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Systematic Risk estimation in the First Companies of Tehran Stock Exchange Market by Wavelet

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ABSTRACT

The present research aims at studying the relationship between risk and stock return based on capital asset pricing model with multi-scale approach through wavelet analysis in Tehran stock exchange market. To investigate on the relationship between stock return and its systematic risk in different time periods, and with adopting wavelet analysis in a sample consisting of 38 active stocks in Tehran stock exchange market from 2006 to 2010, which were included in the first 50 companies of Tehran stock exchange from 2009 to 2011, released every three months, it was proved that the relationship between stock return and its beta is stronger in a short scale (2-4 days). The results of this study indicate that CAPM prediction with multi-scale essence for Tehran stock exchange is more likely to be expanded to the other horizons in short run.
KEYWORDS: wavelet analysis, systematic risk, CAMP, Tehran stock exchange market.

1. INTRODUCTION

Financial markets are one of the effective instruments in every country's economics. Nowadays, it can be said that all industrial countries have at least one stock exchange market, and most of developing countries have also made this market. According to authorities, one of the un-development reasons of developing countries is low fixed investment level in these countries. Among the main challenges of the third world countries is lack of proper structure for organizations people's capitals. On the one hand, importance of the investors' active participation in stock exchange market is so high that stock exchange essence depends on people's investment. Recognition of financial markets and getting assured of investment profitability in these markets leads to attracting more investors and finance resources. One of the major issues of investors in stock market is the relationship between risk and investment return, and expecting more return after taking higher risk is among any investor's proper expectations. Capital assets pricing model, in spite of sharp criticism against it, is still the most applicable model in describing the relationship between risk and return. According to the last findings, it is better to study CAMP model predictions based on multi-scale essence of risk and return. Implying modern methods in analysis finance information leads to obtaining more acute results which help investors a lot regarding the fact that financial markets are unpredictable. Wavelet convert is one of these technics. Wavelets are a string instrument in signals analysis use of which leads to results with more validity regarding being series-like essence of financial diagrams. In this paper, the suggested method to estimate systematic risk (asset beta) is based on wavelet approach, a rather new and innovative approach which allows us to analyze information in different time periods.

2. REVIEW OF THE LITERATURE

The concept of risk in CAMP is defined as a return variability of an asset to return variability of market portfolio. CAMP distinguishes between two general types of stock exchange (Fisher and Jordan, 1991, p:87-89). In investments, uncontrollable and foreign forces which have expanded impacts, are called systematic risk resources (Raei and Talangi, 2004, p:315). It is better for CAMP model predictions to be analyzed with regard to multi-scale essence of risk and return. In this research, a new method to estimate systematic risk (asset beta) is suggested. The suggested method is based on wavelet approach which is a rather new and innovative method in finance which allows us to analyze information in different scales (Octan, 2009). Shahveisi et al (2011) in their study called "Implying wavelet analysis in systematic risk process evaluation based on capital assets pricing model" by using wavelet analysis, they studied beta behavior (systematic risk index) and the relationship between risk and return based on capital assets pricing model in the format of different time periods. Moshiri et al (2010) in a research called

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"studying the relationship between stock return and inflation by using wavelet analysis in Tehran stock exchange", they did an experimental study to investigate on the relationship between stock index return and inflation rate by using multi-scale method of wavelet in Tehran stock exchange. The results of Regression in wavelet and wavelet correlation show that the relationship between inflation and stock return in short run is negative and it is positive in middlerun and long run. This study is in line with researches done by Azizi (2004), Boudoukh and Richardson (1993), Wang and Wu (2000) which were done by non-wavelet analysis approaches. The result of this study also supports Fisher's theory, and is, to some extent, in line with study done by Kim and In (2005) who studied the relationship between inflation and stock return by using wavelet analysis approach. Therefore, in Kim and In's research the relationship between inflation and stock return is positive in short and long run, and it is negative in middle run. Another research dealing with determining systematic risk by wavelet convert was done by Mabruk et al (2009). Studying a sample consisting of 98 active stocks in Istanbul stock exchange market from 2003 to 2007, they showed that the relationship between stock return and its beta increases in middlescale. These results showed that Turkey stock market is more applicable in an 8 to 16 day period. Therefore, these results show that CAMP prediction in middle scale is more expandable (Ben Mabrouk et al, 2009). In another research, estimation of capital assets pricing model in different time periods for France stock market by using wavelet analysis in a sample consisting of 26 stocks which were actively transacted from 2002 to 2005, Ben Mabrouk et al (2007) concluded the relationship between stock return and its beta gets stronger in short and middlerun. Therefore, CAPM prediction in France stock market in multi-scale format is more valid in short and middlerun (Ben Mabrouk et al, 2007). Ghanbari et al (2009) in a research called "estimation of systematic risk in different time periods by using wavelet analysis Tehran stock exchange market" used wavelet analysis as an experimental method in studying the relationship between stock return and systematic risk in different time periods. Shams et al, (2009) in their paper entitled "Studying time of capital assets pricing model through wavelet" investigated on a better description of market return variability and stock return of active companies in Iran and other seven countries' stock markets and studied capital assets pricing model by using wavelet analysis approach. Norsworthy et al (2003, 2005, 2000) used wavelet analysis to estimate CAPM. Norsworthy et al's main conclusion was that the greatest market influence in individual asset return is in high frequency. As opposed to Norsworthy et al who modeled individual assets return in different time periods using market portfolio. Norsworthy et al focused on one single portfolio calculated market return wavelet variance and wavelet covariance between market return and portfolio return in each scale to obtain correlated portfolio beta. Their results showed that the relationship between a portfolio return and its beta gets stronger when scale increases. It shows that CAPM model predictions are more appropriate in middlerun than short run.

3. THEORETICAL BASICS

a. Capital Asset Pricing Model

Capital asset pricing model, which has been extracted from Markwitz's modern portfolio theory (1952) by Sharp (1964) and Mossin (1966) and Lintner (1965), is one of the most applicable models in explaining the relationship between risk and return. CAPM is a main paradigm in the field of finance which is based on inferential Markwitz two-parameter portfolio model. Necessary premises of this study include homogenous expectations, complete competitive market, and loan lending and borrowing unified rate (Raei and Talangi, 2004, p:313). Irrespective of the kind of variety we use in our portfolio, removing all risks seems impossible. From an investor's vantage point, we deserve getting an amount of return which fits tolerated risk. Capital asset pricing model help us calculate investment risk and determine expected return rate. In other words, in any investment, there are two main components: expected returning and the risk which we should tolerate to obtain this return and we determine these two components by CAPM. CAPM model has been put forth by a finance economist named Sharp in the book "portfolio and capital markets". He was awarded the Nobel prize for this book. Indeed, CAPM is a series of predictions about moderated expected return of risky assets which has been developed simultaneously and independently by Sharp (1964) and Mossin (1966) and Lintner (1965), 12 years after Markwitz (1952). Modern portfolio theory believes that a certain risk can be removed by partial variety, but the question is that systematic risk can not be removed even by market diversification. In other words, if your portfolio consists of all market stocks, there is still systematic risk. Therefore, in obtaining a proper return, systematic risk disturbs investor. CAPM aims at measuring this un-removable spooky animal so that decreases loss produced by it.

CAPM equation is often written as follows in which experimental tests are more applicable:

$$R_i = R_f + \beta_i (R_m - R_f)$$

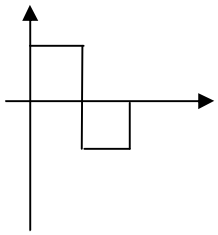
R_i is asset return of i and R_f is un-risky rate and R_m is market portfolio.

Above-mentioned equation is one the most important findings in the field of finance. This equation, called "stock exchange market line", shows expected return for all assets and also a portfolio of assets in economy. Each asset or portfolio expected return, either effective or ineffective, can be obtained through this equation. Note that R_f and R_m are not considered assets functions. Therefore, the relationship between expected return in the two assets can be contributed to their differences at the size of beta. The more sheet beta is, the more its middlereturn is. Besides, the relationship between beta and expected beta is linear. As mentioned earlier, any stock risk can be classified into systematic and unsystematic. Beta is the index of systematic risk. The above-mentioned equation verifies the conclusion that systematic risk is the only main factor in determining expected return, and unsystematic risk plays no role. In other words, investors get rewards because of tolerating systematic risk. So total variance of returns does not influence expected return. This conclusion will produce (if investors can remove all unsystematic risk by diversification) an important economic generalization that there is no reason for investors to get more rewards because of tolerating more unsystematic risk.

b. Wavelet analysis

Immediate analysis question dates back to many years ago, but recently regarding the advancements in this field, immediate series gave way to wavelets in the discussions of engineering and applied mathematics (Fashandi, 1999, p:2). Har (1910) showed that a basis for $L^2(R)$ can be made by transmitting and scaling certain square wave functions. Some years later, the scientists came into conclusion that the functions introduced by Har brings about a certain type of wavelets. Hars wavelet is the smallest possible wavelet. The problem of this wavelet is that it is not continuous and is not derivable.

Real function of $(t)=1_{[0,1/2)}(t)-1_{[1/2,1)}(t)\Psi$ is called Har wavelet. It is clear that Ψ is true in the definition of wavelet. Because:



$$\Psi(t)$$

$$\int_{-\infty}^{+\infty}\Psi(t)d(t)=0 \quad , \quad \int_{-\infty}^{+\infty}|\Psi(t)|^2 d(t)=1$$

Function of $(t)\ _{0,1)}\ (t)=1_{[}\Phi$ is called Har scale. This function has the average and norm of 1.

$$\int_{-\infty}^{+\infty}\Phi(t)d(t)=1 \ _{g} \ \int_{-\infty}^{+\infty}|\Phi(t)|^2 d(t)=1$$

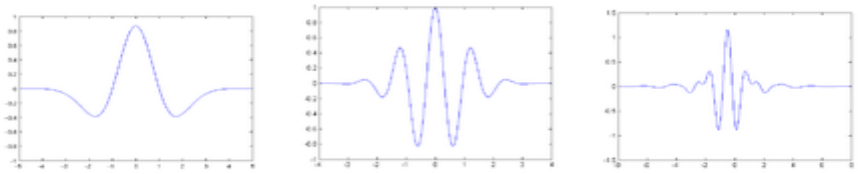
One of the disadvantages of Har wavelet is that it is un-continuous, because we always prefer to use continuous functions to approximate functions. Dabshiz wavelets are an expanded form of Har wavelets which function better than Har functions in functions analysis.

Wavelet Ψ is called Dobshiz wavelet from P order:

$\int_{-\infty}^{+\infty} t^j \Psi(t)d(t)=0$ j=0,1,…,p-1

Wavelets function very strongly in analysis of transient signals, because wavelet series depend on two factors of scale and transmitting which make signal behavior analysis possible in dense set of time situations and in terms of a wide range of scales. The discussion of wavelets and their applications have developed very much in the recent years. One of the interesting features of this discussion is, which can not be found in other math issues, its dependence to other field of knowledge like physics, computer sciences, and majority of engineering branches each of which play an important role in developing wavelets. Among the applications of wavelet in signal analysis are deleting noise from signal, compressing signal, statistical signals processing, signal processing, and image processing (Fashandi, 1999). The issue of signals and systems is one the rich discussions whose concepts are active in a wide range of scopes. Ideas

and methods belonging to these concepts play a crucial role in different fields of science and technology. Using wavelet in our country is classified into engineering and telecommunication and had no application in economic and financial fields in the last years except some cases. Studies on the difference beta estimation indicate the importance of scale timing. By using applying small wavelet, beta behavior, (systematic risk index) and the relationship between risk and return based on capital asset pricing model under the format of time scales can be studied. The main aim of this study is to find out whether there is a significant relationship between systematic risk and stock return in time scales or not? Different types of wavelet are as follows:



4. DATA AND RESULTS

In this paper, to test hypotheses, the studied companies have been selected in a way that first all accepted companies have been listed to the ending of 1385. Then the companies have been selected which have been among the best 50 companies of Tehran stock exchange market from 2009 to 2011 which is released every three months (8 periods). As a result, 38 companies qualifying above conditions have been selected. To analyze data, descriptive statistics like mean, standard deviation, skewedness coefficient have been used, and to normalize time series, Jarko-Bera has been used. The results are as follows in the following tables:

Normality test table based on jb

	companies	kurtosis	Skewedness	variance	mean	median	statistic JB	Sample no
1	parskhodro	-0.4073	-0.1681	1003.753	80.27	87.79	12.19404	1049
2	Abadan petroshimi	0.1432	1.0239	745.114	15.96	10.37	170.3304	970
3	Iran lising	-0.5643	0.7521	6333.667	84.59	66.35	113.0226	1051
4	Iran carbon	-1.1358	-0.076	254.695	-24.29	-22.93	53.45365	977
5	Tehran cement	-0.6499	0.0203	144.479	-6.07	-7.04	16.59241	939
6	Niro moharake	-0.0395	0.9616	6818.541	115.73	85.17	149.4046	969
7	nirokolor	-1.1601	0.1658	34572.799	323.69	293.05	45.21053	745
8	naftpars	-0.5676	-0.4660	121.936	20.97	22.37	45.85407	924
9	alborzdaru	-0.5465	0.7168	47797.849	344.38	273.72	95.32883	972
10	petroshimi	-0.4646	0.4056	427.247	5.65	7.45	36.16569	993
11	Negin zoghalsang	0.4346	1.0068	505.854	25.88	19.58	165.1485	934
12	Loghman darou	-0.5282	0.2063	4485.447	139.92	137.05	17.59756	940
13	Osveh darou	-0.4615	0.3679	127384.403	604.10	592.52	27.53774	876
14	Sijan darou	-0.2767	0.9267	8738.284	178.01	147.80	151.2907	1034
15	saipa	-0.0750	0.8930	1822.998	54.81	52.83	138.7353	1042
16	Bank	-0.7974	0.541	5246.969	91.41	78.67	80.24367	1066
17	Mashad ringsazi	-0.8814	0.5077	1286.968	49.91	41.47	70.80495	940
18	yama	0.7248	0.6044	24104.875	297.96	295.05	65.71965	794
19	chador	-0.7695	0.001	8591.397	184.86	187.52	26.00579	1054
20	Tose sanaei behshar	0.6726	1.3324	1856.258	11.85	-5.98	325.1151	1033
21	Gol gohar	-0.6184	-0.3122	10770.365	213.78	228.94	30.11908	936
22	Bank karafarin	-0.7159	-0.2645	7560.837	150.40	167.24	33.54353	1016
23	tolipers	-0.0430	-0.1295	364.655	47.13	44.16	2.345534	817
24	Mes bahonar	8.7467	2.4526	405.209	14.07	11.39	3528.24	842
25	Bank es	-0.2538	0.3915	5499.837	110.11	100.27	26.05633	923
26	Bahman group	2.6432	1.8718	767.685	-21.90	-35.93	820.8154	938
27	Khar5k petroshimi	-0.4290	0.3418	1499.196	77.42	71.62	23.17751	854
28	Shargh electric	-1.1878	-0.3980	680.996	41.39	50.51	85.70375	1006
29	Amirkabir fulad	0.4342	0.4964	463.945	23.62	26.31	45.73898	935
30	Otomobil gh	-0.8162	0.6470	1062.494	35.66	28.90	98.02063	1005
31	Siman sepahan	1.37	0.8356	161.883	-14.33	-16.20	176.2717	906
32	Darou jaberebn haian	1.7139	-0.3647	2494.433	145.31	143.10	147.4468	1020
33	Farsit doroud	-0.0667	-0.6343	1232.781	66.47	74.79	63.48697	944
34	takinku	0.231	1.1379	377.279	6.41	-2.21	197.9756	908
35	kimiadarou	-0.5082	-0.4524	11043.861	220.65	239.59	42.23088	941
36	mehrkampars	2.9478	-1.7378	374.262	70.74	77.58	747.693	864
37	Azin saipa	-0.9046	0.5194	750.039	41.94	35.12	83.16381	1052
38	Kowsar darou	0.8231	0.3115	5603.958	190.29	188.29	45.02262	1014

After extracting stock price of these companies, through the software Rahavardnovin and being processed by Excel, daily return of these companies has been considered as the basis for testing this research hypotheses.

In this study, daily return rate of all stock exchange market (r_m) has been calculated based on Tehran stock exchange market price index and in the form of the studied companies' stock price difference index in the current day and compared to stock price index in the previous day and based on relation (1-4):

$r_{mt} = \log I_t - \log I_{t-1}$

in which:

r_{mt}: stock exchange total return rate

$\log I_t$: total index of price on day t

$\log I_{t-1}$: total index of price on day t-1

To obtain wavelet beta coefficient, 6 tie scales have been used.

6	5	4	3	2	1	scale
64 to 128 days	32 to 64 days	16 to 32 days	8 to 16 days	4 to 8 days	2 to 4 days	**Time distance**

After analysing daily return of stock in 6 scales, we test its normality, as a result, analysed data in each of these 6 scales has been evaluated to test hypotheses. The results are as follows in the following table;

Normality test scales table (k-s)

scale	D1	D2	D3	D4	D5	D6	Mean-N
number	38	38	38	38	38	38	38
Sig level	0.668	0.241	0.907	0.794	0.376	0.211	.678

Null hypothesis: data is normal

Hypothesis 1: data is not normal

The above table is normality test for Ds, regarding sig values which are higher than 0.05, it means that null hypothesis is accepted and data is normal.

After getting assured of data, relevant beta to each company in each of the given scales, is calculated by wavelet formula and is listed in the following table:

β^j_i indicates beta i in the time scale of j which is explained as follows:

$$\hat{\upsilon}^2_{r_{mt},r_{it}}(\tau_j) = \frac{1}{(n'_j - L'_j)2^j} \sum_{t=L'_j-1}^{n'_j-1} d^{\,r_{mt}}_{j,t}\, d^{\,r_{it}}_{j,t}$$

$$\hat{\upsilon}^2_{r_{mt}}(\tau_i) = \frac{1}{(n'_j - L'_J)2^j} \sum_{t=L'_j-1}^{n'_j-1} d^2_{j,t}$$

$$n'_j = \frac{n}{2^j} \qquad L'_J = \left[(L-2)\left(1-\frac{1}{2^j}\right)\right]$$

In which:

$\hat{\upsilon}^2_{r_{mt},r_{it}}(\tau_j)$: assets market covariance wavelet in scale of j

$\hat{\upsilon}^2_{r_{mt}}(\tau_j)$: market portfolio covariance wavelet estimator in scale j

n'_j: the number of un-continuous convert coefficient of wavelet at level j

L'_j: the number of un-continuous convert bound coefficients of wavelet at level j

N: sample size

$d_{j,t}$: variables wavelet coefficient in scale

l: wavelet filter domain

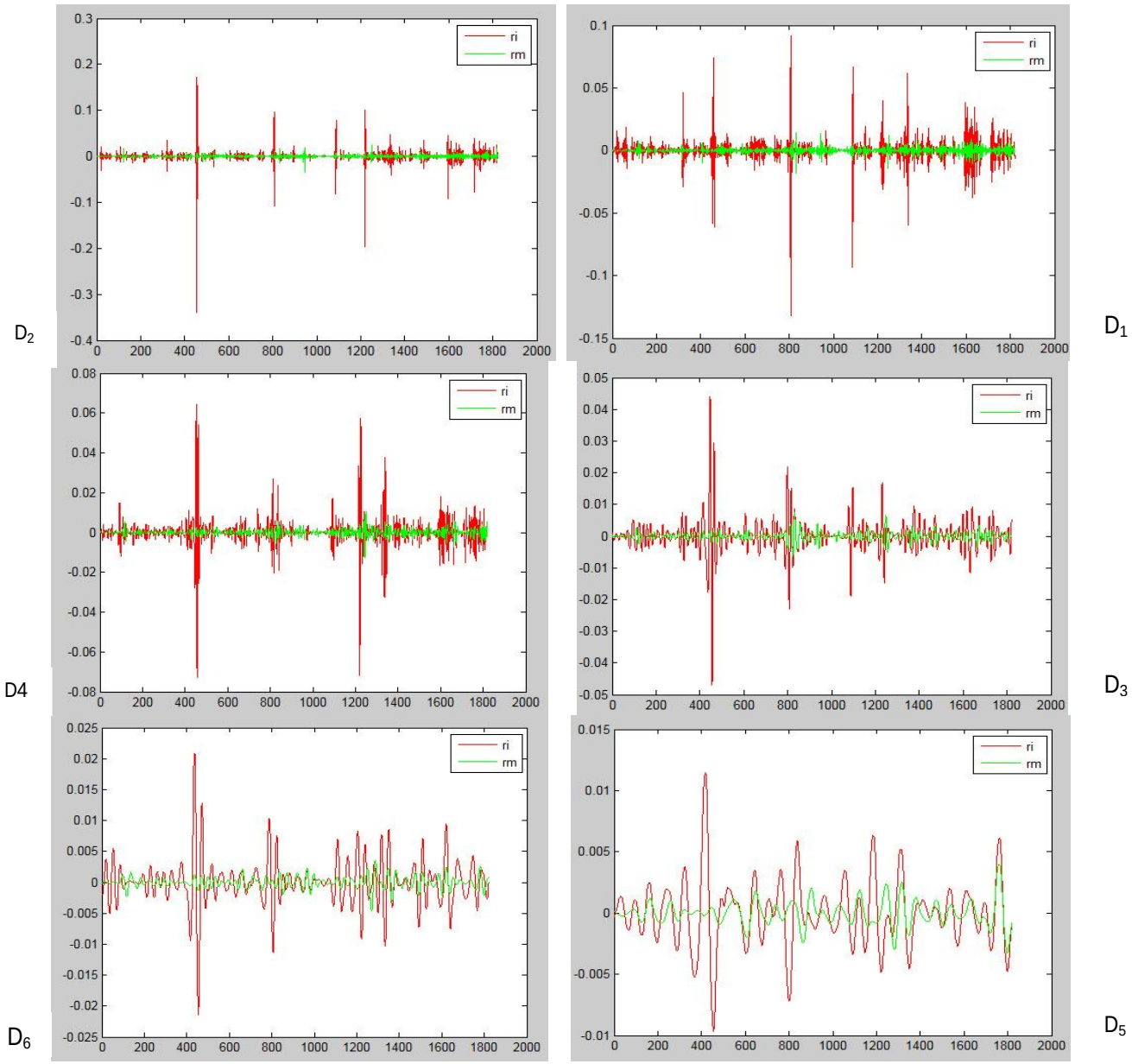
The result of estimated beta through wavelet in different time scales

		β1	β2	β3	β4	β5	β6
1	Pars khodro	0.051	0.194	0.186	0.785	2.144	3.025
2	Abadan petro	0.001	-0.008	0.111	-0.137	-0.686	2.042
3	Iran lising	0.000	0.019	-0.025	0.639	-0.851	-1.042
4	Iran carbon	-0.008	0.138	-0.062	-0.142	2.373	1.642
5	Siman teh	0.014	0.039	-0.209	0.335	0.130	1.593
6	Niro moharek	0.024	0.068	0.192	0.358	0.626	2.909
7	nirokoler	0.008	-0.020	0.024	-0.111	0.135	-0.395
8	Naft pars	0.000	-0.008	0.090	0.347	0.492	1.112
9	Alborz darou	-0.001	-0.089	0.209	-0.675	0.490	0.610
10	Shazand petroshimi	0.020	0.147	0.277	0.205	1.534	1.992
11	Negin zogh	0.019	0.054	0.025	1.055	-0.739	2.427
12	Loghman darou	0.004	-0.083	0.076	-0.475	-0.177	2.053
13	Osveh darou	0.002	-0.004	-0.023	0.141	0.139	1.610
14	Sobhan darou	0.002	0.014	0.000	-0.095	-0.520	1.034
15	saipa	0.071	0.314	0.387	0.556	3.396	2.803
16	Parsian bank	0.044	0.261	0.427	1.193	1.923	3.025
17	Mashad niro	-0.005	0.037	0.164	0.469	0.551	2.435
18	yama	-0.016	0.055	0.046	-0.745	-0.768	2.398
19	Malo chador	-0.030	0.304	0.203	1.490	2.922	3.025
20	beshar	0.028	0.084	0.229	0.208	1.540	1.162
21	golgohar	-0.059	0.064	0.508	0.311	3.535	3.025
22	Bank karafarin	0.020	0.226	0.212	0.220	-0.154	-2.081
23	tolipers	-0.015	0.028	0.175	-0.313	0.163	-0.471
24	bahonar	0.041	0.081	-0.215	-0.632	-1.157	3.025
25	Bank e n	0.030	-0.029	0.259	0.623	2.640	0.899
26	Bahman group	0.110	0.211	0.544	1.147	1.952	3.025
27	Khark petr	0.076	0.145	0.582	1.494	2.208	3.025
28	Shargh electronic	0.027	0.052	0.410	0.180	-0.214	3.025
29	amirkabir	-0.005	-0.036	-0.030	0.405	0.156	-2.059
30	Ghatate oto	0.053	0.129	0.488	0.554	1.634	3.025
31	Sepahan siman	0.015	0.043	0.013	0.125	0.537	3.025
32	Darou jaber	0.034	0.080	0.158	0.545	-1.935	2.681
33	Doroud farest	0.046	0.180	0.349	0.662	-1.218	1.439
34	Takin ko	-0.004	0.044	0.092	-0.127	-1.679	0.346
35	kimidarou	-0.016	-0.074	-0.458	-0.216	1.151	1.478
36	Pars mehrkam	0.025	0.059	0.199	-0.376	1.935	3.025
37	Azin	-0.022	0.062	0.292	0.946	1.201	2.300
38	Kowsar	0.018	0.040	-0.122	-0.464	0.984	0.125

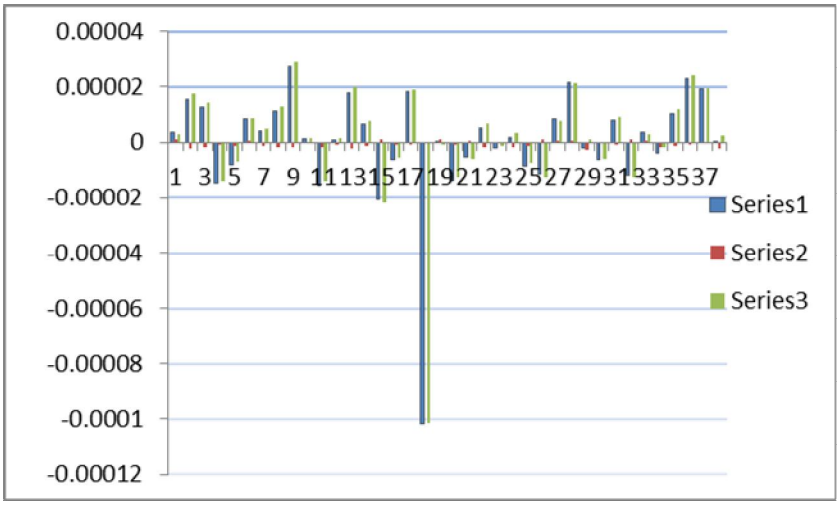
The OLS estimates of average excess return versus average stock beta

scale	steep	statistic t	R^2
1	.393	2.566	.155
2	-.604	-4.547	.365
3	.138	.834	.019
4	-.120	-.727	.014
5	-.443	-2.961	.196
6	-.038	-.231	.001

The above table shows that the highest steep has been obtained in the first scale and for the time horizon 2 to 4 days. It means that multi-scale CAPM model is verified for Tehran stock exchange market for the short time.

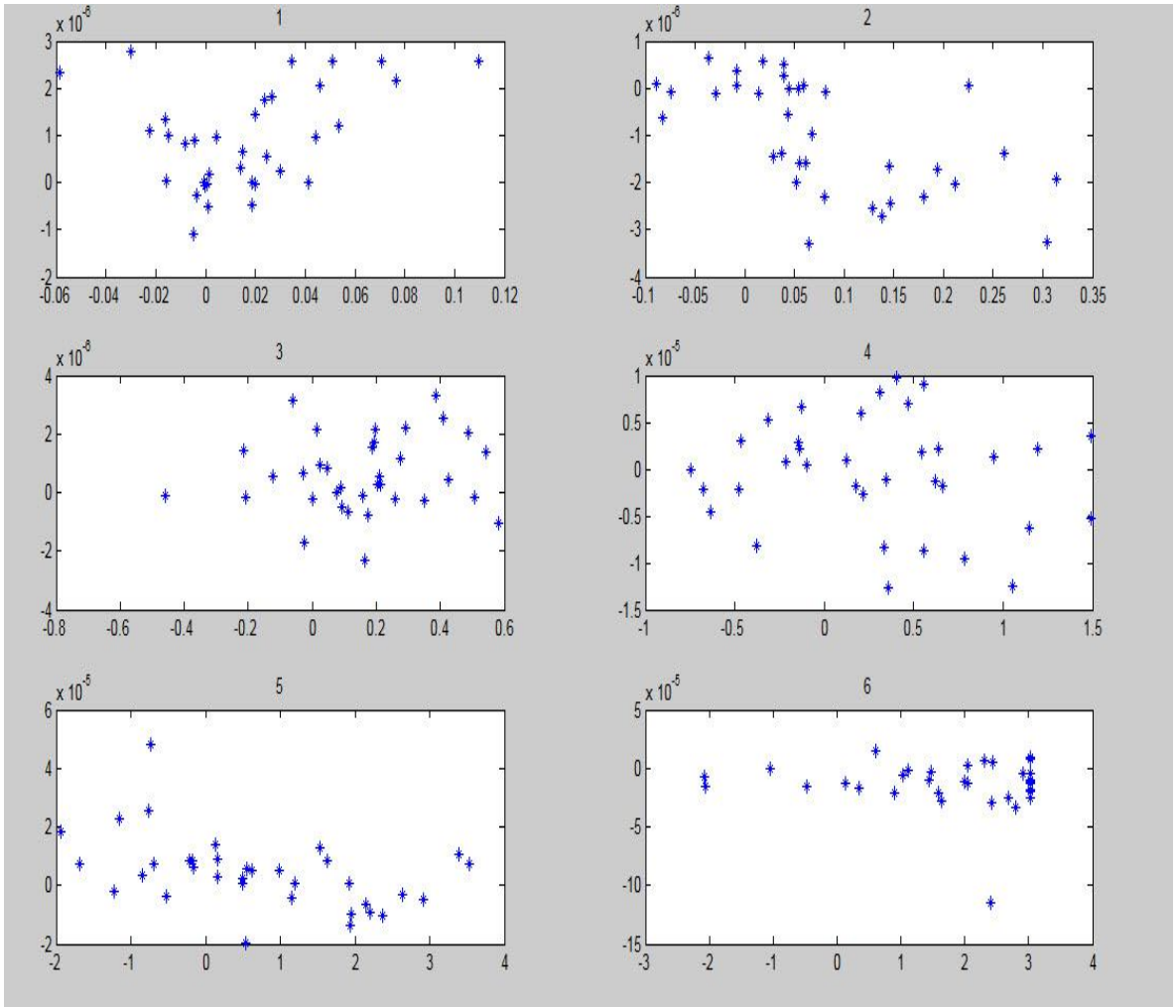


Above diagrams show market return trend and Pars Khodro stock return in 6 different scales. St it can be observed a visual observation of wavelet diagrams in short middletime horizons is really hard. Therefore, to prove the research findings after comparing 6 scales for each stock, the difference between market return mean and expected return mean for each stock for 38 companies were calculated in the form of a diagram. Based on this comparison, the results of the study have been proved, scale 1 and 6 inserted as an example, and the difference between beta and return in scale 1 was smaller than other scales.



The following figure shows the relationship between beta average and expected return. As shown, these two variables have more correlation in scale 1.

The average excess return on each individual stock (vertical axis) versus corresponding beta at different scales.



5. CONCLUSION

In this research, wavelet method as a new technique systematic risk estimation based on capital assets pricing model was used for 38 stocks which were active in Tehran stock exchange market from 2006 to 2010, and they were among the best 50 companies of Tehran stock exchange market released every three months. The results of the current research show that multi-scale CAPM, for Tehran stock exchange market during the given time in this study, in short time scale was more reliable than that in middle and ling time. As the companies, which were deal with in this study, are included in the best 50 companies of Tehran stock exchange market, the results of this study benefit from acceptable validity. According to this research, to the investors that look for more return expectation and take more risk in Tehran stock exchange, it is suggested that they select short term investment.

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