Volatility of ISE and Business Cycle

Saadet Kırbaş-Kasman* and Adnan Kasman

Department of Economics, Faculty of Business,
Dokuz Eylul University

Saadet.kasman@deu.edu.tr

Abstract

In this paper, we use a disaggregated approach suggested in (Campbell et al. 2001) to study the volatility of a typical stock in the Istanbul Stock Exchange (ISE) at the market, industry, and firm levels over the period 1992-1999. The aim of study is to examine the link between these three disaggregated volatility measures and selected macroeconomic variables. The chosen macroeconomic variables are GDP growth, industrial production, inflation rate and exchange rate. The results indicate that market level volatility accounts for the greatest share of the total firm volatility on average. The results further suggest that market and firm level volatility have positive correlation with leads and lags of exchange rate while industry level volatility has positive correlation with inflation rate. The results also suggest that all the components of volatility do not exhibit counter-cyclical behavior with respect to GDP growth and industrial production.

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*Corresponding author.

1. Introduction

The literature on stock market has addressed the question of why stock return volatility is higher at some times than others. Some studies have related the changes in stock market volatility to the time-varying volatility of a variety of macroeconomic variables. The price of equity at any point is equal to the discounted present value of expected future cash flows (including capital gains and dividends) to shareholders. Therefore, at the aggregate level, the value of corporate equity depends on the health of the economy and a change in the level of uncertainty about future macroeconomic conditions that would cause a proportional change in stock return volatility. If macroeconomic data provide information about the volatility of either future expected cash flows or future discount rates, they can help explain why stock return volatility changes over time.

Studies of financial volatility in relation to macroeconomic variables have historically focused on aggregate market volatility using a broad stock market index. (Officer 1973) relates changes in stock market volatility to the volatility of macroeconomic variables. He argues that market volatility is higher in economic downturns. In response to (Officer 1973), (Black 1976) and (Christie 1982) argue that this effect is due to increased financial leverage in recession. (Schwert 1989) presents an extensive analysis of the relation of market volatility with the time-varying volatility of a variety of economic variables, confirming (Officer's 1973) earlier result that market volatility is higher in economic downturns. He shows that stock market volatility increases with financial leverage, as predicted by (Black 1976) and (Christie 1982), but this factor explains a small part of the variation in stock volatility. (Hamilton and Lin 1996) model the joint behavior of stock returns and industrial production growth in regime-switching model. They find that economic recessions explain about 60% of the variation in market volatility. More recently (Campbell et al. 2001) analyze the cyclical behavior of their volatility measures for the U.S. stock market. The results indicate that the volatility measures increase substantially in economic downturns and tend to lead recessions. The results also indicate that the volatility measures, particularly industry-level volatility, help to forecast economic activity.

In this paper, we follow the (Campbell et al. 2001) approach to create market, industry and firm level volatility measures for Istanbul Stock Exchange (ISE).[1] The bjective of this paper is to examine the link between these three disaggregated volatility measures and selected macroeconomic variables. The chosen macroeconomic variables are GDP growth, industrial production, inflation rate and exchange rate. Our interest in this study was spurred by two factors. First, most of the previous studies have focused on the link between broad stock market index and macroeconomic variables. We believe market, industry and firm-level volatility can provide better information with respect to the overall course of the business cycle. Although several studies investigated the volatility of ISE none of them examined the volatility on the disaggregated level.[2] Information on the firm, industry and market level volatility would be valuable for the domestic and global fund investors and researchers. Second, while a few studies have evaluated the disaggregated volatility measures for developed stock markets, none has evaluated the emerging stock markets on the disaggregated level.[3]

The remaining of the paper is organized as follows. Section 2 discusses the methodology on the estimation of volatility series. Section 3 describes the data set and estimation procedure. Empirical results are presented in section 4. The paper's concluding remarks are provided in section 5.

2. Methodology

Following (Campbell et al. 2001) we decompose the return of a typical stock into three components: the market-wide return, an industry-specific return, and a firm-specific return. Based on this return decomposition, time-series of volatility measures of the three components for a typical firm is constructed.

Industries are denoted by an i subscript while individual firms are indexed by f. The simple excess return of firm f that belongs to industry i in period t is denoted as

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[1] The technique proposed in (Campbell et al. 2001) does not require the estimation of covariances of betas for firm, industry and market. This allows us to calculate variances for individual components without requiring a specific parametric estimation procedure.

[2] Some of them are (Yılmaz 1997), (Yavan and Aybar 1998), (Harris and Küçüközmen 2001), (Balaban 1999), (Muradoğlu 1999) and (Payaslıoğlu 2001).

[3] See (Campbell et al. 2001) and (Sequeira and Lan 2003).

R_{ift}. The excess return of industry *i* in period *t* is given by $R_{it} = \sum_{f \in i} w_{ift} R_{ift}$ where w_{ift} is the weight of firm *f* in industry *i*. In this paper, we use a value-weighting based on market capitalization. The weight of industry *i* in the total market is denoted by $w_{it} (= \sum_{f \in i} w_{ift})$ and the excess market return is $R_{mt} = \sum_{i} w_{it} R_{it}$. The excess return is measured as the excess return over the Treasury bill rate.

Using a simplified CAPM, we compute the return on industry *i* as:

$$R_{it} = \beta_{mi} R_{mt} + \tilde{\varepsilon}_{it} \tag{1}$$

where β_{mi} denotes the beta for industry *i,* with respect to the market return, and $\tilde{\varepsilon}_{it}$ is the industry-specific residual that is assumed to be orthogonal to R_{mt}. The return on an individual firm is:

$$R_{ift} = \beta_{mf} R_{mt} + \beta_{if} \tilde{\varepsilon}_{it} + \tilde{\eta}_{ift} \tag{2}$$

where β_{mf} is the beta of firm *f* with respect to the market, β_{if} is the beta of firm *f* in industry *i* with respect to its industry stock, and $\tilde{\eta}_{ift}$ is the firm-specific residual. To decompose volatility into different levels without the need to estimate their respective betas, we use simplified industry return decomposition, which drops the industry beta coefficient β_{mi} from (1).[4]

$$R_{it} = R_{mt} + \varepsilon_{it} \tag{3}$$

Computing the variance of the industry yields

$$\begin{aligned} Var(R_{it}) &= Var(R_{mt}) + Var(\varepsilon_{it}) + 2Cov(R_{mt}, \varepsilon_{it}) \\ &= Var(R_{mt}) + Var(\varepsilon_{it}) + 2(\beta_{mi} - 1)\,\mathrm{var}(R_{mt}) \end{aligned} \tag{4}$$

where taking account of the covariance term introduces the industry beta into the variance decomposition. The weighted sum of the different betas equals unity.[5] Thus, we can eliminate the individual covariances by taking the weighted average of variance across industries:

$$\sum_{i} w_{it} Var(R_{it}) = Var(R_{mt}) + \sum_{i} w_{it} Var(\varepsilon_{it}) \tag{5}$$

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[4] Campbell, Lo and MacKinlay (1997) refer (3) as a "market-adjusted-return model" in contrast to the model of Eq. (1).

[5] $\sum_{i} w_{it} \beta_{mi} = 1$, $\sum_{f \in i} w_{ift} \beta_{mf} = 1$, $\sum_{f \in i} w_{ift} \beta_{if} = 1$

$$= \sigma_{mt}^2 + \sigma_{\varepsilon t}^2$$

The residual ε_{it} in (3) may then be used to construct a measure of average industry-level volatility that does not require any estimation of betas.

Individual firm returns can be decomposed in the same fashion. Consider a firm return decomposition that drops betas from (2):

$$R_{ift} = R_{mt} + \varepsilon_{it} + \eta_{ift} \quad (6)$$

The variance of the firm return is

$$Var(R_{ift}) = Var(R_{mt}) + Var(\varepsilon_{it}) + Var(\eta_{ift}) + 2Cov(R_{mt}, \varepsilon_{it}) + 2Cov(\varepsilon_{it}, \eta_{ift}) + 2Cov(R_{mt}, \eta_{ift}) \quad (7)$$

The weighted average of firm variances in industry i after expressing the covariances in terms of betas and volatility become

$$\sum_{f \in i} w_{ift} Var(R_{ift}) = Var(R_{mt}) + Var(\varepsilon_{it}) + \sigma_{nit}^2 + 2(\beta_{mi} - 1)Var(R_{mt}) \quad (8)$$

Computing the weighted average across industries yields again a variance decomposition without any betas since the industry betas sum to one:

$$\sum_i w_{it} \sum_{f \in i} w_{ift} Var(R_{ift}) = Var(R_{mt}) + \sum_i w_{it} Var(\varepsilon_{it}) + \sum_i w_{it} \sigma_{\eta it}^2$$

$$= \sigma_{mt}^2 + \sigma_{\varepsilon t}^2 + \sigma_{\eta t}^2 \quad (9)$$

Eq. (9) allows us to decompose the aggregate volatility of a typical stock in ISE into its three components; market-level volatility (MRK), industry-level volatility (IND) and firm-level volatility (FIRM).

3. Data and Estimation

We use the firm-level daily return data to estimate the volatility components in (9) based on the return composition (3) and (6). We aggregate individual firms into 15 industries according to the industry classification of ISE. Table 1 includes a list of those 15 industries, number of firms within each industries and market capitalization in ascendant order.

Our sample runs from January 1992 to December 1999. The sample period is dictated by data availability considerations. Data were obtained from ISE. The number of firms in individual industries has changed dramatically over the sample period. The total number of firms covered by the ISE available data set increased from 92 in 92:1 to 222 in 99:12. Textile industry has the most firms for the end of sample period with 34 firms while Power industry has the fewest firms with 2 firms. Based on market capitalization, we see that the three largest industries, on average, over the sample are Chemicals (22.01%), Banking (20.19%), and Engineering (17.10%).

Table 1
Number of Firms and Market Capitalization Ratios of Individual Industries

Industry	Number of firms (end of 1999)	Market Capitalization (%)
Investment trusts	19	0.139
Financial Leasing and Factoring	7	0.448
Power	2	0.916
Insurance	5	0.990
Ferrous Metals	10	1.536
Media and Publishing	13	2.256
Food	24	2.904
Textiles	34	2.953
Wholesale and retail trade	14	3.310
Transportation	3	5.879
Construction Materials	23	5.960
Holdings	11	13.372
Engineering	25	17.105
Banking	13	20.190
Chemicals	19	22.011

Following procedure based on the methodology presented in section 2 is used to estimate the three volatility components in (9). The sample volatility of the market return in period, *t* is computed as:

$$MRK_t = \hat{\sigma}_{mt}^2 = \sum_{d \in t} (R_{md} - \mu_m)^2 \qquad (10)$$

where μ_m is defined as the mean of the R_{md} over the sample period. *d* refers to daily return and *t* refers to quarters. Market capitalization is used for the weights. For weights in period *t* we use the market capitalization of a firm in period $t-1$ and maintain constant weights within each period *t*.

For volatility in industry i we sum the squares of the industry-specific residual in (3) within period t as follows:

$$\hat{\sigma}_{\varepsilon it}^2 = \sum_{d \in t} \varepsilon_{id}^2 \qquad (11)$$

We average over industries to ensure that the covariances of individual industries cancel out. The average industry volatility is computed as:

$$IND_t = \sum_i w_{it} \hat{\sigma}^2_{\varepsilon it} . \quad (12)$$

For firm-specific volatility we first sum the squares of the firm-specific residual in (6) for each firm in the sample:

$$\hat{\sigma}^2_{\eta ift} = \sum_{d \in t} \eta^2_{ifd} \quad (13)$$

Next, we compute the weighted average of the firm-specific volatilities within an industry:

$$\hat{\sigma}^2_{\eta it} = \sum_{f \in i} w_{ift} \hat{\sigma}^2_{\eta ift} \quad (14)$$

and lastly we average over industries to obtain a measure of average firm-level volatility as

$$FIRM_t = \sum_i w_{it} \hat{\sigma}^2_{\eta it} \quad (15)$$

As for industry volatility this procedure ensures that the firm-specific covariances cancel out.

4. Empirical results

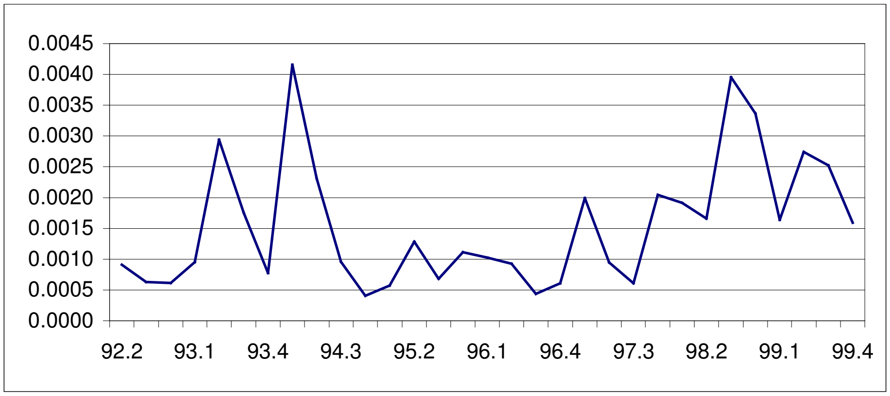
Time Series Behavior of Market, Industry and Firm-level Volatility

Fig.1 is a time plot of three volatility components. All volatility series have been estimated quarterly using daily data over the period January 1992 to December 1999. The market level volatility (MRK) is presented in panel A, the industry-level volatility (IND) in panel B, and firm-level volatility (FIRM) in panel C.

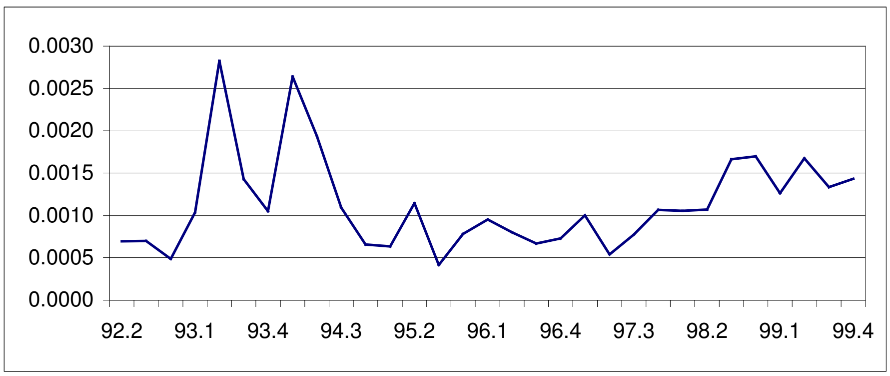
The MRK is on average higher than FIRM and IND. This implies that market-specific volatility is the largest component of the total volatility of an average firm and it appears to capture major shocks (political and economic) to the market volatility. For example, market volatility was particularly high at the beginning of 1993, 1994 and towards the end of 1998.

Fig. 1. Market-Level, Industry-Level, and Firm-Level Volatility from 1992-1999

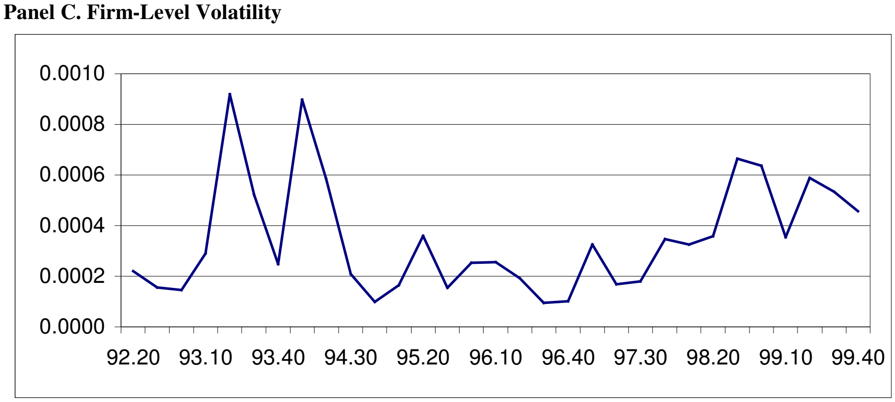
Panel A. Market –Level Volatility



Panel B. Industry-Level Volatility



Panel C. Firm-Level Volatility



Panels A, B, and C are time plots of MRK, IND, and FIRM.

According to IFC, ISE was the second best performing market in 1993, its Composite Index jumping by 416% in lira terms and nearly 210% in dollars terms. Declines in short-term interest rates, expectations of lower inflation, and announcements of strong year-end corporate earnings moved share prices on the ISE sharply higher. Growth in Turkish economy was also remarkable in 1993 with GNP rising despite restricted trade opportunities due to political difficulties in neighboring countries and the recession in Western Europe. GDP grew at an exceptionally high rate of 7%, up from 5.5% the previous year and exceeding initial governmental targets of 5%. Despite the remarkable economic conditions, it is surprising to observe that there is a big jump in volatility measures in first quarter of 1993. One possible explanation for this jump would be related to the political uncertainty created by the unexpected death of president Turgut Özal. The period of uncertainty was ended during the middle of 1993 by the approval of the new Turkish president, Süleyman Demirel.

The currency crisis in February 1994 also caused a huge spike in all three volatility measures. Huge spike in market volatility in 1994 was due entirely to 65% devaluation in the Turkish Lira. ISE registered huge dollar losses. ISE Composite Index rose 31.8% in lira terms but fell 50.7% in dollar terms. Volatility in money markets and political instability undermined foreign confidence in the lira. The market had its worse monthly performance for 1994 in February. A lack of public confidence in the economic outlook dampened market sentiment dramatically and resulted in massive selling. This bad performance caused a big jump in market volatility. The value of MRK in February 1994 is 0.021, about one and half times as high as the previous highest value, which was April of 1993.

MRK has its second highest jump in September of 1998. Domestic political uncertainty mixed economic signals, and declines in emerging markets worldwide weighted heavily on Turkish equities in 1998. ISE Composite Index lost 24.7%. The Russian equity free-fall, particularly, had a severe negative impact on the Turkish market in August. Many portfolio managers carry Turkish and Russian equities in the same basket of stocks and the Russian turmoil prompted foreign investors to shift funds to developed markets.

Next consider the behavior of volatility IND in Panel B. Industry-level volatility shows the exact same pattern with the market volatility; compared to MRK, IND was particularly high at the beginning of 1993, 1994 and at the end of 1998. This implies that the effects of events in those years are significant for industry-specific volatility, although not as much as for market-level volatility.

Lastly, Panel C plots firm-level volatility. The important characteristic of FIRM is that it is on average much lower than MRK and IND. When we look at all the three volatility plots together, it is clear that three different volatility measures tend to move together. However, there are some periods on which they move differently.

The plots of the series suggest that the three volatility series move together. The autocorrelation coefficients, not reported in here, exhibit high amount of serial correlation. To check the possibility of unit root, we employed augmented Dickey and Fuller (ADF) test.[6] Table 2 reports the unit root tests for quarterly series constructed from daily data. The hypothesis of a unit root is not rejected at the 5% level, whether a deterministic time trend is allowed or not. We repeat the unit root test for the first differences of the series. The hypothesis of a unit root is rejected in this case. Given these results, the analysis is conducted in first differences rather than in levels.

Table 2
Unit Root Test

	MRK	IND	FIRM
Constant			
ADF test statistic	-1.749	-2.006	-1.905
Lag order	2	7	7
Constant and trend			
ADF test statistic	-1.980	-1.520	-1.661
Lag order	7	7	7

Note: Critical values at the 5% level are –2.99 when a constant is included in the regression and –3.621 when a constant and a linear trend are included (MacKinnon, 1991). Lag lengths are chosen based on the likelihood ratio, the Akaike information criteria (AIC), and Schwarz information criteria (SIC).

Table 3 reports some descriptive statistics on the three volatility components. As mentioned earlier, MRK is on average larger than IND and Firm. Unconditional standard deviations of the market-level volatility and industry-level volatility imply that these two components are more variable than firm-level volatility.

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[6] One criticism of unit root testing is that a stationary series subject to a structural break can look like a nonstationary series. If the structural break (or breaks) is not taken into account the unit root test leads to false nonrejection of the null of nonstationarity. Therefore, too often series are concluded to be nonstationary. Since Turkish economy witnessed one of the important financial crises in its history in 1994, there might be a structural break in that year. To check the effect of possible structural break due to the financial crisis on unit root tests we followed an approach suggested by Perron (1989). In this approach, a single breakpoint is assumed, which is incorporated into the regression model. We used three tests (with trend and without trend) suggested by Perron (1989) to determine the order of integration of the variables. Our results suggest the presence of unit roots in all variables used in the analysis.

Table 3
Descriptive Statistics

	MRK	IND	FIRM
Mean * 100	0.155	0.113	0.034
Median * 100	0.111	0.105	0.029
Maximum * 100	0.415	0.282	0.091
Minimum * 100	0.040	0.041	0.009
Std. Deviation * 100	0.103	0.057	0.022
Skewness	1.040	1.375	1.064
Kurtosis	3.198	4.707	3.392

Note: The table reports the mean and standard deviation of the three volatility components.

The contemporaneous correlation structure of the data is also examined and reported in Table 4. High contemporaneous correlation among the series confirms the visual evidence of the plot that the three volatility measures tend to move together.

Table 4
Correlation Structure

	MRK	IND	FIRM
Contemporaneous Correlation	1.000	0.849	0.927
		1.000	0.963
			1.000

The importance of the volatility components in total volatility of an average firm is reported in Table 5. Market volatility accounts for the largest portion of unconditional mean of the total volatility with 51% while industry-volatility and firm-level volatility together account for 49%. The variance decomposition shows that variation in MRK and the covariation of MRK and IND are the two largest components of the time-series variation of total volatility.

Table 5
Mean and Variance Decomposition

		MRK	IND	FIRM
Mean		0.510	0.374	0.114
	MRK	0.341	0.311	0.132
Variance	IND		0.105	0.076
	FIRM			0.015

Note: Entries are the shares in the total mean and variance of a typical stock. The mean and variance are computed from following equations:

$$1 = E(MRK_t)/E\sigma_{rt}^2 + E(IND_t)/E\sigma_{rt}^2 + E(FIRM_t)/E\sigma_{rt}^2$$

$$\begin{aligned}1 = &\operatorname{var}(MRK_t)/\operatorname{var}(\sigma_{rt}^2) + \operatorname{var}(IND_t)/\operatorname{var}(\sigma_{rt}^2) + \operatorname{var}(FIRM_t)/\operatorname{var}(\sigma_{rt}^2)\\ &+ 2\operatorname{cov}(MRK_t, IND_t)/\operatorname{var}(\sigma_{rt}^2) + 2\operatorname{cov}(MRK_t, FIRM_t)/\operatorname{var}(\sigma_{rt}^2)\\ &+ 2\operatorname{cov}(IND_t, FIRM_t)/\operatorname{var}(\sigma_{rt}^2).\end{aligned}$$

Table 6 and Table 7 investigate the forecasting power of the volatility series using Granger-Causality test for bivariate VARs and trivariate VAR models. Lag lengths of the VAR models are selected based on Akaike information criteria (AIC) and are shown in the brackets. The results of Granger-Causality tests show that in both bivarite and trivariate VAR system, volatility series do not help to forecast each other.

Table 6
Granger-Causality Bivariate VAR

	MRK_t	IND_t	$FIRM_t$
MRK_{t-l}	–	0.351 (6)	0.108 (6)
IND_{t-l}	0.130 (6)	–	0.424 (5)
$FIRM_{t-l}$	0.120 (6)	0.571 (5)	–

Table 7
Granger-Causality Trivariate VAR

	MRK_t	IND_t	$FIRM_t$
MRK_{t-l}	–	0.278	0.117
IND_{t-l}	0.530	–	0.290
$FIRM_{t-l}$	0.494	0.346	–
	(6)	(6)	(6)

Cyclical Behavior of Volatility Measures

We analyze the relationship between our quarterly volatility series and GDP growth first. Table 8 presents cross-correlation coefficients for our three quarterly volatility measures and the change of real GDP up to a lead and lag of one year. Negative correlation implies that volatility tends to be higher in economic downturns. All three volatility series are negatively or positively correlated with GDP growth. In other words, MRK, IND and FIRM exhibit anticyclical behavior with respect to real GDP prospects. This finding contradicts the finding of studies for the developed stock market.[7]

[7] See (Campbell et al. 2001).

Table 8
Correlation Coefficients of GDP with MRK, IND and FIRM Volatility

Quarters	MRK	IND	***FIRM***
-4	**-0.269**	-0.314	**-0.308**
-3	-0.156	-0.263	-0.270
-2	0.201	0.190	0.186
-1	0.118	0.306	0.287
0	-0.131	-0.223	-0.177
1	0.180	-0.268	-0.270
2	0.210	0.224	0.183
3	0.146	0.319	0.307
4	-0.161	**-0.352**	-0.255

Note: The first difference of each volatility series is taken. The bold figures denote the largest values (in absolute value) for each column.

Next, consider the forecasting power of market, industry and firm-level volatility. Table 9 presents the results of various OLS regressions with GDP growth as a dependent variable. The lagged GDP growth and the lagged volatility series are used as regressors. The first differences of each volatility series are included in the regression. All t-statistics and their p-values are Newey-West corrected with optimal lag length chosen according to (Newey and West 1994). Regressing GDP growth on its own lag, lagged ISE National 100 value-weighted index return and each of the lagged volatility measures provide individually insignificant coefficients. The results of these regressions are reported in the first part of the table. Next, we include pairs of volatility variables as regressors. Market-level volatility has insignificant coefficient while industry-level volatility has significant coefficient in the first regression. In the second regression, both market and firm-level volatility are individually and jointly significant. This regression has the highest R^2 value. The last regression provides insignificant coefficients for industry and firm-level volatility. The bottom of the table reports the regression results when all three volatility variables are included. Market and firm level volatility are individually significant. The p-value for F-test that all coefficients of the volatility variables are zero is 0.047. In other words, volatility measures are jointly significant. The results of various OLS regression show that market and the firm level volatility may have forecasting power of GDP growth.

Table 9
GDP Growth and Forecasting Power of MRK, IND and FIRM

GDP_{t-1}	$INDEX_{t-1}$	MRK_{t-1}	IND_{t-1}	$FIRM_{t-1}$	R^2 (p-value)
-0.207	0.007	0.057			0.093
(0.294)	(0.221)	(0.607)			
-0.159	0.006		0.274		0.140
(0.413)	(0.268)		(0.182)		
-0.172	0.006			0.684	0.144
(0.374)	(0.244)			(0.194)	
-0.128	0.004	-0.270	0.710		0.202
(0.505)	(0.408)	(0.208)	(0.081)		(0.244)
-0.114	0.003	-0.751		4.135	0.321
(0.518)	(0.522)	(0.019)		(0.009)	(0.031)
-0.161	0.006		0.222	0.138	0.147
(0.421)	(0.278)		(0.760)	(0.941)	(0.491)
-0.139	0.003	-0.957	-0.815	7.024	0.354
(0.433)	(0.504)	(0.012)	(0.287)	(0.029)	(0.047)

Note: The table reports results of various OLS regressions with GDP growth as the dependent variable. All regressors are lagged by one quarter. INDEX denotes the excess return of the ISE value-weighted portfolio. We have created this index from the National 100 price index of ISE. The p-values are reported in the parenthesis. The p-values in the last column are for an F-test of joint significance of the volatility measures. All p-values in parenthesis are computed using Newey-West standard errors. The volatility is quarterly constructed from daily returns and differenced once.

We next do the similar analysis with macroeconomic variables. Table 10 presents the cross-correlation coefficients between market-level volatility and monthly percentage change in the index of industrial production, monthly percentage change in consumer price index and the spot exchange rate of the Turkish Lira/U.S. Dollar exchange rate. The results indicate that market-level volatility seems to have negative correlation with most of the leads and lags of industrial production growth. This result implies that market volatility is affected by the business cycle. Even though this is the case, we cannot conclude that market volatility exhibits cyclical behavior because some of the correlation coefficients are not negative. The correlation coefficients between market volatility and inflation rate do not show any pattern while we observe positive correlation between market-level volatility and the spot exchange rate.

Table 10
Correlation Coefficients of Macroeconomic Series with MRK

Months	Industrial Production	Inflation Rate	Exchange Rate
-12	-0.137	0.265	0.103
-6	0.152	-0.077	0.138
-3	-0.072	0.183	0.162
-1	-0.058	0.066	0.143
0	-0.158	0.144	0.097
1	-0.089	-0.009	0.110
3	-0.155	-0.005	0.110
6	0.091	-0.052	0.111
12	-0.124	0.003	0.092

Note: The Volatility series is detrended

Table 11 and Table 12 report the cross-correlation coefficient between these macroeconomic series and industry-level and firm-level volatility, respectively. Industry-level volatility seems to have positive correlation with all the leads and lags of inflation rate and with the most of the leads and lags of exchange rate. The correlations between the industry-level volatility and industrial production are negative in most of the cases but again we do not observe any pattern to conclude that industry-level volatility exhibits cyclical behavior. The findings for firm-level volatility are very similar to findings of market-level volatility. Therefore, one can interpret the results of Table 12 in a similar fashion.

Table 11
Correlation Coefficients of Macroeconomic Series with IND

Months	Industrial Production	Inflation Rate	Exchange Rate
-12	-0.121	0.403	-0.006
-6	0.025	0.046	0.068
-3	-0.036	0.050	0.090
-1	-0.018	0.038	0.142
0	-0.071	0.111	0.096
1	-0.113	0.027	0.097
3	-0.249	0.022	0.088
6	0.035	0.013	0.078
12	-0.089	0.003	0.038

Table 12
Correlation Coefficients of Macroeconomic Series with FIRM

Months	Industrial Production	Inflation Rate	Exchange Rate
-12	-0.132	0.361	0.011
-6	0.114	-0.012	0.090
-3	-0.032	0.026	0.141
-1	-0.040	0.063	0.166
0	-0.105	0.140	0.126
1	-0.095	0.033	0.134
3	-0.210	-0.067	0.129
6	0.082	-0.019	0.124
12	-0.102	0.011	0.101

We now ask whether our monthly volatility series have any power to forecast industrial production. In table 13 we present the results of OLS regressions with industrial production growth as a dependent variable. As regressors we use lagged industrial production, lagged return on the ISE National 100 value-weighted index and lagged volatility series. All t-statistics are Newey-West corrected with the optimal lag length chosen according to (Newey and West 1994). The volatility series are detrended. We regress industrial production growth on its own lag, lagged of ISE index return and each of the lagged volatility measures in turn. In all of these regressions, lagged industrial production growth and lagged ISE index return have significant coefficients while each of the volatility measures has insignificant coefficients.

Table 13
Growth of Industrial Production and Forecasting Power of MRK, IND, FIRM

PRD_{t-1}	$INDEX_{t-1}$	MRK_{t-1}	IND_{t-1}	$FIRM_{t-1}$	R^2 (p-value)
-0.191	-0.010	-0.325			0.118
(0.059)	(0.004)	(0.149)			
-0.171	-0.009		-0.208		0.101
(0.090)	(0.008)		(0.556)		
-0.177	0.010			-0.926	0.107
(0.079)	(0.006)			(0.335)	
-0.210	-0.011	-0.779	0.828		0.133
(0.040)	(0.003)	(0.072)	(0.217)		(0.006)
-0.211	-0.011	1.097		3.472	0.132
(0.039)	(0.003)	(0.108)		(0.230)	(0.007)
-0.184	-0.010		0.858	-3.113	0.114
(0.069)	(0.005)		(0.385)	(0.248)	(0.018)
-0.213	-0.011	-1.012	0.511	1.830	0.135
(0.038)	(0.002)	(0.151)	(0.613)	(0.673)	(0.018)

Next, we include pairs of volatility variables as regressors. Again, in all of these regressions the lagged industrial production and the lagged ISE index return yields individually significant coefficients. Only the coefficient of market level volatility is significant when MRK and IND are included in the regression. While all other volatility series are individually insignificant, they are strongly jointly significant. The results are similar when all three volatility variables are included. None of them is individually significant but the joint significance level is 1 %. These results suggest that there is no conclusive evidence as to which of the three volatility measures has the most forecasting power.

5. Conclusion

This study investigates the main volatility components of a typical stock in the Turkish stock market over the 1992-1999 period, using the (Campbell et al. 2001) approach. There are two important characteristic features of the approach we have taken. First, we have used daily data to construct realized monthly volatility and treat them as observable. Second, the total volatility of a typical firm has defined as the sum of three volatility components.

We also analyze the relationship between market, industry, and firm level volatility and macroeconomic variables. We choose four macroeconomic variables: GDP, industrial production, inflation rate and exchange rate.

We plot the volatility series first. The results indicate that the market level volatility is on average higher than firm level and industry level volatility, suggesting that market-specific volatility is the largest component of the total volatility of an average firm. Industry-level volatility shows the exact same pattern with the market volatility. All three volatility plots appeared to capture important political and economic events in Turkey.

The correlation between three volatility series and leads and lags of macroeconomic variables is also analyzed. The results indicate that market and firm level volatility have positive correlation with leads and lags of exchange rate while industry level volatility has positive correlation with inflation rate. The results also suggest that all the components of volatility do not exhibit counter-cyclical behavior with respect to GDP growth and industrial production.

We run various OLS regressions to see whether the volatility series have any forecasting power of GDP growth and industrial production. The results of these regressions reveal that market and firm level volatility have forecasting power for GDP growth while volatility measures have forecasting power jointly for industrial production.

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