the higher use of opaque assets (characterized by derivatives) has an impact on the investor's annual risk adjusted returns. Because the periodicity of the observations is annual, only five observations per fund remain. Based on the analysis shown in this table, it is verified that an increase in the annual adjusted Sharpe ratio is associated with higher positions in swaps (significant only in absolute terms and lagged one). However, the coefficients of the leverage dummy $Dleverg_i$ (which are more expressive than the ones found for the swaps variables) reveal that leveraged hedge funds that can employ derivatives for speculative purposes present a significant reduction in the $Dasr_{i,m,y}$ value. This finding suggests that a higher investment in opaque assets (for leveraging) negatively affects the shareholders' annual adjusted returns (for the total sample and its subsamples).

Robustness checks

To verify if the results obtained for models M-1 to M-5 (presented in Table 5) are robust, we employ other proxies to measure each dependent variable by considering derivatives in absolute and net terms. Regarding to these proxies we estimated: i) for fund's risk (the kurtoses and the specific risk measures); ii) for fund's return (the absolute return, the style-adjusted return and the Sortino's Index) and iii) for fund's flow (the fund's inflow % and its net flow). The tables with the results of the robustness check were omitted, but it can be requested from the authors.

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With regard to the idiosyncratic (or specific) risk, when the coefficients of the individual derivatives are significant, their values are considerably low, thus indicating that all the significant relationships between risk exposure and derivatives are captured by the measures of total and systematic risk (reported in Table 5). Specifically, for the measures of monthly and annual performance (in net and absolute terms), we also find significant coefficients but with reduced values related to the common return measures (expressed by monthly and annual returns and style-adjusted fund return, where the latter is calculated as expressed in Abinzano, Muga and Santamaria (2010) for the total sample and its subsamples. According to Alexander and Sheedy (2004), traditional measures that just incorporate the variance are not frequently suggested for evaluating hedge funds (such as traditional Sharpe ratio, for example) since this group of funds have asymmetrically distributed returns. As a consequence, the measure of Sortino's Index based on the logic of asymmetric risks as established by Chen, Yang, and Peng (2014) would be more suitable. The results pointed that the coefficients for swaps operations are the highest and still showed a negative association between its usage and the Sortino's index variation (in absolute and net terms) for the context of non-qualified investors. This is convergent with the relationships verified for M-3 regarding to the monthly adjusted Sharpe Ratio. Additionally, the dummy leverage ($Dleverg_i$) is significant for all the subsamples, thus indicating that hedge funds that are allowed to use derivatives for speculative purposes still offer a lower premium to shareholders by considering the downside risks incurred by managers.

To assess the robustness of Model 4, we verify the relationship between derivatives (in net and absolute terms) and the fund's monthly net flows (computed according to Ferreira, Keswani, Miguel and Ramos (2012) and its inflow % (calculated as a proportion of the fund's net worth). Similar to the results in Table 5, these risky assets are generally (regarding the swap and option positions) negatively associated with the funds' financial flows.

Finally, with respect to the annual Sortino's index, we observe a result different from the one obtained for M-5 (see Table 5). Even with the usage of options that are not lagged (in level) (only for retail investors) and swaps (lagged in one year) are associated positively with this measure, the dummy leverage ($Dleverg_i$) is positive for qualified investors and negative but insignificant (at the 10% level) for retail shareholders.

Since the Brazilian regulation allows funds to omit the unpublished positions in derivatives for one quarter after the end of each month, some lagged effects (of three periods) would possibly affect the fund's inflows. To test this possibility we also compute the results for the derivative coefficients using the aforementioned lagged variables. Besides future contracts in net terms (lagged in three months) that are associated with the funds' monthly inflow variation, its coefficient values are very low, thus indicating that the entire disclosure of the hedge fund's portfolio after 90 days does not affect the amount of financial resources of investors (retail or not) directed to these funds.

Conclusions

Our results indicate that nearly all the derivative types are associated with the increase in risk (total or systematic). As primarily observed in the options, futures and swap markets, a higher variation of the percentage of derivatives in the funds' portfolios (in absolute and net terms) is associated with higher funds' volatility. This results in an increase of the fund's risk level, whether directed to qualified investors or not.

When the risk-adjusted return paid to investors is evaluated in monthly terms (by the monthly Sharpe ratio), it can be observed that the coefficients of swap positions show a negative association between this variable and this derivative (in net and absolute terms). Therefore, we can conclude that when managers use swaps to amplify the volatility of the fund shares, they do not generate higher returns (regardless of the information level of the shareholder). Hull (1997) suggested that this derivative involves the possibility of considerable losses, since the increase of the difference between the fees (computed on a notional value considerable higher than the amount required as margins) is unlimited, and generally, the parts are obligated to be positioned until the maturity of the contract.

Given these findings, we conclude that the managers of funds, in particular those focused on retail investors, can increase their positions in derivatives and consequently raise their risk level without necessarily delivering higher risk adjusted returns in monthly or annual terms to shareholders. Furthermore, if one considers that less qualified investors do not have access to or knowledge regarding the advanced techniques used for fund evaluations, this could explain why swaps in the subsample of retail investors show a lower negative relationship to inflows than the one observed to the qualified investors segment. Due to this empirical evidence, some regulatory issues should be considered regarding the protection of retail investors, such as the establishment of restrictions for fund managers' decisions for investments made in derivatives markets. In addition, the requirement of a minimum level of qualifications or an evaluation of total wealth by investors before they invest in leveraged hedge funds (possibly combined with higher initial values to start investing) could be considered as protective measures.

In summary, our findings reinforce the requirement of a minimum level of financial literacy by retail investors before they direct their financial resources to hedge funds, since derivatives are a low cost instrument used by managers to change the funds' risk, and the resulting positive and negative implications on the investors' wealth are not clearly publicized by managers in the fund's prospectus, for instance.

Notes

[1] As one of the models of this article analyzes the opacity impact on funds' inflows, only open funds were selected since in closed funds there is a specific period for investors to buy shares. Thereafter, new financial entrants cannot be accepted.

[2] Exclusive funds are those that are designated only for qualified investors and composed of only one shareholder.

[3] Restricted funds are those that are designated for investors who have familiar or corporate ties or who belong to the same economic group.

[4] Ibrx-100: It is an average performance index of the prices of the 100 most traded assets and is representative of the Brazilian stock market (Bm&FBovespa, 2016).

[5] Selic-over: The Brazilian primary interest rate determined in open market operations that occurs between financial institutions and the Brazilian Central Bank.

[6] For wide panels – in which the cross-section units highly surpasses the time series observations - the fixed effect least squares estimator (also known as least squares dummy variables estimator (LSDV)) is not feasible, due to the fact that the standard errors are estimated with a significant loss of degrees of freedom, since it requires the estimation of N-1 extra parameters for each of the N cross-section units, which aggravates the problem of multicolinearity among regressors. And given the fact that our sample presents 727 cross section units the hedge funds and only 72 time series observations (the monthly data), the results of a LSDV are computationally unfeasible.

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