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The impact of interest rate and exchange rate volatility on bank's returns and volatility: Evidence from Tunisian

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Abstract

This study specially investigates the effect of the market index, interest rate and foreign exchange rate risk on Tunisian banks stock returns using the OLS and GARCH estimation models. These results suggest that exchange rate and market index have an impact and an important role in determining the dynamics on the conditional bank stock return. However, interest rates do not appear to be significant factors in the Tunisian bank return. The results further indicate that long-return interest rate and exchange rate volatility are the major determinants of the conditional bank stock return volatility.

Key words: Market Risk, Market Index, Interest Rate Risk, Foreign Exchange Risk, Bank Stock Returns, GARCH

Introduction

The banking business is like any business because of the specific risks it poses to the community: loss of depositors' savings crisis, systematic failure of one or more credit institutions of the entire banking system. In addition, the system is regularly confronted with a difficulty although this sector is one of the most regulated economies. The most recent example is the subprime crisis. This crisis leads to bank failures with adverse consequences on the real economy across the world. It is therefore imperative to protect the depositors against these bank failures in an environment characterized by the existence of market imperfections (Dewatripont and Tirole, 1994). These failures can lead to a systemic crisis (Bhattachary and Thakor, 1993) where social cost are higher than the private ones therefore, risk is at the heart of the banking business. Moreover, the high volatility in interest rates in recent years a long with the significant level of financial leverage for most companies has also contributed to the growing relevance of interest rate exposure.

The impact of interest rate and exchange rate changes on banks' stock returns has been of major interest to bank managers, regulatory authorities, academic communities and investors, since the failure of numerous banks has been especially attributed to the adverse impacts of fluctuations in interest rates and exchange rates.

The issue of interest rate risk is of major interest to the banking, regulatory, and academic communities. The Interest rate risk (IRR, hereafter) is acknowledged as one of the major financial risks borne by companies. This is due to the fact that changes in interest rates affect both a firm’s expected cash flows and the discount rates used to value them. As a matter of fact, the only two studies that have employed a nonparametric approach in the context of corporate exposure to risk have focused on exchange rate exposure (Guo and Wu, 1998; Aysun and Guldi, 2009). In the study we will focus on the impact of interest rate and exchange rate volatility on bank’s returns and volatility: Evidence from Tunisian.

Literature Review

Early studies of bank interest rate sensitivity include the works of stone (1994), Lloy and Shicks (1977), Chance and Lane (1980), Lynge and Zumwalt (1980), Flannery and Janes (1984), Booth and officer (1985), Scott and Peter-son (1986), and Bae (1990). These authors apply a tow –index model market and interest rate factors) to bank equity returns under the assumption of constant variance error terms.

Saunders and Yourougou (1994) contrast the effect of interest rate changes on banking and non-banking firms during periods of rel- active interest rate stability (pre-october 1979) and high interest rate volatility, (post-october 1979) and report that interest rate effects vary substantially over time. In addition, Yourougou, (1990) explained that the interest rate and exchange rates have a significant impact on these hares of financial institutions including banks. Moreover, (Kessel, 1956, Bach and Ando, 1957, French et al, 1983) explained the sensitivity of banks' interest rate, given the composition of their balance sheets. The first empirical studies have drawn attention to the risk of exchange rate on bank stock returns were generated by Grammatikos and al, 1986 and Chamberlain et al 1997.The results of these studies have shown that U.S. banks were exposed to the risk of exchange rate. Furthermore, by employing the same three-factor model to return the generating process of Korean banks, Hahm (2004)concluded on the risk of interest rate risk and exchange rate in that Korean bank stock returns were sensitive to those factors. His work shows that Korean commercial banks have been very involved with the risk of interest rate and currency risk. The result also shows that the efficiency of Korean banks is significantly associated with the degree of interest rate and credit policy.

Most of existing studies concentrate on the interest rate and exchange rate sensitivity of bank stock returns separately by employing different methodologies. This variation in turn gives rise to different empirical results. Song (1994) was the first study to employ the ARCH –type methodology in banking. Song finds ARCH-type modeling as the appropriate framework for analysis of bank stock return. These studies mainly use linear estimation methods such as OLS and do not consider the sensitivities of bank stock return to both interest rates and exchange rates factors which are time-varying. Whatever empirical studies were used ARCH-type models to capture variation over timeline this regard, the literature has overwhelmingly highlighted this gap more in North America and it is clear from a comparison with international studies which cited examples such asMadura and Zarruk (1995), Adjaoud and Rahman (1996) and Rasad rajan (1995), Choi et al (1998) and Chamberlain et al (1997). They have examined the interaction between partners were market interest rate and exchange rate in U.S financial institutions. In addition, there is another similar empirical work that was conducted by Suzannak et al (2004) who explained the Market, interest rate and foreign exchange rate risk in Australian banking. Even more work was conducted by Saadat Kasman and al (2011) who explained the impact of interest rate and exchange rate volatility on banks' stock returns and volatility: Evidence from Turkey.

Research Methodology

Model Specification

- *Linear Regression*

Most research into market, interest rate and foreign exchange rate risk in banking has been undertaken using single or multi-factor least squares regression where by the parameter estimates provide an indication of risk sensitivity. Examples of two-factor models, largely concerned with market and interest rate risk, include Chance and Lane (1980), Lynge and Zumwalt (1980), Flannery and James (1982, 1984a, 1984b), Booth and Officer (1985), Kane and Unal (1988), Akella and Chen (1990), Brewer and Lee (1990), Madura and Zurruk (1995), and Adjaoud and Rahman (1996). Alternatively, Choi, et al. (1992) and Wetmore and Brick (1994) have employed a three-factor approach to model market, interest rate and foreign exchange rate risk simultaneously.

- *GARCH model*

The sensitivity of bank stock returns to both interest rate and exchange rate changes are time-varying. The crisis is identified with volatility spikes then refers to the extension of the uncertainty in the financial markets. The most common method used to test externalities volatility estimation models in the ARCH.

Since the introduction of the autoregressive conditional heteroscedasticity (ARCH) by Engle (1982), ARCH-type modelling has become the standard econometric approach for describing dynamics of changing variances of time series with heteroscedasticity. In this perspective, an important extension of the generalized autoregressive conditional heteroscedastic (GARCH) is suggested by Bollerslev (1986).The GARCH (p, q) is a form of ARMA model on the conditional variance. This approach requires fewer parameters to estimate the formulation ARCH (p) model for the phenomena of persistence of shocks. The conditional variance of the study variable is determined by the square of the error terms p and q past conditional variances delayed. GARCH models have proven their ability to capture the following properties: The first is that volatility clustering, large variations tend to be followed by large changes, and small changes by small changes. It is a leveraged finance.

The second property is specific to fat tails of financial time series: financial series are generally characterized by a leptokurtic distribution that is away from a normal distribution. Tails of distributions are thicker than those of a normal distribution, which reflects the presence of extreme event.

Process ARCH (q) is given by: $\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \varepsilon_{t-1}^2$

Where $\alpha_0 > 0$ and $\alpha_i \geq 0$ for all itches constraints help ensure the positivity of the conditional variance. A GARCH (p, q) is defined by: $\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \, \varepsilon_{t-1}^2 + \sum_{j=1}^{p} \beta_j \, \sigma_{t-j}^2$ $\alpha_0 > 0, \alpha_i, \beta_j \geq 0$.

Leptokurtic characteristics, heteroscedasticity and clustering of volatility that characterize high-frequency financial time series are correctly modeled by the GARCH process, since they can capture the persistence of volatility shocks using the parameters $\alpha_i$and βj the conditional variance equation. ARCH models (allowing thus eliminating problems of heteroscedasticity) were used to study the propagation of volatility (spillovers) as a main feature of the stock market volatility. Variability over time in volatility is now generally accepted and modeled through ARCH type specifications (as in Bollerslev, 1987, and Engle and Lee, 1994).According to the logic of portfolio choice models, volatility plays a crucial role in determining the performance, a more risky way is supposed to provide superior performance, this effect has been measured primarily through ARCH-M model, in which volatility is directly introduced as an explanatory variable performance (Engle et al, 1987).

Some authors (eg Schwert, 1990) showed that, conversely, the yield may be involved in explaining the volatility. It is then the effect of asymmetry (or leverage), because the reaction of volatility to a shock on output is different depending on the sign of shock: there is usually a shock down performance increases the higher the volatility, all other things being equal, a shock on the rise. These interactions appear to be relatively robust to account for the dynamics of most financial asset prices (stock indices and exchange rates in particular).We can then see that the quadratic specification in the conditional variance equation obscures the characteristic asymmetry of shocks. However, ARCH and GARCH models by establishing a quadratic relationship between the error variance can not take into account the volatility skew. In other words, volatility tends to rise in response to bad news (expected returns lower than expected) and decrease to good news (expected returns higher than expected).Indeed, the most used models for series modeling financial and market models are ARCH (Engle, 1982) and GARCH (Bollerslev, 1986).Both models have shown through modeling the conditional variance of the series studied as a linear function of past squared errors, which can provide estimates where the estimated parameters are highly statistically significant, but which are not stable through time. Hamilton and Susmel (1994) have addressed this problem by introducing the SWARCH model that allows data to follow several ARCH models.

The Data

The construction of our econometric model GARCH is made on the basis a sample that consists of 10 Tunisian commercial bank stocks listed on the stock exchange of Tunisian. The information gathered on the banks, are listed on the principal market, the evolution of stock prices traded and the evolution of sector indices are monthly data for the period 2007 until to 2011.In the empirical part we use a data set consisting of: course of action, volume of transactions, foreign exchange rates, interest rates, risk-free interest rate and market index that we consider to be the most important and the most promising model formulation type ARCH and GARCH as representative as explanatory variables. And as our sample is given monthly to a period ranging from January 2007 to December 2011. Our data source is the BVMT and the BCT. These variables are applied to 10 Tunisian banks traded.

Empirical model

The seminal autoregressive Conditional Heteroscedastic model (ARCH introduced by Engle (1982), to model this phenomenon has given a huge push to both econometric model building and applied research, is used in order to compensate for the lack of representation ARMA (p, q) for monetary and financial problems. Engle's process proposed to model time varying conditional volatility using past innovations to estimate the variance of the series. Based on the ARCH model, Bollerslev (1986) suggested the more widely used generalized autoregressive conditional heteroscedastic model (GARCH), which is an important type of time series model for heteroscedastic data. GARCH model (p) generates episodes of high volatility followed by periods of low volatility. The effect of ARCH or conditional heteroscedastic is the presence of auto correlation in the residuals squared. There are two main approaches to identify. The first known non Engle test is a lagrange multiplier test TR^2 regression, namely the size of the sample multiple R square which follows a chi-square with p degrees of freedom which analyze the presence of ARCH effect. The second approach is Mcleod test which is similar to that ljuing-Box test for the difference in the squared residuals, which are measured as follows.

The transition to the impact of interest rate and exchange rate volatility on banks stock returns requires understanding not only of the sensitivity of bank stock returns and changes in interest rates but also the volatility of exchange rates. This cannot be achieved without using both the OLS and the standard GARCH model. Most empirical studies use OLS to estimate the effect of interest rates and changes in exchange rates on banks' stock returns. The following model is estimated with OLS:

$$r_t = \beta_0 + \beta_1 MRK_t + \beta_2 INT_t + \beta_3 FX_t + \mu_t \qquad \textbf{(1)}$$

Where $r_t$is the return of the ith stock return at time t, $MRK_t$is the return of the market index, $INT_t$is the return of a risk- free interest rate or bond index; and, $FX_t$is the return of the foreign exchange rate. $\beta_0$is the intercept term and $\mu_t,$ is an error term with the assumption of an iid condition. The equation OLS estimation is tested with the test ARCH. The ARCH process was generalized by Bollerslev (1986) with GARCH (Generalized autoregressive conditional heteroskedasticity). The GARCH (1, 1) is specified as follows:

$$r_t = \gamma_0 + \gamma_1 MRK_t + \gamma_2 INT_t + \gamma_3 FX_t + \varepsilon_t$$
$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta\, \sigma_{t-1}^2 \qquad \textbf{(2)}$$

This model takes into account the variance of returns for previous periods and random shocks to model future returns, capturing the stochastic nature of this variance. In addition, they exhibit nonlinear dynamics that captures the impact of skewness observed in financial series. A GARCH models the variance of the following form:

$$r_t = y_0 + \varepsilon_t$$
$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \theta_1 INT_t^2 + \theta_2 FX_t^2 \quad \textbf{(3)}$$

INT^2 is the interest rate and FX^2 is the return volatility of exchange rates,$\alpha_1$is ARCH coefficient, and β is the coefficient of GARCH model .GARCH model contains two parameters to specify the number of delayed shock squared (p) and conditional variance (q) to consider, where its general form GARCH (p, q).

Empirical results

Insert table 1 here

Detecting the presence of ARCH effect

According cf. Berra and Higgins (1993), if the unconditional kurtosis is always greater than the normal distribution it indicates that the process is in liptokurtique. r_t This is the second reason, the conditional variance with time-dependent for which the ARCH process is used to represent financial series or residuals of a linear model defined on financial time series which allows to pass the ARCH model estimation.

Insert table-2 here

From Table 2, the application of two tests, test Ljuing Box and Lagrange multiplier test (TR^2) show that for all series of residues, the probability associated with two statistical tests is very low and zero in two tests which reject all series, The assumption of homoscedasticity in favor of alternative conditional heteroscedasticity . Therefore it rejects the hypothesis of no ARCH effect exists. This conditional heteroscedasticity ARCH effect or there in this series is defined as the presence of autocorrelation in the squared residuals which favors the presence of a combination of volatility (volatility clustering). From this table we note the existence of autocorrelation or heteroscedasticity thereby rejecting the null hypothesis, that is to say there is no ARCH effect.

OLS estimation

Insert table-3 here

Table 3 reports the results of the OLS estimation. The variable of the market risk are positive for all individual bank and portfolio return except BTE bank which are negative. In addition, the coefficients of market risk are statistically significant in only 4 banks (STB, BH, Amen Bank and UIB) compared with 10 banks with a positive effect. Moreover, the results show that the market returns explains a modest proportion of bank returns, compared to interest rates and exchange rates returns. Evidence of the interest rate is not significant for all individual banks and portfolio return and a negative effect in only 5 of 10 cases, therefore, we see that the market risk is considered the most important by the interest rate which has no impact of the bank stock return. The coefficient of exchange rate, are negative for all individual bank and portfolio return expect BNA and UIB banks, and statistically significant in 4 out of 10 cases. Evidence of exchange rate sensitivity is stronger compared to the interest rate since the latter is not significant for all individual bank and portfolio return. Overall, most of the impact on the individual bank and portfolio returns is associated with the overall market returns and the exchange rate return, This result is confirmed by the study of Saadet Kaasman, Gulin Vardar and Gokce Tunc (2011) who find that the market return and the exchange rate has an impact of the individual bank and portfolio return, but the interest rates return has a small effect (significant in only 4 out of 14) of the bank return in Turkey. In addition, we note the presence of the ARCH effect has an impact on the series of bank returns this present for all banks and the portfolio return level analysis. For R^2 is a statistic that will give some information about the best fit of a model. In this table, we see that the quality of model is fitting for low subject in all cases.

At the equation OLS, if the squared residuals contain autocorrelation or hetroscedasticity, it is likely that the null hypothesis will be reject, OLS is not, in this case, the best methods to estimate the model, why we should have tests to detect it.

Estimation of return with GARCH (1,1) model

Insert table 4 here

The estimated GARCH (1, 1) parameters of the conditional return shown in table 4. We find that the coefficient y_1 ,which measures the effect of market returns on each of the bank stock return is positive in all cases except ATB, and BTE and statistically significant in the following cases STB, BH, Amen bank and UIB with a positive effect. In addition, the results indicate that the market returns has a positive impact and more or less on the bank stock returns. The market return is found to explain a greater proportion of conditional bank stock returns compared to interest rate that are negative in only 6 cases out of 10 and non-significant in all cases. Moreover, the most remarkable of the exchange rate is negative in all cases except in the following cases: BNA and UIB and statistically significant in only 5 cases out of

10. This result is confirmed with the study of Ryan, Suzanne K. & Worthington, Andrew C. (2004)" The results suggest that market risk is an important determinant of bank stock returns, along with short and medium term interest rate levels and their volatility. However, long-term interest rates and the foreign exchange rate do not appear to be significant factors in the Australian bank return generating process over the period considered".

The main rationale for the negative relationship with the exchange rate can be explained by the sharp depreciation of the exchange rate that will have an adverse of the economic effects the deterioration of net assets (liabilities denominated in foreign currency exceed assets denominated in foreign currencies) in the banks and companies. On the other hand, the depreciation of the local currency may lead to damage in the bank balance sheet and the deterioration of bank equity may result in a decline in the bank stock return, which makes exports from countries that use the currency, more competitive, means it is cheaper on the international market, however, the price of imports increases, given that money is very impaired, it is not usually a sign of economic health.

Both the ARCH parameter α_1 and the GARCH parameter β. The ARCH parameter α_1 is statistically significant in all classes of bank stock returns except BIAT, BH and UIB. In addition we note that the condition of stationary of the variance for GARCH (1, 1) parameter, namely $\alpha_1+\beta<1$ holds for all courses except BNA (8,377) bank. Changes in market volatility of each may be considered the following of a stationary process. On the other hand, the results is related to estimates of these processes indicate that the coefficients are statistically significant in 5 of 10 at 1%, the volatility persistence, measured by $\alpha_1$and β is very significant since the sum of these parameters within a range of [-0.5, 0.37] which supports a low presence of ARCH parameter and GARCH parameter effects in all cases except ATB which has 0.99 that is to say $\alpha_1+\beta \geq 1$ has a high persistence of volatility shock. Additional, is, according to the conditional variance equation, $\alpha_0$that is positive in all cases of each bank and statistically significant in most cases; this indicates that there is a significant time-invariant component in the process of generating returns. In particular, the bank stock return sensitivities are found to be stronger for market return than interest rates, implying that market return plays an important role in determining the dynamics of the conditional bank stocks return.

Insert table 5 here

Table 5 presents the results of the bank stock and index return volatility model with the inclusion of variables is the reflecting interest rate volatility and the exchange rate volatility. We find that the coefficient $\square_1$ of ARCH model is statistically significant in all cases except in BIAT, STB, BH, Amen Bank and UIB, over the results indicate that the ARCH parameter is small except BNA, and UIB which provides a weak support for the presence of a shock in last period of the bank stock return volatility, While the coefficient β of GARCH is wider, positive and statistically significant in all cases are indicating that solid evidence of previous surprises. Both ARCH and GARCH parameters as a measure of volatility persistence is relatively low in all cases, with the inclusion of interest rates and exchange rate volatility. Concerning the estimated coefficient $\square_1$, which measures the effect of interest rate volatility on the bank stock volatility are positive in all cases except Attijari bank, STB and UBCI, and statistically significant in only 8 out of 10 cases, this manifested that, when the interest rate becomes more volatile, will lead to an increase in the bank stock volatility. One possible explanation for the increase in the bank stock volatility following an increase of interest rates volatility is that banks are unable to refrain from interest rate risk, because they can not hold derivative securities that is to say, the off-balance sheet activities (swaps, and option contracts) is corresponding to a duration of assets and liabilities. Into account, the absence of derivatives in the financial market and the inability to implement effective techniques for risk management. This result is confirmed with studies Elyasiani and Mansur (2003) and also with Saadet Kasman, Gulin Vardar and Gokce Tunc. Concerning, the exchange rates volatility, presented by the coefficient $\square_2$ it is statistically significant in only out 8 of 10 cases. Lastly, in relation to the findings on the effect of exchange rate volatility on bank stock volatility, the exchange rate volatility is positive relationship with bank volatility in only 5out of 10 cases (BIAT, Attijari-bank, STB, UBCI and UIB bank). This necessarily implies that the fluctuation of the exchange rate leads to an increase of bank stock volatility. A number of potential explanations for this unexpected finding exist. First, and foremost, is that Tunisian banks simply are exposed to significant foreign exchange rate risk over the sample period. Second, while exposed to adverse fluctuations in the foreign exchange rate, tunisian banks may simply do not have adequately hedged their foreign exchange rate exposure throughout the sample period. This result is inconsistent with the results of Suzanne K. Ryan & Andrew C. Worthington who find that Australian banks are not exposed to the risk of exchange rate of the sample period, is probably negligible because the vast majority of this exposure was covered in the derivatives markets, primarily using instruments such as currency swaps and foreign exchange forward.

Generally, the interest rates volatility would information relating to the overall of financial markets volatility, and primarily reflects the uncertainty that follows the direction of monetary policy. The interest rates volatility is a determinant of banks stock volatility.

Conclusion

The article provides a comprehensive analysis of the simultaneous interest rate; foreign exchange rate and market risk of the Tunisian banking by employing both OLS and GARCH estimation models.

Among the measures qualifying risk, based on the OLS, most empirical studies use this method to estimate the effect of interest rate and exchange rate fluctuations on stock returns of banks. Besides this method is used as the GARCH model, as we mentioned earlier, it has been proposed to take into account time-dependent conditional variances. However, due to the existence of residual autocorrelation in the data, the GARCH model produces more efficient coefficients than OLS.The general principle is therefore to question the ownership of homodoscedasticity we generally hold in the linear model. Measuring the outcome of conditional volatility GARCH model can capture the volatility as expected ex ante on the basis of the available information related to the past evolution of the volatility. In our work, the results suggest that market returns and exchange rate are an important determinant of bank stock returns, but the more remarkable that the interest rate has no effect of the bank stock returns. However, that long-return interest rate and exchange rate volatility are the major determinants of the conditional bank stock return volatility.

Concerning, the verification of our hypothesis we found that the exchange rate and the market index has an impact on the bank stock return, while the interest rate has no impact of the bank stock returns. Moreover, the effect of exchange rate volatility on bank stock returns volatility, the exchange rate volatility is positive relationship with bank; this necessarily implies that the fluctuation of the exchange rate leads to an increase of bank stock return volatility. While the effect of long-term interest rate volatility on the bank stock volatility is very important, when the long-term interest rate becomes more volatile, this will lead to an increase in the bank stock return volatility

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Table 1: Descriptive statistics

Variables	Mean	Standard error	Skewness	Kurtosis	Jarque-Bera	ADF
ATB	5.271	0.223	1.373	2.628	7.228**(0,026)	-7.202
BIAT	38.446	1.890	1.431	3.341	9.683**(0,017)	-4.232
BNA	12.778	5.148	0.409	-2.141	2.629**(0,026)	-6.396
Attijari Bank	7.633	0.356	0.158	-1.390	1.017**(0,016)	-5.958
STB	11.281	1.253	1.406	0.917	4.374**(0,011)	-5.779
UBCI	33.484	2.252	1.080	-0.212	2.356**(0,031)	-10.65
BH	22.900	1.212	0.208	-0.763	0.377**(0,021)	-11.15
Amen Bank	25.749	2.428	-0.402	-1.438	1.359**(0,050)	-31.69
BTE	30.451	0.823	0.770	-0.082	1.191**(0,045)	-6.383
UIB	15.268	1.570	0.130	-1.439	1.070**(0,048)	-9.551
MRK	0.980	30.67	0.095	8.144	157.64**(0,014)	-8.099
FX	5.138	0.368	-0.385	0.229	1.536 **(0 ,028)	-5.490
INT	5.138	0.368	-0.385	0.229	1.592 **(0,015)	-6.490

Note: MRK, FX and INT, market index return, foreign exchange rate and interest rate respectively.
**: Indicates the significance level at 5%.After applying the ADF tests on the return series, the empirical results indicate that all series are stationary

Table 2: Result of the detecting the presence of ARCH effect

Banks	Test de Mcleod Ljuing Box (Q-stat			Test de Lagrange Multiplicateur $(\mathbf{TR^2})$		
	Stock Return	**Transaction volume**	**Interest Rate**	**Stock Return**	**Transaction volume**	**Interest Rate**
ATB	387.654 0.001)*	487.65(0.000)*	317.22(0.000)*	4.34(0.000)*	7.51 (0.03)*	6.98(0.02)*
BIAT	487.256 0.000)*	391.25(0.001)*	421.57(0.000)*	3 .453(0.000)*	8.42 (0.02)*	6.77(0.03)*
BNA	398.127 0.003)*	318.74(0.000)*	531.74(0.000)*	0.699(0.000)*	9.41(0.00)*	7.54(0.00)*
AttijariB	456.785(0.000)*	402.38(0.000)*	458.32(0.000)*	6.769(0.000)*	10.51(0.02)*	7.84(0.00)*
STB	356.182(0.001)*	476.28(0.000)*	427.51(0.000)*	4.047(0.000)*	7.81(0.00)*	8.21(0.03)*
UBCI	423.857(0.000)*	428.67(0.003)*	483.61(0.000)*	5.685(0.000)*	8.57 (0.00)*	8.54(0.022)*
BH	465.289(0.000)*	452.36(0.000)*	428.34(0.000)*	5.369(0.000)	9.20 (0.00)*	9.57(0.000)*
Amen Bank	458.267(0.000)	436.48(0.005)*	412.68(0.000)*	8.457(0.000)*	7.53(0.000)*	6.57 (0.000)*
BTE	278.618(0.000)*	437.36(0.000)*	473.64(0.000)*	4.295(0.000)*	7.59(0.003)*	7.54 (0.03)*
UIB	387.159(0.000)*	358.47(0.006)*	246.201(0.002)*	6.190(0.000)*	8.63(0.002)*	7.280(0.003)*

Exchange rate	532.18 (0.000)*	7.578 (0.001)*
Market index	357.24 (0.000)*	6.87 (0.00)*

Note: Numbers in parentheses indicate the standard errors.
*: indicates the significance level at 1.

Table 3: Estimates of OLS regression of individual banks and portfolio

Banks	(β_0)	(β_1)	(β_2)	(β_3)	**ARCH**	R^2
ATB	27.968(0.140)	0.000 (0.994)	0.530 (0.848)	-22.915** (0.0424)	8.52*	0.073
BIAT	17.532 (0.347)	0.005 (0.259)	-1.963 (0.457)	-4.811(0.671)	9.24**	0.004
BNA	-60.796 (0.618)	0.0263 (0.651)	-1.479(0.934)	50.472 (0.484)	21.23**	0.011
Attijari Bank	37.340**(0.046)	0.002 (0.713)	-1.332(0.624)	-21.748**(0.049)	35.23*	0.083
STB	-0.945(0.971)	0.023** (0.052)	0.803(0.836)	-2.459(0.874)	43.23*	0.068
UBCI	50.436** (0.022)	0.001(0.853)	-3.592(0.263)	-23.536*** (0.069)	54.23*	0.093
BH	8.120(0.645)	0.009***(0.089)	2.291(0.381)	-15.109 (0.149)	54.89*	0.089
Amen Bank	-3.249 (0.836)	0.013**(0.041)	2.699 (0.247)	-6.899 (0.460)	42.37*	0.101
BTE	0.451(0.391)	-3.974(0.663)	-9.007(0.763)	-3.091**(0.045)	58.36*	0.072
UIB	-2.640(0.862)	0.017*(0.014)	0.012(0.995)	1.894(0.833)	8.42*	0.103

Note: Numbers in parentheses indicate the standard errors.
*: indicates the significance level at 1.
**: indicates the significance level at 5%.
***: indicates the significance level at 10%.

Table 4: Estimation of return

Bank	(γ_0)	(γ_1)	(γ_2)	(γ_3)	(α_0)	(α_1)	(β)	$\alpha_1 + \beta$
ATB	27.795(0.182)	-0.001(0.846)	0.472(0.866)	-22.560 ***(0.083)	19.665***(0.090)	0.9367 **(0.015)	0.0538(0.669)	0.990
BIAT	16.481(0.397)	0.006(0.241)	-1.965(0.468)	-4.066(0.732)	33.244(0.131)	0.1923(0.412)	0.148(0.715)	0.34
BNA	-78.584(0.556)	0.027(0.653)	-1.774(0.923)	64.404(0.433)	88.813(0.161)	8.3779 **(0.013)	-0.000(0.735)	8.377
Attijari bank	37.075***(0.061)	0.002(0.760)	-1.355(0.615)	-21.457 ***(0.077)	41.592*(0.000)	-0.086 *(0.000)	0.379 *(0.000)	0.293
STB	-1.585(0.955)	0.024**(0.048)	0.791(0.841)	-1.950(0.911)	76.796*(0.000)	-0.055 *(0.000)	0.357 *(0.000)	0.32
UBCI	60.029*(0.008)	0.004(0.561)	-3.357(0.276)	-31.355**(0.024)	46.547 *(0.000)	-0.029 *(0.000)	0.402 *(0.000)	0.373
BH	17.345(0.311)	0.009**(0.052)	2.3620.333	-21.854**(0.037)	79.958*(0.003)	0.112(0.271)	-0.628(0.115)	-0.516
Amen Bank	-5.128(0.759)	0.012***(0.063)	2.660(0.267)	-5.397(0.595)	27.908 *(0.001)	0.4980***(0.074)	-0.060(0.413)	0.438
BTE	0.5320(0.347)	-4.924(0.615)	-1.061(0.731)	-3.1732**(0.046)	6.456 *(0.000)	0.000*(0.007)	-0.457 **(0.018)	-0.457
UIB	-8.779(0.498)	0.0167*(0.006)	-0.1300.9432	6.894(0.381)	24.489(0.116)	0.176(0.241)	0.1688(0.690)	0.344

Note: Numbers in parentheses indicate the standard errors.

*:   indicates the significance level at 1.
**: indicates the significance level at 5%.
***: indicates the significance level at 10%.

Table 5: Volatility estimates

Banks	**$\gamma(1)$**	**$\alpha_0(1)$**	**$\alpha_1(1)$**	**β**	**θ_1**	**θ_2**
ATB	-0.361*(0.000)	0.269*(0.000)	-3.275*(0.000)	17.401*(0.000)	17.401*(0.000)	-0.014*(0.000)
BIAT	0.1515(0.326)	-0.189(0.3578)	3.679(0.230)	27.382**(0.047)	0.257(0.327)	0.1974(0.4735)
BNA	-0.151*(0.000)	0.0191*(0.000)	-2.627*(0.000)	193.947*(0.000)	3.688*(0.000)	-0.022*(0.000)
Attijari bank	-0.004*(0.000)	-0.024*(0.000)	1.082*(0.000)	48.979*(0.000)	-0.101*(0.000)	0.357*(0.000)
STB	0.038*(0.000)	-0.058*(0.0000)	0.0318(0.410)	8.2690*(0.000)	-0.045*(0.000)	0.287*(0.000)
UBCI	-0.062*(0.000)	0.027*(0.000)	-0.613*(0.000)	59.863*(0.000)	-0.038*(0.000)	0.337*(0.000)
BH	0.138(0.3483)	0.007(0.971)	-0.102(0.972)	81.138*(0.005)	0.109(0.175)	-0.680***(0.098)
Amen Bank	0.330*(0.000)	-0.073(0.523)	1.0460(0.538)	30.673*(0.000)	0.787*(0.006)	-0.329*(0.000)
BTE	-0.080*(0.000)	-0.061*(0.000)	0.9680*(0.000)	9.479*(0.000)	0.403*(0.000)	-1.057*(0.000)
UIB	0.115(0.399)	-0.210(0.208)	2.964(0.231)	23.42**(0.052)	0.322(0.221)	0.056(0.875)

Note: Numbers in parentheses indicate the standard errors.
**: indicates the significance level at 1.*
***: indicates the significance level at 5%.*
****: indicates the significance level at 10%.*