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Dynamic Correlation between Share Returns, NAV Variation and Market Proxy of Brazilian ETFs

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Exchanged Traded Funds (ETFs) have become one of the largest investment opportunities today. They present special features that differentiate them from other investment funds, in which the most important are their traded shares. Their share prices are market oriented and are not necessarily strongly correlated with the value of their portfolio, i.e, their Net Asset Value (NAV). Then, the relationship between share return, net asset value variation and market return goes beyond the understanding of traditional models, like CAPM, puzzling investors. Hence, the objective of this paper is to analyze the dynamics of share return and NAV variation of Brazilian ETFs and how they behave in relation to the Brazilian Market. We use the Dynamic Conditional Correlation of Engle (2002) to analyze these dynamics. Our results point that the correlation between Share and Market returns were higher that the correlation between NAV variation and Market return, indicating that an investor who buys ETF share is more exposed to Market risk than the risk of the ETF fund portfolio. Another important issue regarding the crisis periods is that the DCC between Share and Market return showed that before the subprime crisis, there was a correlation drop, indicating that ETF market suffers some kind of effect that could be a crisis forecast. But during the Euro zone debt crisis, the correlation drop happened concomitantly with the volatility increment, i.e., with the crisis. That can be because of different natures of the crises, since the former was a financial crisis and the latter an economic crisis. We also find that when not in a financial crisis period, the ETF's returns are more linked with the overall market, but during financial crisis periods, investors seek to trade ETF shares by their NAV value. During the economic crisis, however, the opposite effect seems to occur: the correlation between Share and Market return remains higher than 0.95, but the correlation between Share return and NAV variation drops to very low standards.

Keywords: *ETFs, DCC, Multivariate Volatility, Brazilian Market, Share return, NAV variation*.

Introduction

Exchange Traded Funds (ETFs) have become a widespread investment vehicle, with unique characteristics that have not been sufficiently studied, especially when it comes to emerging markets ETFs. Also, consolidated asset pricing models are not enough to analyze the dynamics of a kind of fund that adds a different dimension in relation to conventional investment funds: the variation of share prices.

The traditional CAP model, developed by (Sharpe, 1964; Lintner, 1965; Mossin, 1966) was based on the relationship between risk and return, outlined by (Markowitz, 1952). Jensen (1967) applied CAP model to the mutual fund performance evaluation, calculating how much mutual fund variation depends on the systematic (market) variation (Beta), how much is due to manager's ability (Alpha) and how much is due to idiosyncratic risk (residual). But ETFs present considerable differences from traditional mutual funds, like traded shares. So, investors face the fact that their share price is different from their net asset value (NAV), an unadvised feature of this investment kind.

There are not enough studies regarding the relationship between ETF share price and NAV and their relationship with the market. A concise review of the recent developments is provided by Charupat and Miu (2012), who identify three main literature strands: (a) the ETFs pricing efficiency (how close ETFs prices are from their NAVs); (b) the ETFs performance (how successfully are they achieving their objectives, measuring the difference between NAV returns and underlying index returns); (c) the effects of ETF trading on their underlying securities.

Exchange Traded Funds of emerging markets have received even less academic attention, although they have become increasingly important for investors, due to their fast growing economies. In an attempt to reduce this gap, the objective of this study is to analyze the pricing efficiency of Brazilian ETFs. As evidenced by Charupat and Miu (2012), we analyze if ETF return is adjusted with its NAV variation. But we also analyze how much of ETF return is due to the overall market (systematic risk, like in the traditional model) and if this relation overcomes the first.

To comply with that, we aim to estimate the Dynamic Conditional Correlation, a method proposed by Engle (2002), between ETF share returns, NAV variations and market returns and analyze their behavior during the period of 2004–2012. Our results point, basically, that ETFs share returns are more correlated with Market returns than with their own NAVs and that the subprime and Euro zone debt crisis cause different reactions on ETFs traders. Section 2 highlights the Brazilian ETF market; Section 3 brings a brief theoretical review on earlier studies; Section 4 presents our method; Section 5 discuses the results and Section 6 resumes the results and points out some conclusions.

Exchange Traded Funds and the Brazilian context

Exchange traded funds (ETFs) are passive investment funds which have become increasingly popular in a relatively short period of time. Their main difference in relation to conventional index funds is that, similarly to individual stocks, ETFs shares can be bought and sold throughout the trading day in an exchange market. Over the past twenty years, the number of ETFs has grown from zero to over 2000 in the United States, holding assets of more than US$ 1.000 billion under management (Blackrock, 2010). Studies that have examined the performance of ETFs that mimic U.S. equity indexes conclude that ETF performance is predictable to a high degree of accuracy, generally managing to stay close to their benchmark indexes with low levels of tracking error.

Brazilian ETFs were created in January 2002 by the instruction nº 359 of *Comissao de Valores Mobiliarios* (CVM), a governmental institution that regulates the Brazilian financial market. As international ETFs, they should track a reference index, commonly the Ibovespa Index, which represents Brazilian market. But differently than ETFs of the US, they don't pay dividends to shareholders, reinvesting the stocks dividends in their portfolios. The instruction nº 359 of CVM determines that at least 95 % of ETF equity should be invested in assets traded in the stock market or other assets authorized by the CVM, in the proportion they integrate the fund reference index, or invested in index futures. This way, ETF is assured to reflect its reference index variation. The remaining 5 % of the fund equity can be invested in government bonds, fixed income bank investments, fixed income mutual funds, commitment transactions and derivatives (exclusively for risk management of the fund portfolio). In the Brazilian market, ETFs are one of the few investment fund kinds that can trade shares at a stock market, unlike the USA where this possibility is available to many kinds of investment funds. Funds with traded shares puzzle investors in the sense that their total share prices may represent a different value of their underlying fundamentals, i.e., their net asset values (NAVs). The difference between share prices and their NAVs is called a discount and some studies such as Berk and Stanton (2007) point out to the discount persistence. But the discount and its persistence are not very well explained by current literature and this kind of funds challenge conventional models of asset pricing. Section 3 presents a brief review of the late studies on this subject.

Theoretical Issues

A concise review of the recent developments of the academic studies on Exchange Traded Funds is provided by Charupat and Miu (2012). They identify three main literature strands: (a) ETFs pricing efficiency (how close ETFs prices are from their NAVs); (b) ETFs performance (how successfully are they achieving their objectives, measuring the difference between NAV returns and underlying index returns); (c) the effects of ETF trading on their underlying securities.

Since before ETFs popularity, a considerable amount of studies have been investigating the pricing efficiency of other kinds of investment funds, especially closed-end investment funds that have traded shares. The discrepancies between share prices and underlying NAVs are often considered an anomaly, still requiring theoretical explanation. Anderson *et al.,* (2011) find an important asymmetry between discounts (the difference between the share price and its NAV) of equity and bond funds. They estimate a dynamic conditional correlation for prices and NAVs of both equity and bond funds, showing that the correlation is much lower for bond funds than for equity funds. They also conclude that there was a structural break after Lehman bankruptcy (late 2008) for bond funds. This result may be linked with the lack of liquidity in the markets for some categories of bonds.

Tse and Martinez (2007) analyze 24 ishares series from January 2, 2002 to December 31, 2004, mostly country index funds. Their results point that ETFs do not trade at high premium or discount because the creation and redemption of ishares through in-kind transactions keep the price closer to their net asset value (NAV). International ishares have a high correlation with US markets, resulting in limited diversification benefits. Engle and Sarkar (2006) examine US and international ETFs, finding that the pricing deviations are larger for the international than for the US ETFs. Besides being larger, they are also more persistent. Jiang *et al.,* (2010) analyze the first Chinese ETF, the SSE 50, showing that the fund price and NAV are co-integrated, and there is unidirectional causality from price to NAV. The fund is priced closely to its NAV with occasional short excursions away, particularly during the second semester of 2007, when the Chinese market experienced substantial volatilities, reflecting sudden increased market risks as a potential opportunity for arbitrage during financial instability. Defusco *et al.*, (2011) studied the pricing deviations of the three most liquid US ETFs. Using intraday data from 1999 to 2005, they estimate an error correction model, showing that the pricing deviations are stationary and predictable.

Ivanov (2012) tested the "disintegration hypothesis" based on REIT and two ETF's from Dow Jones, examining if their shares disintegrate from their underlying assets (NAV) during the subprime financial crisis. Their results failed to support the disintegration hypothesis between funds shares and NAV, but they found co-integration between the REIT and its benchmark index (MSCI US REITs index) before, during and after the crisis. It's also documented that the tracking error increases during the financial crisis.

Qadan and Yagil (2012) use the co-integration tests and the error correction model (ECM) to test the long-run relationship between domestic Exchange Traded Funds and the returns of their underlying indexes. They find that the discrepancies augmented considerably during the subprime crisis, what could lead to arbitrage opportunities. Co-integration isn't found in several banking and real estate ETF's, but is very common among other kinds of ETF's. Albuquerque and Maluf (2011) investigate the arbitrage possibility due to the discounts originated by the difference between the share price and fundamental price of one Brazilian ETF (ishare Ibovespa), with high frequency data of 2009 and 2010 (26400 observations). Their conclusions pointed out that, although both series were strongly co-integrated in the long-run, ETF shares are more volatile than their benchmarks, what could open the possibility of arbitrage. They also analyze a strategy to take an advantage of the discounts, which seems to lead to real gain a priori, but fails when transactions costs are considered, turning out that the net returns could not beat a buy-and-hold strategy.

Hughen and Matthew (2009) compare the price transmission dynamics between closed-end country funds and Exchange Traded Funds using a sample of funds that invest in foreign securities. With a sample period of March 31, 2000 to March 31, 2001, a vector auto-regression model (VAR) is estimated. The analysis shows that ETFs returns are more closely related to their portfolio returns than CEFs are. Innovations in NAV explain 78 % of the 5-day ahead forecast error variance for ETF share prices but only 54 % of the forecast error variance for CEFs. Levy and Lieberman (2013) studied the efficiency of country's ETFs as tracking instruments that are designed to follow foreign indexes, with daily and intraday data. As long as the US and the country market are synchronized, country's ETF prices adjust to their realized NAVs, i.e., as long as foreign markets are open and NAV is actively traded, foreign markets govern the returns of country ETFs in the US. But when foreign markets are closed, the S&P500 index accounts for the largest part of country's ETFs returns.

The second strand of ETF academic literature, according to Charupat and Miu (2012), refers to performance evaluation, based mainly on tracking errors. In this case, tracking errors may be defined as the difference between ETF NAV return and the corresponding underlying index return.

According to Agapova (2011), differences between conventional mutual funds and ETFs performance are not significant. The study used monthly data from 2000 to 2004 on uneven panel, showing that both kinds of funds did not statistically outperform or underperform their benchmarks. The study also found that mutual funds and ETFs are substitutes, but not perfect substitutes.

Drenovalk *et al.*, (2012) analyze 31 European Sovereign ETFs based on four Tracking Error models. The models were estimated by OLS and Co-integration approaches. In a general matter, funds underperform their benchmarks, especially during the euro zone debt crisis. Returns of active funds vary substantially and are higher than the US Treasury Bond ETFs. The effects of volatility and duration of the underlying indexes, as well as equity size affected the fund performance. Blitz *et al.*, (2012) study European index funds and Exchange Traded Funds in the period from January 2003 to December 2008. Their results show that most funds underperform their benchmarks, but there are considerable differences in performance between funds. Also, the expense ratios are an important determinant of relative fund performance, although there is other important factor that could explain this underperformance: the dividend yield.

Shin and Soydemir (2010) tested the performance of ETF using Jensen model. Besides, they tested the dependence of discounts on their historical price movements by employing a serial correlation test and ran the test by observing how each market reacts to discrepancy. Their findings point out that there are significant tracking errors between ETF performance and their benchmark. They also find that Asian ETFs appear to be noisier and more prone to momentum trading, meaning that active management would be more appropriate for Asian markets than for the US markets.

The pricing and performance of leveraged ETFs were also analyzed by Charupat and Miu (2011), who found that while the pricing deviations are on average small, large premium or discounts are prone to occur. Compared to traditional ETFs, the premiums of leveraged ETFs have larger volatility. With respect to tracking errors, leveraged ETFs present good performance over holding periods of up to a week. Jarrow (2010) showed that a risk increase on leveraged ETFs will not earn proportional return.

Blitz and Huij (2012) evaluate the performance of several global emerging markets (GEM) equity Exchange Traded Funds with a sample period from 2003 to 2010. GEM funds exhibit higher levels of tracking errors than ETFs from developed markets. Specially, ETFs that rely on statistical replication techniques are prone to high levels of tracking error, and particularly during the periods of high return dispersion. The GEM ETFs underperformance in relation to their benchmark is similar to that of developed markets ETFs and can be explained mainly by expense ratios and the impact of withholding taxes on dividends.

The third strand of ETFs literature, according to Charupat and Miu (2012), refers to the effect of ETF introduction on the underlying securities. Because composite securities such as ETF are diversified, they present no firm-specific risk and liquidity traders face lower expected losses to insiders by trading in composite securities, rather than in individual securities that make up the composites. In contrast, it is argued that the introduction of a basket security like that opens another avenue for arbitrage.

Although the three main strands were discussed above, there are other ETF features which have been studied, like returns predictability and volatility. Yang *et al.*, (2010) examined daily return predictability for eighteen international stock indices of ETFs employing several non-linear models like the feed-forward artificial neural network, the functional coefficient model and the nonparametric kernel regression model. Their sample period begins in 1996 for developed countries and in 2000 for emerging countries and their results show that 3 funds of emerging countries and 3 funds of developed countries show predictability in returns.

Gutierrez et al. (2009) found that there is a volatility spillover from the US ETFs to Asian ETFs and their returns are granger-caused by the US ETFs. Also, their overnight volatility is higher than daytime volatility, due to information and sentiment that arise from the US market due to schedule differences. In the same sense, Krause and Tse (2012) found bi-directional volatility spillovers between Canada and US ETFs and that US ETFs returns lead the returns of Canadian ETFs.

Data and Method

Brazilian ETFs are this paper's object of study. The data analyzed consist of three time-series: ETFs share return (d_price), ETFs net asset value variation (d_NAV) and the return of Ibovespa Index (d_ibov), used as proxy. Both share return and NAV variation series represent an average from all Brazilian ETFs, weighted by their own NAV. Since Brazilian ETFs do not pay dividends, ETF return refers to share prices variation.

The fund data were obtained from *Associação Brasileira das Entidades dos Mercados Financeiro e de Capitais* (ANBIMA), a non-profit institution of self-regulation of Brazilian investment funds. Ibovespa data were obtained from BM&FBOVESPA, the largest Brazilian stock market. The sample period was chosen according to ETF data availability and it range from 02/08/2004 to 29/03/2012, with daily observations.

Firstly, some basic analysis will be done, such as descriptive statistics and time-series graphics interpretation. Also, Ordinary Least Squares (OLS) regressions will be estimated to verify the influence of NAV, discount and Ibovespa on share return.

Since the objective of this work is to analyze the dynamics of share return, NAV variation and the market, the comprehension of the correlation between share return and NAV variation, as well as correlation of share return and the market proxy, is fundamental. These relationships will be studied by the Dynamic Conditional Correlation (DCC) model.

The correlation is perhaps the most traditional way of measuring the association between two variables, and it is of great importance for the assembly of hedging strategies and portfolio management. However, Engle (2002) draws attention to the problems generated by the unsteadiness of the correlation over time, which makes necessary to recalculate the correlation of each period and adjust these strategies to embed recent information. This understanding also raises the need for predictive models for correlation.

Thus, Engle (2002) proposes the use of Dynamic Conditional Correlation (DCC), previously developed by (Engle & Sheppard, 2001; Tse & Tsui, 2002) as a way to estimate the conditional correlation between two variables. To enable the estimation of DCC model, it is necessary to calculate and understand the estimation of univariate conditional volatility.

The modeling of univariate conditional volatility began with ARCH models (Engle, 1982), which were later supplemented by Bollerslev (1986). The GARCH model of Bollerslev (1986) is a generalization of ARCH, which is a stochastic conditional process on information at *t-1*. Thus, the estimation of univariate volatility can be understood by Equations (1), (2) and (3):

$$r_{i,t} = \mu_i + \sum \phi_{i,m} r_{i,t-m} + \sum \theta_{i,n} \varepsilon_{i,t-n} + \varepsilon_{i,t}, \quad (1)$$

$$\varepsilon_{i,t} = h_{i,t} z_{i,t},\ z_{i,t} \sim t_v, \quad (2)$$

$$h_{i,t} = \omega_i + \sum \alpha_{i,p} \varepsilon_{i,t-p}^2 + \sum \beta_{i,q} h_{i,t-q} \quad (3)$$

Where $r_{i,t}$is a log-return of an asset *i* in period *t*; $h_{i,t}$ is a conditional variance of the asset *i* in period *t*. μ_i, ϕ_i, θ_i, ω_i, α_i and β_i are parameters; $\varepsilon_{i,t}$ is an innovation of the conditional average of the asset *i* in period *t*; $z_{i,t}$ represents a white noise.

The univariate volatility, in this article, is estimated by model (3), assuming a multivariate t-asymmetric distribution, and then used as the first step in calculating DCC, i.e. the correlation in each period, replacing the traditional static index. DCC model, according to Tsay (2010) can be represented by Equation (4).

$$H_t = J_t R_t J_t \quad (4)$$

Where H_t is a matrix of correlation between variables; R_t satisfies $R_t = (1 - \theta_1 - \theta_2)\bar{R} + \theta_1 \varepsilon_{t-1} \acute{\varepsilon}_{t-1} + \theta_2 R_{t-1}$; J_t is a matrix $J_t = diag\left(h_{11,t}^{-1/2} \dots h_{NN,t}^{-1/2}\right)$, which serves as a normalization to ensure that H is the matrix of correlation; $h_{ii,t}$ is a conditional variance of the asset *i* in period *t*; ε_t is a vector of standardized innovation in period *t*; $\bar{R}$ is an unconditional covariance matrix of ε_t. θ_1 and θ_2 are nonnegative scalar parameters that satisfy $0 < \theta_1 + \theta_2 < 1$.

Francq and Zakoian (2010) emphasize that Equation (4) is reminiscent of GARCH model (1,1), in which θ_1 is similar to parameter α_i, and θ_2 is similar to parameter β_i. Todorov and Bidarkota (2012) argue that the conditional correlation between two variables is summarized as the conditional covariance between the standardized disturbances (ε).

Then, it is possible to understand that the dynamic correlation is a process with two stages. At first, the univariate conditional volatility is estimated by GARCH model. The coefficients generated are pre-requisite to calculate the standard disturbances. These, on the other hand, are required for the second stage: calculating the conditional covariance between them, which is precisely the same as the Dynamic Conditional Correlation between the two variables.

However, the original DCC model is estimated under the assumption of multivariate normality (maximum likelihood) or a mixture of elliptical distributions (almost maximum likelihood). The use of a copula function considers the marginal distributions and the dependence structure both separately and simultaneously (Hsu *et al.*, 2008). Thus, it is possible to model the combined distribution of the innovations of each asset in the model based on a proper copula, rather than assuming multivariate normality. Therefore, the combined distribution of asset returns can be specified with complete flexibility, being more realistic.

In this paper, we estimate the Dynamic Conditional Correlation (DCC) between ETF's share return and net asset value, besides DCC between ETF's share and the market proxy. The estimated model used a copula function to calculate DCC model based on the univariate volatility estimated by ARMA (1,1) GARCH with multivariate t-distribution. Section 5 presents the results and discussion.

Results and Discussion

To initiate the analysis, we present summary statistics of return series on Table 1.

Table 1

Descriptive statistics of Share Return (d_price), Net Asset Value (d_NAV) variation and Ibovespa return (d_Ibov), i.e., the return of the market proxy

	Mean	Minimum	Maximum	Std. Deviation	Skewness	Ex Kurtosis
d_price	0,0748	-12,1520	15,1120	1,9136	0,1666	6,7908
d_NAV	-0,0932	-12,1350	15,0050	2,0201	0,0101	6,4680
d_Ibov	0,0518	-12,0960	13,6780	1,9044	-0,0711	5,8798

The descriptive statistics presented in Table 1 show that the mean return of the share and Ibovespa are positive, but the variation of NAV is negative, that means that in the analyzed period, the market proxy and the share prices increased, but NAV decreased. Minimum and Maximum points are similar to the three series, but the market proxy exhibits lower amplitude. Regarding the standard deviation, Price and Ibovespa returns are similar, but NAV variation is higher than them. As could be expected, Ibovespa skewness is negative, that means that, for this series, extreme negative returns may be larger than positive.

Initiating the analysis of the Dynamic Conditional Correlation, as Equation 4, Table 2 presents the results of the model that estimates the dynamic correlation between share return and market return

Table 2

Estimated coefficient of the Asymmetric DCC-Copula model for the variables share return and Market Return

	Parameter	Estimate	Std. Error	t value	Pr(>|t|)
Share Return (d_price)	Mu	0,1222	0,0356	3,4307	0,0006
	Ar (1)	-0,1725	0,2029	-0,8504	0,3951
	Ma (1)	0,1882	0,2017	0,9328	0,3509
	Omega	0,0605	0,0207	2,9212	0,0035
	Alpha (1)	0,0822	0,0158	5,2091	0,0000
	Beta (1)	0,8980	0,0181	49,7017	0,0000
	Shape	9,8403	2,1128	4,6574	0,0000
NAV variation (d_NAV)	Mu	0,1092	0,0298	3,6622	0,0003
	Ar (1)	0,7707	0,0768	10,0410	0,0000
	Ma (1)	-0,8061	0,0686	-11,7504	0,0000
	Omega	0,0661	0,0219	3,0136	0,0026
	Alpha (1)	0,0795	0,0153	5,2007	0,0000
	Beta (1)	0,8991	0,0184	48,8450	0,0000
	Shape	9,5966	2,0312	4,7245	0,0000
DCC Parameters	DCC (θ_1)	0,0442	0,0108	4,0919	0,0000
	DCC (θ_2)	0,9516	0,0127	75,0729	0,0000
	m-Shape	11,5309	2,4203	4,7643	0,0000
Information Criteria	Akaike	4,3623			
	Bayes	4,4122			
	Shibata	4,3621			
	Hannan-Quinn	4,3807			

Assuming multivariate *t* distribution, all coefficients are significant, at 5 % significance level. Concerning the univariate estimated volatility, Beta Coefficients are considerably higher than Alfa Coefficients, that means that previous volatility is the main influence to explain present volatility. In both cases, almost 90 % of the volatility is explained by the previous volatility. Regarding DCC parameters, the sum of $\theta_1 + \theta_2$ would be 1 if all the Conditional Correlation between share and market return was explained by the model, as theorized by Equation (4). Both parameters were significant and their sum is high, evidencing DCC persistency. The Conditional Correlation can be clarified by the graphic on Figure 1.

Figure 1 shows that the conditional correlation between these two variables is very high, reaching values higher than 0,96 during some periods, but also that DCC varies during the sample period. It is perceivable that in the beginning of the series, DCC was low and there was not an identifiable pattern, maybe because that was the beginning of ETFs fund history in Brazil, constituting a primitive period of their development. After some point of around 500 observations (August, 2006), the correlation reaches a stability landing.

But probably the most important point is that before the subprime crisis (characterized by the period of high volatility, clearly identifiable in the graphic), the correlation drops heavily and then rises again when the crisis begins. So, before the crisis actually happens, i.e. before the market/share return volatility rises dramatically, ETF market signaled the crisis eminence.

However, near the series end, there is a decrease on DCC at the same time when an increase of univariate volatility appears, due to the Euro zone debt crisis. Unlike the subprime crisis, DCC drops not before the crisis, but during it, what could be attributed to the nature of the crisis. Since the subprime crisis was a financial crisis, it is natural that it would be more foreseeable by financial traders than an Economic crisis like the Euro zone debt crisis.

It is also valid to register the fact that share return volatility and market return volatility were extremely similar, so that the investor who buys ETF share incurs the same risk level as the market, as expected by definition. Table 3 presents the estimation coefficients of the Dynamic Conditional Correlation between ETF share return and their net asset value (NAV).

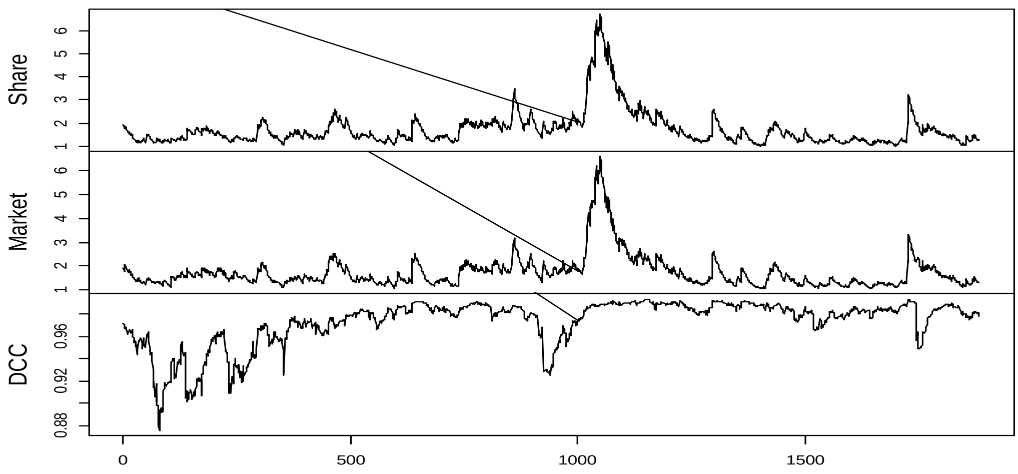

Figure 1. Dynamic Conditional Correlation between Share Return and Market Return

Table 3

Estimated coefficient of the Asymmetric DCC-Copula model for the variables share return (d_price) and NAV variation (d_NAV)

	Parameter	Estimate	Std. Error	t value	Pr(>|t|)
Share Return (d_price)	Mu	0,1222	0,0308	3,9664	0,0001
	Ar (1)	-0,1725	0,2036	-0,8473	0,3968
	Ma (1)	0,1882	0,2018	0,9327	0,3510
	Omega	0,0605	0,0183	3,3131	0,0009
	Alpha (1)	0,0822	0,0192	4,2727	0,0000
	Beta (1)	0,8980	0,0162	55,5507	0,0000
	Shape	9,8403	2,1483	4,5805	0,0000
NAV variation (d_NAV)	Mu	0,0483	0,0382	1,2631	0,2066
	Ar (1)	0,8160	0,0402	20,2758	0,0000
	Ma (1)	-0,8435	0,0274	-30,7982	0,0000
	Omega	0,1050	0,0341	3,0789	0,0021
	Alpha (1)	0,0941	0,0175	5,3889	0,0000
	Beta (1)	0,8765	0,0230	38,1271	0,0000
	Shape	6,4586	0,9624	6,7107	0,0000
DCC Parameters	DCC (θ_1)	0,1137	0,0617	1,8425	0,0654
	DCC (θ_2)	0,8852	0,0629	14,0766	0,0000
	m-Shape	4,0246	0,4296	9,3691	0,0000
Information Criteria	Akaike	4,5485			
	Bayes	4,5985			
	Shibata	4,5483			
	Hannan-Quinn	4,5669			

Differently of what was verified in Table 2, not all coefficients were significant in the estimation of the Asymmetric DCC-Copula model to the variables share return and NAV variation. ARMA (1,1) coefficients are not significant for the variable Share return, that means that this variation cannot be predicted by the model. Regarding to GARCH parameters Alpha and Beta, the results point in the same direction as previous estimation, in the sense that the major part of NAV and share return volatility depend on their previous volatility.

DCC parameters θ_1 and θ_2 present a sum near 1 again, confirming a good model adjustment. Probably, this good fit is due to the flexibility of the copula function, that doesn't depend on a specific kind of distribution, as verified by Hsu, Tse and Wang (2008). However, θ_1 is higher than the previous estimation and θ_2, smaller, that indicates that the Dynamic Conditional Correlation between Share Return and NAV variation presents a larger constant coefficient. This can be verified by Figure 2 which presents the graphic of Dynamic Conditional Correlation between share return and NAV variation.

Figure 2 shows out that during the beginning of the series, there was not a pattern of correlation, as was verified in Figure 1 for DCC of share return and market return. Next, DCC stabilizes near 1, even after the subprime crises, showing that there is a very close relationship between share return and NAV variation. The two series share the same variation for most of the sample period. This constancy is a result of a larger θ_1 coefficient.

However, as the series approximates to its end, the correlation seems to lose its pattern, coincidently with a volatility increase in the univariate volatilities, due to the

Euro zone debt crisis. Again, it is possible to verify differences between the two crises. In this case, the Euro zone debt crisis has made the share return/NAV variation correlation to fall down to a lower standard than the share return/market return correlation. One possible explanation is that both the share and market return are very susceptible to speculation, but as NAV is a form of passive investment, is not so affected by speculation.

DCC between share and market return presented an important feature regarding the crisis signaling. This can lead to an explanation pointing that ETF share traders sensed the upcoming crisis. Another interesting feature is that the conditional correlation between share return and NAV is higher than the correlation between share return and market

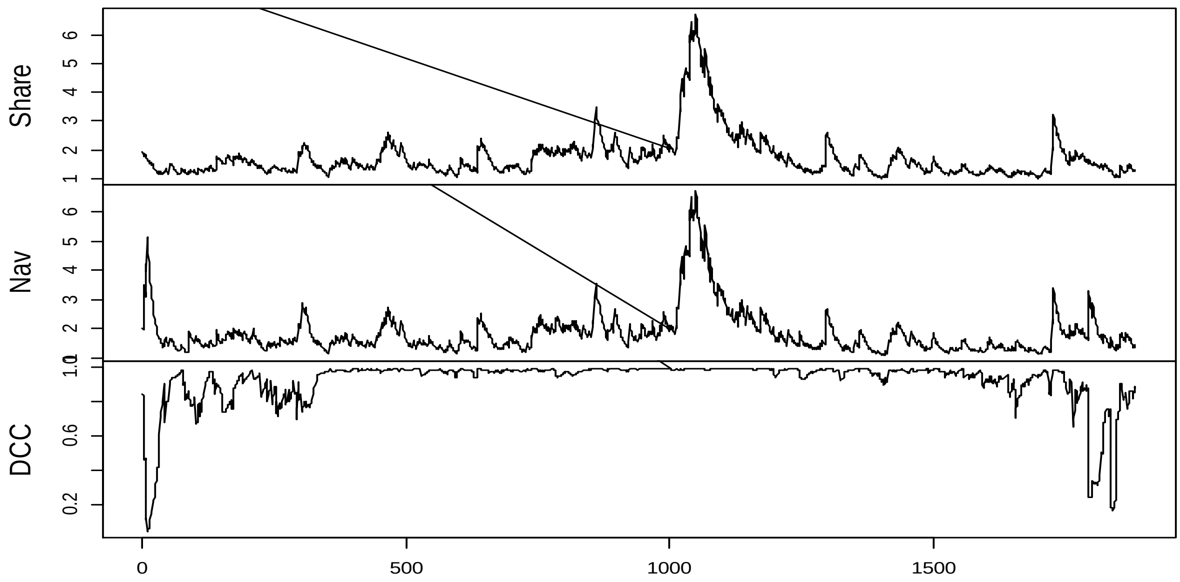

Figure 2. Dynamic Conditional Correlation between Share Return and NAV variation

Conclusions

The objective of this paper was to analyze the dynamics of share return and NAV variation of Brazilian ETFs and how they behave in relation to the Brazilian Exchange Market. The Dynamic Conditional Correlation (ENGLE, 2002) was used to verify the correlation between Share and Market return, besides the correlation between NAV variation and Market return.

Our results point that the correlation between Share and Market returns was higher than the correlation between NAV variation and Market return, indicating that the investor who buys ETF share is more exposed to Market risk than the risk of ETF fund portfolio. Notwithstanding that ETF portfolio seeks to mimic the market index, their shares may work at a different dynamics than its portfolio. Also, they are allowed to operate derivatives, what contributes to detach NAV variation of a spot market index.

Another important issue regarding the crisis periods is that DCC between Share and Market return showed that before the crisis, there was a correlation drop, indicating that ETF market suffered some kind of effect that could be a crisis forecast. But during the Euro zone debt crisis, the correlation drop happened concomitantly with the volatility increment, i.e., with the crisis. That can be because of different natures of the crises, since the former was a financial crisis and the latter, an economic crisis.

Regarding the correlation between share return and NAV variation, it was smaller than the previous DCC. Some similar characteristics remain, like the lack of a correlation pattern in the series beginning and the correlation drop during the Euro zone debt crisis, although these drops were higher than in the first case. But there was no correlation drop during the subprime crises, that may indicate that during the financial crisis the investors traded ETF shares by their NAV value, leaving aside speculation. When not in a financial crisis period, ETF's returns are more linked with the overall market, but during financial crisis periods, investors seek to trade ETF shares by their NAV value. During the economic crisis, however, the opposite effect seems to occur: the correlation between Share and Market return remains higher than 0.95, but the correlation between Share return and NAV variation drops to very low standards.

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Bruno Milani, Paulo Sérgio Ceretta

Dinaminė koreliacija tarp Brazilijos BPF akcijų grąžos, GTV ir rinkos pakaitalo

Santrauka

Biržoje *prekiaujami fondai* (BPF) tapo plačiai paplitusia investavimo priemone, turinčia unikalių savybių, kurios nebuvo iki galo ištirtos, ypač kalbant apie besivystančių rinkų BPF. Neužtenka tirti bendrus turto įkainojimo modelius, kad būtų išsiaiškinta dinamika tos fondų rūšies, kuri prideda kitokį matmenį (lyginant su jungtiniais investiciniais fondais): akcijų kainų kitimą.

Tradicinis KAĮM modelis, kurį sukūrė Sharpe (1964), Lintner (1965) ir Mossin (1966) buvo pagrįstas rizikos ir grąžos santykiu, kurį bendrais bruožais nusakė Markowitz (1952). Jensen (1967) pritaikė KAĮM bendrai fondo veiklai įvertinti, prieš tai suskaičiuodamas kiek bendro fondo svyravimai priklauso nuo sisteminių rinkos svyravimų (*Beta*), kiek nuo vadovo gebėjimų (*Alpha*) ir kiek nuo išskirtinės rizikos (*liekana*). Bet BPF atveju, kai yra akcijų, kuriomis prekiaujama fondų biržoje, investuotojai susiduria su faktu, kad jų akcijų kaina skiriasi nuo jų grynosios turto vertės (GTV).

Mažai atlikta tyrimų apie ryšius tarp BPF akcijos kainų ir GTV bei jų ryšio su rinka. Besivystančių rinkų biržoje *prekiaujamiems fondams* dėmesio skiriama dar mažiau, nors jie investuotojams tampa vis svarbesni dėl greitos ekonomikos plėtros. Bandant sumažinti šią spragą, šiame tyrime siekiama išanalizuoti Brazilijos BPF akcijų grąžos dinamiką ir GTV svyravimus bei jų vietą Brazilijos rinkoje. Anderson ir kt. (2011) nustatė svarbią asimetriją tarp akcijų ir obligacijų fondų diskontų (skirtumo tarp akcijos kainos ir jos GTV). Jie nustatė dinaminę sąlyginę koreliaciją akcijų ir obligacijų fondų kainoms ir GTV, parodydami, kad koreliacija yra daug mažesnė obligacijų, o ne akcijų fondams. Jie taip pat padarė išvadą, kad po Lehman bankroto (2008 metų antroje pusėje), įvyko struktūrinis lūžis obligacijų fonduose. Tai galėjo būti susiję su likvidumo trūkumu kai kurių obligacijų kategorijų rinkose. Albuquerque ir Maluf (2011) tyrė arbitražo galimybę dėl diskontų, atsiradusių dėl skirtumo tarp akcijos kainos ir Brazilijos BPF pagrindinės kainos („*ishare Ibovespa*“), tam panaudodami 2009 ir 2010 metų duomenis (26400 stebėjimų). Jų išvados parodė, kad nors abi eilutės buvo labai kointegruotos į ilgalaikį veikimą, BPF akcijos labiau kinta lyginant su jų etalonu. Tai gali lemti arbitražą. Jie taip pat analizavo privalumus, kurie būtų gauti iš diskontų, nulemiančių išankstinę naudą. Tačiau šios naudos nebūna, kai nagrinėjami operacijos kaštai ir paaiškėja, kad grynoji grąža gali neįveikti „*pirk-ir-laikyk*“ strategijos.

Blitz ir Huij (2012) įvertina kelių, besivystančių pasaulinių rinkų (PBR) ir biržose prekiaujamų fondų veiklos maržą nagrinėjamu laikotarpiu (nuo 2003 iki 2010 metų). Fondo duomenys buvo gauti iš *Associação Brasileira das Entidades dos Mercados Financeiro e de Capitais* (ANBIMA), ne pelno siekiančios Brazilijos investicinių fondų savireguliavimo institucijos. *Ibovespa* duomenys buvo gauti iš *BM FBOVESPA*, didžiausios Brazilijos fondų biržos. Nagrinėjamo pavyzdžio laikotarpis buvo pasirinktas pagal BPF duomenų prieinamumą ir jis apėmė laikotarpį nuo 2004-08-02 iki 2013-03-29. Stebėjimai buvo atliekami kiekvieną dieną.

Kadangi šio *darbo tikslas* yra išanalizuoti akcijų grąžos, GTV kitimo ir rinkos dinamiką, supratimas apie koreliaciją tarp akcijų grąžos ir GTV kitimo, taip pat akcijų grąžos ir rinkos „pakaitalo“ koreliacijų yra svarbiausias. Šie ryšiai bus nagrinėjami naudojant *Dinaminės sąlyginės koreliacijos* (DSK) modelį. Koreliacija yra vienas iš tradiciškiausių matavimo būdų, siekiant nustatyti santykį tarp dviejų kintamųjų. Koreliacija yra labai svarbi sudarant apsisaugojimo strategijas ir siekiant valdyti portfelį. Tačiau Engle (2002) atkreipia dėmesį į problemas, kurias sukelia koreliacijos nestabilumas, atsirandantis bėgant laikui. Todėl reikia perskaičiuoti kiekvieno laikotarpio koreliaciją ir priderinti tas strategijas, kurios leistų įtvirtinti naujausią informaciją.

Taigi Engle (2002) siūlo naudoti *dinaminę sąlyginę koreliaciją* (DSK), kurią anksčiau tobulino Engle ir Sheppard (2001), Tse ir Tsui (2002) kaip būdą, kuriuo galima įvertinti sąlyginę koreliaciją tarp dviejų kintamųjų.

DSK modelis, anot Tsay (2010), gali būti išreikštas lygtimi (4):

$H_t = J_t R_t J_t$ (4) kur H_t yra koreliacijos tarp kintamųjų matrica; R_t tenkina sąlygą $R_t = (1 - \theta_1 - \theta_2)\bar{R} + \theta_1 \varepsilon_{t-1} \acute{\varepsilon}_{t-1} + \theta_2 R_{t-1}$; J_t yra $J_t = diag\left(h_{11,t}^{-1/2} \dots h_{NN,t}^{-1/2}\right)$, matrica, kuri yra kaip normalizacija siekiant užtikrinti, kad H yra koreliacijos matrica; $h_{ii,t}$ yra aktyvo i sąlyginis kintamasis laikotarpiu *t*; ε_t yra standartizuotos inovacijos vektorius laikotarpiu *t*; $\bar{R}$ yra ε_t nesąlyginės kovariacijos matrica. θ_1 ir θ_2 yra teigiami skaliariniai parametrai, kurie tenkina sąlygą $0 < \theta_1 + \theta_2 < 1$.

Tačiau, originalusis DSK modelis yra įvertinamas esant *daugiamačio normalumo* prielaidai (maksimali tikimybė) arba *elipsinių paskirstymų mišiniui* (beveik maksimali tikimybė). Jungties funkcijos panaudojimas leidžia atsižvelgti į ribinius paskirstymus ir priklausomybės struktūrą atskirai, ir kartu (Hsu, Tseng ir Wang, 2008). Tokiu būdu, galima modeliuoti bendrą kiekvieno aktyvo inovacijų paskirstymą modelyje, pagrįstame tinkama jungtimi, o ne laikantis *daugiamačio normalumo.*

Šiame darbe buvo įvertinta *dinaminė sąlyginė koreliacija* (DSK) tarp BPF akcijų grąžos ir grynosios vertės, ir DSK tarp BPF akcijos ir rinkos „pakaitalo“. Įvertintas modelis naudoja jungties formulę, kad apskaičiuotų DSK modelį, pagrįstą *daugiamačiu nepastovumu*, įvertintu panaudojant ARMA (1,1) GARCH su daugiamačiu *t*-paskirstymu.

Sąlyginė koreliacija tarp akcijos grąžos ir rinkos grąžos yra labai aukšta, didesnė už 0.96 reikšmę kai kuriais laikotarpiais, nors DSK, nagrinėjamu laikotarpiu, kinta. Suvokiama, kad serijos pradžioje DSK buvo maža ir nebuvo atpažįstamo modelio galbūt todėl, kad tai buvo BPF pradžia Brazilijoje, apimanti pirminį jos plėtros laikotarpį. Po tam tikrų stebėjimų (2006 metų rugpjūtis), koreliacija buvo stabili.

Tačiau svarbiausia yra tai, kad prieš rizikingų paskolų krizę (kurią apibūdina didelio nepastovumo laikotarpis, aiškiai matomas grafike), koreliacija labai nukrito, o po to vėl pakilo, kai prasidėjo krizė. Taigi, dar iki tol, kol krizė iš tikrųjų prasidėjo, t. y. prieš tai, kai rinkos/akcijos grąžos nepastovumas smarkiai pakilo, BPF rinka signalizavo apie krizės dydį.

Tačiau pabaigoje DSK sumažėjo. Sumažėjo tuo pačiu metu, kai atsirado *daugiamačio nepastovumo* padidėjimas dėl euro zonos skolų krizės. Ne taip, kaip rizikingų paskolų krizės atveju, DSK krenta ne prieš krizę, bet jos metu. Tai galima būtų priskirti krizės prigimčiai. Kadangi rizikingų paskolų krizė buvo finansinė krizė, natūralu, kad finansiniai prekybininkai ją numatė anksčiau nei ekonominę krizę (euro zonos paskolų krizė).

Taip pat reikia įvertinti faktą, kad akcijos grąžos ir rinkos grąžos nevienodumas buvo labai panašūs, todėl investuotojas, kuris perka BPF akcijas, patiria tokio pat lygio riziką kaip ir rinkoje (kaip numatyta apibrėžime).

DSK stabilizuojasi greta 1, net po rizikingų paskolų krizės, rodydama, kad egzistuoja labai artimas ryšys tarp akcijos grąžos ir GTV svyravimų. Šios dvi grupės, didžiąją nagrinėjamo laikotarpio dalį dalinasi tais pačiais svyravimais. Šis pastovumas yra didesnio θ_1 koeficiento rezultatas.

Tačiau, kai artėjama prie pabaigos, koreliacija praranda savo modelį, sutampantį su nepastovumo didėjimu *daugiamačiuose nepastovumuose* dėl euro zonos skolų krizės. Be to, galima patikrinti dviejų krizių skirtumus. Tokiu atveju, euro zonos skolų krizė privertė akcijos grąžos/GTV svyravimo koreliaciją nukristi iki žemesnio standarto, nei akcijos grąžos/rinkos grąžos koreliacija. Vienas galimas paaiškinimas yra tai, kad ir akcijos, ir rinkos grąža yra labai imli spekuliacijoms, bet kai GTV yra pasyvaus investavimo forma, spekuliacija veikia ne taip stipriai.

DSK tarp akcijos ir rinkos grąžos pateikia svarbų požymį, signalizuojantį krizę. Tai galima paaiškinti tuo, kad BPF prekiautojai akcijomis pajuto artėjančią krizę. Kitas įdomus požymis yra tas, kad sąlyginė koreliacija tarp akcijos grąžos ir GTV yra aukštesnė, negu koreliacija tarp akcijos grąžos ir rinkos. Mūsų rezultatai rodo, kad koreliacija tarp akcijos ir rinkos grąžos buvo aukštesnė, negu koreliacija tarp GTV svyravimo ir rinkos grąžos, parodydama, kad investuotoją, kuris perka BPF akcijas, labiau pažeidžia rinkos rizika, negu BPF portfelio rizika. Nepaisant to, kad BPF portfelis siekia minimizuoti rinkos indeksą, jų akcijos gali dirbti kitaip nei jų portfelis. Taip pat, jiems leidžiama naudoti derivatyvus, nes jie padeda atskirti vietinio rinkos indekso GTV svyravimus.

Kitas svarbus klausimas, susijęs su krizės laikotarpiu yra tas, kad DSK tarp akcijos ir rinkos grąžos atskleidė tai, kad prieš krizę buvo koreliacijos kritimas, kuris parodė, kad BPF rinka kenčia tam tikros rūšies poveikį, kuris gali būti susijęs su krizės prognoze. Tačiau nustatyta, kad krizės metu, euro zonos koreliacijos kritimas buvo susijęs su nepastovumo padidėjimu, t. y., su krize. Taip gali būti dėl to, kad skiriasi pati krizių prigimtis, nes ankstesnė krizė buvo finansinė, o vėlesnė buvo ekonominė.

Dėl koreliacijos tarp akcijos grąžos ir GTV svyravimo, ji buvo mažesnė negu ankstesnė DSK. Kai kurios panašios savybės išlieka. Paminėtinas koreliacijos modelio trūkumas serijos pradžioje ir koreliacijos kritimas euro zonos skolų krizės metu (nors šie kritimai buvo aukštesni lyginant su pirmuoju atveju). Tačiau nebuvo koreliacijos kritimo rizikingų paskolų krizės metu, kas gali rodyti, kad finansinės krizės metu investuotojai prekiavo BPF akcijomis už jų GTV, palikdami spekuliacijas nuošaly.

Ne finansinės krizės laikotarpiu BPF grąža yra labiau susijusi su bendra rinka. Finansinės krizės laikotarpiais investuotojai stengiasi prekiauti BPF akcijomis jų GT verte. Tačiau per ekonominę krizę, atrodo, pasireiškia atvirkštinis efektas: koreliacija tarp akcijos ir rinkos lieka aukštesnė kaip 0.95, tačiau koreliacija tarp akcijos grąžos ir GTV svyravimo krenta labai žemai.

Raktažodžiai: *BPF, DSK, daugiamatis nepastovumas, Brazilijos rinka, akcijos grąža, GTV svyravimai.*

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