Assessing the Impact of Short-sale Constraints on the Gains from International Diversification

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Abstract

This paper examines the impact of short-sale constraints on the magnitude of international diversification benefit for U.S. investors during the period of 1976 – 1998. The diversification benefit is measured as the increase in expected return when switching from the U.S. equity index portfolio to the efficient international portfolio with equal variance. Although short-sale constraints reduce the diversification benefit, we find that the reduction caused by the constraints on emerging markets is small. This result holds in both pre- and post-liberalization periods. They are also unaffected by the fact that the U.S. index portfolio is not on the efficient frontier spanned by U.S. securities.

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1 Introduction

An important question in international finance is how big the benefit is when diversifying over securities in foreign countries, especially securities in emerging markets. In theory, if foreign securities do not perfectly correlate with U.S. securities, domestic investors will gain from international diversification. However, before offering advice on asset allocation, we need to have an estimate on the magnitude of diversification benefit. Intuitively, the magnitude of diversification benefit in general depends on investors' ability to take short positions. Although one can short a country or a market using derivative securities, margin requirements, collaterals, or fiduciary rules often restrict or prohibit such short positions. It is therefore important to assess the impact of short-sale constraints on the gains from international diversification.

Ignoring short-sale constraints, many studies have documented low correlations among international markets and substantial diversification benefit. The early literature of Grubel (1968), Levy and Sarnat (1970), and Lessard (1973) finds low correlations for equity returns in industrial countries and concludes that the gains from international diversification are substantial. Harvey (1995) shows that securities in emerging markets promise U.S. investors both higher expected returns and risk, as well as low correlations with securities in developed markets. Bekaert and Urias (1996) reject the hypothesis that equity indices in industrial countries span the mean-variance frontier of all international equity indices and thus demonstrate the existence of diversification benefit from investment in emerging markets. Using the international CAPM, De Santis and Gerrard (1997) estimate that the expected gains from international diversification for a U.S. investor is on average 2.11 percent annually. Errunza, Hogan and Hung (1999) further show that international diversification benefit can be obtained from investment in country funds and ADRs traded in the U.S.

Although an optimal asset allocation over domestic and international markets often involves taking short investment positions, short positions are not always easy to implement in practice. As Sharpe (1991) points out, institutional arrangements for short selling have traditionally required that investors post separate collateral for every position. Since 1974, the Federal Reserve Board has set the initial margin requirement at 50 percent and brokers are allowed to set it even higher. The proceeds from short sales often have to be deposited in a brokerage firm at interest rates lower than the risk-free rate in the market. Short positions on a country have to be constructed from derivatives on the market index in that country. These short positions are not feasible for individual investors who simply allocate their retirement savings among funds tracking country indices. For many emerging markets, no derivatives on indices were listed in exchanges until recently. In addition, many institutional investors are prohibited from taking short positions through either explicit rules or implicit threat of lawsuit for violating fiduciary standards.

The importance of short-sale constraints has gained increasing attention, but the exact impact of short-sale constraints on the magnitude of international diversification benefit remains unknown. Sharpe (1991) conjectures that departures from the original CAPM might be small even in the extreme case where negative holdings are excluded. He postulates that institutional arrangements to improve investors' abilities to take negative positions facilitate the efficient allocation of risk in the economy. Hansen, Heaton and Luttmer (1995), He and Modest (1995), and Luttmer (1996) study how short-sale constraints and transaction costs affect consumption-based asset pricing models. For portfolio efficiency subject to short-sale constraints, Wang (1998) conducts Bayesian inference, and Basak, Jagannathan and Sun (1998) develop an asymptotic test. For international diversification subject to short-sale constraints, Glen and Jorion (1993) empirically show the existence of the benefit in currency hedging, and De Roon, Nijman and Werker (1998) reject international mean-variance spanning. However, none of these papers directly examine how short-sale constraints affect the magnitude of the diversification benefit over emerging markets.

In this paper, we examine the impact of short-sale constraints on the magnitude of the international diversification benefit for U.S. investors. Our measure and inference on the international diversification benefit follow the work of Kandel et al. (1995) and Wang (1998) on portfolio efficiency. The expected return of the U.S. equity index portfolio is either smaller than or equal to the expected return on the internationally efficient portfolio with equal variance. We use the difference between expected returns on the two portfolios to measure the magnitude of the international diversification benefit. With standard non-informative priors on the mean and covariance of returns, posterior distribution of the measure can be approximated easily by Monte Carlo simulation. Such posterior distribution can be used to examine the information contained in data about the magnitude of the international diversification benefit. Although short-sale constraints reduce the diversification benefit, we find that the reduction caused by the constraints on emerging markets is small. Qualitatively similar results are found in the sub-periods before and since 1992, which is believed by some researchers to be the year when most emerging markets became integrated or liberalized (see Bekaert, 1995). Our result is unaffected by the fact that the U.S. equity index is not on the efficient frontier spanned by U.S. securities.

The rest of the paper proceeds as follows. In Section 2 we discuss the measure of the international diversification benefit and the computation of their posterior distributions. In Section 3 we describe the data used in this study. In Section 4 we present our empirical result. In Section 5 we examine whether our result is robust to the integration process of global markets over time. We also examine whether the result is affected by the fact that the U.S. equity index portfolio is not on the efficient frontier of U.S. securities. In Section 6 we discuss some related issues along with our conclusion.

2 Measuring the Diversification Benefit

We measure the international diversification benefit in the mean-variance framework. Let $R = (r_1, \cdots, r_n)'$ be the vector of random returns of n assets. We assume that the vector of returns has a multivariate normal distribution, with mean $\mu = (\mu_1, \cdots, \mu_n)'$ and covariance matrix Ω. Let S be the set of all the real vectors $x = (x_1, \cdots, x_n)'$ such that $x_1 + \cdots + x_n = 1$. The vector of weights in a portfolio is a point in S. A set of constraints on portfolio weights is represented by a closed convex subset C of S. For example, the case in which portfolio holdings are unconstrained can be represented by $C = S$, and the case in which short sales are prohibited can be represented by $C = \{x \in S : x_i \geq 0,\ i = 1, \cdots, n\}$.

Suppose x_m ($\in C$) is a given benchmark portfolio. Since our focus is the international diversification benefit for U.S. investors, the benchmark in this paper is always the index portfolio of the U.S. equity market. The expected return of the benchmark portfolio is $x_m'\mu$, which will be less than the expected return of an efficient portfolio with the same variance, $x_m'\Omega x_m$, unless portfolio x_m is mean-variance efficient. The benefit of diversifying from portfolio x_m to an efficient portfolio of all the n assets, controlling variance, can be measured by

$$\delta(x_m, C, \mu, \Omega) \equiv \max\left\{x'\mu - x_m'\mu \mid x \in C,\ x'\Omega x \le x_m'\Omega x_m\right\} \ . \tag{1}$$

The benchmark portfolio x_m is mean-variance efficient if and only if $\delta = 0$. The measure δ defined in equation (1) is the same measure of portfolio inefficiency used by Wang (1998), which is a straightforward extension of the measure Δ defined by Kandel et al. (1995). When portfolio weights are unconstrained, i.e., $C = S$, the measure δ defined here is equivalent to the measure Δ. This measure has a simple intuitive appeal: It is the gain in expected return by diversifying from the benchmark portfolio into an efficient portfolio with the same variance. The economic interpretation of this measure is straightforward and practical, it tells us by how much the expected return increase if diversifying internationally.

The main purpose of this paper is to draw inferences from the observed financial data. We therefore assume that little is known, a priori, about the expectation and the covariance matrix of asset returns. Therefore, the prior probability density function is assumed to be

$$p(\mu, \Omega) = p(\mu) \cdot p(\Omega), \qquad p(\mu) \propto \text{constant}, \qquad p(\Omega) \propto |\Omega|^{-(n+1)/2} \ . \tag{2}$$

Suppose that there are T independent observations on the vector of returns. Denote the tth observation on the vector of returns by R_t and the matrix of all observed returns by $\mathcal{R} = (R_1, \ldots, R_T)'$. Let $\hat{\mu}$ and $\hat{\Omega}$ be the sample mean and covariance matrix of the asset returns, respectively. It is well known that the posterior probability density function is

$$p(\mu, \Omega \,|\, \mathcal{R}) = p(\mu \,|\, \Omega, \hat{\mu}, T) \cdot p(\Omega \,|\, \hat{\Omega}, T) \ . \tag{3}$$

The marginal posterior distribution $p(\Omega \,|\, \hat{\Omega}, T)$ is the inverted Wishart distribution with the scale matrix $T\hat{\Omega}$ and degrees of freedom $T - 1$. The conditional distribution $p(\mu \,|\, \Omega, \hat{\mu}, T)$ is the multivariate normal distribution with mean $\hat{\mu}$ and covariance matrix $(1/T)\Omega$.[1]

Since the measure of the diversification benefit, δ, is a nonlinear function of μ and Ω, we do not have analytical expressions for the posterior distribution of δ. However, the Monte Carlo method can be used to estimate the posterior distribution. A random sample Ω is drawn from the inverted Wishart distribution with parameter matrix $T\hat{\Omega}$ and degrees of freedom $T-1$. Then, a random sample μ is drawn from the multivariate normal distribution with mean $\hat{\mu}$ and variance $(1/T)\Omega$. The pair (μ, Ω) is thus a random sample from the joint posterior distribution expressed in equation (3). Given μ and Ω, δ is calculated by solving the constrained optimization problem in equation (1). This provides a sample from the posterior distribution $p(\delta \,|\, \mathcal{R})$. By repeating this process, a large number (e.g. 10,000) of independent draws of δ are obtained from its posterior distribution. These samples are used to form the approximate posterior distribution of δ, as described by Geweke (1989).

It is often argued that the main benefit of international diversification is reduction of variance instead of increase in returns. We need a measure of the international diversification benefit in terms of variance reduction. Kandel and Stambaugh (1987) and Shanken (1987) examine the maximum correlation between a given portfolio and an efficient portfolio. In the presence of a risk-free asset, this measure is the portfolio's Sharpe ratio divided by the maximum Sharpe ratio across all portfolios, and can be expressed as

$$\rho = \min\left\{ \sqrt{(x'\Omega x)/(x_m'\Omega x_m)} \mid x \in S,\ x'\mu \geq x_m'\mu \right\} \ .$$

The portfolio x_m is efficient if and only if $\rho = 1$. This measure can be easily extended to

[1] See, for example, Zellner (1971, pp.224-227).

incorporate portfolio constraints:

$$\varphi(x_m, C, \mu, \Omega) \equiv \min\left\{\sqrt{(x'\Omega x)/(x_m'\Omega x_m)} \mid x \in C,\ x'\mu \geq x_m'\mu\right\}\ .$$

When there are constraints on portfolio weights, φ is no longer the maximum correlation. Nevertheless, it is the fraction to which an investor reduces the standard deviation by holding a diversified international portfolio rather than the U.S. equity index portfolio x_m. Since $\varphi = 1$ when the diversification benefit is zero, we use $\phi = (1 - \varphi) \times 100$ as the measure of the international diversification benefit in terms of variance reduction. It is simply the decrease in standard deviation as a percentage of the standard deviation of the benchmark portfolio.[2] The posterior distribution of ϕ can be computed in the same way as the posterior distribution of δ.

The combination of Bayesian inference and Monte Carlo simulation has several advantages. First, it is easy to implement. Once the samples of μ and Ω are drawn, the calculation of the measures of the diversification benefit is straightforward. Second, it allows us to look at both δ and ϕ subject to short-sale constraints. Although Basak et al. (1998) work out the asymptotic distribution theory for the estimated variance reduction in efficient portfolio under short-sale constraints, the sampling distribution of δ based on sample moments remains unknown. Third, instead of testing the null hypothesis of zero diversification benefit, it allows us to draw inference on the magnitude of the benefit. Last, it makes statistical inference on measures of the diversification benefit that do not depend on any asset pricing models. De Santis and Gerrard (1997) use the CAPM to measure the international diversification benefit. The advantage is that they can use the GARCH models, but the disadvantage is

[2]Due to the duality between the problem of maximizing mean given variance and the problem of minimizing variance for given mean, the measure δ equals zero if and only if the measure ϕ is zero. However, there can be cases in which δ is large while ϕ is small, or vice versa. Therefore, a large diversification benefit in expected return does not necessarily imply a large diversification benefit in decreased volatility.

that the CAPM is rejected even in the same study.

As a by-product of Monte Carlo simulation, we also obtain a set of independent draws from the posterior distribution of efficient portfolio weights. Under the classical inference, obtaining the sampling distribution of efficient portfolio weights based on sample moments is a nontrivial task. It is only recently that Britten-Jones (1999) establishes the sampling distribution theory for the case without portfolio constraints. The sampling distribution of efficient portfolio weights subject to constraints is still unknown. In the above Bayesian inference procedure, we can use those independent samples of portfolio weights to estimate posterior distributions of efficient portfolio weights. In Section 4, we report posterior means of the weights.

3 Data

We use dollar-denominated monthly returns on stock indices supplied by Morgan Stanley Capital International (MSCI) for the G7 group of developed countries (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States). We also use dollar-denominated monthly returns on stock indices of eight emerging market countries: Four Latin American markets (Argentina, Brazil, Chile, and Mexico) and four Asian markets (Hong Kong, South Korea, Singapore, and Thailand). Data for Hong Kong and Singapore are also obtained from MSCI. Data for other emerging markets are obtained from the International Finance Corporation (IFC). We examine the data during the period from January 1976 to December 1998. We choose this beginning date because of the availability of data for the emerging markets. The ending date corresponds to the most recent data available to us at the time we started this project.

Table 1 lists the countries along with the symbols used in this paper. It also gives the market capitalization of each country and its market share in 1997. Table 2 provides some descriptive statistics for the data. Similar statistics are provided by Harvey (1995), Bekaert and Harvey (1995), and Bekaert, Erb, Harvey and Viskanta (1996). Since Bekaert (1995) argues that emerging markets became globally integrated in 1992, we also split the sample period into two sub periods: January 1976 – December 1991 and January 1992 – December 1998. Table 2 also reports the summary statistics for the sub periods. Table 3 reports the correlations matrix.

The means and standard deviations of returns do not provide a clear indication as to whether the international diversification benefit exists over emerging markets in addition to G7 countries. For the whole sample, emerging markets generally have both higher means and higher standard deviations relative to G7 countries. The exceptions are Korea and Thailand, where mean returns are comparable to those of the G7 countries but the standard deviation is much higher. The post-liberalization period is also an exception, since many emerging markets have poor returns and high volatility in this period. Even during this period, however, Brazil, Hong Kong and Singapore still exhibit favorable returns relative to G7 countries. It is even harder to see whether G7 countries offer diversification benefit to U.S. investors. Among G7 countries, the performance of the U.S. market is strong. In fact, the U.S. market has higher mean and lower standard deviation of returns relative to Canada, Japan and Germany during the whole sample priod. For the post-1992 period, the U.S. market dominates all other G7 markets in terms of the risk-return tradeoff.

The correlation matrix provides strong evidence for the existence of the diversification benefit over emerging markets in addition to G7 countries. Emerging market countries have low correlations both among themselves, as well as with G7 countries. In fact, Hong Kong and Singapore exhibit negative correlation with many G7 countries. The low correlations suggest that investors may benefit from long positions in emerging market stocks, although the relatively high standard deviation of emerging market stocks could mitigate the benefit of international diversification. In contrast to emerging markets, the G7 countries have relatively high correlation among themselves. In particular, the correlation of U.S. and Canadian stock returns is 0.71. It is worth recalling that the U.S. stock market has more favorable mean return and standard deviation than the Canadian market.

4 Empirical Results

We examine the international diversification benefit during the period from January 1976 to December 1998. Since our focus is on the diversification benefit to U.S. investors, the benchmark portfolio is the U.S. equity index portfolio. We start by considering the diversification benefit over G7 countries. Then, we consider the diversification benefit over the markets in G7 countries and four Latin American emerging markets. We also consider the diversification benefit over the G7 countries and four Asian emerging markets. Finally, we consider the diversification benefit over all the countries in our sample. For each combination of countries, we look at the benefit both with portfolio weights unconstrained and with portfolio weights constrained to be nonnegative. In Table 4 we report the means, standard deviations and percentiles of the posterior distributions of δ for various choices of countries and constraints. The graphs of the posterior distributions of δ are displayed in Figure 1.

The uncertainty in the posterior belief of δ is very high. When portfolio weights are unconstrained and all countries are considered, the 99th percentile of δ is higher than the

1st percentile by more than 15 percent in annualized returns. The standard deviation of the posterior distribution is over 3 percent. Such high uncertainty prevails in all the cases with different choices of countries. Short-sale constraints do not help in reducing the uncertainty. When portfolio weights are constrained to be nonnegative, the difference in the 99th percentile and the 1st percentile is also higher than 15 percent and the standard deviation is again over 3 percent in annualize returns. The uncertainty in the posterior distribution is obvious in the posterior distributions of δ plotted in Figure 1.

Although the uncertainty is high, the diversification benefit over G7 and the emerging markets seems large when portfolio weights are unconstrained. The benefit over G7 and Latin American countries is at least 3.74 percent with a posterior probability of .99. The benefit over G7 and Asian countries is at least 2.67 percent with a posterior probability of .99. The benefit over all the countries is almost 6 percent with a posterior probability of .99. This magnitude of the diversification benefit is probably big enough to justify the costs of investment in different emerging markets. However, the short positions required to achieve such big diversification benefit may not be easy to implement for emerging markets.

As expected, the main effect of short-sale constraints is a shift in the location of the posterior distributions of δ. The posterior mean of the diversification benefit over all the countries reduces to 10.33 percent from 12.85 percent when constraints are imposed on all countries. The 1st percentile drops to 3.29 from 5.97. The diversification benefit over G7 and Latin American countries also decreases. The same is also true for the diversification benefit over G7 and Asian countries. With all portfolio weights constrained to be non-negative, the 1st percentile of the benefit over G7 and Asian countries is almost zero, while the 1st percentile of the benefit over G7 and Latin American countries drop from 3.74 percent to

1.81 percent in annualized returns. The short-sale constraints move the entire posterior distribution of the benefit over all countries towards zero by at least 2 percent in annualized returns.

After imposing short-sale constraints on all countries, the potential diversification benefit over the emerging markets still exist. When all countries are considered, the 1st percentile of δ is 3.29 percent in annualized returns. With G7 and Latin American countries combined, the 1st percentile of δ is 1.81. With G7 and Asian countries combined, however, the 1st percentile of δ is almost zero. The 1st percentile of δ for G7 and Asian countries is smaller because the uncertainty in the posterior distribution is relatively higher. Notice that the standard deviation is higher than in the case of G7 and Latin American countries. Also notice that the 99th percentile for G7 and Asian countries is about the same as the 99th percentile for G7 and Latin American countries.

With or without portfolio weights constrained, De Roon et al. (1998) reject the hypothesis that the securities in G7 countries span the efficient frontier of emerging markets. Here we show that the international diversification benefit exists both with and without short-sale constraints. However, these do not imply that short-sale constraints are unimportant, because the benefit is reduced once constraints are imposed. The impact of short-sale constraints on the posterior distributions of δ can be seen in Figure 1. After imposing short-sale constraints, all the posterior distributions move toward zero, which is evident by comparing panels A and B in Figure 1.

In order to gain a better understanding of the effects of short-sale constraints on the international diversification benefit, in Table 5 we report the posterior mean of weights in the efficient portfolio used to calculate δ. The only short position for emerging markets is on Thailand, and only 1 percent. In contrast, large short positions exist for developed countries. The magnitude of the short position on Canada is around 30 percent. When short-sale constraints are imposed, the weight on Canada is close to zero. It seems that the diversification benefit depends on taking short positions on developed countries like Canada. It is also interesting to note that the efficient portfolio over all countries puts a weight of 61 percent on the U.S. market, which is close to its actual share (about 50 percent, see Table 1). However, in the presence of short-sale constraints, the efficient portfolio weight on the U.S. market, which is 23 percent, is much smaller than the actual share of the U.S. market.

If the diversification benefit mainly depends on shorting some developed countries, those short-sale constraints on emerging markets should not have a big impact. This is confirmed by the posterior distributions of δ reported in the last parts of Table 4. The benefit of diversifying over G7 and Latin American countries is at least 3.56 percent in annualized returns with a posterior probability of .99. However, this is almost as high as in the case where portfolios are unconstrained. The benefit of diversifying over all countries is at least 5.56 percent in annualized returns with a posterior probability of .99, which is also as high as the benefit when portfolio are unconstrained. The posterior distributions plotted in Figure 1C are almost identical to their counterparts in Figure 1A. Given the existence of derivative securities on indices of stock markets and currencies in developed countries, it is often feasible for institutional investors to take short positions on developed markets. Investors nonetheless often face short-sale constraints in many of the emerging markets. Our result indicates that short-sale constraints on emerging markets do not affect the international diversification benefit for sophisticated institutional investors.

It is often argued that the main benefit of international diversification is the reduction in variance rather than the increase in returns. For example, a columnist in *The Wall Street Journal* wrote:[3] "The main reason to invest abroad isn't to replicate the global market or to boost returns. Instead, what we're trying to do by adding foreign stocks is to reduce volatility." Elton and Gruber (1995) argue that, since there is no evidence to support an international CAPM, risk-averse investors with no ability to forecast expected returns might seek to minimize the variance of their portfolios. To capture this aspect, we look at the posterior distribution of ϕ, which is the reduction in standard deviation as a fraction of the standard deviation of the U.S. equity index portfolio. The means, standard deviations and percentiles are reported in Table 6. The results obtained for ϕ are consistent with those obtained for δ: Although the short-sale constraints reduce the magnitude of the diversification benefit, those short-sale constraints on emerging markets have little effects.

5 Robustness

Several papers argue that the benefit from international diversification is getting smaller as emerging markets become more liberalized. For example, De Roon et al. (1998) find that gains in diversification disappear after 1992 if short sale constraints are imposed. Furthermore, our results may be unduly influenced by the recent financial crises. To examine these issues, we measure the diversification benefit separately for the period from January 1976 to December 1991 and the period from January 1992 to December 1998. As before, we look at the benefit with the portfolio weights either unconstrained or constrained to be nonnegative. Tables 7 and 8 report the means, standard deviations and percentiles of the posterior distributions of δ for the two sub periods. The graphs of the posterior distributions of δ for

[3]Jonathan Clements: "Getting Going: International Investing Raises Questions on Allocation, Diversification, Hedging," The Wall Street Journal, July 29, 1997.

the two sub periods are displayed in Figures 2 and 3.

Imposing short-sale constraints on emerging markets has no effects on the diversification benefit in the pre-liberalization period, but has some effects in the later period. In the early period, the diversification benefit over all countries is at least 9.84 percent with a posterior probability of .99 for the case with constraints on emerging markets, compared to 10.15 percent for the case without any constraints. All the other percentiles and the means of the posterior distribution change similarly when short-sale constraints are imposed on emerging markets. In contrast, during the post-liberalization period, the 1st percentile of the benefit of diversifying over all countries falls from 6.86 percent in the case without constraints to 4.11 percent when short-sale constraints are imposed on emerging markets. The 50th percentile drops from 16.95 to 13.21, and the 99th percentile drops from 32.41 to 27.84. However, the changes are small relative to the magnitude of those numbers.

When portfolio weights are unconstrained, the uncertainty in the posterior distributions of δ for the post-liberalization period is much higher than that for the entire period. Since the post-liberalization period contains only 84 observations, the posterior distribution of the first two moments of the returns is rather disperse. An efficient portfolio tends to take long positions on assets with high expected returns and short position on assets with low expected returns. This leads to the high uncertainty in the posterior distributions and the large posterior means of δ. Therefore, for the case without constraints, the posterior means of δ in Table 8 are higher than the corresponding posterior means in Table 4. Imposing short-sale constraints on all countries reduces the swing of portfolio weights and thus reduces the uncertainty. However, the short-sale constraints on emerging markets have much smaller effects on the uncertainty in the posterior distributions of δ.

Since there is considerable evidence that the NYSE-AMEX market portfolio is mean-variance inefficient, the benefit from international diversification found so far may be further reduced if U.S. investors are able to improve on the efficiency of their portfolios of the U.S. equities. We address this issue by including the size and book-to-market portfolios constructed by Fama and French (1993). We start by considering the diversification benefit of moving from the benchmark U.S. market index to the efficient frontier generated by the Fama-French portfolios. Then, similar to our earlier analysis, we successively add market indices of G7, Latin American and Asian countries to the Fama-French portfolios. Table 9 reports the mean, standard deviation and percentiles of the posterior distribution of δ. The graphs of the posterior distributions of δ is in Figure 4. The results obtained here are similar to what we find in Table 4. With or without short-sale constraints, adding emerging markets moves the location of the posterior distribution of δ substantially away from zero. Imposing short-sale constraints on emerging markets does not affect the posterior distribution of δ.

6 Conclusion

We examine the impact of short-sale constraints on the magnitude of the international diversification benefit for U.S. investors during the period of 1976 – 1998. The diversification benefit is measured as the increase in the expected return when switching from the U.S. equity index portfolio to the efficient international portfolio with equal variance. Although the diversification benefit decreases when short-sale constraints are imposed on all countries, they are not affected by those constraints on emerging markets. This result holds in both pre- and post-liberalization periods. They are also unaffected by the fact that the U.S. index portfolio is not on the efficient frontier spanned by U.S. securities. Since short positions on a country have to be constructed from derivatives, the lack of derivative securities for many emerging markets make it hard to implement short positions. The result in this paper indicates that the diversification benefit is not affected as long as we can construct short positions on developed markets.

Our analysis on the benefit from international diversification has at least three advantages. First, since all asset-pricing models are rejected in empirical tests, relying on those models has serious logical and practical problems. However, our approach does not depend on any asset-pricing model. Second, most studies focus on rejection of the null hypothesis of zero diversification benefit and gauge the magnitude of the benefit by looking at the strength of the rejection. However, the combination of Bayesian inference and Monte Carlo simulation allows us to draw exact inference on the magnitude of the diversification benefit. Last, the short-sale constraints can be replaced by realistic margin and collateral requirements, as well as limitations on portfolio proportions for fund managers. In the approach described in Section 2, we only assume that the portfolio constraints form a closed convex set. Since this assumption is rather general, our approach can be used to examine a variety of market frictions.

The study in this paper also has three shortcomings. First, not all the equities covered by the indices used in this study are accessible to U.S. investors. Therefore, the diversification benefit we calculated may not be available to U.S. investors. To address this issue, we can use the investable indices provided by IFC. However, the investable indices of many emerging markets have rather short history. If we cut all the indices to the same length, the number of observations will be too small, and the uncertainty in the posterior distribution will be too great for us to draw reliable inference. To solve this problem, we can incorporate the method suggested by Stambaugh (1997) that allows asset returns to have different lengths of historical observations. This is part of our study for this paper and will be added in later revisions.

Second, our analysis assumes that the prior belief is non-informative. Therefore, the impact of short-sale constraints we examined in this paper is for investors and econometricians whose prior belief is non-informative. Those with non-informative prior belief only use the observed sample mean and variance of historical returns to form their posterior belief. However, if one believes that the observed historical returns are too high or too low and thus will converge to some equilibrium, her belief in asset pricing models should be incorporated into the prior distribution. Black and Litterman (1992), Pastor (1999) and Pastor and Stambaugh (1999) develop some frameworks on prior belief in asset pricing models. The diversification benefit perceived by investors with informative priors can be very different from the benefit perceived by those with non-informative priors. This issue is examined by Wang (1999).

Finally, the asset allocation problem we considered is static rather than conditional or dynamic. Hodrick (1981) and Harvey (1991) document the time-varying risk and expected returns for international equities. Ferson and Harvey (1993) and Harvey (1995) find that international stock returns are predictable. Hodrick, Ng and Sengmueller (1998) examine the hedging demands when international asset returns are predictable. Ang and Bekaert (1999) study how the hedging demands affect the international diversification benefit in dynamic portfolio choices with regime-switching models. An extension of our study to examine the impact of short-sale constraints on the benefit of conditionally or dynamically diversified portfolio will be interesting. This is part of our future research.

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Table 1: Countries and their market capitalization.

This table lists the 15 countries whose equity indices are used in this paper. The second column gives the symbols for these countries. The third column reports the stock market capitalization (in millions of U.S. dollars) of these countries at the end of 1997. The data on market capitalization is obtained from I/B/E/S. The fourth column gives the weight of each country as a fraction of the total capitalization of the 15 countries.

Country	Symbol	Market Cap	Weight
United States	USA	9890.470	.5584
Canada	CAN	400.003	.0226
Japan	JAP	2673.900	.1510
France	FRA	630.545	.0356
Germany	GER	779.926	.0440
Italy	ITA	288.202	.0163
United Kingdom	UK	1919.410	.1084
Argentina	ARG	55.458	.0031
Brazil	BRA	369.379	.0209
Chile	CHI	60.744	.0034
Mexico	MEX	85.768	.0048
Korea	KOR	74.950	.0042
Thailand	THA	37.136	.0021
Hong Kong	HK	332.481	.0188
Singapore	SIN	114.755	.0065

Table 2: Basic statistics of data.

This table gives the sample mean and standard deviations of the dollar-denominated monthly returns on the equity indices of 15 countries. The data are provided by MSCI (Morgan Stanley Capital International) and IFC (International Finance Corporation). The mean is reported in percent and annualized by multiplying 12. The standard deviation is also reported in percent but annualized by multiplying $\sqrt{12}$.

Country	1976–1998		1976–1991		1992–1998	
	Mean	Stdev	Mean	Stdev	Mean	Stdev
USA	16.13	14.70	14.75	15.65	18.66	12.27
CAN	11.85	19.15	13.15	20.16	8.82	16.78
JAP	14.24	23.35	20.47	23.06	-0.58	23.70
FRA	16.96	23.18	17.62	25.60	15.05	16.57
GER	15.39	20.35	15.09	22.08	15.91	15.90
ITA	16.21	27.09	15.39	27.17	17.12	27.12
UK	18.02	20.57	19.42	22.95	14.55	13.79
ARG	53.80	91.15	73.46	106.40	10.32	35.00
BRA	23.03	55.88	22.51	60.54	27.18	43.28
CHI	29.27	37.04	37.81	40.26	11.33	27.57
MEX	23.18	43.08	30.80	45.32	5.15	37.40
KOR	16.31	37.87	21.97	32.02	-1.99	46.88
THA	14.68	34.07	21.37	25.71	-0.26	48.20
HK	27.03	41.17	27.36	45.66	27.41	28.60
SIN	18.84	30.95	17.76	32.49	21.64	27.42

Table 3: The correlation matrix.

This table gives the sample correlation matrix of the dollar-denominated monthly returns on the equity indices of 15 countries during 1976–1998. The indices are provided by MSCI (Morgan Stanley Capital International) and IFC (International Finance Corporation).

	USA	CAN	JAP	FRA	GER	ITA	UK
CAN	0.71	****	****	****	****	****	****
JAP	0.25	0.28	****	****	****	****	****
FRA	0.43	0.42	0.42	****	****	****	****
GER	0.36	0.31	0.33	0.60	****	****	****
ITA	0.24	0.30	0.36	0.45	0.37	****	****
UK	0.50	0.54	0.39	0.53	0.45	0.35	****
	ARG	BRA	CHI	MEX	KOR	THA	HK
BRA	0.01	****	****	****	****	****	****
CHI	0.13	0.08	****	****	****	****	****
MEX	0.19	0.07	0.20	****	****	****	****
KOR	-.06	0.03	0.08	0.11	****	****	****
THA	0.05	0.05	0.19	0.25	0.28	****	****
HK	-.11	0.00	0.00	-.09	0.00	-.06	****
SIN	-.04	0.00	-.02	-.12	0.02	-.02	0.47
	USA	CAN	JAP	FRA	GER	ITA	UK
ARG	0.05	0.14	0.00	0.06	0.02	0.09	-.03
BRA	0.12	0.08	0.08	0.08	0.11	0.12	0.12
CHI	0.09	0.15	0.08	0.07	0.10	0.09	0.06
MEX	0.31	0.26	0.13	0.17	0.14	0.11	0.22
KOR	0.17	0.17	0.32	0.07	0.06	0.15	0.17
THA	0.22	0.21	0.20	0.16	0.23	0.15	0.20
HK	-.09	-.11	0.01	-.04	-.02	0.05	0.02
SIN	-.06	-.04	0.08	0.03	-.07	0.11	-.03

Table 4: Posterior distribution of δ.

The international diversification benefit, δ, is measured as the increase in the expected annualized return when switching from the U.S. index portfolio to the efficient portfolio with the same variance. We calculate δ for various efficient frontiers and report the basic statistics of the posterior distributions of δ. The first frontier is generated from the equity indices of G7 countries and indicated by the symbol G. Similarly, GL indicates the frontier generated from the equity indices of G7 and Latin American countries. The symbol GA indicates the frontier generated from G7 and Asian countries, and GLA indicates the frontier generated from equity indices of G7, Latin American and Asian countries. Dollar-denominated monthly returns on the country indices are obtained from MSCI and IFC. The sample period covers January 1976 through December 1998. For the first subpanel, there are no constraints on the portfolio weights. For the next subpanel, short positions are not allowed. For the last subpanel, short positions on emerging markets are prohibited while weights on G7 countries are unconstrained.

	Mean	Stdev	1%	50%	99%
	No constraints on any markets				
G	4.08	1.93	0.71	3.86	9.60
GL	9.10	2.68	3.74	8.90	16.19
GA	8.00	2.75	2.67	7.77	15.21
GLA	12.85	3.27	5.97	12.66	21.43
	No short sales on any markets				
G	2.29	1.87	0.00	1.97	7.68
GL	7.01	2.63	1.81	6.82	13.91
GA	5.80	2.98	0.03	5.60	13.42
GLA	10.33	3.35	3.29	10.14	19.01
	No shorts on emerging markets				
GL	8.92	2.68	3.56	8.75	16.02
GA	7.82	2.79	2.38	7.58	15.13
GLA	12.49	3.30	5.56	12.32	21.02

Table 5: Posterior mean of efficient portfolio weights.

This table provides information about the weights of those efficient portfolios used to calculate δ in Table 4. Each column gives the posterior mean of the weights on countries for forming an efficient portfolio. The efficient portfolio on the frontier generated from the equity indices of G7 countries are reported in the column indicated by the symbol G. Similarly, GL indicates the frontier generated from the equity indices of G7 and Latin American countries. The symbol GA indicates the frontier generated from G7 and Asian countries, and GLA indicates the frontier generated from equity indices of G7, Latin American and Asian countries. Dollar-denominated monthly returns on the country indices are obtained from MSCI and IFC. The sample period covers January 1976 through December 1998. For the first subpanel, there are no constraints on the portfolio weights. For the next subpanel, short positions are not allowed. For the last subpanel, short positions on emerging markets (EM) are prohibited while weights on G7 countries are unconstrained.

	No constraints				No short sales				No shorts on EM		
	G	GL	GA	GLA	G	GL	GA	GLA	GL	GA	GLA
USA	0.84	0.73	0.70	0.61	0.50	0.39	0.30	0.23	0.71	0.69	0.59
CAN	-.31	-.35	-.30	-.34	0.01	0.00	0.01	0.00	-.35	-.31	-.35
JAP	0.09	0.08	0.01	0.02	0.07	0.06	0.03	0.03	0.08	0.00	0.00
FRA	-.02	-.03	0.02	0.00	0.06	0.03	0.07	0.04	-.03	0.02	0.01
GER	0.12	0.09	0.09	0.07	0.10	0.08	0.08	0.06	0.09	0.08	0.06
ITA	0.09	0.05	0.04	0.00	0.08	0.04	0.05	0.02	0.05	0.03	0.00
UK	0.19	0.20	0.16	0.18	0.18	0.13	0.13	0.10	0.20	0.16	0.18
ARG	****	0.05	****	0.06	****	0.05	****	0.06	0.05	****	0.06
BRA	****	0.03	****	0.02	****	0.04	****	0.04	0.03	****	0.03
CHI	****	0.15	****	0.14	****	0.15	****	0.13	0.15	****	0.13
MEX	****	-.01	****	0.01	****	0.02	****	0.03	0.02	****	0.03
KOR	****	****	0.04	0.04	****	****	0.05	0.04	****	0.05	0.05
THA	****	****	0.03	-.01	****	****	0.04	0.02	****	0.05	0.02
HK	****	****	0.12	0.11	****	****	0.16	0.13	****	0.12	0.11
SIN	****	****	0.10	0.10	****	****	0.09	0.08	****	0.11	0.10

Table 6: Posterior distribution of ϕ.

The international diversification benefit, ϕ, is measured as the decrease in the standard deviation, as the percentage of the standard deviation of the U.S. index portfolio, when switching from the U.S. index portfolio to the efficient portfolio with the same expected return. We calculate ϕ for various efficient frontiers and report the basic statistics of the posterior distributions of ϕ. The first frontier is generated from the equity indices of G7 countries and indicated by the symbol G. Similarly, GL indicates the frontier generated from the equity indices of G7 and Latin American countries. The symbol GA indicates the frontier generated from G7 and Asian countries, and GLA indicates the frontier generated from equity indices of G7, Latin American and Asian countries. Dollar-denominated monthly returns on the country indices are obtained from MSCI and IFC. The sample period covers January 1976 through December 1998. For the first subpanel, there are no constraints on the portfolio weights. For the next subpanel, short positions are not allowed. For the last subpanel, short positions on emerging markets are prohibited while weights on G7 countries are unconstrained.

	Mean	Stdev	1%	50%	99%
	No constraints on any markets				
G	11.16	2.89	4.01	11.20	17.96
GL	15.62	2.73	9.54	15.56	22.36
GA	21.90	3.21	14.05	21.96	29.26
GLA	24.97	2.98	18.30	24.94	31.94
	No short sales on any markets				
G	9.18	4.31	0.00	9.94	17.05
GL	14.56	2.75	8.38	14.52	21.37
GA	20.96	4.07	3.87	21.30	28.76
GLA	24.23	3.04	17.32	24.21	31.33
	No shorts on emerging markets				
GL	15.36	2.73	9.35	15.30	22.12
GA	21.87	3.23	13.89	21.94	29.25
GLA	24.83	2.99	18.08	24.81	31.81

Table 7: Posterior distributions of δ for 1976–1991.

The international diversification benefit, δ, is measured as the increase in the expected annualized return when switching from the U.S. index portfolio to the efficient portfolio with the same variance. We calculate δ for various efficient frontiers and report the basic statistics of the posterior distributions of δ. The first frontier is generated from the equity indices of G7 countries and indicated by the symbol G. Similarly, GL indicates the frontier generated from the equity indices of G7 and Latin American countries. The symbol GA indicates the frontier generated from G7 and Asian countries, and GLA indicates the frontier generated from equity indices of G7, Latin American and Asian countries. Dollar-denominated monthly returns on the country indices are obtained from MSCI and IFC. For the first panel, there are no constraints on the portfolio weights. For the next panel, short positions are not allowed. For the last panel, short positions on emerging markets are prohibited while weights on G7 countries are unconstrained.

	Mean	Stdev	1%	50%	99%
No constraints on any markets					
G	6.39	2.96	1.10	6.06	14.69
GL	14.81	4.12	6.64	14.50	25.87
GA	12.56	4.20	4.36	12.23	23.63
GLA	20.23	4.88	10.15	19.97	32.88
No short sales on any markets					
G	4.97	3.10	0.00	4.65	13.52
GL	13.33	4.17	4.83	13.04	24.40
GA	10.54	4.42	1.46	10.28	21.69
GLA	18.06	4.90	7.59	17.87	30.38
No shorts on emerging markets					
GL	14.73	4.13	6.53	14.42	25.78
GA	12.42	4.25	3.98	12.08	23.63
GLA	20.03	4.92	9.84	19.79	32.63

Table 8: Posterior distributions of δ for 1992–1998.

The international diversification benefit, δ, is measured as the increase in the expected annualized return when switching from the U.S. index portfolio to the efficient portfolio with the same variance. We calculate δ for various efficient frontiers and report the basic statistics of the posterior distributions of δ. The first frontier is generated from the equity indices of G7 countries and indicated by the symbol G. Similarly, GL indicates the frontier generated from the equity indices of G7 and Latin American countries. The symbol GA indicates the frontier generated from G7 and Asian countries, and GLA indicates the frontier generated from equity indices of G7, Latin American and Asian countries. Dollar-denominated monthly returns on the country indices are obtained from MSCI and IFC. For the first panel, there are no constraints on the portfolio weights. For the next panel, short positions are not allowed. For the last panel, short positions on emerging markets are prohibited while weights on G7 countries are unconstrained.

	Mean	Stdev	1%	50%	99%
	No constraints on any markets				
G	8.18	3.78	1.56	7.71	19.02
GL	12.64	4.75	4.04	12.15	26.31
GA	14.13	5.06	4.74	13.66	28.48
GLA	17.45	5.54	6.86	16.95	32.41
	No short sales on any markets				
G	1.57	2.13	0.00	0.63	9.20
GL	2.21	2.40	0.00	1.50	10.24
GA	5.09	4.10	0.00	4.41	17.14
GLA	5.84	4.20	0.00	5.22	17.98
	No shorts on emerging markets				
GL	9.02	4.12	1.95	8.53	21.14
GA	12.83	4.95	3.73	12.34	26.86
GLA	13.73	5.18	4.11	13.21	27.84

Table 9: Posterior distributions of δ with Fama-French portfolios.

The diversification benefit, δ, is measured as the increase in the expected annualized return when stwitch from the U.S. index portfolio to the efficient portfolio with the same variance. We calculate δ for various efficient frontiers and report the basic statistics of posterior distributions of δ. The first frontier is generated from the six portfolios that Fama and French (1993) use to construct SMB and HML factors (available from July 1927 to December 1998). This frontier is indicated by the symbol F. The frontier generated from returns on Fama-French portfolios and the equity indices of G7 countries is indicated by the symbol FG. Similarly, FGL indicates the frontier generated from the Fama-French portfolios and G7 and Latin American countries. The symbol FGA indicates the frontier generated from Fama-French portfolios and G7 and Asian countries, and GLA indicates the frontier generated from Fama-French portfolios and G7, Latin American and Asian countries. Dollar-denominated monthly returns on the country indices are obtained from MSCI and IFC. The sample period covers January 1976 through December 1998. For the first subpanel, there are no constraints on the portfolio weights. For the next subpanel, short positions are not allowed. For the last subpanel, short positions on emerging markets (EM) are prohibited while weights on G7 countries and Fama-French portfolios are unconstrained.

	Mean	Stdev	01%	50%	99%
	No constraints on any markets				
F	12.70	3.17	5.96	12.54	20.71
FG	15.62	3.45	8.23	15.51	24.25
FGL	19.49	3.76	11.62	19.34	29.09
FGA	18.14	3.73	10.31	17.95	27.48
FGLA	21.86	3.98	13.32	21.64	31.91
	No short sales on any markets				
F	2.83	1.46	0.15	2.70	6.74
FG	4.71	1.97	0.67	4.63	9.60
FGL	8.45	2.66	3.00	8.33	15.32
FGA	7.73	2.80	2.12	7.59	15.11
FGLA	11.51	3.28	4.71	11.29	19.68
	No shorts on emerging markets				
FGL	19.24	3.76	11.42	19.10	28.89
FGA	18.03	3.75	10.14	17.84	27.37
FGLA	21.51	3.99	12.92	21.29	31.53

Figure 1: Posterior distribution of δ.

The figure plots the posterior distribution of δ, the increase in expected returns from international diversification for a U.S. investor, for the period 1976-98. The distribution of δ is obtained for efficient frontiers that are generated from the following stock indices: G7 countries (denoted by G); G7 and Latin American countries (denoted by GL); G7 and Asian countries (denoted by GA); and G7, Latin American and Asian countries (denoted by GLA). In panel A portfolio weights are unconstrained, in panel B portfolio weights are constrained to be non-negative, and in panel C only the portfolio weights on emerging markets are constrained to be non-negative.

Figure 2: Posterior distribution of δ for 1976–1991.

The figure plots the posterior distribution of δ, the increase in expected returns from international diversification for a U.S. investor, for the periods of 1976–91. The distribution of δ is obtained for efficient frontiers that are generated from the following stock indices: G7 countries (denoted by G); G7 and Latin American countries (denoted by GL); G7 and Asian countries (denoted by GA); and G7, Latin American and Asian countries (denoted by GLA). In panel A portfolio weights are unconstrained, in panel B portfolio weights are constrained to be non-negative, and in panel C only the portfolio weights on emerging markets are constrained to be non-negative.

Figure 3: Posterior distribution of δ for 1992–1998.

The figure plots the posterior distribution of δ, the increase in expected returns from international diversification for a U.S. investor, for the periods of 1976–91. The distribution of δ is obtained for efficient frontiers that are generated from the following stock indices: G7 countries (denoted by G); G7 and Latin American countries (denoted by GL); G7 and Asian countries (denoted by GA); and G7, Latin American and Asian countries (denoted by GLA). In panel A portfolio weights are unconstrained, in panel B portfolio weights are constrained to be non-negative, and in panel C only the portfolio weights on emerging markets are constrained to be non-negative.

Figure 4: Posterior distribution of δ with Fama-French portfolios.

The figure plots the posterior distribution of δ, the increase in expected returns from international diversification for a U.S. investor, for the period 1976-98. The distribution of δ is obtained for efficient frontiers that are generated from the following stock indices: Fama-French portfolios and G7 countries (denoted by FG); Fama-French portfolios, G7 and Latin American countries (denoted by FGL); Fama-French portfolios, G7 and Asian countries (denoted by FGA); and Fama-French portfolios, G7, Latin American and Asian countries (denoted by FGLA). In panel A portfolio weights are unconstrained, in panel B portfolio weights are constrained to be non-negative, and in panel C only the portfolio weights on emerging markets are constrained to be non-negative.

Figure 1A: No constraints on any markets

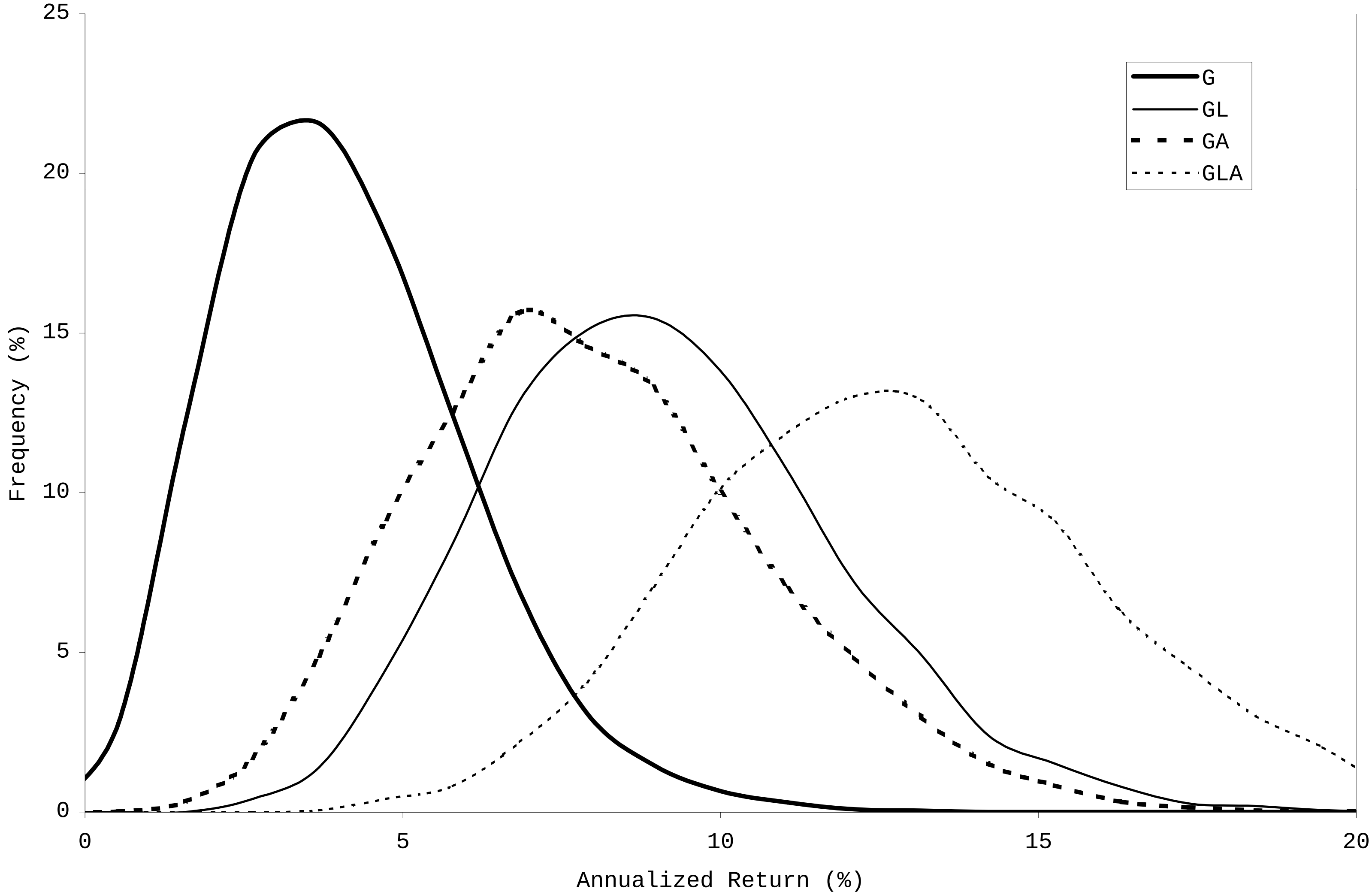

Figure 1B: No short sales on any markets

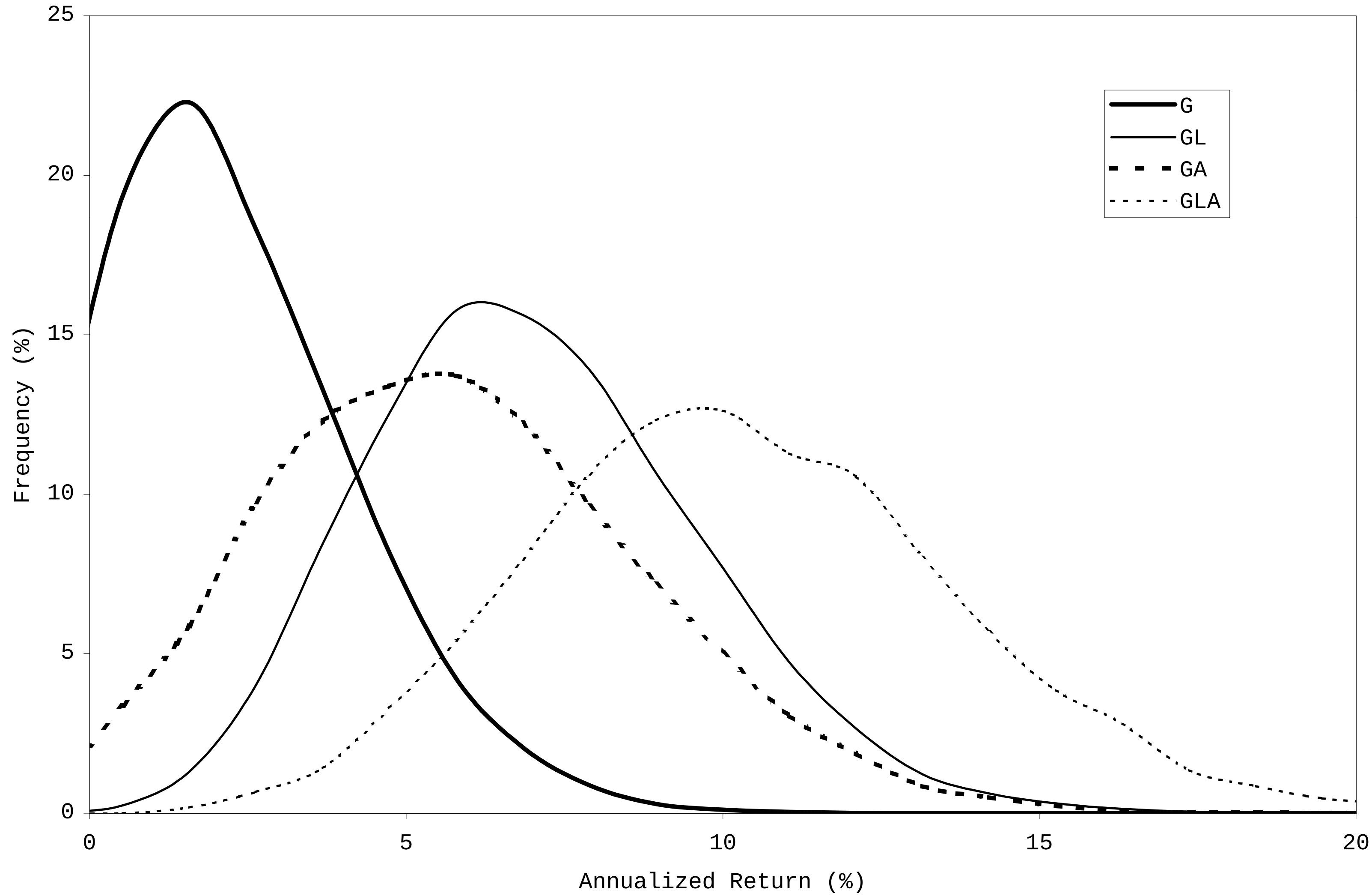

Figure 1C: No short sales on emerging markets

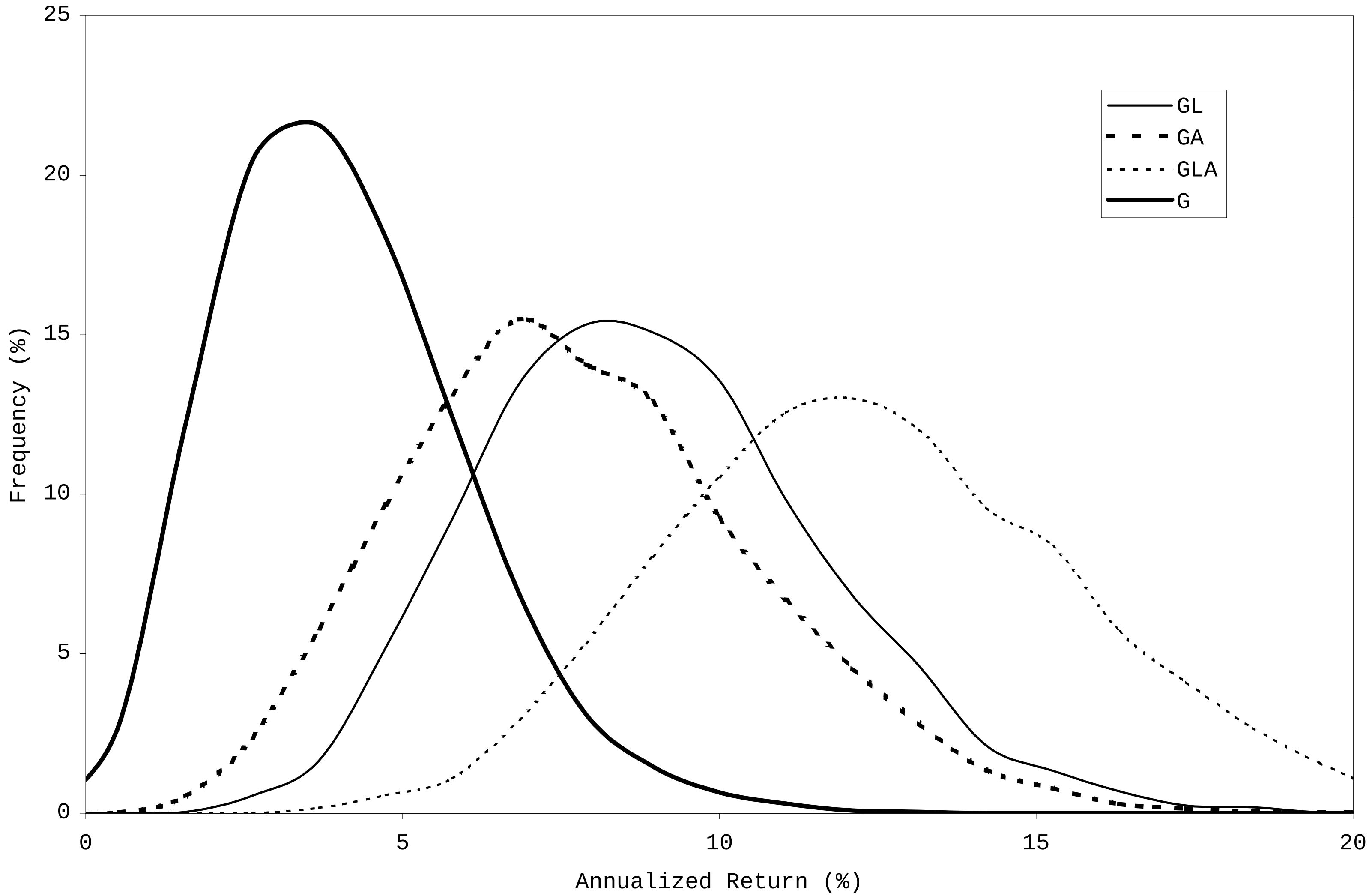

Figure 2A: No constraints on any markets, 1976 - 1991

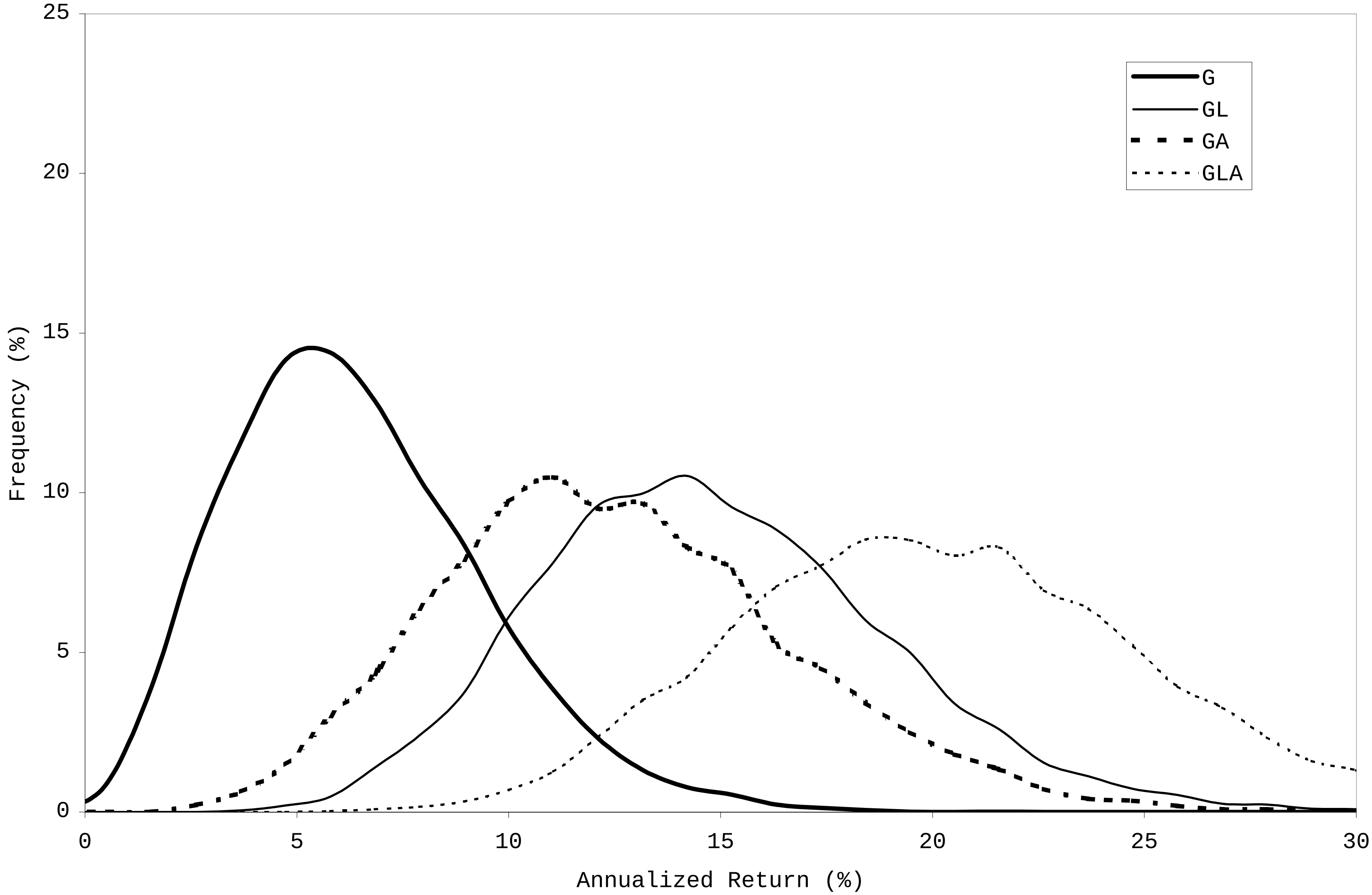

Figure 2B: No short sales on any markets, 1976 - 1991

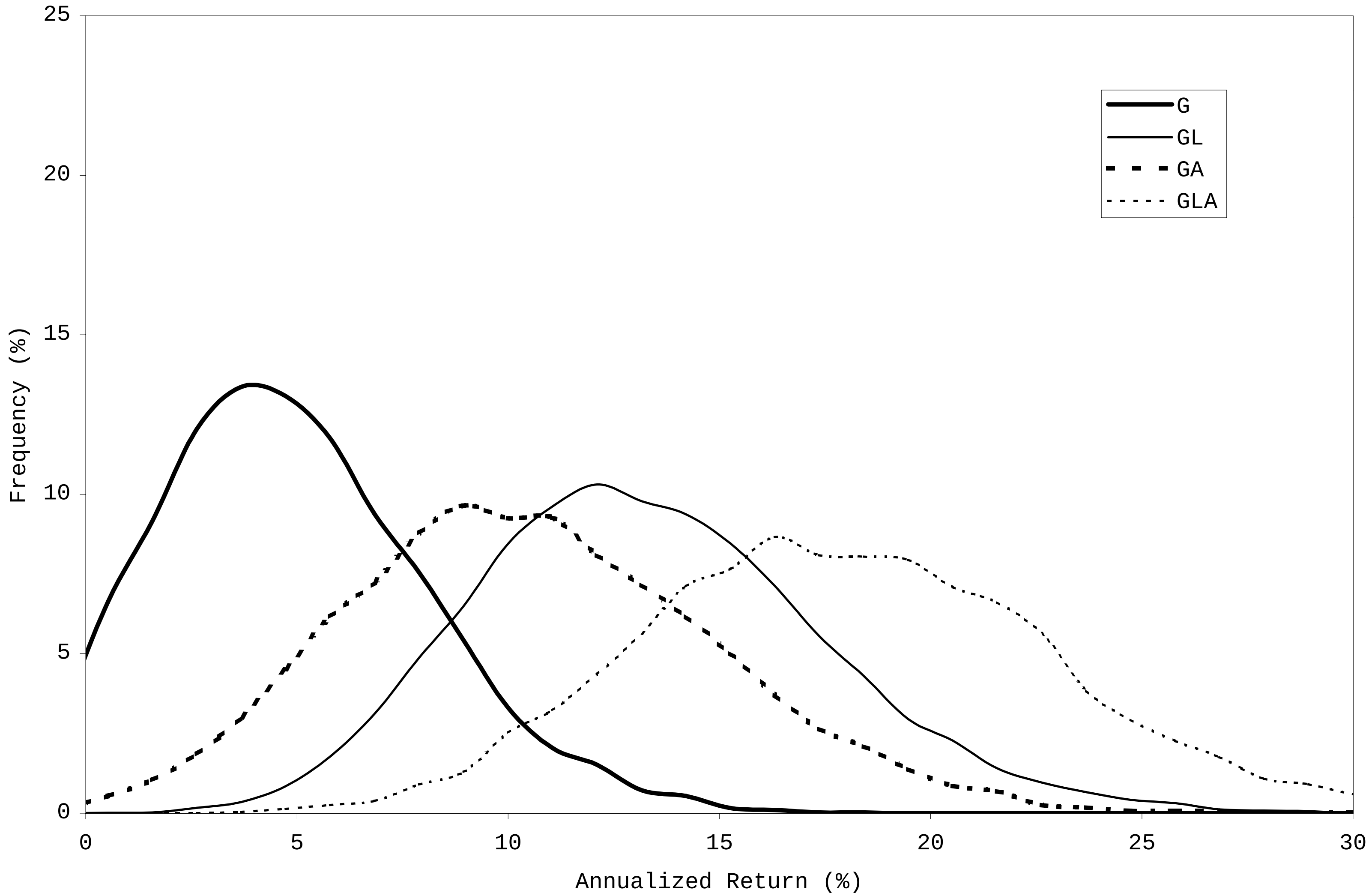

Figure 2C: No short sales on emerging markets, 1976 - 1991

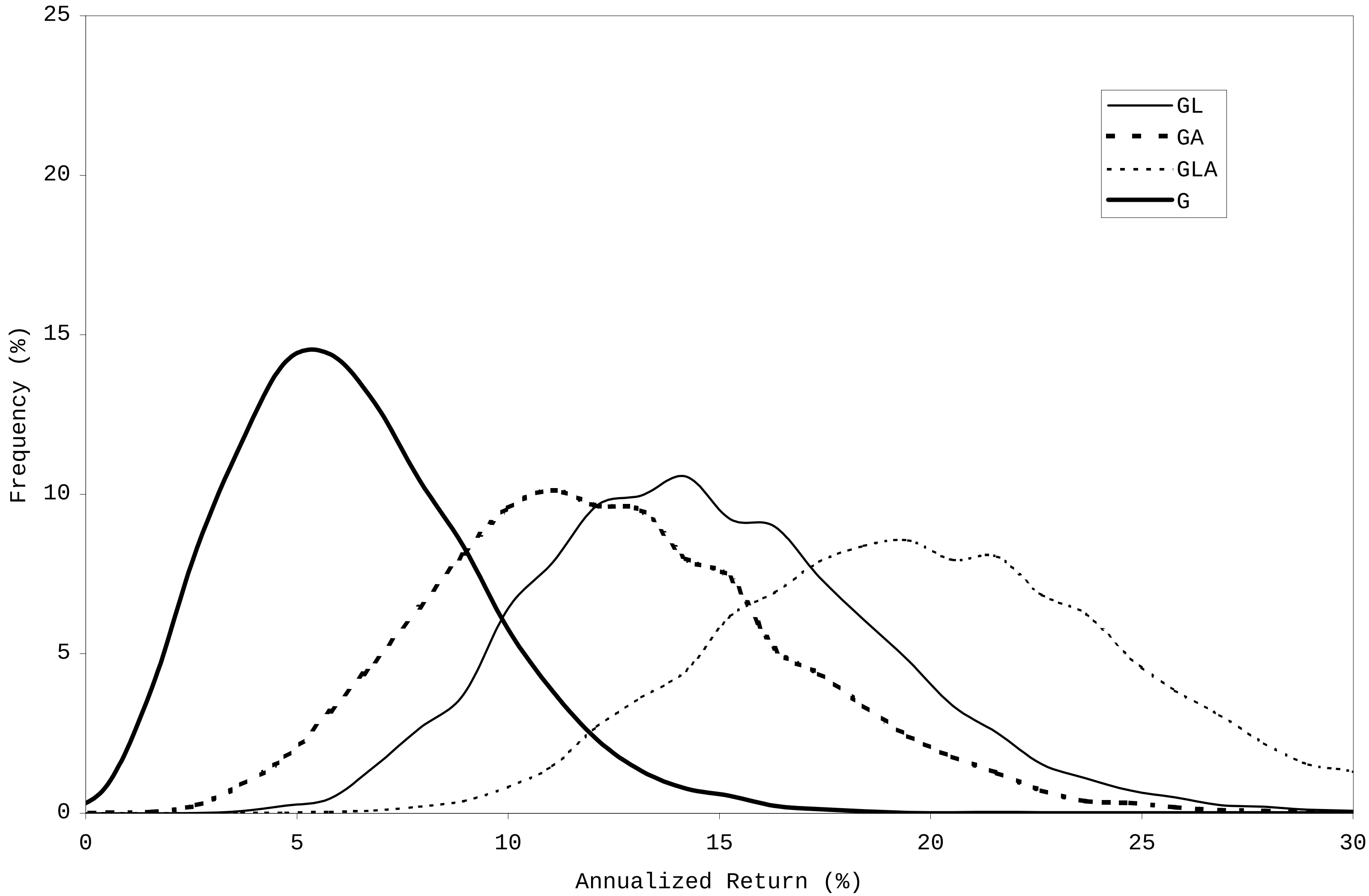

Figure 3A: No constraints on any markets, 1992 - 1998

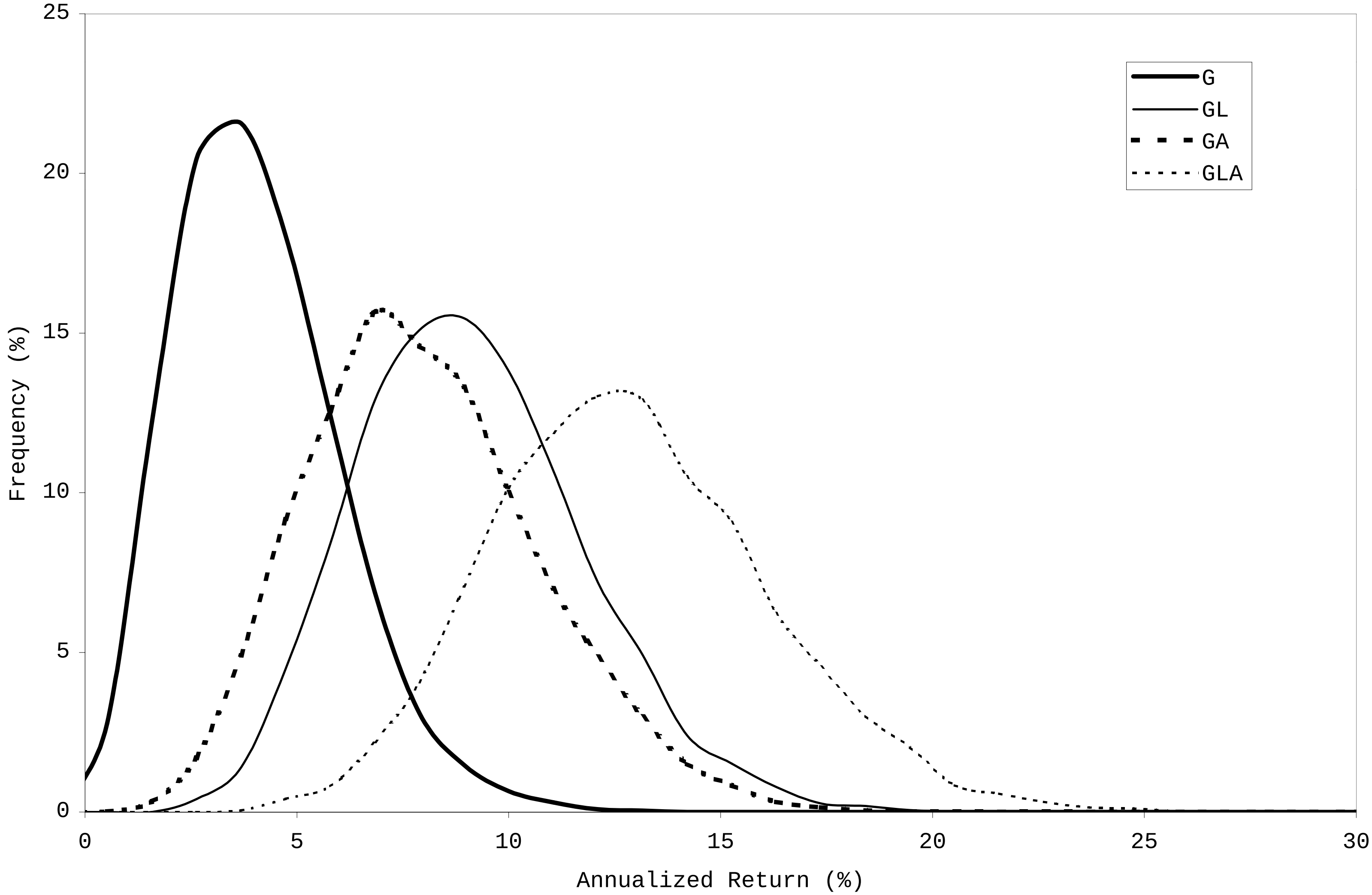

Figure 3B: No short sales on any markets, 1992 - 1998

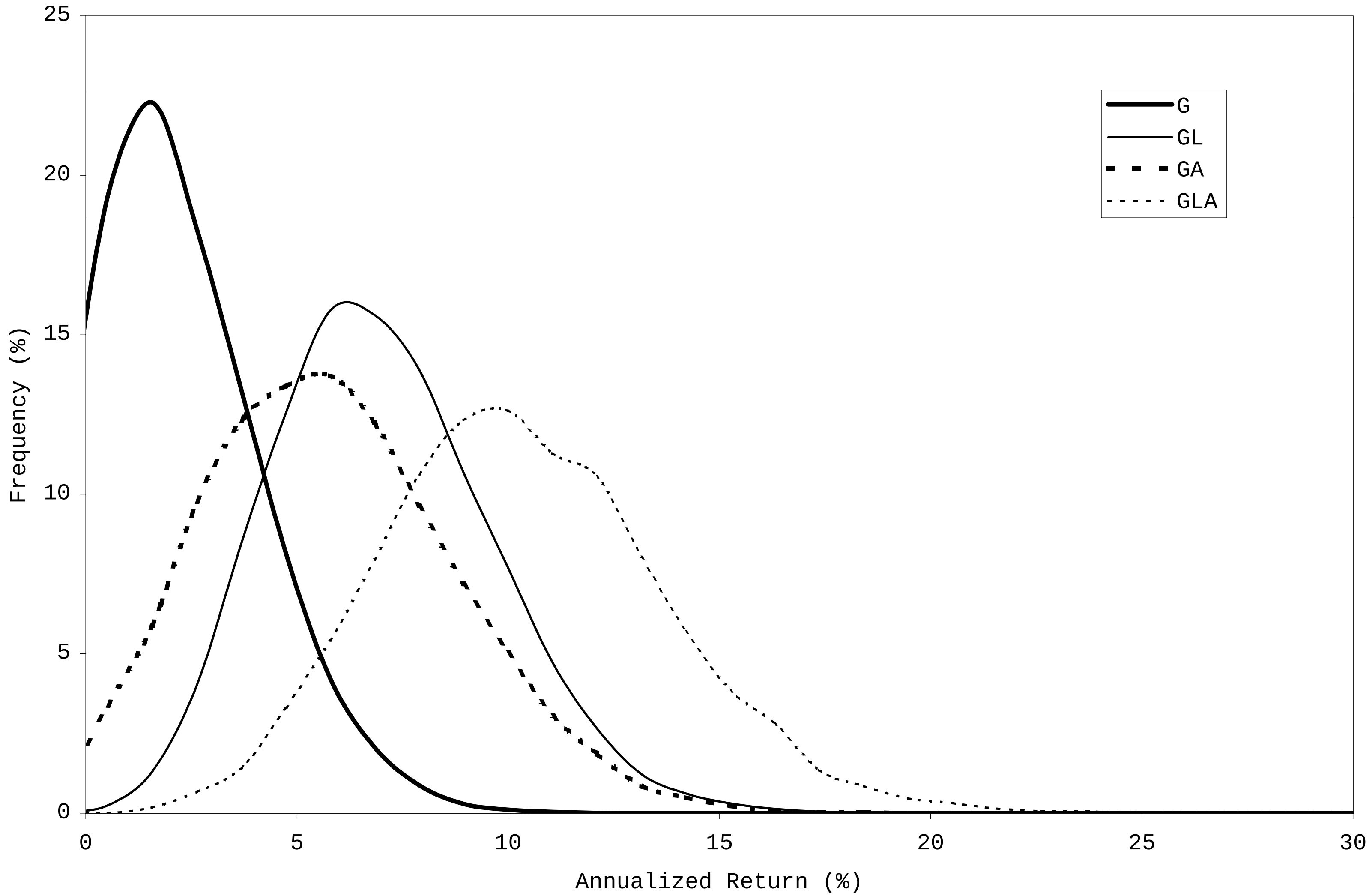

Figure 3C: No short sales on emerging markets, 1992 - 1998

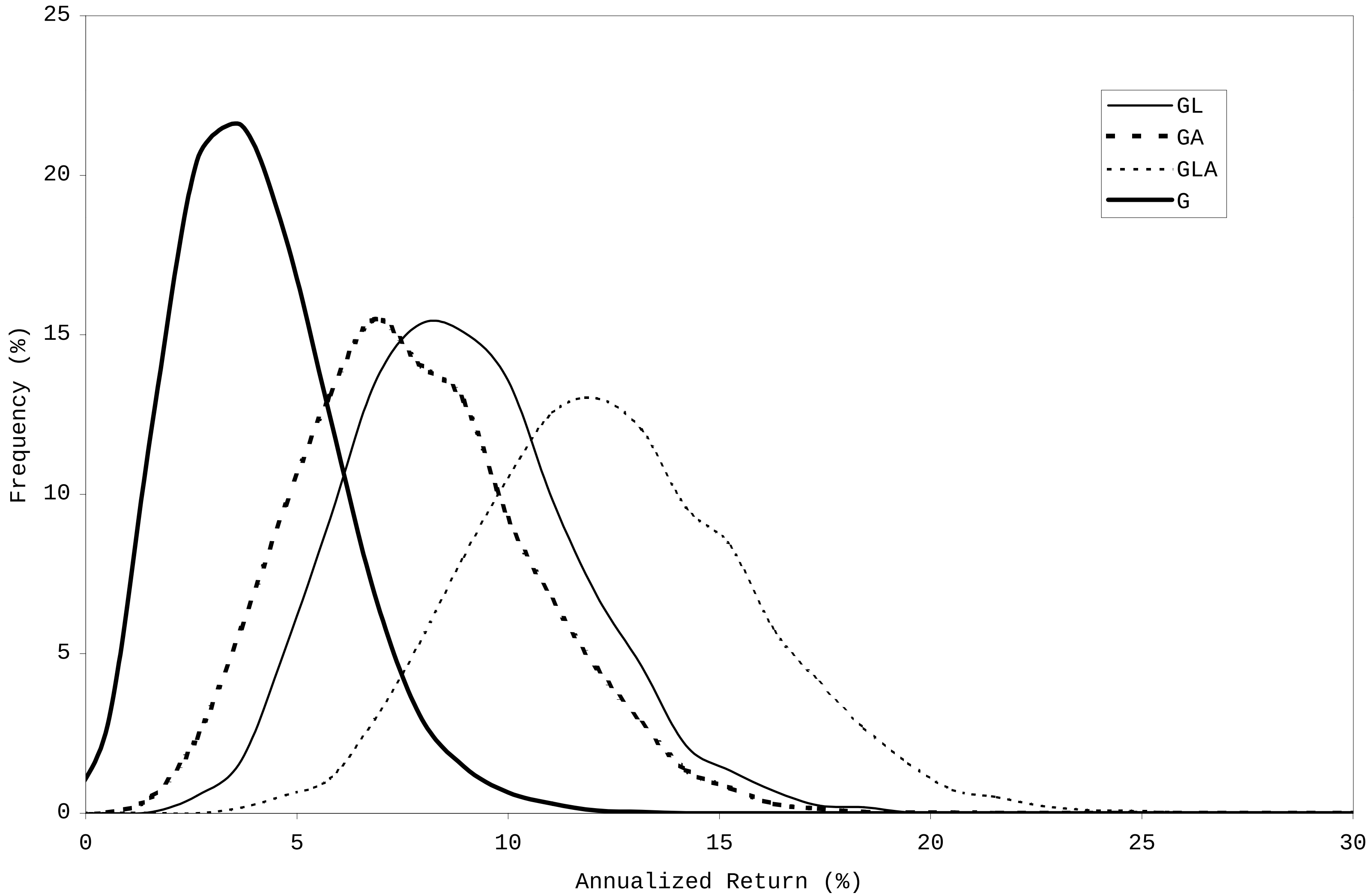

Figure 4A: No constraints on any markets

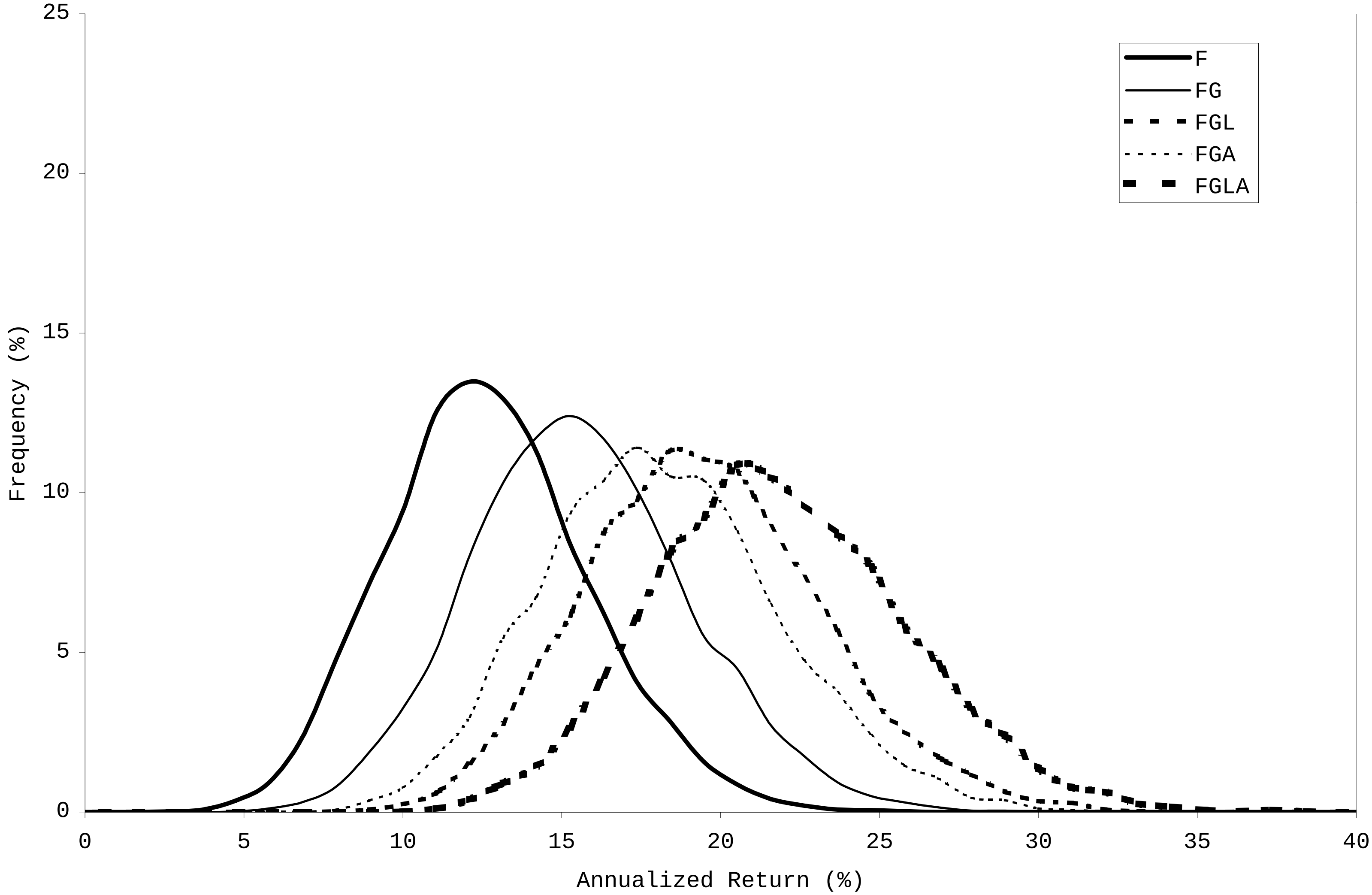

Figure 4B: No short sales on any markets

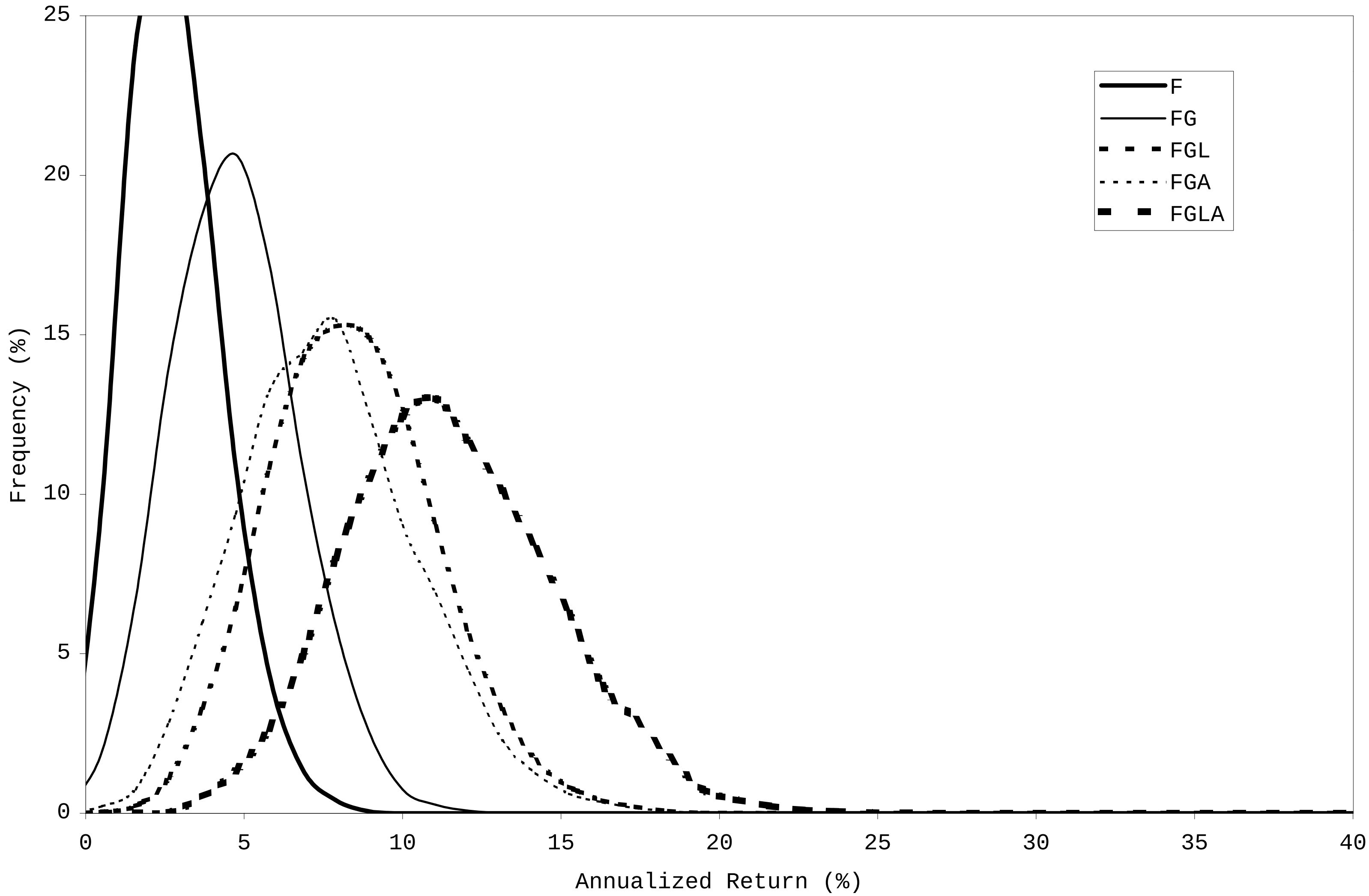

Figure 4C: No short sales on emerging markets