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Therefore a rational research would use a control sample including similar banks to those included in the main sample, but which have never used interest rate swaps before. In this case, if the decrease found in the interest rate swap users group is not significantly measures in the control sample, then the same rational researcher can only claim that interest rate swaps have some role to play in the bank stock volatility decease. Using the same logic, if the control sample group of banks that never have used interest rate swaps decrease stock return volatility, in the same manner as the swap users (main sample), then the rational research would avoid the drifting to error of the simplistic analysis and would claims that this decrease is not due to interest rate swap use, but is the outcome of something else in the wide market. Moreover, the author has chosen to conduct his research over seven years in which each year, studied separately enables the researcher the time specificity market conditions. It also allows the interest rate swaps to have a more homogenous impact, if it does exist!

In the results part, the characteristics of the interest rate swap old users (large banks) are much more different than the other two groups. This is confirmed by the non-parametric Mann-Whitney. The stock return volatility behaviour of this group is stable and the statistical tests conducted such as the A non-parametric Wilcoxon Signed Ranks Test (WSRT) and the regression combined with dummy variable equation, do not show any significant increase or decrease in the daily volatility measured by the two different variables, of those banks that have been using interest rate swaps at least since 2002.

The study of the sample main group that includes banks new in using interest rate swaps (New Users), using the portfolio approach does not show any change in the stock return volatility before and after using the interest rate swap. The three phases of analysis with the two independent variables of stock returns volatility (variance and residuals), in the control sample examinations, show nearly the same outcomes as new users of interest rate swap group.

8. Conclusion

The current research could suggest that, under the rationality assumption, the use of the interest rate swap does not have a significant impact on the bank stock returns volatility.
The process of the interest rate swaps is still in lack of effective regulation. This is quite fair since these pure contracts are privately negotiated and sometimes appear only over the counter, thus supporting the opacity phenomenon of interest rate swaps. Therefore, the author suggests that reaching a good level of transparency in the short and medium terms is very hard and difficult. This is in accordance with new prudential regulation of the Bank of the International Settlements (BIS), Basle III, requiring banks to hold additional capital to support liquidity risk exposure. It is also the extent of previous accord which stipulated that large banks that use derivatives and other new products heavily should be regulated internally in addition to the traditional regulation, and should have at least an internal control system. In other words the regulation makers abdicate part of their tasks to the regulation applicants. At the same the philosophy of Ethics and Deontology is more and more up to date.

All above arguments have possibly shed some light on the thesis of the risk neutrality of derivatives and particularly interest rate swaps, the continuous existence and the growing importance of these products. However, a clear and mostly agreed theory or doctrine has not been established yet, although the practice is there! In other words, like other fields of social sciences nowadays the practice is ahead of the doctrine, contrarily to before. Therefore we need to work, wait and see. At the same time claiming that this thesis is irrational is believed to be too simplistic.

7. Summary and Discussion:

The research tested three important and interrelated hypotheses. The first hypothesis H_{vi0} states that using interest rate derivatives has no impact on the volatility of the underlying stocks. It is argued that even if H_{vi0} was accepted, derivatives use would not necessarily be volatility-neutral. This is because of the possibility that, as stated in a further hypothesis H_{vi1}, derivatives use has a dual effect on the volatility of the underlying stocks (Ma and Rao, 1988). It is also showed that accepting or rejecting either or both H_{vi0} and H_{vi1} will only be meaningful after testing a third hypothesis H_{vi2}, which states that the volatility behaviour of derivatives users stocks is similar to the volatility behaviour of non-users of derivatives banks stocks with similar pre-using characteristics (control sample).

Unconditional risk measures, including variance of returns, daily squared returns, and the variance of the residuals generated from the market model, are commonly used in the empirical literature of the impact of derivative use on the volatility of the underlying stocks. This paper also uses volatility measures when examining the interest rate swaps use's impact.

The current work is quite distinctive as it avoids the possible bias resulting from improper selection of the research samples. This sample selection bias is likely to be connected with such issues as market completeness, market-microstructure and thin trading. It was argued that many, if not all, of the previous empirical studies, suffer to a greater or lesser extent from this sort of bias. Second, this study accounts for the possible changes in the market-wide and industry-wide conditions, using a control sample methodology. The control sample is constructed in such a way to avoid all the possible biases associated with the sample selection. The control sample is obtained by matching each of the 117 New York Stock Exchange and NASDAQ listed banks stocks, which have started using derivatives during the period of study (2002-2009), with a control bank's stock. Initially, each derivatives user bank stock has a group of potential control stocks selected from the same index. From each group of potential control stocks, it was selected the control stock with the closest pre-use size and pre-use volatility to the derivatives user stock counterpart. This way of setting up the control sample is also consistent with mitigation of the biases that may arise from the endogenous nature of the derivatives use decision. This, in turn, improves the degree of accuracy when measuring the possible volatility effect associated with derivative use. Third, as a further mitigation of the derivatives measurement bias, This paper re-investigates, for the first time, the Ma and Rao (1988) proposition that option has a non-uniform effect on the volatility of the underlying. Indeed, if swaps use increases the volatility of relatively stable stocks and decreases the volatility of relatively volatile stocks, the results would suggest derivatives use either increases or decreases the volatility of the underlying stocks depending on an aggregate basis on whether the increased volatility of the relatively stable stocks is higher or lower than the decreased volatility of the relatively stable stocks. (Portfolio approach)

In order to implement the most appropriate methodological model in accordance with available means, the event study method was selected as the major method to conduct this part of the research. The event study method gives the researcher the opportunity to avoid the use of the notional amount of swaps. This notional amount variable is already a subject of validity debate among researchers and authors. The event study method allows the researcher to observe to of the specific bank or group of banks before and after event day. In the current study case, the event day is the day when the bank uses the interest rate swap for the first time. Furthermore, this kind of method enables the researcher to observe the post event volatility separately, and then compare the two volatility behaviours of swap pre-use period and swap post use period. However any change between the interest rate swap pre use period and the swap post use period in the stock return volatility, could not be attributed automatically to the interest rate swap use. For example if the volatility of banks that use interest rate swaps decreases after swap use, a rational researcher would not claim easily that interest rate swaps decrease risk volatility. As this decrease of stock return volatility could also be due to different exist and unknown factor or simply to the market wide conditions.

samples (old-users and non-users). The results of the estimation of Eq.(4.4) and Eq.(4.5), which test whether the change in the sample of swap old-user stocks and that exhibited by the control sample is the same, are reported in Panel A of Table 6.10. The dummy coefficient in Eq.(4.4), d1 = 0.00024281, is positive, suggesting that the increase in the return variance of the sample of old-users stocks is more than that of the control sample. However, a t-statistic of 1.363 (and a p-value of 0.174) on the dummy coefficient d1 suggests that the difference in the return variance change between the two samples is not significantly different from zero. Similarly, the dummy coefficient e1 (equals 0.00020325) is positive, indicating that the residual variance increases less for the control sample than for the sample of swap old user stocks. However, again this difference is not statistically significant, as the t-statistic on the coefficient e1 is only -1.121 (p-value = 0.263). A Mann-Whitney test also supports the above results. Panel B of Table 7.5 shows that Z-score and p-value resulting for the Mann-Whitney test, which examines whether the return variance change in the two samples is the same or different, are -1.024 and 0.306, respectively. Similarly, the Z-score and p-value for Mann-Whitney test, which compares the two samples residual variance change, are -0.296 and 0.767, respectively. Using the swap old users sample in addition to the main sample (the new users) and compare both of their volatility change to the control sample (non-users) change in stocks volatility, exhibits the same results, however the results obtained from the swap new-users are much closer and very similar to the control sample ones than the outcomes of the old users. For example using the non-parametric Wilcoxon Signed Rank test (WSRT) to test any change in the distribution of the return variance and residual variance between the pre and post-period of swap's use showed a significant change in the of return variance and variance of residual's distribution for both new-user stocks and non-user control stocks. However, when applying the same test on the old-user stocks, only the change of the distribution of the residual variance was statistically significant, whereas the change in the return variance was not significant at all, see table 7.4, Panel C, Z-score: -0.428 and P-value 0.668. This difference can be perceived by two ways, the first one is that the use of swap keeps the stocks volatility stable in the long term, as the old users have been using swaps for a long period of time a least 5 years. Or the swap old-users stocks are more stable stocks because they are bigger stocks in term of capitalisation and volume, and old users banks have much bigger assets and a better credit rating than those of the new and non-users of swaps.

Table 6.5: Comparing the Volatility change in the two samples (old users vs non users)

	Panel A: OLS estimation of EQ(4.4) and Q(4.5)			
	$\Delta\sigma_{i,j}^2 = d_0 + d_1 DUM_{i,j} + g,$ (4.4)[2]		$\Delta\sigma_{ui,j}^2 = e_0 + e_1 DUM_{i,j} + h,$ (4.5)[3]	
Intercept (p-value)	-5.4E-05	(0.668)	-5.271E-05	(0.681)
Dummy Coef (p-value)	0.00024281	(0.174)	0.00020325	(0.263)
R Square of the regression	0.00795088		0.00539382	
Adjusted R Adjusted	0.00367481		0.00110672	
F (p-value)	1.8593883	(0.174)	1.25815248	(0.263)
	Panel B: Mann-Whitney Test			
	Equality of the return variance		Equality of the residual variance	
Z-score (p-value)[4]	-1.024	(0.306)	-0.296	(0.767)

[1] This table compares the sample of the swap old-user stocks and the control sample in terms of the change in the return variances and residual variances between pre- and post-swap use periods.

[2] $\Delta\sigma_{i,j}^2$ denotes the variance change between pre- and post-use periods. $\Delta\sigma_{i,j}^2$ takes two value, one is $\Delta\sigma_i^2$, which is the variance change between pre- and post-use for the swap old use stock *i* and the other one is $\Delta\sigma_j^2$, which the variance change between pre- and post-use periods of the control stock *j*. $DUM_{i,j}$ is dummy variable, taking a value of unity if the stock is swap old user and a value of zero if the stock is swap old-user.

[3] $\Delta\sigma_{ui,j}^2$ refers to the change in the residual variance. $\Delta\sigma_{ui,j}^2$ also takes two values, one is the change in the residual variance of the swap old user stock *i* and the other is the change in the residual variance of the control stock *j*.

[4] Mann-Whitney test compares whether the series of the changes in the return variance (and residual variance) of the sample of old user stocks and the control stocks are the same.

equation results, it cannot be stated that swaps decrease the volatility of volatile stocks and increase the volatility of more stable stocks. Whereas options as stated by Ma and Roa (1988) decrease the volatility of volatile stocks and increase the volatility of more stable stocks.

Table 6.4: Average volatility change and a non-uniform effect in the sample of old users stocks[1]:

	Panel A: Summary statistics of the volatility change			
	Variance of return		Variance of residual	
Mean change (%) [2]	1.8975	23.15%	1.5054	18.59%
Meadian change (%)	-0.3270	(-6.76%)	-0.5484	(-11.96%)
Number of Increases (%) [3]	59***	(50.42%)	49***	(41.88%)
Number of Decreases (%)	58***	(49.58%)	68***	(58.12%)
	Panel B: OLS estimation of EQ(4.1) and EQ(4.2)			
	$\sigma_{i,l}^2 = \sigma_0 + \alpha_1 DUM_i + \eta$, (4.1)[4]		$\sigma_{i,ul}^2 = \gamma_0 + \gamma_1 DUM_i + \iota$, (4.2)[5]	
Intercept (p-value)	0.000816***	(0.005)	0.000810***	(0.005)
Dummy Coef (p-value)	0.000189	(0.645)	1.51E-04	(0.714)
	Panel C: Wilcoxon Signed Rank Test			
	Variance of return		Variance of residual	
Z-score (p-value)[6]	-0.428	(0.668)	-2.196 **	(0.028)
	Panel D: OLS estimation of EQ (4.3)			
	$\Delta\sigma_{is}^2 = n_0 + n_1 \Delta\sigma_{iu}^2 + n_2\, \sigma_{iub} + p$ (4.3)[7]			
n_0 (p-value)	4.02E-05***	(0.000)		
n_1 (p-value)	0.9815***	(0.000)		
n_2 (p-value)	0.0066	(0.458)		

*** Indicates significance at the *1%* level.
** Indicates significance at the5*%* level.
[1] This table provides summary statistics of the application of portfolio approach to the sample of swap old user in order to test the null hypothesis H_0, which states that there is no average change in the volatility of the underlying stocks after swap use. The table also shows the results of testing for the possible presence of a non-uniform effect swap use (as stated by the null hypothesis H_1).
[2] The change is calculated as the difference between post-and pre-use variance and the reported mean and median change are multiplied by 10^4.
[3] The significance is based on the Fisher Signed Test.
[4] $\sigma_{i,l}^2$ is the variance of return of each stock i and it takes two values. One is the return variance before the swap use and the other is the return variance after the swap use. DUM_i is a dummy variable which is equal to zero in the pre-use period and unity in the post-use period.
[5] $\sigma_{i,ul}^2$ is the residual variance of each stock *i*; $\sigma_{i,ul}^2$ takes on two values from each stock, one is the pre-use residual variance and the other is post-use residual variance.
[6] The Wilcoxon Signed Rank test examines whether the pre-use variances and the post-use variances of the swap old user stocks belong to the same distribution.
[7] $\Delta\sigma_{is}$ denotes the difference between post-use and pre-use return variance of each stock *i*; $\Delta\sigma_{iu}$ is the change in the residual variance between post- and pre-use periods for each stock *i*; and σ_{iub} refers to the residual variance of stock *i* in the pre-use period.

6.5. Comparing the Old users sample to the control sample stock returns volatility change:

So far, the results suggest that the average volatility change in both samples of swap old-users stocks and the control sample is significantly different from zero, when using the non-parametric Wilcoxon Signed Rank test (WSRT). Using this test suggests that the use of swap has a significant effect on the stock return variance and has a significant effect on the stock residual variance without a clear direction of the change on both samples, which means that the change in the volatility distributions is not due to the use of swaps and the use of the control sample technique was clearly essential, because ignoring the control sample would have resulted in a different statement.

To check the robustness of these results, this section reports the results, from both OLS regressions (Eq.(4.4) and Eq.(4.5)) and the non-parametric Mann-Whitney test, which combine the analysis of the two

6.4. Old- Users stocks' volatility change:

Panel A of Table 7.4 shows the summary statistics for the mean and median changes, and the percentages (numbers) of stocks with a volatility decrease and a volatility increase after swap use. The sample of old-user stocks exhibits a mean increase and a median decrease of 23.15% and 18.59%, respectively. Based on the Fisher Sign test of the difference between the post-and pre-use return variances, 50.42% (59/117) of the stocks experience an increase, and 49.58% (58/117) of them exhibit a decrease in their return variance after swap use. It can also be seen from Panel A that the residual variance increases by an average of 18.59% and decreases by a median of 11.96%. Again, based on the sign of the change in the residual variance, 41.88% (49 in number) of the stocks exhibit a residual variance increase and 58.12% (68 in number) experience a residual variance decrease after swap use.

To test the statistical significance of the change in both return variance and residual variance, Panel B of Table 6.4 shows the Ordinary Least Square (OLS) estimation of Eq.(4.1) and Eq.(4.2). Panel B shows that the dummy coefficient α_1 in Eq.(4.1) takes a positive value, suggesting a possible average volatility increase after the swap use. However, a t-statistic of only 0.460 (and a p-value of 0.645) for the coefficient α_1 suggests that the average increase in the return variance is not significantly different from zero. The positive sign on the dummy coefficient γ_1 in Eq.(4.2) implies a possible increase in the average residual risk, but here the t-statistic of 0.367 (and a p-value of 0.714) indicates that the average decrease in the residual variance is not statistically significant at all.

As a further check on the results, Panel C of Table 6.4 shows the results from the non-parametric Wilcoxon Signed Rank test (WSRT). WSRT, with a Z-score of -0.428 and a high p-value of 0.668 not significant at conventional confidence level, rejects the hypothesis that pre-use return variances and post-use return variances of the swap old -user stocks are drawn from a different distribution. A Z-score of -2.196 ** (p-value of 0.028) from WSRT also suggests that pre-use residual variances and post-use residual variances of the swap old-users stocks do not belong to the same distribution.
The same significance was found when the control sample and new-users sample were tested; this suggests that this significant effect on the stock's volatility is not due to the use of swaps.

Thus, the results reported from the application of the portfolio approach to the swap's old-user stocks seem to support the null hypothesis $\boldsymbol{H_0}$, which states that, on average, swap use does not affect the volatility of the underlying stocks. When using the Ordinary Least Square (OLS) estimation of Eq.(4.1) and Eq.(4.2) at confidence level 5%. Moreover, the same results suggest supporting the null hypothesis $\boldsymbol{H_0}$ and suggest that, on average, swap's use does not affect the volatility of the underlying stocks, when using the non-parametric Wilcoxon Signed Rank test (WSRT). This test confirms that the use of swap has not a significant effect on the stock return variance and has a significant effect on the stock residual variance without a clear direction of the change. However this significance in the change of the residual variances is not enough to make a statement or reject the null hypothesis $\boldsymbol{H_0}$ since this finding on residual variances is in contradiction with the same test (WSRT) findings when applied on the return variance. Again, here it can be seen that using both the return variance and residual variance as measure of stock's volatility gives this research results more robustness and reliability.

Panel D of Table 6.4 shows the results of the OLS estimation of Eq.(4.3). The results from OLS estimation of Eq.(4.3) are considerably different from the expectations generated by Ma and Rao (1988). Consistent with Ma and Rao (1988), the coefficient on n1 in Eq.(4.3) is positive (equal to 0.9815) and is statistically significant at the 0.1% level as the p-value is equal to 0.000. This suggests a positive and statistically significant relationship between the change in the return variance and the change in the residual variance. However, in contrast to Ma and Rao (1988), no statistical significance is discovered as the p-value is equal to 0.458, on the relationship between the change in the return variance and the pre-use residual variance (n2 = 0.0066, p-value = 0.458). Contrarily to Ma and Rao (1988) the sign of the coefficient n2 is positive and not statistically significant, whereas Ma and Rao (1988) have found a significant negative n2, this suggests that swaps do not have a dual effect on stocks volatility as the options do. In other words, from the above

7.3. The dummy coefficient in Eq.(4.4), d1 = -2.496E-05, is negative, suggesting that the increase in the return variance of the sample of new-users stocks is less than that of the control sample. However, a t-statistic of -0.475 (and a p-value of 0.667) on the dummy coefficient d1 suggests that the difference in the return variance change between the two samples is not significantly different from zero. Similarly, the dummy coefficient e1 (equals -4.469E-05) is negative, indicating that the residual variance increases more for the control sample than for the sample of swap's new-user stocks. However, again this difference is not statistically significant, as the t-statistic on the coefficient e1 is only -0.872 (p-value = 0.384). A Mann-Whitney test also supports the above results. Panel B of Table 7.3 shows that Z-score and p-value resulting for the Mann-Whitney test, which examines whether the return variance change in the two samples is the same or different, are -0.101and 0.919, respectively. Similarly, the Z-score and p-value for Mann-Whitney test, which compares the two samples residual variance change, are -0.445and 0.656, respectively which, means that results across the two samples (new-users and control sample) are very similar and swaps have a specific effect on the volatility of their new-user stocks.

Table 6.3: Comparing the Volatility change in the two samples (new-users vs non-users)

	Panel A: OLS estimation of EQ(4.4) and EQ(4.5)			
	$\Delta\sigma_{i,j}^2 = d_0 + d_1 DUM_{i,j} + g,\ (4.4)$ [2]		$\Delta\sigma_{ui,j}^2 = e_0 + e_1 DUM_{i,j} + h,\ (4.5)$ [3]	
Intercept (p-value)	-5.4E-05	(0.147)	-5.271E-05	(0.147)
Dummy Coef (p-value)	-2.496E-05	(0.635)	-4.469E-05	(0.384)
R Square of the regression	0.00097324		0.00327229	
Adjusted R Adjusted	-0.0033329		-0.001024	
F (p-value)	0.22601159	(0.635)	0.7616631	(0.384)
	Panel B: Mann-Whitney			
	Equality of the return variance		Equality of the residual variance	
Z-score (p-value)[4]	-0.101	(0.919)	-0.445	(0.656)

[1] This table compares the sample of the swap new-user stocks and the control sample in terms of the change in the return variances and residual variances between pre- and post-swap use periods.

[2] $\Delta\sigma_{i,j}^2$ denotes the variance change between pre- and post-use periods. $\Delta\sigma_{i,j}^2$ takes two value, one is $\Delta\sigma_i^2$, which is the variance change between pre- and post-use for the swap new use stock *i* and the other one is $\Delta\sigma_j^2$, which the variance change between pre- and post-use periods of the control stock *j*. $DUM_{i,j}$ is dummy variable, taking a value of unity if the stock is swap new user and a value of zero if the stock is swap new-user.

[3] $\Delta\sigma_{ui,j}^2$ refers to the change in the residual variance. $\Delta\sigma_{ui,j}^2$ also takes two values, one is the change in the residual variance of the swap new user stock *i* and the other is the change in the residual variance of the control stock *j*.

[4] Mann-Whitney test checks whether the series of the changes in the return variance (and residual variance) of the sample of new user stocks and the control stocks are the same.

Again comparing the two samples results by using the OLS estimation EQ 4.4 and EQ 4.5 and by using the Mann-Whitney test, confirms that the series of the changes in the return variance, of the sample of swap new user stocks and the control stocks are the same and there is no difference between the results obtained from the two samples. Therefore, it is confirmed that the changes in the changes in the variance (and residual variance) of the sample of swap new-user stocks and the control stocks are not due to the swap use.

To give more robustness to these findings and in order to eliminate any doubt about these changes in the stock return variance (and residual variance) between the pre and post swap use periods for both samples (the new-users and the non-users), this research uses another sample of study which is the swap's old-users, as defined previously, this sample is composed of bank stocks that have been using swaps for the whole period of study (2002-2009). The same empirical procedure as the one used for the swap new-users sample is employed and then the findings and the results obtained with the control sample of swap non-users are compared.

Table 6.2: Average volatility change and a non-uniform effect in the control sample[1]

	Panel A: Summary statistics of the volatility change			
	Variance of return		Variance of residual	
Mean change (%) [2]	-0.5400	(-9.18%)	-0.5300	(-9.02%)
Meadian change (%)	-0.5300	(-10.93%)	-0.4500	(-9.35%)
Number of Increases (%) [3]	50***	(42.73%)	49***	(41.88%)
Number of Decreases (%)	67***	(57.27%)	68***	(58.11%)
	Panel B: OLS estimation of EQ(4.1) and EQ(4.2)			
	$\sigma_{i,I}^2 = \sigma_0 + \alpha_1 DUM_i + \sigma,$ (4.1)[4]		$\sigma_{i,ul}^2 = \gamma_0 + \gamma_1 DUM_i + \iota,$ (4.2)[5]	
Intercept (p-value)	0.000588***	(0.000)	0.000585***	(0.000)
Dummy Coef (p-value)	-5.40E-05	(0.308)	-5.30E-05	(0.318)
	Panel C: Wilcoxon Signed Rank Test			
	Variance of return		Variance of residual	
Z-score (p-value)[6]	-2.058 **	(0.040)	-1.998 **	(0.046)
	Panel D: OLS estimation of EQ (4.3)			
	$\Delta\sigma_{is}^2 = n_0 + n_1\Delta\sigma_{iu}^2 + n_2\,\sigma_{iub} + p$ (4.3)[7]			
n_0 (p-value)	-9.30E-07	(0.104)		
n_1 (p-value)	1.0008***	(0.000)		
n_2 (p-value)	0.00115**	(0.147)		

*** Indicates significance at the *1%* level.
**Indicates significance at the *5%* level.

[1] This table provides summary statistics of the application of portfolio approach to the sample of swap non-user in order to test the null hypothesis H_0, which states that there is no average change in the volatility of the underlying stocks after swap use. The table also shows the results of testing for the possible presence of a non-uniform effect swap use (as stated by the null hypothesis H_1).

[2] The change is calculated as the difference between post-and pre-use variance and the reported mean and median change are multiplied by 10^4.

[3] The significance is based on the Fisher Signed Test.

[4] $\sigma_{i,I}^2$ is the variance of return of each stock i and it takes two values. One is the return variance before the swap use and the other is the return variance after the swap use. DUM_i is a dummy variable which is equal to zero in the pre-use period and unity in the post-use period.

[5] $\sigma_{i,ul}^2$ is the residual variance of each stock i; $\sigma_{i,ul}^2$ takes on two values from each stock, one is the pre-use residual variance and the other is post-use residual variance.

[6] The Wilcoxon Signed Rank test examines whether the pre-use variances and the post-use variances of the swap non- user stocks belong to the same distribution.

[7] $\Delta\sigma_{is}$ denotes the difference between post-use and pre-use return variance of each stock i; $\Delta\sigma_{iu}$ is the change in the residual variance between post- and pre-use periods for each stock i; and σ_{iub} refers to the residual variance of stock i in the pre-use period.

6.3. Comparing the samples' volatility change:

So far, the obtained results suggest that the average volatility change in both sample of swap new-users stocks and the control sample is significantly different from zero, when using the non-parametric Wilcoxon Signed Rank test (WSRT). This test suggests that the use of swap has a significant effect on the stock return variance and has a significant effect on the stock residual variance without a clear direction of the change on both samples, which means that the change in the volatility distributions is not due to the use of swaps and the use of the control sample technique has shown all its benefits in this case, because the absence of a control sample would have led to a complete opposite statement.

To check the robustness of these results, this section reports the results, from both OLS regressions (Eq.(4.4) and Eq.(4.5) and the non-parametric Mann-Whitney test, which combine the analysis of the two samples. The results of the estimation of Eq.(4.4) and Eq.(4.5), which test whether the change in the sample of new user stocks and that exhibited by the control sample is the same, are reported in Panel A of Table

Although the results reported above suggest that there is a volatility effect associated with the use of swap on the underlying stocks (Wilcoxon Signed Rank test Table 6.1 panel C), it is argued that examining the possible volatility change of the control stocks is still important. This is because factors other than swap use, i.e., changes in market-wide and/or industry-wide conditions, may have driven the volatility of non-users of swap stocks to change. If there is a change in the volatility of new-user stocks and there is no change in the volatility of control stocks, with similar pre-use characteristics to the new-user stocks, then it is possible to argue that swap use increases or decreases the volatility of new-user stocks from following the change in the volatility of the control stocks.

6.2. Control stocks' volatility change:

Panel A of Table 6.2 shows the summary statistics of the average and median volatility change in the control sample after swap use. Based on the Fisher Sign test, Panel A also shows the percentage (a number) of the stocks with a volatility increase and volatility decrease. The control sample exhibits that both the mean and the median of the return volatility decrease by 9.18%% and 10.93%, respectively, after swap use. Similarly, the mean and the median of the residual risk decrease, after swap use, by 9.02% and 9.35%, respectively. Furthermore, only (42.73%) (50 in number) of the stocks experience a return variance increase after swap use, with the remaining stocks (57.27% (67 in number)) exhibiting a return variance decrease. Similarly, the number of stocks that experience an increase in residual variance (41.88% (49/117)) is only a little lower than those with a decrease in residual variance (58.11% (68/117)).

Panel B of Table 6.2 shows the results of the OLS estimation of Eq.(4.1) and Eq.(4.2) applied to the control sample. The dummy coefficient α_1 in Eq.(4.1) equals -5.40E-05 with a t-statistic of -1.020 (p-value = 0.308) and the dummy coefficient γ_1 in Eq.(4.2) is -5.30E-05 with a t-statistic equal to -0.9987 (and p-value of 0.318). Thus, the results from empirical analysis of Eq.(4.1) and Eq.(4.2) show neither return variances nor residual variances experience a statistical significant change after swap use.

Similar to the analysis applied to the sample of new users stocks, the results of the possible change in the volatility of the control sample between the pre- and post-swap use periods are also checked by using a non-parametric Wilcoxon Signed Rank Test (WSRT). Panel C of Table 6.2 reports that the results of the WSRT test do not support the regression results which indicate no volatility change suggested by Eq.(4.1) and Eq.(4.2). The Z-score from WRST equals -2.058 (p-value = 0.040) for the total volatility change between pre- and post-swap use periods, and is significant at the 5% level. Also, the Z-score of -1.998 (p-value = 0.046) rejects hypothesis that the residual variance series of the pre- and post-swap's use periods belong to the same distribution and is significant at the 5% level.

The OLS estimation results of Eq.(4.3) on the control sample are reported in Panel C of Table 6.2. It is shown in the table that the application of Eq.(4.3) to the control sample provides similar results to those obtained applying the same equation to the sample of new user stocks. However, this time the coefficient n_2 on the residual error is positive and equal to 0.00115 and statistically not significant even at the 10% level (p-value equal to 0.147).

Rao (1988), the sign of the coefficient n2 is positive whereas Ma and Rao (1988) have found a significant negative n2, this suggests that swaps do not have a dual effect on stocks volatility as the options do. In other words, from the above equation results it may not be confirmed that swaps decrease the volatility of volatile stocks and increase the volatility of more stable stocks. Whereas options as stated by Ma and Rao (1988), decrease the volatility of volatile stocks and increase the volatility of more stable stocks. In this research case, a full statement cannot be made until the empirical test of the control sample is carried out.

This difference in results may arise for a number of possible reasons. First, Ma and Rao examine a different derivative instrument, which is the options, then examine a different sample; they examine non-financial firms where this research studies the commercial banks stocks. The period of study is also different as the current examination period (2002 to 2009) is more recent, than their period of study (1970 to 1984).

These findings suggest that swaps, contrarily to options, do not have a dual effect on the bank's stock volatility, the use of swap does not reduce the volatility of the volatile banks whereas the use of swaps does not increase the volatility of stable stocks.

Table 6.1: Average volatility change and a non-uniform effect in the sample of swap new users[1]:

	Panel A: Summary statistics of the volatility change			
	Variance of return		Variance of residual	
Mean change (%) [2]	-0.7900	(-12.22%)	-0.9739	(-15.80%)
Meadian change (%)	-0.6800	(-13.65%)	-0.8100	(-16.57%)
Number of Increases (%) [3]	54***	(46.20%)	54***	(46.20%)
Number of Decreases (%)	63***	(53.84%)	63***	(53.84%)
	Panel B: OLS estimation of EQ(4.1) and EQ(4.2)			
	$\sigma_{i,l}^2 = \sigma_0 + \alpha_1 DUM_i + \eta,$ (4.1)[4]		$\sigma_{i,ul}^2 = \gamma_0 + \gamma_1 DUM_i + \iota,$ (4.2)[5]	
Intercept (p-value)	0.000624***	(0.000)	0.000616***	(0.000)
Dummy Coef (p-value)	-7.90E-05	(0.191)	-9.70E-05	(0.092)
	Panel C: Wilcoxon Signed Rank			
	Variance of return		Variance of residual	
Z-score (p-value)[6]	-2.014 **	(0.044)	-2.392 **	(0.017)
	Panel D: OLS estimation EQ (4.3)			
	$\Delta\sigma_{is}^2 = n_0 + n_1 \Delta\sigma_{iu}^2 + n_2 \sigma_{iub} + p$ (4.3)[7]			
N_0 (p-value)	2.17E-05**	(0.016)		
N_1 (p-value)	1.0008***	(0.000)		
N_2 (p-value)	0.02349**	(0.032)		

*** Indicates significance at the *1%* level.

**Indicates significance at the*5%* level.

[1] This table provides summary statistics of the application of portfolio approach to the sample of swap new user in order to test the null hypothesis H_0, which states that there is no average change in the volatility of the underlying stocks after swap use. The table also shows the results of testing for the possible presence of a non-uniform effect swap use (as stated by the null hypothesis H_1).

[2] The change is calculated as the difference between post-and pre-use variance and the reported mean and median change are multiplied by 10^4.

[3] The significance is based on the Fisher Signed Test.

[4] $\sigma_{i,l}^2$ is the variance of return of each stock i and it takes two values. One is the return variance before the swap use and the other is the return variance after the swap use. DUM_i is a dummy variable which is equal to zero in the pre-use period and unity in the post-use period.

[5] $\sigma_{i,ul}^2$ is the residual variance of each stock *i*; $\sigma_{i,ul}^2$ takes on two values from each stock, one is the pre-use residual variance and the other is post-use residual variance.

[6] The Wilcoxon Signed Rank test examines whether the pre-use variances and the post-use variances of the swap new user stocks belong to the same distribution.

[7] $\Delta\sigma_{is}$ denotes the difference between post-use and pre-use return variance of each stock *i*; $\Delta\sigma_{iu}$ is the change in the residual variance between post- and pre-use periods for each stock *i*; and σ_{iub} refers to the residual variance of stock *i* in the pre-use period.

Fisher Sign test of the difference between the post-and pre-use return variances, 46.16% (54/117) of the stocks experience an increase, and 53.84% (63/117) of them exhibit a decrease in their return variance after swap use. It can also be seen from Panel A that the residual variance decreases by an average of 15.80%and a median of 16.57%. Again, based on the sign of the change in the residual variance, 53.8% (63 in number) of the stocks exhibit a residual variance decrease and 46.2% (54 in number) experience a residual variance increase after swap use.

To test the statistical significance of the change in both the return variance and residual variance, Panel B of Table 6.1 shows the Ordinary Least Square (OLS) estimation of Eq.(4.1) and Eq.(4.2). Panel B shows that the dummy coefficient $\alpha 1$ in Eq.(4.1) takes a negative value, suggesting a possible average volatility decrease after the swap use. However, a t-statistic of only -1.31 (and a p-value of 0.191) for the coefficient $\alpha 1$ suggests that the average decrease in the return variance is not significantly different from zero. The negative sign on the dummy coefficient $\gamma 1$ in Eq.(4.2) implies a possible decrease in the average residual risk, but here the t-statistic of -1.66 (and a p-value of 0.09) indicates that the average decrease in the residual variance is statistically significant only at weak confidence level of 10%, which is not conventional confidence level (5%).

As a further check on the results, Panel C of Table 6.1 shows the results from the non-parametric Wilcoxon Signed Rank test (WSRT). WSRT, with a Z-score of -2.014 and a significant p-value of 0.044 at 5% confidence level, supports the rejection of the hypothesis that pre-use return variances and post-use return variances of the new-user stocks are drawn from a different distribution. A Z-score of -2.392** (a p-value of 0.017) from WSRT also suggests that pre-use residual variances and post-use residual variances of the swap new users stocks do not belong to the same distribution[13]. Therefore, if this significance is not be found when the control sample is tested it might be said that the use of swap has a significant effect on the stock's volatility.

Thus, the results reported from the application of the portfolio approach seem to support the null hypothesis H0, which states that, on average, swap use does not affect the volatility of the underlying stocks. When using the Ordinary Least Square (OLS) estimation of Eq.(4.1) and Eq.(4.2) at confidence level 5%. However, the same result suggest the rejection of the null hypothesis H0, which states that, on average, swap's use does not affect the volatility of the underlying stocks, when using the non-parametric Wilcoxon Signed Rank test (WSRT). Using this test suggests that the use of swap has a significant effect on the stock return variance and has a significant effect on the stock residual variance without a clear direction of the change. It is not known if this significant change in the volatility after the swap use is an increase or a decrease in the volatility or if this significant change in the stocks volatility is an increase for certain stocks and is a decrease for other stocks. Moreover, the argument is that the results could be spurious as the sample contains nearly an equal number of stocks with an increase and those with a decrease in the return variance (and residual variance) after swap use with a significant change.

Since the existence of a significant variation in the swap new users volatility without a clear direction (Increase for some and a decrease for some), it is suspected that the swaps have a dual effect or non-uniform effect on the volatility of the underlying stocks and these effects are simply balanced out and average to zero. Panel D of Table 6.1 shows the results of the OLS estimation of Eq.(4.3). The results from OLS estimation of Eq.(4.3), suggest that swaps have a different effect from options. This research outcomes on swaps use are considerably different from the expectations generated by Ma and Rao (1988) on options. Consistent with Ma and Rao (1988), the coefficient on n1 in Eq.(4.3) is positive (equal to 1.0008) and is statistically significant at the 0.1% level as the p-value is equal to 0.000. This suggests a positive and statistically significant relationship between the change in the return variance and the change in the residual variance. However, in contrast to Ma and Rao (1988), this study discovers statistical significance at the 5% level as the p-value is equal to 0.032 relationship between the change in the return variance and the pre-use of swap residual variance (n2 = 0.02349, p-value = 0.032). Contrarily to Ma and

[13]In WSRT pre-use variances and post-swap's use variance are tested under distribution free assumption.

2009. Then banks that have used the interest rate swap for the first time, without a previous use of any other derivative product are picked. Only those stocks with swap use after January 2002 (298 stocks) are retained. To be selected, a stock must have complete daily dividend-adjusted price data for 500 observations around the use of swap date (250 observations before the swap use and 250 observations after the swap use). This restriction is necessary to avoid thin trading problems[11]. Therefore, Data is available for 117 stocks. These 117 banks constitute the main sample, from which, 5 banks went on swaps market for the first time in year 2002, 12 banks used the swaps for the first time during the year 2003, whereas in 2004 and 2005 only 10 banks started their swaps activity in each year. An additional 19 banks came on swaps in 2006, 25 banks in 2007 and finally 36 banks used the interest rate swaps for the first time in the year 2008. This sample is called the NEW USERS. As stated previously a control sample to this sample called the NON USERS[12] is defined. This sample is constructed from the same population but only with banks that have never used any kind of derivatives, including swaps before the 31/12/2009, this is because for a bank that used the swap on 20/12/2008, the 250 post-use observations end in 12/2009. The control stock for this new-user stock price observations start and finish on the same dates with the ones of new-user stock ones.

Banks usually start their derivatives activity with the interest rate swap, and this instrument is much more used than any other derivatives instrument, also its notional amount represents more than 60% of the total derivative products notional amount, where these products, in addition to swaps include the Futures, the Options and lately the Credit Derivatives. Source: BIS. As stated, the introduction of swaps by banks during a period of time as long as possible (7 years) has been chosen, in order to avoid the market wide conditions effect and the seasonality and époque's effect.

Finally to test effectively the impact of swaps use on banks stock volatility. A third sample of banks, called the OLD USERS sample is constructed, this sample is made of banks that have reported using interest rate swaps for every single year from 2002 to 2009 continuously. This sample is used to check the long-term effect of swaps on stock volatility over time, moreover comparing the volatility of the NEW USERS to the volatility of NON-USERS bank stocks do not show if this change (if there is any) is maintained over time.
As complete daily price data for stock prices and for the Standard and Poor's 500 Index (S&P500), which is used as a proxy for the market index, is only available from January 2002, from Thomson Reuters DataStream.

6. Findings: Volatility change under the portfolio approach:

Results of using the portfolio approach to measure the volatility effect of swaps use are presented. These results are generated from applying the portfolio approach to: (i) the sample of new users stocks; (ii) the control sample (Non-users); (iii) the combination of the two samples, (iv) the sample of old-users stocks, (v) the combination of the two samples, the old-users stocks and the non- users (control sample).

6.1. New Users stocks' volatility change:

Panel A of Table 6.1 shows the summary statistics for the mean and median changes, and the percentages (numbers) of stocks with a volatility decrease and a volatility increase after swap's use. The sample of new-user stocks exhibits a mean and a median decrease of 12.229% and 13.65%, respectively. Based on the

[11] According to Chaudhury and Elfakhani (1997) data availability is an indicator of whether the stock is thinly traded or not. In other words, if a stock has a complete data set around the option listing date than it is unlikely to be thinly traded.

[12] The control sample methodology is important to test whether the volatility change, between pre- and post-swap use periods, in the sample of new user stocks is caused by swap's use or by other exogenous factors (i.e., changes in market-wide and/or industry-wide conditions and the endogenous nature of the use of derivative decision). Thus, unless we have a full control sample (which matches each new user of swaps stock with a control stock), we will not be able to test whether the volatility change, if any, in the sample of new user of swap stocks is caused by swap's use or by other factors.

number 2 is associated to the potential control sample with the second closest pre-use average size to the benchmark, and so on. The second step involves using the swap new user stock pre-use return variance as a return variance benchmark and then the potential control stocks is ranked according to how close their pre-use return variance is to the return variance benchmark. Therefore the ranking with numbers starting from 1 for the potential control stock with the closest pre-use return variance is associated to the return variance benchmark, 2 for the potential control stock with the second closest pre-use return variance to the return variance benchmark, and so on. The third step is to take the swap new user stock pre-use residual variance as a benchmark and then rank the potential control stocks according to how close their pre-use residual variance is to the residual variance benchmark. Then, associate number 1 to the potential control stock with the closest pre-use residual variance to the benchmark, number 2 to the potential control stock with the second closest pre-use residual variance to the benchmark, and so on. After these three steps, each potential control stock, of a given swap new user's stock will have three numbers associated with it. The first number indicates how close the potential stock's average pre-use size is to the pre-use size of the swap new user stock. The second (third) number indicates how close the pre-use return variance (residual variance) of the potential control stock is to that of the swap new user stock. For each new user stock a selection the best control stock is made, from all the potential control stocks, as that stock with the smallest sum of ranks. The selected control sample is then used to test hypothesis $\boldsymbol{H_2}$ in the following manner:

First, employ the same portfolio approach, described to the control sample to test whether the volatility change, if any, in the sample of swap new user stocks can be explained by factors other than swap use.

Then, check the results using another alternative portfolio approach which combines the volatility observations of both the sample of new users stocks and the control sample. This alternative portfolio approach uses both a t-test and a non-parametric Mann-Whitney test to check whether the volatility change, if any, in the sample of swap new users stocks is the same as, or different from, that of the control sample.

$$\Delta\sigma_{i,j}^{2} = d_0 + d_1 DUM_{i,j} + g \qquad \textit{Equation } (4.4)$$

$$\Delta\sigma_{ui,j}^{2} = e_0 + e_1 DUM_{i,j} + h \qquad \textit{Equation } (4.5)$$

where $\Delta\sigma_{i,j}^{2}$ and $\Delta\sigma_{ui,j}^{2}$ represent the series of the change, measured between the post-use and pre-use periods, in the return variance and residual variance of each new user stock i and each control stock j, respectively. $DUM_{i,j}$ is a dummy variable, which takes a value of 1 if the stock is swap user and a value of 0 if the stock is not swap user. The sign of coefficients d_1 and e_1 indicates whether the change in the volatility of the swap user stock is higher or lower than the change in the volatility of the control sample. A t-test is then used to check the significance of the difference. As a further check on the results, a non-parametric Mann-Whitney test is performed test to see whether the change in the volatility of the sample of swap user stocks is significantly different from the volatility change in the control sample.

Furthermore, Ma and Rao (1988) proposition is checked (explained in Eq.(4.3)), which argues that the swap use might have a dual effect depending on the pre-swap use volatility of the underlying stocks. If all of the above tests show that there is a similar change (if any) between pre- and post-swap use periods in the volatility for both samples, and if Ma and Rao's equation (Eq.(4.3)) holds in a similar way for both samples, then one can more confidently accept hypothesis $\boldsymbol{H_{vi2}}$. Accepting $\boldsymbol{H_{vi2}}$ means that the swap use has no impact on the volatility of the underlying stocks.

5. Data

After presenting the hypotheses that are intended to be tested and explaining the procedure used to test these hypotheses, turn now attention to the data definition. Firstly, all the population of NASDAQ and New York Stock Exchange listed banks (534 banks) are selected, then their FDIC's quarterly reports from January 2002 to December 2009 examined, which provide the selected banks annual report financial information, and their derivatives positions and notional amount for the period January 2002 to December

Ma and Rao argue that if option reduces the volatility of the relatively volatile stocks because of the hedging effect, and increases the volatility of the relatively stable stocks because of the speculation effect, it would be expected that the coefficient n_1 to be positive and coefficient n_2 to be negative in the context of interest rate swap use.

Thus, if the expectation of Ma and Rao from Eq.(4.3) holds for the sample used for this study, then there is a possibility for the presence of a non-uniform effect of swap use. But, even if H_{vi1} is confirmed, there is still the possibility that stocks with similar characteristics to the selected new-user stocks show similar behaviour and the volatility change between pre- and post-use of swaps periods is then explained by the market-wide conditions (hypothesis H_{vi2}). Therefore, unless H_{vi2} is rejected, there is no swap use impact on the volatility of the underlying stocks. The best way to test H_{vi2} is possibly to use the control sample methodology.

4.4. Control sample approach

The control sample methodology is not entirely new in the area of derivatives effect; however the application of control sample and the use of banks that are using swaps for the first time in order to test the effect of swap use on bank volatility is new. Bollen (1998) uses the control sample methodology to test whether the behaviour of the residual variance across the pre- and post-option listing periods is an industry-wide phenomenon[9]. Mayhew and Mihov (2000) also use a similar approach to test whether the change, after option listing, in the variance of return can be explained by the endogenous nature of the option listing decision[10]. However, control sample methodology employed in the literature may suffer to a greater or lesser extent from a sample selection bias. In addition, the control sample has never been used to test whether the Ma and Rao (1988) proposition of the non-uniform swap use effect is a market-wide and/or industry-wide phenomenon.

Before employing the control sample methodology to account for the volatility change that may be caused by factors other than swap use and test the Ma and Rao (1988) proposition, it is important to begin by explaining how the control sample is constructed. The control sample is constructed as follows:

First, each swap new user stock is matched with a group of potential control stocks from the same index (NASDAQ and NYSE Banks) and which: (i) have never had any derivative use for at least a 2-year period before and after the swap's use date, and (ii) have complete daily price data available. These selection requirements are used to avoid the possible biases arising from different trading locations, market completeness, thin trading and combined effect of other derivative products.

Then, the best control stock for each swap new user-listed stock (among the group of potential control stocks) is selected by employing a ranking approach Mendenhall and Fehrs, 1999) based on pre-event average size, pre-event return variance and pre-event residual variance. The ranking approach is used to select a control stock for each swap new user stock, and consists of three steps. The first step, is to consider a given swap new user stock's pre-use average size as a benchmark and then the potential control stocks according to how close their pre-use average size is to the benchmark is ranked. The first digit umber 1 is then associated to the potential control stock with the closest pre-use average size to the benchmark,

[9] Bollen (1998) matches each optioned stock in his sample with a control stock from the same industry and with the closest pre-listing residual variance. However, Bollen makes explicit assumption that option listing has no impact on the beta coefficient of the market model.

[10] Mayhew and Mihov (2000) use a logit model to match each optioned stock in their sample with another stock that is regarded to be eligible but not yet listed. However, because our purpose is to examine the impact of swaps use on the volatility of the underlying stocks, the use of more factors in order to select the sample may undermine the importance of the underlying stock's volatility as being the main focus. In addition, the logit model of Mayhew and Mihov needs to be estimated in arbitrary sub-periods following the changes in the event day requirements. However, no assumptions about the periods of regulatory changes are required in our sample selection procedure.

4.3. Measuring the use of swaps effect through Portfolio Approach:

This section, discusses the way in which the volatility effect of swaps use is measured. It begins by describing the portfolio approach. Then, it shows how the control sample is designed and how it is used to account for the volatility changes that may be caused by factors other than swaps use. Finally, it highlights the usefulness of the individual stock approach as a measure of the volatility change that may be caused by the use of swaps.

To begin the analysis of the effect of the swaps on the bank underlying equity volatility, a portfolio of 3n observations (where n is the size of the sample) is constructed. The 3n observations are obtained by taking a pre-use variance (σ_{ib}^2) and a post-use variance (σ_{ia}^2) from each stock included in the sample, then the following regression model[7] is estimated.

$\sigma_{i,l}^2 = \alpha_0 + \alpha_1 DUM_i + \eta,$ Equation (4.1)

where index l takes two values: b before swap's use, and a after the interest rate swaps use, and DUM_i is a dummy variable, taking a value of zero if $\sigma_{i,l}^2$ is a pre-use variance observation and unity if $\sigma_{i,l}^2$ is a post-use variance observation, η is the random error term. α_0 is the average daily pre-use variance and $(\alpha_0 + \alpha_1)$ is the average daily post-use variance. If interest rate swaps use increases (decreases) the return's variance of the underlying bank stocks, it is expected that the coefficient on the dummy variable α_1 to be positive (negative) and statistically significant. Otherwise, it could be argued that Eq.(4.1) supports hypothesis $\boldsymbol{H_{vi0}}$.

To check the robustness of Eq.(4.1), the following Eq.(4.2) to residual variances is applied:

$\sigma_{i,ul}^2 = \gamma_0 + \gamma_1 DUM_i + \iota,$ Equation (4.2)

where $\sigma_{i,ul}^2$ takes on two values (pre-use variance $\sigma_{i,ub}^2$ and post-use residual variance $\sigma_{i,ua}^2$) from each stock i included in the sample[8]. DUM_i denotes a dummy factor, which takes a value of zero if $\sigma_{i,ul}^2$ is equal to $\sigma_{i,ub}^2$ and a value of unity if $\sigma_{i,ul}^2$ is equal to $\sigma_{i,ua}^2$. It is the dummy coefficient γ_1 that indicates the direction and the significance of the change in the volatility of the underlying stocks. If γ_1 is positive (negative) and statistically significant, Eq.(4.2) suggests that there is a significant increase (decrease) in the residual variance after the use of interest rate swaps. Otherwise, hypothesis $\boldsymbol{H_0}$ is supported.

Following Skinner (1989), Kumar et al. (1995), and others, the results are checked by using the non-parametric Wilcoxon Signed Rank Test (WSRT). WSRT is used to test whether the return variance series (residual variance series) before swap use and the return variance series (residual variance series) after swap use are the same.

Accepting or rejecting hypothesis $\boldsymbol{H_{vi0}}$ based only on the above tests does not end the task. This is because, as the hypothesis $\boldsymbol{H_{vi1}}$ states, swaps use may have a differential effect on different stocks. Furthermore, the analysis so far depends on the sign and the magnitude of the volatility change without any emphasis being given to the statistical significance of the individual stock volatility change.

The same equation used by Ma and Rao (1988) to test hypothesis $\boldsymbol{H_{vi1}}$ is used**.** Ma and Rao (1988) estimate the following equation:

$\Delta\sigma_{is}^2 = n_0 + n_1\Delta\sigma_{iu}^2 + n_2\,\sigma_{iub} + p$ *Equation* (4.3)

where $\Delta\sigma_{is}^2 = \sigma_{ia}^2 - \sigma_{ib}^2$ and $\Delta\sigma_{iu}^2 = \sigma_{iua}^2 - \Delta\sigma_{iub}^2$

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[7] *The principal underlying model construction is similar to Kumar et al. (1995) and Mendenhall and Fehrs (1999).*

[8] $\sigma_{i,ul}^2$ *takes two residual variance values from each stock included in the sample. Because the size of the sample is n,* $\sigma_{i,ul}^2$ *contains 3n observations.*

***H_{vi1}**: The interest rate swaps use has a dual effect on the volatility of the underlying stocks. It increases the volatility of relatively volatile stocks, because of the hedging effect of uninformed traders, and it decreases the volatility of relatively stable stocks, because of the speculative effect of the informed traders (Ma and Rao, 1988).*

Again the failure to reject hypothesis H_{vi1} does not necessarily suggest that the proposition of Ma and Rao (1988) holds only for swap users stocks. In other words, the possibility that stocks that are stable in one period become more volatile in the following period and stocks that are volatile in one period become less volatile in the following period may be a market-wide phenomenon. Thus, the following hypothesis is to be tested:

***H_{vi2}**: The volatility behaviour of swap users stocks is similar to the volatility behaviour of swap non-users stocks with similar pre-use characteristics.*

If H_{vi2} is accepted, it can be argued that interest rate swaps use does not affect the volatility of the underlying stocks. Otherwise, a further investigation is required.

4.2. Returns and volatility measures:

Initially, selecting the control sample and testing the above stated hypotheses requires the calculation of daily returns. Following Hamill et al. (2002), daily returns for stocks and the market index using the following formulas are calculated:

$$y_{i,t} = ln[(P_{i,t}+D_{i,t})/P_{i,t-1}]$$
$$x_{m,,t}=ln(P_{m,t})-ln(P_{m,t-1})$$

where $y_{i,t}$ and $x_{m,t}$ are the returns on stock i and the market index at time t, respectively. $P_{i,t}$ is the price of security i on day t; $D_{i,t}$ is the total dividend paid during period t; $P_{i,t-1}$ is the price of security i at the end of the day $t-1$; and $P_{im,t}$ and $P_{im,t-1}$ are the prices of the market index on day t and day $t-1$, respectively.

Then, similar to Ma and Rao (1988) and Kumar et al. (1995), among others, the variance of returns for the underlying stocks, in both the pre- and post-event periods is calculated, by using the following variance formulas:

$$\sigma_{ib}^2 = \Sigma^{t=-1}{}_{t=-251} (y_{i,t} - y_{ib})^2/n-1$$
$$\sigma_{ia}^2 = \Sigma^{t=250}{}_{t=0} (y_{i,t} - y_{ia})^2/n-1$$

where σ_{ib}^2 is the variance of the return of the stock i before the use of the interest rate swaps and σ_{ia}^2 is the variance of return of the stock i after the use of the interest rate swaps date. y_{ib} and y_{ia} are the mean of returns in the pre-use period and in the post-swap use period for the stock i, respectively.

In a similar fashion to Ma and Rao (1988) and Chaudhury and Elfakhani (1997), the single index model (SIM) is used to estimate the residual risk for each stock i. The single index model is:

$$y_{it} = \alpha + \beta x_{imt} + \varepsilon_t$$
$$\varepsilon_t \sim N(E(\varepsilon_t) = 0, Var(\varepsilon_t) = \sigma_{iul})$$

where σ_{iul} is the stock i's residual risk. σ_{iul} takes two values depending on the estimation period of SIM. If SIM is estimated in the pre-use period (day -250 to day -1), σ_{iul} becomes σ_{iub} and if SIM is estimated in the post-use period (day 0 to day +250), σ_{iul} becomes σ_{iua}[6].

[6] *As a reminder, index b means before swap use and index a means after swap use.*

3. Empirical procedure

This research employs a number of different unconditional volatility measures, i.e., the variance of returns, the average daily squared returns, and the residual variance generated from the market model, in order to examine the impact of derivative use on the volatility of the underlying banks stocks. These unconditional volatility measures are probably the most common ones in the derivatives volatility impact literature (see, among others, Whiteside et al., 1983; Stoll and Whaley, 1987; Skinner, 1989; Trennepohl and Duke, 1989; Kumar et al., 1995; Bollen, 1998; and Mayhew and Mihov, 2000). It is important to stress, however, that although the same volatility measures are employed in the existing literature, the purpose of the study is not merely to replicate the existing studies by using a new set of data, which covers a more recent period. Instead, a number of contributions are made to the existing literature for studies, which use unconditional volatility measures to investigate the possible volatility effects associated with derivative use.

The first important contribution of this major part of the study is to mitigate the bias that may result from selecting the samples. This is achieved by using *clean* samples, a term that will be define later. The argument is that ignoring factors such as market completeness, trading location and thin trading when selecting the samples may cause a substantial bias in the empirical study. Different authors recognise the potential mitigating impact of different factors, which are linked to the sample selection, but none of them have successfully accounted for all these factors simultaneously.

The second contribution to the literature is the use of the control sample methodology, which accounts for the possible changes in market-wide and industry-wide conditions that may coincide with the derivative use. One has to admit that employing the control sample methodology is not entirely new in the context of stock volatility. What is new, however, is the way in which the control sample is constructed. More specifically, the control sample is designed to account for the possible volatility changes that may be caused by factors other than the derivatives use[5] and to avoid the biases that may result from the effect of market completeness, trading location and thin trading. It is argued that the biases associated with market completeness, trading location and thin trading are ignored to a greater or lesser extent by previous studies that use the control sample to account for changes in the market-wide and industry-wide conditions. It is also important to note that the control sample methodology allows the researcher to mitigate to some degree the bias that may be caused by the measurement of the derivative use effect. This bias is namely the endogenous nature of the derivative use decision. Furthermore, this research re-examines, for the first time since Ma and Rao (1988), the possible dual volatility effect associated with the swaps use and investigates whether what appears to be a dual volatility effect of swaps may actually be a market-wide and/or industry-wide phenomenon.

4.1. Hypotheses to be tested:

The central purpose of this study is to examine whether swaps use by itself has any impact on the volatility of the swaps user stocks. Driven by this aim, the following hypothesis is to be tested:

H_{vi0}: *There is no effect of the Interest rate swaps use on the volatility of the underlying bank's stocks.*

The failure to reject hypothesis H_{vi0} does not necessarily suggest that interest rate swaps use has no impact on the volatility of the underlying stocks. This is because some stocks may experience a volatility increase and others may experience a volatility decrease and the overall interest rate swaps use effect may be neutral. Thus, this section tests the following hypothesis:

[5] The factors other than derivatives use, which may cause the volatility of the underlying stocks to change, include changes in market-wide and industry-wide conditions and the endogenous nature of the use of derivatives decision.

simultaneity difficulties of some of the earlier work in this area.[4] The market-based measure of interest rate risk exposure can be seen as the "output" of banks' attempts to manage their interest rate risk exposure, using the "inputs" of balance sheet positions and derivatives. In other words, the interest rate risk measures captured by the market model take into account the banks' joint decision-making process concerning the on- and off-balance sheet components that contribute to overall interest rate risk exposure. Thus, the simultaneity problem in using both balance sheet gap measures and measures of derivatives usage in a single regression is avoided.

A large body of work confirmed these early findings that financial institution returns are generally more sensitive to interest rates with longer maturities, that interest rate sensitivity has declined over time and that ignoring the time-varying data properties of bank returns may result in biased or inefficient estimates of interest rate sensitivity [see, for example, Saunders and Yourougou (1990) and Yourougou (1990), Kwan (1991), Choi *et al.* (1992), Hirtle (1997), Flannery, *et al*. (1997)].

Elyasiani and Mansur (1998) also used ARCH methodology to aid their investigation into interest rate risk in banking in the form of Engle's *et al.* (1987) Generalised ARCH in the Mean (GARCH-M) model. Elyasiani and Mansur (1998) pointed out that the fundamental attraction of the 'in mean' extension is its ability to capture the dynamic pattern of changing risk premium over time, whilst portraying the trade-off between expected return and volatility and therefore is arguably a better *ex post* statistical approximation of the orthodox *ex ante* asset pricing theories. Extending earlier work suggestive of the pertinent role that interest rate volatility played in the bank return generating process [see for example, Lynge and Zumwalt (1980), Booth and Officer (1985), Kane and Unal (1988), Flannery, *et al.* (1997)], Elyasiani and Mansur (1998) considered both the effects of long term interest rates and its volatility on monthly US bank stock returns, complied into three distinct portfolios (money centre, large and regional banks) over the period from 1970 to 1992. Consistent with the earlier empirical literature, Elyasiani and Mansur (1998) found that long-term interest rates had a significantly negative impact on bank returns. Further, interest rate volatility, as measured by the conditional variance of the long term interest rate was similarly found to be an important determinant of both bank return volatility and bank risk premium for money centre and large banks, though not the regional bank portfolio.

Only in the late 90's, that the analysis of bank interest rate attracted empirical attention outside the United States. For example, Madura and Zarruk (1995), comparing banks in Canada, Germany, Japan, the United Kingdom and the United States, found evidence that non-US banks have greater interest rate sensitivity than their US counterparts. Later work by Adjaoud and Rahman (1996) provided complementary evidence of interest rate sensitivity in the Canadian and UK markets, respectively. In Australia, Faff and Howard (1999) focused on the period 1978-1992 to examine interest rate risk in four broad categories; namely, an aggregate banking and finance industry portfolio, large banks portfolio, small banks portfolio, and a finance companies portfolio. The sample period was divided into a pre-deregulation, deregulation and post-deregulation period, in the face of Kane and Unal's (1988) warning about arbitrary assignment of sub-periods.

In line with findings in the United States, large banks, and less important finance companies, were found to be sensitive to interest rates, with responsiveness varying across sub-periods and particularly for long-term interest rates. Interestingly no sensitivity was recorded for the post-deregulation period. Faff and Howard (1999: 99) suggested that this declining interest rate sensitivity is attributable to the development of "…better systems for measuring and managing interest rate risk".

[4] *Choi and Elyasiani (1997) use a three-factor model that incorporates changes In both interest rates and exchange rates to examine the relationship between derivatives and interest rate and exchange rates exposures. They estimate the model for a sample of 59 large U.S. banking companies and find a significant relationship between the resulting interest and exchange rate betas and the banks' interest rate and exchange rate derivatives usage.*

derivatives by banks tends to result in higher levels of interest rate risk exposure.[2] For instance, Sinkey and Carter (1994) and Gunther and Siems (1995) found a significant, negative relationship between the balance sheet "gap" measures of interest rate risk exposure (the difference between assets and liabilities that mature or reprice within specified time horizons) and the extent of derivatives usage by banks. These papers argue that this finding is consistent with the idea that banks use derivatives as a substitute for on-balance sheet sources of interest rate risk exposure, rather than as a hedge. In contrast, Simons (1995), using a similar empirical approach, finds no consistent relationship between on-balance sheet gaps and derivatives usage.

While these results point to a significant relationship between derivatives and banks' interest rate risk profiles, the empirical specifications used in these papers raise questions about the robustness of their findings. In particular, these papers use interest rate gap measures as explanatory variables in regressions describing the extent of derivatives usage for a large panel of banks. However, both derivatives and on-balance sheet positions can be seen as "inputs" that can be used by banks to achieve a desired level of interest rate risk exposure. In fact, the conclusions drawn by some of these papers that derivatives are used as a substitute for on-balance sheet interest rate exposures are consistent with this view.

Gorton and Rosen (1995) use a different approach to this question that avoids the difficulties of working with balance-sheet based maturity gap data. Specifically, they use the limited data available from banks' Reports of Condition and Income (the Call Reports) on the maturity distribution of interest rate derivatives to derive estimates of the direction of interest rate risk exposure arising from these positions. Their conclusion is that the interest rate exposures arising from interest rate swaps tend to be mostly, though not completely, offset by exposures from other bank activities. Further, they find that the extent of offsetting varies with bank size, with large dealer banks experiencing the greatest amount of offset. Thus, Gorton and Rosen's results can also be interpreted, as suggesting that the net impact of banks' interest rate swap activity is to increase interest rate risk exposures.

In order to extend this earlier work on derivatives and interest rate risk exposure, it is helpful to consider another body of work that has examined the general nature of banks' interest rate risk exposures. In particular, these studies have used stock market data to measure the interest rate sensitivity of banks' common stock.[3] These papers use two-factor market models that relate the return on the equity of individual banks to the return on the market and a term designed to capture interest rate changes. The coefficient on the interest rate term (the interest rate "beta") can be interpreted as a measure of interest rate risk exposure.

Most of these studies have examined the time series properties of the interest rate and exchange rate betas, attempting to assess whether these coefficients are stable over time. In general, the papers have found that the coefficients on both the market rate of return and the interest rate term vary significantly over time (Kane and Unal (1988), Yourougou (1990), Neuberger (1991), Song (1994), Robinson (1995), and Hess and Laisathit (1996)). A few papers have attempted to explain the variation in the interest rate and exchange rate sensitivity measure *across banks by using balance sheet data to account for differences in banks' activities* (Flannery and James (1984a, 1984b), Kwan(1991)). These papers find a significant relationship between balance sheet characteristics and banks' interest rate risk exposure.

The market-model approach to interest rate risk and exchange rate risk measurement provides a way to assess the relationship between derivatives and interest rate risk and exchange rate exposure that avoids the

[2] In contrast, papers examining the relationship between derivatives activity and interest rate risk exposures among thrifts have found that greater use of derivatives has tended to be associated with lower risk exposures. See Brewer, Jackson and Moser (1996) and Schrand (1996).

[3] Another group of papers has used Call Report data to estimate the duration of banks' net worth (see Wright and Houpt (1996), Neuberger (1993)).

markets." For instance, the danger of credit exposure tends to transmit shocks from one market to another because dealers for derivatives are highly concentrated among a few large financial institutions. This is precisely the justification that the Federal Reserve System used in support of its efforts to arrange a bailout of the Long Term Capital, Inc.[1]. Other researches (Culp and Mackay 1994; Goswami and Shrikhande 1997) emphasise that these derivative instruments, swaps in particular, offer firms new choices to help minimize financing costs and interest rate risk, and representing a true financial innovation as well. More importantly, derivatives have strengthened linkages between markets that have increased market liquidity and efficiency.

As seen above, considerable controversy regarding the effects of derivative usage still exists as witnessed by the conflicting findings of Sinkey and Carter (1994); Gunther and Siems (1995); Simons (1995); and Hirtle (1997***)***. It is a priori unclear whether derivatives tend to reduce or enhance risk exposures. Most previous works on derivatives and their impact on risk in the banking industry remain quite broad and general, most empirical works had severe methodological limitations. The most accepted one is the use of the notional amount of derivatives in measuring the extent of the activity. A higher notional amount does not necessarily mean a higher risk exposure. As the bank might counter use derivatives positions and have a final exposure equal to zero with a very high notional amount. The second gap is that no research, to our knowledge, focused on interest rate swaps impact on banks stocks return volatility using a large sample of banks entering into the interest rate swap activity for the first time in their history. At the same time, observing a long period of examination, because the swaps impact in 2002 might be very different from the one in 2009 due to market conditions. Finally, most previous studies ignored the use of a control sample in examining interest rate swap activity and its impact on bank stock risk. They limited their analysis on banks active with swaps only. Furthermore, interest rate swaps could have a dual effect, which increases the volatility of highly volatile stocks and reduces the volatility of the more stable ones. This issue also was not addressed by previous researches. From there, this research addresses the next three questions:

- *Do interest rate swaps increase, decrease or are neutral to banks stock returns volatility?*
- *Does the impact of interest rate swaps on banks stock returns volatility change with the size of the bank and the period of using swaps. (control sample factor)?*
- *Do interest rate swaps have a dual effect on bank stock returns volatility?*

The contribution of this paper is methodological and empirical, because most previous cited researches did not fully succeed to make a dynamic measure of risk. Moreover, most of them based their analysis on a cross-section panel of banks by using on-balance sheet data to measure the risk. In This study the measure of risk relies on a market data time dynamic. Furthermore, all US banks listed in NYSE and active in the interest rate swaps market will be considered, while other banks, that are not using interest rate swaps and listed in the NTSE will be used as control sample. Our methodology will also measure the bank risk volatility before and after using interest rate swaps for the first time (event Study). With this technique the market wide condition bias will be eliminated. The other contribution of this second part of the empirical research is the test of the dual effect of the interest rate swaps as Ma and Rao tested positively on the options. Interest rate swaps might have a dual effect on volatility. This duality is the increase in volatility of already volatile stocks, due to speculation as Ma and Rao claim, and the decrease in volatility of the stable stocks due to hedging as the same researchers claim.

3. Derivatives and Bank Risk Exposure

A number of papers have examined the relationship between interest rate risk exposure and banks' derivatives usage. Several of these papers have found results consistent with the idea that increased use of

[1] *LTC was a $100 billion hedge fund that was rescued by a group of large domestic and international banks during 1998.*

The Impact of Interest Rates Swap Activity on Bank's Stock Volatility:
An Empirical Portfolio Approach

1. Introduction

In the last ten to fifteen years, financial derivative securities have become important and controversial products. These securities are powerful instruments for transferring and hedging risk. However, they also allow agents to quickly and cheaply take speculative risk. Determining whether agents are hedging or speculating is not a simple matter because it is difficult to value portfolios of derivatives. The relationship between risk and derivatives is especially important in banking since banks dominate most derivatives markets and, within banking, derivative holdings are concentrated at a few large banks. If large banks are using derivatives to increase risk, then losses on derivatives, such as those of Procter and Gamble, and Orange County, may seem small in comparison with the losses by banks (Barings, AIB, AIG, Lehman Brothers). In addition, the major banks are all taking similar gambles, then the banking system is becoming the most vulnerable sector since the lasting financial crisis that started in 2009.

2. Research Background and Motives

Many studies investigating the effect of the derivatives use on the firm risk have emerged, however, their outcomes are different and sometimes controversial, some authors, Allayannis and Ofek (2001), Makar and Huffman (2001), argue that the use of currency derivatives for hedging foreign exchange risk, as their use, significantly reduces the exchange rate exposure firms face. Moreover, their results indicate that cross-sectional differences in the magnitude of lagged currency exposure are inversely related to foreign exchange derivative use. Brewer, Jackson and Moser (1996), using a sample of savings and loan associations (S&Ls), examine the proposition that involvement with interest-rate derivatives instruments increases depository institutions' risk. They have found that greater use of derivatives has tended to be associated with lower risk exposures. Shanker (1996) and Venkatachalam (1996) find that derivatives are effective in reducing banks' interest rate risk. Choi and Elyasiani (1997) stress the relative influence of risk reduction involving exchange rates compared to the reduction in interest rate risk. On the other hand some authors, such as Gorton and Rosen (1995), examined the relationship between interest rate risk exposure and banks' derivatives usage, and their conclusion is that the interest rate exposures arising from interest rate swaps tend to be mostly, though not completely, offset by exposures from other bank activities. They also found that the extent of offsetting varies with bank size, with large dealer banks experiencing the greatest amount of offset. Thus, Gorton and Rosen's results can also be interpreted, as suggesting that the net impact of banks' interest rate swap activity is to increase interest rate risk exposures.

A third group of researchers defend the thesis of the non-relationship between banks risk and the usage of derivatives. Their arguments are banks use derivatives to be involved as an intermediate in a financial transaction and generate profit from the transactions and intermediation fees. In support of this, Hentschel and Kothari (2001), examine how stock return volatility, interest rate and exchange rate exposures are related to the extent of derivative use in a panel of large non-financial U.S. Firms. The authors find no statistically or economically significant increase or decrease of these risk measures associated with derivative use, and conclude that, for most firms, even large derivative positions should have a small effect.

From the above we can clearly note that a debate on the derivative use and its impact on the firm's risk has already taken place in the academic arena. On the market place the same debate has also emerged. On one side we can clearly note that the derivative market did not cease growing for the last fifteen years. Toady this market is estimated at more than 600 trillion dollars which is more than 15 times the world equity market (ISDA.COM).

The rapid growth in the market for swaps and other derivatives has generated controversy regarding the economic rationale for and benefits of these instruments. Some observers such as "Thorbecke (1995) argue that unrestricted growth in swaps and other derivatives may ultimately threaten the stability of the financial