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How Important is Forward-Looking Behavior in Brazilian Sectorial Indices Risk Premium?[1]

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Abstract: We add to the empirical literature of asset pricing, by proposing a forward-looking conditional approach for the volatility of Brazilian sectorial indices. We aim to identify statistically which series of expectations of main macroeconomic variables are relevant to the variance equation of a GARCH model of the Brazilian sectorial indices, assuming that CAPM is adequate to compose mean equation. Our main findings, obtained for the period from January 2009 to June 2014 using weekly data, suggest that the expectation of some macroeconomic variables have significant power to influence the volatility of most sectorial indices, except for real estate. We may highlight the relevance of different price indices, which can affect the sectors of electrical energy, public utility, consumption and industry. The basic interest rate is significant in predicting the volatility of the financial sector and basic materials, while trade balance is able to influence the financial, industrial and public utility sectors.

Keywords: Sectorial analysis. CAPM. Forward-looking volatility. GARCH effects
JEL Classification: G12, G17

1. Introduction

There seems to be a consensus in the literature on finance that the mainstream of asset pricing theory is associated with the ability to "write" microfundamented theoretical models capable to accommodate the main empirical evidences in various financial markets.[2]

A landmark of the modern version of this financial theory is the specification of the preferences of an investor depending on the moments of the probability distribution function of returns on assets suggested by Markowitz (1952). Some of the most significant extensions in the sequence are Tobin (1958), and Sharpe (1964). Thenceforth, we can see the development of a concatenated range of approaches aiming to price various types of assets.

Specifically regards pricing equities and indices, the first approach widely accepted by the academy dates of the 60: the Capital Asset Pricing Model (CAPM) developed by Sharpe (1964), Lintner (1965) and Mossin (1966). Although this model is largely used in the financial markets around the world, we can mention a wide range of limitations, critical and contrary robust empirical evidences in studies such as Ball (1978), Stattman (1980), Banz (1981), Basu (1983), Rosenberg et al. (1985) and Bhandari (1988), for instance.

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[2] The first contribution in this literature possibly dates to the sixteenth century, with the returns following a random walk as proposed by Cardano (1565).

In order to deal with these uncomfortable stylized facts, one of the most promising routes is based on extensions of the CAPM, incorporating macroeconomic and sectorial factors, as proposed by Chen, Roll and Ross (1986), or identifying variables that capture robust anomalies, as in Fama and French (1992, 1993) and Carhart (1997).

Our paper adds to this historical context by suggesting an approach that captures issues that are common to these two aspects. On the one hand, our approach is aligned to Chen, Roll and Ross (1986) when we incorporate exogenous macroeconomic variables. On the other hand, our novelty aims to accommodate a common anomaly in the financial market: the conditional heteroscedasticity and the volatility cluster, both evidenced in a very specific category of the Brazilian economy, sectorial indices BM&FBOVESPA.

These indices are dynamic portfolios rebalanced every four months according to the representativeness in terms of trading of company shares in a particular sector. Here, we apply our approach to indices of the following sectors of the Brazilian economy: consumption (ICON), electricity (IEE), financial (IFNC), basic materials (IMAT), real estate (IMOB), industrial (INDX) and public utility (UTIL).

The relevance of writing specific models for the risk premium of sectorial indices is firstly due to the scarcity of the literature about it. We may mention the performance analysis suggested in Righi, Ceretta and Silveira (2012), the study of cointegration proposed by Righi, Ceretta and Silveira (2014) and sectorial contagion in Matos, Trompieri and Canamary (2014). Secondly, we must recognize the role of these assets in the strategy of diversification of Brazilian and foreign investors, given their low levels of volatility.

We know that idiosyncratic risk drivers are usually not relevant when one intend to price dynamic portfolios. Thus, using simple models as CAPM to price indices often has results that are more satisfactory if we compare to the results obtained if we use CAPM to price equities. For instance, we evidence that using CAPM to model Brazilian sectorial indices explains two to four times the what would explain if this model were used to price Brazilian equities. This finding can suggest that we should not look for a much better model for these assets. In this context, why should we suggest a more sophisticated and specific pricing model for these indices?

Actually, we rely on this satisfactory performance of CAPM. However, we must take into account that the time series of returns on most of these sectorial indices, on a daily or weekly frequency, should not be treated as homoscedastic and that this conditional volatility may depend on macroeconomic variables. Aiming to model statistically this macroeconomic dependence, dealing with time varying volatility, and considering the capacity of the CAPM to price returns of Brazilian sectorial indices, we propose here a conditional heteroscedasticity framework applied to the risk premiums of these assets. We apply our model in an empirical exercise with weekly frequency, during the period from January 2009 to June 2014, based on a mean equation with the market excess return as the explanatory variable (CAPM) and a variance equation depending of weekly series of expectations of main macroeconomic variables in Brazil (forward-looking GARCH).

This forward-looking volatility is our main methodological novelty, so that we are implement carefully this procedure. We use the expectations series for the economic variables monitored by Market Report - Focus of the Central Bank of Brazil (BCB) that reflect the market perception for the macroeconomic performance of the country. Our best specified and parsimonious version of the model is based on Bayesian criteria information proposed by Schwarz (1978).

This paper is structured so that in section 2 we offer a brief description of the sectorial indices. In section 3 we detail the methodology proposed, while in Section 4 we present the empirical exercise and discuss the results. The final considerations are in the fifth section.

2. Brazilian Sectorial Indices

The sectorial indices summarize a segmented view of the stock market behavior, because they are composed by the equities of the most significant companies in a specific sector, thus consisting in an indicator of the aggregate behavior of the economic segment considered.[3]

The Industrial Sector Index (INDX) arose from an agreement between the Federation of São Paulo State Industries (FIESP) and the BM&FBOVESPA, aiming to measure the performance of the shares of the industrial sector based on a value weighted portfolio. This general criteria for the selection and weighting apply to indices that follow, except for the IEE.

Consumption Index (ICON) aims to provide a segmented view of the stock market through the equities of most representative companies in the cyclical and non- cyclical consumption sector. The latest sector index, the Real Estate (IMOB), whose negotiations began in 2008, measures the performance of shares of most representative companies in the civil construction, real estate brokerage and exploitation of real estate.

The Financial Index (IFNC) measures the performance of shares of most representative companies of the financial intermediation, financial services and pensions, insurance sectors, while the Basic Materials Index (IMAT) deals with the behavior of the shares of most representative companies in the materials sector basic. The Public Utilities Index (UTIL) aims to measure the performance of shares in companies representing the utilities sector: electricity, water, sanitation and gas. The theoretical portfolio of Electric Energy Index (IEE) is composed by the assets of most representative electric power companies. This is the only index with equal-weighted composition.

In order to compare these sectorial indices and the market index of the Brazilian economy, Ibovespa, we plot in Figure 1 the cumulative gain, based on the weekly series end-of-day quote during the period from January 2009 to June 2014. According to Matos, Canamary and Trompieri (2014), these indices have common relations in the long and short term, as apparently shown in this figure. We may highlight that IMAT in the unique index that underperformed the market benchmark, while index of the consumption sector detaches from the other indices from mid-2012, with the largest of the net nominal cumulative gains, with almost 250%.

3. Methodology

We suggest a linear pricing approach to model risk premiums of Brazilian sectorial indices, which incorporates weekly series of expectations of exogenous macroeconomic variables to the conditional volatility framework. This procedure accommodates the conditional heteroscedasticity and clustering of volatility, a fairly common evidence, according to Bollerslev, Chou and Kroner (1992).

[3] On the website of BM&FBOVESPA there are available documents with the complete methodology of each index, which are detailed order, the assets eligible for the theoretical portfolio, the criteria for inclusion and exclusion of assets, the criterion weighting and procedures for rebalancing this portfolio.

More specifically, regarding the average equation, we assume as satisfactory the ability of CAPM to model the returns. Thus, we use this simple framework developed by Sharpe (1964), Lintner (1965) and Mossin (1966), whose main assumptions are investors with short-term strategies, users of portfolio selection model a la Markowitz, with homogeneous expectations and absence of transaction costs. To summarize, in the mean equation the risk premium of each index depends linearly on the intercept and on the market risk premium.

The second step is the adoption of a framework for modeling the volatility. Here, we follow West and Cho (1995), who show that for short time horizons the family of Generalized Autoregressive Heteroscedasticity (GARCH) models, originally developed by Engle (1982) and generalized by Bollerslev (1986) is more accurate and appropriate to predict volatility than a constant standard deviation or even compared to other frameworks of conditional volatility.

More specifically about the equation of variance, Engle (1982) suggests a conditional variance as a linear function of the square of past innovations, giving rise to the famous framework entitled Autoregressive Conditional Heteroscedasticity (ARCH). Aiming to get a more parsimonious framework, no major problems with signal parameters and to allow both a long memory and a more flexible lag structure, we follow the extent suggested in Bollerslev (1986) entitled Generalized ARCH (GARCH). A recent application of this very interesting framework for Brazil and other Latin American countries is Hegerty (2014).

In the third step, we have our innovation key by incorporating the dependence of each sector volatility in relation to the change in expectation of the main macroeconomic variables. These expectations are monitored and reported on Market Report - Focus, published weekly by the Central Bank of Brazil (BCB). Our forward-looking volatility can be described as follows:

$$r_t^i = \alpha^i + \beta^i r_t^{IBOV} + \varepsilon_t^i, \text{ for all } i \tag{1}$$

$$\varepsilon_t^i | \Psi_{t-1} \sim N(0, {\sigma_t^i}^2), \text{ for all } i \tag{2}$$

$$ {\sigma_t^i}^2 = \theta_0 + \sum_{l=1}^{q} \theta_l \, {\varepsilon_{t-l}^i}^2 + \sum_{j=1}^{p} \gamma_j \, {\sigma_{t-j}^i}^2 + \sum_{s=1}^{13} \varphi_s^i x_{s,t} + \vartheta_t^i, \text{ for all } i \tag{3}$$

Formalizing r_t^i denotes the weekly nominal net return on sectorial index i in the period t over the current risk free rate, given in Brazil by savings account. In equation (1), r_t^{IBOV} is the weekly nominal net excess market return in t over current risk free rate, while the parameters α^i and β^i represent the performance adjusted for risk of sectorial index i and the sensitivity of index i to oscillation in the market portfolio return, respectively.

Concerning the GARCH model, μ_t^i represents the time varying average of r_t^i, while ε_t^i is the demeaned series of r_t^i, which follows a normal, and whose conditional variance ${\sigma_t^i}^2$ is expressed by equation (4). About this equation of variance, as usual in the GARCH specification, we have that $p \geq 0,\ q > 0,\ \theta_0 > 0, \theta_l \geq 0,\ \gamma_j \geq 0,\ \text{e}\ 0 \leq \sum_{l=1,j=1}^{\max(p,q)} \theta + \gamma_j < 1$. Also in this equation, φ_s^i measures the reaction of the sectorial index i to a change of forward-looking variable s in question, expressed by $x_{s,t}$. The residual of the variance equation is given by ϑ_t^i.

Finally, we have to find the best specification for the GARCH, i.e., defining how many lags, p and q, and identifying which forward-looking explanatory variables must be incorporated into the final specification framework, a non-trivial step, according to Tsay (2005). As reported in this literature, low-order GARCH are used in most applications. Here, we get the volatility models by means of recursive programming routines. Aiming at the most parsimonious model, we consider only the Schwarz criterion information, to be more severe in penalizing the inclusion of regressors than Akaike criterion.

We have thirteen forward-looking variables and thus, more than 8,000 possible combinations with these variables. We also have six possible combinations of GARCH, with one or two lags of both terms explanatory and two ARCH combinations with up to two lags of the squared error. In total, we have more than 64,000 possible specifications for each index. We report here the results based on the specification from these tens of thousands with better Schwarz criterion information.

4. Empirical Exercise

4.1. Data and summary statistics: endogenous variables

The endogenous variables in this article are the excess returns of the Brazilian sectorial indices over savings account, which imposes a limitation in terms of time series. The oldest of these indices came in 1996, associated with the electricity sector. However, indices such as ICON and IMOB are more recent and date from 2007 and 2008, respectively. Aiming to deal with a common sample for the largest set of indices possible, our database covers the period from 5 January 2009 to 30 June 2014, on a weekly frequency, totalizing 286 observations. We work with weekly data instead of daily, because of the availability of expectations series in the report Focus of the Central Bank of Brazil: this report is always disclosed to the financial market on the first working day of each week. Our data source for endogenous variables is the BM&FBOVESPA data center.

According to Figure 2, the weekly excess return series of sectorial indices BM&FBOVESPA have apparently heteroscedastic behavior, with periods in which there are high peaks of volatility. Some highlights are the first months of the sample, with amplitudes greater than 30% in the sectors of consumption and real estate, and punctually in June 2013 for the public utility sector.

Apparently, there is also evidence of volatility clusters, i.e., as noted by Mandelbrot (1963), in these series of excess return large changes tend to be followed by large changes, of either sign, and small changes trend to be by followed small changes.

We report the main descriptive statistics in the Table 1, panel a.

IMAT had the lowest minimum weekly excess return, about -18%, while the biggest weekly excess return was observed in real estate sector, with more than 24%. On average, IMAT was the only one to present a negative value, while all other indices beating the market, whose average was 0.012%. The sectors of basic materials and real estate were the most volatile, considering the standard deviation or even semivariance. As expected, IEE was more stable over time. There seems not to be pattern for the asymmetries, and all sectorial indices and market index have high kurtosis, greater than three.

Still according to this table, panel b, we observe a desirable and usual aspect: the return series are stationary, according to test proposed by Phillips and Perron (1988). This unit root test is indicated for heteroscedastic series, a relevant issue here. One must remember that the evidence of heteroscedasticity motivates us to use a conditional volatility approach. With regards this violation, with the exception of electricity and public utility sectors, for all other sectors, the series of excess returns are heteroscedastic.

4.2. Data and summary statistics: exogenous variables

Table 2 reports for each exogenous variable a simplified notation in the first column and its respective detailed description. To summarize, we are working with weekly series of expectations of the main macroeconomic indicators in Brazil: inflation measures, exchange rate against the US dollar, basic interest rates, public debt to Gross Domestic Product (GDP), GDP growth, industrial production, current account, trade balance, foreign direct investment and administered prices.

For our purposes, and aiming to deal with stationary series, we need to work with change of expectations. Other relevant detail is the forecast horizon. The series correspond to market expectations of the closing value of the year following the year in which the information is collected at the Central Bank. The question we want to answer is, for instance, if on January 19, 2009, following the disclosure about change of market forecast on GDP growth for 2010 in relation to previous forecast disclosed a week before, this information affects the conditional current volatility of a certain Brazilian sectorial index. In this case, the question is more complex, since it analyzes the effects of expectations of all thirteen series of explanatory variables, by the means of the best specification for the forward-looking GARCH.

All these series are stationary, according to Augmented Dickey-Fuller (ADF) unit root test proposed by Dickey and Fuller (1979, 1981). According to descriptive statistics reported in Table 3, some of the expectations of variables show little variability, which may be a limitation to our model, compromising the ability to explain part of the variance of the dependent variable.

4.3. Results

Figure 3 shows the conditional volatilities with weekly frequency obtained from the specification indicated by Schwarz information criterion in terms of time lags in the GARCH or ARCH, as well as the choice of forward-looking exogenous variables, among the thirteen series used. This estimation takes into account the CAPM in the mean equation.

Except for real estate sector, there is a pattern of volatility in terms of amplitude: volatility ranges between 0% and 3% during all the period. The real estate sector also appears as an exception, suggesting a volatility without much fluctuation, but with a decreasing trend over time, stabilizing at around 2% from mid-2012. There seems not to be common patterns concerning to peaks in volatilities. With regards the estimations of the best specified models for each sector reported in Table 4, we observe that all indices have significant market beta at 1%, which suggests that using CAPM for the average equation is valid. All sectors show pro cyclical behavior, with IMAT presenting the highest market risk. The indices of the consumption, financial and industrial sectors seem to be interesting investment options due to the significant and positive intercept, which can signal as an indicator of good performance adjusted for risk.

Regarding equation of variance, the best specified version for all indices is parsimonious, following a GARCH (1,1). The exceptions are ICON, whose specification follows an ARCH (1) and IMAT following a GARCH (1,2). IMAT is the unique exception in respect of individual insignificance of GARCH parameters. For all other sectors, most of the parameters is significant to 1%. We do not have problems with explosive trajectories of the conditional risk, or negativity.

With respect to the most important and innovative issue of our approach, only the Brazilian real estate sector seems to be indifferent to the influences of macroeconomic expectations, according to the best specification, based on the criterion of Schwarz.

The consumption and energy indices are the most parsimonious, and the positive change in expectations of price indicators, IPCA and IGP-M, use to soften the turbulence in these sectors, respectively. An expected rise in government debt also makes consumption sector more nervous.

The turmoil in the financial sector increases due to a positive revision in expectations in the IPC and interest (SELIC) and due to an expected reduction of trade balance. Increases in forecasts on foreign exchange and SELIC imply greater turbulence in the basic materials sector, while expected increase for in the IPCA, the trade balance and foreign direct investment calm the public utilities sector. The most affected sector is the industry whose oscillation increases due to raising of IGPDI and administered prices expectations. For other side, the reduction of forecasts for the IGP-M, current account and trade balance may stabilize Brazilian industry.

Table 5 summarizes the results reported in Table 4, to allow a better view on what direction each macroeconomic variable affects each sectorial index. Adjusted explanatory power ranges from 35% for the sector of public utilities to almost 85% in the industrial sector. These values are close to those obtained in the estimation of the simple CAPM, but higher than those obtained from the estimation of GARCH without expectations. The mean square error ranges from 1.2% for the industrial sector to 3.0% in real estate. Our findings suggest that the carefully incorporation of selected forward-looking variables to variance equation enables us to: i) accommodate the anomaly of conditional volatility, ii) obtain estimations significant at 1% in six of the seven indices and iii) get a reasonable fitting, as shown in Figure 4 dispersion.

The comparison exercise with other studies close to us for Brazil is not trivial, because there are few contributions for sectorial indices, as Righi, Ceretta and Silveira (2012, 2014) and Matos, Canamary and Trompieri (2014). These studies deal with performance and with short and long-term relationships and not with conditional volatility modeling. However, we acknowledge some limitations that can be future research object, such as the extension of GARCH frameworks, allowing for asymmetry or even accommodating other patterns or anomalies. Using longer time series or sub samples over time may be useful in understanding this issue, as well as addressing the forward looking behavior based on other conditional volatility models or even replacing CAPM for other framework in the mean equation.

5. Conclusion

Given the fact that the main variations of the stock market can not be predicted and they depend on news, Blanchard (2011) suggests two possible actions to market participants: at the beginning of the week, one defines the strategy based on what happened in the past, or another possibility is to formulate questions such as " what... if... ", reacting to expectations.

Aligned to the second action, we analyze which series of macroeconomic variables expectations are relevant in order to soften or accentuate the turbulence in each of the main sectors of Brazilian economy. We add to the limited literature on these indices, by proposing an innovative framework aiming to accommodate the dependence of each to different sets of expectations, taking into account the heteroscedasticity of excess returns on indices and the role of CAPM, as a reasonable specification for modeling the mean equation. Based on our results, except for real estate sector, all other Brazilian sectors analyzed here react significantly to changes in macroeconomic expectations. In other words, some of these macroeconomic variables have significant power to influence the volatility of most sectorial indices. Some highlights are the price indices that influence five sectors, trade balance, able to influence three sectors and the basic interest rates shown significant in predicting the volatility of two sectors.

We do not intend to establish deterministic relationship between the short-term expectations for macroeconomic variables and the volatility of sectorial indices, as stylized facts, but shedding light on issues hitherto little explored in Brazil. Our findings suggest using most widely expectations of macroeconomic variables in empirical finance applications. More broadly, we hope that our paper motivates the maturation of a new research route modelling the impact of macroeconomic expectations on the behavior of financial assets of this economy.

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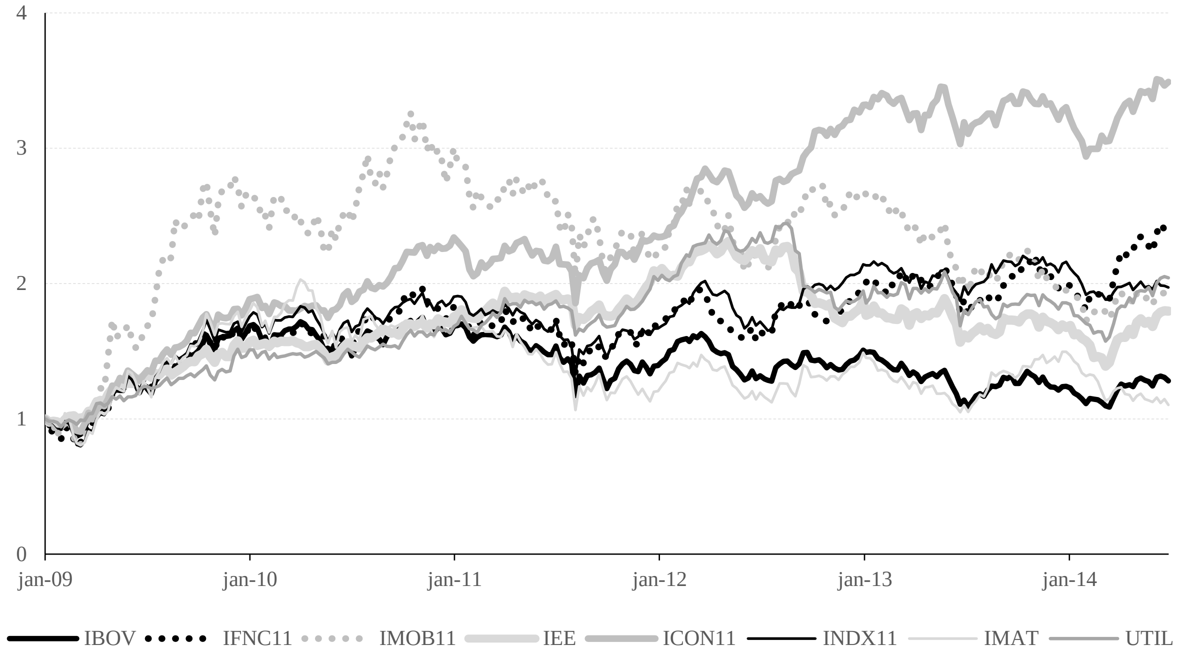
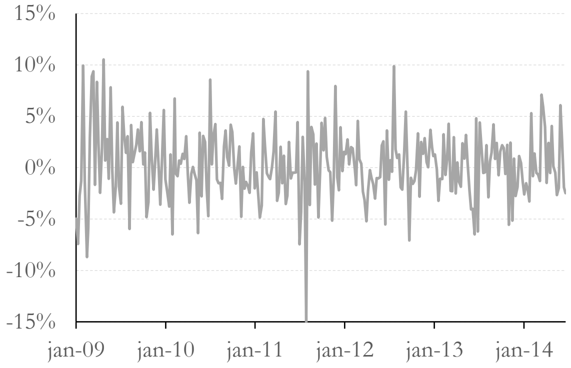
Figure 1. Evolution of the cumulative return on the Brazilian sectorial indices [a, b]

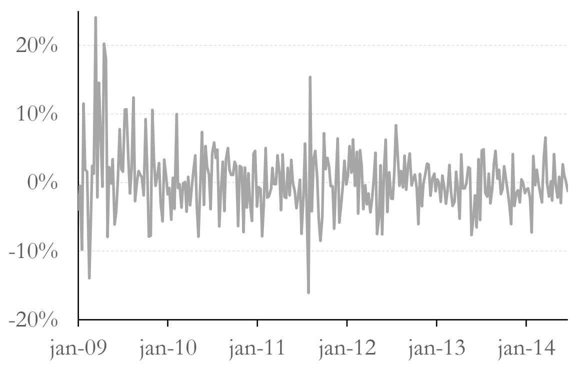


[a] The figure plots the nominal cumulative return on each sectorial index, based on the weekly time series for the respective end-of-day quote, during the period from January 2009 to June 2014. [b] The data source is BM&FBOVESPA.

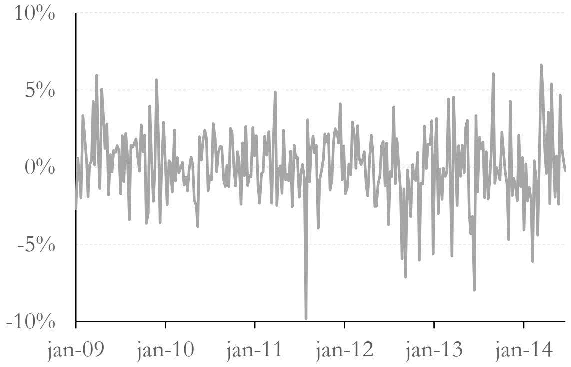
Figure 2. Evolution of weekly excess return on the Brazilian sectorial indices [a, b]



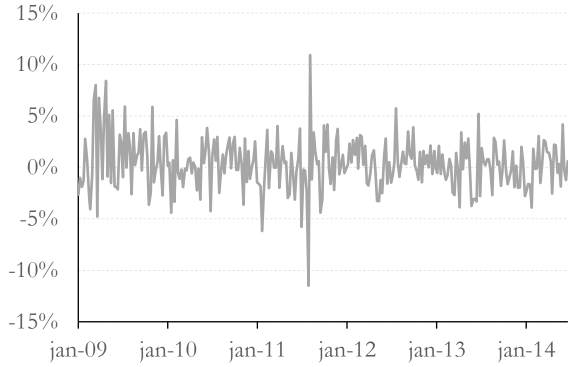
a. IFNC



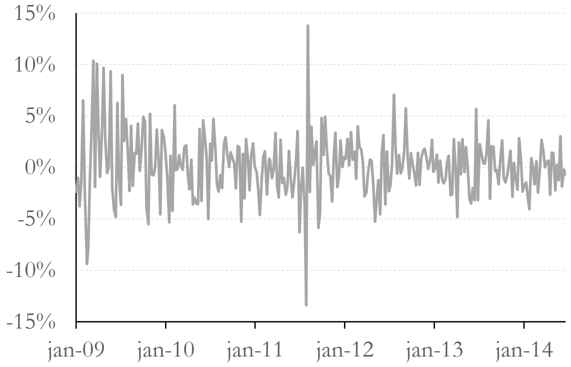
b. IMOB



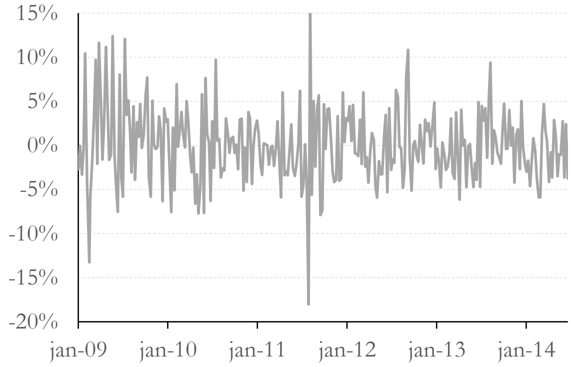
c. IEE



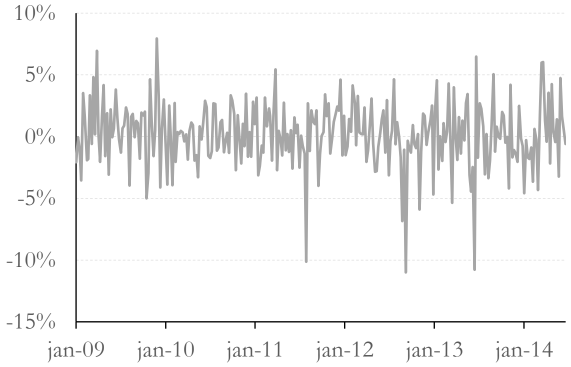
d. ICON



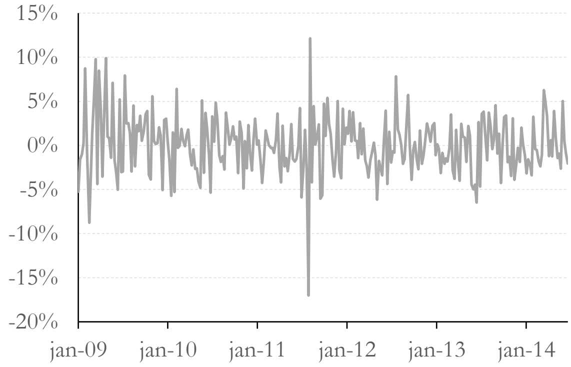
e. INDX



f. IMAT



g. UTIL



h. IBOVESPA

[a] The figure plots the weekly nominal net excess return on each sectorial index over saving account, based on the weekly time series for the respective end-of-day quote, during the period from January 2009 to June 2014. [b] The data source is BM&FBOVESPA.

Table 1. Summary statistics of excess return on the Brazilian sectorial indices [a, b]

Statistic/ Index		Exogenous	Endogenous (Sectorial indices)						
		Market (IBOV)	Consumption (ICON)	Eletric power (IEE)	Finance (IFNC)	Basic material (IMAT)	Real Estate (IMOB)	Industry (INDX)	Public utility (UTIL)
Panel a. Summary statisticis									
gain	minimum	-17.014%	-11.495%	-9.826%	-14.986%	-18.034%	-16.091%	-13.395%	-10.999%
	maximum	12.134%	10.919%	6.633%	10.531%	16.150%	24.075%	13.787%	7.948%
	average	0.012%	0.340%	0.103%	0.228%	-0.005%	0.207%	0.156%	0.155%
risk	standard deviation	3.331%	2.543%	2.352%	3.454%	4.262%	4.760%	3.122%	2.616%
	semivariance	2.310%	1.746%	1.730%	2.386%	2.861%	3.078%	2.120%	1.931%
other moments	asymmetry	-0.020	0.143	-0.429	0.051	0.273	0.876	0.322	-0.553
	kurtosis	5.418	5.239	4.543	4.369	4.563	6.881	5.698	5.288
Panel b. Violation tests									
Stationarity (Phillips-Perron test) [b]									
Statistic		-17.910 ***	-18.234 ***	-17.088 ***	-17.265 ***	-17.917 ***	-17.170 ***	-17.316 ***	-17.737 ***
p-value		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Heteroskedasticity (ARCH LM test) [c]									
Statistic		22.953 ***	43.317 ***	0.070	5.200 **	23.313 ***	13.066 ***	28.002 ***	0.366
p-value		[0.000]	[0.000]	[0.792]	[0.023]	[0.000]	[0.000]	[0.000]	[0.546]

[a] Statistics of weekly series of excess returns on Brazilian sectorial indices, during the period from January 12, 2009 to June 30, 2014. Data source: BM&FBOVESPA. [b] Phillips and Perron (1988) test is performed to infer about stationarity of returns, whose null hypothesis is nonstationarity. Respective p-values are in the box brackets. Bandwidth: Newey-West. [c] ARCH LM test is performed to infer about heteroscedasticity of returns, whose null hypothesis is homoscedasticity. Respective p-values are in the box brackets. *** indicates rejection of null hypothesis at 1% level. ** indicates rejection of null hypothesis at 5% level. * indicates rejection of null hypothesis at 10% level.

Table 2. Description of expectation of macroeconomic variables [a]

Notation	Detailed description
$\Delta ipca^{exp}$	First difference time series of expectation of anual inflation measured by Price Index to Broader Consumer (known in Brazil, as IPCA)
$\Delta igpdi^{exp}$	First difference time series of expectation of anual inflation measured by Generalized Price Index - Domestic Availability (known in Brazil, as IGP-DI)
$\Delta igpm^{exp}$	First difference time series of expectation of anual inflation measured by Generalized Price Index to Market (known in Brazil, as IGP-M)
Δipc^{exp}	First difference time series of expectation of anual inflation measured by Price Index to Consumer (known in Brazil, as IPC)
$\Delta forex^{exp}$	Variation (%) time series of expectation of spot foreign exchange rate (R$/US$)
$\Delta selic^{exp}$	First difference time series of expectation of anual SELIC rate
$\Delta debt^{exp}$	First difference time series of expectation of anual net public sector debt to GDP ratio
Δgdp^{exp}	First difference time series of expectation of anual GDP grwoth
Δind^{exp}	First difference time series of expectation of anual industrial production grwoth
Δcur^{exp}	Variation (%) time series of expectation of current account balance
$\Delta trade^{exp}$	Variation (%) time series of expectation of balance of trade
Δfdi^{exp}	Variation (%) time series of expectation of foreing direct investment
Δadm^{exp}	First difference time series of expectation of anual inflation measured by administered prices

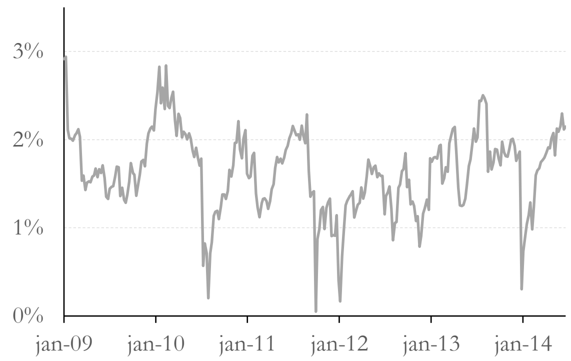
[a] Data source: Weekly Focus Report from BM&FBOVESPA

Table 3. Summary statistics of expectation of macroeconomic variables [a]

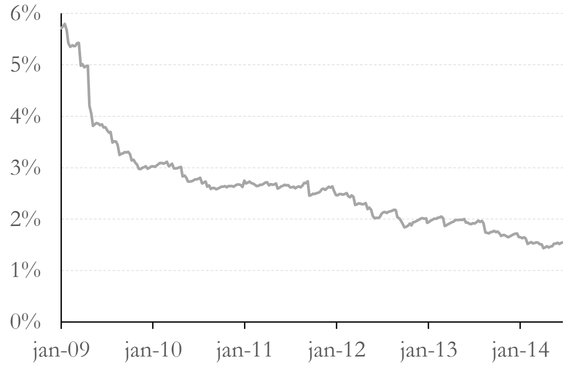
Variable	Maximum	Minimum	Mean	Standard deviation
$\Delta ipca^{exp}$	0.300%	-0.820%	0.006%	0.073%
$\Delta igpdi^{exp}$	0.300%	-1.000%	0.004%	0.081%
$\Delta igpm^{exp}$	0.240%	-1.040%	0.004%	0.087%
Δipc^{exp}	0.310%	-0.520%	0.002%	0.068%
$\Delta forex^{exp}$	3.604%	-4.762%	0.041%	0.923%
$\Delta selic^{exp}$	1.000%	-1.500%	0.002%	0.197%
$\Delta debt^{exp}$	0.900%	-1.900%	-0.002%	0.259%
Δgdp^{exp}	0.900%	-0.700%	-0.008%	0.104%
Δind^{exp}	0.880%	-3.500%	-0.007%	0.253%
Δcur^{exp}	20.000%	-10.000%	0.353%	2.605%
$\Delta trade^{exp}$	75.000%	-68.000%	0.647%	11.712%
Δfdi^{exp}	11.364%	-5.741%	0.292%	1.547%
Δadm^{exp}	1.150%	-0.500%	0.008%	0.152%

[a] Statistics of weekly series of expectations of main macroeconomic variables, during the period from January 12, 2009 to June 30, 2014. Data source: Weekly Focus Report from BM&FBOVESPA

Figure 3. Evolution of weekly conditional volatility of excess return on the Brazilian sectorial indices [a]

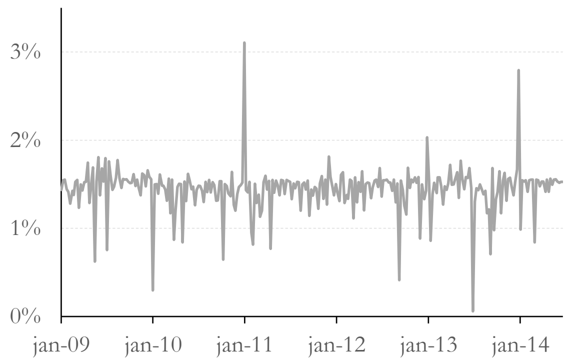


a. IFNC

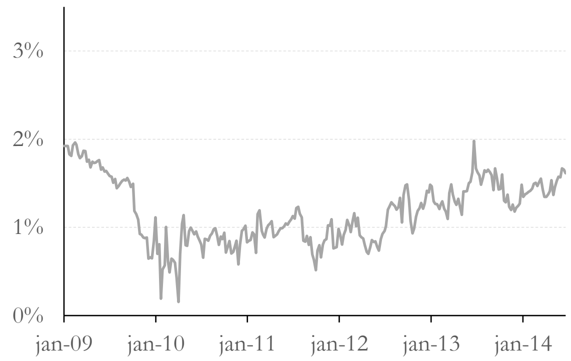


b. IMOB

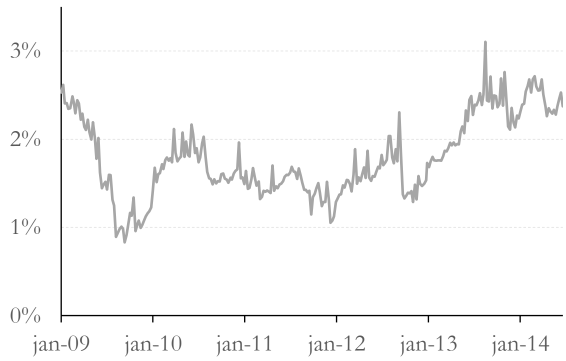
c. IEE



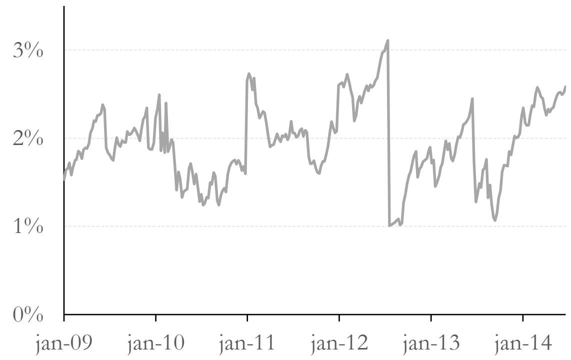
d. ICON



e. INDX



f. IMAT



g. UTIL

[a] The figure plots the weekly conditional volatility of excess return on each sectorial index, during the period from January 2009 to June 2014, extracted from the best specified version of forward-looking GARCH model.

Table 4. Results of estimation of forward-looking based GARCH with CAPM [a]

Estimations	Endogenous (Sectorial indices)						
	Consumption (ICON)	Eletric power (IEE)	Finance (IFNC)	Basic material (IMAT)	Real Estate (IMOB)	Industry (INDX)	Public utility (UTIL)
Mean equation							
Constant	0.220*** [0.001]	0.146 [0.144]	0.166** [0.042]	-0.032 [0.739]	0.001 [0.995]	0.126** [0.049]	0.160 [0.150]
Market excess return	0.632*** [0.000]	0.440*** [0.000]	0.899*** [0.000]	1.196*** [0.000]	1.009*** [0.000]	0.855*** [0.000]	0.455*** [0.000]
Variance equation (usual regressors)							
Constant	2.414*** [0.001]	0.080 [0.115]	0.278*** [0.000]	0.048** [0.039]	0.039 [0.160]	0.057*** [0.000]	0.212*** [0.000]
ε_{t-1}^2	-0.106*** [0.000]	-0.031*** [0.000]	-0.106*** [0.000]	0.071 [0.345]	-0.025*** [0.001]	-0.048** [0.021]	-0.050*** [0.000]
ε_{t-2}^2				-0.101 [0.192]			
σ_{t-1}^2		1.016*** [0.000]	0.998*** [0.000]	1.014*** [0.000]	1.012*** [0.000]	1.014*** [0.000]	1.021*** [0.000]
σ_{t-2}^2							
Variance equation (time series of expectations as regressors)							
$\Delta ipca^{exp}$		-4.808*** [0.008]					-4.381** [0.017]
$\Delta igpdi^{exp}$						4.579*** [0.000]	
$\Delta igpm^{exp}$	-8.854*** [0.000]					-3.756*** [0.002]	
Δipc^{exp}			5.806*** [0.000]				
$\Delta forex^{exp}$		0.058 [0.158]		0.149*** [0.000]			
$\Delta selic^{exp}$			0.738*** [0.000]	0.586*** [0.001]	-0.397 [0.263]		
$\Delta debt^{exp}$	1.032 ** [0.039]						
Δgdp^{exp}							
Δind^{exp}							
Δcur^{exp}						-0.040*** [0.000]	
$\Delta trade^{exp}$			-0.038*** [0.000]			-0.008*** [0.000]	-0.031*** [0.001]
Δfdi^{exp}							-0.072* [0.062]
Δadm^{exp}						0.865*** [0.006]	
Complementary results							
Adjusted R^2	0.673	0.394	0.784	0.798	0.584	0.844	0.351
Schwarz criterion	3.649	4.064	3.821	4.139	4.833	3.217	4.336

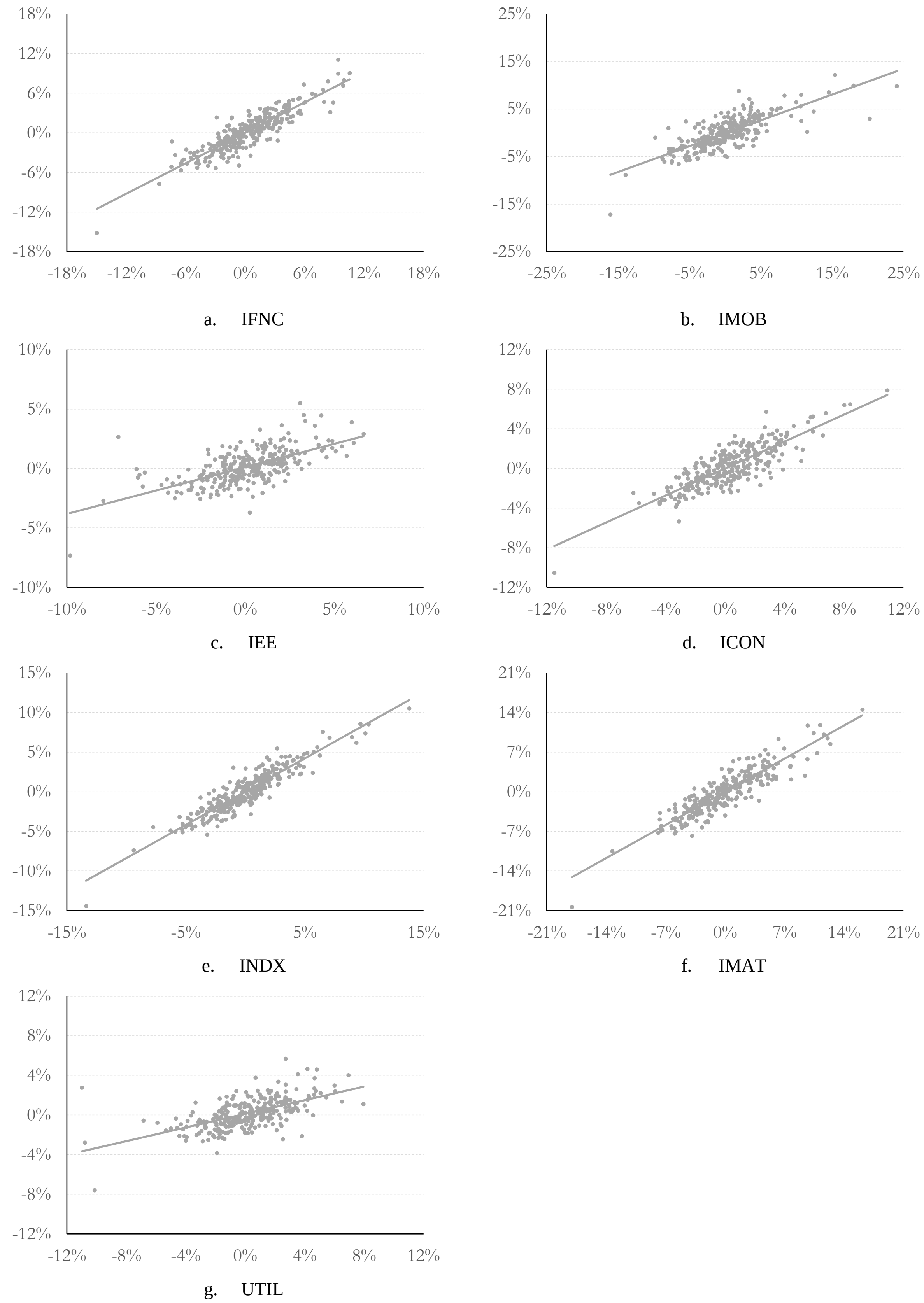
[a] GARCH models estimated through ARCH with normal distribution errors, using the Bollerslev-Wooldridge robust covariance coefficient heteroscedasticity of the residuals, during the period from January 12, 2009 to June 30, 2014, with weekly frequency. Respective p-values are in the box brackets. * Indicates significance at 10% level. ** Indicates significance at 5% level. *** Indicates significance at 1% level.

Table 5. Summary of significant results (sign) of forward-looking based GARCH with CAPM [a]

Variance regressors	Endogenous (Sectorial indices)						
	Consumption (ICON)	Eletric power (IEE)	Finance (IFNC)	Basic material (IMAT)	Real Estate (IMOB)	Industry (INDX)	Public utility (UTIL)
$\Delta ipca^{exp}$		(-)					(-)
$\Delta igpdi^{exp}$						(+)	
$\Delta igpm^{exp}$	(-)					(-)	
Δipc^{exp}			(+)				
$\Delta forex^{exp}$				(+)			
$\Delta selic^{exp}$			(+)	(+)			
$\Delta debt^{exp}$	(+)						
Δgdp^{exp}							
Δind^{exp}							
Δcur^{exp}						(-)	
$\Delta trade^{exp}$			(-)			(-)	(-)
Δfdi^{exp}							(-)
Δadm^{exp}						(+)	

[a] GARCH models estimated through ARCH with normal distribution errors, using the Bollerslev-Wooldridge robust covariance coefficient heteroscedasticity of the residuals, during the period from January 12, 2009 to June 30, 2014, with weekly frequency

Figure 4. Dispersion of weekly excess return on the Brazilian sectorial indices [a]



[a] The figure plots the weekly realized excess return (horizontal axis) versus its prediction of forward-looking based volatility model (vertical axis) for each sectorial index, during the period from January 2009 to June 2014.