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THE IMPACT OF INTEREST RATE AND EXCHANGE RATE
VOLATILITY ON BANKS' STOCK RETURNS AND VOLATILITY:
EVIDENCE FROM ITALY

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TABLE OF CONTENTS

| | |
|--|---------------|
| LIST OF FIGURES | VII |
| LIST OF TABLES | IX |
| ABSTRACT | XI |
| SOMMARIO..... | XIII |
| 1. INTRODUCTION..... | - 15 - |
| 1.1. The specific role of banks in the financial system and bank stock returns | - 16 - |
| 1.2. Bank stock returns and volatility | - 18 - |
| 2. PROBLEM STATEMENT- RESEARCH QUESTION..... | - 19 - |
| 2.1. Research Objectives | - 19 - |
| 2.2. Research Questions..... | - 20 - |
| 2.3. Expected Benefits | - 20 - |
| 2.4. Scope of the Study | - 21 - |
| 3. THEORY AND LITERATURE | - 22 - |
| 3.1. Studies focused on interest rate effect on bank stock returns | - 22 - |
| 3.2. Studies focused on exchange rate effect on bank stock returns | - 28 - |
| 3.3. Studies focused on interest rate and exchange rate effect on bank stock returns . | - 29 - |
| 4. DATA | - 33 - |
| 5. METHODOLOGY | - 38 - |
| 6. EMPRICAL EVIDENCE..... | - 40 - |
| 6.1. Empirical Results..... | - 40 - |
| 6.1.1. OLS Estimation | - 40 - |
| 6.1.2. Estimation of return with GARCH (1,1) model | - 41 - |
| 6.1.3. Estimation of volatility with GARCH (1,1) model | - 43 - |
| 7. DISCUSSION AND CONCLUSIONS | - 44 - |
| 7.1. Discussion on Empirical Results | - 44 - |
| 7.2. Conclusions | - 45 - |
| APPENDIX | - 46 - |
| A. COMPLETE OUTPUT OF THE ESTIMATES OF RETURN WITH OLS ... | - 46 - |
| B. COMPLETE OUTPUT OF THE ESTIMATES OF RETURN WITH GARCH (1,1) MODEL | - 49 - |
| C. COMPLETE OUTPUT OF THE ESTIMATES OF VOLATILITY WITH GARCH (1,1) MODEL..... | - 54 - |
| BIBLIOGRAPHY | - 59 - |



LIST OF FIGURES

| | |
|--|--------|
| Figure 1 An overview of the financial system | - 16 - |
| Figure 2 Return of FTSE ALL index | - 34 - |
| Figure 3 Return of FTSE ALL BANKS index..... | - 34 - |
| Figure 4 Difference of Interest Rate | - 35 - |
| Figure 5 Return of Exchange Rate | - 35 - |
| Figure 6 Stock return of Intesa Sanpaolo | - 36 - |
| Figure 7 Stock return of Medio Banca | - 36 - |
| Figure 8 Stock return of Unicredit calculated | - 37 - |
| Figure 9 Stock return of Unione di Banche Italiane..... | - 37 - |



LIST OF TABLES

| | |
|--|--------|
| Table 1 Descriptive Statistics | - 33 - |
| Table 2 Estimates of the OLS model given in equation (1) | - 40 - |
| Table 3 Estimates of the mean model given in equation (2) and variance equation given in (3) | - 41 - |
| Table 4 Estimates of the mean model given in equation (4) and variance equation given in (5) | - 43 - |
| Table 5 Estimates of return with OLS - FTSE ALL BANKS | - 46 - |
| Table 6 Estimates of return with OLS - MEDIOBANCA..... | - 47 - |
| Table 7 Estimates of return with OLS - INTESA SANPAOLO | - 47 - |
| Table 8 Estimates of return with OLS - UNICREDIT | - 48 - |
| Table 9 Estimates of return with OLS - UNIONE DI BANCHE ITALIANE | - 48 - |
| Table 10 Estimates of return with GARCH (1,1) - FTSE ALL BANKS | - 49 - |
| Table 11 Estimates of return with GARCH (1,1) - MEDIOBANCA | - 50 - |
| Table 12 Estimates of return with GARCH (1,1) - INTESA SANPAOLO | - 51 - |
| Table 13 Estimates of return with GARCH (1,1) - UNICREDIT | - 52 - |
| Table 14 Estimates of return with GARCH (1,1) - UNIONE DI BANCHE ITALIANE.. | - 53 - |

Table 15 Estimates of volatility with GARCH (1,1) - FTSE ALL BANKS - 54 -

Table 16 Estimates of volatility with GARCH (1,1) - MEDIOBANCA..... - 55 -

Table 17 Estimates of volatility with GARCH (1,1) - INTESA SANPAOLO - 56 -

Table 18 Estimates of volatility with GARCH (1,1) - UNICREDIT - 57 -

Table 19 Estimates of volatility with GARCH (1,1)-UNIONE DI BANCHE ITALIANE - 58 -



ABSTRACT

Grounding on the paper by Kasman, Vardar and Tunc (2011), the purpose of this study is to investigate the impact of interest rate and exchange rate changes and volatility on FTSE Italia All Share Banks Index and four Italian banks' stocks returns using the OLS and GARCH models.

The results present that interest rate changes have a negative and significant impact on the conditional bank stock returns. An increase on interest rate may negatively affect the cost of funding, the net interest margin of the securities portfolio and loan portfolio. In contrast, exchange rate changes have a positive and significant effect on the conditional bank stock returns. An increase in exchange rate (stronger local currency) may affect bank profitability in a positive way if the bank has a short position. Besides the results show that interest rate and exchange rate volatility have a strong positive impact on the conditional bank stock return volatility.

Keywords: Bank stock returns, Exchange rate risk, Market risk, Interest rate risk, Volatility, ARCH, GARCH, OLS



SOMMARIO

Basandosi sul lavoro di Kasman, Vardar e Tunc (2011), lo scopo di questo studio è quello di esaminare l'impatto dei cambiamenti del tasso di interesse, del tasso di cambio e la volatilità sull'indice FTSE Italia All Share Banks e sui rendimenti azionari di quattro banche italiane utilizzando i modelli OLS e GARCH.

I risultati mostrano che i cambiamenti del tasso di interesse hanno un impatto negativo e significativo sui rendimenti delle azioni bancarie. Un aumento del tasso di interesse potrebbe influire negativamente il costo del finanziamento, il margine di interesse netto del portafoglio titoli e portafoglio crediti. Al contrario, i cambiamenti del tasso di cambio hanno un effetto positivo e significativo sui rendimenti delle azioni bancarie. Un aumento del tasso di cambio (più forte valuta locale) potrebbe influire positivamente la redditività bancaria se la banca ha una posizione corta. Inoltre, i risultati mostrano che la volatilità del tasso di interesse e del tasso di cambio ha un forte impatto sulla volatilità del rendimento delle azioni bancarie.

Parole chiave: Rendimenti azionari bancari, Rischio tasso di cambio, Rischio di mercato, Rischio tasso di interesse, Volatilità, ARCH, GARCH, OLS



1. INTRODUCTION

Trade is an ongoing activity since the earliest periods of history, with the aim of meeting people's diverse needs. The trade action, started with the barter method before the presence of money, entered a different path with the use of money. Especially with the development of information and communication technologies, the trade action has become more sophisticated and adapted to the modern world. This has led to the constant development of world trade volume and speed. In all phases of the development of commercial life, there were always people, actors and institutions who have the same function as banking, even though the name was not a bank. In this sense, the development and growth of trade has made a great contribution to the development of the banking system. With the developments in business life, the importance of banks has been increasing and this has caused a rapid growth in bank numbers.

As financial intermediary institutions, banks aim to profit by investing the deposits collected from their customers in high yielding and safe areas. The intense competition in the banking sector forces banks to use their resources effectively and efficiently. Banks' shareholders, customers and legal authorities related to the banking system expect the banks to be productive and profitable. Nowadays, developments in information and communication technologies have affected the banking sector and increased the functions of the sector in commercial and financial areas. With these developments, banks have started to increase their profits over time and this makes the banks' stock returns more important.

Banking sector have transformed into an attractive investment area for people who want to be partner those banks through buying shares rather than only depositing savings and borrowing loans. Therefore, the banking sector developed in a serious sense and its impact on our lives has increased greatly. With this increasing trend of development of the banking sector, the profitability of banks has become important as well. The stock returns of banks concern closely not only the bank owners, shareholders and bank managers but also investors who are interested in buying shares of banks which are traded on the stock exchange.

1.1. The specific role of banks in the financial system and bank stock returns

The execution and sustainability of economic growth, placed among the main goals of countries, are highly important for development and welfare enhancement. Banks contribute to the economic growth and development of the country due to the nature of its activities. In literature, numerous studies support the idea that a positive relationship exists between economic growth and development of financial system (King and Levine, 1993; Demirgüç-Kunt and Levine, 1996; Demirgüç-Kunt and Maksimovic, 1995; Levine, 1997; Levine and Zervos 1998; Beck, Levine, and Loayza 2000; Rajan and Zingales, 2001; Beck and Levine, 2004; Levine, 2005; Pradhan Dasgupta & Samadhan, 2013).

The financial system comprises all financial markets, instruments and institutions (see Figure 1). As a key component of the financial system, banks channel funds from savers to borrowers continually through their financial intermediation function. The banking industry is important since it is the primary source of credit to both public and private firms in all industries.

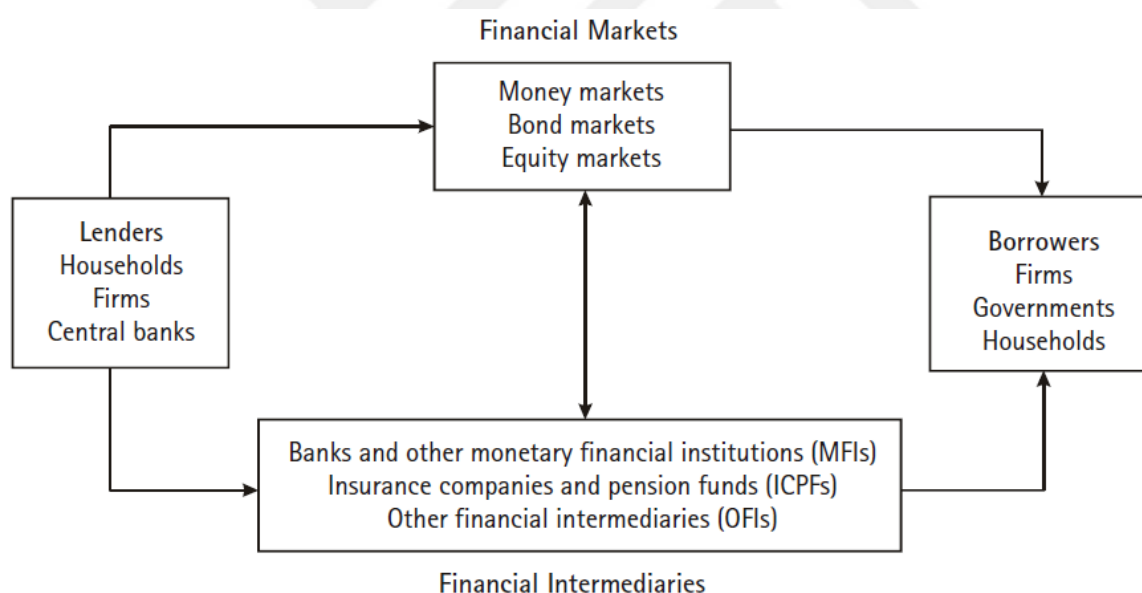


Figure 1 An overview of the financial system (Source: Allen, Chui, and Maddaloni (2004) p. 491)

Performance of the banking sector is an effective indicator for the situation of any economy. The banking sector's performance is regarded as the replica of the economy. A healthy banking system plays a crucial role in economic, social and industrial growth of an economy.

Based on the proposition that an advanced banking system is an important determinant of economic growth, there must be a relationship between banks' stock prices and future economic

growth. The market prices of bank securities provide important information for market participants, financial stability authorities-central banks and bank supervisors. A bank's stock price may represent all the public information available from the bank, including potential risks. Under the efficient-market hypothesis, banks' stock prices reflect the expectations of both positive and negative future incomes.

In the stock return literature financial firms are sometimes excluded because banks are different. There are some reasons why banks' stock returns behave differently than non-financial firms' stock returns. The main difference between banks and non-financial firms is the way of how banks make profit. Banks borrow short and lend long which means most of the assets that banks hold on their balance sheets are long-term financial claims - such as loans - on households and firms. Banks finance these assets by selling their own debt and/or equity and collecting their funds in the form of short-term deposits. The maturity mismatch between the assets and liabilities of banks and unexpected change in interest and exchange rates lead banks tend to be more highly leveraged. Banks hold their liquid deposits against relatively illiquid loans, and since they are highly leveraged, banks are vulnerable to runs. There are high social and financial costs of bank failures. For this reason, the banking industry is highly regulated. After the recent financial crisis, it became more important to monitor closely the risks facing banks (Castren, Fitzpatrick and Sydow, 2006).

1.2. Bank stock returns and volatility

Return, in financial terms, is the gain or loss on an investment for a given period. Besides, volatility is a statistical measure of dispersion around the average return of a security or an index and it refers to the amount of uncertainty or risk related to the size of changes in a security's value. Volatility is measured by using the standard deviation or variance of return. Generally, as volatility becomes higher, the security becomes riskier. More precisely, higher volatility means that the value of a security may be spread out over a larger range of values. This means that the price of the security can fluctuate dramatically over a short time period in both directions. A lower volatility means that a security's value does not change dramatically and tends to be steadier. Analyzing the behavior of stock returns volatility has accelerated with the introduction of the Autoregressive Conditional Heteroscedasticity (ARCH) model by Engle (1982) and its generalization by Bollerslev (1986) the Generalized Autoregressive Conditional Heteroscedasticity (GARCH).

Understanding volatility is essentially important in stock market. It is important for investors and portfolio managers to optimize their risk and return profiles by monitoring the volatility. Moreover, stock market regulators are interested in volatility because high volatile stock market increases uncertainty, which reduces investors' confidence in the market, and lead to high cost of capital. Monitoring volatility is critical also for risk management strategists in banks. Exploring the variables effect the banks stock returns and volatility may provide a better hedge against unexpected losses for the banks.

In this context, this study is focused on the effect of interest rate and exchange rate changes on banks' stock returns and volatility in Italy. The results of this study will provide a better understanding of the behavior of bank stock returns and volatility for academics, practitioners, investors, policymakers and regulators.

2. PROBLEM STATEMENT- RESEARCH QUESTION

In the literature, there are many studies that analyzed the effect of interest rate and exchange rate on banks' stock returns separately, but less literatures focused on these effects together. This study analyzes the effect of interest rate and exchange rate on bank stock return together and also the volatility effect using the ARCH/GARCH models.

The statement of problems in this study is to investigate the impact of interest rate and exchange rate on banks' stock returns in Italy.

2.1. Research Objectives

The research objectives are:

1. To examine the effect of interest rate changes on banks' stock returns in Italy.

2. To examine the effect of exchange rate changes on banks' stock returns in Italy.

3. To examine the effect of interest rate volatility on banks' stock returns' volatility in Italy.

4. To examine the effect of exchange rate volatility on banks' stock returns' volatility in Italy.

2.2. Research Questions

The research questions are:

1. What is the relationship between interest rate changes and banks' stock returns in Italy?

2. What is the relationship between exchange rate changes and banks' stock returns in Italy?

3. How does interest rate volatility affect banks' stock returns' volatility in Italy?

4. How does exchange rate volatility affect banks' stock returns' volatility in Italy?

2.3. Expected Benefits

The expected benefits are

- Useful for the investors and bank managers that analyze the trend of stock prices, they can manage investments risks and increase return.

- Useful for the policymakers that monitor the situation of the stock market and bank supervising authorities, they can forecast the future economic conditions.

2.4. Scope of the Study

The study is to investigate the impact of interest rate and exchange rate changes and volatility on banks' stock returns and volatility over the period June 2009 to June 2017 in Italy. Since bank index gives an overall information about the banking sector, FTSE Italia All Share Banks Index and four Italian commercial bank stocks (Intesa Sanpaolo SpA, Mediobanca SpA, Unione di Banche Italiane SpA and Unicredit SpA) are chosen for the analysis. Exchange rate is used as ECB reference exchange rate, US dollar/Euro, and gathered from European Central Bank Statistical Data Warehouse. Interest rate is measured as the 10-year Italian Government Bond yield and obtained from Eurostat.

The remainder of the thesis is organized as follows. Section 3 presents the related theory and literature, section 4 presents the data, section 5 explains the methodology, section 6 presents the empirical results. The study ends with concluding remarks.

3. THEORY AND LITERATURE

3.1. Studies focused on interest rate effect on bank stock returns

Theoretical explanation of interest rate sensitivity mostly has been based on the Stone (1974) two-factor model, which adds a systematic interest rate change factor into the classical capital asset pricing model (CAPM). Stone (1974) proposed a two-factor model as an expansion of the CAPM to reach a better explanation of the stochastic return generating process. (Arango, Gonzalez & Posada 2002; Jareno, 2008):

$$r_{jt} = \alpha_j + \beta_j r_{mt} + \gamma_j \Delta i_t^u + \varepsilon_{jt}$$

where r_{jt} represents the stock return for j stock in t, β_j indicates the stock sensitivity, r_{mt} is the return on the market, γ is the sensitivity of interest rate risk, Δi_t^u shows the unexpected changes in nominal interest rates and ε_{jt} is the error term. In the CAPM, stock return of J has just based on the return on the market index. On the other hand, the Stone (1974) two-factor model involves the ‘return on the equity’ and ‘debt markets’. Return on equity indicates r_{mt} and ‘debt markets’ indicates Δi_t^u . Stone (1974) called them systematic equity risk and systematic interest rate risk, respectively.

Following Stone (1974) two-factor model, Chance and Lane (1980) examined the relationship between the interest rate changes and returns on common stocks of financial institutions. They used Standard and Poor's 500 Stock Composite Index as market index. Ninety-day Treasury Bills, three-to-five-year Treasury Notes, ten-year and longer Treasury Bonds were utilized as the short, intermediate, and long-term interest rates respectively. Their results suggest that an interest rate factor should not be significant in explaining the financial institutions’ stock returns.

Lynge and Zumwalt (1980) investigated the existence of the interest rate sensitivity on returns of commercial bank common stocks by estimating several multi index models. They used the model to test a sample of 57 commercial banks (or bank holding companies) and 30 firms in the Dow Jones Industrial Average. In this multi-index model, they used ‘short term debt index’ and ‘long term bond return index’ factors. The results found from the study of Lynge and Zumwalt (1980) were that bank common stock returns are more sensitive to debt returns than industrial common stock returns. In order to test the impact of market rate fluctuations on bank profitability, Flannery (1981) developed a method for determining average asset and liability

maturities for 15 large money center banks for the period 1959-1978. According to the results, there is no significant impact of interest rate fluctuations on banks' profits since the banks implement effective hedging strategies against market rate risk by creating asset and liability portfolios with similar maturities. Flannery and James (1984) used the two-index model to analyze the relationship between the interest sensitivity of common stock returns and the maturity composition of the firm's nominal contracts. Nominal contracts promise a payment of a fixed value of money at a pre-determined future date. As the interest rates change, the value of the nominal contracts will change as well, since the discount rate used while determining the value of the contracts changes. The results show that the effect of nominal interest rate changes on common stock prices is related to the maturity composition of a firm's net nominal asset holding. The maturity composition of nominal contracts is found to be a significant factor affecting common stock returns.

In the study of Booth and Officer (1985), they examined the interest rate sensitivity of commercial bank and bank holding company stocks relative to stocks of nonfinancial firms. They specified and estimated a multiple index market model of bank security returns to determine the effect of current and expected interest rate changes on bank equity values. Their sample consists of the largest U.S. banks or bank-holding companies and a random sample of 66 large nonfinancial firms for the 1966-1980 period. The results show that stocks of nonfinancial firms are not as interest rate sensitive as the bank securities. Commercial bank and bank holding company stocks have extra-market sensitivity to actual, anticipated, and unanticipated changes in short term interest rates. Scott and Peterson 1986 used an approach developed by Flannery and James (1984) to determine the different effects of interest rate changes on equity values of hedged and unhedged financial institutions, also the interest rate sensitivity of life insurance companies. In general, the unhedged equity values of savings and loans are significantly more sensitive to unexpected interest rate changes than hedged equities of commercial banks. The life insurance equities (generally hedged) have the similar interest rate sensitivity with the hedged bank equities.

Elyasiani and Mansur (2004) investigate the bank stock return sensitivities to the long-term and short-term Interest rates. They employ a multivariate GARCH model and create three portfolios; the money center banks, large banks, and small banks. The Standard and Poor's 500 index is used as the proxy for market portfolio and ten-year treasury yield and 3-month T-bill yield are used as the interest rate proxy. Data is daily and covers from January 4, 1988 to December 29, 2000. The paper has three main findings: i) insensitivity of bank stock return to

the changes in the short-term and long-term interest rates, ii) insensitivity of bank stock returns to the changes in the volatilities of short-term and long-term interest rates, and iii) insensitivity of bank stock return volatility to the changes in the short-term and long-term interest rate volatilities. These findings have implications on bank hedging strategies against the interest rate risk, regulatory decisions concerning risk-based capital requirement, and investor's choice of a portfolio mix. Following Elyasiani and Mansur (2004), Verma and Jackson (2007) examined the extent of asymmetries between short-term and long-term interest rates and portfolios of money center, large, and medium-size banks in the U.S. Multivariate Exponential Generalized Autoregressive Conditionally Heteroscedastic (EGARCH) model was employed and daily data was used for the period January 2, 1996 to December 30, 2002 of 70 commercial bank stocks traded on the New York Stock Exchange or American Stock Exchange. The 3-month Treasury bill yield and 10-year Treasury composite yield are used for the proxy of the short-term interest rate and the long-term interest rate, respectively. They show that the existence of price and volatility spillovers from short- and long-term interest rates to the three bank portfolios. They also find that money center and large banks are more sensitive to negative than positive short and long-term interest rate changes due to asymmetries for the portfolios of money center and large banks.

Jareno (2008) explored the Spanish stock sensitivity to real interest and inflation rate movements, controlling for the size and growth opportunities of the company using a hybrid model between Stone (1974) two-factor model and Fama and French (1993) three-factor model. Jareno (2008) used the Spanish consumer price index and 'Indice General de la Bolsa de Madrid-IGBM' (Madrid Stock Exchange General Index) from February 1993 to December 2004. One-year Treasury debt securities indicates the interest rate, a year-to-year inflation rate indicates the inflation rate and monthly return of the IGBM Index indicates the market portfolio. The paper shows that the sectorial returns are affected significantly and negatively by real interest rate movements.

Considering the non-linear relationship between interest rate changes and bank stock returns, Ballester (2011) attempted to analyze the interest rate effect on the Spanish banking industry employing both parametric and non-parametric estimation methods. "Indice General de la Bolsa de Madrid-IGBM" (Madrid Stock Exchange General Index) is used as market portfolio and 10-year Spanish government bond yield and 3-month interbank rate are used as long term and short-term interest rate, respectively. A sample consists of 23 banking institutions over the period from January 1993 to December 2008 is used. The total sample period is split into two subsamples, the pre-euro period, from January 1993 to December 1998, and the post-euro

period, from January 1999 to December 2008. Ballester (2011) argued that the Spanish banking sector shows a remarkable degree of interest rate exposure. On the other hand, the effect of interest rate changes on bank stock returns have significantly declined following the introduction of the euro.

The Arbitrage Pricing Theory (APT) is an asset pricing model based on the idea that an asset's returns can be predicted using the relationship between that asset and many common risk factors. The Arbitrage Pricing Theory (APT) was developed primarily by Ross (1976a, 1976b), APT predicts a relationship between the returns of a portfolio and the returns of a single asset through a linear combination of many independent macroeconomic variables. The APT tries to overcome of the CAPM's potential weaknesses adding the multi factor models such as GDP, inflation rate, gold prices and so on.

Each asset return is linearly related to k factors plus its own idiosyncratic disturbance (risk) under the assumption that asset markets are perfectly competitive and frictionless (see Cagnetti, 2002:3):

$$r_{jt} = \alpha_0 + \beta_1 b_1 + \beta_2 b_2 + \dots + \beta_k b_k + \varepsilon_{jt}$$

where r_{jt} represents the stock return for j stock in t, α_0 shows the riskless or zero beta coefficient, β_k can be interpreted as the risk premium corresponding to factor k and b_k is the sensitivity of the return of asset j to the factor k, ε_{jt} is the error term.

Sweeney and Warga (1986) presented evidence that interest-rate risk is priced by capital markets. Authors use a two-factor APT model with the market and changes in the yield on long-term government bonds. The paper shows that, empirically, most of the interest-sensitive stocks are in the utility industries (especially electric utilities), and that there is reasonable evidence that the interest factor is priced in the sense of the APT.

Tarhan (1986) investigated the relationship between unexpected interest rate movements and bank stock returns in the context of the nominal contracting hypothesis. In contrast with Flannery and James (1984), it is found that the impact of unanticipated interest rate changes on bank stock prices does not appear to be related to the maturity structure of bank assets and liabilities.

In their studies, Chen and Chan (1989) attempted to reconcile the conflicting results found in previous studies by analyzing the interest rate sensitivity of financial institutions' stock returns. The evidence from the study shows that there are some asymmetrical interest rate sensitivities during various interest rate cycles. In the savings and loans industry, stock returns are more sensitive to interest rate changes during periods of falling rates. However, in the banking industry the stock returns are more sensitive to interest rate changes during periods of increasing rates. Bae 1990 re-examined the impacts of current, anticipated, and unanticipated changes in interest rates on financial firms' common stock returns by using a sample consists of 97 firms including banks, saving and loans associations, finance companies, insurance companies, real estate investment trusts and nonfinancial firms. The results show that stock returns of financial firms get affected negatively from the current and unanticipated interest rate changes.

Saunders and Yourougou (1990) showed that differences in ex-post common stock returns are partially explained by the interest-rate sensitivity of firms' underlying assets and liabilities. They further showed that securities which are claims on real assets, such as industrial firm stocks, are relatively less sensitive to unexpected changes in nominal interest rates than those which are claims on monetary assets, such as financial intermediary common stocks. The results indicate that banks are "special" in the sense that the activity/balance-sheet regulation forces them to bear unnecessary interest rate risk. Yourougou (1990) examined the impact of interest-rate risk on security prices in a period of relative interest-rate stability (pre-October 1979) and during a period of great volatility of interest rate (post-October 1979). The sample shows the weekly return of 83 banks, 32 savings and loan associations and 100 industrial firm. Using a likelihood ratio test, this paper provides evidence to the effect that interest rate risk is priced by capital markets. These results support earlier findings presented by Sweeney and Warga (1986) which were based on a different sample and used a different methodological technique. The results indicate that interest-rate risk contributed incrementally to the expected returns of financial intermediary common stocks during the post-October 1979 period. However, such results were not observed in the pre-October 1979 period.

Kwan (1991) examines the effect of unanticipated interest rate changes on bank stock returns using a random coefficient two-index model for commercial bank stock returns. The major innovation in this article is to control for the time-varying stock return interest rate sensitivity. Using a sample of 51 actively traded commercial banks, the seemingly unrelated

regression results provide evidence that commercial bank stock returns are significantly interest rate sensitive. The evidence is consistent with the hypothesis that bank stock return interest rate sensitivity is related to its balance sheet composition. The effect of interest rate changes on bank stock returns is found to be positively related to the maturity mismatch between the bank's assets and liabilities, when the proxy for interest rate changes and the proxy for maturity mismatch are compatible to each other.

Madura and Zarruk (1995) argue that bank interest rate risk varies among countries, which supports the need to capture interest rate risk differentials in the risk-based capital requirements. They also find that non-U.S. bank values are sensitive not only to domestic interest rates, but to international interest rates as well. In 1993, the Basel Committee on Banking Supervision considered whether to incorporate interest rate risk in risk-based capital requirements for international banks. At issue was whether a bank's interest rate risk varies with the country of concern. While the effects of interest rate movements on U.S. banks are well documented, the effects on banks from other countries are not. The Basel Committee established capital requirements based on the credit risk in 1988. In May 1993, the Basel Committee on Banking Supervision was considering whether to add interest rate risk within the risk-based capital requirements calculation for international banks. The paper presents an evidence for the Basel Committee to add interest rate risk as an essential risk factor besides credit risk.

Mansur and Elyasiani (1995) attempts to determine whether the level and volatility of interest rates affect the equity returns of commercial banks for the period of January 1970 to December 1992. The monthly data consists of 56 commercial bank stocks traded on the New York and the American Stock Exchanges. The authors use the one-year Treasury bill, the seven-year US Treasury note, and the ten-year Treasury Composite yield as the short-term, intermediate-term, and long-term interest rate proxies, respectively. The ARCH model is used to generate the volatility of interest rates defined as the conditional variance. Two sets of models are estimated. The basic models attempt to determine the effect of contemporaneous and lagged interest rate volatility on bank equity returns, while the extended models incorporate additional contemporaneous macroeconomic variables. Contemporaneous interest rate volatility has little explanatory power, while lagged volatilities do possess some explanatory power, with the lag length varying depending on the interest rate series used and the time period examined. The results from the extended model suggest that the long-term interest rate affects bank equity returns more adversely than the short-term or the intermediate-term interest rates. The findings

establish the relevance of incorporating macroeconomic variables and their volatilities in models determining bank equity returns.

Flannery, Hameed & Harjes (1997) explore the effect of interest rate risk on security price changes. They develop and test a two-factor linear beta pricing model of security returns in which the factors are the excess returns on the long-term, riskless bond and the equal-weighted equity market index. We find that time-variation in the interest rate and market risk premia influence expected security returns. Furthermore, conditional interest rate volatility affects security returns, particularly during periods of substantial interest rate movements.

Arango et al. (2002) showed some evidence of the non-linear and inverse relationship between the asset prices on the Bogota stock market and the Colombian interbank loan interest rate (TIB). They used the returns from the Bogotá stock index and the first difference of the interbank loan interest rate, a proxy for the short-term interest rate, for the period of January 1994 up to February 2000 as daily frequency. Authors shows that interest rate has negative and non-linear effect on the stock prices. However, that impact is rather limited and lagged. This lag length can be explained if the agents wait some days before acting in order to distinguish temporary movements of interest rate from the permanent, because of supposed high transaction costs.

3.2. Studies focused on exchange rate effect on bank stock returns

Chamberlain, Howe & Popper (1997) explore the exchange rate effect on the bank stock returns, which are operating in USA and Japan. The daily and monthly return of the largest 100 USA banking companies and 110 largest Japanese banks, nominal exchange rates and NYSE financial index and Nikkei's bank index are used in the paper. The paper indicates that the stock returns of approximately one-third of thirty large U.S. bank holding companies appear to be sensitive to exchange rate changes. In contrast, relatively few Japanese bank returns appear to be sensitive to exchange rate changes. Authors explain the difference between the exchange rate sensitivities of Japanese and U.S. banking firms with the differences in the operation and regulatory conditions of the firms in the two countries.

Martin and Mauer (2003) focus the direct and indirect effects of exchange rate risk on cash flows of banks. They decompose exchange rate exposure into short-term and long-term elements for 105 individual US banks over 1988–1998. The paper finds the strong evidence that exchange rate risk affects the operating income of the domestically oriented banks. More

specifically, 88% of the domestically oriented banks have significant exposure to either the British pound, Canadian dollar, German mark, Japanese yen, or Mexican peso. Additionally, they find that longer-term exposures are more prevalent than short-term exposures across the sample of US banks, sub-sample of domestically oriented banks, and sub-sample of internationally oriented banks.

3.3. Studies focused on interest rate and exchange rate effect on bank stock returns

Choi, Elyasiani & Kopecky (1992) estimated the sensitivity of bank stock returns to market, interest and exchange rate risks using a multi-factor model. The sample consists of the monthly data of the 48 largest US commercial banking institutions over the period January 1975 to December 1987. The rate of price change and the dividend yield for Standard and Poor's 500 stocks is proxy for market return and the monthly average of daily rates of return on three-month US Treasury bills is proxy for the interest rate variable. The exchange rate is the trade-weighted multilateral foreign exchange value of the dollar against a basket of currencies of the other Group of Ten countries plus Switzerland. They find that exchange rate was significantly negatively related to bank stock returns prior to October 1979. However, the relationship became significantly positive after that date. They explained this finding with different foreign exchange positions, the balance sheet of the banking system showed a decline from a positive net position in several major foreign currencies to a negative position that became especially large in the mid-1980s.

Following Choi, Elyasiani, and Kopecky (1992), Wetmore and Brick (1994) used a multi-index model to estimate the effect of market, interest rate, and foreign exchange on commercial bank risk. They used weekly data for seventy-nine U.S. banks from 1986 to 1991. The coefficient of market risk, interest rate risk, and foreign exchange risk continue to be unstable. As interest rate risk declines, foreign exchange risk increases.

Choi and Elyasiani (1997) estimated the interest rate and exchange rate risk betas of 59 large U.S. commercial banks for the period of January 1975-December 1992. They use a modified seemingly unrelated simultaneous method and find the exchange rate risk betas are more significant than the interest rate risk betas. They also show that the use of derivative contracts creates a significant additional potential systematic risk beyond the level that reflects a bank's traditional financial statement exposures. The influence of derivatives is particularly important in the case of exchange rate betas. Ryan and Worthington (2002) explore the time-series

sensitivity of Australian bank stock returns to market, interest rate and foreign exchange rate risks by employing the Generalized Autoregressive Conditional Heteroskedasticity in Mean (GARCH-M) model. Daily Australian bank portfolio returns, a market wide accumulation index -The value-weighted ASX All Ordinaries Index (AOI)-, short, medium and long-term interest rates -Yields on 10-year and 5-year Treasury Bonds and 90-day Bank Accepted Bills-, and a trade-weighted foreign exchange index are used to model these risks over the period 1996 to 2001. The results suggest that market risk is an important determinant of bank stock returns, along with short-term 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 to the Australian bank return generating process over the period considered.

Elyasiani and Mansur (2003) examined bank stock sensitivities to market, interest rate, and exchange rate using the bivariate GARCH methodology. They also investigated the spillover effects of interest rate volatility and unsystematic risk among the banking sectors of the United States and Japan, and the United States and Germany. The data covers the monthly returns of forty-seven, eighty-five, and seven large banking institutions for the United States, Japan, and Germany, respectively from January 1986 to November 1995. Interest rate volatility is measured by the conditional variance of the interest rate and is generated using a GARCH-M process. They find that profitability of banks is highly sensitive to the exchange rate and interest rate, with the latter exerting its impact at the volatility level.

Hahm (2004) examined the interest rate and exchange rate exposures of Korean commercial banks and merchant banking corporations. The data covers monthly stock prices of the 26 commercial banks and 29 merchant banking corporations that were listed at the Korea Stock Exchange from March 1990 to November 1997. The three-year corporate bond yield was used for the interest rate proxy and the won/dollar spot exchange rate was used for the exchange rate proxy. They find that the interest rate and exchange rate risks have negative effect on commercial banks and merchant banking corporations' value.

Hooy (2004) examined the sensitivity of Malaysian commercial bank stocks to the volatility level and financial risk factors, measured by interest rates risk and exchange rates risk. They used weekly data of seven commercial bank stocks, traded on Kuala Lumpur Stock Exchange from the period from January 1, 1995 to July 26, 2000. And separated into two equal weighted portfolios by size according to their capital: large bank portfolio and small bank portfolio. As a proxy for interest rates, the weekly average of overnight Kuala Lumpur Interbank Offered Rates (KLIBOR) is used. The selling rate of ringgit denominated in USD is used as the exchange rate proxy. The paper has two main conclusions. First, both commercial banks and merchant

banking corporations became increasingly exposed to interest rate and exchange rate risks in the 1994–1997 period, during the Asian financial crisis. Second, commercial banks and merchant banking corporations were significantly negatively exposed to the interest rate and exchange rate risks during this subperiod, implying that higher interest rates and Exchange rates negatively impacted the firm value of the financial institutions.

Shamsuddin (2009) investigated the systematic risk exposure of Australian banks to market, interest rate and foreign exchange rate employing a GARCH-in-Mean model. Ten banks listed on the Australian Stock Exchange are used to build two portfolios as large banks and small banks. Weekly returns on individual bank stocks are calculated from the total return index (RI) series from 26 September 1994 to 4 June 2007. The DataStream total stock market index for Australia is used as a proxy for the market portfolio. The weekly change in the 10-year Treasury bond yield is used as a proxy for interest rate change. The rate of change in the value of the Australian dollar against the US dollar is used as a proxy for foreign exchange rate change. According to the results almost all banks exhibit varying degrees of market risk exposure. However, stock returns of large banks are highly sensitive to interest rate changes, while most small banks are almost immune to both interest and exchange rate changes.

Kasman, Vardar & Tunc (2011) investigated the impact of interest rate and foreign exchange rate volatility on banks' stock returns and volatility using the OLS and GARCH estimation models. The data consists of thirteen Turkish commercial bank stocks listed on the Istanbul Stock Exchange (ISE). The daily closing individual bank stock price, the closing price of the bank index, exchange rates and interest rates are used for the period beginning on 27 July 1999 and ending on 9 April 2009. They used The Istanbul Stock Price Index 100 as market index, the 2-year Turkish Government Bond as interest rate and a basket of equally weighted two major currencies, the US dollar and the Euro as foreign exchange rate. Their results indicate that interest rate and exchange rate changes have a negative and significant impact on the conditional bank stock return. They also find that market return plays an important role in determining the dynamics of conditional return of bank stocks. According to the results interest rate and exchange rate volatility are the major determinants of the conditional bank stock return volatility.

Sukcharoensin (2013) investigated the sensitivity of the stock returns of commercial banks in Thai to market, interest rate, and foreign exchange rate risks in a time-varying framework using the GARCH model. The sample consists of ten commercial banks listed on the Stock Exchange of Thailand (SET) and separated into three groups based on bank size as large banks, medium banks and small banks. Daily returns on bank stocks from 4 January 2005 to 31 May 2012 are

used in the study. As the market portfolio, the SET index is used as a proxy, and for the change in the foreign exchange rate, the rate of change in the value of the Thai baht against the U.S. dollar is used as a proxy. As an interest rate proxy, 1-month, 3-month, 6-month, and 1-year T-bill yields are used in the paper. The empirical evidence offers that market risk is the major component of the sensitivity of bank stock returns, with large banks being more sensitive to changes in market conditions than medium and small banks. The effect of interest rate on bank return both positive and negative depending on the balance sheet of the bank. Furthermore, the foreign exchange rate risk has the effect for small banks, but there is no significant evidence for most of the large and medium banks.



4. DATA

The sample consists of FTSE All-Share Index (FTSE ALL), FTSE Italia All Share Banks Index (FTSE ALL BANKS), four Italian commercial bank stocks (Intesa Sanpaolo SpA, Mediobanca SpA, Unione di Banche Italiane SpA and Unicredit SpA) listed on the FTSE Italia All Share Banks, foreign exchange rate and interest rate variables. The common sample period based on data availability begins on 03 June 2009 and ends on 30 June 2017 with 2020 observations. The daily closing individual bank stock prices, the closing prices of the FTSE ALL and FTSE ALL BANKS are obtained from Thomson Reuters DataStream.

The daily return for all the variables calculated as $r_t = (\ln p_t - \ln p_{t-1})$ except interest rate. Where p_t is the asset price at time t and p_{t-1} is the asset price at time $t - 1$. The return of FTSE ALL BANKS and bank stocks indicate the performance of banking sector and banks respectively, and the return of the FTSE ALL indicates the market risk, which reflects economy-wide factors.

Exchange rate is used as ECB reference exchange rate, US dollar/Euro, and gathered from European Central Bank Statistical Data Warehouse. The exchange rate daily continuously-compounded returns are computed same as stock returns. Interest rate is measured as the 10-year Italian Government Bond yield and obtained from Eurostat in the context of following the Maastricht Treaty EMU convergence criterion series relates to interest rates for long-term government bonds denominated in national currencies. The first difference of interest rate is used to provide stationary condition $\Delta i_t = i_t - i_{t-1}$.

Table 1 Descriptive Statistics

| | Mean | Max. | Min. | SD | Skewness | Kurtosis | Jarque-Bera | ADF |
|-------------------------------|------------|----------|-----------|----------|-----------|----------|-------------|------------|
| FTSE ALL | 0.000279 | 0.050260 | -0.046334 | 0.009706 | -0.232415 | 5.217604 | 432.0977* | -43.61409* |
| FTSE ALL BANKS | -0.000325 | 0.164170 | -0.249449 | 0.026185 | -0.381963 | 8.967033 | 3045.913* | -44.30824* |
| MEDIOBANCA SPA | 0.0000223 | 0.153283 | -0.238468 | 0.024901 | -0.443425 | 9.235606 | 3338.831* | -43.09509* |
| INTESA SANPAOLO SPA | 0.0000741 | 0.179620 | -0.260594 | 0.028034 | -0.433062 | 9.749920 | 3897.892* | -45.93826* |
| UNICREDIT SPA | -0.000640 | 0.190067 | -0.271658 | 0.031825 | -0.271492 | 8.660534 | 2721.653* | -43.55681* |
| UNIONE DI BANCHE ITALIANE SPA | -0.000409 | 0.103076 | -0.231775 | 0.029685 | -0.190685 | 5.965770 | 752.5542* | -45.51111* |
| INTEREST RATE | -0.0000121 | 0.005500 | -0.008200 | 0.000742 | -0.289787 | 17.88271 | 18670.76* | -25.23485* |
| FX | -0.000113 | 0.024664 | -0.036820 | 0.005994 | -0.304840 | 4.958275 | 354.0512* | -46.22384* |

* Indicates the significance level at 1%.

Table 1 reports the descriptive statistics for the returns of the bank index (FTSE ALL BANKS), market index (FTSE ALL), the individual banks, interest rate and foreign exchange rate as

identified at the data section. The return distribution is negatively skewed for all variables. Negative skewness means an asymmetrical distribution with a long tail to the left, or to put it differently, big losses in the crisis periods. All data have big kurtosis values suggests that the underlying data are leptokurtic, or fat-tailed and sharply peaked about the mean when compared with the normal distribution. As expected, the normality has been rejected at 1% significance level by Jarque-Bera tests. Augmented Dickey-Fuller (ADF) statistics indicates that all data have proven stationary condition by rejecting the unit root at 1% significance levels.

FTSE ALL

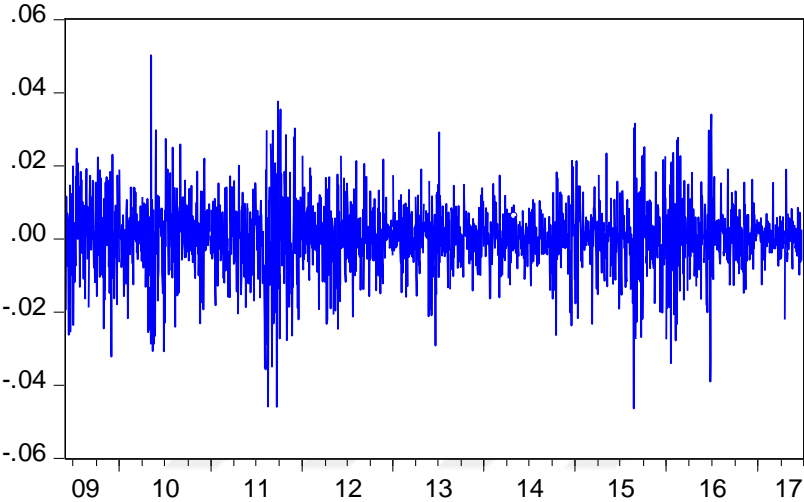


Figure 2 Return of FTSE ALL index [calculated as $r_t = \ln p_t - \ln p_{t-1}$]

FTSE ALL BANKS

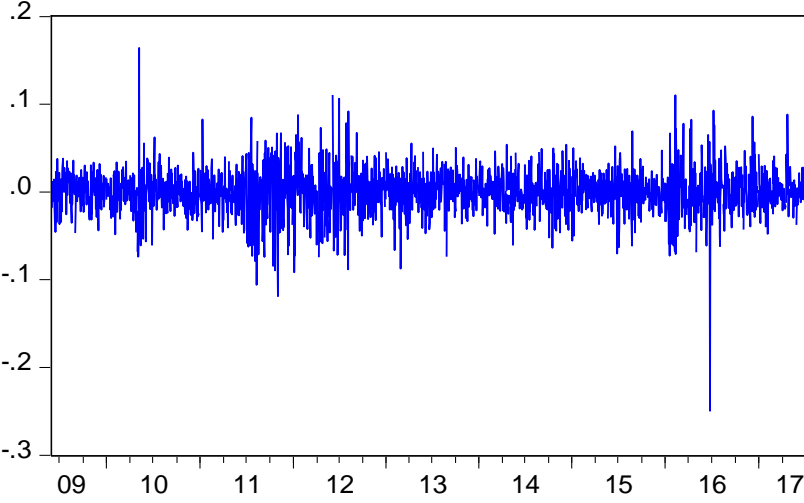


Figure 3 Return of FTSE ALL BANKS index [calculated as $r_t = \ln p_t - \ln p_{t-1}$]

INTEREST RATE

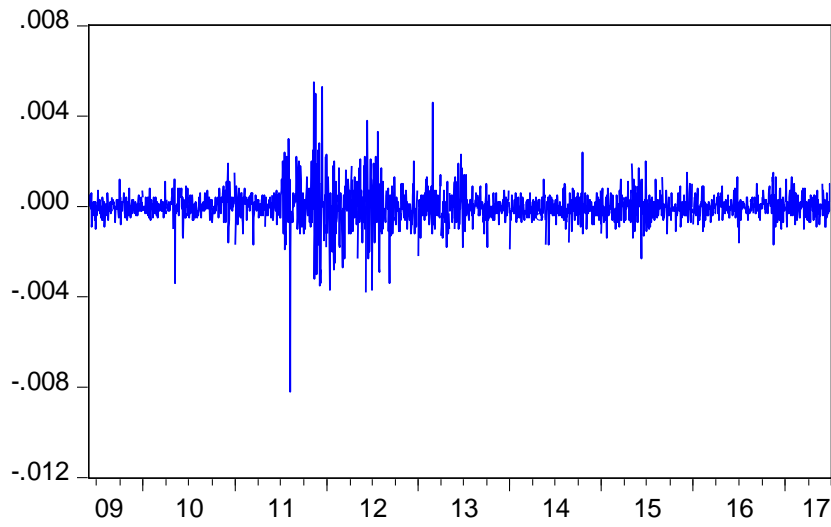


Figure 4 Difference of Interest Rate (10- year Italian Government Bond yield) [calculated as $\Delta i_t = i_t - i_{t-1}$]

FX RATE

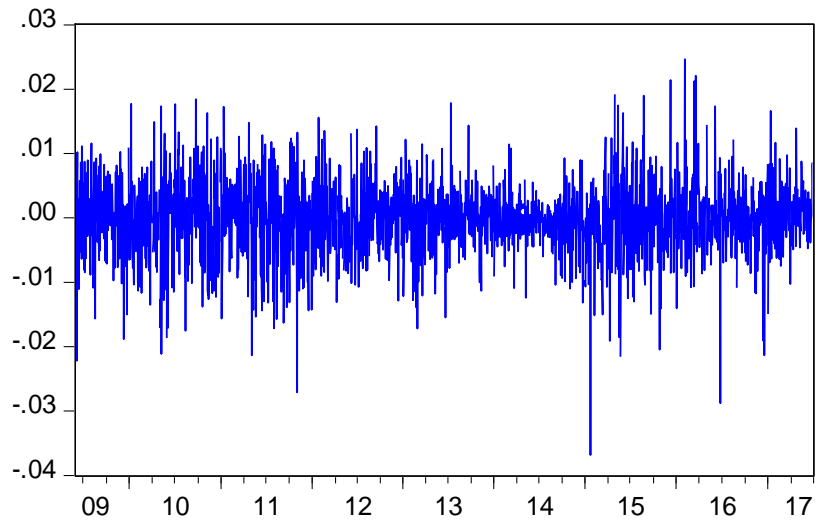


Figure 5 Return of Exchange Rate (US dollar/Euro) [calculated as $r_t = \ln p_t - \ln p_{t-1}$]

INTESA SANPAOLO

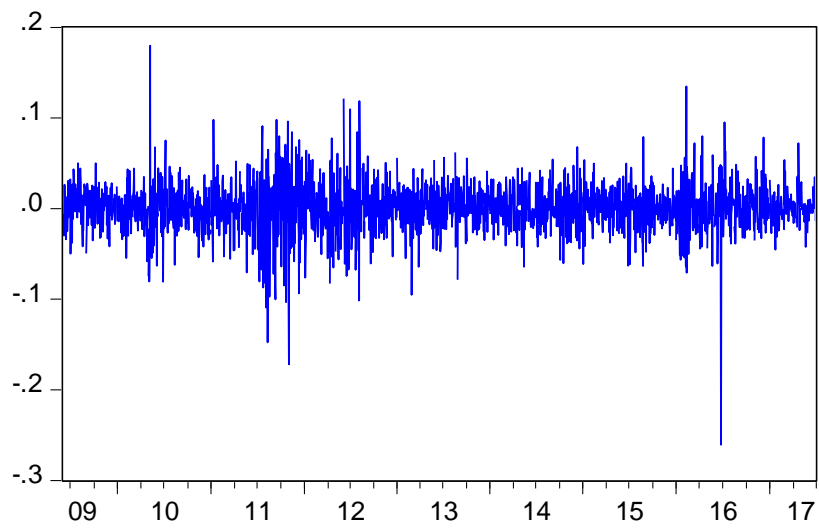


Figure 6 Stock return of Intesa Sanpaolo [calculated as $r_t = \ln p_t - \ln p_{t-1}$]

MEDIO BANCA

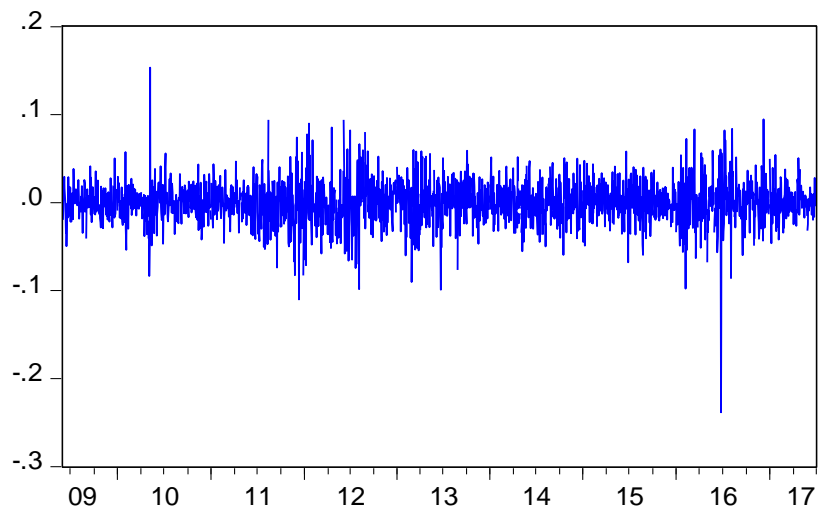


Figure 7 Stock return of Medio Banca [calculated as $r_t = \ln p_t - \ln p_{t-1}$]

UNICREDIT

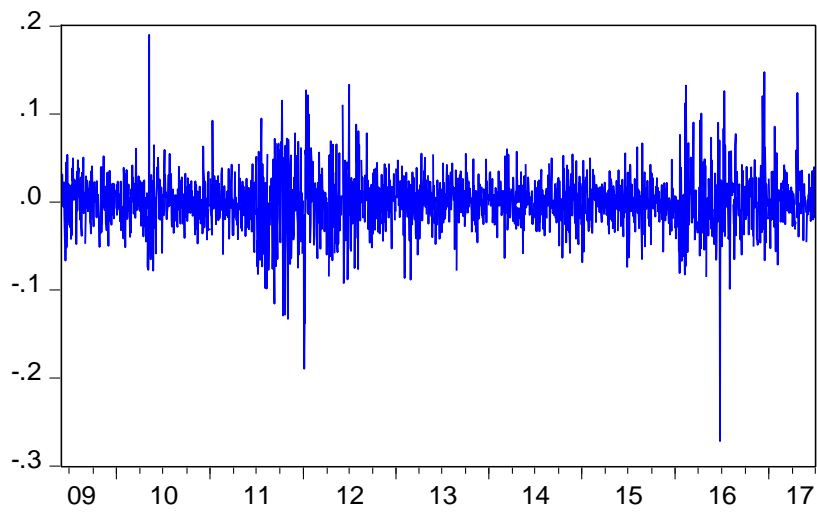


Figure 8 Stock return of Unicredit [calculated as $r_t = \ln p_t - \ln p_{t-1}$]

UNIONE DI BANCHE ITALIANE

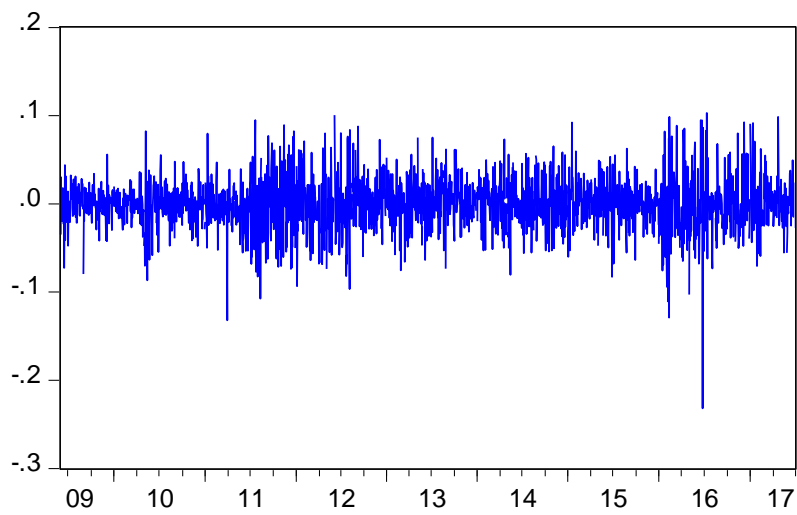


Figure 9 Stock return of Unione di Banche Italiane [calculated as $r_t = \ln p_t - \ln p_{t-1}$]

5. METHODOLOGY

Following model is estimated with Ordinary Least Square (OLS) method to estimate the effect of interest rate and exchange rate changes on bank stock returns in the literature:

$$r_t = \beta_0 + \beta_1 r_{mrk_t} + \beta_2 \Delta_{int_t} + \beta_3 r_{fx_t} + \varepsilon_t \quad (1)$$

where r_t is the return of the i th stock at time t ; r_{mrk_t} is the return of the market index which is considered to reflect economy-wide factors; Δ_{int_t} is the first difference of a risk-free interest rate; and, r_{fx_t} is the return of the foreign exchange rate (FX). β_0 is the intercept term and ε_t is an error term with the assumption of an independent and identically distributed (*iid*) condition.

Heteroskedasticity is valid especially in financial time series that exhibit time-varying volatility. The OLS point estimates are unbiased and consistent, but their standard errors will be inconsistent, as will hypothesis test statistics and confidence intervals under the heteroscedasticity. The most common model of heteroscedasticity employed in the time series context is that of the generalized autoregressive conditional heteroskedasticity, or GARCH. Following Kasman et al. (2011), the GARCH (1, 1) model, first introduced by Bollerslev (1986), is employed to understand the effect of changes in interest rate and exchange rate on bank return:

$$r_t = \gamma_0 + \gamma_1 r_{mrk_t} + \gamma_2 \Delta_{int_t} + \gamma_3 r_{fx_t} + \varepsilon_t \quad (2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (3)$$

The mean equation given in (2) is written as a function of exogenous variables, defined in (1) equation, with an error term. Where r_t is the return of FTSE ALL bank index or bank stocks, r_{mrk_t} is the market risk defined as the return of the FTSE ALL index at time t . Δ_{int_t} refers to the first difference of the 10-year Italian Government Bond yield at time t , r_{fx_t} stands for the return of the US dollar/Euro exchange rate, and ε_t is the error term which is normally

distributed with zero mean and a variance of σ_t^2 . The sensitivity of banking sector or bank performance at time t to the market risk, interest rate and exchange rate are measured by the parameters, γ_1 , γ_2 and γ_3 , respectively. The conditional variance σ_t^2 is given by equation (3), and α_0 is the time-invariant component of risk. Furthermore, α_1 is the ARCH parameter, which indicates the news about volatility from the previous period and measured as the lag of the squared residual from the mean equation, and β is the GARCH parameter, which is measured as the last period's forecast variance. The GARCH specification requires that in the conditional variance equation, parameters α_0 , α_1 and β should be positive for a non-negativity condition and the sum of α_1 and β should be less than one to secure the covariance stationarity of the conditional variance. Moreover, the sum of the coefficients α_1 and β must be less than or equal to unity for stability to hold.

As a second model, the following GARCH (1, 1) model is used next to focus on the effect of interest and foreign exchange rate volatility on the bank index and bank stock returns volatility. The model is specified as follows:

$$r_t = \gamma_0 + \varepsilon_t \quad (4)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \phi_1 \Delta_{int_t}^2 + \phi_2 r_{fx_t}^2 + \varepsilon_t \quad (5)$$

The return of the bank index or bank stocks r_t is written as a function of the constant term and an error term. The variance model given in equation (5) is the traditional GARCH (1, 1) model, plus interest rate risk measured as $\Delta_{int_t}^2$ and the exchange rate risk measured as $r_{fx_t}^2$.

6. EMPIRICAL EVIDENCE

6.1. Empirical Results

6.1.1. OLS Estimation

$$r_t = \beta_0 + \beta_1 r_{mrk_t} + \beta_2 \Delta_{int_t} + \beta_3 r_{fx_t} + \varepsilon_t \quad (1)$$

Table 2 Estimates of the OLS model given in equation (1)

| | β_0 | β_1 | β_2 | β_3 | Adjusted R ² | ARCH (1) |
|----------------------------------|----------------------------|-------------------------|--------------------------|-------------------------|-------------------------|-----------|
| FTSE ALL BANKS | -0.000801*** (0.000440) | 1.550320* (0.047047) | -6.402495* (0.610932) | 0.309641* (0.075841) | 0.431309 | 33.09659* |
| MEDIOBANCA | -0.000382 (0.000451) | 1.318443* (0.048226) | -5.241434* (0.626249) | 0.241702* (0.077742) | 0.339233 | 65.57075* |
| INTESA SANPAOLO | -0.000421 (0.000476) | 1.650848* (0.050914) | -6.154599* (0.661150) | 0.358433* (0.082075) | 0.418929 | 39.78630* |
| UNICREDIT | -0.001155** (0.000571) | 1.686665* (0.061049) | -7.202127* (0.792755) | 0.379748* (0.098412) | 0.351760 | 210.1046* |
| UNIONE DI BANCHE ITALIANE | -0.000864 (0.000554) | 1.474541* (0.059240) | -5.938942* (0.769266) | 0.257444* (0.095496) | 0.298423 | 43.23563* |

Note: Numbers in parenthesis indicate the standard errors.

* indicates the significance level at 1%

** indicates the significance level at 5%

*** indicates the significance level at 10%

Table 2 reports the results of the OLS estimation. As expected, the return of the market index β_1 has a positive and statistically significant (at %1 significance level) relation with the return of the bank index and individual bank stocks. The market index coefficient β_1 is 1.55 for FTSE ALL BANKS index, the highest for the Unicredit as 1.68, and the lowest for the Mediobanca as 1.31. The variables of interest rate β_2 are negative and statistically significant at %1 level for all individual bank stocks and bank index. The interest rate coefficient β_2 is -6,40 for FTSE ALL BANKS index, the highest effect for the Unicredit as -7.20 and the lowest for the Mediobanca as -5.24. The coefficients of exchange rate returns β_3 are positive and statistically significant at %1 level in all cases. The exchange rate coefficient β_3 is 0,30 for FTSE ALL

BANKS index, the highest effect for the Unicredit as 0.37 and the lowest for the Mediobanca as 0.24.

The suitability of the regression estimates is examined with the ARCH test. If the squared residuals in Eq. (1) contain autocorrelation or heteroscedasticity, it is likely that the null hypothesis will be rejected. The last column of Table 2 reports the results of the ARCH (1) test. Unsurprisingly, heteroscedasticity is present for all cases. The presence of heteroscedasticity may lead a failure of the OLS classical assumption because its presence implies that the OLS coefficients are not efficiently estimated and statistical inferences based on standard t and F-tests would not be reliable. Therefore, GARCH type models would appear to be more appropriate for estimating such data.

6.1.2. Estimation of return with GARCH (1,1) model

$$r_t = \gamma_0 + \gamma_1 r_{mrk_t} + \gamma_2 \Delta_{int_t} + \gamma_3 r_{fx_t} + \varepsilon_t \quad (2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (3)$$

Table 3 Estimates of the mean model given in equation (2) and variance equation given in (3)

| | γ_0 | γ_1 | γ_2 | γ_3 | α_0 | α_1 | β |
|----------------------------------|----------------------------|-------------------------|--------------------------|--------------------------|-------------------------------|-------------------------|-------------------------|
| FTSE ALL BANKS | -0.000600*** (0.000370) | 1.469019* (0.042417) | -6.200634* (0.758236) | 0.261947* (0.067585) | 0.000004** (0.000002) | 0.073139* (0.014642) | 0.917366* (0.014952) |
| MEDIOBANCA | -0.000317 (0.000392) | 1.225856* (0.040490) | -5.569379* (0.729887) | 0.251656* (0.069866) | 0.000004** * (0.000002) | 0.059383* (0.011101) | 0.931447* (0.013360) |
| INTESA SANPAOLO | -0.000212 (0.000430) | 1.524772* (0.054179) | -6.493711* (0.835577) | 0.290702* (0.090112) | 0.000007** (0.000003) | 0.057984* (0.014553) | 0.926888* (0.020182) |
| UNICREDIT | -0.000631 (0.000454) | 1.588290* (0.053855) | -6.706379* (0.880557) | 0.323709* (0.079376) | 0.00001* (0.000003) | 0.092758* (0.017650) | 0.889795* (0.016931) |
| UNIONE DI BANCHE ITALIANE | -0.000686 (0.000472) | 1.375920* (0.058030) | -5.774688* (0.841349) | 0.196468** (0.085333) | 0.00001* (0.000004) | 0.070892* (0.014536) | 0.910272* (0.015991) |

Note: Numbers in parenthesis indicate the standard errors.

* indicates the significance level at 1%

** indicates the significance level at 5%

*** indicates the significance level at 10%

Table 3 presents the estimates of the mean model given in equation (2) and variance equation given in (3). Furthermore, α_1 is the ARCH parameter, which indicates the news about volatility from the previous period and measured as the lag of the squared residual from the mean equation, and β is the GARCH parameter, which is measured as the last period's forecast variance. After considering heteroscedasticity and adding variance equation, the return of the market index β_1 , interest rate coefficient β_2 and exchange rate coefficient β_3 are still statistically significant at %1 level in all cases.

The market index coefficient β_1 is 1.46 for FTSE ALL BANK index, the highest for the Unicredit as 1.58, and the lowest for the Mediobanca as 1.22. The variables of interest rate β_2 are negative and statistically significant at %1 level for all individual bank stocks and bank index. The interest rate coefficient β_2 is -6.20 for FTSE ALL BANK index, the highest effect for the Unicredit as -6.70 and the lowest for the Mediobanca as -5.56. The coefficients of exchange rate returns β_3 are positive and statistically significant at %1 level in all cases. The exchange rate coefficient β_3 is 0.26 for FTSE ALL BANK index, the highest effect for the Unicredit as 0.32 and the lowest for the UBI as 0.19.

The conditional variance σ_t^2 follows the process described in Equation (3) and determined by the time-invariant component of risk α_0 , ARCH parameter α_1 and GARCH parameter β . The intercept term α_0 is positive and statistically significant at %1 level in all cases in the conditional variance equation, which indicates that there is a significant time-invariant component in the return generating process. Both the ARCH parameter α_1 and the GARCH parameter β satisfy the non-negativity condition. The GARCH parameter is significantly greater than the ARCH parameter, which implies that the volatility of each stock return is more sensitive to its own lagged values than it is to new surprises. To put it in another way, the effects of a previous period's forecast variance are more persistent. The sum of α_1 and β parameters are close to unity for all cases, stating that shocks to the bank stock and index returns have highly persistent effects and the response of volatility decays at a slower rate.

6.1.3. Estimation of volatility with GARCH (1,1) model

$$r_t = \gamma_0 + \varepsilon_t \quad (4)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \phi_1 \Delta_{int_t}^2 + \phi_2 r_{fx_t}^2 \quad (5)$$

Table 4 Estimates of the mean model given in equation (4) and variance equation given in (5)

| | γ_0 | α_0 | α_1 | β | ϕ_1 | ϕ_2 |
|----------------------------------|-------------------------|-----------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| FTSE ALL BANKS | 0.000239 (0.000489) | 0.00005* (0.00001) | 0.124213* (0.018603) | 0.652998* (0.026074) | 104.6990* (19.09867) | 1.085907* (0.138154) |
| MEDIOBANCA | 0.000458 (0.000478) | 0.00004* (0.00000) | 0.100582* (0.014433) | 0.723098* (0.028720) | 84.15941* (15.62932) | 0.534468* (0.092410) |
| INTESA SANPAOLO | 0.000652 (0.000511) | 0.00005* (0.00001) | 0.109012* (0.019225) | 0.668451* (0.025881) | 100.7696* (18.97556) | 1.500093* (0.149683) |
| UNICREDIT | 0.000180 (0.000566) | 0.00005* (0.00001) | 0.150021* (0.017690) | 0.697163* (0.025432) | 109.3370* (20.74392) | 1.114874* (0.191334) |
| UNIONE DI BANCHE ITALIANE | -0.000104 (0.000580) | 0.00002* (0.00000) | 0.074013* (0.009269) | 0.872595* (0.015471) | 35.52039* (9.342782) | 0.089412* (0.108037) |

Note: Numbers in parenthesis indicate the standard errors.

* indicates the significance level at 1%

Table 4 shows the results of the bank stock and index return mean model and volatility model with the inclusion of variables reflecting interest rate volatility and exchange rate volatility. The small and statistically significant ARCH parameter α_1 provides a weak support for the presence of the last period's shock on bank volatility, whereas the larger and statistically significant GARCH parameter β indicates strong evidence of previous surprises. As a measure of volatility persistence, the sum of ARCH and GARCH parameters is relatively low after the adding of interest rate and exchange rate volatility. The empirical findings show that the estimated coefficient ϕ_1 , which measures the effect of the interest rate volatility on bank stock and index volatility, is positive and statistically significant for all cases. This manifests that, when the interest rate becomes more volatile, this will lead to an increase in bank stock return volatility. The exchange rate volatility on the bank stock return volatility ϕ_2 is found to be positively significant in all cases. The positive and significant exchange rate coefficients mean that the increase in exchange rate volatility leads to an increase in the bank stock return volatility.

7. DISCUSSION AND CONCLUSIONS

7.1. Discussion on Empirical Results

The return of the market index β_1 is positive and statistically significant at %1 significance level for the mean model given at equation (1) and for the mean model with GARCH effect given at equation (2) for all cases. Market index shows us the return of the firms at the FTSE All-Share Index which reflects the expectations on Italian firms' profitability in the future. Therefore β_1 (γ_1 for the GARCH (1,1) model) shows us the relationship between the bank return and the macroeconomic growth prospects in Italy. The empirical results also argue that the bank returns increase more than the market index (the coefficients are bigger than 1). For the OLS estimation and extension model with GARCH (1,1) model, Unicredit has the biggest coefficient value and Mediobanca has the smallest coefficient value.

The effect of changes in the spread of the 10-year Italian Government Bond yield is negative and statistically significant at %1 level for OLS model and for the conditional return model in line with the main literature (Flannery, 1981; and Flannery and James, 1984; Kasman et al., 2011). An increase in the 10-year Italian Government Bond yield may make the cost of funding higher than before for banks and may affect the value of securities portfolio negatively. Also increasing interest rate increases the loan rates and decreases the loan volume for banks. As a result, net interest margin from loans and from securities portfolio decreases and it will lead the lower profit. Similar to the market index, Unicredit has the biggest interest rate effect and Mediobanca has the lowest interest rate effect on their bank returns.

The exchange rate coefficient is positive and statistically significant at %1 level for OLS model and for the conditional return model. The exchange rate variable shows the daily continuously-compounded returns for the US dollar/Euro. So the increase in exchange rate means stronger Euro currency against the US dollar. The profitability of banking sector and all other banks has been affected by the increase of the exchange rate positively. The increase in exchange rate and (i.e. stronger local currency) may affect Italian banks profitability in a positive way if a bank has a short position. For the OLS estimation and extension model with GARCH (1,1) model, Unicredit has the biggest coefficient value and UBI (Unione Di Banche Italiane) has the smallest coefficient value.

7.2. Conclusions

The results of this study show that changes in interest rate (10- year Italian government bond yield) have a negative and significant impact on individual banks' stock returns and banking index (FTSE ALL SHARE BANKS). In contrast, the study indicates that the exchange rate (US dollar/Euro) changes have a positive and significant impact on individual banks' stock returns and banking index (FTSE ALL SHARE BANKS). Also the changes in market index (FTSE ALL) have a positive and significant impact on individual banks' stock returns and banking index (FTSE ALL SHARE BANKS). Besides interest rate and exchange rate volatility have a strong impact on the volatility of individual banks' stock returns.

The findings of this study provide important information particularly for investors related to the banks' stocks, for risk management strategists in banks and finally for banking supervisors and policy makers which monitors banks closely. Since interest rate and exchange rate changes have strong effects on bank stock returns and volatility, financial investors should monitor strictly the monetary policies before making decisions about their investments and making changes on their portfolios. In addition to this, asset & liability managers and risk managers in the banks should strictly follow the variables effecting banks to avoid unexpected losses in the bank. Considering that the banking sector's performance is regarded as the replica of the economy and a healthy banking system plays a crucial role in growth of an economy, policy makers and bank supervising authorities should watch over these macroeconomic variables.

APPENDIX

A. COMPLETE OUTPUT OF THE ESTIMATES OF RETURN WITH OLS

$$r_t = \beta_0 + \beta_1 r_{mrk_t} + \beta_2 \Delta_{int_t} + \beta_3 r_{fx_t} + \varepsilon_t \quad (1)$$

| Dependent Variable: FTSE ALL BANKS | | | | |
|------------------------------------|-------------|-----------------------|-------------|--------|
| Method: Least Squares | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| C | -0.000801 | 0.000440 | -1.821008 | 0.0688 |
| FTSE_ALL | 1.550320 | 0.047047 | 32.95270 | 0.0000 |
| INT | -6.402495 | 0.610932 | -10.47988 | 0.0000 |
| FX | 0.309641 | 0.075841 | 4.082778 | 0.0000 |
| R-squared | 0.432154 | Mean dependent var | -0.000325 | |
| Adjusted R-squared | 0.431309 | S.D. dependent var | 0.026185 | |
| S.E. of regression | 0.019747 | Akaike info criterion | -5.009702 | |
| Sum squared resid | 0.786088 | Schwarz criterion | -4.998592 | |
| Log likelihood | 5063.799 | Hannan-Quinn criter. | -5.005625 | |
| F-statistic | 511.4204 | Durbin-Watson stat | 2.041083 | |
| Prob(F-statistic) | 0.000000 | | | |

Table 5 Estimates of return with OLS - FTSE ALL BANKS

| Dependent Variable: MEDIOBANCA | | | | |
|--------------------------------|-------------|-----------------------|-------------|--------|
| Method: Least Squares | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| C | -0.000382 | 0.000451 | -0.848128 | 0.3965 |
| FTSE_ALL | 1.318443 | 0.048226 | 27.33865 | 0.0000 |
| INT | -5.241434 | 0.626249 | -8.369569 | 0.0000 |
| FX | 0.241702 | 0.077742 | 3.109031 | 0.0019 |
| R-squared | 0.340215 | Mean dependent var | 2.23E-05 | |
| Adjusted R-squared | 0.339233 | S.D. dependent var | 0.024901 | |
| S.E. of regression | 0.020242 | Akaike info criterion | -4.960179 | |
| Sum squared resid | 0.825998 | Schwarz criterion | -4.949068 | |
| Log likelihood | 5013.780 | Hannan-Quinn criter. | -4.956101 | |
| F-statistic | 346.5140 | Durbin-Watson stat | 2.009662 | |
| Prob(F-statistic) | 0.000000 | | | |

Table 6 Estimates of return with OLS - MEDIOBANCA

| Dependent Variable: INTESA SANPAOLO | | | | |
|-------------------------------------|-------------|-----------------------|-------------|--------|
| Method: Least Squares | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| C | -0.000421 | 0.000476 | -0.885244 | 0.3761 |
| FTSE_ALL | 1.650848 | 0.050914 | 32.42422 | 0.0000 |
| INT | -6.154599 | 0.661150 | -9.308923 | 0.0000 |
| FX | 0.358433 | 0.082075 | 4.367158 | 0.0000 |
| R-squared | 0.419793 | Mean dependent var | 7.41E-05 | |
| Adjusted R-squared | 0.418929 | S.D. dependent var | 0.028034 | |
| S.E. of regression | 0.021370 | Akaike info criterion | -4.851712 | |
| Sum squared resid | 0.920630 | Schwarz criterion | -4.840601 | |
| Log likelihood | 4904.229 | Hannan-Quinn criter. | -4.847634 | |
| F-statistic | 486.2070 | Durbin-Watson stat | 2.104582 | |
| Prob(F-statistic) | 0.000000 | | | |

Table 7 Estimates of return with OLS - INTESA SANPAOLO

| Dependent Variable: UNICREDIT | | | | |
|-------------------------------|-------------|-----------------------|-------------|--------|
| Method: Least Squares | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| C | -0.001155 | 0.000571 | -2.024903 | 0.0430 |
| FTSE_ALL | 1.686665 | 0.061049 | 27.62820 | 0.0000 |
| INT | -7.202127 | 0.792755 | -9.084934 | 0.0000 |
| FX | 0.379748 | 0.098412 | 3.858763 | 0.0001 |
| R-squared | 0.352723 | Mean dependent var | -0.000640 | |
| Adjusted R-squared | 0.351760 | S.D. dependent var | 0.031825 | |
| S.E. of regression | 0.025623 | Akaike info criterion | -4.488646 | |
| Sum squared resid | 1.323618 | Schwarz criterion | -4.477536 | |
| Log likelihood | 4537.533 | Hannan-Quinn criter. | -4.484569 | |
| F-statistic | 366.1952 | Durbin-Watson stat | 1.977377 | |
| Prob(F-statistic) | 0.000000 | | | |

Table 8 Estimates of return with OLS - UNICREDIT

| Dependent Variable: UNIONE DI BANCHE ITALIANE | | | | |
|---|-------------|-----------------------|-------------|--------|
| Method: Least Squares | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| C | -0.000864 | 0.000554 | -1.561212 | 0.1186 |
| FTSE_ALL | 1.474541 | 0.059240 | 24.89105 | 0.0000 |
| INT | -5.938942 | 0.769266 | -7.720276 | 0.0000 |
| FX | 0.257444 | 0.095496 | 2.695859 | 0.0071 |
| R-squared | 0.299465 | Mean dependent var | -0.000409 | |
| Adjusted R-squared | 0.298423 | S.D. dependent var | 0.029685 | |
| S.E. of regression | 0.024864 | Akaike info criterion | -4.548802 | |
| Sum squared resid. | 1.246342 | Schwarz criterion | -4.537692 | |
| Log likelihood | 4598.290 | Hannan-Quinn criter. | -4.544725 | |
| F-statistic | 287.2669 | Durbin-Watson stat | 2.088677 | |
| Prob(F-statistic) | 0.000000 | | | |

Table 9 Estimates of return with OLS - UNIONE DI BANCHE ITALIANE

B. COMPLETE OUTPUT OF THE ESTIMATES OF RETURN WITH GARCH (1,1) MODEL

$$r_t = \gamma_0 + \gamma_1 r_{mrk_t} + \gamma_2 \Delta_{int_t} + \gamma_3 r_{fx_t} + \varepsilon_t \quad (2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (3)$$

| Dependent Variable: FTSE ALL BANKS | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 28 iterations | | | | |
| Coefficient covariance computed using Bollerslev-Wooldridge QML sandwich with expected Hessian | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1) | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | -0.000600 | 0.000370 | -1.621803 | 0.1048 |
| FTSE_ALL | 1.469019 | 0.042417 | 34.63250 | 0.0000 |
| INT | -6.200633 | 0.758236 | -8.177710 | 0.0000 |
| FX | 0.261947 | 0.067585 | 3.875824 | 0.0001 |
| Variance Equation | | | | |
| C | 4.74E-06 | 2.05E-06 | 2.313696 | 0.0207 |
| RESID(-1)^2 | 0.073139 | 0.014642 | 4.995138 | 0.0000 |
| GARCH(-1) | 0.917366 | 0.014952 | 61.35324 | 0.0000 |
| R-squared | 0.430813 | Mean dependent var | | -0.000325 |
| Adjusted R-squared | 0.429966 | S.D. dependent var | | 0.026185 |
| S.E. of regression | 0.019770 | Akaike info criterion | | -5.162270 |
| Sum squared resid | 0.787944 | Schwarz criterion | | -5.142827 |
| Log likelihood | 5220.893 | Hannan-Quinn criter. | | -5.155134 |
| Durbin-Watson stat | 2.040495 | | | |

Table 10 Estimates of return with GARCH (1,1) - FTSE ALL BANKS

| Dependent Variable: MEDIOBANCA | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 30 iterations | | | | |
| Coefficient covariance computed using Bollerslev-Wooldridge QML sandwich with expected Hessian | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1) | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | -0.000317 | 0.000392 | -0.809055 | 0.4185 |
| FTSE_ALL | 1.225856 | 0.040490 | 30.27554 | 0.0000 |
| INT | -5.569379 | 0.729887 | -7.630466 | 0.0000 |
| FX | 0.251656 | 0.069866 | 3.601972 | 0.0003 |
| Variance Equation | | | | |
| C | 4.52E-06 | 2.53E-06 | 1.783464 | 0.0745 |
| RESID(-1)^2 | 0.059383 | 0.011101 | 5.349547 | 0.0000 |
| GARCH(-1) | 0.931447 | 0.013360 | 69.71789 | 0.0000 |
| R-squared | 0.338980 | Mean dependent var | | 2.23E-05 |
| Adjusted R-squared | 0.337996 | S.D. dependent var | | 0.024901 |
| S.E. of regression | 0.020261 | Akaike info criterion | | -5.089585 |
| Sum squared resid | 0.827545 | Schwarz criterion | | -5.070141 |
| Log likelihood | 5147.480 | Hannan-Quinn criter. | | -5.082449 |
| Durbin-Watson stat | 2.014643 | | | |

Table 11 Estimates of return with GARCH (1,1) - MEDIOBANCA

| Dependent Variable: INTESA SANPAOLO | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 33 iterations | | | | |
| Coefficient covariance computed using Bollerslev-Wooldridge QML sandwich with expected Hessian | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1) | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | -0.000212 | 0.000430 | -0.492841 | 0.6221 |
| FTSE_ALL | 1.524772 | 0.054179 | 28.14304 | 0.0000 |
| INT | -6.493711 | 0.835577 | -7.771527 | 0.0000 |
| FX | 0.290702 | 0.090112 | 3.226003 | 0.0013 |
| Variance Equation | | | | |
| C | 7.55E-06 | 3.67E-06 | 2.059095 | 0.0395 |
| RESID(-1)^2 | 0.057984 | 0.014553 | 3.984368 | 0.0001 |
| GARCH(-1) | 0.926888 | 0.020182 | 45.92613 | 0.0000 |
| R-squared | 0.417485 | Mean dependent var | | 7.41E-05 |
| Adjusted R-squared | 0.416618 | S.D. dependent var | | 0.028034 |
| S.E. of regression | 0.021412 | Akaike info criterion | | -4.971013 |
| Sum squared resid | 0.924293 | Schwarz criterion | | -4.951569 |
| Log likelihood | 5027.723 | Hannan-Quinn criter. | | -4.963877 |
| Durbin-Watson stat | 2.112939 | | | |

Table 12 Estimates of return with GARCH (1,1) - INTESA SANPAOLO

| Dependent Variable: UNICREDIT | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 31 iterations | | | | |
| Coefficient covariance computed using Bollerslev-Wooldridge QML sandwich with expected Hessian | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1) | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | -0.000631 | 0.000454 | -1.388879 | 0.1649 |
| FTSE_ALL | 1.588290 | 0.053855 | 29.49203 | 0.0000 |
| INT | -6.706379 | 0.880557 | -7.616068 | 0.0000 |
| FX | 0.323709 | 0.079376 | 4.078160 | 0.0000 |
| Variance Equation | | | | |
| C | 1.18E-05 | 3.84E-06 | 3.078525 | 0.0021 |
| RESID(-1)^2 | 0.092758 | 0.017650 | 5.255375 | 0.0000 |
| GARCH(-1) | 0.889795 | 0.016931 | 52.55269 | 0.0000 |
| R-squared | 0.351014 | Mean dependent var | | -0.000640 |
| Adjusted R-squared | 0.350048 | S.D. dependent var | | 0.031825 |
| S.E. of regression | 0.025657 | Akaike info criterion | | -4.735344 |
| Sum squared resid | 1.327113 | Schwarz criterion | | -4.715901 |
| Log likelihood | 4789.698 | Hannan-Quinn criter. | | -4.728209 |
| Durbin-Watson stat | 1.973720 | | | |

Table 13 Estimates of return with GARCH (1,1) - UNICREDIT

| Dependent Variable: UNIONE DI BANCHE ITALIANE | | | | |
|--|-------------|-----------------------|-------------|--------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 28 iterations | | | | |
| Coefficient covariance computed using Bollerslev-Wooldridge QML sandwich with expected Hessian | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1) | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | -0.000686 | 0.000472 | -1.455345 | 0.1456 |
| FTSE_ALL | 1.375920 | 0.058030 | 23.71045 | 0.0000 |
| INT | -5.774688 | 0.841349 | -6.863607 | 0.0000 |
| FX | 0.196468 | 0.085333 | 2.302368 | 0.0213 |
| Variance Equation | | | | |
| C | 1.22E-05 | 4.55E-06 | 2.683606 | 0.0073 |
| RESID(-1)^2 | 0.070892 | 0.014536 | 4.877048 | 0.0000 |
| GARCH(-1) | 0.910272 | 0.015991 | 56.92360 | 0.0000 |
| R-squared | 0.297987 | Mean dependent var | -0.000409 | |
| Adjusted R-squared | 0.296942 | S.D. dependent var | 0.029685 | |
| S.E. of regression | 0.024890 | Akaike info criterion | -4.684493 | |
| Sum squared resid | 1.248972 | Schwarz criterion | -4.665050 | |
| Log likelihood | 4738.338 | Hannan-Quinn criter. | -4.677358 | |
| Durbin-Watson stat | 2.089436 | | | |

Table 14 Estimates of return with GARCH (1,1) - UNIONE DI BANCHE ITALIANE

C. COMPLETE OUTPUT OF THE ESTIMATES OF VOLATILITY WITH GARCH (1,1) MODEL

$$r_t = \gamma_0 + \varepsilon_t \quad (4)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \phi_1 \Delta_{int_t}^2 + \phi_2 r_{fx_t}^2 \quad (5)$$

| Dependent Variable: FTSE ALL BANKS | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 27 iterations | | | | |
| Coefficient covariance computed using outer product of gradients | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1) + C(5)*INT2 + C(6) *FX2 | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | 0.000239 | 0.000489 | 0.488427 | 0.6252 |
| Variance Equation | | | | |
| C | 5.69E-05 | 1.06E-05 | 5.387790 | 0.0000 |
| RESID(-1)^2 | 0.124213 | 0.018603 | 6.676991 | 0.0000 |
| GARCH(-1) | 0.652998 | 0.026074 | 25.04422 | 0.0000 |
| INT2 | 104.6990 | 19.09867 | 5.482006 | 0.0000 |
| FX2 | 1.085907 | 0.138154 | 7.860103 | 0.0000 |
| R-squared | -0.000464 | Mean dependent var | | -0.000325 |
| Adjusted R-squared | -0.000464 | S.D. dependent var | | 0.026185 |
| S.E. of regression | 0.026191 | Akaike info criterion | | -4.638007 |
| Sum squared resid | 1.384975 | Schwarz criterion | | -4.621341 |
| Log likelihood | 4690.387 | Hannan-Quinn criter. | | -4.631891 |
| Durbin-Watson stat | 1.971608 | | | |

Table 15 Estimates of volatility with GARCH (1,1) - FTSE ALL BANKS

| Dependent Variable: MEDIOBANCA | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 34 iterations | | | | |
| Coefficient covariance computed using outer product of gradients | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1) + C(5)*INT2 + C(6) *FX2 | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | 0.000458 | 0.000478 | 0.957126 | 0.3385 |
| Variance Equation | | | | |
| C | 4.62E-05 | 9.50E-06 | 4.862083 | 0.0000 |
| RESID(-1)^2 | 0.100582 | 0.014433 | 6.968808 | 0.0000 |
| GARCH(-1) | 0.723098 | 0.028720 | 25.17762 | 0.0000 |
| INT2 | 84.15941 | 15.62932 | 5.384714 | 0.0000 |
| FX2 | 0.534468 | 0.092410 | 5.783691 | 0.0000 |
| R-squared | -0.000306 | Mean dependent var | | 2.23E-05 |
| Adjusted R-squared | -0.000306 | S.D. dependent var | | 0.024901 |
| S.E. of regression | 0.024905 | Akaike info criterion | | -4.709893 |
| Sum squared resid | 1.252303 | Schwarz criterion | | -4.693227 |
| Log likelihood | 4762.992 | Hannan-Quinn criter. | | -4.703777 |
| Durbin-Watson stat | 1.916302 | | | |

Table 16 Estimates of volatility with GARCH (1,1) - MEDIOBANCA

| Dependent Variable: INTESA SANPAOLO | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 28 iterations | | | | |
| Coefficient covariance computed using outer product of gradients | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1) + C(5)*INT2 + C(6) *FX2 | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | 0.000652 | 0.000511 | 1.277356 | 0.2015 |
| Variance Equation | | | | |
| C | 5.81E-05 | 1.06E-05 | 5.488676 | 0.0000 |
| RESID(-1)^2 | 0.109012 | 0.019225 | 5.670423 | 0.0000 |
| GARCH(-1) | 0.668451 | 0.025881 | 25.82751 | 0.0000 |
| INT2 | 100.7696 | 18.97556 | 5.310492 | 0.0000 |
| FX2 | 1.500093 | 0.149683 | 10.02179 | 0.0000 |
| R-squared | -0.000426 | Mean dependent var | | 7.41E-05 |
| Adjusted R-squared | -0.000426 | S.D. dependent var | | 0.028034 |
| S.E. of regression | 0.028040 | Akaike info criterion | | -4.533755 |
| Sum squared resid | 1.587403 | Schwarz criterion | | -4.517089 |
| Log likelihood | 4585.093 | Hannan-Quinn criter. | | -4.527639 |
| Durbin-Watson stat | 2.043461 | | | |

Table 17 Estimates of volatility with GARCH (1,1) - INTESA SANPAOLO

| Dependent Variable: UNICREDIT | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 27 iterations | | | | |
| Coefficient covariance computed using outer product of gradients | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1) + C(5)*INT2 + C(6) *FX2 | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | 0.000180 | 0.000566 | 0.317502 | 0.7509 |
| Variance Equation | | | | |
| C | 5.40E-05 | 1.18E-05 | 4.562741 | 0.0000 |
| RESID(-1)^2 | 0.150021 | 0.017690 | 8.480550 | 0.0000 |
| GARCH(-1) | 0.697163 | 0.025432 | 27.41329 | 0.0000 |
| INT2 | 109.3370 | 20.74392 | 5.270800 | 0.0000 |
| FX2 | 1.114874 | 0.191334 | 5.826855 | 0.0000 |
| R-squared | -0.000663 | Mean dependent var | | -0.000640 |
| Adjusted R-squared | -0.000663 | S.D. dependent var | | 0.031825 |
| S.E. of regression | 0.031836 | Akaike info criterion | | -4.297269 |
| Sum squared resid | 2.046259 | Schwarz criterion | | -4.280603 |
| Log likelihood | 4346.242 | Hannan-Quinn criter. | | -4.291153 |
| Durbin-Watson stat | 1.937479 | | | |

Table 18 Estimates of volatility with GARCH (1,1) - UNICREDIT

| Dependent Variable: UNIONE DI BANCHE ITALIANE | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) | | | | |
| Sample: 6/03/2009 6/30/2017 | | | | |
| Included observations: 2020 | | | | |
| Convergence achieved after 47 iterations | | | | |
| Coefficient covariance computed using outer product of gradients | | | | |
| Presample variance: backcast (parameter = 0.7) | | | | |
| GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1) + C(5)*INT2 + C(6) *FX2 | | | | |
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
| C | -0.000104 | 0.000580 | -0.179466 | 0.8576 |
| Variance Equation | | | | |
| C | 2.60E-05 | 6.04E-06 | 4.305867 | 0.0000 |
| RESID(-1)^2 | 0.074013 | 0.009269 | 7.984911 | 0.0000 |
| GARCH(-1) | 0.872595 | 0.015471 | 56.40196 | 0.0000 |
| INT2 | 35.52039 | 9.342782 | 3.801907 | 0.0001 |
| FX2 | 0.089412 | 0.108037 | 0.827603 | 0.4079 |
| R-squared | -0.000106 | Mean dependent var | | -0.000409 |
| Adjusted R-squared | -0.000106 | S.D. dependent var | | 0.029685 |
| S.E. of regression | 0.029686 | Akaike info criterion | | -4.327951 |
| Sum squared resid | 1.779318 | Schwarz criterion | | -4.311285 |
| Log likelihood | 4377.230 | Hannan-Quinn criter. | | -4.321835 |
| Durbin-Watson stat | 2.024989 | | | |

Table 19 Estimates of volatility with GARCH (1,1) - UNIONE DI BANCHE ITALIANE

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