ARTICLES

REDEMPTION CONSTRAINTS OF BRAZILIAN EQUITY FUNDS, LIQUIDITY OF ASSETS, AND PERFORMANCE

Restrições de resgate em fundos de ações, liquidez dos ativos e desempenho

Restricciones de rescate en fondos de acciones, liquidez de los activos y desempeño

ABSTRACT

This paper analyzed the relation between redemption constraints and liquidity of assets under management of Brazilian equity funds, as well as its effect on performance. The sample included 2,706 Brazilian equity funds with investments in stocks listed on BM&FBovespa, or in shares of other equity funds, between 2009 and 2016. The analysis was carried out through descriptive statistics and linear regressions with panel data. The results indicated that redemption constraints positively impact equity funds performance. In addition, the results suggested that liquidity constraints allow the funds to exploit less liquid investments in stocks and shares of other funds. When verifying whether investments in low liquidity assets by equity funds imply superior performance from liquidity premia, the results did not indicate a positive effect.

KEYWORDS | Redemption constraints, portfolio liquidity, performance, equity funds, investment funds.

RESUMO

Este trabalho analisou a relação entre restrições de resgate e liquidez dos ativos sob gestão de fundos de ações brasileiros, bem como seu efeito no desempenho. A amostra contou com 2.706 fundos de ações brasileiros com investimentos em ações listadas na BM&FBovespa ou em cotas de outros fundos de ações no período entre 2009 e 2016. Os dados foram analisados a partir de estatísticas descritivas e aplicação de modelos de regressão linear com dados em painel. Os resultados indicaram que as restrições de resgate impactam positivamente o desempenho dos fundos de ações. Além disso, os resultados sugeriram que as restrições de resgate possibilitam aos fundos explorar investimentos menos líquidos em ações e em cotas de outros fundos. Por outro lado, o investimento em ativos de baixa liquidez por parte dos fundos de ações não necessariamente está relacionado à melhores indicadores de performance.

PALAVRAS-CHAVE | Restrições de resgate, liquidez de carteiras, desempenho, fundos de ações, fundos de investimento.

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RESUMEN

Este trabajo analizó la relación entre restricciones de rescate y liquidez de los activos bajo gestión de fondos de acciones brasileños, así como su efecto en el desempeño. La muestra contó con 2.706 fondos de acciones brasileños con inversiones en acciones listadas en la BM&FBovespa o en cuotas de otros fondos de acciones en el período entre 2009 a 2016. Los datos fueron analizados a partir de estadísticas descriptivas y regresión lineal con datos de panel. Los resultados indicaron que las restricciones de rescate impactan positivamente en el desempeño de los fondos de acciones. Además, los resultados sugirieron que las restricciones de liquidez permiten a los fondos explotar inversiones menos líquidas en acciones y en cuotas de otros fondos. Al verificar si la inversión en activos de baja liquidez por parte de los fondos de acciones implica un desempeño superior proveniente del premio de liquidez, los resultados no necesariamente mostraron un efecto positivo.

PALABRAS CLAVE | Restricciones de rescate, liquidez de portfolio, desempeño, fondos de acciones, fondos de inversión.

INTRODUCTION

Investment funds are subject to the demand for liquidity by investors, which may adversely affect their performance. Since this demand by investors may cause the fund manager to liquidate or acquire assets at inappropriate times, the income that the fund could raise may be reduced (Nanda, Narayanan, & Warther, 2000). To prevent this, certain investment funds limit the redemption of shareholders through mechanisms called redemption constraints or liquidity constraints. Liquidity constraints typically involve requirements for minimum invested amounts, lockup period, provisions for the frequency of redemptions, and redemption notice periods (Hong, 2014). Moreover, funds may use their rate structure to discourage redemptions, for example, by setting high exit rates (Nanda et al., 2000).

According to Agarwal, Daniel, and Naik (2009), liquidity constraints act as management incentives that can even positively impact the performance of funds; by limiting unexpected redemptions, they provide greater discretion in terms of management. Aragon (2007) states that the best performances in funds with liquidity constraints occur due to the efficient management of investments in low liquidity assets. This understanding is in line with Ang and Bollen (2010), who state that liquidity constraints enable gains from liquidity premiums, by allowing fund managers to invest in illiquid assets.

Thus, investment funds can establish mechanisms that restrict the exit of investors to reduce liquidity risks and collaborate in the managers' investment strategies. By reducing exits, liquidity constraints make it possible to exploit opportunities that take time to become profitable and prevent the liquidation of assets at inappropriate times and prices to meet unexpected redemption requests. Furthermore, given the argument that less liquid assets have higher returns, redemption constraints may encourage fund managers to invest in illiquid assets in the pursuit of better performance. Therefore, this study analyzes the relationship between redemption constraints and the liquidity of assets under management of Brazilian equity funds, as well as the effect of this relationship on their performance.

This study contributes to the literature by providing evidence of the effect that liquidity constraints imposed by funds have on investment options and their performance. Although international studies have already suggested that these constraints provide better performance for investment funds (e.g., Agarwal et al., 2009; Aragon, 2007; Bali, Gokcan, & Liang, 2007; Liang, 1999; Schaub & Schmid, 2013), the explanations for the origin of a superior performance, such as the liquidity premium

from the investment in illiquid assets that operate despite the redemption constraints, are still little explored.

Studies on this subject that address the Brazilian market are almost non-existent. Normally, national studies on the performance of investment funds do not consider liquidity constraints and their relationship with the performance, or liquidity of assets under management. Moreover, there are some gaps in the few Brazilian studies that address liquidity constraints, and they need to be explored further. For example, Pontes, Rogers, and Malaquias (2015) studied the relationship between lockup constraints and the performance of Brazilian Long and Short multimarket funds, but their results showed that the funds in the sample do not necessarily deliver the lockup premium. Gonzaga (2016) found that funds with a redemption period longer than seven days had higher average annual returns, but only descriptive statistics were used in this study.

LITERATURE REVIEW

In order to efficiently manage liquidity risks, certain categories of investment funds use mechanisms that restrict the exit of investors, to prevent the fund manager from disposing assets at inappropriate times and at low prices to meet any sudden redemption requests from shareholders. These mechanisms are called liquidity constraints and refer to the minimum amount required to invest or the minimum balance to be maintained, minimum time to remain in the fund, deadlines for prior notification and redemption, and exit rates, among others (Hong, 2014).

According to Agarwal et al. (2009), redemption constraints are usually associated with a better performance of funds, since they provide greater freedom in management. Since such constraints discourage redemptions or oblige investors to remain in the fund for a certain period, managers gain greater discretion in investment strategies. For example, if a fund has a long lockup period, the manager may explore investment opportunities that take time to become profitable or may avoid selling assets at unfavorable prices.

Liang (1999) was one of the first studies to address the effect of liquidity constraints on the performance of investment funds; after analyzing descriptive statistics and stepwise regressions, it showed that the lockup period is decisive in determining hedge fund returns. The longer this period, the better is its performance. This is because lockup constraint prevents early redemptions, reduces the need to maintain cash availability, and enables the manager to focus on the long term.

Aragon (2007) conducted a study with a sample composed of hedge funds between January 1994 to December 2001, and after analyzing the data through descriptive statistics, probit models, and pooled regressions, observed that the funds with lockup periods had returns between 4% and 7% (depending on the criteria used in the tests), which was higher when compared to those funds that did not have this constraint. Furthermore, the results indicated that each US$ 1 million increase in the minimum investment value caused an increase in return between 0.60% and 0.81%, suggesting the existence of a liquidity premium from efficient portfolio management and investment in illiquid assets, despite the redemption constraints.

Hong (2014) analyzed the liquidity constraints of hedge funds through descriptive statistics and logit regression models, based on monthly data from January 2007 to May 2012, by focusing on aspects such as liquidity risk, liquidity of portfolio assets, and performance of the funds. He found that the funds change the structure of their liquidity constraints according to their needs, that is, hedge funds with high portfolio liquidity and low liquidity risks tend to soften the redemption constraints, suggesting a negative relationship between liquidity constraints and the liquidity of assets under management. He also found that although funds with weak liquidity constraints perform poorly (as they do not benefit from higher returns from illiquid assets), their capital flows are significantly higher (as they provide liquidity to investors).

According to Boyle, Li, and Zhu (2010), liquidity constraints have serious implications for both investors and fund managers regarding investment decisions. From the managers' perspective, liquidity constraints are desired, because they enable investments in illiquid assets without the concern of unexpected redemptions by shareholders. However, they can harm investors by forcing them to remain in a fund with weak performance for a longer period. In this context, the results from the study of Boyle et al. (2010), addressing hedge funds from 1978 to 2009, with data analyzed through descriptive statistics, regressions with fixed effects, and pooled OLS regressions, indicate that in the periods of economic stability, the funds with redemption constraints had significantly higher returns, lower volatility, and higher Sharpe ratio, while in the periods of economic crisis the effect was the opposite.

Moreover, the study of Bali et al. (2007), through descriptive statistics analysis and cross-section regressions, found a positive relationship between the lockup constraint and the returns of hedge funds. According to the results of this study, the funds that had a lockup period obtained significantly higher returns compared to the funds that did not have this constraint; this difference was statistically significant at 1% for different cuts in the sample, including active funds that ceased to exist at some point during the period under analysis. They attributed this to a liquidity premium, that is, since redemption is limited, the lockup constraint enables investments in low liquidity assets, which are generally more profitable.

Similarly, Schaub and Schmid (2013) addressed the impact of portfolio liquidity and the liquidity provided to investors, measured through liquidity constraints, on the performance of hedge funds, considering crisis and non-crisis periods from 1994 to 2008, with analysis through descriptive statistics, cross-section regressions, and pooled OLS regressions. They observed better performance of less liquid funds in periods of non-crisis, considering the premium generated to investors as compensation for limited liquidity. Despite this, in the periods of economic crisis (2007 and 2008), the most liquid funds performed better, that is, the liquidity constraints were not enough for the efficient management of illiquid assets during the crisis periods.

In the Brazilian context, despite the lack of studies addressing the impact of liquidity constraints on the performance of investment funds, Pontes et al. (2015) have investigated the determinants of the profitability of Brazilian multimarket funds (which are similar to the hedge funds existing in the international market), while focusing on the lockup provision. They analyzed a sample of 54 multimarket long and short funds from May 2009 to May 2014 and found no statistically significant evidence of the positive relationship between lockup constraint and performance of multimarket funds.

Conversely, when analyzing 545 Brazilian multimarket funds from 2010 to 2015, Gonzaga (2016) found that the funds with a redemption period longer than seven days, (classified in the study as less liquid) showed a higher average annual return (12.72% for funds with a performance rate and 14.65% without a performance rate) compared to funds with a redemption period shorter or equal to seven days, considered as more liquid (11.26% for funds with a performance rate and 11.05% for funds without a performance rate). Despite this, multimarket funds with lower liquidity were more volatile than those with higher liquidity.

Given the studies presented above, we raise the following hypotheses:

> H1: There is a positive relationship between redemption constraints and the performance of Brazilian equity investment funds.
>
> H2: There is a positive relationship between redemption constraints and illiquidity of assets under management of Brazilian equity investment funds.

H3: There is a positive relationship between the illiquidity of assets under management of Brazilian equity funds and their performance.

METHODOLOGY

Sample definition

In this study, we considered all the Brazilian equity funds with investments in stocks listed on BM&FBovespa, or in shares of other equity funds and that presented information about the composition of the portfolios (investments in stocks listed on BM&FBovespa and other funds) from 2009 and 2016, with data available on December 31 of each year. Therefore, the sample included 2,706 funds, totaling 12,447 observations over the entire period under review.

The time horizon of the sample, from 2009 to 2016, was mainly chosen due to data availability. The year 2009 was chosen because it represents the year when detailed information on the composition of the funds' portfolios were disclosed in the Economatica database. The year 2016 was chosen because it was the last year with complete information on the portfolios of the funds until the development of this study. It should be mentioned that, since data was collected on January 31, 2017, some values may have been omitted, since some funds have not yet disclosed the composition of their portfolios.

Regarding the criteria for classifying the assets that make up the portfolios with liquid and illiquid funds, we considered the liquidity indicators provided in the Economatica database. In its formula, the liquidity indicator (Stock Market Liquidity) takes into account the number of days in which the stock was traded at least once, how many times the stock was traded in the chosen period, how many times all the stocks were traded, the cash volume in the stock in the chosen period, and the cash volume in all the stocks in the chosen period. Initially, the stocks were classified on a monthly basis, and 12 indicators were generated per stock for 2016. Subsequently, they were classified on an annual basis. With a correlation matrix between each monthly liquidity index and the annual liquidity, the coefficients indicated that using an annual liquidity classification instead of a monthly one would not bring bias in the results, since the coefficients were all strong and significant at 1%. In order to classify the stocks according to their market stock liquidity, the market stock liquidity index was used for each year of the sample period. Based on these indicators, two dummy variables were established: i) one to identify actively traded stocks, whose cut-off criterion was the fourth quintile of the liquidity indicators of the stocks being available for acquisition by the funds at the end of each year; ii) and the other to identify thinly traded stocks, whose cut-off criterion was the first quintile of the liquidity indicators of the stocks available for acquisition by the funds at the end of each year.

Similarly, for the classification of funds into liquid and illiquid, two dummy variables were established: i) one to identify high liquidity funds, whose cut-off criterion was the lockup period being equal to 0 days and minimum balance being equal to R$ 0.00 and no exit rate; ii) and other to identify low liquidity funds, whose cutoff criterion was the lockup period being greater than or equal to 30 days or minimum balance being greater than or equal to R$ 10 thousand or the existence of an exit rate.

Furthermore, some procedures were carried out in order to treat outliers. First, all the funds whose sum of the percentage of the portfolio in equity investments and other funds resulted in zero were eliminated from the sample. The percentages of the portfolios allocated to stocks and funds were higher than 200% in some cases, so the 100 highest values were replaced by the value in the position 101 (in descending order). For example, the value of 112.621% represents the value in the 101st position in descending order for the variable stocks; thus, the 100 highest values (among 12,477 observations) of the variable stocks were replaced by 112.621%, this being the new maximum value for this variable, thus eliminating potential biases resulting from extremely high values in this variable. This same procedure was applied to the 100 highest values in percentage of actively traded stocks, thinly traded stocks, high liquidity funds (in the portfolios), and low liquidity funds (in the portfolios). Thus, the difs, diff and difa variables (Exhibition 1) were automatically adjusted to avoid bias from extremely high values. It should be noted that this procedure affected less than 1% of the data related to the composition of the portfolios. This same procedure was carried out with the 100 highest and 100 lowest values of the performance variables (Sharpe, Sortino, Alpha), affecting about 2% of the data related to performance.

Description of the variables

Given the objective of this study to analyze the relationship between redemption constraints and the liquidity of assets under management of Brazilian equity investment funds, and the effect of the interaction between liquidity of portfolios and redemption constraints on performance, we have chosen measures to represent redemption constraints, liquidity of portfolios, performance, and characteristics of funds. The study variables are presented in Exhibition 1..

Exhibiton 1. Study variables

Variable	Sign	Description
sharpe	..	Sharpe ratio by year (frequency of returns: monthly).
sharpepos	..	Sharpe ratio by year (frequency of returns: monthly), only returns from funds with a positive risk premium.
sortino	..	Sortino ratio by year (frequency of returns: monthly).
alpha	..	Jensen's alpha by year (frequency of returns: monthly).
nllockup	+	natural logarithm of (lockup in days + 1).
nlminbal	+	natural logarithm of minimum balance.
exitrate	+	dummy variable with value 1 for funds that charge an exit rate and 0 in others.
liqconst	+	dummy variable with value 1 for funds with lockup greater than or equal to 30 days or minimum balance greater than or equal to R$ 10 thousand or dummy variable that charge exit rate and have value 0 in the other funds.
iliqcart	+	dummy variable with value 1 for funds in which most of the portfolio is invested in low liquidity assets and have value 0 in others.
*const*iliqcart*	+	product of the multiplication of the variables liqconst and iliqcart (liqconst x iliqcart).
nlnw	+	natural logarithm of total net assets.
age	-	number of years since the registration of the fund in the CVM.
ifp2	+/-	*dummy with value 1 if the fund has a quantity equal or superior to 40% of its portfolio invested for other funds, and value 0 for other cases.*
manrate	-	the maximum management rate charged by the fund on an annual basis.
perrate	+	dummy variable that receives value 1 if the fund charges performance rate and value 0 for other cases.
difs	..	difference between the percentage of the portfolio allocated in thinly traded stocks and actively traded stocks.
diff	..	difference between the percentage of the portfolio allocated in low liquidity and high liquidity funds.
difa	..	difference between the percentage of the portfolio allocated in low liquidity and high liquidity assets.

Analysis procedures

Linear regression models with panel data were used for analyzing the variables. Initially, we aimed to determine the effect of liquidity constraints on the performance of Brazilian equity investment funds, also considering the possible influences of the fund's characteristics. The generic econometric model for these tests is given by:

$$Performance_{i,t} = \beta_0 + \beta_1 Liquidity\ Constraint_{i,t} + \gamma Control_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where $Performance_{i,t}$ is the performance of fund i in year t measured for each of the performance variables considered; $Liquidity\ Constraint_{i,t}$ represents each of the redemption constraint variables considered for fund I in year t; $Control_{i,t}$ represents the control variables for the characteristics of fund I in year t; β_0 is the intercept of the model and the β_1 and γ are the coefficients for the variables of interest and control variables, respectively; the error term is given by $\varepsilon_{i,t}$.

In a second step, we sought to determine the relationship between the liquidity constraints and the liquidity of the assets under management of Brazilian equity investment funds. Thus, the following econometric model was established:

$$Portfolio\ liquidity_{i,t} = \beta_0 + \beta_1 Liquidity\ Constraint_{,t} + \gamma Control_{i,t} + \varepsilon_{i,t} \qquad (2)$$

where $Liquidity\ Constraint_{,t}$ is the difference between the percentage of low and high liquidity assets in the portfolio of fund I in year t measured for each of the three liquidity variables of the portfolios analyzed; $Liquidity\ Constraint_{,t}$ represents the redemption constraint variable considered for fund I in year t; $Control_{i,t}$ represents the control variables for the characteristics of fund I in year t; β_0 is the intercept of the model and β_1 is the coefficient for the variable of interest; the error term is given by $\varepsilon_{i,t}$.

Finally, the following econometric model was used for estimating the possible effects of the liquidity of the funds' portfolios on their performance:

$$Performance_{i,t} = \beta_0 + \beta_1 Portfolio\ liquidity_{i,t} + \gamma Control_{i,t} + \varepsilon_{i,t} \qquad (3)$$

where $Performance_{i,t}$ is the performance of fund i in year t measured for each of the performance variables considered; $Portfolio\ liquidity_{i,t}$ represents the dummies for identifying the low liquidity portfolio of fund i in year t; $Control_{i,t}$ represents the control variables for the characteristics of fund i in year t; β_0 is the intercept of the model and the β_1 and γ are the coefficients for the variables of interest and control variables, respectively; the error term is given by $\varepsilon_{i,t}$.

We used the pooled model with robust standard errors clustered by funds for defining the panel data model. Pooled models were used in the studies of Aragon (2007), Boyle et al. (2010), and Schaub and Schmid (2013) for analyzing the relationship between liquidity constraints and performance of investment funds. Variance Inflation Factor (VIF) was used to detect possible multicollinearity problems in the models.

RESULTS

Redemption and performance constraints

Table 1 shows the descriptive statistics of the study variables regarding measures of performance, redemption constraints, and fund characteristics. Moreover, we developed the linear regression models shown in Table 2, namely: Model 1 estimates the effect of the lockup period on performance; Model 2 estimates the effect of minimum balance on performance; Model 3 estimates the effect of exit rate on performance; and Model 4 estimate the combined effect of these three redemption constraints on the performance of the funds. In addition to addressing these relationships, the models consider the characteristics of the funds that determine performance according to previous studies as control variables.

Table 1. **Descriptive Statistics**

Variables	Observations	Average	Standard Deviation	Min	Max
alpha	10,616	1.472	15.477	-41.940	59.673
sharpe	10,616	-0.085	1.524	-2.593	4.700
sharpepos	4,030	1.459	1.292	0.000	4.700
sortino	10,616	1.246	5.883	-2.228	38.076
nllockup	12,422	1.992	0.923	0.000	7.510
nlminbal	10,874	6.223	4.660	0.000	16.118
exitrate	7,154	0.208	0.406	0.000	1.000
liqconst	12,447	0.411	0.492	0.000	1.000
nlnw	11,857	17.021	1.716	5.534	24.405
age	12,447	5.939	6.068	0.003	50.219
ifp2	12,447	0.386	0.487	0.000	1.000
perrate	12,389	0.390	0.488	0.000	1.000
manrate	12,189	1.538	1.258	0.000	8.500

Notes: nllockup: natural logarithm of (lockup in days + 1); nlminbal: natural logarithm of minimum balance; exitrate: dummy variable with value 1 for funds that charge exit rate and value 0 for others; liqconst: dummy variable with value 1 for funds with lockup greater than or equal to 30 days or minimum balance greater or equal to R$10,000 or that have an exit rate, and value 0 for the other funds; nlnw: natural logarithm of total net assets; age: number of years since the registration of the fund at CVM; ifp2: dummy variables with value 1 if the fund has 40% or more of its portfolio invested in other funds and value 0 for other cases; manrate: maximum management rate charged by the fund annually; perrate: dummy variable that receives value 1 if the fund charges performance rate and value 0 in other cases.

Table 2. **Liquidity Constraints and Sharpe Ratio**

Variáveis	Model 01		Model 02		Model 03		Model 04	
sharpe	b	rse	b	rse	b	rse	b	rse
nllockup	0.023*	0.012	-	-	-	-	-	-
nlminbal	-	-	0.010***	0.002	-	-	-	-
exitrate	-	-	-	-	0.161***	0.031	-	-
liqconst	-	-	-	-	-	-	0.107***	0.020
nlnw	0.083***	0.007	0.088***	0.006	0.107***	0.011	0.081***	0.006
age	-0.017***	0.002	-0.016***	0.002	-0.024***	0.004	-0.016***	0.002
ifp2	0.150***	0.019	0.139***	0.020	0.141***	0.026	0.136***	0.019
manrate	-0.042***	0.007	-0.050***	0.007	-0.047***	0.010	-0.041***	0.007
perrate	0.060***	0.020	0.064***	0.020	-0.010	0.026	0.034*	0.019
Constant	2.028***	0.113	1.981***	0.113	1.956***	0.183	2.077***	0.111
Observations	10,039		8,894		5,506		10,064	
Maximum VIF	1.29		1.25		1.27		1.33	

Notes: ***significant at 1%; **significant at 5%; *significant at 10%; rse = robust standard error.

The results of the models shown in Table 2 indicate a positive and statistically significant relationship between all the variables used to represent the liquidity/redemption constraints in this study (lockup, minimum balance, exit rate, and the combination of the three constraints), and the performance of the stock funds (measured by the Sharpe ratio), which suggests that the funds that have redemption constraints perform better. Similarly, all the variables related to the characteristics of the funds, except for performance rate

in Model 3, showed a statistically significant relationship with the Sharpe ratio.

In order to correct eventual inconsistencies in the measurement of the funds' performance by the Sharpe ratio when the risk-free rate is higher than the expected return, that is, when the risk premium is negative, models similar to those presented previously were estimated, after considering only the funds with a positive risk premium. The results for these models are shown in Table 3 and corroborate the findings presented in Table 2.

Table 3. Liquidity Constraints and Sharpe Ratio (positive risk premium)

Variables	Model 01		Model 02		Model 03		Model 04	
sharpepos	b	rse	b	rse	b	rse	b	rse
nllockup	0.074***	0.016	-	-	-	-	-	-
nlminbal	-	-	0.011***	0.003	-	-	-	-
exitrate	-	-	-	-	0.091**	0.040	-	-
liqconst	-	-	-	-	-	-	0.162***	0.027
nlnw	0.045***	0.009	0.046***	0.009	0.056***	0.015	0.042***	0.009
age	-0.018***	0.002	-0.017***	0.002	-0.027***	0.004	-0.016***	0.002
ifp2	0.106***	0.025	0.095***	0.026	0.049	0.034	0.096***	0.025
manrate	-0.047***	0.010	-0.057***	0.010	-0.050***	0.014	-0.045***	0.010
perrate	0.153***	0.027	0.164***	0.028	0.080**	0.034	0.131***	0.027
Constant	2.633***	0.164	2.720***	0.168	2.921***	0.252	2.775***	0.160
Observations	3,812		3,395		2,161		3,819	
Maximum VIF	1.25		1.27		1.24		1.37	

Notes: ***significant at 1%; **significant at 5%; *significant at 10%; rse = robust standard error.

Despite being a performance measure that is widely used in the evaluation of financial investments regarding the relationship between risk and return, the Sharpe ratio has certain limitations. In order to overcome these limitations and obtain greater evidence on the effect of liquidity/redemption constraints on the performance of stock funds, models were estimated using the Sortino ratio for measuring performance, as shown in Table 4. The results presented in the table indicate a positive and statistically significant relationship between the liquidity constraints and the Sortino ratio in all the estimated models, thereby corroborating the previous findings, which suggest that the funds using mechanisms that limit the redemptions of shareholders perform better. Regarding the characteristics of the funds, the results indicated that size, investment in shares of other funds, and performance rate are positively associated, while age and management rate are negatively associated with the Sortino ratio.

Table 4. Liquidity Constraints and Sortino Ratio

Variables	Model 01		Model 02		Model 03		Model 04	
sortino	b	rse	b	rse	b	rse	b	rse
nllockup	0.136***	0.046	-	-	-	-	-	-
nlminbal	-	-	0.032***	0.010	-	-	-	-
exitrate	-	-	-	-	0.322**	0.128	-	-
liqconst	-	-	-	-	-	-	0.389***	0.087
nlnw	0.133***	0.026	0.130***	0.029	0.170***	0.042	0.127***	0.026
age	-0.046***	0.006	-0.043***	0.006	-0.055***	0.011	-0.042***	0.006
ifp2	0.426***	0.079	0.418***	0.084	0.317***	0.096	0.391***	0.079
manrate	-0.105***	0.034	-0.136***	0.036	-0.175***	0.045	-0.102***	0.034
perrate	0.561***	0.086	0.574***	0.092	0.389***	0.101	0.495***	0.085
Constant	14.197***	0.578	14.627***	0.632	17.125***	0.961	14.422***	0.571
Observe.	10,039		8,894		5,506		10,064	
Max. VIF	1.29		1.25		1.27		1.33	

Notes: ***significant at 1%; **significant at 5%; *significant at 10%; rse = robust standard error.

Models considering Jensen's Alpha as a dependent variable were used for extending the evidence, and the results are summarized in Table 5. Jensen's Alpha tests confirmed the previously estimated findings of the models, regarding the positive relationship between liquidity constraints and performance.

Table 5. Liquidity Constraints and Jensen's Alpha

Variables	Model 01		Model 02		Model 03		Model 04	
alfa	b	rse	b	rse	b	rse	b	rse
nllockup	0.309*	0.179	-	-	-	-	-	-
nlminbal	-	-	0.082**	0.037	-	-	-	-
exitrate	-	-	-	-	2.108***	0.464	-	-
liqconst	-	-	-	-	-	-	1.035***	0.333
nlnw	1.105***	0.100	1.195***	0.099	1.509***	0.148	1.097***	0.100
age	-0.215***	0.024	-0.208***	0.025	-0.403***	0.061	-0.207***	0.026
ifp2	1.358***	0.284	1.236***	0.296	1.335***	0.391	1.243***	0.284
manrate	-0.653***	0.121	-0.747***	0.127	-0.530***	0.167	-0.628***	0.121
perrate	0.407	0.294	0.542*	0.318	-0.599	0.402	0.190	0.304
Constant	-5.939***	1.821	-6.859***	1.832	-3.669	2.826	-5.443***	1.817
Observations	10,039		8,894		5,506		10,064	
Maximum VIF	1.29		1.25		1.27		1.33	

Notes: ***significant at 1%; **significant at 5%; *significant at 10%; rse = robust standard error.

Redemption constraints, liquidity of assets under management, and performance

This subsection addresses the results obtained from the relationship between redemption constraints and the liquidity of assets under management of equity funds, as well as the effect of the interaction between portfolio liquidity and redemption constraints on performance. Initially, Table 6 shows the descriptive statistics of the analyzed data. Based on the descriptive statistics of the portfolio composition, it can be observed that the funds have 51.50% of their portfolios allocated in stocks and 39.55% allocated in other funds. Moreover, Brazilian equity funds have a higher percentage of assets, whether in stocks or shares of other funds considered as highly liquid. Although 41.08% of the funds in the sample have redemption constraint, only 14.12% of the funds have most of the portfolio allocated to low liquidity assets. The average value for the interaction between illiquidity of the portfolios and redemption constraints indicated that 7.6% of the funds have some redemption constraint and most of the portfolio is allocated to low liquidity assets. Nevertheless, this low percentage does not necessarily indicate that a small sample may compromise the proposed analyses, since other funds have a significant percentage of their portfolios allocated to low liquidity assets, but do not impose redemption constraints on their shareholders.

Table 6. Descriptive Statistics of Funds' Portfolios

Variables	Observations	Average	Standard Deviation	Min	Max
stocks	12,447	51.498	42.774	0	112.621
funds	12,447	39.546	46.742	0	102.748
difs	12,447	-36.283	38.215	-103.786	57.062
diff	12,447	-12.358	52.286	-102.071	100.094
difa	12,447	-48.683	58.399	-404.701	100.094
liqconst	12,447	0.411	0.492	0	1
iliqcart	12,447	0.141	0.348	0	1
restr*iliqcart	12,447	0.076	0.266	0	1

Notes: stocks: percentage of portfolios allocated in stocks; funds: percentage of portfolios allocated in other investment funds; difs: difference between the percentage of the volume of the portfolio allocated in low liquidity stocks and the percentage of the volume of the portfolio allocated in high liquidity stocks; diff: difference between the percentage of portfolio volume allocated to low liquidity funds and the percentage of portfolio volume allocated to high liquidity funds; difa: difference between the percentage of portfolio volume allocated to low liquidity assets and the percentage of portfolio volume allocated to high liquidity assets; liqconst: dummy variable with value 1 for funds with lockup greater than or equal to 30 days or minimum balance greater or equal to R$10,000 or that charge exit rate, and value 0 for the other funds; iliqcart: dummy variable with value 1 for funds that invest most of the portfolio in low liquidity assets and value 0 for the others; restr*iliqcart: product of the multiplication of the variables liqconst and iliqcart (liqconst x iliqcart).

In order to identify possible effects of redemption constraints on the liquidity of assets under management of equity investment funds, linear regression models were estimated. They are presented in Table 7, namely: Model 1 determines the effect of redemption constraints on the illiquidity of stocks in the funds' portfolios; Model 2 determines the effect of redemption constraints on the illiquidity of investments in shares of other funds; Model 3 determines the effect of redemption constraints on the illiquidity of assets in general, whether stocks or funds, of portfolios.

Table 7. Portfolio Liquidity and Liquidity Constraints

Variables	Model 01 difa		Model 02 diff		Model 03 dift	
	b	rse	b	rse	b	rse
liqconst	6.456***	0.939	8.693***	2.462	15.198***	2.637
nlnw	1.462***	0.369	-2.786***	0.508	-1.280**	0.636
age	-0.775***	0.110	-0.418**	0.184	-1.186***	0.207
ifp2	54.307***	0.780	-27.689***	2.679	26.504***	2.789
manrate	1.435***	0.395	-5.932***	1.059	-4.510***	1.118
perrate	3.241***	0.873	-16.665***	2.482	-13.404***	2.631
Constant	-91.514***	6.322	58.348***	9.172	-33.973***	11.300
Observations	11,629		11,629		11,629	
Maximum VIF	1.33		1.33		1.33	

Notes: ***significant at 1%; **significant at 5%; *significant at 10%; rse = robust standard error.

The results presented in Table 7 show that there is a positive and statistically significant relationship between the redemption constraints and the difference between the percentage of investment in low and high liquidity assets, in the case of stocks (Model 1), shares of other funds (Model 2) and both (Model 3), suggesting that redemption constraints imply a higher percentage of low liquidity assets in the funds' portfolio.

We estimated the models to determine whether the illiquidity of the funds' portfolio enables better performance from an eventual premium for liquidity, as shown in Table 8. In this table, Model 1 investigates the effect of the illiquidity of the portfolios on the performance of the funds, measured by the Sharpe ratio. Model 2 investigates the same but considers only the Sharpe ratio of funds that had a positive risk premium; Model 3 investigates the illiquidity effect of the portfolios on performance, measured by the Sortino ratio; Model 4 investigates the same but measures performance using the Jensen's Alpha.

Table 8. Portfolio Liquidity and Performance

Variáveis	Model 01 sharpe		Model 02 sharpepos		Model 03 sortino		Model 04 alpha	
	b	rse	b	rse	b	rse	b	rse
iliqcart	-0.010	0.034	0.022	0.044	0.181	0.119	-0.154	0.465
nlnw	0.084***	0.007	0.046***	0.009	0.137***	0.026	1.116***	0.101
age	-0.018***	0.002	-0.018***	0.002	-0.048***	0.006	-0.223***	0.025
ifp2	0.160***	0.023	0.120***	0.029	0.405***	0.087	1.498***	0.337
manrate	-0.040***	0.007	-0.042***	0.010	-0.092***	0.034	-0.624***	0.124
perrate	0.072***	0.019	0.195***	0.026	0.648***	0.083	0.551***	0.291
Constant	2.063***	0.114	2.734***	0.163	14.312***	0.574	-5.553***	1.850
Observations	10,064		3,819		10,064		10,064	
Maximum VIF	1.41		1.38		1.41		1.41	

Notes: ***significant at 1%; **significant at 5%; *significant at 10%; rse = robust standard error.

The results presented in Table 8 show that the superior performance of the funds does not come from investment in low liquidity assets (liquidity premium of the portfolios' assets), since the relationship between the variable that measures the illiquidity of the funds' portfolios and the different variables of performance was not statistically significant. In order to support this evidence, we estimated models that analyze the effect of the relationship between redemption constraints and portfolio liquidity on the performance of the funds, as shown in Table 9.

Table 9. Liquidity Constraints, Portfolio Liquidity, and Performance

Variáveis	Model 01 sharpe		Model 02 sharpepos		Model 03 sortino		Model 04 alpha	
	b	rse	b	rse	b	rse	b	rse
restr*iliqcart	0.042	0.039	0.065	0.494	0.060	0.125	0.002	0.476
nlnw	0.084***	0.006	0.046***	0.009	0.136***	0.026	1.118***	0.100
age	-0.017***	0.002	-0.018***	0.002	-0.048***	0.006	-0.222***	0.025
ifp2	0.149***	0.020	0.117***	0.026	0.456***	0.083	1.445***	0.294
manrate	-0.039***	0.007	-0.042***	0.010	-0.098***	0.034	-0.618***	0.122
perrate	0.073***	0.019	0.194***	0.026	0.636***	0.083	0.562*	0.289
Constant	2.053***	0.112	2.731***	0.161	14.354***	0.574	-5.598***	1.821
Observations	10,064		3,819		10,064		10,064	
Maximum VIF	1.29		1.25		1.29		1.29	

Notes: ***significant at 1%; **significant at 5%; *significant at 10%; rse = robust standard error.

Table 9 shows that even when considering the relationship between liquidity constraints and portfolio liquidity in the models, the results corroborated previous findings regarding the interest variable and the characteristics of the funds.

Robustness tests

Different robustness tests were performed: i) funds with age less than or equal to three years were excluded from the sample in order to correct any incubation bias; ii) tests with a sample containing only actively managed funds, since indexed funds may not have sufficient incentives to invest in illiquid assets in the search for a liquidity premium; iii) tests with panel estimators (fixed effects, random effects or stacked MQO) as indicated by the Breush-Pagan, Chow and Hausman tests; iv) tests considering a sample containing only funds that had three redemption constraints simultaneously (lockup, exit rate, and minimum balance) or no constraints. The results for these tests were similar to those previously shown in Tables 1 to 7, presented in supplementary material, check it out: http://bibliotecadigital.fgv.br/ojs/index.php/rae/article/view/78260/75003.

The results of the robustness test in which the database was separated in two distinct periods: 2009–2013 and 2014–2016, are noteworthy, and the models were estimated again. The objective of this new round of tests was to determine whether the results would be equivalent in periods of relative economic prosperity when compared to periods of recession (the proxy for the second period was the years 2014–2016). The results are shown in Tables 8 to 23, presented in supplementary material, check it out: http://bibliotecadigital.fgv.br/ojs/index.php/rae/article/view/78260/75003. The combination of the effect of the funds' liquidity constraints and the liquidity of the assets in the portfolio remained equivalent, as did the effect of the funds' liquidity constraints on the portfolio liquidity. In other words, regardless of the period, the funds in the sample with greater redemption constraints had a higher percentage of their portfolios invested in less liquid assets. Conversely, the effect of redemption constraints on fund performance was positive and significant only in periods of recession, suggesting that liquidity constraints are not necessarily responsible for better performance indices of the funds in the sample in periods of financial constraints. These different results may be related to the regulatory change that occurred in 2014, opening opportunities for future studies on this subject.

DISCUSSION

In general, the results indicate that there is a positive and statistically significant relationship between the redemption constraints (whether lockup period, minimum balance, exit rate, or their combination) and the performance of Brazilian equity investment funds, suggesting that funds, which have redemption constraints, perform better. Thus, the first hypothesis of this work (H1) was not rejected. These findings are in line with previous studies such as Agarwal et al. (2009), Aragon (2007), Bali et al. (2007), Hong (2014), and Liang (1999), among others.

Similarly, when analyzing the relationship between liquidity constraints and illiquidity in the fund portfolios, the results corroborate the literature, specifically the findings of Aragon (2007), Hong (2014), and Schaub and Schmid (2013) that report lower liquidity of assets under management of funds with redemption constraints. The main argument of these authors is that liquidity constraints increase the discretion of the fund manager by limiting unforeseen redemptions by shareholders, thus enabling the efficient management of low liquidity assets, or opportunities that take time to become profitable. Thus, the H2 hypothesis was not rejected.

Conversely, although evidence suggest that funds with liquidity constraints have a higher percentage of low liquidity assets in their portfolios, it is not possible to identify any superior performance of the funds resulting from the investment in low liquidity assets (liquidity premium) from the results of the models, since the relationship between the variable that measures the illiquidity of the funds' portfolios and the different variables of performance was not statistically significant. Even when considering the relationship between liquidity constraints and portfolio liquidity in the models, the results were similar. Thus, the evidence did not allow the indication of a premium from the investment in illiquid assets; therefore, the H3 hypothesis was rejected.

With regard to the characteristics of the funds, there was a positive and statistically significant relationship between size and performance, that is, the larger funds performed better. This effect is in line with the studies of Castro and Minardi (2009), Milani and Ceretta (2013), and Rochman and Eid (2006). Nevertheless, according to Milani and Ceretta (2013), a large part of the literature on investment funds report results differently from those found in this study, regarding the relationship between these variables.

There was a negative and statistically significant relationship between age and performance; this means that new funds achieve better performance than old funds. It is worth noting that some studies, such as Ferreira, Keswani, Miguel,

and Ramos (2013), Juvercina (2016), and Silva and Iquiapaza (2017) have already found evidence in this regard. A possible explanation for this result is market competitiveness, that is, for a given new fund to survive and attract customers, it must meet certain requirements or provide superior benefits (such as better performance), when compared to funds that are already established in the market.

When looking at the effect that investing in shares of other funds has on the performance of equity funds, the results suggest a positive relationship. Studies on this relationship are scarce since there is no consensus among the researches that investigate this subject. On one hand, some authors state that investment funds in investment fund shares (IFIFS) deliver lower performance on account of their structure, which involves double incidence of rates, coming from the underlying funds and IFIFS management. This hypothesis is corroborated by the studies of Denvir and Hutson (2006) and Ang, Rhodes-Kropf, and Zhao (2008). On the other hand, other authors state that even with the costly structure, the IFIFS obtain better performance from the diversification of markets and asset classes, managers, and management models. This hypothesis is corroborated by the studies of Dai and Shawky (2012) and Malaquias and Eid (2014). The evidence found in this study corroborates the latter hypothesis.

Furthermore, the results showed that management rate is negatively associated with the performance of the equity funds, that is, the higher the management rate charged by the fund, the lower its performance tends to be. Although high administration rates are usually justified by the remuneration of managers with superior ability, who achieve better performance for the fund, Brazilian studies conducted with equity funds, such as those of Dalmácio, Nossa, and Filho (2007), Matos, Penna, and Silva (2015), and Rochman and Ribeiro (2003) corroborate the findings of this work, in this specific aspect.

Finally, although a part of the estimated models indicates a positive relationship between the incidence of performance rate and the performance of equity investment funds, in some models (in which performance was measured by Sharpe ratio and Jensen's Alpha), the statistical significance was not sufficient to confirm this hypothesis.

FINAL CONSIDERATIONS

This study analyzed the relationship between redemption constraints and the liquidity of assets under management of Brazilian equity investment funds, as well as the effect of the relationship between portfolio liquidity and redemption

constraints on performance. Moreover, some determinants of fund performance were considered as control variables based on their characteristics.

The results of this study showed that the redemption constraints (whether lockup period, exit rate, minimum balance or even their combination) are positively related to performance, regardless of the performance measure used, which suggests that the funds with these constraints to shareholders have superior performance. However, they do not explain why this relationship occurs. We hypothesized that these constraints, by limiting redemptions at inopportune or unexpected moments on the part of shareholders, allow the fund manager to have room for his investment strategies, thus exploring profitable opportunities, but with a view of the long-term and low liquidity.

Therefore, regression models were estimated to analyze the relationship between redemption constraints and portfolio liquidity, as well as the effect of their interaction on fund performance, in order to present empirical evidence. Regarding the effect of redemption constraints on portfolio liquidity, the results indicate that the funds that establish redemption constraints tend to have portfolios with a higher percentage of investments in assets, stocks, and shares of less liquid funds. Regarding the effect that portfolios with low liquidity assets have on the performance of equity funds, the results were not sufficient to confirm the existence of a liquidity premium.

Thus, further studies can consider other categories of funds in their samples, especially multimarket funds, which are similar to hedge funds normally investigated in international studies on redemption constraints, portfolio liquidity, and performance. Furthermore, it would be interesting to compare the findings from the Brazilian market with other markets, or even to determine how economic crises affect the composition of redemption constraints and their related aspects. Other measures for portfolio liquidity could also be used to discover liquidity premium in Brazilian funds.

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