FINANCIAL SERVICES REVIEW

Financial Services Review 21 (2012) 35–50

Random diversification over time: The case of five European countries surrounding the Euro introduction

Emiliano Giudici[a] Axel Grossmann[b,*]

[a]*Department of Economics & Finance, Stephen F. Austin State University, Box 13009-SFA Station, Nacogdoches, TX 75962-3009, USA*

[b]*Department of Accounting, Finance and Business Law, Radford University, Radford, VA 24142, USA*

Abstract

This article adds to the financial literacy of active individual investors who restrict themselves to a limited number of securities. Using monthly observations and a sample size of up to 5,177 stocks from five major European equity markets, this study provides evidence that the marginal benefit of adding a random stock to a portfolio is time varying. Moreover, for small portfolios, the marginal diversification benefits are less pronounced during times of high volatility than during periods of low volatility. Further, while we show that the relative risk of European equity markets has increased after the introduction of the Euro, our study demonstrates that in the post-Euro period a smaller portfolio size is necessary to achieve the same percentage average relative risk reduction than in the pre-Euro period. The highest average relative risk reductions are obtained in the larger equity markets, where a random portfolio of 15 stocks yields an average relative risk reduction of close to 50% of a two-stock portfolio. Our study implies that most individual investors, who enjoy direct investing and, hence, restrict themselves to invest in a small number of securities to reduce transactions cost, may not be as irrational and underdiversified as commonly thought.

JEL classification: G11; G15

Keywords: Random diversification; European equity markets; Euro conversion; Small portfolios

* Corresponding author. Tel.: +1-540-831-6446; fax: +1-540-831-6626.
E-mail address: agrossman2@radford.edu (A. Grossmann)

1057-0810/12/$ – see front matter

1. Introduction

With the exception of a few countries, most industrialized countries face the challenge of a growing population of retirees in combination with a shrinking population entering the workforce. This shift in demographics is putting future social security benefits in jeopardy and requires younger individuals to invest more for retirement. This in turn demands that individuals obtain a certain level of financial literacy, especially with respect to benefits from diversification.

The lack of financial literacy is stressed and discussed in studies such as Mandell and Schmid Klein (2007), Volpe, Chen, and Liu (2006), and Chen and Volpe (1998). This article tries to add to the financial literacy of active individual investors who restrict themselves to a limited number of securities by investigating the benefits from random diversification in major European equity markets surrounding the introduction of the Euro. Addressing benefits from random diversification in non-U.S. equity markets to enhance financial literacy among active individual investors may be important, because Kyrychenko and Shum (2009) find that lack of financial sophistication, especially the awareness with respect to diversification benefits, is negatively correlated with allocation of funds towards foreign stocks.

Financial literature has long recognized that total risk decreases as stocks are added to a portfolio. This process is driven by the imperfect correlation among stock returns and the risk reduction occurs at a decreasing rate (e.g., Evans and Archer, 1968; Fama, 1976; Gup, 1983; Stevenson and Jennings, 1984; Reilly, 1985; Francis, 1986; Statman, 1987). Hence, modern portfolio theory assumes that investors hold well-diversified portfolios, which is easily accomplished by individual investors through indirect investments in mutual funds. With respect to indirect investing, Fortin and Michelson (2002) show that on average, with the exception of small company equity funds and international stock funds, indexing provides higher returns than actively managed funds, even after considering taxation. In contrast to United States based mutual funds, Fortin and Michelson (2005) demonstrate that, with the exception of European funds, actively managed international mutual funds outperform the index funds.

Nevertheless, the literature shows that small individual investors are highly underdiversified and invest only in a very limited number of stocks (e.g., Lease, Lewellen, and Schlarbaum, 1974; Kelly, 1995; Sankaran and Patil, 1999; Barber and Odean, 2000; Polkovnichenko, 2005; Goetzmann and Kumar, 2007). Moreover, Sarkis (2003) points out that many American investors are only invested in few assets: their house and/or a portfolio that is heavily weighted in stocks of the employer's company.

Additionally, many individual investors seem to enjoy investing directly in equity markets (Lease, Lewellen, and Schlarbaum, 1974), as choosing a limited number of stocks allows them to better allocate their time to follow and analyze those individually selected securities (Sankaran and Patil, 1999). Likewise, Goetzmann and Kumar (2007) argue that the reason why individual investors are underdiversified is related to their personal preference for certain stock characteristics, such as specific industries or local stocks, as well as certain behavioral biases, such as overconfidence.

Since individual investors seem to hold portfolios of smaller size demonstrates the importance of investigating the ideal number of stocks that provides an economically

acceptable level of diversification benefit. In fact, many researchers have tried to determine the optimal number of stocks that provides equilibrium between the marginal risk reduction and the marginal cost of purchasing one more stock; yet, with inconsistent results. For example, Evans and Archer (1968) conclude that approximately 10 stocks reduce portfolio risk to an economically acceptable level. Gup (1983) suggests nine stocks, Stevenson and Jennings (1984) suggest eight to 16, Francis (1986) 10 to 15, Reilly (1985) 12 to 18, Fama (1976) 20 stocks and Statman (1987) suggests 30 stocks. Woerheide and Persson (1993) confirm the 10 stock portfolio presented by Evans and Archer (1968) for equally distributed holdings. However, they argue that most individual investors are holding unevenly distributed portfolios. Based on a complement of the Herfindahl index and randomly constructed unevenly distributed portfolios, Woerheide and Persson (1993) find 15 stock portfolios to be adequately diversified. The above literature may leave the individual investor, who holds on average not more than 15 stocks (see surveys by Lease, Lewellen, and Schlarbaum, 1974; Kelly, 1995; Barber and Odean, 2000; Goetzmann and Kumar, 2007), wonder if the ideal number of stocks is time varying and/or is dependent upon different market conditions.

While most studies focus solely on the U.S. stock market, individual investors may still be puzzled about the efficacy of random diversification benefits in other major equity markets, for example, European stock markets. Analyzing European equity markets may be important because they represent a significant portion of global market capitalization. Moreover, while the percentage of households that hold stocks is significantly lower in most European countries (compared to the United States), this number has doubled over the last decade and continues to grow rapidly (Guiso, Haliassos, and Jappelli, 2003). Further, the introduction of the Euro is commonly perceived as one of the most influential events on the architecture of global capital markets; hence, it has elevated the importance of the European equity markets as a whole. Moreover, it can be expected that a common currency may have eliminated or mitigated the systematic risk factor related to exchange rate risk. For example, Batram and Karolyi (2006) find that the post-Euro conversion period is related to a decrease of market risk of companies that have their business activity associated with Europe. Thus, one may expect the reduction of systematic risk has altered the marginal benefit of adding a stock to a European equity portfolio after the introduction of the Euro and, hence, may have changed the ideal number of stocks that provides an economically optimal level of diversification benefits.

Based on the above discussion, the main purpose of this article is fourfold: First, we investigate whether the marginal benefits of adding a stock to a portfolio is static over time for the three major European equity markets of France, Germany, United Kingdom, as well as the two smaller equity markets of Spain and Italy. Second, active individual investors seem to hold on average rather small portfolios of around 15 securities. Hence, we investigate the average relative risk reduction investors will achieve with a 15-stock portfolio over a two-asset portfolio. Third, individual investors may be interested in knowing the marginal benefits from diversification are dependent on the performance of the market or its volatility. Hence, we examine if the marginal benefit of adding stocks to a portfolio is conditional on certain market conditions, that is to say ex-post market returns and risk. For example, from the investor's perspective, it may be desirable that diversification is most effective when it is most needed, during times of high volatility. Fourth, because it is argued in the literature

that the introduction of the Euro has impacted the systematic risk factor, we also examine if the Euro has altered domestic diversification benefits of the five European markets under investigation.

Our findings are particularly important for those individuals who hold portfolios of relatively small size. We provide evidence that marginal benefits of adding a random stock to a portfolio are not stable over time in the five European equity markets, which may explain the discrepancies in previous literature. Additionally, the average relative risk reduction from adding a random stock to a portfolio seems to be higher in more recent years. For example, while we find an increase in total relative risk in the post-Euro introduction period, we also find that individual investors seem to obtain a higher level of average relative risk reduction during the post-Euro introduction period than in the pre-Euro period. Moreover, the highest average relative risk reductions are obtained in the larger equity markets, such as France, Germany, and the United Kingdom, where an individual investor holding a random portfolio of 15 stocks would have obtained an average relative risk reduction from a two-asset portfolio of close to 50%. This may suggest that individual investors, who enjoy direct investing and, hence, restrict themselves to a small portfolio size to reduce transactions cost, are not as irrational and underdiversified as commonly thought. Further, in the post-Euro introduction period a smaller portfolio size seems to provide the same average relative risk reduction as in the pre-Euro period, and portfolios in larger European equity markets seem to require a smaller portfolio size to obtain the same average relative risk reduction as a portfolio in smaller European equity markets.

Finally, we do not find any relationship between the efficacy of random diversification and market returns. However, for very small portfolios (up to a size of 10 stocks), we find that the marginal benefits of adding one more stock are least effective in periods of high volatility versus times of relatively low volatility. This may suggest that individual investors, who intend to hold equity while limiting their risk exposure, should hold larger portfolios during times of high volatility or shift part of their strategy from direct investing to indirect investing, such as indexing.

2. Data and methodology

The data used in this article are obtained from DataStream. The series consists of monthly prices of all listed securities of France, Germany, Spain, Italy, and United Kingdom. from January 1988 to December 2005. Depending on the year, the sample consists of 155 to 946 stocks for France, 234 to 1,005 for Germany, 181 to 285 for Italy, 62 to 166 for Spain, and 1,363 to 2,088 for the United Kingdom. For each country, we randomly construct 200 equally weighted portfolios starting with portfolios consisting of two stocks. We then construct 200 portfolios with three randomly selected stocks. This process is repeated up to the portfolio size of 50 stocks. For each portfolio size (i.e., portfolio size two to 50 stocks), we compute the average returns and standard deviations of the 200 portfolios over the course of a one year holding period, spanning January to December. For instance, in 1999 we obtain the average return and risk for portfolios of two stocks through 50 stocks for Germany. Only stocks with data available for the full year are considered for the random selection.

To obtain a comparable measure of risk across the different countries, we divide the calculated standard deviation of each portfolio by the market risk of the country under consideration. The market risk is based on a portfolio containing all stocks of a particular country that are listed on DataStream during a given year. We call the obtained risk measure relative risk or relative volatility as it scales risk relative to holding the most diversified domestic portfolio. Hence, a relative risk measure of 1.0 would specify that the risk of the particular portfolio has been reduced to systematic risk, while any relative risk measure above 1.0 would indicate that the portfolio contains some portion of unsystematic risk. Furthermore, we estimate the marginal risk reduction of adding one more stock to an existing portfolio by computing the percentage difference in relative risk for portfolios that differ in size by one stock.

Finally, we analyze if the marginal risk reduction is time varying and if any time variation can be explained by ex-post market returns and risk. For the latter approach, we estimate several pooled cross-section/time-series regression models.

3. Results

The first step in our analysis is qualitative in nature. For every year and every country, we compute the average risk of the 200 portfolios and divide it by the country's market risk. The average relative risk of each portfolio is reported, by country, in Fig. 1. As to be expected from the literature, we find that for all countries, adding stocks to a portfolio decreases risk at a diminishing rate. However, the plots indicate that for a given country, the marginal benefit of adding a random stock to a portfolio of a given size is not stable over time. For instance, in Italy in the year 2000, the average risk of a two-stock portfolio was almost twice that of the market; while in the year 1990 it was less than one and a half times that of the market. Adding stocks to a two-stock portfolio in these two years had a larger impact in the year 2000 than in the year 1990. A similar trend is observable in all countries considered. Albeit qualitatively, we have established that the marginal benefit of randomly adding a stock to a portfolio is not stable, potentially explaining the discrepancies in the literature on this topic. The results show that one cannot make a general statement about the level of diversification benefits one achieves from actively investing in restricted number of stocks. A relatively small portfolio may be highly underdiversified during some periods, while it may provide an economically acceptable level of diversification benefits during other times. Moreover, we find that individual investors, who according to surveys presented in the literature, hold on average not more than 15 stocks (Lease, Lewellen, and Schlarbaum, 1974; Kelly, 1995; Barber and Odean, 2000; Goetzmann and Kumar, 2007), may have obtained an average relative risk reduction, from a two-asset portfolio, of close to 50% in the larger European equity markets over the sample period. Table 1 shows the average relative risk reduction of adding 14 stocks to a randomly selected security. For the period from 1988 to 2005 the average relative risk reduction, from a two-asset portfolio, for France, Germany, Italy, Spain, and the United Kingdom was 44%, 47%, 31%, 35%, and 43%, respectively. This may suggest that individual investors are not as underdiversified as commonly thought.

Next, we empirically test if the variability in the efficacy of random diversification is

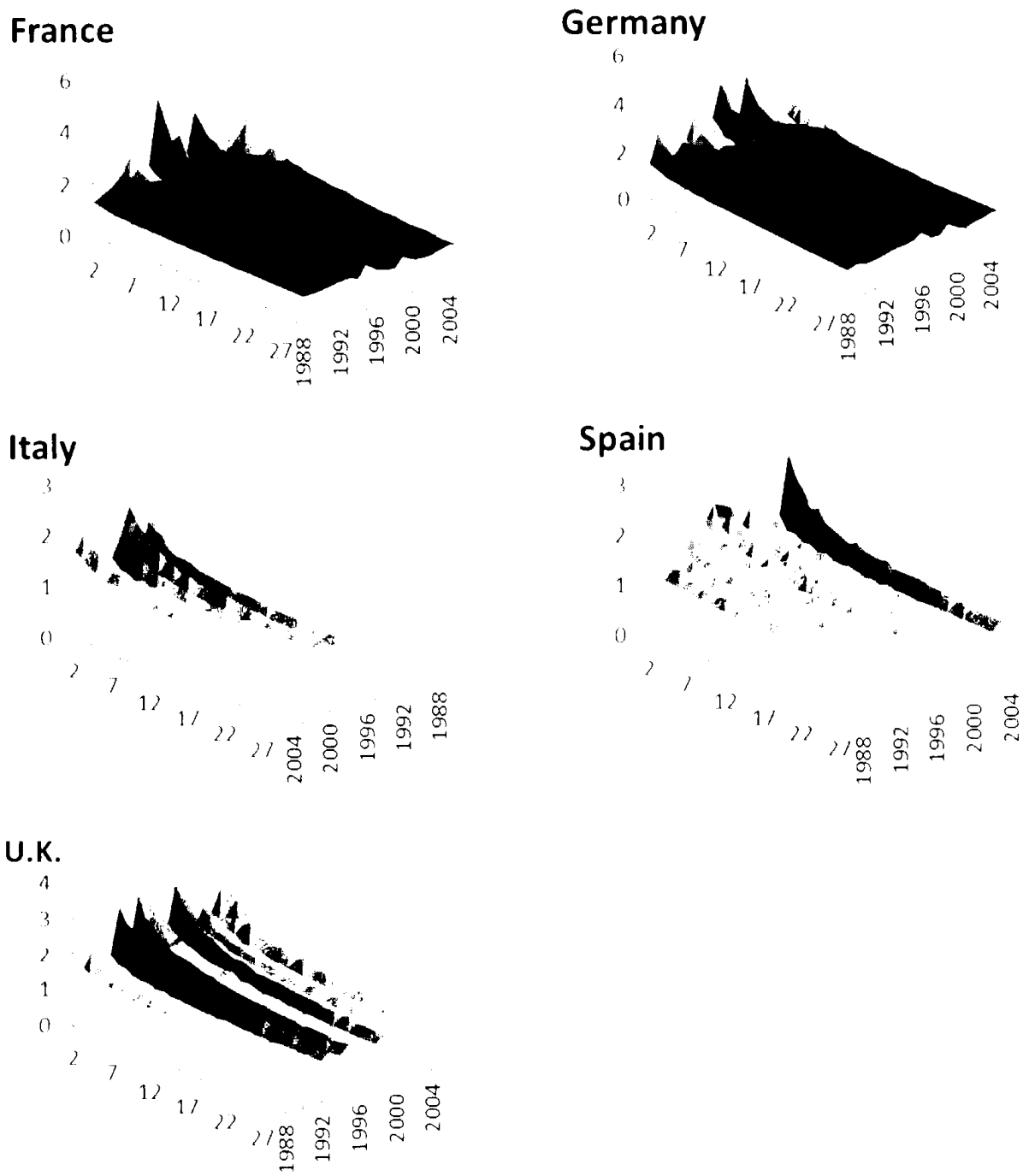

Fig. 1. Portfolio risk versus size and time.

conditional on market conditions, that is to say: (1) market returns during the holding period; (2) market volatility during the holding period; and (3) structural changes that followed the introduction of the Euro. Over the period from 1988 to 2005 the five European markets provide a wide range of returns (from a minimum average monthly return of −5.37% to a maximum of 3.36%). Similarly, the standard deviations span from a low of 1.47% to a maximum of 11.72%.

Table 1 Percentage average relative risk reduction of a 15 stock portfolio

	France	Germany	Italy	Spain	United Kingdom
1988–2005	44%	47%	31%	35%	43%
1988–1998	42%	45%	28%	33%	41%
1999–2005	47%	49%	35%	39%	45%

Individual investors may be interested in knowing if the effectiveness of random diversification is conditional on the return performance of the market. If this is the case, individual investors may want to change the size of their portfolios or their whole investment strategy, for example, shifting from direct to indirect investing, depending on their expectation of future market performance.

To test this conjecture, we run the following pooled cross-section/time-series regression model:

$$(1)\quad MARG_{i,t} = \beta_0 + \beta_1 MKTRET_{i,t} + \varepsilon_{i,t},$$

where $MARG_{i,t}$ is the marginal risk reduction of a given portfolio size from country i at time t, which is calculated as described in the previous section, and $MKTRET_{i,t}$ is the market returns for the corresponding country i and time t. This model is tested for portfolio sizes ranging from 2 through 26 stocks and the results are reported in Table 2.

If there is a relationship between marginal risk reduction and market returns, the coefficient β_1 should be significantly different than zero. We find no significance in β_1, except in a few sporadic cases. Moreover, there appears to be no clear pattern with respect to the sign of the coefficient; hence, we conclude that there seems to be no relationship between the performance of the market and marginal benefits from random diversification. On the other hand, the constant terms are all significant and negative. This confirms what is expected from the literature: adding one stock to a portfolio of a given size does reduce portfolio risk. Furthermore, the magnitude of the intercepts tends to decrease with portfolio size, confirming the notion that the marginal benefit of adding one stock to a portfolio decreases with portfolio size.

The previous section indicates that the effectiveness of random diversification, albeit not constant over time, is not related to returns. From the individual investor's perspective, it may be desirable that diversification is most effective when it is most needed: in times of high volatility. Thus, we test if there is a relationship between the marginal risk reduction (*MARG*) and the level of volatility experienced by the domestic market during the holding period (*MKTRSK*):

$$(2)\quad MARG_{i,t} = \beta_0 + \beta_1 MKTRSK_{i,t} + \varepsilon_{i,t}$$

In this model, we expect the constant term β_0 to be negative; indicating that, on average, adding a stock to a portfolio reduces risk. Next, if the impact of random diversification is more effective during periods of high volatility, we would obtain negative values for β_1.

The results of this regression are reported in Table 3. The intercepts are all negative, as expected. However, the coefficients of volatility are all positive for portfolios of sizes up to

Table 2 Marginal risk reduction and ex-post returns: $MARG_{i,t} = \beta_0 + \beta_1 MKTRET_{i,t} + \varepsilon_{i,t}$

Portfolio size	*Intercept*	*t* statistics	*MKTRET*	*t* statistics	R^2
2	−11.825	−23.73***	19.148	0.72	0.006
3	−6.975	−14.36***	−23.708	−0.92	0.009
4	−5.601	−13.41***	−42.971	−1.94*	0.041
5	−4.422	−8.84***	19.412	0.73	0.006
6	−3.399	−9.20***	−17.830	−0.91	0.009
7	−3.522	−9.04***	3.075	0.15	0.000
8	−1.962	−5.27***	−21.423	−1.08	0.013
9	−2.751	−10.52***	2.147	0.15	0.000
10	−1.282	−4.48***	4.604	0.30	0.001
11	−1.731	−7.46***	−22.094	−1.79*	0.035
12	−1.529	−4.86***	14.259	0.85	0.008
13	−1.522	−5.75***	0.019	0.00	0.000
14	−0.701	−2.49***	−12.585	−0.84	0.008
15	−1.085	−3.70***	−0.845	−0.05	0.000
16	−0.824	−3.16***	−7.987	−0.58	0.004
17	−0.874	−3.56***	−9.868	−0.75	0.006
18	−0.932	−4.64***	21.330	2.00**	0.043
19	−0.923	−4.37***	−28.204	−2.51**	0.067
20	−0.303	−1.083	−1.632	−0.11	0.000
21	−0.561	−2.22**	4.184	0.31	0.001
22	−0.754	−3.61***	−12.015	−1.08	0.013
23	−0.597	−2.82***	1.301	0.12	0.000
24	−0.493	−2.23**	15.915	1.35	0.020
25	−0.514	−2.64***	−7.575	−0.73	0.006
26	−0.344	−1.60	10.138	0.89	0.009

*, **, ***Indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

10 stocks. This information may be important for individual investors who hold portfolios with a very limited number of stocks; as it indicates that for small portfolios, the marginal benefits of adding a stock are least effective in periods of high volatility as compared with times of relatively low volatility. This may suggest that individual investors should increase their portfolio size during times of high volatility or shift their strategy from direct to indirect investing, such as indexing. For larger portfolios, the relationship between marginal benefits and market volatility weakens. This is to be expected, as the risk reduction is bounded by systematic risk.

A possible explanation for this finding is that during turbulent markets systematic risk increases relatively more than unsystematic risk; this uneven change reduces the proportion of diversifiable risk to nondiversifiable, thus reducing the benefits from diversification. This conjecture finds support in the literature on international diversification, which states that during volatile markets the correlation structure between countries changes and shifts towards stronger positive correlations (e.g., Longin and Solnik, 1995; Ball and Torous, 2000).

The last point of this article analyzes whether the marginal benefit of adding a stock to a portfolio has changed after the introduction of the Euro. In general, the literature states that the introduction of the Euro caused European equity markets to be more integrated (e.g., Morana and Beltratti, 2002; Holmes, 2003; Flavin, 2004; Kim, Moshirian, and Wu, 2005;

Table 3 Marginal risk reduction and market volatilities: $MARG_{i,t} = \beta_0 + \beta_1 MKTRSK_{i,t} + \varepsilon_{i,t}$

Portfolio size	*Intercept*	*t* statistics	*MKTRSK*	*t* statistics	R^2
2	−15.305	−12.65***	79.363	3.13***	0.100
3	−11.815	−10.62***	110.266	4.73***	0.202
4	−8.124	−7.74***	57.444	2.61***	0.072
5	−7.111	−5.73***	61.331	2.36***	0.059
6	−5.037	−5.43***	37.316	1.92*	0.040
7	−6.685	−7.23***	72.088	3.72***	0.136
8	−4.060	−4.38***	47.787	2.46**	0.064
9	−4.505	−7.08***	39.985	3.00***	0.093
10	−2.929	−4.15***	37.545	2.54**	0.068
11	−2.330	−3.89***	13.619	1.08	0.013
12	−2.542	−3.19***	23.105	1.38	0.021
13	−2.625	−3.95***	25.124	1.80*	0.036
14	−1.206	−1.68*	11.486	0.76	0.007
15	−2.739	−3.79***	37.684	2.48**	0.066
16	−1.291	−1.94*	10.628	0.76	0.007
17	−1.576	−2.52**	15.971	1.22	0.017
18	−1.797	−3.49***	19.756	1.83	0.037
19	−2.227	−4.14***	29.671	2.63***	0.073
20	0.403	0.57	−16.084	−1.08	0.013
21	−2.379	−3.91***	41.437	3.25***	0.107
22	−1.037	−1.94*	6.435	0.57	0.004
23	−1.098	−2.04**	11.415	1.01	0.012
24	−0.682	−1.19	4.322	0.36	0.001
25	−0.951	−1.92*	9.955	0.96	0.010

*, **, ***Indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Askari and Chatterjee, 2005; Bartram and Karolyi, 2006; Bartram, Taylor, and Wang 2007; Leon, Nave, and Rubio, 2007), which in turn may have reduced the benefits of international diversification by investing in those countries. Moreover, if markets become more integrated because of more price and information transparency, one would expect an increase in market efficiency (Kim and Singal, 2000), and, thus, a decrease in stock market volatility. This especially should be the case for the equity markets of those countries that joined the Euro-zone, because a common currency should have, at least, eliminated or mitigated the systematic risk factor related to exchange rate risk (e.g., Morana and Beltratti, 2002).

If the Euro has reduced systematic risk among European equity markets, as it is argued in the literature, it may have also changed the marginal benefit of adding a stock to a portfolio. To answer this question, we look first at the marginal relative risk reduction of each country and each portfolio during the pre-Euro period (1988 to 1998), as well as the post-Euro period (1999 to 2005). Table 4 shows that across all countries and all portfolios relative risk has increased after the Euro. This suggests that the proportion of unsystematic risk has increased relative to systematic risk after the introduction of the Euro.

Furthermore, Table 5 indicates that in the post-Euro period a smaller portfolio size is necessary to obtain the same average relative risk reduction, as it was the case in the pre-Euro period. Table 5 shows the portfolio size that provides a 50% relative risk reduction from an initial two-asset portfolio. In cases where a portfolio size of 50 stocks does not obtain a 50%

Table 4 Portfolio size and relative risk reduction pre/post Euro introduction

	France			Germany			Italy			Spain			United Kingdom		
	1988 to 2005	1988 to 1998	1999 to 2005	1988 to 2005	1988 to 1998	1999 to 2005	1988 to 2005	1988 to 1998	1999 to 2005	1988 to 2005	1988 to 1998	1999 to 2005	1988 to 2005	1988 to 1998	1999 to 2005
2	2.530	2.330	2.844	2.620	2.465	2.862	1.621	1.517	1.784	1.779	1.675	1.943	2.271	2.154	2.455
3	2.196	2.030	2.457	2.256	2.141	2.437	1.456	1.371	1.590	1.582	1.509	1.696	1.978	1.885	2.125
4	1.987	1.823	2.244	2.039	1.929	2.211	1.377	1.300	1.498	1.490	1.420	1.599	1.836	1.770	1.939
5	1.899	1.752	2.130	1.928	1.830	2.082	1.303	1.242	1.399	1.411	1.363	1.487	1.683	1.605	1.806
6	1.742	1.621	1.933	1.803	1.706	1.955	1.267	1.215	1.349	1.352	1.293	1.445	1.632	1.568	1.733
7	1.704	1.574	1.908	1.713	1.643	1.822	1.230	1.191	1.292	1.296	1.260	1.354	1.574	1.514	1.669
8	1.615	1.499	1.797	1.630	1.553	1.751	1.200	1.161	1.262	1.275	1.238	1.332	1.499	1.437	1.597
9	1.574	1.472	1.733	1.591	1.532	1.685	1.173	1.140	1.225	1.255	1.227	1.299	1.463	1.413	1.541
10	1.518	1.425	1.664	1.530	1.474	1.619	1.160	1.122	1.220	1.222	1.196	1.264	1.412	1.364	1.489
11	1.484	1.389	1.633	1.501	1.442	1.593	1.152	1.124	1.195	1.216	1.187	1.262	1.392	1.345	1.465
12	1.461	1.368	1.608	1.466	1.418	1.541	1.137	1.110	1.178	1.189	1.164	1.229	1.368	1.332	1.425
13	1.433	1.365	1.541	1.435	1.392	1.504	1.130	1.109	1.163	1.178	1.158	1.208	1.332	1.296	1.388
14	1.403	1.321	1.531	1.414	1.374	1.477	1.112	1.092	1.143	1.162	1.137	1.200	1.310	1.279	1.359
15	1.398	1.328	1.507	1.395	1.347	1.471	1.112	1.085	1.155	1.151	1.126	1.190	1.296	1.266	1.345
16	1.351	1.275	1.471	1.380	1.336	1.449	1.111	1.089	1.146	1.148	1.128	1.180	1.277	1.243	1.330
17	1.349	1.284	1.452	1.355	1.319	1.410	1.102	1.081	1.135	1.135	1.118	1.161	1.274	1.238	1.330
18	1.332	1.269	1.431	1.334	1.301	1.386	1.093	1.076	1.119	1.131	1.112	1.161	1.260	1.232	1.303
19	1.313	1.257	1.401	1.318	1.280	1.377	1.089	1.070	1.118	1.122	1.100	1.158	1.244	1.219	1.284
20	1.295	1.230	1.397	1.298	1.268	1.345	1.085	1.072	1.106	1.116	1.099	1.142	1.231	1.200	1.279
21	1.303	1.247	1.393	1.292	1.256	1.349	1.082	1.067	1.105	1.107	1.089	1.135	1.225	1.198	1.267
22	1.284	1.224	1.378	1.279	1.246	1.331	1.079	1.060	1.108	1.108	1.094	1.132	1.215	1.192	1.250
23	1.265	1.218	1.340	1.273	1.244	1.317	1.071	1.055	1.096	1.097	1.085	1.116	1.209	1.181	1.254
24	1.257	1.212	1.327	1.261	1.234	1.302	1.069	1.056	1.091	1.096	1.083	1.116	1.194	1.173	1.227
25	1.254	1.204	1.333	1.248	1.223	1.288	1.065	1.050	1.088	1.087	1.073	1.108	1.191	1.171	1.224

Notes: The above table shows relative risk, which is obtained by dividing each portfolio standard deviation by the market risk of the country under consideration. This scales risk relative to holding the most diversified domestic portfolio. A relative risk measure of one specifies that the risk of the particular portfolio has been reduced to systematic risk, while any relative risk measure above one indicates that the portfolio contains some portion of unsystematic risk.

relative risk reduction, the table reports the percentage relative risk reduction achieved with a 50-stock portfolio. For example, Table 5 documents that for France, Germany, and the United Kingdom a 50% average relative risk reduction from a two-asset portfolio is achieved in the pre-Euro period based on a 31, 25, and 50-asset portfolio, respectively; while in the post-Euro period a 50% average relative risk reduction is achieved for those countries based

Table 5 Percentage average relative risk reduction

	France		Germany		Italy		Spain		United Kingdom	
	Portfolio size	Relative risk reduction	Portfolio size	Relative risk reduction	Portfolio size	Relative risk reduction	Portfolio size	Relative risk reduction	Portfolio size	Relative risk reduction
1988–2005	25	50%	19	50%	50	36%	50	42%	35	50%
1988–1998	31	50%	25	50%	50	33%	50	38%	50	50%
1999–2005	18	50%	17	50%	50	42%	50	46%	24	50%

on an 18, 17, and 24-asset portfolio, respectively. For Italy and Spain a 50-stock portfolio provides a 33% and 38% average relative risk reduction in the pre-Euro period, while a 42% and 46% average relative risk reduction is achieved in the post-Euro period, respectively.

Moreover, Table 1 shows that individual investors holding a random portfolio of 15 stocks would have obtained an average relative risk reduction, from a two-asset portfolio, in the post-Euro period for France, Germany, Italy, Spain, and the United Kingdom of 47%, 49%, 35%, 39%, and 45%, respectively. This indicates that in the post-Euro period individual investors reach a higher level of average relative risk reduction with a 15-stock portfolio than during the pre-Euro period.

The findings presented in Tables 1 and 5 may have the following implications for individual investors who enjoy direct investing. First, most individual investors may not be as underdiversified in the pre-Euro period as commonly thought. Second, in the post-Euro period a smaller portfolio will obtain the same relative risk reduction as in the pre-Euro period. Third, portfolios in larger European equity markets seem to require a smaller portfolio size to obtain the same relative risk reductions as a portfolio in smaller European equity markets. Thus, in the post-Euro period, investing in portfolios of 15 stocks may provide an economically acceptable level of diversification benefits for those individual investors who favor direct investing in major European equity markets and restrict themselves to invest in a small number of securities to reduce transactions cost.

The finding of improved percentage average relative risk reduction in combination with an overall increase in relative risk after the Euro introduction may again be explained by an uneven impact on unsystematic risk and systematic risk. If the common currency has eliminated or mitigated the systematic risk factor related to exchange rate risk, one can expect that systematic risk has decreased relative to unsystematic risk. This may explain why in the post-Euro period a smaller number of stocks are able to obtain the same percentage average relative risk reduction as it is the case in the pre-Euro period.

Further, to empirically examine if the introduction of the Euro has produced a change in the marginal benefit of adding a stock to a portfolio, we introduce a dummy variable to the previous discussed models, $PREEU_t$, which takes a value of 1 before the Euro and zero otherwise.

$$(3)\quad MARG_{i,t} = \beta_0 + \beta_1 PREEU_t + \beta_2 MKTRSK_{i,t} + \varepsilon_{i,t}$$

Should there be a change in marginal benefits, the coefficient β_1 would be significant.

The next model is modified to examine whether the relationship between the benefits of diversification and market volatility has changed after the introduction of the Euro:

$$(4)\quad MARG_{i,t} = \beta_0 + \beta_2 MKTRSK_{i,t} + \beta_3 PREEU_t * MKTRSK_{i,t} + \varepsilon_{i,t}$$

A change in the relationship would result in β_3 being significantly different than zero.

The last model accommodates for both the average marginal benefit of adding a stock to a portfolio and the relationship with market risk to change after the introduction of the Euro:

$$(5)\quad MARG_{i,t} = {}_0 + \beta_1 PREEU_t + \beta_2 MKTRSK_{i,t} + \beta_3 PREEU_t * MKTRSK_{i,t} + \varepsilon_{i,t}$$

Table 6 Model (3), marginal risk reduction and market volatilities pre/post Euro introduction: $MARG_{i,t} = \beta_0 + \beta_1 PREEU_t + \beta_2 MKTRSK_{i,t} + \varepsilon_{i,t}$

Portfolio size	*Intercept*	*t* statistics	*PREEU*	*t* statistics	*MKTRSK*	*t* statistics	Adj. R^2
2	−16.055	−12.27***	1.407	1.45	76.871	3.04***	0.101
3	−11.892	−9.77***	0.144	0.16	110.01	4.68***	0.184
4	−8.416	−7.35***	0.547	0.65	56.475	2.55***	0.055
5	−7.55	−5.58***	0.823	0.82	59.873	2.29**	0.045
6	−5.825	−5.87***	1.476	2.01**	34.701	1.81*	0.062
7	−6.415	−6.35***	−0.506	−0.68	72.984	3.74***	0.120
8	−4.847	−4.89***	1.475	2.01**	45.174	2.36**	0.085
9	−4.500	−6.46***	−0.009	−0.02	40.002	2.97***	0.072
10	−2.934	−3.80***	0.01	0.02	37.528	2.52***	0.047
11	−2.765	−4.29***	0.815	1.72*	12.174	0.98	0.023
12	−3.281	−3.86***	1.386	2.20	20.649	1.26	0.052
13	−2.399	−3.31***	−0.422	−0.79	25.872	1.85*	0.021
14	−1.026	−1.31	−0.337	−0.58	12.083	0.80	−0.012
15	−2.811	−3.55***	0.136	0.23	37.442	2.45**	0.045
16	−1.641	−2.28**	0.656	1.23	9.467	0.68	0.001
17	−1.857	−2.73***	0.527	1.05	15.038	1.15	0.007
18	−1.772	−3.14***	−0.048	−0.12	19.842	1.82*	0.015
19	−2.279	−3.87***	0.097	0.22	29.500	2.60	0.052
20	0.391	0.50	0.022	0.04	−16.123	−1.08	−0.010
21	−2.427	−3.64***	0.090	0.18	41.277	3.21***	0.087
22	−1.34	−2.31**	0.566	1.32	5.432	0.49	0.001
23	−1.386	−2.38**	0.541	1.26	10.456	0.93	0.007
24	−0.510	−0.82	−0.321	−0.7	4.891	0.41	−0.016
25	−1.201	−2.23**	0.468	1.18	9.126	0.88	0.003

*, **, ***Indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Models (3) to (5) are estimated on the whole set of countries and on a sub-sample from which we excluded United Kingdom, as it did not adopt the Euro.

The results of Model (3) are reported in Table 6 and show that only four out of the 24 portfolios exhibit a change in the marginal benefit from diversification. The results of Model (4) are presented in Table 7. The regression shows that there are no significant changes in the relationship between the benefit of diversification and market conditions after the introduction of the Euro. Of the 24 regressions, only three slope coefficients are significant.

The results of Model (5) are shown in Table 8. This model is consistent with the previous simpler models in that it also fails to detect changes in diversification benefits after the introduction of the Euro. In both samples only a few of the coefficients associated with the dummy variables are significant. Furthermore, the addition of the dummy variable seems to weaken the significance of the relationship between the marginal benefits and the volatility of the market. The findings are virtually identical if we exclude the United Kingdom. Hence, to preserve space, we do not report those results; however, they are available from the authors upon request.

4. Conclusion

This article adds to the financial literacy of active individual investors by investigating the benefits from random diversification in major European equity markets surrounding the

Table 7 Model (4), marginal risk reduction and market volatilities pre/post Euro introduction: $MARG_{i,t} = \beta_0 + \beta_2 MKTRSK_{i,t} + \beta_3 PREEU_t * MKTRSK_{i,t} + \varepsilon_{i,t}$

Portfolio size	*Intercept*	*t* statistics	*MKTRSK*	*t* statistics	*PREEU*MKTRSK*	*t* statistics	Adj. R^2
2	−15.025	−12.42***	51.259	1.69*	34.753	1.66*	0.108
3	−11.759	−10.42***	104.702	3.71***	6.881	0.35	0.185
4	−8.072	−7.58***	52.150	1.96**	6.547	0.36	0.052
5	−6.887	−5.51***	38.773	1.24	27.894	1.29	0.056
6	−4.780	−5.19***	11.437	0.50	32.002	2.01**	0.062
7	−6.770	−7.22***	80.598	3.44***	−10.523	−0.65	0.120
8	−3.882	−4.17***	29.911	1.28	22.106	1.38	0.063
9	−4.476	−6.93***	37.001	2.29**	3.691	0.33	0.073
10	−2.895	−4.05***	34.143	1.91*	4.206	0.34	0.048
11	−2.227	−3.69***	3.220	0.21	12.859	1.24	0.008
12	−2.247	−2.89***	−6.502	−0.33	36.613	2.73**	0.078
13	−2.716	−4.05***	34.290	2.04**	−11.335	−0.98	0.024
14	−1.252	−1.72*	16.041	0.88	−5.632	−0.45	−0.014
15	−2.698	−3.68***	33.654	1.83*	4.983	0.39	0.046
16	−1.212	−1.80*	2.678	0.16	9.831	0.85	−0.008
17	−1.486	−2.36**	6.937	0.44	11.172	1.03	0.006
18	−1.770	−3.39***	16.985	1.30	3.426	0.38	0.016
19	−2.231	−4.09***	30.086	2.20**	−0.513	−0.05	0.052
20	0.389	0.54	−14.763	−0.82	−1.633	−0.13	−0.009
21	−2.354	−3.81***	38.981	2.52**	3.037	0.28	0.087
22	−0.986	−1.82*	1.272	0.09	6.385	0.68	−0.014
23	−0.967	−1.80*	−1.680	−0.13	16.194	1.75*	0.023
24	−0.748	−1.29	10.972	0.76	−8.224	−0.82	−0.014
25	−0.870	−1.74*	1.791	0.14	10.095	1.17	0.003

*, **, ***Indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

introduction of the Euro. The study examines if the efficacy of random diversification varies over time and if such variation is related to ex-post market returns and risk. The literature shows that the average active individual investors hold rather small portfolios of around 15 securities. Hence, this article analyzes the average relative risk reduction investors will achieve with a 15-stock portfolio compared with a two-asset portfolio. Moreover, the study examines the dynamic aspect of domestic diversification in that we investigate whether the benefits from diversification have changed after the introduction of the Euro.

Overall, the study provides evidence that randomly adding stocks to a portfolio does decrease portfolio risk. Furthermore, the decrease in portfolio risk decreases as the size of the portfolio increases. While these results are not new, we demonstrate that marginal benefits from adding a random stock to a portfolio are not stable over time in the five European equity markets, which may explain the discrepancies in previous literature. Additionally, the average relative risk reduction from adding a random stock to a portfolio seems to be increasing with time. The finding implies that a general statement about the level of diversification benefits one achieves from actively investing in restricted number of stocks may be invalid. A relatively small portfolio may be highly underdiversified during some periods; while it may provide an economically acceptable level of diversification benefits during other times.

Moreover, we find that the typical 15-stock portfolios held by small investors have

Table 8 Model (5), marginal risk reduction and market volatilities pre/post Euro introduction: $MARG_{i,t} = \beta_0 + \beta_1 PREEU_t + \beta_2 MKTRSK_{i,t} + \beta_3 PREEU_t * MKTRSK_{i,t} + \varepsilon_{i,t}$

Portfolio size	*Intercept*	*t* statistics	*PREEU*	*t* statistics	*MKTRSK*	*t* statistics	*PREEU*MKTRSK*	*t* statistics	Adj R^2
2	−14.576	−6.61***	−0.647	−0.25	41.876	0.86	47.773	0.84	0.098
3	−10.978	−5.34***	−1.123	−0.46	88.407	1.94*	29.492	0.55	0.178
4	−9.445	−4.89***	1.975	0.85	80.805	1.88*	−33.215	−0.66	0.049
5	−4.944	−2.19**	−2.793	−1.03	−1.75	−0.04	84.125	1.43	0.056
6	−5.299	−3.16***	0.746	0.37	22.263	0.60	16.979	0.39	0.052
7	−6.493	−3.80***	−0.397	−0.19	74.835	1.97**	−2.527	−0.06	0.11
8	−6.592	−3.97***	3.896	1.96**	86.436	2.35**	−56.328	−1.31	0.093
9	−3.608	−3.08***	−1.247	−0.89	18.908	0.73	28.796	0.95	0.071
10	−2.011	−1.55	−1.27	−0.82	15.712	0.54	29.782	0.88	0.044
11	−3.582	−3.30***	1.949	1.50	31.5	1.31	−26.382	−0.94	0.022
12	−1.278	−0.91	−1.393	−0.82	−26.715	−0.85	64.66	1.77*	0.074
13	−3.052	−2.50**	0.483	0.33	41.301	1.52	−21.064	−0.67	0.014
14	−0.761	−0.57	−0.706	−0.44	5.802	0.20	8.575	0.25	−0.023
15	−2.297	−1.72*	−0.577	−0.36	25.286	0.85	16.594	0.48	0.036
16	−2.416	−1.99**	1.731	1.19	27.791	1.03	−25.016	−0.79	−0.003
17	−1.726	−1.50	0.345	0.25	11.943	0.47	4.225	0.14	−0.005
18	−0.76	−0.81	−1.452	−1.28	−4.075	−0.20	32.65	1.33	0.023
19	−2.845	−2.87***	0.882	0.74	42.888	1.95*	−18.277	−0.71	0.047
20	−0.088	−0.07	0.686	0.44	−4.807	−0.17	−15.449	−0.45	−0.019
21	−2.145	−1.91*	−0.3	−0.22	34.63	1.39	9.075	0.31	0.077
22	−2.494	−2.57***	2.168	1.87*	32.721	1.52	−37.254	−1.48	0.014
23	−0.167	−0.17	−1.15	−0.99	−18.37	−0.85	39.352	1.56	0.023
24	−0.914	−0.87	0.238	0.19	14.425	0.62	−13.016	−0.48	−0.025
25	−1.045	−1.15	0.252	0.23	5.444	0.27	5.026	0.21	−0.008

*, **, ***Indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

obtained a considerable risk reduction relative to a two-stock portfolio. In particular, over the period 1988–2005 the risk reduction is 44% for France, 47% for Germany, 31% for Italy, 35% for Spain, and 43% for the United Kingdom.

Further, our analysis demonstrates that while total relative risk has increased in the post-Euro introduction period, it also shows that in the post-Euro introduction period a smaller portfolio size seems to provide the same percentage average relative risk reduction than in the pre-Euro period. In the context of the above findings, this may be expected, as the literature points out that a common currency may eliminate or mitigate the systematic risk factor related to exchange rate risk, which in turn may have caused a higher reduction in systematic risk relative to unsystematic risk.

Additionally, our findings indicate that to obtain the same relative risk reduction a smaller portfolio is required in large markets (France, Germany, and United Kingdom) than in smaller markets (Italy and Spain). For example, in the post-Euro introduction period individual investors holding a random portfolio of 15 stocks, in the equity markets of France, Germany, and the United Kingdom, obtained on average a relative risk reduction over a two-asset portfolio of close to 50%. Hence, our study may imply that most individual investors, who enjoy direct investing and, hence, restrict themselves to holding a small

number of securities to reduce transactions cost, are not as irrational and underdiversified as commonly thought.

In addition, our models show that there is a systematic relationship between the marginal benefit of adding one stock to a portfolio and market volatility, and this relationship is inverse in nature. In fact, as volatility increases, the marginal benefit of diversification is reduced. This finding may be explained by the fact that an increase in volatility impacts the two components of risk (unsystematic and systematic risk) differently. For example, if the increase in overall volatility is mainly due to an increase in systematic risk, adding stocks to a portfolio will be less effective in reducing risk. The result may suggest that individual investors should increase their portfolio size during times of high volatility or shift their investments strategy from direct to indirect investing, such as indexing.

In summary, this study provides important implications for any active portfolio investor focusing on European equity markets, especially for those who want to obtain an economically acceptable level of diversification benefits based on a relatively small number of securities.

Acknowledgments

This project was funded with a research enhancement grant from Stephen F. Austin State University.

References

Askari, H., & Chatterjee, J. (2005). The Euro and financial market integration. *Journal of Common Market Studies, 43*, 1–11.

Ball, A. C., & Torous, W. N. (2000). Stochastic correlation across international stock markets. *Journal of Empirical Finance, 7*, 373–388.

Barber, B. M., & Odean, T. (2000). Trading is hazardous to your wealth: The common stock investment performance of individual investors. *Journal of Finance, 55*, 773–806.

Bartram, S. M., & Karolyi, G. A. (2006). The impact of the introduction of the Euro on foreign exchange rate risk exposures. *Journal of Empirical Finance, 13*, 519–549.

Bartram, S. M., Taylor, S. J., & Wang, Y. H. (2007). The Euro and European financial market dependence. *Journal of Banking & Finance, 31*, 1461–1481.

Chen, H., & Volpe, R. P. (1998). An analysis of personal financial literacy among college students. *Financial Services Review, 7*, 107–128.

Evans, J. L., & Archer, S. H. (1968). Diversification and the reduction of dispersion: An empirical analysis. *Journal of Finance, 23*, 761–767.

Fama, E. F. (1976). *Foundations of Finance*. New York: Basic Books.

Flavin, T. J. (2004). The effect of the Euro on country versus industry portfolio diversification. *Journal of International Money and Finance, 23*, 1137–1158.

Fortin, R., & Michelson, S. (2005). Active international mutual funds management: Can managers beat the index? *Managerial Finance, 31*, 41–51.

Fortin, R., & Michelson, S. (2002). Indexing versus active mutual fund management. *Journal of Financial Planning, 15*, 82–94.

Francis, C. J. (1986). *Investments: Analysis and Management, 4th ed.* New York: McGraw-Hill.

Goetzmann, W. N., & Kumar, A. (2007). *Why Do Individual Investors Hold Under-Diversified Portfolios?* Working paper (August), University of Texas at Austin and Yale University.

Guiso, L., Haliassos, M., & Jappelli, T. (2003). Stockholding in Europe: Where do we stand and where do we go? *Economic Policy, April*, 117–164.

Gup, B. E. (1983). *The Basics of Investing, 2nd ed.* New York: John Wiley and Sons.

Holmes, M. J. (2003). Financial integration and the European Union: An assessment of the impact of capital controls, exchange rate turbulence and the introduction of the Euro. *European Review of Economics and Finance, 2*, 3–18.

Kelly, M. (1995). All their eggs in one basket: Portfolio diversification of U.S. households. *Journal of Economic Behavior and Organization, 27*, 87–96.

Kim, E. H., & Singal, V. (2000). Stock market openings: Experience of emerging economies. *Journal of Business, 73*, 25–66.

Kim, S. J., Moshirian, F., & Wu, E. (2005). Dynamic stock market integration driven by the European Monetary Union: An empirical analysis. *Journal of Banking & Finance, 29*, 2475–2502.

Kyrychenko, V., & Shum, P. (2009). Who holds foreign stocks and bonds? Characteristics of active investors in foreign securities. *Financial Services Review, 18*, 1–21.

Lease, R. C., Lewellen, W. G., & Schlarbaum, G. G. (1974). The individual investor: Attributes and attitudes. *Journal of Finance, 29*, 413–433.

Leon, A., Nave, J. M., & Rubio, G. (2007). The relationship between risk and expected return in Europe. *Journal of Banking and Finance, 31*, 495–512.

Longin, F., & Solnik, B. (1995). Is the correlation in international equity returns constant: 1960–1990? *Journal of International Money and Finance, 14*, 3–26.

Mandell, L., & Schmid Klein, L. (2007). Motivation and financial literacy. *Financial Services Review, 16*, 105–116.

Morana, M., & Beltratti, A. (2002). The effects of the introduction of the Euro on the volatility of European stock markets. *Journal of Banking & Finance, 26*, 2047–2064.

Polkovnichenko, V. (2005). Household portfolio diversification: A case for rank dependent preferences. *Review of Financial Studies, 18*, 1467–1502.

Reilly, F. K. (1985). *Investment Analysis and Portfolio Management, 2nd ed.* San Francisco: Dryden Press.

Sankaran, J. K., & Patil, A. A. (1999). On the optimal selection of portfolios under limited diversification. *Journal of Banking & Finance, 23*, 1655–1666.

Sarkis, J. K. (2003). Country risk and international portfolio diversification for the individual investor. *Financial Services Review, 12*, 73–93.

Statman, M. (1987). How many stocks make a diversified portfolio? *Journal of Financial and Quantitative Analysis, 22*, 353–363.

Stevenson, R. A., & Jennings, E. H. (1984). *Fundamental of Investments, 3rd ed.* San Francisco: West Publ. Co.

Volpe, R. P., Chen, H., & Liu, S. (2006). An analysis of the importance of personal finance topics and the level of knowledge possessed by working adults. *Financial Services Review, 15*, 81–99.

Woerheide, W., & Persson, D. (1993). An index of portfolio diversification. *Financial Services Review, 2*, 73–85.