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THE PORTFOLIO DIVERSIFICATION EFFECT IN THE ATHENS STOCK EXCHANGE

By
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I. INTRODUCTION

A stock market can offer a broad variety of investment opportunities to investors if the returns of the traded stocks are not closely correlated. This provides the investors with two opportunities: first, they can hold assets with different risk-return combinations which best fit their personal attitudes toward risk, and second, they can reduce the risk of their investments by increasing the number of different securities in their portfolios. This latter opportunity is known as the diversiffication effect, and it is possible when the stock returns are not perfectly positively correlated.

The ability to take full advantage of the diversification effect is particularly important for the managers of mutual funds, trust funds, and pension funds who have either a managerial or a fiduciary responsibility in pursuing the investment of the funds entrusted to them. It is also of importance to the conservative investor who is averse to holding high return assets if, at the same time, the risk is also high. In these cases, the diversification effect allows one to reduce risk without sacrificing materially the expected return of the investment.

In the case of a small stock market like that of the Athens Stock Exchange (ASE), it is worth investigating the extent to which the diversification effect works since the outcome can shed light on the potential of this market to serve as a proper investment medium. Thus, in this paper we study empirically the relationship between portfolio size and portfolio risk using a sample of 40 stocks traded in the period

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1973-76. Our work is similar in spirit to the informative studies on the diversification effect in the New York Stock Exchange by Evans and Archer (1968) and Warner and Lau (1971).

Recognizing the fact that in a thin market many stocks have irregular transaction frequencies we also examine whether an investor can obtain the same opportunities in risk-reduction by spreading the funds only among the most active issues. If this proves to be an adequate diversification stategy, then we may conlude that the ASE is a severely segmented market from a portfolio approach point of view.

In Section II we briefly discuss the theoretical underpinnings of the diversification efect; in Section III we describe the methodology; in Section IV we present the results, and finally we conclude with Section V.

II. THEORETICAL BACKGROUND

The portfolio approach to investments originated by Markowitz (1952) and simplified by Sharpe (1963) suggests that investors should allocate their funds among different assets with the objective to maximize the expected return for given level of risk or, conversely, to minimize the risk for a given level of expected return. The formal approach to this goal is to apply a portfolio construction model to derive the frontier of the mean variance efficient portfolios. Each portfolio on the efficient frontier is a combination of stocks which, for a given expected return, offers the minimum variance (or standard deviation), where the latter is a proxy for risk.

It is well known that whereas the expected return of a portfolio of assets is a weighted average of the expected returns of the individual assets, this does not hold necessarily for the standard deviation of the portfolio[1]. The portfolio standard deviation will be less than the weighted average of the individual assets' standard deviations when the correlation coefficients of the returns of the assets with each other are less than unity. Consequently, for portfolios of different securities, the intensity of the diversification effect can be measured by the extent to which the portfolio standard deviation is reduced below the level given by the weighted average of the assets' standard deviations. This in turn depends necessarily on whether or not the asset returns are not perfectly positively correlated.

1. The standard deviation of a portfolio is a weighted average of the standard deviations of the constituent assets only if the returns of the assets are perfectly positively correlated. In this case

$$\sigma_p = \sum_{i=1}^{N} \chi_i \sigma_i$$

where x_i is the allocational weight of the asset i and σi is its standard deviation.

As the number of the different securities in a portfolio increases, the number of the covariance terms increases in an even faster rate relative to the number of the variances implying a progressive dominance of the values of the covariance terms over those of the variance terms[2]. At the limit, that is the portfolio that encompasses the population of the stocks in the market, the part of each stock's return variation that is due to idiosyncratic, firm-specific conditions is completely offset through its covariation with the idiosyncratic component of the returns of al other stocks or, as we say, it is diversified away. Thus, such a portfolio, called also the market portfolio, is a perfectly diversified portfolio, meaning that risk cannot be reduced any further.

Using this market portfolio as the benchmark of diversification performance, we can examine how well diversified a given portfolio is by estimating the coefficient of determination, R^2, from the regression of the portfolio returns against the market portfolio returns.[3] An R^2 equal to one indicates that the variation of the portfolio returns is fully explained by the variation in the returns of the market portfolio and, hence, the two portfolios are perfect substitutes from a risk point of view. On the contrary, an R^2 value closer to zero indicates that the portfolio risk contains firm-specific return variations which could be eliminated away by adding more securities to the portfolio.

In the context of the mean-variance asset pricing theory, the perfectly diversified market portfolio contains only systematic risk, that is, risk which cannot be diversified away further and which is due to the ups and downs of the market[4]. Any other single asset or portfolio of assets contains both systematic and unsystematic risk. The latter kind of risk can be reduced through diversification by continuously increasing the number of securities in the portfolio until one ends up with the market portfolio.

2. Adding one more security to a portfolio means the addition of one more variance and N-1 covariance terms. Thus, in an N-security portfolio we have N variance terms and N (N-1) covariance terms which implies that as N increases the portfolio variance reflects more and more the contribution of the covariance terms. For a formal proof of this result see Fama (1976) p. 251.

3. The coefficient of determination can be estimated from the regression model $R. = a + \beta R_m + \varepsilon$,, where R; and R_m are the returns of the asset i and of the market portfolio respectively, and ε; is the random disturbance term. Taking the variance on both sides of the equation we have.

$\sigma i = \beta^2 \sigma m + {}^{\sigma}\varepsilon'$

ςηερε $\beta^2 = Pim^2\sigma^2 / \sigma\mu =$

$= \rho im^2 \sigma^2 \cdot / \sigma^2$.

Carrying out the substitution we get $\sigma i^2 = p_{in}\sigma i^2 + \sigma\varepsilon^2$, which finaly yields $\underline{\sigma}^2 / \sigma^2$ i=1 — pim^2, where p_{in}^2 is the coefficient of determination. Clearly, when $\underline{p}_{in}^2 = 1$, $\sigma / \sigma \cdot = 0$ implying that $\sigma^2. = 0$, i.e., the firm-specific or unsystematic risk is diversified away. See Levy and Sarnat (1972) p. 485.

4. Of course, for the market portfolio, total and systematic risk are the same.

In view of the above analysis, this paper investigates, on the one hand, to what degree one can achieve risk reduction in the ASE by increasing the number of different securities in the portfolio. On the other hand, judging by the rate of convergence of the R^2 toward unity, the paper examines how fast diversification works to obtain portfolios which are close substitutes of the market portfolio in terms of risk.

III. METHODOLOGY

The study is based on a sample of 40 common stocks traded in the four year period January, 1973 to December, 1976.[5] The weekly returns are drawn from the data base developed by Papaioannou (1979), and they reflect the necessary adjustments for stock splits, stock dividends and rights offerings.

Analytically, the weekly return of the i stock, Ri, is given by

$$R_{it} = \frac{P_{t+1} - P_t + D_t}{P_t}$$

where P_{t+1} is the price at the end of the t week, P_t is the price at the beginning of the t week, and D_t is the total dividend payment in the span of the t week. Each weekly return R_{it} is then multiplied by 52 to be converted into an annualized weekly return, AR_{it}.

In order to study the effect of the size of the portfolio on the risk and the mean return of the portfolios we need further to calculate the standard deviations and the mean returns of each different size portfolio under the conventional condition that each time the investor invests 1/N of the available funds in each of the N stocks.

Thus, the portfolio mean return,, Rp, is calculated as

$$\overline{R}_p = \frac{1}{N} \sum_{i=1}^{N} \overline{AR}_i \tag{1}$$

Where ARi is the estimated mean return of the stock i according to the formula.

$$\overline{AR}_i = \frac{1}{T} \sum_{t=1}^{T} AR_{it}.^{6}$$

5. The names of the 40 stocks are given in Appendix A.

6. In the period 1973-76 there were 203 trading weeks resulting in 202 weekly returns. However, due to the lack of transactions several of the 40 stocks had fewer than 202 returns. Thus T varies across the 40 stocks.

The portfolio standard deviation, Sp, is estimated from the equation

$$S_p = \frac{1}{N}\sqrt{\sum_{i=1}^{N}\sum_{j=1}^{N} S_{ij}^2} = \frac{1}{N}\sqrt{\sum_{i=1}^{N} S_i^2 + 2\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} S_{ij}} \quad (2)$$

where Sij is the returns covariance of the i stock with the j stock, and S_j^2 is the variance of the returns of the i stock, the latter estimated by the formula

$$S_i^2 = \frac{1}{T-1}\sum_{t=1}^{T} (AR_{it} - \overline{AR}_i)^2.$$

The random portfolios with the different numbers of securities were formed as follows. By means of a a random number generating process we chose one security to form, at first, a one-stock portfolio. We repeated this experiment 100 times by replacing each time the number of the chosen stock in the total sample of the 40 stocks.[7] This way we obtained 100 one-stock portfolios. We repeated this process to obtain random portfolios of 2,3 4, ... 40 stocks. All in all, we constructed 100 random portfolios of M stocks, where M ranged from 1 to 40. Obviously, due to the replacement condition in a random portfolio of say, 10 stocks, it was possible for a given stock to be included in the same portfolio more than one time. Thus, each of the 100 portfolios of size M was not composed of M distinctly different stocks. The implications of the results of this study, then, are relevant for an investor who naively allocates his funds equally over a number of stocks randomly selected from a black box with replacement.

By applying respectively the formulae in (1) and (2), above, we calculated the mean return, R_pk, and the standard deviation, S_pk for each of the 100 random portfolios of size M. Next, for each group of 100 portfolios of M stocks, we took the average of the mean returns across the 100 portfolios of that size, R^M_p according to the expression.

$$\overline{R}^M_p = \frac{1}{100}\sum_{K=1}^{100} R_{pk}$$

Accordingly, we calculated the average value of the standard deviations of the 100 portfolios of size M, S_{φ} as.

7. The random selection by replacement was followed because of the rather small size of our sample, so that in the repeated drawings the likelihood of successive selections would not be affected.

$$\overline{S}^M_p = \frac{1}{100} \sum_{K=1}^{100} S_{pk}$$

Thus, we calculated 40 average mean returns and 40 average standard deviations over the 100 portfolios of the 40 different sizes.

To test whether the reduction of the risk of portfolios of successively larger sizes was significant we conducted t-tests on the average standard deviations of pairs of portfolio groups differing η size by 1 and 2 stocks respectively.[8] We also tested whether the standard deviations of the 100 portfolios of each size converged toward their average value as the size of the portfolio M increased. In other words, using F-tests, we tested for the equality of the variances of the stadard deviations of the groups of 100 portfolios with sizes differing by 1 and 2 stocks.[9] Although, a priori we expect both the average standard deviation and the variance of the standard deviations to fall as we increase the portfolio size, the statistical tests are useful in pinpointing the portfolio size beyond which the addition of one or two stocks offers no statisticaly significant benefits to the investors.

For the estimation of the coefficient of determination R^2, we ran regressions of the weekly returns of random portfolios of sizes from 1 to 40 stocks on the weekly returns of a proxy for the market portfolio. We assumed the set of the 40 stocks to constitute a fairly good representation of the stock market portfolio. The returns of this portfolio were calculated for each week according to the formula.

$$R_{m,t} = \frac{1}{N} \sum_{i=1}^{N} AR_{it}$$

8. The t-test conducted by calculating

$$t = (\overline{S}^M_p - \overline{S}^{M+L}_p) / (S_M^2 + S_{M+L}^2)/100)^2,$$

where S_p and S_p are the average standard deviations for each of the 100-portfolio groups of M and M+L (L= 1,2) stocks respectively, and S_M^2 and S_{M+L}^2 are the variances of the standard deviations of each 100-portfolio group size M and M+L. This computation of the t-statistic is appropriate when despite the nonhomogeneity of the variances the samples are equal and large enough to even allow application of the normal approximation given by the normal tables of the ζ variable. See Winkler and Hays (1975), pp. 369 - 374.

9. For the F-tests we calculated the ratios $F = S_M^2 / S_{M+L}^2$ of the variances of the standard deviations for groups of 100-portfolios of sizes M and M+L (L=1,2) under the alternative hypothesis that

where N is the number of stocks with available returns in week t. Ideally, of course. N should be always 40, if all stocks were traded in every week.

The weekly returns of the k random portfolio of size M were calculated by the formula.

$$R^{M}_{pt} = \frac{1}{M'} \sum_{i=1}^{M'} AR_{it}$$

where R_{pt} is the annualized return of the t week for a random portfolio of M stocks, and AR_{it} is the annualized return of the t week of the i stock. M' is the number of 'the stocks with returns available in each week t among the total M stocks of the portfolio.

Then we regressed the weekly returns of the k random portfolio against the corresponding weekly returns of the market portfolio to calculate the R^2 of the k Portfolio.

The average value of the R^2s for each 100-portfolio group of size M was computed as

$$\bar{R}^2_M = \frac{1}{100} \sum_{K=1}^{100} R^2_{MK}$$

The significance of the changes in R_M^2 and of the variance of the RM_K around the mean R_M^2 for each size were tested in a similar fashion as above by means of the t and the F tests.

IV. THE RESULTS

In Table 1, we present the mean returns and the standard deviations of the 40 stocks of the sample for the whole period as well as for two subperiods. one for the years 1973-74 and the other for the years 1975-76. Judging from the overall average values of the mean returns and of the standard deviations, we infer that the behavior of the stock market was quite different in the two subperiods. In particular, during the years 1973-74 the market moved from an early high activity phase to the political instability of the late months of 1973 and the summer months of 1974. This is reflected in the considerably higher average standard deviation of the returns of this period as compared to the average risk of the more stable period 1975-76. It is also evident from Table 1 that the 40 stocks offered a wide variety of mean returns and standard deviations to the investors.

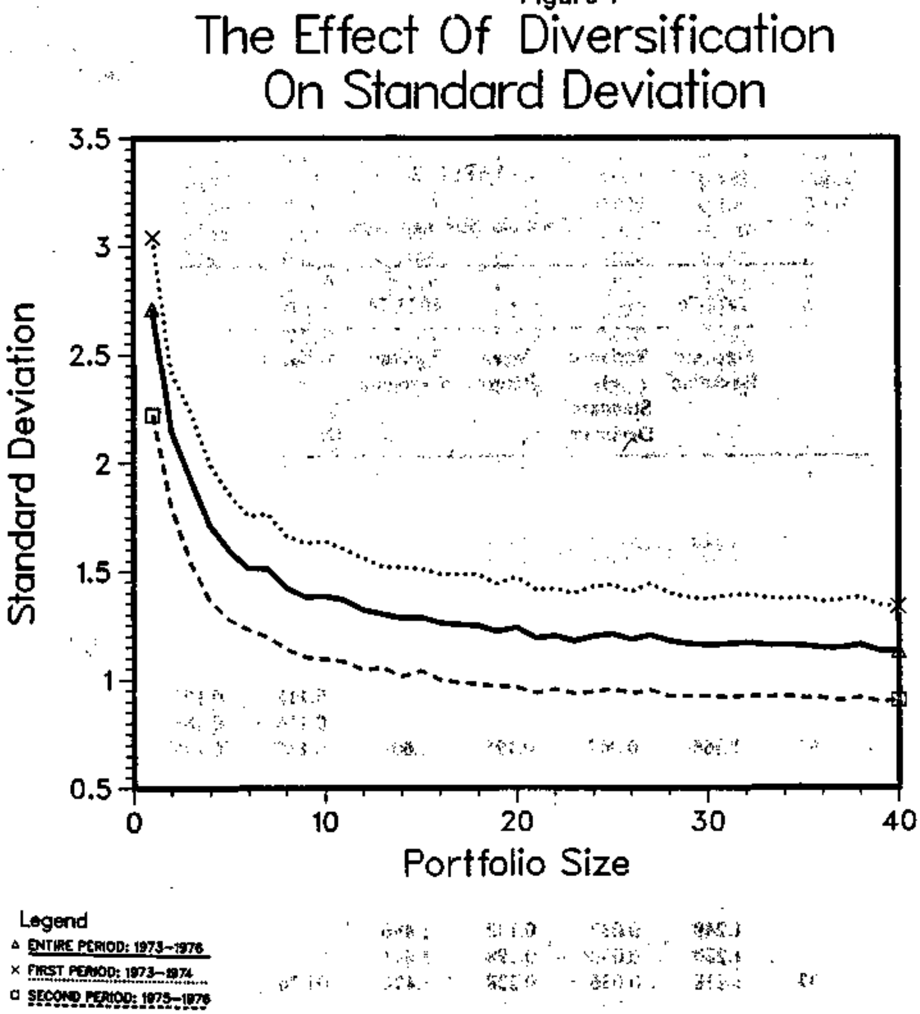
TABLE 1

Mean Return and Standard Deviation of the 40 Stocks

	1973-76		1973-74		1975-76	
Stock	Mean Return	Standard Deviation	Mean Return	Standard Deviation	Mean Return	Standard Deviation
1	−0.001	2.093	−0.086	1.781	0.084	2.358
2	−0.008	1.429	−0.073	1.538	0.056	1.307
3	−0.019	2.153	−0.161	2.242	0.122	2.050
4	−0.060	2.104	−0.164	2.384	0.048	1.758
5	−0.170	3.481	−0.365	3.045	0.052	3.908
6	0.180	1.909	0.308	2.372	0.053	1.291
7	0.115	2.194	0.094	1.847	0.140	2.535
8	0.051	2.865	0.025	3.447	0.079	2.091
9	0.120	2.071	0.020	2.088	0.245	2.043
10	0.322	2.839	0.617	3.133	−0.025	2.403
11	−0.030	1.711	−0.064	2.081	0.005	1.235
12	0.008	1.646	0.032	1.979	−0.017	1.203
13	−0.073	2.174	−0.019	2.411	−0.128	1.901
14	0.192	3.041	0.105	3.053	0.297	3.023
15	0.297	2.823	0.284	2.704	0.314	2.981
16	0.139	1.759	0.109	1.697	0.190	1.860
17	0.149	3.455	0.280	3.623	−0.038	3.191
18	0.419	7.014	0.701	8.920	0.019	2.460
19	−0.037	3.313	−0.311	3.199	0.225	3.398
20	0.195	1.549	0.310	1.712	0.064	1.327
21	0.027	1.690	−0.084	1.741	0.152	1.622
22	0.106	2.504	0.017	2.582	0.217	2.399
23	0.193	2.712	0.034	2.967	0.273	2.572
24	0.119	2.141	−0.115	1.741	0.370	2.473
25	0.262	2.290	0.310	2.747	0.217	1.756
26	0.143	1.084	0.098	1.314	0.188	0.786
27	−0.011	1.648	−0.039	1.803	0.018	1.469
28	0.022	1.195	−0.012	1.510	0.066	0.573
29	0.538	5.398	0.887	7.789	0.261	2.014
30	−0.094	2.289	−0.416	2.594	−0.047	2.237
31	0.152	3.005	0.361	3.645	0.012	2.475
32	0.585	5.897	0.925	7.864	0.252	2.831
33	1.292	5.157	0.754	5.892	1.678	4.518
34	0.339	2.492	0.669	2.936	−0.006	1.859
35	0.329	3.615	0.504	4.983	0.206	2.182
36	0.494	3.727	0.938	4.680	0.072	2.432
37	0.327	3.175	0.463	2.882	0.203	3.417
38	0.349	3.495	0.163	3.560	0.464	3.450
39	0.682	3.131	0.526	3.542	0.794	2.793
40	0.115	3.101	0.216	3.523	0.011	2.590
Avg.	0.194	2.784	0.196	3.180	0.180	2.269

The mean return and the average risk performance of the random portfolios of increasing size are displayed in Table 2. We observe that as the portfolio size increases from 1 to 40 stocks, the mean returns of the 100-portfolio groups remain remarkably stable at around 19 percent for the whole and the early period and at around 18 percent for the late period. On the contrary, the average standard deviation declines almost monotonically as the size increases. For the whole period the

Figure 1



average risk of the 40-stock potfolios is 112.7% compared to 270.9% for the 1-stock portfolios, a reduction of 58.40%, Similarly, for the two subperiods, the diversification effect resulted in a risk reduction of 56.12 and 59.40 percent respectively for the early and the late period.

The gains from diversification are shown graphically in Fiqure 1, where we notice that most of the diversifiable or unsystematic risk has been eliminated for portfolios of 10 stocks. Beyond this size, the addition of one more stock reduces risk by a practically unnoticeable amount. Consequently, an investor could have reduced the risk of his stock portfolio during that period considerably by holding only 10 stocks without, at the same time, affecting significantly the average return of his investment.

TABLE 2

Portfolio Size and Risk

	1973-76			1973-74			1975-76		
Size	Mean Return	Standard Deviation	Variance of Standard Deviation	Mean Return	Standard Deviation	Variance of Standard Deviation	Mean Return	Standard Deviation	Variance of Standard Deviation
1	0.180	2.709	1.300	0.197	3.040	2.685	0.153	2.221	0.505
2	0.207	2.145	0.469	0.202	2.413	0.916	0.201	1.791	0.232
3	0.201	1.922	0.278	0.202	2.232	0.557	0.189	1.538	0.154
4	0.192	1.712	0.170	0.188	1.990	0.359	0.180	1.364	0.070
5	0.189	1.594	0.131	0.180	1.856	0.297	0.187	1.276	0.057
6	0.183	1.512	0.087	0.174	1.753	0.182	0.179	1..228	0.049
7	0.196	1.510	0.097	0.207	1.763	0.211	0.171	1.194	0.031
8	0.185	1.422	0.064	0.,194	1.661	0.138	0.166	1.136	0.033
9	0.192	1.379	0.050	0.194	1.626	0.115	0.177	1.101	0.024
10	0.203	1.384	0.055	0.203	1.637	0.116	0.188	1.092	0.028
11	0.191	1.366	0.067	0.195	1.601	0.135	0.179	1.080	0.028
12	0.187	1.321	0.040	0.185	1.558	0.086	0.178	1.043	0.015
13	0.197	1.303	0.043	0.193	1.522	0.090	0.190	1.054	0.018
14	0.186	1.283	0.038	0.189	1.517	0.083	0.169	1.013	0.017
15	0.193	1.287	0.028	0.188	1.510	0.061	0.184	1.039	0.016
16	0.195	1.260	0.024	0.205	1.487	0.058	0.175	0.999	0.014
17	0.190	1.254	0.025	0.189	1.487	0.059	0.178	0.985	0.012
18	0.196	1.248	0.032	0.198	1.486	0.061	0.182	0.979	0.015
19	0.194	1.220	0.030	0.198	1.441	0.062	0.177	0.968	0.013
20	0.197	1.238	0.036	0.208	1.471	0.076	0.175	0.963	0.014
21	0.182	1.190	0.021	0.185	1.414	0.043	0.169	0.936	0.011
22	0.190	1.199	0.015	0.194	1.416	0.035	0.174	0.954	0.009
23	0.191	1.175	0.015	0.190	1.394	0.032	0.180	0.933	0.010

	1973-76			1973-74			1975-76		
Size	Mean Return	Standard Deviation	Variance of Standard Deviation	Mean Return	Standard Deviation	Variance of Standard Deviation	Mean Return	Standard Deviation	Variance of Standard Deviation
24	0.191	1.196	0.015	0.193	1.426	0.033	0.176	0.941	0.010
25	0.199	1.208	0.019	0.198	1.435	0.038	0.186	0.955	0.012
26	0.190	1.182	0.015	0.191	1.402	0.034	0.177	0.934	0.009
27	0.202	1.203	0.019	0.198	1.439	0.042	0.191	0.949	0.011
28	0.196	1.174	0.016	0.198	1.397	0.034	0.181	0.920	0.009
29	0.193	1.161	0.017	0.192	1.377	0.038	0.181	0.920	0.009
30	0.196	1.156	0.010	0.193	1.369	0.021	0.185	0.922	0.006
31	0.191	1.161	0.010	0.191	1.383	0.025	0.179	0.915	0.006
32	0.199	1.167	0.017	0.199	1.390	0.034	0.188	0.922	0.009
33	0.192	1.156	0.013	0.190	1.375	0.029	0.180	0.919	0.008
34	0.200	1.155	0.010	0.197	1.370	0.023	0.190	0.921	0.007
35	0.196	1.154	0.012	0.196	1.375	0.024	0.185	0.914	0.008
36	0.196	1.143	0.010	0.198	1.357	0.023	0.181	0.912	0.006
37	0.193	1.143	0.009	0.198	1.366	0.022	0.178	0.901	0.005
38	0.199	1.157	0.010	0.201	1.379	0.020	0.183	0.915	0.007
39	0.179	1.129	0.009	0.186	1.341	0.019	0.160	0.893	0.006
40	0.191	1.127	0.009	0.194	1.334	0.019	0.175	0.902	0.006

The t-tests on the average standard deviations of sucessive portfolio sizes presented in Table 3 confirm the validity of the above observations. As we see, for portfolios of 1 to 8 stocks the values of the t-statistic are above the critical value for a one-tail test which is 1.645.[10] Beyond this size expanding the portfolio by one more stock results in insignificant risk reduction as indicated by the values of t."

10. This is the critical value of the ζ variable for a=.05 used here in accordance with footnote 8.
11. Exceptions to this pattern are the portfolios with 21 and 39 stocks respectively.

TABLE 3

Test Results of the Impact of Portfolio Size on Portfolio Risk

Size	«t» Values						F – Values					
	1973-76		1973-74		1975-76		1973-76		1973-74		1975-76	
	L=1	L=2	L=1	L=2	L=1	L=2	L=1	L=2	L=1	L=2	L=1	L=2
1	–	–	–	–	–	–	–	–	–	–	–	–
2	4.24	–	3.30	–	5.01	–	2.77	–	2.93	–	2.17	–
3	2.58	6.27	1.49	4.48	4.06	8.41	1.68	4.67	1.64	4.82	1.51	3.28
4	3.13	5.42	2.54	3.75	3.67	7.75	1.64	2.77	1.55	2.56	2.19	3.30
5	2.15	5.12	1.65	4.07	2.49	5.72	1.29	2.12	1.21	1.87	1.24	2.71
6	1.76	3.95	1.49	3.22	1.46	3.94	1.51	1.95	1.64	1.97	1.15	1.43
7	0.05	1.77	–0.16	1.31	1.21	2.77	0.90	1.35	0.86	1.41	1.59	1.82
8	2.20	2.33	1.72	1.62	2.28	3.21	1.52	1.37	1.53	1.32	0.93	1.48
9	1.27	3.41	0.71	2.40	1.45	3.95	1.27	1.93	1.21	1.85	1.38	1.30
10	–0.16	1.09	–0.23	0.48	0.39	1.76	0.91	1.16	0.99	1.20	0.86	1.20
11	0.51	0.37	0.71	0.49	0.50	0.91	0.82	0.75	0.86	0.85	1.00	0.86
12	1.39	2.05	0.91	1.75	1.83	2.40	1.67	1.37	1.57	1.35	1.86	1.85
13	0.63	1.92	0.88	1.68	–0.62	1.25	0.93	1.55	0.96	1.50	0.86	1.59
14	0.70	1.37	0.11	1.01	2.19	1.65	1.13	1.06	1.08	1.04	1.04	0.89
15	–0.18	0.58	0.19	0.30	–1.41	0.82	1.38	1.56	1.35	1.46	1.03	1.08
16	1.20	0.91	0.67	0.81	2.31	0.82	1.15	1.59	1.06	1.42	1.20	1.24
17	0.28	1.46	–0.01	0.66	0.84	3.15	0.95	1.09	0.98	1.04	1.10	1.32
18	0.23	0.49	0.03	0.02	0.39	1.18	0.80	0.76	0.97	0.95	1.17	0.97
19	1.14	1.44	1.27	1.31	0.67	1.11	1.06	0.84	0.98	0.95	1.17	0.97
20	–0.72	0.38	–0.75	0.42	0.30	0.95	0.84	0.89	0.82	.80	0.90	1.06
21	2.03	1.33	1.63	0.84	1.68	2.06	1.70	1.42	1.75	1.43	1.25	1.13
22	–0.48	1.73	0.00	1.65	–1.26	0.61	1.35	2.30	1.26	2.20	1.32	1.65
23	1.38	0.79	0.86	0.75	1.51	0.19	1.05	1.41	1.10	1.38	0.85	1.12
24	–1.22	0.17	–1.27	–0.39	–0.54	0.93	0.95	1.00	0.95	1.04	0.98	0.84
25	–0.62	–1.78	–0.33	–1.56	–0.96	–1.49	0.83	0.79	0.87	0.83	0.86	0.84
26	1.41	0.83	1.21	0.91	1.47	0.49	1.25	1.04	1.11	0.97	1.39	1.19
27	–1.13	0.26	–1.31	–0.13	–1.06	0.41	0.79	0.99	0.81	0.90	0.80	1.10
28	1.57	0.48	1.49	0.19	1.91	0.91	1.20	0.95	1.24	1.00	1.17	0.93
28	0.72	2.22	0.74	2.16	0.12	2.05	0.91	1.09	0.90	1.11	1.07	1.25
30	0.25	1.08	0.38	1.19	–0.15	–0.02	1.80	1.63	1.84	1.66	1.35	1.45
31	–0.36	–0.05	–0.64	–0.22	0.65	0.45	0.98	1.75	0.84	1.56	1.02	1.38
32	–0.35	–0.66	–0.28	–0.88	–0.59	0.00	0.59	0.58	0.73	0.62	0.70	0.72
33	0.65	0.36	0.58	0.33	0.25	–0.34	1.29	0.76	1.16	0.85	1.11	0.78
34	0.08	0.75	0.22	0.82	–0.20	0.06	1.26	1.63	1.27	1.47	1.11	1.23
35	0.02	0.10	–0.21	0.01	0.57	0.36	0.87	1.10	0.94	1.19	0.93	1.03
36	0.77	0.82	0.83	0.83	0.22	0.83	1.19	1.04	1.08	1.01	1.31	1.22
37	–0.00	0.77	–0.44	0.40	0.99	1.14	1.07	1.28	1.01	1.09	1.15	1.51
38	–0.98	–0.97	–0.60	–1.05	–1.19	–0.24	0.96	1.03	1.10	1.11	0.71	0.82
39	2.06	1.08	1.92	1.26	1.91	0.82	1.08	1.04	1.07	1.17	1.30	0.83
40	0.15	2.22	0.34	2.26	–0.88	1.05	1.03	1.11	1.03	1.10	0.90	1.17

The convergence of the standard deviations toward the mean standard deviation of each 100-portfolio group is shown in Table 2 to increase substantially as the portfolio size increases. Portfolios of 10 stocks have standard deviations with an average dispersion of only 5.5 percent around their mean standard deviation which is far smaller in comparison to the average dispersion of 130 percent for one-stock portfolios (whole period).

The practical implication of this convergence for the investor is that a random portfolio of size M will have risk measured by standard deviation, that will differ very little from the risk of any other random portfolio of equal size provided that~M is sufficiently large. Therefore, the investor may not worry that his randomly selected portfolio will have, by chance, an extraordinarily high risk relative to that borne by another portfolio of equal size.

According to Table 3, this convergence is taking place at a significant rate as one adds one more stock up to 8 stocks since the F-values (except for size M=7) are above the critical F-value of 1.39 for a one-tail test.[12]

Next, we turn to the question whether an investor can achieve the same gains from diversification by concentrating his funds within the segment of the most active stocks of the ASE. Such a strategy would be motivated by the cost and the inconvenience confronting an investor who has to liquidate stocks with very low trading frequency, that is low marketability.

However, for this strategy to be risk efficient it should produce active stocks portfolios whose risk is about equal or lower than the risk of portfolios of equal size formed by random selection from the total number of active and thin stocks.

To this, effect, we classified the 40 stocks into two groups of 20 active and 20 thin stocks respectively by using as a criterion of marketability the percentage of non-transaction days over the total trading days during the whole period 1973-76 and for each stock.[13] Next, we calculated the standard deviation of a portfolio containing only the 20 active stocks. The same calculation was repeated for the portfolio of the 20 thin stocks.

The standard deviation of the active-stocks portfolio was found to be 173.3 percent, whereas that of the thin-stocks portfolio was only 132.3 percent. From Table 2 we see that a random portfolio of 20 securities had, on the average, a standard deviation of only 123.8 percent. This implies that concentrating only on the active or the thin stocks, the investor could not have taken full advantage of the diversification effect as in the case of diversifying across all stocks. This conclusion is all the more stronger in the case of the active-stocks portfolio. It is clear that if there exists an inverse relationship between the size of portfolios and the cost of acquiring portfolios,

12. The significance level a is .05.
13. The active stocks are indicated with an asterisk in Appendix A.

then as is shown in Table 2, an investor would be better off with a random portfolio of only 4 stocks than with one of only 20 active stocks, since both portfolios would have carried the same risk. In general, the ivestor is forced to consider the trade-off between risk reduction and the costs of thinness.

The above results bear an important implication for the ASE. The fact that it is more efficient to diversify among all stocks than to concentrate within the segment of active stocks should serve as a motivation to investors not to neglect outright the thin stocks. Thus, the thin stocks turn out to be not totally inferior compared to the active stocks and, hence, they should be held as risk-reducing assets.

TABLE 4

Portfolio Size and R^2

	1973-76		1973-74		1975-76	
Size	Mean R^2	Variance of R^2	Mean R^2	Variance of R^2	Mean R^2	Variance of R^2
1	0.290	0.014	0.331	0.015	0.272	0.017
2	0.384	0.017	0.411	0.022	0.381	0.016
3	0.462	0.013	0.497	0.017	0.438	0.016
4	0.530	0.014	0.559	0.017	0.517	0.014
5	0.573	0.009	0.599	0.012	0.556	0.011
6	0.603	0.010	0.625	0.015	0.590	0.010
7	0.656	0.009	0.674	0.014	0.647	0.010
8	0.680	0.007	0.695	0.010	0.676	0.007
9	0.694	0.008	0.705	0.013	0.694	0.005
10	0.734	0.005	0.750	0.008	0.723	0.005
11	0.759	0.006	0.771	0.008	0.751	0.004
12	0.772	0.004	0.788	0.006	0.757	0.005
13	0.778	0.004	0.793	0.005	0.766	0.004
14	0.786	0.004	0.795	0.006	0.785	0.003
15	0.797	0.003	0.809	0.005	0.790	0.004
16	0.814	0.004	0.825	0.005	0.790	0.004
17	0.834	0.002	0.844	0.003	0.826	0.002
18	0.826	0.003	0.833	0.004	0.824	0.004
19	0.829	0.003	0.839	0.004	0.825	0.003
20	0.843	0.002	0.852	0.003	0.835	0.002
21	0.845	0.002	0.853	0.003	0.840	0.002
22	0.858	0.001	0.866	0.002	0.855	0.002
23	0.862	0.002	0.870	0.003	0.856	0.001
24	0.869	0.002	0.880	0.002	0.859	0.002
25	0.863	0.002	0.869	0.003	0.864	0.001
26	0.867	0.002	0.872	0.003	0.870	0.002

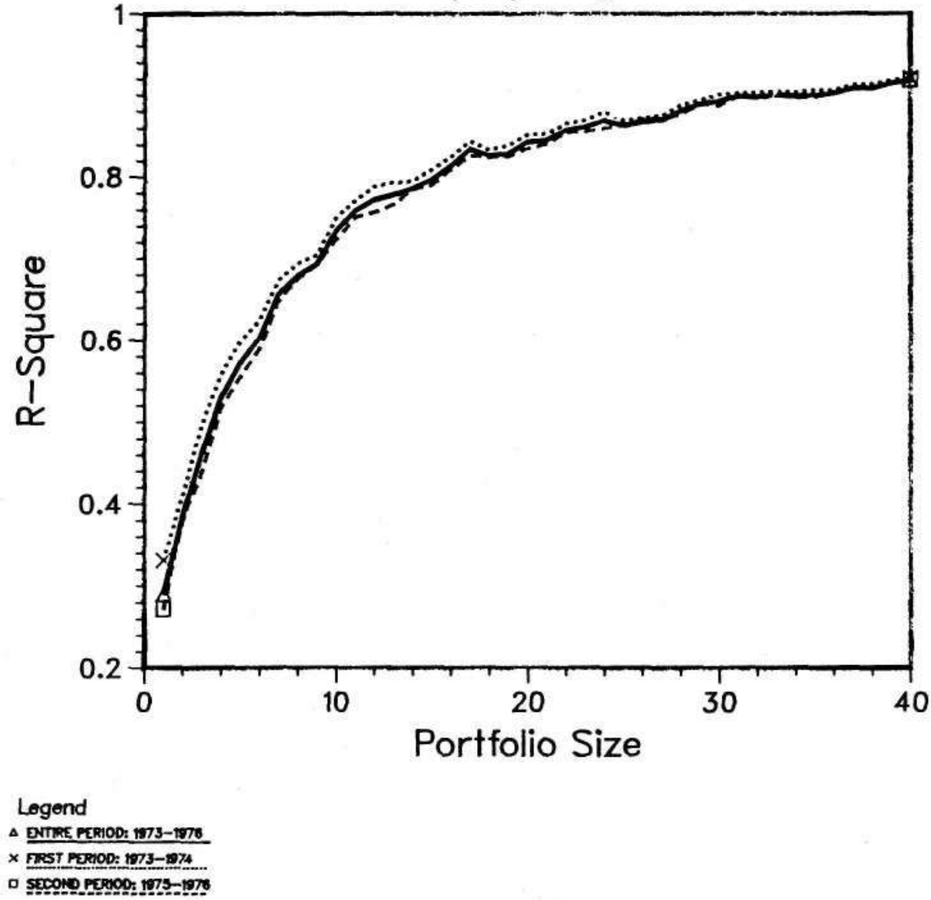
	1973-76		1973-74		1975-76	
Size	Mean R^2	Variance of R^2	Mean R^2	Variance of R^2	Mean R^2	Variance of R^2
27	0.870	0.002	0.875	0.003	0.872	0.002
28	0.881	0.002	0.888	0.002	0.876	0.002
29	0.889	0.002	0.894	0.002	0.889	0.001
30	0.893	0.001	0.901	0.001	0.887	0.001
31	0.899	0.001	0.903	0.001	0.899	0.001
32	0.898	0.001	0.903	0.002	0.896	0.001
33	0.901	0.002	0.905	0.003	0.902	0.001
34	0.899	0.001	0.904	0.001	0.897	0.001
35	0.900	0.002	0.906	0.002	0.897	0.001
36	0.903	0.001	0.907	0.002	0.904	0.001
37	0.909	0.001	0.913	0.002	0.908	0.001
38	0.909	0.001	0.914	0.002	0.909	0.001
39	0.915	0.001	0.919	0.001	0.915	0.001
40	0.918	0.001	0.921	0.001	0.919	0.001

Finally, in Table 4 we show the relationship between portfolio size and the R^2, where the latter was estimated from the regression of the portfolio returns against the returns of the proxy for the market portfolio.

Portfolios of only one stock are shown to do very poorly in terms of eliminating the unsystematic component of risk since in all periods the average R^2 is around. 30 compared to the maximum value of .92 realized by 40-stock portfolios.[14] In all periods the portfolios of 10 stocks seem to be efficiently diversified since they have mean R^2 values varying from .72to .75. In Fiqure 2 we show graphically the convergence of the mean R^2 toward unity as the portfolio size increases. It is evident that the rate of convergence was about identical for all periods.

14. Since the returns of the market portfolio are estimated from all 40 stocks in the same manner as the returns of the random portfolios, the maximum R^2 ought to be 1.0. This is not the case here simply because the random selection process of the securities in the 40-stock portfolios does not preclude the selection of the same stock in these portfolios more than one time.

Figure 2
The Effect Of Diversification
On R-Square
With An Equally Weighted Index



From the t-tests on the average R^2 values of portfolio groups of successive sizes, presented in Table 5, we notice that there are significant gains from diversification as we keep adding one more stock up to 11. Beyond this size the R^2 changes materially only as we increase the portfolio size by more than one stock at a time.

TABLE 5

Test Results of the Impact of Portfolio Size on the R^2

	Values of the T-Statistic					
	1973-76		1973-74		1975-76	
Size	L=1	L=2	L=1	L=2	L=1	L=2
1	—	—	—	—	—	—
2	5.34	—	3.94	—	5.99	—
3	4.49	10.53	4.37	8.76	3.15	9.08
4	4.14	8.26	3.35	7.46	4.60	7.85
5	2.80	7.43	2.30	5.97	2.42	7.17
6	2.24	4.76	1.61	3.67	2.37	4.71
7	3.78	6.09	2.91	4.72	4.08	6.29
8	1.90	5.90	1.37	4.43	2.28	6.73
9	1.09	2.86	0.66	1.93	1.71	3.97
10	3.49	4.85	3.16	4.12	2.86	4.25
11	2.33	5.49	1.66	4.55	2.86	6.07
12	1.31	3.83	1.38	3.18	0.59	3.22
13	0.72	2.02	0.46	1.87	1.02	1.76
14	0.89	1.60	0.26	0.70	2.16	2.99
15	1.36	2.25	1.39	1.69	0.55	2.62
16	2.01	3.31	1.60	2.91	2.16	2.80
17	2.70	5.06	2.22	4.01	2.13	4.54
18	−1.10	1.45	−1.35	0.81	−0.18	1.73
19	0.42	−0.69	0.67	−0.68	0.13	−0.04
20	1.94	2.26	1.66	2.26	1.41	1.43
21	0.34	2.29	0.11	1.78	0.75	2.12
22	2.35	2.66	2.00	2.09	2.36	3.11
23	0.57	2.70	0.47	2.23	0.30	2.78
24	1.27	1.97	1.53	2.26	0.43	0.68
25	−0.98	0.26	−1.58	−0.10	1.03	1.63
26	0.63	−0.32	0.41	−1.17	1.01	1.87
27	0.39	1.01	0.37	0.78	0.32	1.31
28	1.82	2.29	1.89	2.28	0.82	1.17
29	1.46	3.11	0.93	2.70	2.23	3.07
30	0.78	2.42	1.07	2.12	−0.40	1.98
31	1.31	1.95	0.47	1.50	2.80	2.19
32	−0.28	0.89	−0.07	0.36	−0.51	2.23
33	0.60	0.39	0.33	0.29	1.27	0.80
34	−0.42	0.23	−0.16	0.21	−0.84	0.22
35	0.28	−0.14	0.28	0.09	0.08	−0.91
36	0.52	0.87	0.22	0.55	1.44	1.43
37	1.31	1.72	1.04	1.17	1.09	2.55
38	0.13	1.39	0.14	1.19	0.14	1.15
39	1.38	1.56	0.97	1.11	1.51	1.77
40	0.54	1.89	0.41	1.40	1.25	2.67

The negligible values of the variances of the R^2 within each 100-portfolio group indicates that the correlation of the returns of any random portfolio of a given size with those of the market portfolio is about the same as similar correlations for any other portfolio of the same size.[15]

V. CONCLUDING REMARKS

Our results have demonstrated convincingly that despite its small size and its thinness the Athens Stock Exchange affords the investor significant opportunties for diversification benefits. This is borne out by both the size-standard deviation results as well as by the size-R^2 results. Moreover, it has been shown that a portfolio will be more efficiently diversified if it contains active and thin stocks.

The implications of these findings for the individual investor and the institutional fund manager is that although stock returns exhibit high variability, and hence risk, a great deal of this risk can be diversified away by holding a random portfolio of no more than 10 stocks.

To the extent that there are restrictions or higher costs for the execution of odd-lot orders, the stronger the diversification effect the greater the opportunity to allocate the limited available funds, in the case of small investors, for the purchase of the few stocks needed to construct an efficiently diversified portfolio.

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15. Since all F-values were found insignificant they are not reported.

APPENDIX A

THE SAMPLE STOCKS:

General Bank
National Bank*
Commercial Bank*
Bank of Greece*
Credit Bank*
National Insurance Company*
Hellenic Electric Railways
Chemical Products and Fertlizers Company*
Pireus Paints «Chropi»
AEBAL
Petzetakis*
ETMA
Moutalaskis
Piraiki-Patraiki
Ariston
GEPA*
Wool-Textiles*
Naoussa Spinning Mills*
Lekkas*
Chrislan*
Aget Cememt Co.*
Titan Cement Company*
Chalkis Cement Company*
Felizol*
Viometal*
Viosol
Metka*
Izola
Cambas
Spirits Company
Wines and Spirits Company
Fix Brewery Company
St. Georg's Flour Mills
Paper Mills Company
Lampsas Hotel Enterprises*
State Monopoly
Katrantzos Sports
Lambropulos Bros.*
Claoudatos G. Company
Hippotour

*The stocks with the asterisk were classified as active; the remaining stocks were classified as thin.