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The Influence of EU Regulation of Margin Requirements on Market Stock Volatility

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***Abstract*—**In this paper it was examined the influence of margin regulation on stock market volatility in EU 1993 – 2014. Regulating margin requirements or haircuts for securities financing transactions has for a long time been considered as a potential tool to limit the build-up of leverage and dampen volatility in financial markets. The margin requirement dictates how much investors can borrow against these securities. Margin can be an important part of investment. Using daily and monthly stock returns and there is no convincing evidence that EU Regulation margin requirements have served to dampen stock market volatility. In this paper was detected the expected negative relation between margin requirements and the amount of margin credit outstanding. Also, it confirmed that changes in margin requirements by the EU regulation have tended to follow than lead changes in market volatility. For the analysis have been used the modified Levene statistics to test whether the standard deviation of stock returns in the 25, 50 and 100 days preceding margin changes is the same as that in the succeeding 25, 50 and 100 days. The analysis started in May 1993 when it was first empowered to set the initial margin requirement and the last sample was in May 2014. To test whether margin requirements influence stock market volatility over the long term, the sample of stock returns was divided into 14 periods, according to the 14 changes in margin requirements.

***Keywords*—**Levene statistic, Margin Regulation, Stock Market, Volatility.

I. Introduction

THE term "margin" means the amount of equity to be maintained on a security position held or carried in an account. EU regulators have paused progress on margin requirements (including types of eligible collateral) pending the outcome of the BCBS-IOSCO consultation on common international standards. A margin account permits investors to borrow funds from their brokerage firm to purchase marginable securities on credit and to borrow against marginable securities already in the account [14]. The terms of a margin loan require that the qualifying securities or case that you have in your account be used as collateral to secure the loan. Interest is charged on the borrowed funds for the period of time that the loan is outstanding. Both, the amount of money that a brokerage firm may loan an investor and the terms of the loan agreement are subject to change and regulated by the EU Regulation [3].

When we buy securities on margin, we pay only a portion of the total cost, and a brokerage firm extends credit to our on the balance. An interest charge is made monthly to our account on the amount we borrow. From then on, the price of our security may go up or down, but the amount we owe our brokerage firm should remain relatively unchanged, varying only with the interest charges.

In addition to market-determined margin requirements, we also consider regulated margin requirements which are set by a (not further modeled) regulating agency [1], [2]. The regulator requires debtors to hold a certain minimum amount of equity relative to the value of the loan-financed securities they hold.

To test whether margin requirements influence stock market volatility over the long term, the sample was divided of stock returns into 14 periods, according to the 14 changes in margin requirements [1], [2]. To examine the short-term relation between margins and volatility, ask whether the standard deviation of daily stock returns changes when margins change, taking the logarithmic difference in the FTSE100 stock index as a measure of daily stock returns.

FTSE 100 stands for Financial Times Stock Exchange. In the FTSE indices, share prices are weighted by market capitalization, so that the larger companies make more of a difference to the index than smaller companies. FTSE 100 is a share index of the 100 companies listed on the London Stock Exchange with the highest market capitalization. It is the most widely used stock indices and is seen as a gauge of business prosperity for business regulated by UK company law.

For this analysis was used the variance, as it is the measures of dispersion that is a measure of by how much the values in the data set are likely to differ from the mean of the values. It is the average of the squares of the deviations from the mean. Squaring the deviations ensures that negative and positive deviations do not cancel each other out. The variance (σ^2) is a measure of how far each value in the data set is from the mean. The standard deviation (σ) is simply the (positive) square root of the variance. This calculator uses the following formulas for calculating the variance:

The formula for the variance of a sample is:

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2 \quad (1)$$

where n is the sample size and x-bar is the sample mean.

The formula for the variance of an entire population is:

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{n}(x_i - \mu)^2 \quad (2)$$

where N is the population size and μ is the population mean.

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II. Margin Regulation – Initial Equity Requirements

Regulations require a client to establish a minimum equity on initial transactions in a margin account. For purchases, the minimum required deposit is $2,000, or 100% of the purchase price, whichever is less. If the deposit required by EU Regulation meets the $2,000 requirement, the client would have to meet the EU Regulation Board requirement of 50%. Equity requirements [10]:

1. A minimum of $2,000 is required to open a position on margin
2. A minimum of $2,000 is required to maintain short stock position
3. A minimum of $5, 00 is required to maintain an uncovered equity options position.
4. A minimum of $5,000 is required to maintain an uncovered index options position.

The following example is based upon current EU Regulation requirements of 50%, and is an example of how the leverage in a margin account works: it was opened a margin account with $10,000 of our money and a $10,000 margin loan from our brokerage firm and purchased 1,000 shares of a marginable stock at $20 per share. If the stock price rises to $25 and we decide to sell, the proceeds amount to $25,000. It should be repaid the $10,000 was borrowed and put $15,000 into the pocket (minus interest, commissions and Regulatory fees). That's a net profit of $5,000 – almost a 50% profit on our original investment. If it was used all of the money and purchased $10,000 worth of stock, then would have made a 25% profit – a $2,500 return on a $10,000 investment.

As it can be seen from the example, buying on margin can potentially double our return on investments, or double our losses, depending on stock price [9]. When the stock has been bought on margin drops in value so much that our maintenance requirement exceeds the equity in our account, we would issue a margin call. That means it must be increased our equity by trading assets held in our portfolio, such as selling securities, buying to cover short positions, or closing options positions. Or it may deposit marginable securities or cash to increase the equity. If this will not be taken action to meet the margin call, stocks may be sold with or without prior notice to increase our equity percentage to satisfy the margin call requirement. Any loss suffered by the investor when selling securities to meet a margin call is the responsibility of the investor.

III. Margin Regulation And Stock Market Volatility

The regulation set the minimum margins that securities brokers and dealers must require of customers purchasing common stocks on credit [4], [9].

Defining a set of organizational, conduct of business and prudential requirements for CCPs including margin requirements, default fund, default waterfall, liquidity risk management, and investment policy of CCPs, as well as stress and back tests [6]:

- ESMA [5] has maintained the 99.5% minimum confidence interval for OTC derivatives, but clarifying that a lower percentage can be used for products similar to exchange traded ones;
- The calculation of the look-back period has been substantially redesigned, going towards a period of at least one year including stressed market conditions and procyclicality addressed in a different and more flexible manner;
- The two-day minimum liquidation period for margin calculation has been maintained;
- More flexibility has been introduced for the models applicable to portfolio margining;
- The skin in the game, as a percentage of the minimum capital, has been reduced to 25% from the initial 50%; and
- The condition for the backing of bank guarantees has been revised and a delayed date of application introduced for energy markets.

ESMA held two rounds of public consultations in developing these standards, receiving 165 responses which contributed to shaping the final standards published today. The final standards have been sent today to the European Commission for their adoption as EU Regulations that will be directly applicable throughout the EU.

For those over-the-counter (OTC) derivative transactions that will not be subject to central clearing, these draft RTS prescribe that counterparties apply robust risk mitigation techniques to their bilateral relationships, which will include mandatory exchange of initial and variation margins. This will reduce counterparty credit risk, mitigate any potential systemic risk and ensure alignment with international standards. These draft RTS elaborate on the risk-management procedures for the exchange of collateral and on the procedures concerning intragroup exemptions including the criteria that identify practical and legal impediments to the prompt transfer of funds.

These draft RTS lay down the methodologies for the determination of the appropriate level of margins, the criteria that define liquid high-quality collateral, the list of eligible asset classes, collateral haircuts and concentration limits.

Given the substantial effort required for the operational implementation of this framework, the public consultation aims at ensuring that margin requirements are implemented in a proportionate fashion. Therefore, the consultation focuses on specific points such as the impact on small or medium-sized entities or entities from specific sectors, operational capabilities, the special treatment for covered bonds swaps, the use of internal models and concentration limits. In addition, the ESAs are proposing not to allow re-hypothecation of collateral collected for initial margins.

The timely raising of margin requirements are the monetary authorities might dampen speculative excesses before they raged out of control; or in today's terms, margin controls might reduce “market volatility”,

Institutional investors, virtually none of whom buy on margin, were steadily supplanting individual investors. The

requirements do not apply to market professionals such as investment banks, securities dealers, or exchange specialists. And even for ordinary investors, securities already owned may be pledged as collateral with banks or other lenders on any terms satisfactory to the parties. Substitutes for margin loans to investors thus were, and still are, readily available.

These findings are not entirely negative, however. It was detected that the expected negative relation between margin requirements and the amount of stock market margin credit outstanding. It was also confirmed that changes in margin requirements by the Regulators have tended to follow rather than lead changes in volatility. The European Market Infrastructure Regulation (EMIR) apparently raised margins when the market was booming and cut them after it fell. Because volatility normally rises when the market falls, a negative association between margins and volatility may well be detected in the data.

IV. Margin and Volatility: A Fresh Look at the Data

What is the EU Regulation ESMA European Market Infrastructure Regulation (EMIR) has done since then with its margin setting authority can be seen from Fig. 1 which represents the time paths both of margins and measure of market volatility from May 1993 to May 2014. Margin requirements were set initially at 50 percent and cut to a low of 35 percent, after raised back to 50 percent. Changes were frequent over the years.

Number of changes	Date of change of Margin requirement	Margin requirement %
1	25/05/1993	50
2	17/01/1997	45
3	26/01/1998	40
4	24/02/1999	45
5	18/12/2000	50
6	05/03/2002	35
7	05/11/2003	40
8	06/10/2004	45
9	09/12/2005	35
10	26/05/2006	40
11	18/01/2007	45
12	21/01/2011	35
13	04/07/2012	40
14	15/05/2014	50

Fig. 1 Regulation of Margin Requirement changes in EU 1993 - 2014

Difficult as it often is to explain the actions banks do take, it is harder yet to account for the actions they don't take.

The EU Regulation hesitation to use the tool after 2000 may reflect concerns about possible undesirable side-effects of margin requirement increases [7], [8]. If higher margins reduce speculation, and if speculation is destabilizing, then higher margins would presumably reduce volatility. But in the 2002 and 2005 some economists were suggesting that speculation, under some conditions, might actually be stabilizing influence. Higher volatility might not be an unmixed curse when it represents the faster incorporation of new information into prices. The EU Regulation reluctance to tinker with margins after 1993 May, however, simply have reflected its recognition that the impact of margin changes on the stock market or on the economy was unlikely to be large enough to bother with.

A connection between margin requirements and volatility is strong and would surely leave a readily detectable track in the raw data. Calibrating a weak connection precisely might well require refined econometric techniques, but a strong connection should show itself even in a relatively crude preliminary data analysis. This section offers analysis of relationship between margin regulation and stock market volatility. However, using daily data, it was tested for signs of short-term of impact relations between the 14 historical changes in margin requirements and the immediately subsequent levels of volatility. Here was found a small but positive correlation between margins and volatility. Then, taking a longer-term perspective, and switching to monthly data, it was presented a test that asks essentially whether knowing the true margin requirements month by month makes the observed patterns of volatility over time appear more coherent and explainable. It can be concluded that it does not. Checking it further, has been observed that a regression of average volatility on the level of margin requirements yields a weak negative association, tradable mainly to the late 1993's.

A. The Short Term (25 days) Relation between Margins and Volatility

To examine the short-term relation between margins and volatility, was asked whether the standard deviation of daily stock returns changes when margins change, taking the logarithmic difference in the FTSE100 stock index as a measure of daily stock returns. Fig. 2 compares the volatility as measured by standard deviations of returns for the 25 trading day before and after margin changes. In this paper was excluded the days immediately before and after the margin changes, although the results are not sensitive to the number of days excluded.

Out of 14 margin changes since 1993, there was found 13 occasions when the variances before the margin changes were different from the variances afterwards and the hypothesis H0 at significance level doesn't rejected. Only in 2002 the change in margin requirements will be rejected at the 5% significance level. So, in this occasion the P-value rejects the null hypothesis of equal variances too frequently. If the heavier tails data than the normal distribution, then the modified Levene statistic is not sensitive to departures from Normality.

Brown and Forsythe (1974) suggest using the modified Levene statistic, which is described as follows. For test for Homogeneity of Variances used the Levene Test for Equality of Variances

Levene's test is used to test if k samples have equal variances [11], [12]. Equal variances across samples are called homogeneity of variance. Some statistical tests, for example the analysis of variance, assume that variances are equal across groups or samples. The Levene test can be used to verify that assumption.

The Levene test is defined as:

H_0: $\sigma 21=\sigma 22=\ldots=\sigma 2k$

H_a: $\sigma 2i\neq\sigma 2j$ for at least one pair (i,j)

Test Statistic: Given a variable Y with sample of size N divided into k subgroups, where N_i is the sample size of the subgroup, the Levene test statistic is defined as:

$$W = (N-k)(k-1)\sum_{n=1}^{\infty}(k_i) = 1N_i Z_i^- - Z_{..}^-) \qquad (3)$$
$$2\sum_{n=1}^{\infty} k_i = 1\sum_{n=1}^{\infty} N_{ij} = 1(Z_{ij} - Z_i^-)$$

where $\mathbf{Z_{ij}}$ can have one of the following three definitions:

1. $Z_{ij} = \left|Y_{ij} - Y_i^-\right|$, where Y¯i. is the mean of the i-th subgroup.
2. $Z_{ij} = \left|Y_{ij} - Y_i^{\sim}\right|$, where $\left|Y_i^{\sim}\right|$. is the median of the i-th subgroup.
3. $Z_{ij} = \left|Y_{ij} - Y_{ij}^-\right|$, where $\left|Y_i^-\right|$ is the 10% trimmed mean of the i-th subgroup.

Z¯i. are the group means of the Z_{ij} and Z¯...is the overall mean of the Z_{ij}.

The three choices for defining Z_{ij} determine the robustness and power of Levene's test. By robustness, we mean the ability of the test to not falsely detect unequal variances when the underlying data are not normally distributed and the variables are in fact equal. By power, we mean the ability of the test to detect unequal variances when the variances are in fact unequal. Levene's original paper only proposed using the mean.

Brown and Forsythe (1974) extended Levene's test to use either the median or the trimmed mean in addition to the mean. They performed Monte Carlo studies that indicated that using the trimmed mean performed best when the underlying data followed a Cauchy distribution (i.e., heavy-tailed) and the median performed best when the underlying data followed a χ24 (i.e., skewed) distribution [13]. Using the mean provided the best power for symmetric, moderate-tailed, distributions. Heavy-tailed distributions are probability distributions whose tails are not exponentially bounded: that is, they have heavier tails than the exponential distribution. In many applications it is the right tail of the distribution that is of interest, but a distribution may have a heavy left tail, or both tails may be heavy [15].

Although the optimal choice depends on the underlying distribution, the definition based on the median is recommended as the choice that provides good robustness against many types of non-normal data while retaining good power. If it has the knowledge of the underlying distribution of the data, this may indicate using one of the other choices.

The Levene test rejects the hypothesis that the variances are equal if

$$W \rangle F_{\alpha,k-1,N-k} \qquad (4)$$

where $F_{\alpha,k-1,N-k}$ is the of the F distribution with k-1 and N-k degrees of freedom at a significance level of α.

In the above formulas for the critical regions, the Handbook follows the convention that F_α is the upper critical value from the F distribution and $F_{1-\alpha}$ is the lower critical value. Note that this is the opposite of some texts and software programs.

Therefore, here was used the modified Levene statistics to test whether the standard deviation of stock returns in the 25 days preceding margin changes is the same as that in the succeeding 25 days. For the analysis was chosen 25 days, because 25 days is half the smallest number of trading days between two margin changes.

The modified Levene statistic tests the equality of the standard deviations of stock returns for the 25 trading days before and after each of the 14 margin changes. It was calculated the corresponding 1000 modified Levene statistics for the 25 trading days before and after.

Notes for the Fig. 2: *Significant at the 5% level/ # - 14 historical changes in margin requirements/ Date – date of changes in margin requirements/ % -Margin requirement percentage/ Before – Volatility before the change in margin requirement/ After – Volatility after the change in margin requirement/ P-value - the probability of obtaining the relation between margins and volatility when the null hypothesis is actually true / Result – the result of the test. "YES" - reject the hypothesis H0 at significance level of equality of variance. "NO" - doesn't reject the hypothesis H0 at significance level.*

#	Date	%	Before	After	P-value	Result
1	25/05/1993	50	0.006735	0.004466	0.082724	NO
2	17/01/1997	45	0.006705	0.005759	0.526369	NO
3	26/01/1998	40	0.009309	0.008577	0.925964	NO
4	24/02/1999	45	0.011399	0.010211	0.772865	NO
5	18/12/2000	50	0.012998	0.011062	0.292574	NO
6	05/03/2002	35	0.010147	0.005341	0.000101	YES
7	05/11/2003	40	0.008013	0.007227	0.813603	NO
8	06/10/2004	45	0.005536	0.005273	0.740891	NO
9	09/12/2005	35	0.012335	0.004521	0.315322	NO
10	26/05/2006	40	0.005829	0.011794	0.769126	NO
11	18/01/2007	45	0.008179	0.005821	0.735294	NO
12	21/01/2011	35	0.010066	0.007842	0.936309	NO
13	04/07/2012	40	0.005701	0.009918	0.957629	NO
14	15/05/2014	50	0.005701	0.003753	0.105076	NO

Fig. 2 Margins and Volatility of Daily Stock Returns 25 – Day Window around Margin Changes

It can be concluded that, the relation between volatility and margin are not well explained, as we can see from the result that we have very low standard deviation and residuals. In general, there are very low dependence between margin and volatility. The short – term (25 days) relation between margin regulation and volatility before and after changes shows that, the volatility after the change in margin regulation is decreasing after changes. However, the margin regulation does have a big influence of changes of volatility, because the changes are frequent.

B. The Mid-Term (50-Days) Relation between Margins and Volatility

Twenty-five days may perhaps be too short an interval for volatility to respond to initial margin requirements. To examine the possibly mid-term relation between margins and volatility, it was turned to 50-days real returns of FTSE 100 stock index. The analysis began in May 1993 when it was first empowered to set the initial margin requirement and the sample was finished in May 2014.

Fig. 3 compares the volatility as measured by standard deviations of returns for the 50 trading day before and after margin changes. Here was excluded the days immediately before and after the margin changes, although the results are not sensitive to the number of days excluded.

To test weather margin requirements influence stock market volatility over the long term, it was divided sample of stock returns into 14 periods, according to the 14 changes in margin requirements. The main real goal is to discover whether the volatility in periods with high margins differs systematically from that in periods with low margins. To answer this question, it has sought the distribution of the modified Levene statistic, but computed somehow without having to assume as the null hypothesis that stock returns are independent and identically distributed within the 14 margin periods.

Out of 14 margin changes since 1993, was found 13 occasions when the variances before the margin changes were different from the variances afterwards and the hypothesis H0 at significance level doesn't rejected. Only in 2007 the change in margin requirements will be rejected at the 5% significance level. So, in this occasion the P-value rejects the null hypothesis of equal variances too frequently.

The modified Levene statistic tests the equality of the standard deviations of stock returns for the 50 trading days before and after each of the 14 margin changes. It was calculated the corresponding 1000 modified Levene statistics for the 50 trading days before and after.

Notes for Fig. 3: *Significant at the 5% level/ # - 14 historical changes in margin requirements/ Date – date of changes in margin requirements/ % -Margin requirement percentage/ Before – Volatility before the change in margin requirement/ After – Volatility after the change in margin requirement/ P-value - the probability of obtaining the relation between margins and volatility when the null hypothesis is actually true / Result – the result of the test. "YES" - reject the hypothesis H0 at significance level of equality of variance. "NO" - doesn't reject the hypothesis H0 at significance level.*

C. The Long -Term (100 - Days) Relation between Margins and Volatility

Twenty-five days and fifty days may perhaps be too short an interval for volatility to respond to initial margin requirements. To examine the possibly mid-term relation between margins and volatility, it was turned to 100-days real returns of FTSE 100 stock index. The analysis began in May 1993 when it was first empowered to set the initial margin requirement and it ended the sample in May 2014.

#	Date	%	Before	After	P-value	Result
1	25/05/1993	50	0.005933	0.004831	0.373645	NO
2	17/01/1997	45	0.007161	0.006464	0.781767	NO
3	26/01/1998	40	0.011672	0.008205	0.056169	NO
4	24/02/1999	45	0.013069	0.010606	0.232171	NO
5	18/12/2000	50	0.011768	0.009417	0.065828	NO
6	05/03/2002	35	0.008798	0.006937	0.055666	NO
7	05/11/2003	40	0.007736	0.005791	0.070629	NO
8	06/10/2004	45	0.006396	0.005286	0.468893	NO
9	09/12/2005	35	0.007362	0.005517	0.156638	NO
10	26/05/2006	40	0.009641	0.010601	0.409934	NO
11	18/01/2007	45	0.005585	0.008977	0.029335	YES
12	21/01/2011	35	0.009716	0.008799	0.819487	NO
13	04/07/2012	40	0.010852	0.008489	0.074007	NO
14	15/05/2014	50	0.006697	0.005009	0.058519	NO

Fig. 3 Margins and Volatility of Daily Stock Returns 50 – Day Window around Margin Changes

Fig. 4 represents the volatility as measured by standard deviations of returns for the 50 trading day before and after margin changes. Here was excluded the days immediately before and after the margin changes, although the results are not sensitive to the number of days excluded.

Out of 14 margin changes since 1993, was found 10 occasions when the variances before the margin changes were different from the variances afterwards and the hypothesis H0 at significance level doesn't rejected. Only in 2002 the change in margin requirements will be rejected at the 5% significance level. So, in this occasion the P-value rejects the null hypothesis of equal variances too frequently.

Notes for Fig. 4: *Significant at the 5% level/ # - 14 historical changes in margin requirements/ Date – date of changes in margin requirements/ % -Margin requirement percentage/ Before – Volatility before the change in margin requirement/ After – Volatility after the change in margin requirement/ P-value - the probability of obtaining the relation between margins and volatility when the null hypothesis is actually true / Result – the result of the test. "YES" - reject the hypothesis H0 at significance level of equality of variance. "NO" - doesn't reject the hypothesis H0 at significance level.*

#	Date	%	Before	After	P-value	Result
1	25/05/1993	50	0.006842	0.004977	0.019421	YES
2	17/01/1997	45	0.006336	0.006476	0.845886	NO
3	26/01/1998	40	0.011802	0.009031	0.031919	YES
4	24/02/1999	45	0.014164	0.010104	0.007074	YES
5	18/12/2000	50	0.009956	0.012548	0.202943	NO
6	05/03/2002	35	0.010719	0.015286	0.238608	NO
7	05/11/2003	40	0.008085	0.006573	0.027717	YES
8	06/10/2004	45	0.006265	0.00498	0.067866	NO
9	09/12/2005	35	0.006034	0.005704	0.944761	NO
10	26/05/2006	40	0.008146	0.008541	0.709428	NO
11	18/01/2007	45	0.005757	0.007433	0.126907	NO
12	21/01/2011	35	0.008513	0.008728	0.741427	NO
13	04/07/2012	40	0.009973	0.008276	0.085208	NO
14	15/05/2014	50	0.006371	0.005412	0.230634	NO

Fig. 4 Margins and Volatility of Daily Stock Returns 100 – Day Window around Margin Changes

V. Regression of Volatilities

In addition, here have been analyzed a regression of Volatility as regression and margin as repressor and the margin

seemed insignificant as well (Fig. 5). Regression, perhaps the most widely used statistical technique, estimates relationships between independent (predictor or explanatory) variables and a dependent (response or outcome) variable [16]. Regression models can be used to help understand and explain relationships among variables; they can also be used to predict actual outcomes. Regression analysis allows to model, examine, and explore spatial relationships, and can help explain the factors behind observed spatial patterns. When used properly, this method is powerful and reliable statistics for examining/estimating linear relationships [16].

Linear relationships are either positive or negative. If it was found that the number of search and rescue events increases when daytime temperatures rise, the relationship is said to be positive; there is a positive correlation. Another way to express this positive relationship is to say that search and rescue events decrease as daytime temperatures decrease. Conversely, if we find that the number of crimes goes down as the number of police officers patrolling an area goes up, the relationship is said to be negative. It can also express this negative relationship by stating that the number of crimes increases as the number of patrolling officers decreases. However, the main indicator is P-value which is 0.8035. P-value is the most regression methods perform a statistical test to compute a probability, for the coefficients associated with each independent variable. The null hypothesis for this statistical test states that a coefficient is not significantly different from zero (in other words, for all intents and purposes, the coefficient is zero and the associated explanatory variable is not helping your model). Small p-values reflect small probabilities, and suggest that the coefficient is, indeed, important to the model with a value that is significantly different from zero. You would say that a coefficient with a p value of 0.01, for example, is statistically significant at the 99% confidence level; the associated variable is an effective predictor. Variables with coefficients near zero do not help predict or model the dependent variable; they are almost always removed from the regression equation, unless there are strong theoretical reasons to keep them.

Moreover, the Multiple R-Squared and Adjusted R-Squared are both statistics derived from the regression equation to quantify model performance. The value of R-squared ranges from 0 to 100 percent. From this table below we can see that the value of R-square is 0.005366. If the model fits the observed dependent variable values perfectly, R-squared is 1.0. More likely, we can interpret by saying: this model explains 5% of the variation in the dependent variable.

The other type of indicators is residuals. Residuals are the unexplained portion of the dependent variable, represented in the regression equation as the *random error term*. Known values for the dependent variable are used to build and to calibrate the regression model. Using known values for the dependent variable (*y*) and known values for all of the explanatory variables (the *X*s); the regression tool constructs an equation that will predict those known *y* values, as well as possible. The predicted values will rarely match the observed values exactly.

```
Call:
lm(formula = vola ~ x)

Residuals:
      Min         1Q     Median         3Q        Max
-0.0046816 -0.0030105  0.0002792  0.0026263  0.0055935

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.220e-02  7.787e-03   1.567    0.143
x           -4.627e-05  1.818e-04  -0.254    0.803

Residual standard error: 0.003579 on 12 degrees of freedom
Multiple R-squared:  0.005366,  Adjusted R-squared:  -0.07752
F-statistic: 0.06474 on 1 and 12 DF,  p-value: 0.8035
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Fig. 5 Source: R 3.0.0. Tool for analysis (Vola = Volatility/ X= Margin)

VI. Conclusion

The main purpose of this paper was to identify the differences and relation between margin regulation and stock market volatility. Margin requirement is the percentage of equity that must be deposited or maintained to purchase or hold a position on margin.

To examine the short-term relation between margins and volatility, was asked whether the standard deviation of daily stock returns changes when margins change, taking the logarithmic difference in the FTSE100 stock index as a measure of daily stock returns. The analysis included the comparison of the volatility as measured by standard deviations of returns for the 25, 50 and 100 trading days before and after margin changes. It was excluded the days immediately before and after the margin changes, although the results are not sensitive to the number of days excluded.

For this analysis have been used the modified Levene statistics to test whether the standard deviation of stock returns in the 25, 50 and 100 days preceding margin changes is the same as that in the succeeding 25, 50 and 100 trading days.

The modified Levene statistic tests the equality of the standard deviations of stock returns for the 25, 50 and 100 trading days before and after each of the 14 margin changes. It was calculated the corresponding 1000 modified Levene statistics for the 25 trading days before and after.

By eye it can be seen an interesting fact in the short term (25 days) relation between margins and volatility, that volatility decreased for any change of margin requirements (for up and for down change). But statistically speaking, at significance level of 0.05 was rejected the hypothesis, because the P-values are equal. That means that on 0.05 we can say that the volatility didn't change enough to think that the margin requirements influence the volatility.

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