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Full Length Article

Testing postmodern portfolio theory based on global and local single factor market model: Borsa Istanbul case

Mehmet Emin Yildiz [a], Yaman O. Erzurumlu [b,*]

[a] *Department of International Trade and Business, Faculty of Economics and Administrative Sciences Dogus University, 34722, Istanbul, Turkey*
[b] *Engineering Management Department, Faculty of Engineering and Natural Sciences, Bahcesehir University, 34353, Istanbul, Turkey*

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Abstract

This study makes a comparative analysis of the explanatory power of CAPM and downside CAPM based risk measures for stock returns in Borsa Istanbul. 22 risk measures based on mean-variance and mean-semivariance approaches using global and local single factor models are examined for 2005–2016 period in a panel data setting. Mean-semivariance approach (downside CAPM) based downside betas and downside standard deviations have significant explanatory power for stock returns whereas CAPM based local and global betas fail to explain stock returns. The mean-semivariance approach (downside CAPM) could determine cost of equity more accurately. Deviations of returns below the mean are better risk indicators than deviations of returns below risk free rate of return and negative returns. Borsa Istanbul is partially integrated with the global market index and the degree of integration is higher during periods of negative returns. Results suggest that USD/TRY relationship is the dominating factor compared to MSCI movements.

Jel Classification: C21; C23; G11; G12

Keywords: Asset pricing; Downside beta; Downside CAPM; Downside risk; Semivariance; Borsa Istanbul

1. Introduction

Determination of the free cash flows and cost of equity are crucial steps of financial asset, firm and project valuation in order to make correct decisions. Although, free cash flow calculation gets well deserved attention, at the course of the determination of cost of equity (mostly due to uncertainty in literature) approximations and presumptions preponderate. Allocational efficiency of financial sources necessitates correct investment decisions which are closely tied to the cost of capital along with other parameters. Hence, determination of appropriate risk measure is critical for accurate estimation of cost of equity and accurate estimation of cost of equity is critical for cost of capital calculation.

The degree of the explanatory power of the chosen risk measure for stock returns and its statistical significance are milestones for the determination of the cost of equity model. Harvey (1995a) argues that some asset valuation models used for developed markets do not perform well for emerging markets. Emerging market betas calculated based on world market index are insignificant as risk measure for explaining emerging market stock returns (Harvey, 1995b). This finding coincides with the view that emerging markets and developed markets are segmented and the sources of risk could differ.[1]

* Corresponding author.
E-mail addresses: mehmetyildiz@dogus.edu.tr (M.E. Yildiz), yamanomer.erzurumlu@eng.bau.edu.tr (Y.O. Erzurumlu).
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[1] If there are obstacles for investors to invest at multiple countries' financial markets, this would prevent them from active diversification. In that case investors have to take into account the country risk. Hence, the emerging markets will be isolated and segmented from the developed markets.

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Asset's local beta as the risk measure explains the risk-return relationship only if markets are completely segmented (Mishra and O'Brien, 2005). In that case, using local beta in a CAPM set-up would lead to inaccurate results for partially segmented and integrated markets. In order to overcome this obstacle, international investors make some adjustments while using global CAPM model for partially segmented markets (Cooper and Kaplains, 1995). Obstacles to international diversification further separate risk factors between developed and emerging markets (Bekaert, 1995). In addition, the correlation between emerging market returns and risk measures (e.g. country betas) changes over time implying that alternative valuation models deserve to be examined (Harvey, 1995b). CAPM leads to excessive values when there was greater downside risk and lower values when there was less downside risk (Chong and Phillips (2011)).

Another important characteristic of emerging market returns is that they are generally not normally distributed. When returns are normally distributed, both variance and semivariance-based risk measures could be used (Markowitz, 1959). However, in case of asymmetric distribution only semivariance-based downside risk measures should be used because positive skewness would attain equal weights to upward moves and downward moves if the returns are assumed to be normally distributed by default. This would overstate risk and the cost of equity, thus decreasing the calculated value of the asset. Therefore, alternative approaches such as "downside CAPM" (D-CAPM hereafter) are essential due to these five reasons, (i) weak relationship between betas and stock returns, (ii) segmentation, (iii) insufficient diversification, (iv) country specific risks, (v) asymmetric distribution of returns make.

Main objective of this paper is to examine the validity of variance-based modern portfolio theory and semivariance-based postmodern portfolio theory at Borsa Istanbul from a comparative perspective.[2] In order to do so, we investigate whether variance and semivariance risk measures are statistically significant at explaining the BIST-100 index stock returns and if so to what degree. Risk measures are derived using both the local and the global models and explanatory power of "mean-variance" and "mean-semivariance" based risk measures are examined from a quantitative perspective.

Markets has to be examined individually since each of risk variables could have an impact on returns which varies from country to country (Estrada and Serra (2005)). Aggregating multiple company or market data in a single sample leads to pricing constraint. Although, previous studies focusing solely on Borsa Istanbul provide valuable insight, they are market index or sector index based (Korkmaz et al. (2012)), in a cross-section analysis set-up and limited to local downside risk measures (Kaptan and Beker (2011); Tuna and Tuna (2013)). The study attempts to contribute to literature mainly at three points by examining Borsa Istanbul (i) at firm level, (ii) using both local and global risk measures, (iii) following a panel data methodology. First, by extending the analysis to firm level, the study attempts to contribute to the understanding of the degree of company specific risk and diversification by measuring unsystematic risk at firm level along other risk measures. Second, the study attempts to contribute to understanding the impact of factors such as integration and USD/TRY exchange rate dynamic by extending the analysis to global based risk measures besides the local based risk measures. Finally, from methodological point of view, panel regression model contributes to the examination of risk measures and return relationship. As Estrada (2000) points out, results change if risk measures and returns are summarized by long-term averages since statistics change dramatically from one period to the next. Prior, cross sectional studies suffer from ignoring the change in variance of measures over time.

There would be two implications of the findings. First, determining the appropriate risk measures that explain the stock returns better would contribute to the accuracy of stock valuation models in Borsa Istanbul and further to the firm and project valuation in emerging markets. Second, the explanatory power of "mean-variance" and "mean-semivariance" risk measures based on local and global single factor market models should shed light on the nature of the integration of Borsa Istanbul and the global financial market.

The paper proceeds as follows. The next section provides prior developments in the emerging market asset valuation in a D-CAPM related approach and lays down the theoretical framework. Following section describes data and the variables. Section 4 explains the methodology. Section 5 discusses the empirical results and the implications. Final section concludes.

2. Literature review

As a pioneer of cross sectional studies on stock returns in emerging markets, Harvey (1995a) documented that betas were smaller than 1 and insignificant for most of the emerging markets. His findings indicated that CAPM had limited ability to explain the change in the stock prices. However, his study was covering the period up to 1992 prior to the increase in integration between emerging markets and developed markets followed by the increase in the country betas.

Harvey (1995b) later examined 5 different global risk factors; global index returns, foreign exchange index return, change in oil prices, change in the world industrial production output and global inflation rate. He documented that only a small number of the countries' market returns and the 5 global risk factors were statistically related and one of the twenty emerging market country beta was above 1. Low betas found were indicating lower required rate of returns than those used by the industry for evaluation purposes. Harvey (1995b) concluded that lack of integration was responsible for his findings. Claessens, Dasgupta and Glen (1995) documented that firm size, MV/BV, P/E ratio and dividend yield explain cross sectional market returns of 19 emerging markets. Their study was particularly interesting in the sense that after

[2] The term postmodern portfolio theory is used in literature as a generic term for versions which the downside risk measures are used. The term was used first by Rom and Ferguson (1993).

introducing these variables to the model, beta was no longer explaining the returns. In his study on 20 emerging markets, Rouwenhorst (1999) did not find significant relationship between local betas and equity returns. More important, he documented that global factors failed to explain the emerging market equity returns. These and following studies gave support to the need to search for alternative risk measures and factors that explain the risk and return relationships at emerging markets.

Later, Harvey (2000) documented findings different than his previous two studies mostly due to increasing integration between the markets. He analyzed 28 emerging and 19 developed markets. He documented that total risk explains 52% of the total variance of emerging market stock returns indicating that not all of the market specific risks are diversified away at emerging markets. He found that mean semivariance, standard deviation, unsystematic risk and country beta (systematic risk) were statistically significant at explaining emerging market stock returns whereas all risk measures he examined, failed to explain developed market stock returns. His finding was interesting in the sense that it suggested semivariance-based risk measures could be alternative for explaining the emerging market stock returns. Nevertheless, a significant total risk/stock return relationship implied that significant unsystematic risk exists at emerging markets and country specific risks would be an important factor behind market segmentation. Hence, following Harvey (2000) we examine both semivariance and variance risk measures and both the global and the local unsystematic risks.

Estrada had a series of studies on the subject. In his first study on cost of equity (Estrada, 2000) he found that downside risk measures are significant at explaining emerging markets expected returns. According to his findings; total risk, unsystematic risk, mean semivariance, downside beta and VaR had significant relationship with expected return but systematic risk did not. This result suggested that unsystematic risks were priced by the investors at emerging markets (Alles and Murray (2013)) and developed markets such as Australia (Alles and Murray (2017)). Estrada (2000) suggested 4 reasons for that: (i) emerging markets are not fully integrated with the developing markets, (ii) global market index does not have the mean-variance effect, (iii) there might be some other factors (e.g. MV/BV or momentum), (iv) betas change over time. His findings are valuable for our study in the sense that they provide insight to why CAPM may not be successful at emerging markets. He also proposes that downside risk measure based cost of equity would be fairer because downside risks are greater than systematic risk and smaller than total risk. This characteristic is consistent with the view that cost of equity in a semi integrated market should be between fully integrated and fully segmented market cost of equity. Later, Estrada (2002) proposed D-CAPM as an alternative model where he documented downside risk measures derived from mean semivariance approach explains returns better that mean variance approach. Out of standard deviation, beta, semi standard deviation and downside beta; only downside beta had explanatory power for returns. (Estrada, 2003, pp. 2–17) also supported his previous findings that downside risk measures perform better for emerging markets with skewed return distribution align with Markowitz (1959). Galagedera (2007) examined the CAPM beta and three downside beta calculation models documented in literature for developed markets. Similar to (Estrada, 2003, pp. 2–17), he found that the relationship between CAPM based beta and other three downside betas were based on the skewness, kurtosis and standard deviation of the market portfolio return distribution. This indicates each market characteristic is unique in the way it prices a specific risk measure. Later, Alles and Murray (2008) documented for 5 Asian markets that downside beta remains relatively important, when in combination with beta, variance, skewness, and co-skewness of returns. Nevertheless, the relationship between expected returns and downside risk is documented to be much weaker for developed markets (Atilgan & Demirtas, 2013) Tahir, Abbas, Sargana, Ayub, and Saeed (2013) made a similar comparison between CAPM and D-CAPM from intercept, risk-return relationship, nonlinearities and effect of residuals. D-CAPM came out to be stronger contender compared to CAPM for risk-return relationship (Tahir et al. (2013)) and priced by the investors (Alles and Murray (2013)). Estrada and Serra (2005) suggested that number of variables needed to estimate expected returns at emerging markets is higher than developed markets. In their individual firm level based study, only one of the six variables used (MV/BV) revealed significant relationship with expected returns. Estrada and Serra (2005) argued that their finding contradicts with the assumption behind global valuation based on cross sectional regression.

Downside beta remains to be intuitively more appealing as a risk measure when it is calculated using alternative methodologies (Tsai, Chen, and Yang (2014)) or tested together with other factors such as investor sentiment (Da et al. (2015)). Semivariance and downside beta are found to play strong role in explaining the cross-section of country returns (Beach (2011)). Hence, accurate estimation of the cost of equity could be problematic based on CAPM betas.

Although, Estrada and Serra (2005)'s study indicates that risk measures relationship with the expected returns vary from country to country, our study will not be affected from it since it focuses on Turkish market only. Regarding Borsa Istanbul, studies predominantly fail to confirm the validity of CAPM. Akdeniz et al. (2000), Karatepe et al. (2002) and (Gürsoy et al. 2007, pp. 43–64), Dalgin et al. (2012) fail to document positive relationship between company betas and returns. Korkmaz et al. (2010) documents that CAPM could hold in a panel model regression. Studies favor D-CAPM over CAPM. Korkmaz et al. (2012) on their study covering 14 sector indices, Kaptan and Berker (2011) on their study covering only 10 banking company and Tuna and Tuna (2013) document that power of downside beta coefficient is higher than the traditional beta coefficient on explaining the return changes.

Hence, following (Estrada, 2003, pp. 2–17), Ang, Chen, and Xing (2006), Galagedera (2007) and Beach (2011) we expect downside beta and other mean semivariance-based risk measures to have more explanatory power for expected returns. Additionally, we expect global index based risk measures to have more explanatory power for expected returns compared to local index based risk measures as documented by Mishra and O'Brien (2005).

3. Data and descriptive statistics

Data set covers the period between June 2005 and June 2016 and includes 122 companies listed in Borsa Istanbul market index (BIST100) between June 2009 and June 2016. The index is representative of the market in the sense that correlation of price index and correlation of return index between the BIST100 firms and the entire market set are 99.93% and 99.90% respectively. Index firms constitute 81.21% of the total trading volume over the study period. In order to overcome survivorship bias BIST100 index companies are scanned between 2009 and 2016 for index exclusions.[3] 165 companies are determined as entering the index which 65 are no longer listed. 141 of these companies stay in the index at least one fiscal year. Final data set is comprised of 122 companies (84 still listed in the index and 38 are not) with minimum 9 years of data allowing us to calculate 4 periods of risk measures.[4] All data are retrieved from Bloomberg. We use Turkish lira (TRY) and US dollar (USD) monthly returns of each stock, TRY based monthly returns of BIST100 as local index return and monthly returns of MSCI world index as global index returns. Both "price index" and "return index" of BIST100 are available at Borsa Istanbul data base. Recent "return index" based returns include both the capital gain and dividend gain. However, entire "return index" data do not include dividend gain. Therefore, the single factor market model for earlier periods would have dependent variable (stock returns) capturing only capital gain whereas independent variable (market index returns) capturing both the capital and dividend gain. Such a discrepancy would lead the results to be biased. For that reason we use "price index" for BIST100 index returns.

Monthly returns are calculated based on the following formula:

$$R_{i,t} = \frac{P_{i,t}}{P_{i,t-1}} - 1 \quad (1)$$

where $R_{i,t}$ is the monthly return of stock i at t^{th} period and $P_{i,t}$ is the value of stock i at month t.

There are seven 60 months (5 years) time windows for 122 stocks. Having multiple time frames enables us to conduct a panel data analysis and 60 months time frame is a generally accepted norm in the literature for analytical studies (Brealey, Stewart, & Franklin, 2008). Periodic mean returns of the seven time windows are calculated as the arithmetic average of 60 months mean returns. Final data set consists of seven periodic mean returns for 122 stocks. Table 1 lists dates for each time window.

Table 2 summarizes descriptive statistics for stock returns in TRY and USD. Average stock return of 122 BIST-100 index stocks is 1.16% in TRY and 1.62% in USD. Return series are not normally distributed. They are positively skewed that increases the likelihood of downside risk measures to perform better for Borsa Istanbul as suggested by (Estrada, 2003, pp. 2−17) for emerging markets in general. Standard deviation of both series are close.

Return series are used in a single factor model to generate risk measures. Methodology and classification of the 22 risk measures calculated in 4 groups; local mean variance, local mean semivariance, global mean variance and global mean semivariance are explained in the next section.

4. Methodology and variables

This section consists of two sub-sections. First sub-section explains the calculation of beta and standard deviation based risk measures using global and local single factor market models. Second sub-section summarizes the standard unbalanced panel data analysis methodology of the relationship between 22 risk measures and the periodic mean return of stocks.

4.1. Risk measure models

There are three groups of risk measures. First group is based on classic CAPM, second group is downside beta based

Table 1
Date of time windows.

Beginning and Ending Dates	Number of Observations
June 2005−June 2010	60 monthly returns
June 2006−June 2011	60 monthly returns
June 2007−June 2012	60 monthly returns
June 2008−June 2013	60 monthly returns
June 2009−June 2014	60 monthly returns
June 2010−June 2015	60 monthly returns
June 2011−June 2016	60 monthly returns

Table 2
Descriptive statistics.

	R_i (TRY)	R_i (USD)
Mean	0.0116	0.0162
Median	0.0100	0.0150
Standard Deviation	0.0168	0.0178
Kurtosis	18.0059	15.8031
Skewness	2.4021	2.0457
Maximum	0.1460	0.1558
Minimum	−0.0279	−0.0291
Number of observation	813	813

Note: R_i (TRY) is the monthly return of all stocks in the data set over 11 years period measured by Turkish lira. R_i (USD) is the monthly return of all stocks in the data set over 11 years period measured by US dollar.

[3] We thank an anonymous reviewer for pointing out the survivorship and selection bias issues. Since, at least 5 years of data "between 2005 and 2010" is required to calculate the beta, scanning was started from 2009.

[4] We excluded 14 currently listed 2 previously listed companies without sufficient data. 3 companies with abnormal volatility due to very high political risk (asyab, kozaa and ipeke) are also excluded.

risk measures and the third group is downside standard deviation based risk measures.

4.1.1. Global single factor market model

First group of global risk factors are classic CAPM based and calculated based on single factor market model developed by Sharpe (1964). They are systematic risk, downside systematic risk and unsystematic risk measures. The global single factor model is specified as follows:

$$R_{iDt} - r_{fGt} = \alpha_i + \beta_{iG}(R_{mGt} - r_{fGt}) + e_{it} \quad (2)$$

where R_{iDt} is the USD based monthly return of stock i at t^{th} period, r_{fGt} is 30 days US T-Bill rate at t^{th} period, R_{mGt} is the MSCI world index at t^{th} period and e_{it} is the error term of stock i at t^{th} period.[5]

$(R_{iDt} - r_{fGt})$ stands for excess stock return and $(R_{mGt} - r_{fGt})$ stands for excess world market index return. Some studies argue that using excess returns makes insignificant difference to the results and choose to use single factor market model with nominal returns instead (Abell & Krueger, 1989; Gangemi et al., 2000).

We obtain the global beta (GB) denoted as β_{iG} for each stock "i" as a risk measure of the global systematic risk. Standard deviation of the error terms (e_{it}) indicates the unsystematic risk (idiosyncratic risk) of each stock. Global unsystematic risk (GIR) is the part of the stock return that is not explained by the USD based global market return. Finally, standard deviation of the USD stock returns (R_{iDt}) is the risk measure for the global total risk (GSD).[6]

Second and third group of global risk measures are downside betas and downside standard deviations based on semivariance approach. Mean variance approach above gives equal importance and weight to the deviations below and above mean return. However, alternative mean semivariance approach explained below calculates semivariance, semi−standard deviation, cosemivariance and downside beta based on the deviations below a predefined benchmark.

5 different downside betas are calculated as global risk measures following the literature. 3 of them are developed by Estrada (2002, 2006), one by Bawa and Lindenberg (1977) and one by Harlow and Rao (1989).

Estrada (2002) estimates downside beta using the Equation (3) below:

$$\beta_B^D = \frac{E\{Min(R_i - B_i, 0).\, Min(R_M - B_M, 0)\}}{E\{Min(R_M - B_M, 0)\}^2} \quad (3)$$

where numerator is the cosemivariance between the market and stock, denominator is the semivariance of the market. "B" is the target return set as the benchmark. Betas are calculated using three different benchmarks; mean return of past sixty months of stock i (μ_i), risk free rate of return (R_f) and zero percent return.

We exclude α_i from our model and use the version of global single factor market model without the constant term which is proposed by Estrada (2002) and argued to be more practical in calculating downside betas. β_{iG}^D signifies the global downside beta for stock i and our final regression model is as follows;

$$R_{iDt} - r_{fGt} = \beta_{iG}^D(R_{mGt} - r_{fGt}) + e_{it} \quad (4)$$

Three versions of the regression model (4) are estimated. First version includes the observations which stock excess returns and world index excess returns are below their means. The obtained betas are called "Mean based global downside beta" (GDB-M). Second version includes the observations which stock excess returns and world index excess returns are below the risk free rate of return. The obtained betas are called "Risk free rate of return based global downside beta" (GDB-R). Third version includes the observations which stock excess returns and world index excess returns are below zero. The obtained betas are called "Zero based global downside beta" (GDB-Z). "Mean based global downside beta" (GDB-M) is previously examined by Harvey (2000), Estrada (2000, 2001, 2002, 2003, 2006), Estrada and Serra (2005), Galagedera (2007), Galagedera and Brooks (2007) and Collins and Abrahamson (2006). Although Estrada (2006) calculates the other two; "Risks free rate of return based global downside beta" (GDB-R) and "Zero based global downside beta" (GDB-Z); he does not examine them in detail.

In addition to these three model versions above, we also calculate and examine beta based on Bawa and Lindenberg (1977) and Harlow and Rao (1989). Bawa and Lindenberg (1977) calculate the downside beta for the first time calculating using Equation (5) below.

$$\beta_{im}^{BL} = \frac{E\lfloor (R_i - R_f) min(R_m - R_f, 0) \rfloor}{E[min(R_m - R_f, 0)]^2} \quad (5)$$

Equation (5) takes both the negative and positive returns $(R_i - R_f)$ into account using conditional market returns. Conditional market return is defined as the return below risk free rate of return $[min(R_m - R_f, 0)]$. It has no downside deviation requirement and is widely used in literature (Harvey (2000), Galagedera (2007), Galagedera and Brooks (2007) and (Post et al. 2009, pp. 1−28)). "Bawa and Lindenberg global downside beta" (GDB-BL) is calculated based on single factor model.

Harlow and Rao (1989) calculate the downside beta using Equation (6) below.

$$\beta_{im}^{HR} = \frac{E\lfloor (R_i - \mu_i) min(R_m - \mu_m, 0) \rfloor}{E[min(R_m - \mu_m, 0)]^2} \quad (6)$$

They use market returns that are below the average market return and unconstrained stock returns leading to higher betas for cases where $R_i < \mu_i$ and $R_m < \mu_m$ and leading to lower beta when $R_i > \mu_i$ and $R_m < \mu_m$ due to lower semi-covariance. We calculate "Harlow and Rao global downside beta" (GDB-HR) using single factor model as well.

[5] Retrieved from Bloomberg (Code: GB1M).

[6] We conduct tests for excess return $(R_i - r_f)$ and return (R_i) standard deviations separately. The results are qualitatively same and the difference is statistically insignificant.

Third group of risk measures are downside standard deviation based and calculated by the specified model as follows:

$$\sigma_B = \sqrt{\left(\frac{1}{T}\right) \cdot \sum_{t=1}^{T} \left(R_{iDt} - B\right)^2 \; R_{iDt} < B} \quad (7)$$

where R_{iD} is USD based return of stock i, B is the benchmark return, T is the number of observations.

Similar to the previous risk measures group, we use arithmetic mean of past sixty months stock return (μ_i), global risk free rate of return and zero as target benchmark return obtaining three types of standard deviation for each stock. Mean based downside standard deviation (GDSD-M) is calculated using negative deviations of stock USD return from stock mean return. Risk free rate of return based downside standard deviation (GDSD-R) is calculated based on negative deviations of stock USD return from risk free rate of return. Zero return based downside standard deviation (GDSD-Z) is calculated based on negative stock USD return.

4.1.2. Local single factor market model

Methodology is the same for the local versions of single factor model based risk measure as their global versions. USD based stock returns are replaced by Turkish Lira (TRY) based stock returns. MSCI world index return is replaced by Borsa Istanbul (BIST-100) return and Turkish government Treasury bond yield is taken as risk free rate of return for obtaining systematic, downside systematic and unsystematic risk measures. Local version of single factor market model could be specified as in Equation (8):

$$R_{it} - r_{ft} = \alpha_i + \beta_i\left(R_{mt} - r_{ft}\right) + e_{it} \quad (8)$$

where R_{it} is the monthly return of stock i at period t, r_{ft} is the monthly return of Turkish government treasury security retrieved from Bloomberg, R_{mt} is the return of BIST-100 index at period t, e_{it} is the error term of stock i at period t.[7] A complete list of all global and local risk measures is given below at Table 3.

4.2. Panel data analysis methodology

Panel data analysis of risk measures introduces methodological advantages over cross sectional analysis. As Estrada (2000) argues returns and betas may be uncorrelated if these two magnitudes are summarized by long-term averages but their true values change widely over time. In order to overcome this he divides the data set into two subsamples and finds that in most cases statistics change dramatically from one period to the next. Considering that not only beta but other examined risk measures could be subject to similar phenomenon.

Taking the arithmetic average of 60 months for 7 time windows, we obtain a 7 period 122 stocks unbalanced panel

[7] Bloomberg code is TYDRA.

Table 3
Risk measure variables.

Risk class		Global Single Factor Model		Local Single Factor Model	
		Abbrev.	Name	Abbrev.	Name
Mean-Variance approach	Total risk	GSD	Global Standard Deviation	LSD	Local Standard Deviation
	Unsystematic risk	GIR	Global Unsystematic Risk	LIR	Local Unsystematic Risk
	Systematic risk	GB	Global Beta	LB	Local Beta
Mean-Semivariance approach	Downside total risk	GDSD-M	Mean based Global downside standard deviation	LDSD-M	Mean based Local downside standard deviation
		GDSD-Z	Zero based Global downside standard deviation	LDSD-Z	Zero based Local downside standard deviation
		GDSD-R	Risk free rate of return based Global downside standard deviation	LDSD-R	Risk free rate of return based Local downside standard deviation
	Downside systematic risk	GDB-M	Mean based Global downside beta	LDB-M	Mean based Local downside beta
		GDB-Z	Zero based Global downside beta	LDB-Z	Zero based Local downside beta
		GDB-R	Risk free rate of return based Global downside beta	LDB-R	Risk free rate of return based Local downside beta
		GDB-BL	Bawa and Lindenberg Global downside beta	LDB-BL	Bawa and Lindenberg local downside beta
		GDB-HR	Harlow and Rao Global downside	LDB-HR	Harlow and Rao local downside beta

data set with 41 missing periods for 22 series of risk measures and a stock return series. Next, we analyze the relationship between the stock returns and risk measures applying an unbalanced panel data univariate regression analysis. The model is specified as follows:

$$MR_{i,t} = \gamma_0 + \gamma_1 RV_{i,t} + u_{i,t} \quad (9)$$

where $MR_{i,t}$ is the arithmetic mean return of stock i at time window t, $RV_{i,t}$, risk measure for stock i at time window t, γ_0 and γ_1 predicted regression coefficients and $u_{i,t}$ is the error term.

Hausmann test is conducted after running the Random Effect model for each pair of stock return series and a specific risk measure series. Whether each univariate model would be estimated as a Fixed Effect model or Random Effect model is based on the Hausmann test results. If the Hausmann test favors Fixed Effect model, the univariate model is run with White's cross-section standard errors and covariance. If Hausmann test favors Random Effect model, the model is run using Wallace-Hussein Random effects along with White Cross Section standard errors and covariance coefficients. The procedure is repeated for the 22 pairs of stock return and the specific risk measure. All results are summarized and discussed in the next section.

5. Empirical results and discussion

Explanatory power results of 11 global and 11 local risk measures are examined. The results are summarized below at Table 4 and Table 5 respectively. Explanatory power is measured by the adjusted R^2 values of each model. Primary focus is given to the adjusted R^2 values of positive and statistically significant risk measure coefficients.

Regarding global model results; relationships between stock returns and four risk measures are significant at 1% and the direction of the relationships are in line with the risk/return theory. These risk measures are; total risk (GSD), unsystematic risk (GIR), mean based downside standard deviation (GDSD-M) and mean based downside beta (GDB-M).

Table 4
Global risk measure panel data analysis results.

Model	Risk Measure Name	γ_1	Adj-R^2
1	GSD	0.1774**	0.7141
2	GIR	0.1862**	0.7054
3	GDSD-M	0.3753**	0.2983
4	GDSD-Z	0.1434	0.0312
5	GDSD-R	0.1458	0.0331
6	GB	0.0033	0.0062
7	GDB-M	0.0218**	0.1658
8	GDB-Z	−0.0103*	0.0318
9	GDB-M	−0.0110*	0.0359
10	GDB-BL	−0.0145**	0.1882
11	GDB-HR	0.0064	0.5104

Note: GSD: Standard deviation; GIR: Unsystematic (idiosyncratic) risk; GDSD-M: Mean based downside standard deviation; GDSD-Z: Zero based downside standard deviation; GDSD-R: Risk free rate of return based downside standard deviation; GB: MSCI world index based global beta; GDB-M: Mean based downside beta; GDB-Z: Zero based downside beta; GDB-R: Risk free rate of return based downside beta; GDB-BL: Bawa and Lindenberg based downside beta; GDB-HR: Harlow and Rao based downside beta. γ_1 is the coefficient independent variable of univariate panel regression results. ** and * indicate significance at the 1% and 5% respectively.

Table 5
Local risk measure panel data analysis results.

Model	Risk Measure Name	γ_1	Adj-R^2
1	LSD	0.1411**	0.7052
2	LIR	0.1591**	0.7297
3	LDSD-M	0.2528**	0.1253
4	LDSD-Z	−0.0497	0.0039
5	LDSD-R	−0.0519	0.0046
6	LB	−0.0010	0.0002
7	LDB-M	0.0132**	0.0326
8	LDB-Z	−0.0193**	0.0831
9	LDB-R	−0.0213**	0.0890
10	LDB-BL	−0.0221**	0.1590
11	LDB-HR	0.0033	0.0028

Note: LSD: Standard deviation; LIR: Unsystematic (idiosyncratic) risk; LDSD-M: Mean based downside standard deviation; LDSD-Z: Zero based downside standard deviation; LDSD-R: Risk free rate of return based downside standard deviation; LB: Local beta calculated based on BIST 100 market index; LDB-M: Mean based downside beta; LDB-Z: Zero based downside beta; LDB-R: Risk free rate of return based downside beta; LDB-BL: Bawa and Lindenberg downside beta; LDB-HR: Harlow and Rao downside beta. γ_1 is the coefficient independent variable of univariate panel regression results. ** and * indicate significance at 1% and 5% respectively.

Results indicate that global mean based semivariance risk measures have significant explanatory power for stock returns at Borsa Istanbul, thus postmodern portfolio theory is valid. Two global semivariance risk measures; the global mean based downside beta (GDB-M) and global mean based downside standard deviation (GDSD-M) explain stock returns significantly. The significant relationship between stock return and global mean based downside beta (GDB-M) is especially interesting considering the absence of such relationship between stock returns and variance-based classic beta (GB). This result further supports the argument that semivariance (D-CAPM) based risk measures could perform well for Borsa Istanbul whereas variance (CAPM) based beta (GB) fails, thus raising question on the validity of classic CAPM at Borsa Istanbul. The result of the shortcoming of variance-based beta (GB) is further supported by the explanatory power of global index. Global unsystematic risk (GIR) measure is statistically significant and has an R^2(0,7054) close to total risk (GSD) measure R^2(0,7141) stating that 70% of USD based returns of the stocks are due to company specific risks.

The signs of the other three significant downside beta based risk measures (GDB-Z, GDB-R and GDB-BL) are negative contradicting with the underlying risk/return theory. From investors and analysts point of view, deviations of returns below the mean would be better risk indicators than deviations of returns below risk free rate of return and negative returns. In other words, negative relationship between risk free based and zero based betas and the mean returns suggests that risk measures using these two targets as benchmark could be misleading at explaining the mean stock returns.

Overall, the results are compatible with the general characteristic of an emerging market documented in literature. For example, both Harvey (2000) and (Estrada, 2003, pp. 2–17) document that downside risk measures are significant for emerging markets. Possible reason behind this finding is the asymmetric distribution of emerging market stock returns (Estrada, 2003, pp. 2–17; Harvey, 2000; Hwang & Pedersen, 2002; Susmel, 2001). As indicated by our descriptive statistics, BIST-100 stock return distributions both in TRY and USD have positive skewed structure.

Second group of results are based on the local market index and TRY returns are summarized at Table 5. They are qualitatively similar to the global model results. Total risk (LSD) and unsystematic risk (LIR) are statistically significant at 1%. Local versions of the same two risk measures, mean based downside standard deviation (LDSD-M) and mean based downside beta (LDB-M) are significant at 1% level. Similar to the global version results, local classic beta (LB) is insignificant. The significance of local downside risk measures provide further support for the argument that postmodern portfolio theory and D-CAPM based models would provide better valuation results for an emerging market like Turkey.

Considering that, the significant risk measures are the mean based downside betas for both risk measure groups, one could suggest that adjusted R^2 values indicate that D-CAPM is more distinct when mean return is the benchmark. Significant unsystematic risk measures (GIR and LIR) and significant mean based downside betas (GDB-M and LDB-M) yet insignificant CAPM betas (GB and LB) imply that the downside movements of the index are rather reflected to stock returns. Moreover, global mean based downside beta has an explanatory power (adjusted R^2) higher than its local counterpart (0,1658 for GDB-M; 0,0326 for LDB-M) and the explanatory power of local downside standard deviation (R^2 for LDSD-M is 0,1253) is less than global downside standard deviation (R^2 for GSD is 0,2983). These two results indicate that global factors are relatively more important and USD/TRY relationship should be the dominating factor compared to MSCI index movements. It is in line with the argument of Ormos and Timotity (2017) that international capital flow play an important role in asset prices.

One last point the results indicate regards the degree of integration between the Borsa Istanbul and global market. Global beta is the risk measure of global CAPM and a significant global beta would rely on the assumption that markets are fully integrated. Local beta is the risk measures of local CAPM and a significant local beta would rely on the assumption that markets are fully segmented. We obtain insignificant results for both cases. Thus, Borsa Istanbul and global world market index are neither fully integrated nor fully segmented. They are rather partially integrated. In addition to that, significant global downside mean based beta indicates that the integration could be more pronounced for decreasing market periods. Actually, aggregate results favoring D-CAPM for Borsa Istanbul support this argument as well.

6. Conclusion

Main motivation for this study is the argument that "CAPM″ model based classic beta could not successfully explain the emerging market stock returns, valuation based on it would be misleading and "D-CAPM″ based semivariance risk measures could be a sufficient alternative. We test the argument using a data set of 122 stocks listed in Borsa Istanbul BIST-100 index between June 2009 and June 2016 in a univariate unbalanced panel data analysis setup over the period of 2005–2016. Accordingly, the results raise question on sufficiency of CAPM and supports the validity of D-CAPM models for Turkish stock market. Both global and local mean based downside betas (GDB-M and LDB-M) have significant explanatory power for mean return while classic global beta (GB) and local beta (LB) do not. Insignificant global beta (GB) and local beta (LB) suggest that Borsa Istanbul and global market index are partially integrated and downward movements of market are rather priced by the market. Among the benchmark based downside models, mean return is an appropriate benchmark compared to "risks free rate of return" and "zero return" for practical and analytical purposes. In other words, risk measure could serve the valuation purpose better if deviations of returns below the mean are chosen as the benchmark. The domination of mean based mean-semivariance risk measures at explaining the mean returns significantly indicates that postmodern portfolio theory is a suitable alternative for valuation models in Turkey over classic mean-variance-based models. Results also document that the company specific risk is still a significant portion of the total risk and crucial for pricing securities at Borsa Istanbul. Borsa Istanbul is partially integrated with the global market. The integration is stronger for downward markets and USD/TRY exchange rate could be the dominating factor compared to MSCI index returns.

The results of this study are relevant and would be valuable for financial analysts and investment analysts. D-CAPM based cost of equity would be more precise and improve the analysts and investors valuation activities. Results would be more accurate not only for stock valuation but also at the course of company and project valuations. This would reduce the potential cost of equity related ambiguity over portfolio management, project management, M&A activities and other related areas.

The study posits certain limitations. First, the price index does not include dividend gain but had to be used in order to match with the stock returns. Second, the results could be sensitive to the model approved by the Hausmann test. However, one could overcome this favoring fixed or random effect model purely based on theoretical approach. It deserves to be noted that the results remain qualitatively same but quantitatively sensitive to data set size and study period. Third, D-CAPM model results are distorted by very high volatilities due to political or company specific risks. Three such companies are excluded from the study. Finally, neither CAPM nor D-CAPM could capture the risk measure and return relationship of illiquid stocks. These stocks have very low trading volume, display price jumps and discontinuous price data.

Findings do not suggest any evidence regarding the systematic and unsystematic portions of the total downside risk. We believe this would be an interesting subject to examine for further studies. Another interesting subject to examine deeper would be D-CAPM betas being sometimes larger sometimes smaller than stock betas. The results could not be completely generalized to all emerging markets. Considering the relevant argument summarized at the literature review section, different emerging markets could potentially display changing degrees of downside risk and deserve to be examined separately. As a future research, we also aim to conduct a comparative study between multiple emerging and developed markets in order to understand to what extent the relationship between same risk measures and stock returns hold at the company level.

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