# Reward-to-Risk Ratios in Turkish Financial Markets

Yigit Atilgan[a] and K. Ozgur Demirtas [b]

## ABSTRACT

This paper investigates how reward-to-risk ratios compare among various government debt security (GDS) indices and sector indices in the Istanbul Stock Exchange. Risk is measured by either standard deviation or nonparametric and parametric value at risk. We find that the GDS indices have higher reward-to-risk ratios compared to the sector indices. GDS indices with longer maturities have lower reward-to-risk ratios and this reduction is especially pronounced when the ratios take downside risk into account. The reward-to-risk rankings for the sector indices are similar for each measure and the results are robust to currency conversion.

JEL Codes: G10, G11, G12.

[a] Yigit Atilgan is an Assistant Professor of Finance at the School of Management, Sabanci University. Orhanli, Tuzla 34956, Istanbul, Turkey. Phone: +90 (216) 483-9663, Email: yatilgan@sabanciuniv.edu.
[b] K. Ozgur Demirtas is a Professor of Finance at the School of Management, Sabanci University. Orhanli, Tuzla 34956, Istanbul, Turkey. Phone: +90 (216) 483-9985, Email: ozgurdemirtas@sabanciuniv.edu.

## 1. INTRODUCTION

In today's financial markets, investors have access to many different instruments such as bonds, stocks and indices composed of such instruments. The risk and return characteristics of these instruments are important to study since investors allocate their wealth to asset portfolios based on the interactions between risk and return of such financial securities. It is common knowledge that stock indices have higher expected returns compared to those of bond indices due to the fact that stocks are riskier and in equilibrium, investors demand higher returns for undertaking more risk. However, whether stock indices have higher expected returns per unit risk compared to bond indices is an open question. In this paper, we investigate how various reward-to-risk ratios for different government debt security (GDS) and stock sector indices compare to each other.

When we calculate reward-to-risk, we give special emphasis to the concept of downside risk. There are several reasons why downside risk should be important in comparing the relative performances of various indices. First, Roy (1952) introduces the idea of safety-first investors who seek to minimize their losses in case of a disaster and Levy and Sarnat (1972) and Arzac and Bawa (1977) relate this safety-first principle to the expected utility framework. Investors who aim to maximize their expected return subject to a maximum loss constraint will reflect downside risk to their asset valuations. Second, the empirical regularities that stock returns are typically skewed and leptokurtic contradict the assumptions of the mean-variance framework of Markowitz (1952). The theoretical models of Rubinstein (1973) and Kraus and Litzenberger (1976) incorporate the effect of

unconditional co-skewness in asset pricing. More recently, behavioral theories offered by studies such as Brunnermeir and Parker (2005) and Barberis and Huang (2008) underline the importance of idiosyncratic skewness. These studies collectively suggest that investors prefer positively skewed investments to negatively skewed investments. Additionally, Dittmar (2002) draws on the theoretical works of Pratt and Zeckhauser (1987) and Kimball (1993) and suggests that investors have a preference for less leptokurtic investments. Finally, Bali, Demirtas, and Levy (2009a) show that downside risk is significantly priced in the U.S. financial markets. Asset distributions with more negative skewness and thicker tails have higher downside risk and it is crucial to adjust for this particular dimension of risk in index performance comparisons. Finally, many players in the financial markets need to take downside risk into account in their investment decisions. For example, regulatory bodies conduct capital adequacy tests on banks based on various crash scenarios. Due to all these considerations, downside risk is expected to have potential asset pricing consequences.

The first measure of reward-to-risk that we employ is the Sharpe (1966) ratio which is equal to the ratio of the mean excess return of an index to its standard deviation. Although it is the most commonly used reward-to-risk ratio, Sharpe ratio is too broad since it incorporates the total risk of a portfolio to its denominator. Therefore, to investigate how much return each index generates per unit of downside risk, we use both a nonparametric and parametric measure of value at risk in the construction of our alternative reward-to-risk ratios. For the nonparametric VarSharpe measure, the denominator of the ratio is the absolute value of the minimum index return over a specific

past sample window. For the parametric reward-to-downside risk measure (PVarSharpe), the denominator is based on the lower tail of Hansen's (1994) skewed *t*-density.

In our empirical analysis, we compute three distinct reward-to-risk ratios for 5 GDS indices[3] and 25 sector indices. The results for the GDS indices show that the reward-to-risk ratios decrease monotonically as the time to maturity of the four maturity-specific bond indices increases. This decrease is sharper for VarSharpe and PVarSharpe. The fifth GDS index is a market value-weighted composite index and the reward-to-risk ratios for this index are lower than those of the other four GDS indices. This finding indicates that the lower values of the higher order moments of this composite index cannot compensate for its low mean return. A key result of our paper is that all GDS indices outperform all the sector indices in terms of reward-to-risk ratios. Although the distributions of GDS indices are more skewed and leptokurtic compared to those of the sector indices, the substantially larger standard deviations of the sector indices drive this result. The implication of this result for risk-averse investors is that, in Turkey, debt markets generated higher returns per unit risk compared to equity markets for the sample period studied in this paper. We also find that the best and worst performing sectors are similar across all reward-to-risk ratios and these rankings are mostly driven by the mean returns. Finally, we repeat the sector index analysis by also looking at index levels denominated in US dollars and find that although the additional fluctuations in exchange rates have an upward effect on the standard deviations of index returns, the rankings stay similar.

[1] GDS indices are important instruments both because of the large volume of trades seen in fixed income markets and also due to the fact that they reflect monetary policy. In return, there are many studies which show that monetary policy successfully predicts the direction of the financial markets (see, for example, Tas (2011)).

The paper is organized as follows. Section 2 discusses the methodology for calculating the reward-to-risk ratios. Section 3 explains the data and presents the summary statistics. Section 4 discusses the empirical results. Section 5 concludes.

## 2. METHODOLOGY

As mentioned earlier, we estimate three distinct reward-to-risk ratios. One of these ratios is the standard Sharpe ratio:

$$Sharpe_{i,t} = \frac{R_{i,t} - R_f}{StDev_{i,t}} \tag{1}$$

where $R_{i,t}$ denotes the day $t$ return on the bond or stock index $i$ and $R_f$ is the risk-free rate approximated by the average return of the repo index. The standard deviation for index $i$ is computed using squares of daily returns. For each day $t$ and index $i$, past 100 days is used to compute the standard deviation. Specifically,

$$StDev_{i,t} = \sqrt{\frac{1}{99}\sum_{j=0}^{99}\left(R_{i,t-j} - \overline{R}i\right)^2} \tag{2}$$

As a robustness check, we computed the second moment using various other return windows as well as using first order covariance correction. We do not report these results to save space; however, we find that the results are robust to these choices.

In order to take into account the downside risk, we first use a nonparametric measure of value at risk (VaR) which measures how much the value of a portfolio could decline in a

fairly extreme outcome if one were to rank order possible outcomes from best to worst. In other words, VaR attempts to answer the question of how much an investor can expect to lose on a portfolio in a given time period at a given level of probability. In our analysis, we use the minimum index returns observed during past 100 days of daily data and estimate alternative VaR measures from the lower tail of the empirical return distribution. We should note that the original VaR measures are multiplied by -1 before they are included in the calculations so that higher magnitudes of the measures correspond to greater downside risk.

After we construct nonparametric VaR measures in a rolling window fashion, Sharpe ratios that incorporate these nonparametric VaR estimates are computed. Specifically, VarSharpe is defined as:

$$VarSharpe_{i,t} = \frac{R_{i,t} - R_f}{VaR_{i,t}} \tag{3}$$

where $VaR_{i,t}$ is the nonparametric value at risk.

Next, in order to focus on the parametric measure of value at risk, we utilize the skewed *t*-density, which accounts for skewness and excess kurtosis in the data. Hansen (1994) introduces a generalization of the Student *t*-distribution where asymmetries may occur, while maintaining the assumption of a zero mean and unit variance. This skewed *t* (ST) density is given by:

$$f(z_t;\mu,\sigma,v,\lambda)=\begin{cases} bc\left(1+\frac{1}{v-2}\left(\frac{bz_t+a}{1-\lambda}\right)^2\right)^{-\frac{v+1}{2}} & \text{if } z_t<-a/b \\ bc\left(1+\frac{1}{v-2}\left(\frac{bz_t+a}{1+\lambda}\right)^2\right)^{-\frac{v+1}{2}} & \text{if } z_t\geq -a/b \end{cases} \tag{4}$$

where $z_t=\frac{R_t-\mu}{\sigma}$ is the standardized excess market return, and the constants $a$, $b$, and $c$ are given by

$$a=4\lambda c\left(\frac{v-2}{v-1}\right)\; b^2=1+3\lambda^2-a^2,\; c=\frac{\Gamma\left(\frac{v+1}{2}\right)}{\sqrt{\pi(v-2)}\Gamma\left(\frac{v}{2}\right)} \tag{5}$$

Hansen (1994) shows that this density is defined for $2 < v < \infty$ and $-1< \lambda < 1$. This density has a single mode at $-a/b$, which is of opposite sign with the parameter $\lambda$. Thus, if $\lambda > 0$, the mode of the density is to the left of zero and the variable is skewed to the right, and vice versa when $\lambda < 0$. Furthermore, if $\lambda = 0$, Hansen's distribution reduces to the traditional standardized t distribution. If $\lambda = 0$ and $v = \infty$, it reduces to a normal density.[4]

A parametric approach to calculating VaR is based on the lower tail of the ST distribution. Specifically, we estimate the parameters of the ST density (μ, σ, υ, λ) using the past 1 to 12 months of daily data and then find the corresponding percentile of the estimated distribution. Assuming that $R_t = f_{v,\lambda}(z)$ follows an ST density, parametric VaR is the solution to

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[2] The parameters of the ST density are estimated by maximizing the log-likelihood function of $R_t$ with respect to the parameters μ, σ, υ and λ:

$$\log L = n\ln b + n\ln\Gamma\left(\frac{v+1}{2}\right)-\frac{n}{2}\ln\pi - n\ln\Gamma(v-2)-n\ln\Gamma\left(\frac{v}{2}\right)-n\ln\sigma-\left(\frac{v+1}{2}\right)\sum_{t=1}^{n}\ln\left(1+\frac{d_t^2}{(v-2)}\right)$$

where $d_t = (bz_t+a)/(1-\lambda s)$ and s is a sign dummy taking the value of 1 if $bz_t+a<0$ and s = -1 otherwise.

$$\int_{-\infty}^{\Gamma_{ST}(\Phi)} f_{v,\lambda}(z)dz = \Phi \tag{6}$$

where $\Gamma_{ST}(\Phi)$ is the VaR threshold based on the ST density with a loss probability of $\Phi$. Equation (6) indicates that VaR can be calculated by integrating the area under the probability density function of the ST distribution. Specifically, to compute a quantile of a distribution, we utilize the Cornish-Fisher expansion which is a moment-based approximation motivated by the theory of estimating functions, saddle-point approximations, and Fourier-inversion. We should note that Bali, Demirtas, and Levy (2009b) use Cornish-Fisher expansion to examine the left hand tail of return distribution. The advantage of the Cornish-Fisher (1937) approximation is that it can be computed without any matrix decomposition. It is based on the cumulants, which are the power series coefficients of the cumulant generating function. According to the fourth-order Cornish-Fisher expansion, the lowest daily return can be specified as a nonlinear function of the mean, standard deviation, skewness, and kurtosis of the daily returns. Hence by using rolling estimates of the first four moments of index return distributions we construct parametric VaR (PVaR). Thus, Sharpe ratios that incorporate parametric VaR are defined as:

$$PVarSharpe_{i,t} = \frac{R_{i,t} - R_f}{PVaR_{i,t}} \tag{7}$$

## 3. DATA AND SUMMARY STATISTICS

Founded in 1986, the Istanbul Stock Exchange (ISE) is the only market in Turkey established to provide trading in stocks, bonds and bills, rights coupons, revenue-sharing

certificates and real estate certificates. ISE provides a liquid and transparent investment floor for investors through its order-driven, multiple-price, continuous auction market structure. The members of ISE, which are incorporated banks and brokerage houses, collect orders from investors electronically and transmit them to the computerized system in ISE that matches orders based on a price and time priority rule. Trades are executed in two trading sessions and both the morning and the afternoon sessions have an opening session based on a single price system. Settlement of securities traded in the ISE is realized by the ISE Settlement and Custody Bank Inc, a separate and independent institution founded by the ISE and its members. Since August 1989, the Turkish financial markets have been open to foreign investors and currently a big majority of the institutional investors in our ISE are foreigners.

The Bonds and Bills market is comprised of several submarkets. The Outright Purchases and Sales Market opened on June 1991 and is the platform where the secondary market transactions of fixed income securities are conducted. The Repo-Reverse Repo Market, where repo and reverse repo transactions are conducted opened on February 1993. Other submarkets include an offerings market for qualified investors, a repo market for specified securities and an interbank repo-reverse repo market. Government debt securities denominated in Turkish and foreign currency start to be traded on the Bonds and Bills Market on the day they are issued. Trading is conducted electronically via an automated multiple price-continuous auction system. Settlement and custody operations are again realized by the ISE Settlement and Custody Inc.

The daily return data for the GDS indices and the sector indices are obtained from the ISE. The sample covers all available observations between January 2001 and December 2011. ISE provides historical data on both price- and performance-based GDS indices. The price indices only measure the change in price driven by the fluctuations in interest rates whereas the performance indices also take the reduction in the number of days to maturity into account. As such, the performance indices reflect the actual return that investors earn and we focus on these performance indices in subsequent analysis. GDS performance indices are calculated for debt securities with 6-month (182 days), 9-month (273 days), 12-month (365 days) and 15-month (456 days) maturities. ISE calculates the rates of return from the weighted average prices of discounted bills and bonds published at the end of each trading day and converts these returns into a maturity-yield curve through regression analysis. The 182, 273, 365 and 456-day yields are selected from this curve. We also look at a market value-weighted composite index (MVCOMP) which is calculated from the prices of discounted bills and bonds traded on the market. Finally, we use the repo index (REPO) to calculate the risk-free rate to be used in subsequent analysis since repo transactions involve government securities that act as collateral. This index is calculated using the weighted average daily return (net of withholding) on repo transactions to be resolved at the same day on the normal orders market and as such it reflects the net return that an investor who continually engages in 1-day repo transactions will earn.

We also obtain data on 25 different sector indices from ISE. There are two types of sector indices available in the database, namely, the price index and the return index. The difference between these indices is related to cash dividends. The divisor of the return index is adjusted assuming that the dividends are invested in the stocks included in the index whereas the price index excludes the cash dividends. We focus on the return indices since they reflect the actual return of an investor who holds the index portfolio. All of the sector indices are weighted by market value where market value is calculated by multiplying the total number of shares outstanding by the stock price. The sector indices exclude stocks that are traded on the watchlist market and stocks included in ISE list C since such stocks have restrictions regarding buying on margin and short-selling. Moreover, these stocks are not traded continuously but instead are subject to a single-price system. A new sector index is only calculated after the number of companies included in the scope of the index reaches five and the calculation of the index is halted if the number of companies falls to two. All sector indices are adjusted for cash dividends, capital increases in cash through or without right offerings, inclusion and exclusion of new stocks in the indices, spin-offs and mergers. ISE also calculates the end-of-session closing values of all sector indices in different currencies for international comparison purposes, thus we are able to analyze sector index returns both in terms of Turkish lira and US dollars.

The descriptive statistics for GDS indices are presented in Table 1. The means for the maturity-specific daily returns are close to each other and vary between 10 and 12 basis points. The market value-weighted composite performance index has a lower daily

average return of 6 basis points. The mean for the repo index is 4.48 basis points and this value is used as the risk-free rate in the calculation of the reward-to-risk ratios. When we focus on the standard deviations, it is evident that they increase monotonically as the time to maturity of the underlying index gets longer. The standard deviation is 44 basis points for the 182-day bill and increases to 183 basis points for the 456-day bill. These standard deviation figures are large compared to their respective means. Investigating the extreme returns shows that the daily fluctuations in the values of GDS indices can get very large. For example, there has been a trading day during which the 182-day bill has dropped by 11.08% in value and the minimum statistic is even more extreme for the 456-day bill which lost almost half of its value in a given day. The same pattern also holds for the maximum statistics. The 182-day and 456-day bills have experienced daily increases of 13.95% and 61.19% in their values, respectively. The extreme movements are more pronounced for longer term bills and this finding is consistent with the positive relation between interest rate sensitivity and time to maturity. MVCOMP is less vulnerable to extreme daily shocks with a minimum (maximum) daily return of -1.35% (1.03%). The median statistics for the maturity-specific indices are around 6 basis points and are uniformly lower than the medians for all indices. This is also evidenced by the positive skewness statistics between 3.93 and 7.87. Except the market value-weighted composite index, the right tails of the distributions of the GDS index returns are longer than the left tails. Finally, the kurtosis statistics are very high and vary between 551.01 and 809.36 for the maturity-specific GDS indices. Consistent with the lower significance of extreme events for the composite index, the kurtosis statistic is much lower and equal to 18.73 for MVCOMP.

The descriptive statistics for the returns of sector indices denominated in Turkish liras is presented in Table 2. In terms of means, the five sectors with the highest returns are banking, insurance, financials, basic metal and food and beverage. The average returns are between 16 and 18 basis points for these sectors. The lowest mean returns belong to the information technology, real estate, technology, electricity and telecommunication sectors. For these sectors, the mean returns vary between 3 and 8 basis points. Comparing these results to those in Table 1, we see that there are some sectors that bring a higher average return than the maturity-specific GDS indices but there are also many sectors that perform worse than the GDS indices on average. The standard deviations vary from 2.13% for the sports sector to 3.54% for the defense sector. These figures are very large compared to their respective means with a minimum standard deviation to mean ratio of 15 for the nonmetal mineral products sector and a maximum ratio of 80 for the information technology sector. The daily standard deviations of the sector indices are also much higher compared to the standard deviations of the GDS indices in Table 1. Focusing on the extreme returns, one sees that although there are large daily fluctuations for every sector, these fluctuations do not get as extreme as those for the GDS indices. The lowest minimum return is observed for the defense sector (-21.88%) and the highest minimum return is observed for the insurance sector (-8.26%). The maximum returns vary from 14.04% for the new economy sector to 21.95% for the tourism sector. In line with the result that the minimum and maximum statistics are less extreme than those for the GDS indices in absolute value, the kurtosis statistics for the sector indices are not in the magnitude of those for the GDS indices. The lowest kurtosis belongs to the banking

sector (6.97) whereas the highest kurtosis belongs to the sports sector (14.90). For all sector indices, except real estate, industrials, technology and textiles and leather, we see that the medians are slightly lower than the means and the skewness statistics associated with all sector indices are lower than those for the GDS indices. We see that the highest skewness statistic belongs to the defense sector (0.66) and skewness becomes negative for only two sectors, namely new economy (-0.45) and textiles and leather (-0.37).

Table 3 presents the descriptive statistics for the returns of sector indices denominated in US dollars. The findings are mostly similar to those in Table 2, but there are a few points worth mentioning. First, the mean returns for every sector, except new economy, are smaller than those for the indices denominated in Turkish liras. The ranking of the means shows that, although there are some exceptions, there are no dramatic changes in relative index performances due to currency conversion. For example, the banking, insurance and financials sectors that performed well based on indices denominated in Turkish liras continue to perform well based on indices denominated in US dollars. Similarly, the information technology, electricity, real estate and technology sectors which were in the bottom five based on indices denominated in Turkish liras continue to be in the bottom five. The information technology sector still has the lowest mean return with a 1 basis point daily average whereas the defense, insurance and banking sectors have the highest mean returns with a 12 basis points daily average. The standard deviation of the sports (defense) sector is still the lowest (highest) and equal to 2.49% (4.03%). All the standard deviations in this table are greater than those in Table 2 reflecting the fact that fluctuations in exchange rates add another dimension of volatility to the index returns.

This extra volatility also makes the minimum and maximum daily returns more extreme. For example, there was a trading day during which the leasing and factoring sector index lost 31.05% of its value and another trading day during which the tourism sector index increased by 37.71% in value. Unlike the results in Table 2, the median return is higher than the mean return for 14 of the 25 indices and as a result, although the distributional asymmetries do not get more dramatic, the daily return distribution for 9 out of 25 sector indices becomes negatively skewed when the indices are denominated in US dollars. The highest skewness belongs to the tourism sector (0.55) whereas the lowest skewness belongs to the new economy sector (-0.41). The kurtosis statistics are comparable to those in Table 2 varying between 7.54 for the chemical and petroleum sector and 13.01 for the sports sector.

## 4. EMPIRICAL RESULTS

In this section, we investigate how three reward-to-risk ratios, namely the Sharpe ratio, nonparametric value at risk based Sharpe ratio (VarSharpe) and parametric value at risk based Sharpe ratio (PVarSharpe), compare among various GDS and sector indices.

### 4.1 Government Debt Security Indices

The results for the GDS indices are presented in Table 4. The table presents the medians and standard deviations for each reward-to-risk ratio. We see that the Sharpe ratio and its standard deviation decrease as the maturity of the indices increases. For example, the Sharpe ratio for the 182-day index is equal to 0.4252 whereas this value drops to 0.2845 for the 456-day index. This decrease in the Sharpe ratio for longer maturities is not

surprising since Table 1 reveals that the average returns for each maturity-specific index are close to each other, however, the standard deviations increase monotonically as the time to maturity of the underlying index gets longer. The Sharpe ratio for MVCOMP is lower than all the maturity-specific indices. In Table 1, it was found that this composite index had both a lower mean and standard deviation compared to the maturity-specific GDS indices and now it becomes evident that the lower standard deviation does not compensate for the lower mean as far as generating a higher return per unit of risk is concerned.

For VarSharpe, we again see that there is a monotonic downward trend as index maturity increases. The VarSharpe for the 182-day index is equal to 0.4234 whereas this value drops to 0.0975 for the 456-day index. It is worth to mention that the decline in VarSharpe is much sharper than the decline in Sharpe. We see that the Sharpe ratio falls only 40% from 0.4252 to 0.2845 as the maturity increases from 182 to 456 days, but the corresponding fall for VarSharpe is more than fourfold from 0.4234 to 0.0975. We attribute this dramatic decrease to the pronounced skewness and kurtosis statistics especially for longer maturity GDS indices and the fact that these higher order moments come into play in the calculation of VarSharpe.

Very similar to the findings for VarSharpe, we again find a dramatic decrease in PVarSharpe as the maturity of the GDS indices increase. The PVarSharpe ratios for the 182-day index and the 456-day index are 0.5198 and 0.1256, respectively, again more

than a fourfold decrease. The results for all reward-to-risk ratios show that the risk-adjusted performances of the shorter term bills are higher than the longer term bills and this is especially true when downside risk is taken into account.

One final point worth to mention is that the market value-weighted composite index, MVCOMP, has lower VarSharpe and PVarSharpe values compared to the maturity-specific GDS indices. The median for VarSharpe (PVarSharpe) is 0.0639 (0.0793) for MVCOMP. In Table 1, we had found that the skewness and kurtosis values associated with MVCOMP were lower than the other GDS indices. The downside risk adjusted performance ratios in Table 4 reveal that the lower asymmetry and leptokurtosis for the composite index are not enough to compensate for its lower mean. In other words, the reward for a lower kurtosis and skewness is not enough to justify the lower average returns.

**4.2 Sector Indices**

The medians and standard deviations of the reward-to-risk ratios for the sector indices denominated in Turkish liras are presented in Table 5. The first finding is that all of the ratios for all sectors are lower than those for the GDS indices. The highest median Sharpe, VarSharpe and PVarSharpe ratios belong to the sports sector and are equal to 0.0660, 0.0229 and 0.0281, respectively. These values are all lower than the corresponding values for all maturity-specific indices and MVCOMP. This result suggests that the risk-adjusted performances of the GDS indices are higher than those of

the sector indices across the board. In Table 2, we had found that the mean returns for some of the sector indices are higher than those of the GDS indices whereas some are lower. Another finding was that the skewness and kurtosis statistics were much lower for the sector indices. Therefore, the lower reward-to-risk ratios for the sector indices can be attributed to the fact that the sector index returns have much higher standard deviations than the GDS indices and standard deviation has an impact on all the reward-to-risk ratios. The low skewness and kurtosis values do not make up for the high standard deviations.

Next, we investigate how different sectors compare to each other in terms of risk-adjusted performance. Focusing on the Sharpe ratios, we find that the sectors with the highest Sharpe ratios are sports, industrials, nonmetal mineral products, basic metals and chemical and petroleum. The Sharpe ratios vary from 0.0486 to 0.0660 for these sectors. The economic meaning for these numbers can be illustrated by stating that the sector with the highest Sharpe ratio, sports, generates 6.6 basis points of excess returns per 1% of standard deviation. The lowest Sharpe ratios belong to the information technology, technology, electricity, real estate and telecommunications sectors with values that vary from -0.0068 to 0.0137. Referring back to Table 2, we see that most of the sectors that have the highest Sharpe ratios are among the sectors that rank among the top five according to either the mean or median returns. One notable exception is the sports sector which ranks 19$^{th}$ according to its mean return, however, we had also noted that this is the sector with the lowest standard deviation of returns and this low variability makes sports the sector with the highest Sharpe ratio. When we focus on the sectors with the lowest

Sharpe ratios, we again find that all of these five sectors rank at the bottom according to either the mean or the median returns in Table 2. Given that the standard deviations of returns are close to each other for all sector indices, it is not surprising that the mean and median return rankings in Table 2 are the driving factor behind the Sharpe ratio rankings in Table 5.

We also compare the VarSharpe and PVarSharpe ratios of various sectors. The sectors with the highest VarSharpe ratios are sports, nonmetal mineral products, chemical and petroleum, industrials and banking. VarSharpe ratios are between 0.0163 and 0.0229 for these sectors. In other words, the sports sector generates 2.29 basis points of excess returns for every additional 1% loss during the past 100 days. The sectors with the lowest median VarSharpe ratios are information technology, technology, electricity, real estate and telecommunications with values that vary from -0.0020 and 0.0049. Except banking, four of the five best performing sectors are also among the best performers in terms of Sharpe ratios. Similarly, the five worst performing sectors according to VarSharpe are also the five sectors that have the lowest Sharpe ratios. In other words, Sharpe ratio and VarSharpe ratio comparisons yield very similar pictures in terms of the best and worst performing sector indices. This result is not surprising given that the skewness and kurtosis statistics reported in Table 2 are not extreme and also close to each other for all sector indices. Given the lack of a large dispersion in these higher order moments, a downside risk adjusted return comparison via value at risk gives similar results to a total risk adjusted return comparison via standard deviation. The results for the PVarSharpe ratio further support this conclusion as the best and worst performers according to this

metric are also the best and worst performers according to the VarSharpe ratio. The highest PVarSharpe belongs to the sports sector (0.0281) whereas the lowest PVarSharpe belongs to the information technology sector (-0.0025).

Table 6 presents the results for the sector indices denominated in US dollars. The first result is that, the reward-to-risk ratios are lower for the US dollar-denominated indices compared to the Turkish lira-denominated indices for 20 out of 25 sectors. The exceptions are the information technology, real estate, defense, technology and new economy sectors. In Table 3, we had found that the mean returns for sector indices denominated in US dollars are lower than those of Turkish lira-denominated indices and the standard deviations are higher due to the additional variability in exchange rates. Coupled with the finding that the skewness and kurtosis statistics are similar for the sector indices denominated in different currencies, it is no surprise that the reward-to-risk ratios are lower for the sector indices denominated in US dollars. Other than this, most of the results from Table 5 are intact. The rankings for all three ratios exhibit similar patterns and the best and worst performers are common for each ratio. Sports, wholesale and retail trade, chemical and petroleum, banking and nonmetal mineral products are consistently the best performing sectors based on Sharpe, VarSharpe and PVarSharpe ratios. The only exception is that the financials sector becomes the sector with the highest VarSharpe and PVarSharpe ratios knocking nonmetal mineral products from the top five. The electricity, tourism, textiles and leather, information technology and telecommunications sectors always constitute the bottom five in rankings across all reward-to-risk ratios. These best and worst performers are also very similar to the top and

bottom five sectors in the Turkish-lira denominated index rankings implying that the currency conversion does not have a big impact on the relative performance of sector indices.

### 4.3 Graphical Comparison

Next, we compare the Sharpe ratios for GDS indices and sector indices across time. For this comparison, first, we calculate the median Sharpe ratio for each GDS and sector index during each month. Then, we take the monthly averages across the four maturity-specific GDS indices to create a single time series of Sharpe ratios. Likewise, we take the averages of monthly median Sharpe ratios across 25 sector indices denominated both in Turkish liras and US dollars. Figure 1 presents the plots of these monthly average Sharpe ratios against time.

Similar to the findings in the tables, the figure shows that the Sharpe ratios for the GDS indices are much higher than those of the sector indices at the beginning of the sample period. The curve for the GDS indices reaches its peak on April 2002 and stays above the curves for the sector indices until a brief period between July and September 2006 during which the average Sharpe ratio for the GDS indices turns negative. From September 2006 to August 2009, the GDS curve is again consistently above the sector curves. The comparative performance of the GDS and sector indices changes after August 2009 and the sector curves are above the GDS curve which becomes substantially negative at the end of the sample period. This reversal is due to the increasing trend of the Sharpe ratios

of sector indices that start at the beginning of 2009. The major event that triggered this structural break has been the interest rate reductions announced by the Central Bank of the Republic of Turkey (CBRT). After the credit crisis that had impacted the global financial markets in the second half of 2008, the CBRT announced reductions in the key borrowing and lending rates to energize the economy and stabilize the real and financial sectors in Turkey. Specifically, reductions of 1.25 and 2 percent were announced during December 2008 and January 2009, respectively. The lower interest rates affected the equity prices in the ISE positively since lower discount rates began to be applied to future cash flows.

Another notable observation from Figure 1 is that the sector curves stay within a relatively narrow band whereas the fluctuations for the GDS curve are much more pronounced. Finally, the US dollar- and Turkish-lira denominated sector curves move together which indicates their high positive correlation. The figures for the VarSharpe and PVarSharpe ratios exhibit similar patterns and are available from the authors upon request.

## 5. Conclusion

We compare the risk-adjusted returns of various bond and stock indices in the Istanbul Security Exchange. Adjusting for risk is crucial because, in equilibrium, investors demand higher expected returns for financial securities with higher risk and we want to be able to see which indices generate higher returns per unit risk. In our empirical

analysis, we first adjust the mean excess returns of each index for the standard deviation of the index over the recent past. Moreover, we take the downside risk into account and calculate the ratios of mean excess returns to both nonparametric and parametric value at risk.

Some patterns are apparent from the results for 5 government debt security (GDS) indices and 25 sector indices. First and foremost, all GDS indices have higher reward-to-risk ratios compared to all sector indices. Although many sector indices have higher mean returns compared to GDS indices, this high average return is not sufficient to compensate for the large standard deviations of the sector indices. From the perspective of a risk-averse investor with a long investment horizon, the implication is that investing in GDS indices promised a higher return per unit risk for the sample period considered. However, an investor cannot expect to earn consistently positive profits by taking a short position in the equity markets and a long position in the debt markets since sector indices proved to be the superior performers during the last three years of the sample period

Second, the reward-to-risk ratios monotonically decrease for GDS indices with longer maturities. This decrease is especially pronounced when the reward-to-risk measures are based on downside risk. Third, although the market value-weighted composite GDS index has lower standard deviation, skewness and kurtosis values than the maturity-specific GDS indices, this is not enough to compensate for its lower mean. Fourth, the rankings for the sectors according to the reward-to-risk ratios are mostly driven by the

mean return rankings and these rankings are similar for all the ratios. Finally, calculating the reward-to-risk ratios based on US dollar-denominated sector indices does not dramatically alter the results.

## REFERENCES


Arzac, Enrique R., and Vijay S. Bawa. 1977. "Portfolio Choice and Equilibrium in Capital Markets with Safety-First Investors." *Journal of Financial Economics,* 4:3, 277–288.

Bali, Turan G., K. Ozgur Demirtas, and Haim Levy. 2009a. "Is There an Intertemporal Relation between Downside Risk and Expected Returns?" *Journal of Financial and Quantitative Analysis* 44, 883-909.

Bali, Turan G., K. Ozgur Demirtas, and Haim Levy. 2009b. "Nonlinear Mean Reversion in Stock Prices." *Journal of Banking and Finance* 32:5, 767-782.

Barberis, Nicholas, and Ming Huang. 2008. "Stocks as Lotteries: The Implications of Probability Weighting for Security Prices." *American Economic Review* 98:5, 2066-2100.

Brunnermeier, Markus K., and Jonathan A. Parker. 2005. "Optimal Expectations." *American Economic Review* 95:4, 1092-118.

Cornish, E. A., and Fisher, R. A. 1937. "Moments and Cumulants in the Specification of Distributions." Extrait de la Revue de l'Institute International de Statistique 4, 1–14, Reprinted in: Fisher, R.A. (Ed.), Contributions to Mathematical Statistics, Wiley, New York, 1950

Dittmar, Robert F. 2002. "Nonlinear Pricing Kernels, Kurtosis Preference, and Evidence from the Cross Section of Equity Returns." *Journal of Finance,* 57:1, 369–403.

Hansen, B. E., 1994. Autoregressive conditional density estimation. *International Economic Review* 35:3, 705-730.

Kimball, Miles S. 1993. "Standard Risk Aversion." *Econometrica,* 61:3, 589–611.

Kraus, Alan, and Robert H. Litzenberger. 1976. "Skewness Preference and the Valuation of Risk Assets." *Journal of Finance* 31:4, 1085-1100.

Levy, Haim, and Marshall Sarnat. 1972. "Safety First – An Expected Utility Principle." *Journal of Financial and Quantitative Analysis,* 7:3, 1829–1834.

Markowitz, Harry M. 1952. "Portfolio Selection." *Journal of Finance* 7:1, 77–91.

Pratt, John W., and Richard J. Zeckhauser. 1987. "Proper Risk Aversion." *Econometrica,* 55:1, 143–154.

Roy, Arthur D. 1952. "Safety First and the Holding of Assets." *Econometrica,* 20:3, 431–449.

Rubinstein, Mark. 1973. "The Fundamental Theory of Parameter-Preference Security Valuation." *Journal of Financial and Quantitative Analysis* 8:1, 61-69.

Sharpe, William F. 1966. "Mutual Fund Performance." *Journal of Business* 39:1, 119-138.

Tas, Bedri Kamil Onur. 2011. "Private Information of the Fed and Predictability of Stock Returns." *Applied Economics* 43:19, 2381-2398.

## Table 1. Descriptive Statistics for Government Debt Security Indices

This table presents descriptive statistics for the returns of various government debt security indices in the Istanbul Stock Exchange. 182, 273, 365 and 456-day yields are extracted from a maturity-yield curve that is constructed by applying regression analysis on the rates of return from the weighted average prices of discounted bills and bonds published at the end of each trading day. MVCOMP is the return on a composite performance index weighted by market value and is calculated from the prices of discounted bills and bonds traded on the market. REPO is the return on a repo index which is calculated using the weighted average daily return (net of withholding) on repo transactions to be resolved at the same day on the normal orders market. The descriptive statistics that are presented in the table are the mean, standard deviation, minimum, 25$^{th}$ percentile, median, 75$^{th}$ percentile, maximum, skewness and kurtosis.

| | **Mean** | **St Dev** | **Min** | **25th** | **Median** | **75th** | **Max** | **Skewness** | **Kurtosis** |
|---|---|---|---|---|---|---|---|---|---|
| 182DAYS | 0.0010 | 0.0044 | -0.1108 | 0.0003 | 0.0006 | 0.0012 | 0.1395 | 3.9328 | 551.0116 |
| 273DAYS | 0.0011 | 0.0086 | -0.2593 | 0.0003 | 0.0006 | 0.0013 | 0.2932 | 4.0502 | 809.3554 |
| 365DAYS | 0.0011 | 0.0134 | -0.3962 | 0.0002 | 0.0006 | 0.0014 | 0.4609 | 5.8654 | 789.7245 |
| 456DAYS | 0.0012 | 0.0183 | -0.4995 | 0.0002 | 0.0006 | 0.0015 | 0.6119 | 7.8653 | 698.2036 |
| MVCOMP | 0.0006 | 0.0013 | -0.0135 | 0.0000 | 0.0005 | 0.0011 | 0.0103 | -0.7140 | 18.7292 |
| REPO | 0.0004 | 0.0003 | 0.0000 | 0.0002 | 0.0004 | 0.0005 | 0.0039 | 2.3963 | 12.2422 |

## Table 2. Descriptive Statistics for Sector Indices (Turkish Lira)

This table presents descriptive statistics for returns on various sector indices in the Istanbul Stock Exchange. All indices include the dividends paid on the constituent stocks and are weighted by the market value. Stocks that are traded on the watchlist market and stocks included in list C are excluded from the sector indices. All sector indices are adjusted for cash dividends, capital increases in cash through or without right offerings, inclusion and exclusion of new stocks in the indices, spin-offs and mergers. The returns in this table are based on index levels denominated in Turkish liras. The descriptive statistics that are presented in the table are the mean, standard deviation, minimum, 25$^{th}$ percentile, median, 75$^{th}$ percentile, maximum, skewness and kurtosis.

| | **Mean** | **St Dev** | **Min** | **25th** | **Median** | **75th** | **Max** | **Skewness** | **Kurtosis** |
|---|---|---|---|---|---|---|---|---|---|
| Banking | 0.0018 | 0.0319 | -0.1908 | -0.0153 | 0.0009 | 0.0179 | 0.1884 | 0.3621 | 6.9674 |
| Basic Metal | 0.0016 | 0.0310 | -0.1874 | -0.0140 | 0.0008 | 0.0165 | 0.2192 | 0.2555 | 7.4168 |
| Chemical, Petroleum | 0.0015 | 0.0269 | -0.1694 | -0.0117 | 0.0009 | 0.0145 | 0.2057 | 0.3078 | 8.3555 |
| Defense | 0.0014 | 0.0354 | -0.2188 | -0.0159 | 0.0000 | 0.0167 | 0.2037 | 0.6608 | 8.8496 |
| Electricity | 0.0008 | 0.0310 | -0.1800 | -0.0138 | 0.0000 | 0.0140 | 0.2152 | 0.4334 | 8.6219 |
| Financials | 0.0017 | 0.0300 | -0.1881 | -0.0142 | 0.0010 | 0.0170 | 0.1907 | 0.2812 | 7.3554 |
| Food, Beverage | 0.0016 | 0.0254 | -0.1746 | -0.0112 | 0.0013 | 0.0143 | 0.2013 | 0.1032 | 9.4509 |
| Holding, Investment | 0.0015 | 0.0297 | -0.1826 | -0.0138 | 0.0007 | 0.0162 | 0.1966 | 0.2060 | 7.3130 |
| Industrials | 0.0014 | 0.0237 | -0.1648 | -0.0094 | 0.0017 | 0.0127 | 0.1978 | 0.0559 | 10.1193 |
| Information Technology | 0.0003 | 0.0261 | -0.1811 | -0.0123 | 0.0003 | 0.0128 | 0.2054 | 0.2446 | 9.9693 |
| Insurance | 0.0018 | 0.0311 | -0.0826 | -0.0137 | 0.0011 | 0.0177 | 0.1881 | 0.0336 | 7.3690 |
| Leasing, Factoring | 0.0013 | 0.0288 | -0.1681 | -0.0125 | 0.0007 | 0.0152 | 0.1869 | 0.0513 | 7.1514 |
| Metal Products, Machinery | 0.0015 | 0.0275 | -0.1697 | -0.0119 | 0.0013 | 0.0143 | 0.1933 | 0.1707 | 8.5044 |
| New Economy | 0.0010 | 0.0257 | -0.1466 | -0.0103 | 0.0000 | 0.0131 | 0.1404 | -0.4495 | 8.3552 |
| Nonmetal Mineral Products | 0.0015 | 0.0215 | -0.1611 | -0.0081 | 0.0015 | 0.0114 | 0.1854 | 0.0828 | 10.6879 |
| Real Estate | 0.0005 | 0.0249 | -0.1738 | -0.0117 | 0.0007 | 0.0133 | 0.1974 | 0.1027 | 9.1706 |
| Services | 0.0013 | 0.0254 | -0.1752 | -0.0110 | 0.0008 | 0.0129 | 0.1893 | 0.3653 | 9.3712 |
| Sports | 0.0010 | 0.0213 | -0.1842 | -0.0077 | 0.0005 | 0.0087 | 0.1638 | 0.0956 | 14.9031 |
| Technology | 0.0005 | 0.0255 | -0.1792 | -0.0115 | 0.0010 | 0.0124 | 0.2049 | 0.1704 | 10.8973 |
| Telecommunications | 0.0008 | 0.0311 | -0.1781 | -0.0144 | 0.0000 | 0.0153 | 0.1967 | 0.3585 | 8.4082 |
| Textile, Leather | 0.0010 | 0.0242 | -0.1759 | -0.0091 | 0.0019 | 0.0127 | 0.1949 | -0.3682 | 10.6198 |
| Tourism | 0.0011 | 0.0352 | -0.1771 | -0.0156 | -0.0003 | 0.0168 | 0.2195 | 0.5447 | 8.5375 |
| Transportation | 0.0014 | 0.0292 | -0.1673 | -0.0139 | 0.0005 | 0.0151 | 0.2078 | 0.3023 | 7.3299 |
| Wholesale and Retail Trade | 0.0015 | 0.0264 | -0.1843 | -0.0113 | 0.0007 | 0.0133 | 0.1949 | 0.4269 | 9.7646 |
| Wood, Paper, Printing | 0.0013 | 0.0271 | -0.1522 | -0.0123 | 0.0008 | 0.0149 | 0.1719 | 0.0086 | 7.1636 |

# Table 3. Descriptive Statistics for Sector Indices (US Dollar)

This table presents descriptive statistics for returns on various sector indices in the Istanbul Stock Exchange. All indices include the dividends paid on the constituent stocks and are weighted by the market value. Stocks that are traded on the watchlist market and stocks included in ISE list C are excluded from the sector indices. All sector indices are adjusted for cash dividends, capital increases in cash through or without right offerings, inclusion and exclusion of new stocks in the indices, spin-offs and mergers. The returns in this table are based on index levels denominated in US dollars. The descriptive statistics that are presented in the table are the mean, standard deviation, minimum, 25$^{th}$ percentile, median, 75$^{th}$ percentile, maximum, skewness and kurtosis.

| | **Mean** | **St** | **Min** | **25th** | **Median** | **75th** | **Max** | **Skewness** | **Kurtosis** |
|---|---|---|---|---|---|---|---|---|---|
| Banking | 0.0012 | 0.0361 | -0.2407 | -0.0177 | 0.0008 | 0.0196 | 0.2761 | 0.3146 | 8.0355 |
| Basic Metal | 0.0010 | 0.0350 | -0.2245 | -0.0169 | 0.0014 | 0.0187 | 0.3057 | 0.2319 | 8.4485 |
| Chemical, Petroleum | 0.0009 | 0.0308 | -0.1753 | -0.0146 | 0.0010 | 0.0167 | 0.2143 | 0.1241 | 7.5411 |
| Defense | 0.0012 | 0.0403 | -0.2985 | -0.0183 | 0.0004 | 0.0193 | 0.2630 | 0.3209 | 9.0767 |
| Electricity | 0.0001 | 0.0345 | -0.1858 | -0.0163 | -0.0003 | 0.0159 | 0.2239 | 0.2900 | 7.9522 |
| Financials | 0.0010 | 0.0344 | -0.2318 | -0.0168 | 0.0006 | 0.0187 | 0.2719 | 0.2481 | 8.4268 |
| Food, Beverage | 0.0009 | 0.0291 | -0.1733 | -0.0133 | 0.0015 | 0.0163 | 0.2311 | 0.0155 | 8.8371 |
| Holding, Investment | 0.0008 | 0.0339 | -0.1998 | -0.0164 | 0.0003 | 0.0184 | 0.2723 | 0.1885 | 8.1530 |
| Industrials | 0.0008 | 0.0281 | -0.1868 | -0.0124 | 0.0019 | 0.0155 | 0.2205 | -0.0212 | 9.4523 |
| Information Technology | 0.0001 | 0.0317 | -0.2330 | -0.0146 | 0.0008 | 0.0158 | 0.2140 | 0.1066 | 9.6869 |
| Insurance | 0.0012 | 0.0353 | -0.2432 | -0.0168 | 0.0011 | 0.0193 | 0.2549 | -0.0391 | 7.8716 |
| Leasing, Factoring | 0.0007 | 0.0332 | -0.3105 | -0.0150 | 0.0009 | 0.0172 | 0.2291 | -0.2050 | 9.0211 |
| Metal Products, Machinery | 0.0008 | 0.0317 | -0.1979 | -0.0143 | 0.0012 | 0.0172 | 0.2456 | 0.1228 | 8.7633 |
| New Economy | 0.0011 | 0.0302 | -0.1538 | -0.0124 | 0.0019 | 0.0159 | 0.2098 | -0.4126 | 8.6472 |
| Nonmetal Mineral Products | 0.0008 | 0.0259 | -0.1949 | -0.0116 | 0.0016 | 0.0141 | 0.2019 | -0.0631 | 9.8635 |
| Real Estate | 0.0002 | 0.0305 | -0.2516 | -0.0139 | 0.0012 | 0.0160 | 0.2314 | -0.0896 | 9.8218 |
| Services | 0.0007 | 0.0295 | -0.2035 | -0.0139 | 0.0008 | 0.0151 | 0.2721 | 0.2655 | 9.9012 |
| Sports | 0.0009 | 0.0249 | -0.2098 | -0.0100 | 0.0008 | 0.0114 | 0.1717 | -0.1464 | 13.0070 |
| Technology | 0.0003 | 0.0313 | -0.2392 | -0.0142 | 0.0012 | 0.0161 | 0.2222 | 0.0356 | 10.6821 |
| Telecommunications | 0.0006 | 0.0357 | -0.2140 | -0.0170 | 0.0001 | 0.0181 | 0.3031 | 0.3735 | 9.8198 |
| Textile, Leather | 0.0004 | 0.0288 | -0.2347 | -0.0118 | 0.0018 | 0.0152 | 0.2706 | -0.3227 | 11.6798 |
| Tourism | 0.0004 | 0.0387 | -0.1852 | -0.0183 | -0.0003 | 0.0178 | 0.3771 | 0.5462 | 9.9662 |
| Transportation | 0.0008 | 0.0329 | -0.1872 | -0.0159 | 0.0005 | 0.0167 | 0.2561 | 0.2497 | 7.9858 |
| Wholesale and Retail Trade | 0.0009 | 0.0302 | -0.1991 | -0.0139 | 0.0008 | 0.0154 | 0.2701 | 0.3142 | 9.9782 |
| Wood, Paper, Printing | 0.0006 | 0.0314 | -0.2702 | -0.0148 | 0.0008 | 0.0169 | 0.2390 | -0.1092 | 8.8596 |

## Table 4. Reward-to-Risk Ratios for Government Debt Security Indices

This table presents various reward-to-risk ratios for various government debt security indices in the Istanbul Stock Exchange. Each row reports the medians for each ratio and the standard deviations are presented in parentheses. The government debt security indices are defined in Table 1. The reward-to-risk ratios presented are Sharpe ratio (Sharpe), non-parametric value at risk based Sharpe ratio (VarSharpe) and parametric value at risk based Sharpe ratio (PVarSharpe). The numerator of all the ratios is equal to the average daily return during the past 100 trading days minus the daily risk-free rate measured by the average daily return of the repo index over the sample period. The denominator of Sharpe is equal to the standard deviation of daily returns over the past 100 trading days. The denominator of VarSharpe is equal the absolute value of the minimum daily index return observed during the last 100 trading days. The denominator of PVarSharpe is equal to the first percentile of Hansen's (1994) skewed t-density estimated using the daily returns from the last 100 trading days.

| | **Sharpe** | | **VarSharpe** | | **PVarSharpe** | |
|---|---|---|---|---|---|---|
| 182DAYS | 0.4252 | (0.5161) | 0.4234 | (1.9749) | 0.5198 | (33.4897) |
| 273DAYS | 0.3953 | (0.4223) | 0.2505 | (0.9644) | 0.3838 | (109.4763) |
| 365DAYS | 0.3094 | (0.3773) | 0.1364 | (0.8695) | 0.1927 | (27.9146) |
| 456DAYS | 0.2845 | (0.3179) | 0.0975 | (1.0140) | 0.1256 | (13.7235) |
| MVCOMP | 0.2017 | (0.2371) | 0.0639 | (0.1947) | 0.0793 | (21.2954) |

# Table 5. Reward-to-Risk Ratios for Sector Indices (Turkish Lira)

This table presents various reward-to-risk ratios for various sector indices in the Istanbul Stock Exchange. Each row reports the medians for each ratio and the standard deviations are presented in parentheses. The sector indices are defined in Table 2. The reward-to-risk ratios presented are Sharpe ratio (Sharpe), non-parametric value at risk based Sharpe ratio (VarSharpe) and parametric value at risk based Sharpe ratio (PVarSharpe). The numerator of all the ratios is equal to the average daily return during the past 100 trading days minus the daily risk-free rate measured by the average daily return of the repo index over the sample period. The denominator of Sharpe is equal to the standard deviation of daily returns over the past 100 trading days. The denominator of VarSharpe is equal the absolute value of the minimum daily index return observed during the last 100 trading days. The denominator of PVarSharpe is equal to the first percentile of Hansen's (1994) skewed t-density estimated using the daily returns from the last 100 trading days.

| | **Sharpe** | | **VarSharpe** | | **PVarSharpe** | |
|---|---|---|---|---|---|---|
| Banking | 0.0440 | (0.1095) | 0.0163 | (0.0460) | 0.0194 | (0.0531) |
| Basic Metal | 0.0500 | (0.1123) | 0.0161 | (0.0524) | 0.0193 | (0.0596) |
| Chemical, Petroleum | 0.0486 | (0.1077) | 0.0169 | (0.0417) | 0.0200 | (0.0482) |
| Defense | 0.0164 | (0.1380) | 0.0054 | (0.0651) | 0.0067 | (0.0775) |
| Electricity | 0.0055 | (0.1125) | 0.0018 | (0.0438) | 0.0022 | (0.0499) |
| Financials | 0.0412 | (0.1137) | 0.0146 | (0.0470) | 0.0168 | (0.0543) |
| Food, Beverage | 0.0472 | (0.0892) | 0.0144 | (0.0348) | 0.0171 | (0.0403) |
| Holding, Investment | 0.0329 | (0.1191) | 0.0114 | (0.0465) | 0.0134 | (0.0546) |
| Industrials | 0.0557 | (0.1239) | 0.0168 | (0.0451) | 0.0196 | (0.0531) |
| Information Technology | -0.0068 | (0.1217) | -0.0020 | (0.0826) | -0.0025 | (0.0540) |
| Insurance | 0.0464 | (0.1235) | 0.0155 | (0.0459) | 0.0191 | (0.0531) |
| Leasing, Factoring | 0.0355 | (0.1210) | 0.0109 | (0.0471) | 0.0132 | (0.0630) |
| Metal Products, Machinery | 0.0405 | (0.1306) | 0.0133 | (0.0481) | 0.0159 | (0.0571) |
| New Economy | 0.0263 | (0.2528) | 0.0067 | (0.3033) | 0.0077 | (0.1028) |
| Nonmetal Mineral Products | 0.0524 | (0.1457) | 0.0173 | (0.0557) | 0.0197 | (0.0671) |
| Real Estate | 0.0112 | (0.1417) | 0.0037 | (0.5561) | 0.0043 | (0.1067) |
| Services | 0.0402 | (0.1096) | 0.0148 | (0.0456) | 0.0171 | (0.0575) |
| Sports | 0.0660 | (0.1259) | 0.0229 | (0.0687) | 0.0281 | (0.7134) |
| Technology | 0.0019 | (0.1305) | 0.0006 | (0.2056) | 0.0006 | (0.0531) |
| Telecommunications | 0.0137 | (0.1012) | 0.0049 | (0.0476) | 0.0058 | (0.0453) |
| Textile, Leather | 0.0325 | (0.1341) | 0.0092 | (0.0443) | 0.0111 | (0.0538) |
| Tourism | 0.0206 | (0.1225) | 0.0070 | (0.0519) | 0.0085 | (0.0740) |
| Transportation | 0.0275 | (0.1232) | 0.0094 | (0.0521) | 0.0111 | (0.0672) |
| Wholesale and Retail Trade | 0.0476 | (0.1036) | 0.0159 | (0.0439) | 0.0193 | (0.0558) |
| Wood, Paper, Printing | 0.0429 | (0.1162) | 0.0135 | (0.0441) | 0.0159 | (0.0503) |

## Table 6. Reward-to-Risk Ratios for Sector Indices (US Dollar)

This table presents various reward-to-risk ratios for various sector indices in the Istanbul Stock Exchange. Each row reports the medians for each ratio and the standard deviations are presented in parentheses. The sector indices are defined in Table 3. The reward-to-risk ratios presented are Sharpe ratio (Sharpe), non-parametric value at risk based Sharpe ratio (VarSharpe) and parametric value at risk based Sharpe ratio (PVarSharpe). The numerator of all the ratios is equal to the average daily return during the past 100 trading days minus the daily risk-free rate measured by the average daily return of the repo index over the sample period. The denominator of Sharpe is equal to the standard deviation of daily returns over the past 100 trading days. The denominator of VarSharpe is equal the absolute value of the minimum daily index return observed during the last 100 trading days. The denominator of PVarSharpe is equal to the first percentile of Hansen's (1994) skewed t-density estimated using the daily returns from the last 100 trading days.

| | **Sharpe** | | **VarSharpe** | | **PVarSharpe** | |
|---|---|---|---|---|---|---|
| Banking | 0.0366 | (0.1098) | 0.0126 | (0.0446) | 0.0146 | (0.0509) |
| Basic Metal | 0.0311 | (0.1148) | 0.0102 | (0.0478) | 0.0120 | (0.0543) |
| Chemical, Petroleum | 0.0384 | (0.1058) | 0.0124 | (0.0405) | 0.0144 | (0.0458) |
| Defense | 0.0278 | (0.1231) | 0.0090 | (0.0869) | 0.0107 | (0.6358) |
| Electricity | -0.0002 | (0.1171) | 0.0000 | (0.0460) | -0.0001 | (0.0505) |
| Financials | 0.0315 | (0.1126) | 0.0103 | (0.0452) | 0.0124 | (0.0514) |
| Food, Beverage | 0.0236 | (0.0932) | 0.0075 | (0.0376) | 0.0087 | (0.0412) |
| Holding, Investment | 0.0215 | (0.1152) | 0.0068 | (0.0451) | 0.0079 | (0.0516) |
| Industrials | 0.0307 | (0.1177) | 0.0087 | (0.0442) | 0.0100 | (0.0494) |
| Information Technology | 0.0062 | (0.1210) | 0.0021 | (0.1264) | 0.0023 | (0.0537) |
| Insurance | 0.0320 | (0.1215) | 0.0102 | (0.0441) | 0.0119 | (0.0509) |
| Leasing, Factoring | 0.0202 | (0.1207) | 0.0059 | (0.0466) | 0.0073 | (0.0582) |
| Metal Products, Machinery | 0.0273 | (0.1222) | 0.0084 | (0.0476) | 0.0097 | (0.0527) |
| New Economy | 0.0290 | (0.7783) | 0.0073 | (0.1924) | 0.0087 | (0.2349) |
| Nonmetal Mineral Products | 0.0332 | (0.1318) | 0.0098 | (0.0484) | 0.0117 | (0.0562) |
| Real Estate | 0.0192 | (0.1489) | 0.0056 | (0.1488) | 0.0066 | (0.5057) |
| Services | 0.0268 | (0.1114) | 0.0090 | (0.0438) | 0.0099 | (0.0514) |
| Sports | 0.0690 | (0.1195) | 0.0217 | (0.0528) | 0.0255 | (0.0607) |
| Technology | 0.0143 | (0.1279) | 0.0044 | (0.4028) | 0.0050 | (0.0536) |
| Telecommunications | 0.0089 | (0.1168) | 0.0030 | (0.0525) | 0.0033 | (0.0514) |
| Textile, Leather | 0.0050 | (0.1260) | 0.0014 | (0.0418) | 0.0016 | (0.0489) |
| Tourism | 0.0042 | (0.1215) | 0.0013 | (0.0491) | 0.0016 | (0.0722) |
| Transportation | 0.0122 | (0.1256) | 0.0041 | (0.0509) | 0.0048 | (0.0607) |
| Wholesale and Retail Trade | 0.0391 | (0.1050) | 0.0128 | (0.0418) | 0.0153 | (0.0491) |
| Wood, Paper, Printing | 0.0250 | (0.1129) | 0.0078 | (0.0420) | 0.0093 | (0.0475) |

# Figure 1. Sharpe Ratios

This figure compares the Sharpe ratios for GDS indices and sector indices across time. For this comparison, the median Sharpe ratios for each GDS and sector index during each month are calculated first. Then, the monthly averages across the four maturity-specific GDS indices are taken to create a single time series of Sharpe ratios. Similarly, the averages of monthly median Sharpe ratios across 25 sector indices are also calculated. The figure presents the time series for the sector indices denominated both in Turkish liras and US dollars.