BARRA

Global Equity

RISK MODEL HANDBOOK

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Contents

About BARRA

In recent years, the international investment environment has experienced major changes: industries are more globalized and local markets are more integrated. The global marketplace includes more and more players. International portfolios offer global investors opportunities for diversification and the potential for exceptional return. BARRA has responded to this increased institutional interest with the development of the Global Equity Model.

A pioneer in risk management

As the leading provider of global investment decision tools, BARRA provides quantitative products and services for global investment managers and financial institutions. Since our founding in 1975, BARRA has been a leader in modern financial research and techniques.

Initially, our services focused on risk analysis in equity markets. Our U.S. Equity Model set a standard of accuracy that BARRA continues to follow. BARRA uses the best risk predictors available to develop risk prediction models. In turn, these models are the basis of software products designed to enhance portfolio performance through risk analysis, portfolio optimization, returns forecasting, transaction cost analysis, and historical performance attribution.

In 1979 BARRA expanded into the fixed income area with the release of our bond valuation and risk models. In the late 1980s BARRA developed the Global Equity Model (GEM), designed to analyze international portfolios of equity and currency holdings.

BARRA offices are located in all major financial regions. By 1998 our clients comprised over 1200 financial institutions worldwide who rely on BARRA's investment technology and consulting services to strengthen their financial analysis and investment decision-making.

The Global Equity Model

As BARRA has expanded internationally, we have developed equity models for the major asset markets throughout the world. Initially released in January 1989, BARRA's Global Equity Model extends the conceptual principles of its single-country counterparts to the international equity market.

A multiple-factor model, GEM captures the effects of common factors (such as local markets and industries) as well as currencies on portfolio return. The model partitions return into its various components so investors can pinpoint sources of return and adjust their portfolios accordingly.

There are two versions of GEM—MSCI and FT. The MSCI version uses the local markets and industry classifications of the Morgan Stanley Capital International World Index while the FT version uses local markets and industries listed in the Financial Times-Actuaries World Index.

BARRA delivers the Global Equity Model via the Windows-based Aegis System™. Applications within Aegis include risk analysis and portfolio optimization, to allow BARRA clients to make better investment choices.

Introduction

In this handbook

This handbook first outlines the theoretical background of the Global Equity Model and then describes the model in greater detail. It is designed to be a technical reference manual for the model.

A discussion of risk and return is the starting point for explaining the model and its capabilities. Chapter 1. Risk and Return defines important measures of risk and outlines the decomposition of return.

Multiple-factor models represent a breakthrough in financial theory and provide a framework for understanding GEM. Chapter 2. The Evolution of Risk Models catalogues the theoretical advances leading to the development of multiple-factor models and explains how these models work.

BARRA risk models are multiple-factor models that are developed for particular asset markets. Chapter 3. The Global Equity Model lists the common factors and currencies of GEM-MSCI and GEM-FT and includes examples of common factor correlations.

To help you further understand the technical and analytical foundation of the model, Chapter 4. Model Estimation explains the estimation procedure used in deriving the model. The chapter describes risk formulation, industry definition, local market selection, and currency risk estimation.

Chapter 5. Portfolio Management covers portfolio construction, as well as passive and active management techniques. In addition, BARRA's GEM software applications and their uses are discussed.

Finally, Chapter 6. Global Equity Case Studies includes three case studies to illustrate how the model can enhance your financial decision making. The first analyzes an active portfolio, while the second indexes a passive one. The third describes an example of index optimization.

For more background on the output of the model, the Appendices include risk index formulas, factor return plots, and other information. In addition, the Glossary is a useful resource for clarifying terminology and concepts.

Further references

BARRA has a comprehensive collection of articles and other materials describing the models and their applications. To learn more about the topics contained in this handbook, consult the following references or our extensive *BARRA Publications Bibliography*, all available from BARRA offices and from our Web site at: *http://www.barra.com*.

Books

Richard C. Grinold and Ronald N. Kahn, *Active Portfolio Management: Quantitative Theory and Applications*, Probus Publishing, Chicago, IL, 1995.

Andrew Rudd and Henry K. Clasing, *Modern Portfolio Theory: The Principles of Investment Management*, Orinda, CA, Andrew Rudd, 1988.

Articles

Richard Grinold, Andrew Rudd, and Dan Stefek, "Global Factors: Fact or Fiction?" *Journal of Portfolio Management*, Fall 1989, pp. 79–88.

Barr Rosenberg, "Extra-Market Components of Covariance in Securities Markets," *Journal of Financial and Quantitative Analysis*, March 1974, pp. 263–274.

Barr Rosenberg, Kenneth Reid, and Ron Lanstein, "Persuasive Evidence of Market Inefficiency," *Journal of Portfolio Management*, Spring 1985, pp. 9–16.

Andrew Rudd and Barr Rosenberg, "Realistic Portfolio Optimization," *TIMS Studies in Management Sciences*, Volume 11, 1979, pp. 21–46.

1. Risk and Return

The concepts of risk and return are central to a discussion of financial investment. They illustrate the major tension faced by investors: in exchange for bearing risk, investors require a higher return. In financial parlance, this is called the risk/return tradeoff and investors choose a risk/return combination based on their attitudes toward risk.

Some definitions

In an uncertain investment environment, investors bear risk. Risk is defined as the total dispersion or volatility of returns on a security or portfolio. Furthermore, risk reflects uncertainty about the future.

Conventional notions of risk are negative, describing outcomes that are less than desirable. However, in investment circles, risk measures more than negative outcomes. It describes outcome probability in both directions—positive and negative—as well as the magnitude of uncertainty. This is a small but significant distinction. Appropriate risk levels and "best" investments are in the eyes of the investor and depend on several investor characteristics, most notably total wealth and risk preferences.

Return is the reward to owning an investment. Return includes payments received in cash (dividends) and changes in the value of an investment (capital gains or losses). Simply stated, return is the risk premium earned by a security or a portfolio—the *excess return*—plus the risk-free rate of interest.

Risk measurement

An intuitive measure of risk is the *standard deviation of return*. One standard deviation is the range on either side of the expected or average value in which outcomes are likely to fall with a two-thirds probability.

A related measure is *variance*, the standard deviation squared. The formulae are:

$$Std[\tilde{r}] = \sqrt{Var[\tilde{r}]} \quad \text{(EQ 1-1)}$$

$$Var[\tilde{r}] = \mathrm{E}\left[(\tilde{r} - \bar{r})^2\right] \quad \text{(EQ 1-2)}$$

where:

$\tilde{r}$ = return,

$\bar{r}$ = expected or mean return,

$Std[x]$ = standard deviation of x,

$Var[x]$ = variance of x, and

$\mathrm{E}[x]$ = expected value of x.

The standard deviation is the more common risk indicator since it is measured in the same units as return. Of course, if the standard deviation is known, the variance can be easily computed and vice versa.

Standard deviation is symmetrical, reflecting both positive and negative returns (*see* Figure 1-1). Critics claim that this symmetry is misleading and does not truly measure the impact of negative uncertainty—that is, the loss investors wish to avoid. For example, large positive returns are treated in the same way as large negative returns. However, standard deviation is useful because it provides a relative measure of risk exposure.

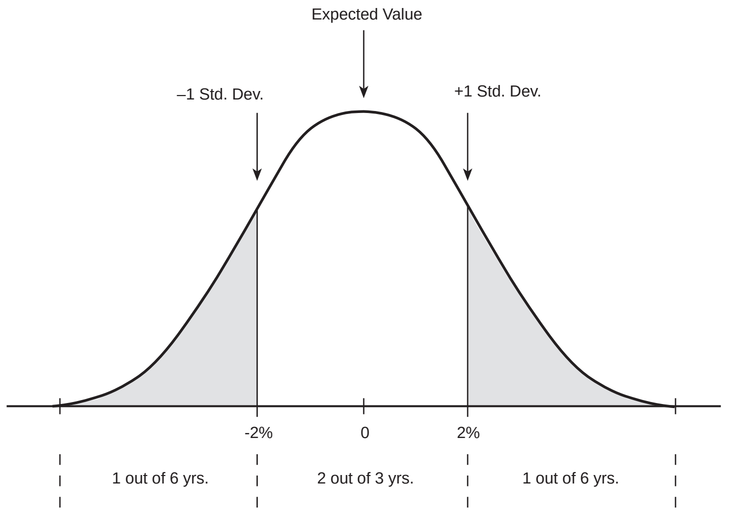


Figure 1-1
Risk: The Dispersion of Returns
The standard deviation is a statistical measure of dispersion around an expected value—in this case, zero.

Return decomposition

Each source of risk corresponds to a portion of total return. The primary components of return (shown in Figure 1-2) are:

- *Risk-free return*—the certain return promised on a purely risk-free investment, usually the rate of return on a short-term government-issued bond (considered a riskless investment); and

- *Excess return*—for a multiple-country portfolio, the return over and above the numeraire risk-free rate, that is, the numeraire total return less the risk-free rate.

Although the risk-free rate is influenced by aggregate investor behavior, individual portfolio managers have more control over the expected excess return of a portfolio. Investors can adjust their investment strategy or portfolio composition to alter the risk profile of a portfolio and, hence, its return. For assets outside the investor's local market or perspective, excess return includes local excess return and currency return.

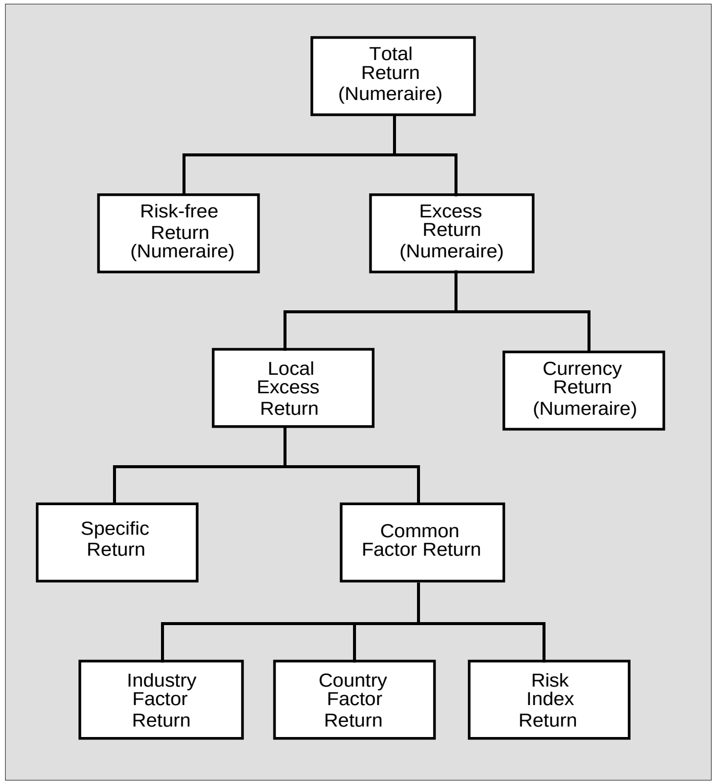
Numeraire

The *numeraire* is the currency perspective of the investor. In most cases it is the investor's domicile. For example, the numeraire for a U.S. investor is the U.S. dollar.

Figure 1-2

Return Decomposition

Total return is excess return plus the risk-free rate. Excess return consists of local excess return and currency return. Some returns are calculated from the currency perspective of the investor (numeraire).



Local excess return is the return accruing to an investment above the local risk-free rate of return, expressed in local currency terms. It is partitioned into specific return and common factor return.

Specific return is the return to an individual asset not explained by common factors. *Common factor return* comprises returns to relevant characteristics across stocks. In the Global Equity Model, these common factors are industries, local markets, and risk indices. Local excess return is calculated using the following GEM equation:

$$\underset{\textit{Return}}{\textit{Local Excess}} = \underset{\textit{Return}}{\textit{Country}} + \underset{\textit{Return}}{\textit{Industry}} + \underset{\textit{Return}}{\textit{Risk Index}} + \underset{\textit{Return}}{\textit{Specific}} \quad \text{(EQ 1-3)}$$

This model equation and the common factors are described in greater detail in Chapter 3. The Global Equity Model. The estimation of these factors is outlined in Chapter 4. Model Estimation.

The Global Equity Model separates currency returns from local returns. *Currency return* is the risk-free market return plus changes in the exchange rate. Although separate, currency return is not independent of local excess return, since certain country-specific events influence both exchange rates and local market conditions.

The investor's choice of numeraire provides the basis for evaluating currency return. The numeraire is the perspective from which the investor views the portfolio. Usually, the numeraire currency reflects the domicile of the investor.

This simplified excess return equation shows how currency return is related to exchange rate return and local excess return:

$$
\begin{aligned}
&1+r=(1+rx)\cdot(1+rl) \\
&1+r=1+rx+(rx\cdot rl)+rl \\
\rightarrow\ &1+r=1+rx+rl
\end{aligned}
\tag{EQ 1-4}
$$

and:

$$
\begin{aligned}
&rl=rle+rfl \\
&rc=rfl+rx+(rfl\cdot rx) \\
\rightarrow\ &1+r=1+rle+rc
\end{aligned}
\tag{EQ 1-5}
$$

where:

r = return,

rx = exchange rate return,

rl = local asset return,

rle = local asset excess return,

rc = currency return, and

rfl = local risk-free return.

To linearize these functions for estimation purposes, the Global Equity Model eliminates the cross-products $(rx\cdot rl)$ and $(rfl\cdot rx)$ because, in most cases, these terms are negligible. For more information on currency risk and GEM, *see* Chapter 4. Model Estimation.

2. The Evolution of Risk Models

The development of equity risk models has travelled a long road from the modest and unscientific guesswork of early investment theory to the more quantitative analysis and technical sophistication of modern financial tools. With more advanced concepts of risk and return, models have changed to reflect the growing complexity of the investment environment.

Systematic return and diversification

Before the 1950s, there was no concept of systematic return. Return was a rise in the value of a stock and risk was a drop in the value of a stock. The investor's primary investment tools were intuition and insightful financial analysis. Portfolio selection was simply an act of assembling a group of "good" stocks.

"Buy a stock. If it goes up, sell it. If it goes down, don't buy it."

Will Rogers, 1931

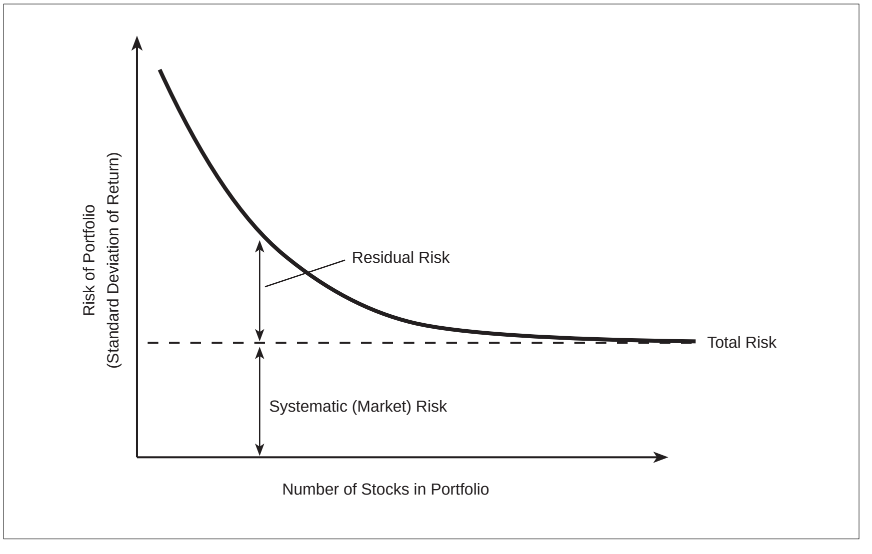


Figure 2-1

Diversification and Risk

As a portfolio manager increases the number of stocks in a portfolio, residual—or non-market-related—risk is diversified. Market risk is undiversifiable.

Financial theorists became more scientific and statistical in the early 1950s. At that time, investment strategy was viewed as a problem of random outcomes. To protect against negative returns, investors could diversify their portfolios, allowing assets with higher returns to compensate for assets with low or negative returns.

"Diversification is good."
Harry Markowitz, 1952

We now know how diversification affects risk exposures. It averages factor-related risk and significantly reduces security-specific risk. However, diversification does not eliminate all risk, because stocks tend to move up and down together with the market. Therefore, systematic—or market—risk cannot be eliminated by diversification.

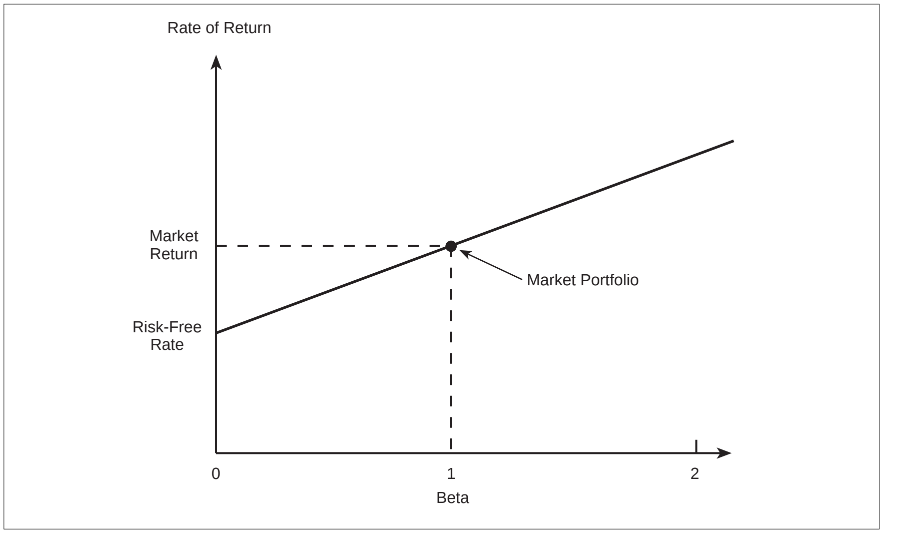
The Capital Asset Pricing Model

"Only undiversifiable risk should earn a premium."
William F. Sharpe, 1964
Capital Asset Pricing Model

As investment and money managers became more savvy, there was a push to identify the conceptual basis for investment analysis. The Capital Asset Pricing Model (CAPM) is one approach that describes the equilibrium relationship between return and systematic risk.

The central premise of CAPM is that, on average, investors are not compensated for taking on diversifiable (residual) risk. CAPM asserts that the expected residual return is zero, while the expected systematic return is greater than zero and linear.

Figure 2-2
The Capital Asset Pricing Model
The Capital Asset Pricing Model asserts that the expected excess return on securities is proportional to their systematic risk coefficient, or beta. The market portfolio is characterized by a beta of unity.



The measure of portfolio exposure to systematic risk is called *beta* (β). Beta is the relative volatility or sensitivity of a security or portfolio to market moves. More simply, beta is the numerical value of an asset's systematic risk. Returns, and hence risk premiums, for any stock or portfolio will be related to beta, the exposure to undiversifiable systematic risk.

$$\mathrm{E}[\tilde{r}_i] - r_F = \beta_i \mathrm{E}[\tilde{r}_M - r_F] \qquad \text{(EQ 2-1)}$$

where:

$\tilde{r}_i$ = return on asset i,

r_F = risk-free rate of return,

$\tilde{r}_M$ = return on market portfolio, and

$$\beta_i = \frac{Cov[\tilde{r}_i, \tilde{r}_M]}{Var[\tilde{r}_M]}$$

CAPM is easy to use and begins to partition the components of risk. However, this simplified single-factor model is incomplete. It ignores the risk that arises from common factor sources.

The Arbitrage Pricing Theory

By the 1970s, the investment community recognized that assets with similar characteristics tend to behave in similar ways. This notion is captured in the Arbitrage Pricing Theory (APT). APT asserts that security and portfolio expected returns are linearly related to the expected returns of an unknown number of underlying systematic factors.

"The arbitrage model was proposed as an alternative to the mean variance capital asset pricing model."

Stephen A. Ross, 1976

Arbitrage Pricing Theory

APT does have its limitations. While it prescribes a multiple-factor model for risk analysis, it does not specify the factors to be used. Moreover, APT does not define the weighting of different factors or recommend a method for calculating exposures. For that, investors must rely on a robust, intuitively derived multiple-factor model.

What are multiple-factor models?

The development of multiple-factor models (MFMs) paralleled the theoretical advances of APT. MFMs further partition residual risk into specific and common factor risks, moving beyond APT to select and estimate factors that affect the expected returns and risks of a security or portfolio. These models provide a framework to develop tools for risk measurement, portfolio construction, and performance attribution.

"Companies possessing similar characteristics may, in a given month, show returns that are different from the other companies. The pattern of differing shows up as the factor relation."

Barr Rosenberg, 1974

Multiple Factor Models

Multiple-factor models are formal statements about the relationships among security returns in a portfolio. The basic premise of MFM's is that similar stocks should display similar returns. This "similarity" is defined in terms of asset attributes that are based on market information—such as price and volume—or fundamental data derived from a company's balance sheet and income statement.

MFMs identify common factors and determine return sensitivity to investors' expectations about these factors. The resulting risk profile incorporates the weighted sum of common factor return and specific return. This risk profile will respond immediately to changes in fundamental information.

How do MFMs work?

MFMs are based on securities patterns observed over time. The difficult steps are pinpointing these patterns and then identifying them with asset attributes that investors can understand. Asset attributes are characteristics that are related to securities price movements, such as industry characteristics.

At this stage of model development, uncorrelated risk and return are separated. It is important that MFMs include only permanent sources of risk and return; they must exclude transitory or idiosyncratic items that may bias the analysis.

Risk calculation is the final step in constructing a sound and useful model. Variances, covariances, and correlations among factors are estimated and weighted. These calculations are used to describe the total risk exposure of a portfolio and are covered in greater detail later in this chapter.

Investors rely on risk exposure calculations to determine stock selection, portfolio allocation, and other investment strategies. Their decisions are based on information gleaned from MFM analysis combined with return expectations they derive from other research sources. For more on the model estimation process, *see* Chapter 4. Model Estimation.

Advantages of MFMs

There are several advantages to using MFMs for security and portfolio analysis.

- MFMs offer a more thorough breakdown of risk and, therefore, a more complete analysis of risk exposure.
- Because economic logic is used in their development, MFMs are not limited by purely historical analysis.
- MFMs are robust investment tools that can withstand outliers.
- As the economy and individual firms change, MFMs adapt to reflect changing asset characteristics.
- MFMs isolate the impact of individual factors, providing segmented analysis for better informed investment decisions.
- From an applications viewpoint, MFMs are realistic, tractable, and understandable to investors.
- Lastly, MFMs are flexible models allowing for a wide range of investor preferences and judgment.

Of course, MFMs have their limitations. Although they predict a large proportion of risk, they do not explain all of it. In addition, a model will not offer stock recommendations; investors must make their own strategy choices.

Model mathematics

MFMs build on single-factor models by including and describing the interrelationships among factors. For single-factor models, the equation that describes the excess rate of return is:

$$\tilde{r}_j = X_j \tilde{f} + \tilde{u}_j \qquad \text{(EQ 2-2)}$$

where:

$\tilde{r}_j$ = total excess return over the risk-free rate,

X_j = sensitivity of security j to the factor,

$\tilde{f}$ = rate of return on the factor, and

$\tilde{u}_j$ = nonfactor (specific) return on security j.

We can expand this model to include K factors. The total excess return equation for a multiple-factor model becomes:

$$\tilde{r}_j = \sum_{k=1}^{K} X_{jk}\,\tilde{f}_k + \tilde{u}_j \tag{EQ 2-3}$$

where:

X_{jk} = risk exposure of security j to factor k, and

$\tilde{f}_k$ = rate of return on factor k.

Note that when K=1, the MFM equation reduces to the earlier single-factor version. For example, the CAPM is a single-factor model in which the "market" return is the only relevant factor.

When a portfolio consists of only one security, Equation 2-2 describes its excess return. But most portfolios comprise many securities, each representing a proportion, or weight, of the total portfolio. When weights h_{P1}, h_{P2},...,h_{PN} reflect the proportions of N securities in portfolio P, we express the excess return in the following equation:

$$\tilde{r}_P = \sum_{k=1}^{K} X_{Pk}\,\tilde{f}_k + \sum_{j=1}^{N} h_{Pj}\,\tilde{u}_j \tag{EQ 2-4}$$

where:

$$X_{Pk} = \sum_{j=1}^{N} h_{Pj}\,X_{jk}$$

This equation includes the risk from all sources and lays the groundwork for further MFM analysis.

Risk prediction with MFMs

Investors look at the variance of their total portfolios to provide a comprehensive assessment of risk. To calculate the variance of a portfolio, you need to calculate the covariances of all the constituent components.

Without the framework of a multiple-factor model, estimating the covariance of each asset with every other asset is computationally burdensome and subject to significant estimation errors. For example, using an estimation universe of 1,600 assets, there are 1,280,800 covariances and variances to calculate (*see* Figure 2-3).

$$V(i, j) = \text{Covariance}\,[r(\tilde{i}),\ r(\tilde{j})]$$

where $V(i, j)$ = asset covariance matrix, and
i, j = individual stocks.

$$V = \begin{bmatrix} V(1,1) & V(1,2) & \cdots & V(1,N) \\ V(2,1) & V(2,2) & \cdots & V(2,N) \\ V(3,1) & V(3,2) & \cdots & V(3,N) \\ \vdots & \vdots & & \vdots \\ V(N,1) & V(N,2) & \cdots & V(N,N) \end{bmatrix}$$

Figure 2-3

Asset Covariance Matrix

For N = 1,600 assets, there are 1,280,800 covariances and variances to estimate.

An MFM simplifies these calculations dramatically. This results from replacing individual company profiles with categories defined by common characteristics (factors). Since the specific risk is assumed to be uncorrelated among the assets, only the factor variances and covariances need to be calculated during model estimation (*see* Figure 2-4).

Figure 2-4

Factor Return Calculation

Using an MFM greatly simplifies the estimation process. Figure 2-4 depicts the multiple-factor model in matrix terms.

$$\tilde{r} = X\tilde{f} + \tilde{u}$$

where $\tilde{r}$ = vector of excess returns,
X = exposure matrix,
$\tilde{f}$ = vector of factor returns, and
$\tilde{u}$ = vector of specific returns.

$$\begin{bmatrix} \tilde{r}(1) \\ \tilde{r}(2) \\ \vdots \\ \tilde{r}(N) \end{bmatrix} = \begin{bmatrix} X(1,1) & X(1,2) & \dots & X(1,K) \\ X(2,1) & X(2,2) & \dots & X(2,K) \\ \vdots & \vdots & & \vdots \\ X(N,1) & X(N,2) & \dots & X(N,K) \end{bmatrix} \begin{bmatrix} \tilde{f}(1) \\ \tilde{f}(2) \\ \vdots \\ \tilde{f}(K) \end{bmatrix} + \begin{bmatrix} \tilde{u}(1) \\ \tilde{u}(2) \\ \vdots \\ \tilde{u}(N) \end{bmatrix}$$

Expressed in factor terms, the number of estimations is significantly reduced. In GEM-MSCI, for example, there are 90 factors (excluding currencies)—48 local markets, 38 industries, and 4 risk indices—which capture the risk characteristics of equities. The number of covariance and variance calculations is reduced to 4,095 (*see* Figure 2-5). Moreover, since there are fewer parameters to determine, they can be estimated with greater precision.

Figure 2-5

Factor Covariance Matrix

For K = 90 factors, there are 4,095 covariances and variances to estimate. This covariance matrix excludes currency factors (46 in GEM-MSCI), which are the final addition to the matrix.

$$F(k, m) = \text{Covariance}\,[\tilde{f}(k), \tilde{f}(m)]$$

where $F(k, m)$ = factor covariance matrix, and
k, m = common factors.

$$F = \left[\begin{array}{ccc:ccc:ccc}
F(1,1) & \dots & F(1,48) & F(1,49) & \dots & F(1,86) & F(1,87) & \dots & F(1,90) \\
\vdots & \textbf{Local Markets} & \vdots & \vdots & & \vdots & \vdots & & \vdots \\
F(48,1) & \dots & F(48,48) & F(48,49) & \dots & F(48,86) & F(48,87) & \dots & F(48,90) \\
\hdashline
F(49,1) & \dots & F(49,48) & F(49,49) & \dots & F(49,86) & F(49,87) & \dots & F(49,90) \\
\vdots & & \vdots & \vdots & \textbf{Industries} & \vdots & \vdots & & \vdots \\
F(86,1) & \dots & F(86,48) & F(86,49) & \dots & F(86,86) & F(86,87) & \dots & F(86,90) \\
\hdashline
F(87,1) & \dots & F(87,48) & F(87,49) & \dots & F(87,86) & F(87,87) & \dots & F(87,90) \\
\vdots & & \vdots & \vdots & & \vdots & \vdots & \textbf{Risk Indices} & \vdots \\
F(90,1) & \dots & F(90,48) & F(90,49) & \dots & F(90,86) & F(90,87) & \dots & F(90,90)
\end{array}\right]$$

In multiple-country risk models, currency exposure affects risk. In GEM, the computation of currency returns is the final step in calculating the covariance matrix. For simplicity, we have shown the covariance matrix before the addition of currency effects.

We can easily derive the matrix algebra calculations that support and link the above diagrams by using an MFM. From Figure 2-4, we start with the MFM equation:

$$\tilde{r}_i = X\tilde{f} + \tilde{u} \qquad \text{(EQ 2-5)}$$

where:

$\tilde{r}_i$ = excess return on asset i,

X = exposure coefficient on the factor,

$\tilde{f}$ = factor return, and

$\tilde{u}$ = specific return.

Substituting this relation in the basic equation, we find that:

$$Risk = Var\left(\tilde{r}_j\right) \qquad \text{(EQ 2-6)}$$

$$= Var\left(X\tilde{f} + \tilde{u}\right) \qquad \text{(EQ 2-7)}$$

Using the matrix algebra formula for variance, the risk equation becomes:

$$Risk = XFX^T + \Delta \qquad \text{(EQ 2-8)}$$

where:

X = exposure matrix of companies upon factors,

F = covariance matrix of factors,

X^T = transpose of X matrix, and

Δ = diagonal matrix of specific risk variances.

This is the basic equation that defines the matrix calculations used in risk analysis in the Global Equity Model.

3. The Global Equity Model

The primary functions of the Global Equity Model are (1) to predict risk and (2) to explain return. The model, like other multiple-factor models, analyzes risk exposures based on factors identified by BARRA. These common factors categorize a portfolio's exposures by "style" factors (such as Size and Success), local market membership, and industry classification, providing useful information for portfolio construction. GEM contains a separate model that addresses risk analysis for currency.

Model development

Model development is both an art and a science. The art is the selection of common factors that will sufficiently capture the risk exposures of a portfolio. This selection process combines experience and judgment with quantitative testing.

The science of model development is the process of calculating factor returns. The covariances of these returns are the building blocks of the covariance matrix used in risk analysis, explained in Chapter 2. The Evolution of Risk Models.

The equation for the Global Equity Model is derived from the basic MFM equation and adapted to include BARRA factors (90 factors and 46 currencies in the MSCI version, and 93 factors and 51 currencies in the FT version as of March 1998) and their exposures (weights). The model equations are:

$$Rl(n) - Rfl(n) = \sum_{k=1}^{46} b(n,k)h(k) + \sum_{j=1}^{38} y(n,j)g(j) + \sum_{i=1}^{4} z(n,i)q(i) + e(n)$$

(local excess) (country) (industry) (risk index) (specific)

GEM-MSCI

$$Rl(n) - Rfl(n) = \sum_{k=1}^{51} b(n,k)h(k) + \sum_{j=1}^{36} y(n,j)g(j) + \sum_{i=1}^{4} z(n,i)q(i) + e(n)$$

(local excess) (country) (industry) (risk index) (specific)

GEM-FT

where:

$Rl(n)$ = local return to asset n,

$Rfl(n)$ = local risk-free rate in country of asset n,

$b(n,k)$ = asset n's exposure to country factor k,

$y(n,j)$ = asset n's exposure to industry factor j,

$z(n,i)$ = asset n's exposure to risk index i,

$h(k)$ = return to country factor k,

$g(j)$ = return to industry factor j,

$q(i)$ = return to risk index i, and

$e(n)$ = specific return to asset n.

Risk indices

The Global Equity Model contains four risk indices that quantify common characteristics among companies for portfolio analysis. They provide easily interpreted comparative information about sources of risk. The higher the absolute value of the index value, the greater the factor's influence on total portfolio risk.

These risk indices are listed below. Risk index selection and standardization is discussed in Chapter 4. Model Estimation. Risk index formulas appear in Appendix A.

1. Size (SIZE) values companies based on their market capitalization to differentiate between large and small companies. This risk index has been a significant determinant of performance over the years as well as an important source of risk.

2. Success (SUCCESS) identifies recently successful stocks using price behavior in the market as measured by relative strength. The relative strength of a stock is significant in explaining its volatility.

3. Value (VALUE) captures the extent to which a stock is priced inexpensively in the market.

4. Variability in Markets (VIM) predicts a company's volatility, *net of* the market, based on its historical behavior.

Local markets

When evaluating international portfolios, a manager must consider the effects of both local markets and industries. In the Global Equity Model, local market effects explain more portfolio risk than industry classifications do. For more information, see Chapter 4. Model Estimation.

For lists of the local markets represented as of March 1998, *see* Table 3-1 (GEM-MSCI) and Table 3-2 (GEM-FT).

For regional analysis, GEM also allows the user to group countries into customized regions. In GEM-MSCI, the default BARRA regions are: Americas, Europe, Europe/Australia/Far East, Far East, Mideast/Africa, and Pacific Rim. In GEM-FT, the default BARRA regions are: Asia, Europe, Latin America, North America, and Pacific Basin. These defaults are used in BARRA's performance products and are also available for risk analysis.

Table 3-1

Local Markets Represented in GEM-MSCI as of March 1998

ARG	Argentina	**KOR**	Korea
AUS	Australia	**MAL**	Malaysia
AUT	Austria	**MEX**	Mexico
BEL	Belgium	**NET**	Netherlands
BRA	Brazil	**NZE**	New Zealand
CAN	Canada	**NOR**	Norway
CHI	Chile	**PAK**	Pakistan
CHN	China	**PER**	Peru
COL	Colombia	**PHI**	Philippines
CZE	Czech Republic	**POL**	Poland
DEN	Denmark	**POR**	Portugal
FIN	Finland	**RUS**	Russia
FRA	France	**SIN**	Singapore
GER	Germany	**SAF**	South Africa
GRE	Greece	**SPA**	Spain
HKG	Hong Kong	**SRI**	Sri Lanka
HUN	Hungary	**SWE**	Sweden
IND	India	**SWI**	Switzerland
IDN	Indonesia	**TAI**	Taiwan
IRE	Ireland	**THA**	Thailand
ISR	Israel	**TUR**	Turkey
ITA	Italy	**UKI**	United Kingdom
JPN	Japan	**USA**	United States
JOR	Jordan	**VEN**	Venezuela

Table 3-2

Local Markets Represented in GEM-FT as of March 1998

ARG	Argentina	**MAL**	Malaysia
AUS	Australia	**MEX**	Mexico
AUT	Austria	**MOR**	Morocco
BEL	Belgium	**NET**	Netherlands
BRA	Brazil	**NZE**	New Zealand
CAN	Canada	**NIG**	Nigeria
CHI	Chile	**NOR**	Norway
CHN	China	**PAK**	Pakistan
COL	Colombia	**PER**	Peru
CZE	Czech Republic	**PHI**	Philippines
DEN	Denmark	**POL**	Poland
EGY	Egypt	**POR**	Portugal
FIN	Finland	**RUS**	Russia
FRA	France	**SIN**	Singapore
GER	Germany	**SLV**	Slovakia
GRE	Greece	**SAF**	South Africa
HKG	Hong Kong	**SPA**	Spain
HUN	Hungary	**SRI**	Sri Lanka
IND	India	**SWE**	Sweden
IDN	Indonesia	**SWI**	Switzerland
IRE	Ireland	**TAI**	Taiwan
ISR	Israel	**THA**	Thailand
ITA	Italy	**TUR**	Turkey
JPN	Japan	**UKI**	United Kingdom
JOR	Jordan	**USA**	United States
KOR	Korea	**VEN**	Venezuela

Industries

Industry classification is an important source of common factor risk and accounts for a great deal of similarities observed in securities behavior.

There are 38 industries in GEM-MSCI (*see* Table 3-3). Classifications are based on Morgan Stanley industry categories.

Table 3-3
Industry Classifications in GEM-MSCI

1. Energy Sources	20. Food & Household Products
2. Utilities—Electrical & Gas	21. Health & Personal Care
3. Building Materials & Components	22. Recreation
4. Chemicals	23. Textiles & Apparel
5. Forestry & Paper Products	24. Broadcasting & Publishing
6. Metals—Non-Ferrous	25. Business & Public Services
7. Metals—Steel	26. Leisure & Tourism
8. Miscellaneous Materials & Commodities	27. Merchandising
9. Aerospace & Military Technology	28. Telecommunications
10. Construction & Housing	29. Transportation—Airlines
11. Data Processing & Reproduction	30. Transportation—Road & Rail
12. Electrical & Electronics	31. Transportation—Shipping
13. Electronic Components & Instruments	32. Wholesale & International Trade
14. Energy Equipment & Services	33. Banking
15. Industrial Components	34. Financial Services
16. Machinery & Engineering	35. Insurance
17. Appliances & Household Durables	36. Real Estate
18. Automobiles	37. Multi-Industry
19. Beverages & Tobacco	38. Gold Mines

There are 36 industries in GEM-FT (*see* Table 3-4). Classifications are based on Financial Times categories.

Table 3-4
Industry Classifications in GEM-FT

1. Commercial & Other Banks	19. Business Services & Computer Software/Services
2. Financial Institutions and Services	20. Retail Trade
3. Insurance—Life & Agents/Brokers	21. Wholesale Trade
4. Insurance—Multiline/Property & Casualty	22. Diversified Consumer Goods/ Services
5. Real Estate (excluding REIT)	23. Aerospace/Defense
6. Diversified Holding Companies	24. Computers/Telecommunications & Office Equipment
7. International Oil	25. Electrical Equipment
8. Non-Oil Energy Sources	26. Electronics & Instrumentation/ Control Equipment
9. Electric	27. Machinery & Engineering Services
10. Transportation & Storage	28. Heavy Engineering & Shipbuilding
11. Automobiles	29. Auto Components
12. Household Durables & Appliances	30. Diversified Industrial (Manufacturing)
13. Textiles & Wearing Apparel	31. Construction & Building
14. Beverage Industries/Tobacco Manufacturers	32. Chemicals
15. Health & Personal Care	33. Mining
16. Food & Grocery Products	34. Precious Metals & Minerals
17. Entertainment/Leisure/Toys	35. Forestry & Paper Products
18. Media	36. Fabricated Metal & Container Products

These industries can also be combined into economic sectors. The BARRA default sectors are shown in Table 3-5.

Table 3-5
GEM-MSCI and GEM-FT Economic Sectors

MSCI Version	FT Version
1. Energy	1. Financing, Insurance, & Real Estate
2. Materials	2. Energy
3. Capital Equipment	3. Utilities
4. Consumer Goods	4. Transportation & Storage
5. Services	5. Consumer Goods/Services
6. Finance	6. Capital Goods
7. Multi-Industry	7. Basic Industry
8. Gold Mines	

Users can define customized sectors utilizing any grouping of GEM industries.

Currencies

GEM-MSCI contains 46 currencies and GEM-FT contains 51 currencies. They allow investors to analyze their portfolios using the country perspective of their choice.

Argentinian and Brazilian currencies are excluded due to highly volatile historical exchange rates. Assets in these countries are valued in U.S. dollars; this offers more stable valuation.

Table 3-6 lists the currencies contained in the Global Equity Model.

Table 3-6
Currencies in GEM-MSCI and GEM-FT

Currency	MSCI Version	FT Version
1. Australian dollar	✓	✓
2. Austrian schilling	✓	✓
3. Belgian franc	✓	✓
4. Canadian dollar	✓	✓
5. Chilean peso	✓	✓
6. Chinese yuan (renminbi)	✓	✓
7. Colombian peso	✓	✓
8. Czech koruna	✓	✓
9. Danish krone	✓	✓
10. Egyptian pound		✓
11. Finnish markka	✓	✓
12. French franc	✓	✓
13. German deutschemark	✓	✓
14. Greek drachma	✓	✓
15. Hong Kong dollar	✓	✓
16. Hungarian forint	✓	✓
17. Indian rupee	✓	✓
18. Indonesian rupiah	✓	✓
19. Irish punt	✓	✓
20. Israeli shekel	✓	✓
21. Italian lira	✓	✓
22. Japanese yen	✓	✓
23. Jordanian dinar	✓	✓
24. Korean won	✓	✓
25. Malaysian ringitt	✓	✓
26. Mexican peso	✓	✓
27. Moroccan dirham		✓
28. Dutch guilder	✓	✓
29. New Zealand dollar	✓	✓
30. Nigerian nair		✓
31. Norwegian krone	✓	✓

Currency	MSCI Version	FT Version
32. Pakistani rupee	✓	✓
33. Peruvian new sol	✓	✓
34. Philippine peso	✓	✓
35. Polish zloty	✓	✓
36. Portuguese escudo	✓	✓
37. Russian rouble	✓	✓
38. Singapore dollar	✓	✓
39. Slovakian koruna		✓
40. South African rand	✓	✓
41. Spanish peseta	✓	✓
42. Sri Lanka rupee	✓	✓
43. Swedish krona	✓	✓
44. Swiss franc	✓	✓
45. Taiwanese dollar	✓	✓
46. Thai baht	✓	✓
47. Turkish lira	✓	✓
48. U.K. pound	✓	✓
49. U.S. dollar	✓	✓
50. Venezuelan bolivar	✓	✓
51. Zimbabwe dollar		✓

4. Model Estimation

The Global Equity Model is the product of a thorough and exacting model estimation process. This section provides a brief overview of model estimation. Certain procedures are described in greater detail, such as risk index selection and standardization, industry definition, and local market selection. In addition, currency calculations and model updating are explained.

Figure 4-1
Model Estimation Process

1. *Data acquisition and cleaning*
2. *Risk index formulation*
3. *Industry definition*
4. *Local market selection*
5. *Factor return estimation*
6. *Covariance matrix calculation*
7. *Currency risk estimation*
8. *Specific risk forecasting*
9. *Model testing*

An overview

The creation of a comprehensive equity risk model is an extensive, detailed process of determining the factors that describe asset returns. Model estimation involves a series of intricate steps that is summarized by the procedures in Figure 4-1.

The first step in model estimation is acquiring and cleaning data. Market information, such as price, dividend yield, and capitalization, is used. Capital restructurings and other atypical events are included to provide consistent cross-period comparisons. GEM uses data from many sources, including Morgan Stanley (for GEM-MSCI), Financial Times (for GEM-FT), as well as regional and local data sources.

Risk index selection follows. This involves choosing variables that best capture the risk characteristics of the assets. To determine which asset attributes partition risk in the most effective and efficient way, the risk indices are tested for statistical significance. A risk index is included in the model if it (1) forecasts beta, (2) identifies historical sources of exceptional return, or *alpha*, or (3) measures a source of residual volatility.

Next, industry classification and local market membership are assigned to each asset in the estimation universe, the Morgan Stanley Capital International World Index (MSWLD) for GEM-MSCI and the Financial Times-Actuaries World Index (FTWLD) for GEM-FT. Through cross-sectional regressions, factor returns for risk indices and industries are calculated. These factor returns are combined with country index returns to generate a covariance matrix. The covariances among factors are used to forecast risk. For more information on these procedures, see Chapter 2. The Evolution of Risk Models.

At this point, currency is reintroduced into the estimation process. Currency volatilities and correlations are calculated independently and then added to the covariance matrix.

Specific return is independent of the factor returns and is estimated using a separate model. This is the portion of total risk that is related solely to a particular stock and cannot be accounted for by the factors. The greater an asset's specific risk, the larger the proportion of return is attributable to idiosyncratic or company-specific influences rather than common factors.

Lastly, the model undergoes final testing. Risk forecasts are tested against alternative models. Tests include ex ante and ex post evaluations of beta, specific risk, and active risk.

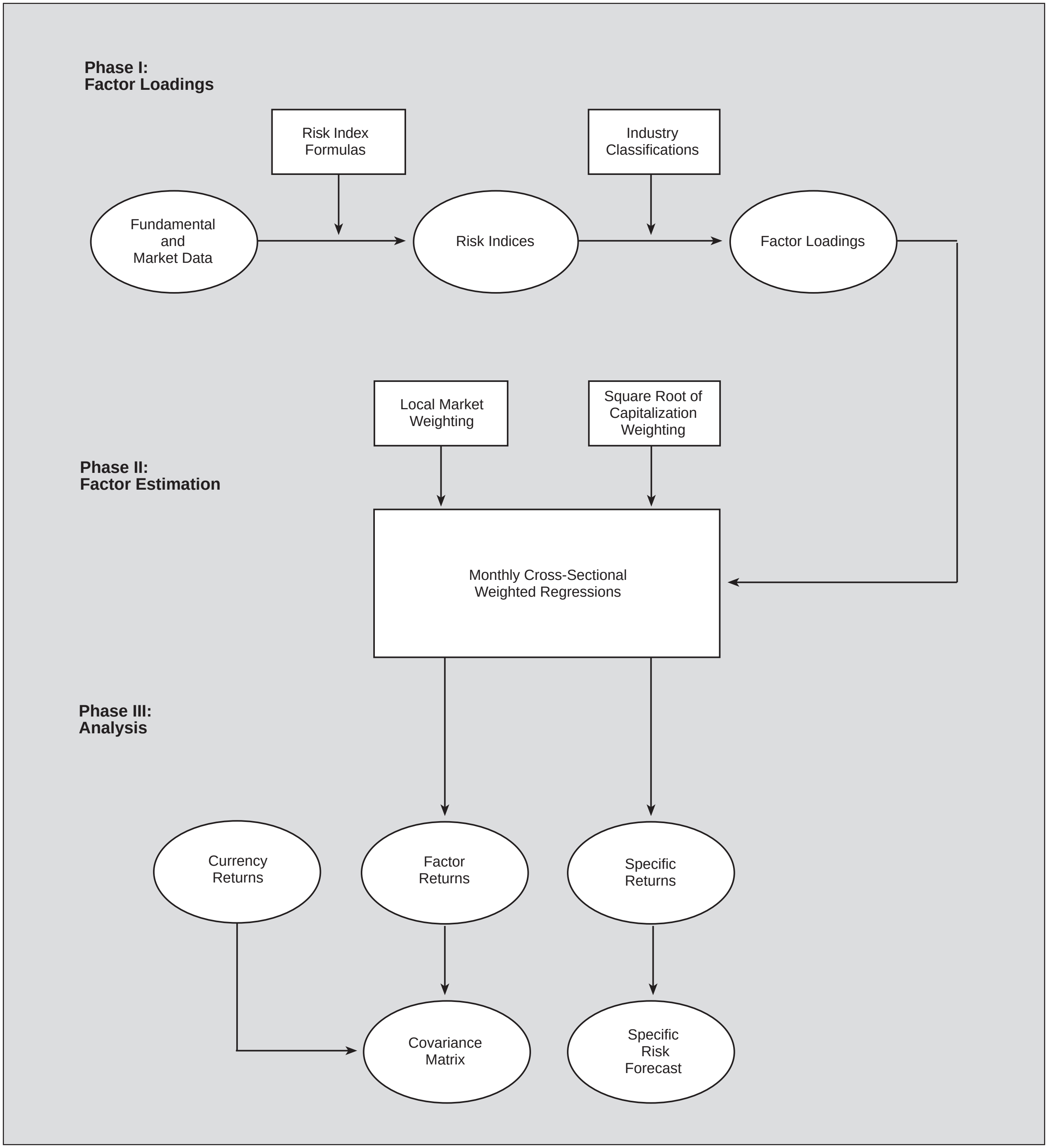


Figure 4-2

Data Flow for Model Estimation

This figure depicts the model estimation process. Factor returns and currency returns form the covariance matrix used to forecast risk. Specific risk is estimated separately.

Normalization

Normalization is the process of setting random variables to a uniform scale. Also called *standardization*, it is the process by which a constant (usually the mean) is subtracted from each number to shift all numbers uniformly. Then each number is divided by another constant (usually the standard deviation) to shift the variance.

Winsorization

Winsorization refers to the process of truncating outliers at a fixed number of standard deviations (usually 3) from the mean. This prevents unusual occurrences from having an undue influence on forecasts.

Risk index selection and standardization

Risk index selection is a largely qualitative process that is subjected to rigorous quantitative testing. First, preliminary risk indices are identified. Good candidates are individually meaningful; that is, they are based on generally accepted and well-understood asset attributes. Furthermore, they characterize significant portfolio attributes across local markets.

Selected risk indices must have a sound theoretical justification for inclusion in the model. They must be useful in predicting risk and based on timely, accurate, and available data. In other words, each risk index must add value to the model.

Risk index factor returns are calculated and normalized—that is, standardized with respect to the estimation universe using capitalization-weighted means and equal-weighted standard deviation. The normalization process is summarized by the following relation:

$$[Normalized\ Risk\ Index] = \frac{[Raw\ Data] - [Capitalization - weighted\ Mean]}{[Equal - weighted\ Standard\ Deviation]}$$

Risk index standardization sets the zero value at the capitalization-weighted mean of the companies within each local market. The scale is calibrated so that one unit equals one cross-sectional standard deviation of that variable among the assets in each local market (*see* Figure 4-3). For model estimation, the absolute value of the standard deviation of a factor exposure should be between 0 and 4. If the value is between 4 and 10, the factor exposure is truncated to ±4 through winsorization; values greater than 10 are eliminated. Missing values are set to zero.

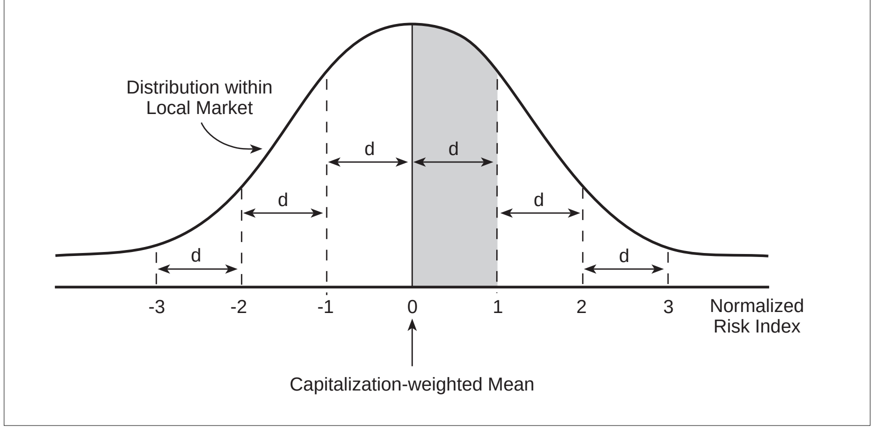


Figure 4-3

Standardization of Risk Indices

Standardization fits risk indices to a uniform scale. The risk indices are normalized within local markets with the capitalization-weighted mean set to zero. In this figure, ***d*** *equals one cross-sectional equal-weighted standard deviation.*

Industry definition

The Global Equity Model assigns assets to industry categories by mapping industry data to Morgan Stanley or Financial Times classifications. GEM assigns each security to a single industry. Industry risk exposures indicate the percentage of total portfolio value in each industry classification.

Like risk indices, industries are global factors—that is, they behave similarly across local markets. Factor returns are calculated to measure the effects of industry net of all other factors. These factor returns are used to generate the covariance matrix.

Factor return estimation

The previous steps have defined the exposures of each asset to the factors at the beginning of every period in the estimation window. The factor excess returns over the period are then obtained via a cross-sectional regression of asset excess returns on their associated factor exposures:

$$\tilde{r}_t = X_t \tilde{f}_t + u_t \qquad \text{(EQ 4-1)}$$

where:

$\tilde{r}_t$ = excess returns to each asset

X_t = exposure matrix of assets to factors

$\tilde{f}_t$ = factor returns to be estimated

u_t = specific returns

The resulting factor returns are robust estimates which can be used to calculate a factor covariance matrix to be used in the remaining model estimation steps.

Covariance matrix calculation

The simplest way to estimate the factor covariance matrix is to compute the sample covariances among the entire set of estimated factor returns. Implicit in this process is the assumption that we are modeling a stable process and, therefore, each point in time contains equally relevant information.

There is evidence, however, that correlations among factor returns change. Moreover, a stable process implies a stable variance for a well-diversified portfolio with relatively stable exposures to the factors. There is considerable evidence that, in some markets, the volatility of market index portfolios changes. For example, periods of high volatility are often followed by periods of high volatility. The changing correlations among factor returns, and the changing volatility of market portfolios, belie the stability assumption underlying a simple covariance matrix.

We relax the assumption of stability in the GEM covariance matrix in two ways. First, in computing the covariance among the factor returns, we assign more weight to recent observations relative to observations in the distant past. Second, we utilize GARCH techniques to scale the factor covariance matrix so that it produces comparable volatility forecasts for selected country portfolios as their single country models would produce.

Exponential weighting

Suppose that we think that observations that occurred 60 months ago should receive half the weight of the current observation. Denote by T the current period, and by t any period in the past, $t = 1,2,3,\ldots,T\text{-}1,T$, and let $\delta = .5^{1/60}$. If we assign a weight of δ^{T-t} to observation t, then an observation that occurred 60 months ago would get half the weight of the current observation, and one that occurred 120 months ago would get one-quarter the weight of the current observation. Thus, our weighting scheme would give *exponentially declining weights* to observations as they recede in the past.

Our choice of sixty months was arbitrary in the above example. More generally, we give an observation that is *HALF-LIFE* months ago one-half the weight of the current observation. Then we let:

$$\delta = (.5)^{\frac{1}{HALFLIFE}} \qquad \text{(EQ 4-2)}$$

and assign a weight of:

$$w(t) = \delta^{T-t}. \qquad \text{(EQ 4-3)}$$

The length of the *HALF-LIFE* controls how quickly the factor covariance matrix responds to recent changes in the market relationships between factors. Equal weighting of all observations corresponds to *HALF-LIFE* = ∞. Too short a *HALF-LIFE* effectively "throws away" data at the beginning of the series. If the process is perfectly stable, this decreases the precision of the estimates. Our tests show that the best choice of *HALF-LIFE* varies from country to country. Hence, we use different values of *HALF-LIFE* for different single country models.

The factor correlation matrix in GEM is exponentially weighted with a half-life of 48 months. Volatility forecasts for local market, industry, and risk factors are exponentially weighted using a 48-month half-life, except for Australia, Canada, Korea, South Africa, Taiwan, Thailand, and U.K. local markets, which use half-lives matching the Single Country Models. These choices are based on internal BARRA testing.

Computing market volatility: GARCH models

There is considerable evidence that, in some markets, market volatility changes in a predictable manner. We find that returns that are large in absolute value cluster in time, or that volatility persists. We also find that actual asset return distributions exhibit a higher likelihood of extreme outcomes than is predicted by a normal distribution with a constant volatility.

The following discussion lays out the general theory of GARCH modeling.

Formally, denote by $\tilde{r}_t$ the market return at time *t*, and decompose it into its expected component, $\mathrm{E}(\tilde{r}_t)$, and a surprise, ε_t:

$$\tilde{r}_t = \mathrm{E}(\tilde{r}_t) + \varepsilon_t \qquad \text{(EQ 4-4)}$$

The observed persistence in realized volatility indicates that the variance of the market return at *t*, $Var(\tilde{r}_m)_t$, can be modeled as:

$$Var(\tilde{r}_m)_t = \omega + \alpha\varepsilon_{t-1}^2 + \beta\, Var(\tilde{r}_m)_{t-1} \qquad \text{(EQ 4-5)}$$

This equation, which is referred to as a GARCH(1,1) model, says that current market volatility depends on recent realized volatility via ε_{t-1}^2, and on recent forecasts of volatility via $Var(\tilde{r}_m)_{t-1}$. If α and β are positive, then this period's volatility increases with recent realized and forecast volatility.

Having satisfactorily fit a GARCH model to the volatility of a local market proxy portfolio, it is used to scale the local market factor in the covariance matrix.

We use GARCH volatility forecasts for the Japanese, Swedish, and U.S. markets and a GARCH model for some currency factors based on daily currency returns from the BARRA Cosmos System™ global bond model. GARCH parameters are incorporated only when there are significant improvements to the model.

Countries in GEM

Local market exposures measure your portfolio's sensitivity in each local market. The local market exposure is calculated by multiplying the portfolio's weight within each market by the local market factor, a statistically-manipulated version of historical beta derived from asset-specific information. Unlike currency exposures, local market exposures are not percentage weights.

BARRA research has shown that local market factors typically contribute more to total portfolio risk than do industry factors. In model estimation, the country index returns are used to determine local market returns in the calculation of the covariance matrix.

Currency risk estimation

Investing from a numeraire currency involves two bets—a bet on the performance of an asset in its local market and a currency bet. To analyze local excess risk, GEM considers covariances among risk indices, industries, and countries, discussed above. Currency returns are then computed for each asset using the following equation. The risks and correlations that result from these returns are added to the covariance matrix.

$$Currency\ Return = rx + rfl - rf$$

where:

rx = the exchange rate return,

rfl = risk-free local market rate, and

rf = risk-free numeraire return.

In GEM, currency risk exposures are percentage weights of holdings in each country.

Updating the model

Model updating is a process whereby the most recent market data is used to calculate individual stock exposures to the factors, to estimate the latest month's factor returns, and to recompute the covariance matrix. Country index returns are used for local market values.

The latest data is collected and cleaned. Risk index and industry exposures for each company in the database are computed. Next, a cross-sectional regression is run on the asset returns for the previous month. This generates factor returns, which are used to update the covariance matrix. Finally, this updated information is distributed to users of BARRA's applications software.

5. Portfolio Management

The Global Equity Model provides the foundation for BARRA's global portfolio construction and analysis applications. Optimization programs assemble assets to meet portfolio management objectives while risk analysis programs offer investment managers the necessary information to evaluate risk/return tradeoffs.

Portfolio construction

To create a portfolio, a manager relies on personal experience, individual judgment, and preferences toward risk. By combining these elements with BARRA data and portfolio construction software, the manager can tailor a portfolio to meet particular needs.

The main concern for investors is balancing their risk preferences with their return expectations, selecting stocks that reflect both. Number of assets, share turnover, and factor alphas (expected returns) all impact a portfolio's risk profile (*see* Figure 5-1).

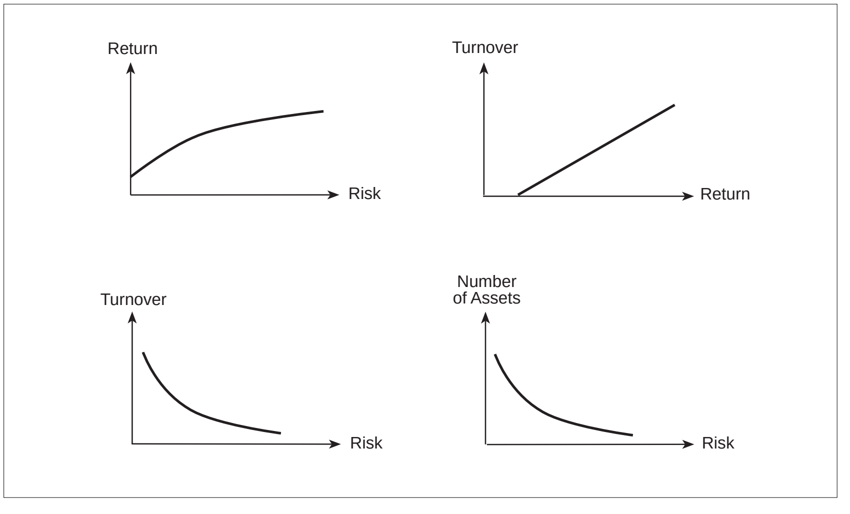


Figure 5-1

Portfolio Construction Tradeoffs

In constructing a portfolio, an investor chooses a risk/return combination compatible with risk preferences. Points along the risk/return curve represent efficient portfolios at varying levels of risk aversion. The number of assets in a portfolio, share turnover, and expected return also affect a portfolio's risk profile.

Weighting schemes are an important part of portfolio construction. A capitalization-weighted portfolio reflects market valuation of stocks with larger securities dominating the portfolio. An equal-weighted portfolio, on the other hand, contains an implicit bet on smallness and ignores benchmark weights. A manager's weighting decisions depend on investment objectives and management style.

Benchmark

A *benchmark* is the standard of comparison for investment performance and risk analysis. It is widely used to evaluate and track performance of investment managers. The benchmark is also known as the *normal portfolio*—that is, the asset basket a manager would hold in the absence of any judgmental information. It reflects the manager's particular style and biases.

Tracking Error

Tracking error is a measure of risk exposure. It is the annualized standard deviation of the difference between portfolio return and benchmark return.

Because it provides a relative measure of risk exposure, tracking error is a useful evaluation tool, particularly for passive portfolios. Moreover, it offers relevant performance comparisons because the benchmark is selected based on portfolio characteristics and investor objectives.

Passive management

In its broadest sense, *passive management* refers to any management strategy that does not rely on obtaining superior information. More specifically, disclosure of a passive investment strategy offers no competitive information that would undermine the strategy's validity. Passive management does not use return expectations, investment research, or valuation models.

One type of passive management is indexing, tracking the performance of a particular index. An example is the "buy-and-hold" philosophy that exposes the portfolio only to systematic risk. The second form of passive management is constructing a portfolio to match prespecified attributes or constraints. The portfolio may be yield-biased with a selected beta or match an index within certain parameters.

Passive management procedures are characterized by the following characteristics:

- They meet certain factor or sectoral goals, perhaps through defining beta.
- They often involve country, industry, or sector weighting.
- They contain relatively minimal residual risk with respect to the benchmark or index.
- They do not include any transactions based on security valuations and the market as a whole.

Active management

Active management refers to investment strategies designed to increase return by using superior information. The active manager seeks to profit from information that would lose its value if all market participants interpreted it in the same way. If, for example, an investment manager observed that securities in a particular industry performed better (or worse) than expected, the manager could increase (or decrease) holdings in that industry to enhance the subsequent value of the portfolio.

By following active management strategies, investors can add value to their portfolio if they predict returns better than the consensus expectations of the market. Information is obtained through ongoing research to forecast yield curve changes, common factor returns, and transitory mispricing. At any given time, portfolio construction should reflect the tradeoff between risk and return—that is, any contribution to risk should be offset by the contribution to reward.

There are several basic types of active investment strategies. They include country selection, currency bets, sectoral emphasis, and stock selection.

Country selection is the process of altering local market weights based on short-term forecasts in order to earn superior returns. The manager seeks to overweight markets which are expected to perform exceptionally and underweight markets that are expected to underperform. However, this strategy increases the variability in the portfolio beta, indicating increased risk through time. Country market bets include implicit currency bets, unless the investor hedges the portfolio against currency risk.

Another type of active management is *sectoral emphasis*. The manager attempts to increase residual return through manipulating common factor exposures. For example, the manager can bet on an industry or high-yield stocks. Diversification is possible because a manager can emphasize several sectors at any given time.

Lastly, *stock selection* is a portfolio allocation strategy based on picking mispriced stocks. It uses security alphas to identify over- and undervalued stocks. The manager can then adjust the asset proportions in the portfolio to maximize specific return. These active holdings, in both positive and negative directions, increase residual risk and expected return. The primary objective of this strategy is to manage asset holdings so that any change in incremental risk is exactly compensated by a comparable change in return.

In each case, the manager's goal is to earn a superior return with minimum risk. The use of a multiple-factor model permits the manager to efficiently capture expected returns by ensuring that there are no incidental risks in the portfolio.

Alpha

Alpha (α) generally refers to the expected exceptional return of a portfolio, factor, or individual asset. The use of alphas is a distinction of active management. They indicate that a manager believes a portion of expected return is attributable to particular factors.

Historical alpha is the difference between actual performance and the performance of a diversified market portfolio with identical systematic risk over the same period. *Judgmental*, or *predicted*, *alpha* is the expected value of subsequent extraordinary return based on a return forecast.

Model applications

The BARRA Aegis System™ Risk Manager provides the basis for BARRA's PC software. Through sensitivity analysis, the Risk Manager reveals the effects of proposed trades on a portfolio's risk sources. With each change in holdings, the Risk Manager immediately recalculates your portfolio's beta and exposure to various countries, risk indices, industries, and currencies. The Risk Manager can also recommend reallocations to help you reach an optimal balance of risk and return.

In addition, the Risk Manager lets you create customized benchmarks for use in portfolio analysis. You can also add unlisted or newly listed securities to the database or modify the characteristics of an existing security.

The Aegis System also has an Optimizer designed for use under both active and passive management conditions. The Optimizer creates efficient portfolios within user-specified constraints. You can define factor and industry expected returns, risk aversion, transaction costs, and other parameters to implement tilt and market timing strategies. After using the Optimizer, you can easily transfer your newly optimized portfolio to the Risk Manager to assess and adjust its active risk.

The Aegis System also features a Screening Tool so you can create a list of assets screened on risk indices, industries, and other fundamental characteristics. The Aegis System Risk Manager, Optimizer, and Screening Tool provide an integrated system of risk analysis and portfolio construction.

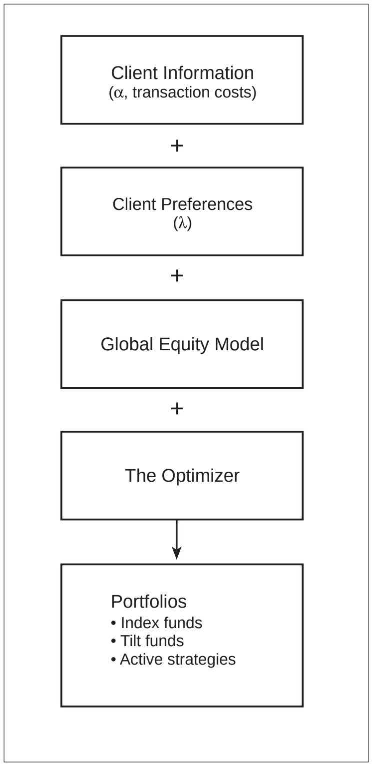


Figure 5-2

Portfolio Construction

The Aegis System Optimizer balances user specifications with investment objectives to create efficient portfolios.

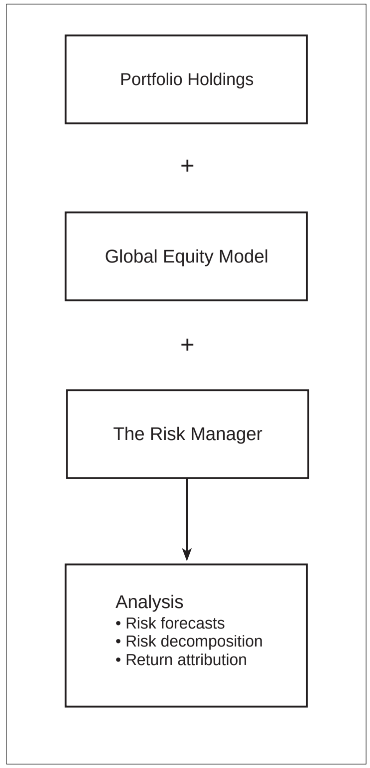


Figure 5-3

Portfolio Analysis

The Aegis System Risk Manager is a risk analysis tool that allows the user to assess and adjust sources of risk.

6. Global Equity Case Studies

This chapter includes three GEM-MSCI case studies that demonstrate the use of the BARRA Global Equity Model. The first case study analyzes an active portfolio. The second case study describes how the model can be used to track the MSEAFE with a basket of 250 stocks. Finally, the third demonstrates the optimization of a tilt strategy using the Aegis Optimizer.

Case 1: Analyzing an active portfolio

The Global Equity Model can be used to determine the sources and amounts of risk in an active portfolio. As an example, let's use a portfolio called CASE1 (*see* Figure 6-1). Notice that the portfolio holds stocks in many countries.

The Aegis Risk Manager lets you focus on particular assets. For example, Figure 6-1 indicates that Alcatel Alsthom has a predicted global beta of 0.93 relative to the Morgan Stanley Capital International Europe Australia Far East Index (MSEAFE). We can also view the Asset Detail report (*see* Figure 6-2), which shows a predicted local beta of 1.09 relative to the French market.

Figure 6-1

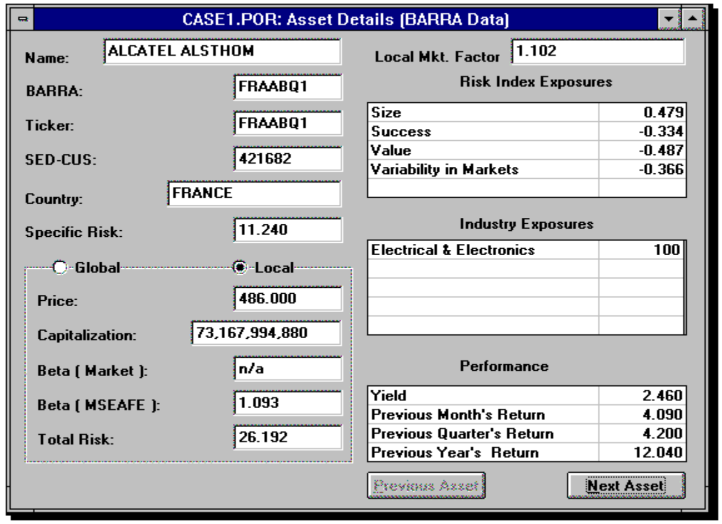
Risk Manager CASE1 workspace display

C:\GEMHAN~1\CASE1.POR

	Input ID	Name	Shares	Price	Beta	Weight	Yield	Country	Main Industry
1	421682	ALCATEL ALSTHOM	38,980	93.8709	0.93	0.19 %	2.46 %	FRANCE	ELCTEQ
2	405671	ASSICURAZIONI GENER/	4,118,685	24.9280	0.66	5.35 %	0.93 %	ITALY	INSURE
3	405120	ASTRA, AB, SER. A, FR	987,788	44.3567	0.67	2.28 %	1.00 %	SWEDEN	HEALTH
4	405121	ASTRA, AB, SER. B, FR	785,879	44.0624	0.70	1.80 %	1.00 %	SWEDEN	HEALTH
5	417754	CARREFOUR	74,222	779.9397	0.85	3.01 %	1.18 %	FRANCE	MRCHND
6	418224	CRH	4,765,099	8.9246	0.96	2.21 %	2.10 %	IRELAND	BLDG
7	431536	ENDESA	1,636,333	62.7215	0.90	5.34 %	2.33 %	SPAIN	UTIL
8	432155	ERICSSON, TEL.-AB,B,FI	389,913	20.2290	1.02	0.41 %	1.27 %	SWEDEN	ELCTEQ
9	453564	LVMH MOET HENNESSY	8,860	255.3443	0.84	0.12 %	2.17 %	FRANCE	BEVTOB
10	473681	RHONE-POULENC -A	502,162	23.9506	0.90	0.63 %	3.61 %	FRANCE	CHEM
11	488082	TELEFONICA DE ESPAN/	4,884,179	17.7803	0.87	4.52 %	3.36 %	SPAIN	TELECM
12	013849	BRITISH PETROLEUM	11,491,378	8.9883	0.90	5.38 %	3.18 %	UK	ENERGY
13	006811	BAT INDUSTRIES	4,270,380	7.5478	0.81	1.68 %	6.89 %	UK	MULTI
14	080341	SHELL TRNSPT&TRDG	6,866,862	13.1598	0.76	4.71 %	4.75 %	UK	ENERGY
15	037178	GLAXO WELLCOME	4,718,225	12.0944	0.66	2.97 %	4.65 %	UK	HEALTH
16	040054	HSBC HLDGS	3,114,833	14.7654	1.08	2.39 %	4.07 %	UK	BANKS
17	040049	HSBC HLDGS ($)	1,652,775	14.7654	0.85	1.27 %	4.07 %	UK	BANKS
18	614469	BROKEN HILL PTY LTD	5,016,224	15.4026	0.75	4.02 %	2.60 %	AUSTRAL	ENERGY
19	442448	BULGARI SPA	3,538,104	12.4800	0.82	2.30 %	0.92 %	ITALY	RECCON
20	443639	ENI	32,095,270	4.3200	0.84	7.22 %	3.19 %	ITALY	ENERGY
21	607036	BK OF TOKYO-MITSUBIS	4,867,621	23.1110	1.27	5.86 %	0.35 %	JAPAN	BANKS
22	625144	DAIWA SECURITIES	793,426	15.3755	2.05	0.64 %	0.50 %	JAPAN	FINANC
23	635628	FUJI BANK	3,611,119	21.8695	1.54	4.11 %	0.14 %	JAPAN	BANKS
24	646284	INDUSTRIAL BANK OF J/	2,073,638	26.7400	1.48	2.89 %	0.30 %	JAPAN	BANKS
25	659682	MITSUBISHI TRUST&BAI	330,969	17.2855	1.96	0.30 %	0.39 %	JAPAN	BANKS

Figure 6-2

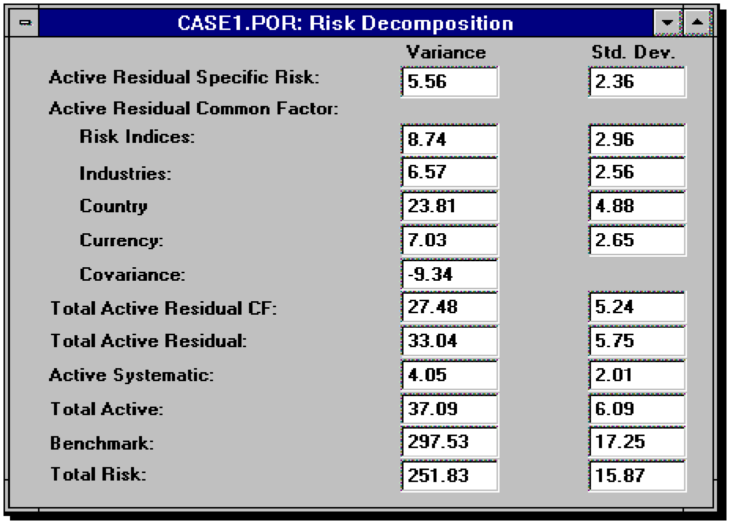
Risk Manager Asset Detail report for Alcatel Alsthom



The Risk Manager Risk Decomposition report (*see* Figure 6-3) shows the characteristics and risk exposures of the overall portfolio compared with those of the MSEAFE. The predicted annualized standard deviation of portfolio returns (that is, total risk) from a U.S. investor's point of view is 15.87%. This is actually lower than the predicted total risk of the benchmark (17.25%). The total active risk (6.09%) is the model's prediction of the difference in return over the next year for CASE1 relative to the MSEAFE, to one standard deviation of probability. The most significant portion of the active risk is due to country bets (4.88%). The other sources of active risk—"style" or risk indices, industries, and currencies—are all roughly equivalent at between 2.5%–3% per year.

What are the country bets? In Figure 6-4, the Risk Manager Portfolio Characteristics report, you can see that the portfolio is overweighted in Italy and underweighted in Japan relative to the benchmark. The manager may have intentionally made these country bets.

If the manager has made any incidental country bets, they can be seen in the Portfolio Characteristics reports. The manager can reduce country risk by adjusting portfolio holdings in these markets to track the benchmark more closely.

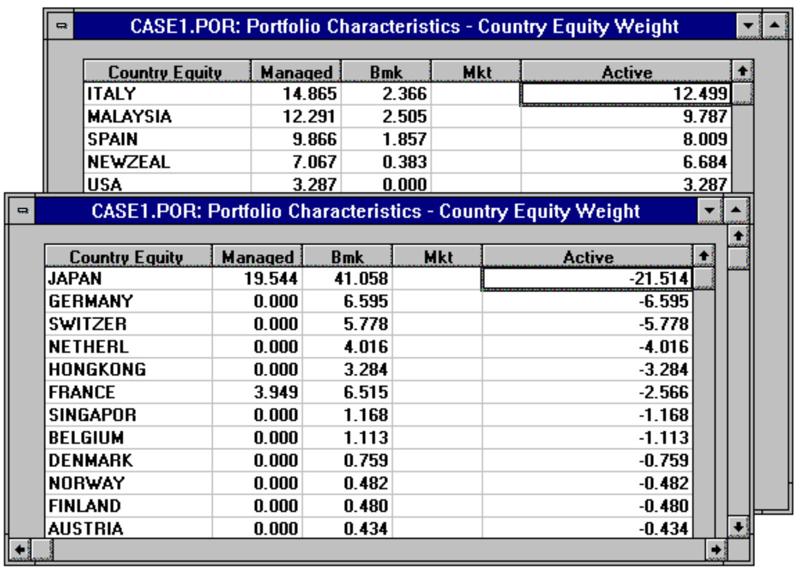


CASE1.POR: Risk Decomposition

	Variance	Std. Dev.
Active Residual Specific Risk:	5.56	2.36
Active Residual Common Factor:		
Risk Indices:	8.74	2.96
Industries:	6.57	2.56
Country	23.81	4.88
Currency:	7.03	2.65
Covariance:	-9.34	
Total Active Residual CF:	27.48	5.24
Total Active Residual:	33.04	5.75
Active Systematic:	4.05	2.01
Total Active:	37.09	6.09
Benchmark:	297.53	17.25
Total Risk:	251.83	15.87

Figure 6-3

Risk Manager CASE1 Risk Decomposition report against the benchmark MSEAFE



CASE1.POR: Portfolio Characteristics - Country Equity Weight

Country Equity	Managed	Bmk	Mkt	Active
ITALY	14.865	2.366		12.499
MALAYSIA	12.291	2.505		9.787
SPAIN	9.866	1.857		8.009
NEWZEAL	7.067	0.383		6.684
USA	3.287	0.000		3.287

CASE1.POR: Portfolio Characteristics - Country Equity Weight

Country Equity	Managed	Bmk	Mkt	Active
JAPAN	19.544	41.058		-21.514
GERMANY	0.000	6.595		-6.595
SWITZER	0.000	5.778		-5.778
NETHERL	0.000	4.016		-4.016
HONGKONG	0.000	3.284		-3.284
FRANCE	3.949	6.515		-2.566
SINGAPOR	0.000	1.168		-1.168
BELGIUM	0.000	1.113		-1.113
DENMARK	0.000	0.759		-0.759
NORWAY	0.000	0.482		-0.482
FINLAND	0.000	0.480		-0.480
AUSTRIA	0.000	0.434		-0.434

Figure 6-4

Risk Manager CASE1 Portfolio Characteristics reports for countries against the benchmark MSEAFE

Case 2: Matching the MSEAFE

Suppose that a fund manager wants to match the MSEAFE, which contains over 1500 stocks, with a basket of only 250 stocks. This task is easily accomplished with the Aegis Optimizer, BARRA's portfolio optimization program for tracking indices and constructing active portfolios. The manager specifies the market to be matched and the number of stocks to be included in the portfolio; the Optimizer does the rest.

The Aegis Risk Manager Risk Decomposition Report (*see* Figure 6-5) depicts the risk profile of the tracking portfolio, called CASE2. Note that the common factor active risks of the tracking portfolio are small relative to the MSEAFE. Note also that the total active risk (or tracking error) for this 250-stock portfolio is only 0.64%. That is, the annual return to this portfolio has a two-thirds likelihood of being within 0.64% of the MSEAFE return.

Figure 6-5

Risk Manager Risk Decomposition report of CASE2 against the benchmark MSEAFE

CASE2.POR: Risk Decomposition

	Variance	Std. Dev.
Active Specific Risk:	0.33	0.57
Active Common Factor:		
Risk Indices:	0.04	0.19
Industries:	0.03	0.18
Country	0.05	0.23
Currency:	0.00	0.06
Covariance:	-0.02	
Total Act. Common Factor:	0.08	0.29
Total Active:	0.41	0.64
Benchmark:	297.53	17.25
Total Risk:	295.50	17.19

Any common factor risk component can be further broken down. For example, the overall industry exposures match the MSEAFE very closely, but some specific industries have larger deviations. In Figure 6-6, we've sorted the industries by their active exposures; the largest deviation from the benchmark is in Business Services (-0.943%).

A BARRA multiple-factor model approach gives a manager the ability to match a tracking portfolio to an index such as the MSEAFE, along common factors like industries, currencies, and countries. However, with a portfolio of limited size like CASE2, some specific risk occurs due to the idiosyncratic nature of the stocks selected. Figure 6-5 shows that we can reduce this to only 57 basis points of active specific risk. This is the largest single source of risk in this case, though still small on an absolute basis.

CASE2.POR: Portfolio Characteristics - Industry

Industry	Managed	Bmk	Mkt	Active	MC to Risk
BUSSVC	1.534	2.477		-0.943	-0.001
FOODHS	2.594	3.469		-0.876	0.001
UTIL	4.007	4.775		-0.768	0.006
PAPER	0.500	1.104		-0.605	0.002
ELCTEQ	3.244	3.764		-0.519	-0.009
BANKS	16.002	16.510		-0.508	0.002
APPLNC	1.761	2.140		-0.380	-0.018
INSURE	3.852	4.229		-0.378	0.002
BRDCST	1.111	1.478		-0.367	-0.000
STEEL	1.342	1.660		-0.318	0.003
WHSLE	1.022	1.307		-0.285	0.004
AEROSP	0.000	0.279		-0.279	0.008
BEVTOB	1.715	1.946		-0.231	0.000
MRCHND	4.481	4.660		-0.179	-0.002
CONSTR	1.876	2.044		-0.169	0.011
REALES	2.562	2.711		-0.149	0.003

Graph

Figure 6-6
Risk Manager Portfolio Characteristics report for industries

Case 3: Creating and optimizing a tilt fund

The final case shows how the factors underlying the Global Equity Model can be used as indicators of predicted return in active portfolio management. In this example, suppose we want to create a portfolio tilted toward small, successful stocks with low variability in markets, because we believe that these attributes will outperform the market in the near future.

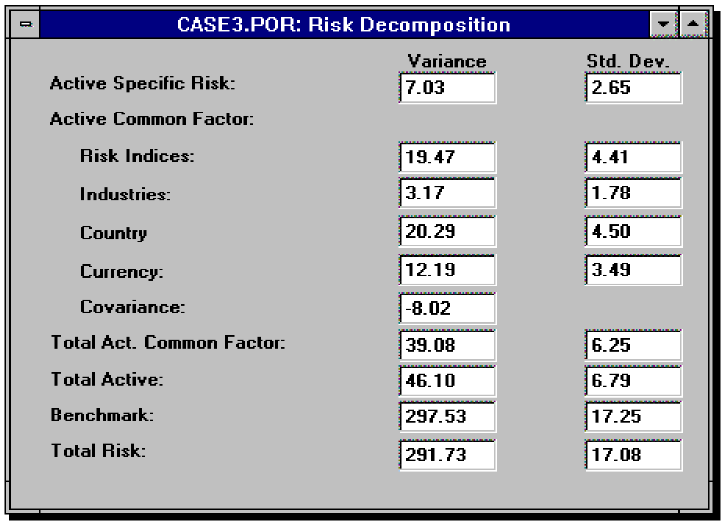
One approach would be to screen the universe for all firms with these characteristics, and to capitalization-weight or equal-weight the resulting portfolio. However, because this introduces large incidental bets into the analysis, it does not ensure an "efficient" portfolio—that is, a portfolio that optimally reduces risk and transactions costs while maximizing expected return.

An alternative method would be to use the Aegis Optimizer to assign explicit alphas—that is, expected returns—to these three risk indices. The factor alphas we used for this example are SIZE = -1.0, SUCCESS = 1.0, and VIM = 0.5 percent. We set the benchmark to MSEAFE and limited the number of assets to 125. Given these parameters, the Optimizer generates a portfolio with the risk characteristics shown in Figure 6-7.

Not surprisingly, this tilting strategy produces a portfolio (CASE3) dominated by small, successful companies with low market variability (factor exposures of SIZE = -1.54, SUCCESS = 0.76, and VIM = -0.01) (*see* Figure 6-8). We can see that much of the common factor risk derives from these risk index bets: the active risk index risk is 4.41% per year, which, along with the country risk, dominates total active risk. Although our tilt on risk index factors introduced significant incidental country and currency risk, the strategy did keep active specific risk under control at 2.65%. Total active risk of 6.79% per year is also typical of a global portfolio reflecting active tilts on fundamental attributes.

Figure 6-7

Risk Manager Risk Decomposition report of CASE3 against the MSEAFE

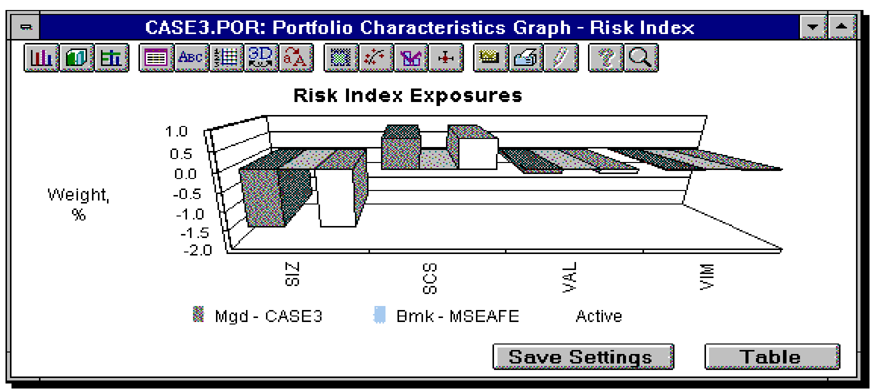


CASE3.POR: Risk Decomposition

	Variance	Std. Dev.
Active Specific Risk:	7.03	2.65
Active Common Factor:		
Risk Indices:	19.47	4.41
Industries:	3.17	1.78
Country	20.29	4.50
Currency:	12.19	3.49
Covariance:	-8.02	
Total Act. Common Factor:	39.08	6.25
Total Active:	46.10	6.79
Benchmark:	297.53	17.25
Total Risk:	291.73	17.08

Figure 6-8

Risk Manager Portfolio Characteristics graph of CASE3 against the MSEAFE



Appendix A: Risk Index Formulas

This Appendix gives the detailed definitions of the descriptors which underlie the risk indices in The Global Equity Model. The method of combining these descriptors into risk indices is proprietary to BARRA.

Size

A measure of company size.

$$Size = \ln\left[(number\ of\ shares\ outstanding) \cdot (price\ per\ share)_t\right]$$

where:

price = the latest monthly closing price.

Success

Stock price momentum.

$$Success = \sum_{i=1,12} \ln\left(1 + rl_{t-i}\right) - \sum_{i=1,12} \ln\left(1 + rfl_{t-i}\right)$$

where:

rl = local return and

rfl = local risk-free rate.

Value

Includes the following four descriptors:

$$\text{i) Forecast E/P} = \frac{\textit{IBES fiscal year 1 earnings / share}}{\textit{price}}$$

where:

price = the latest monthly closing price.

$$\text{ii) Reported E/P} = \frac{\textit{income before extraordinary items}}{(\textit{total shares outstanding}) \cdot \textit{price}}.$$

$$\text{iii) Reported B/P} = \frac{\textit{common equity}}{\textit{market capitalization}}$$

where:

$$\textit{market capitalization} = \textit{shares outstanding} \cdot (\textit{price per share})$$

and:

price = the latest monthly closing price.

$$\text{iv) Yield} = \frac{\textit{predicted annual dividend}}{\textit{price}_t}.$$

VIM

Variability in markets.

$$VIM_t = \sigma_\in$$

where:

$\sigma_\in$ = the standard deviation of the residual term $\in$ in the regression:

$$r_l - r_{fl} = \alpha + \beta\left(r_m - r_{fl}\right) + \in$$

where:

r_l = local return,

r_{fl} = local risk-free return,

r_m = local market return,

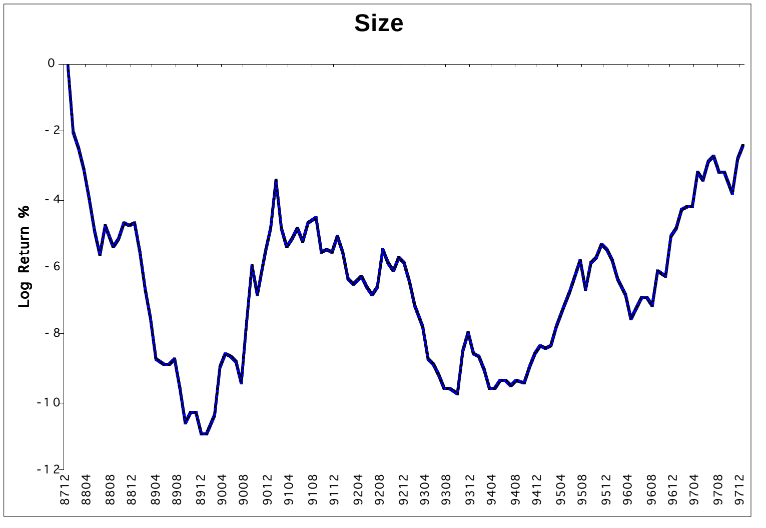
α = intercept,

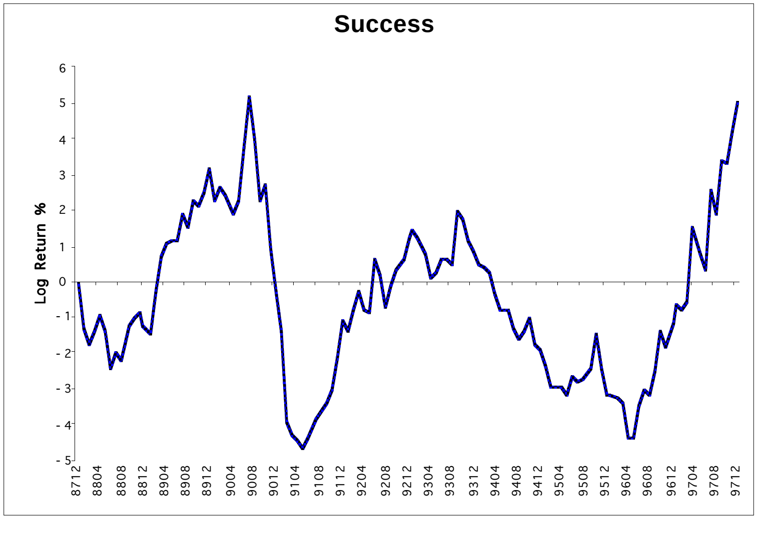
β = beta, and

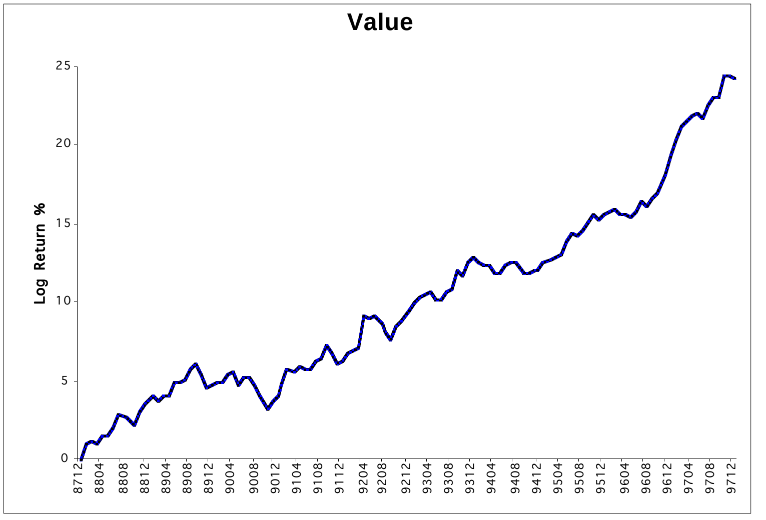
$\in$ = residual term.

Appendix B:
GEM-MSCI Risk Index Factor Returns

The following pages display factor return charts for GEM-MSCI risk indices over the period December 1987–December 1997. These represent the cumulative returns to each risk index net of all other common factors.






Value
Log Return %
25
20
15
10
5
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
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9404
9408
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9504
9508
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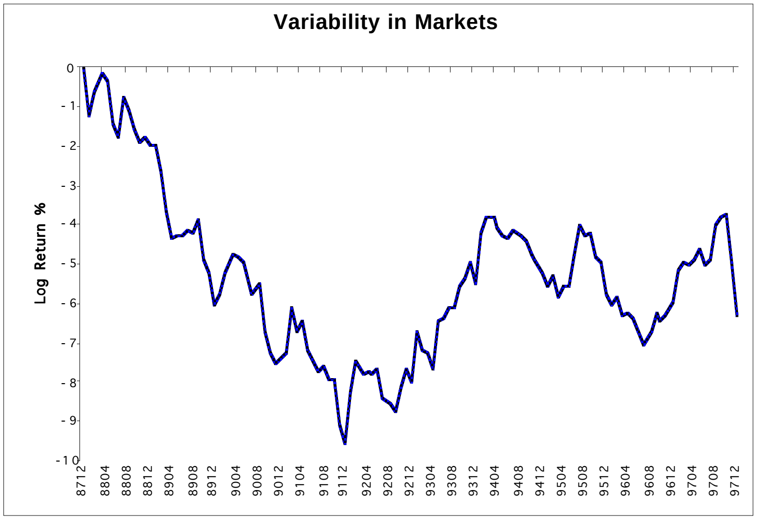
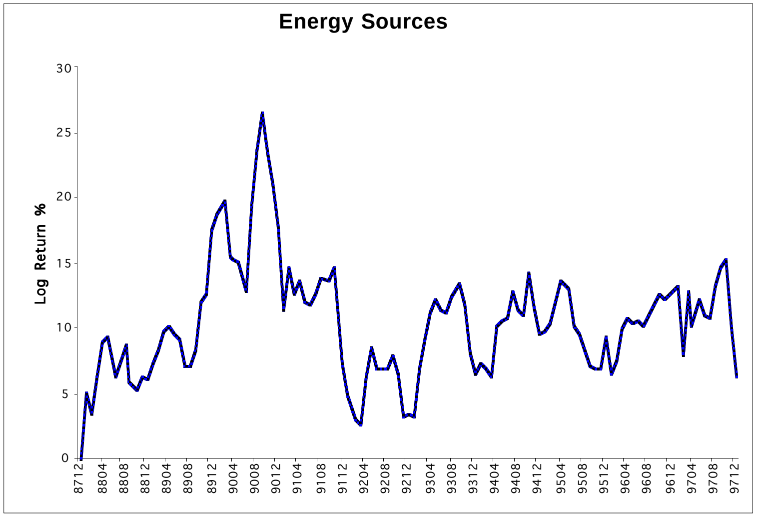
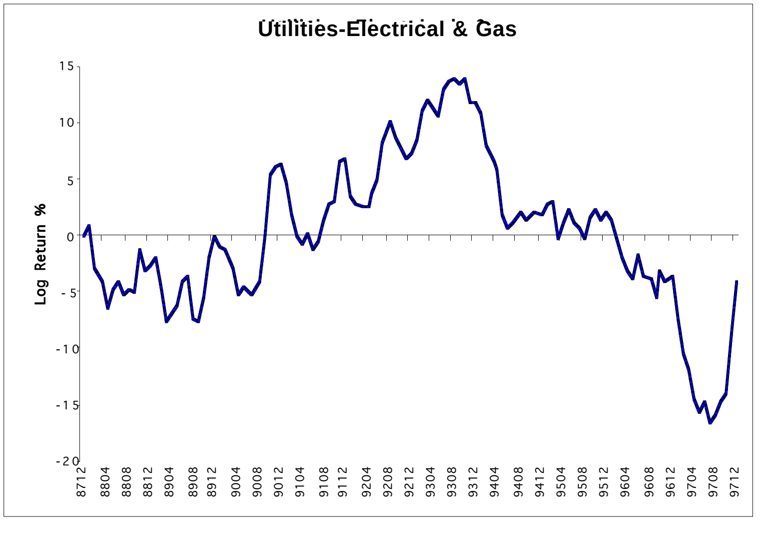
9604
9608
9612
9704
9708
9712

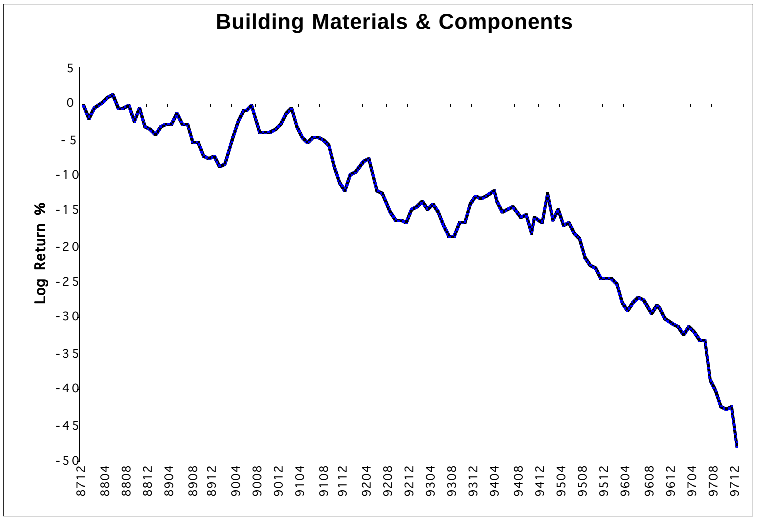

Variability in Markets
Log Return %
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

Appendix C:
GEM-MSCI Industry Factor Returns

The following pages display factor return charts for GEM-MSCI industries over the period December 1987–December 1997. These represent the cumulative returns to each industry factor net of all other common factors.






Building Materials & Components
Log Return %
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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9508
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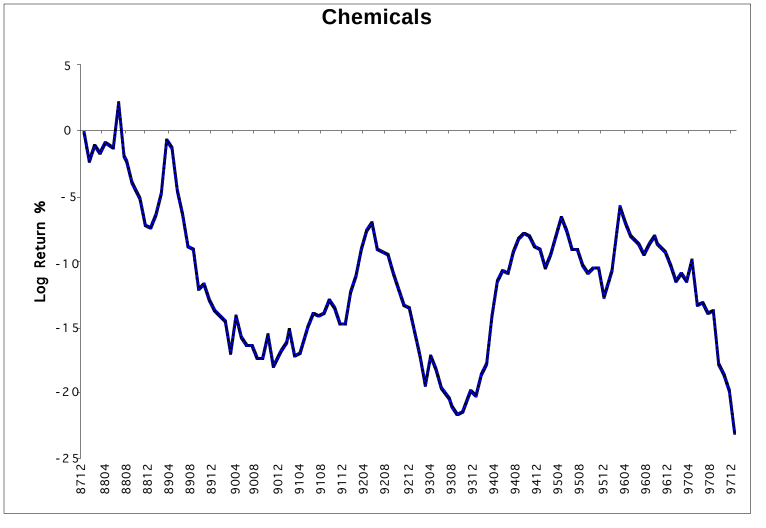
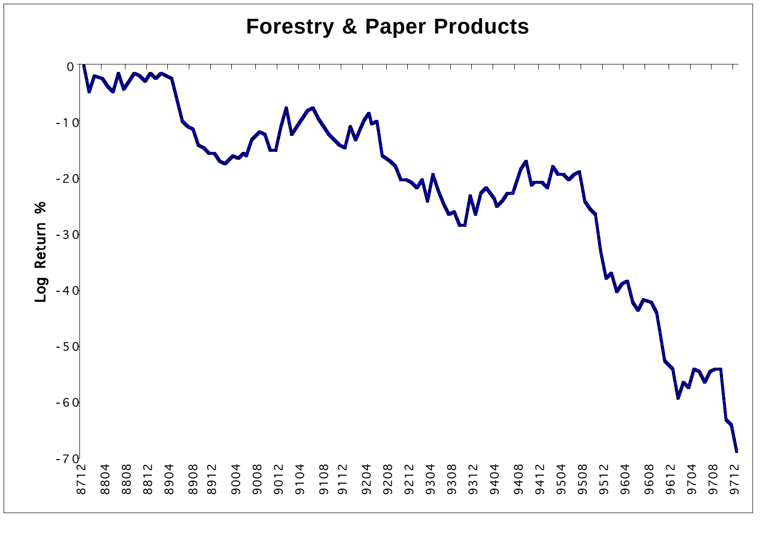
9612
9704
9708
9712


Chemicals
Log Return %
5
0
-5
-10
-15
-20
-25
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Forestry & Paper Products
Log Return %
0
-10
-20
-30
-40
-50
-60
-70
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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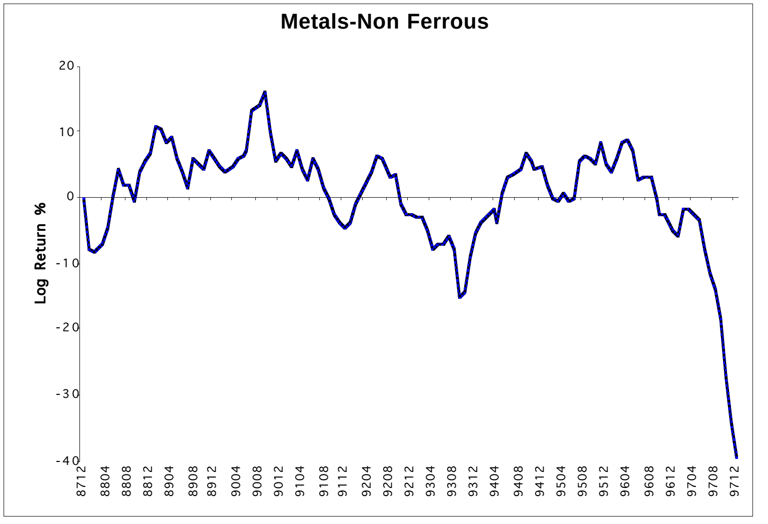
9612
9704
9708
9712


Metals-Non Ferrous
Log Return %
20
10
0
-10
-20
-30
-40
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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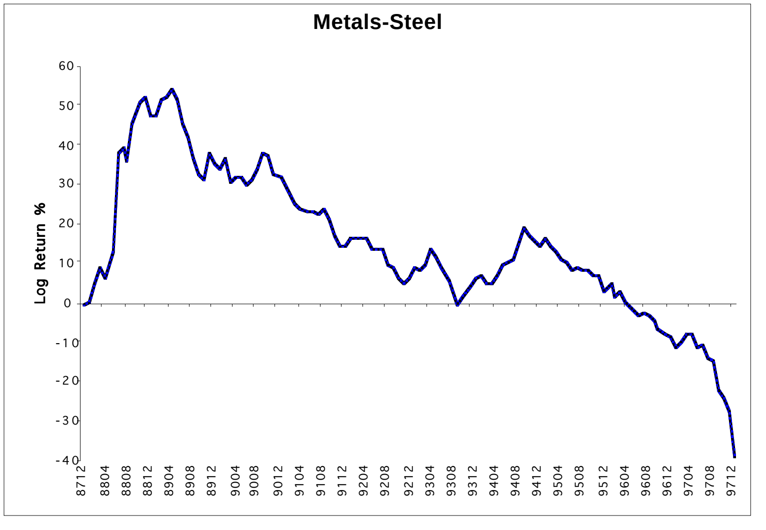
9612
9704
9708
9712


Metals-Steel
Log Return %
60
50
40
30
20
10
0
-10
-20
-30
-40
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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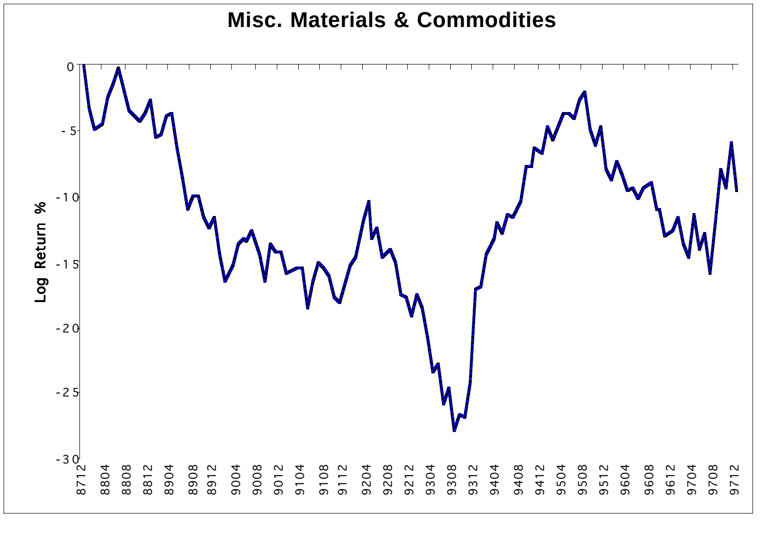
9612
9704
9708
9712


Misc. Materials & Commodities
Log Return %
0
-5
-10
-15
-20
-25
-30
8712
8804
8808
8812
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8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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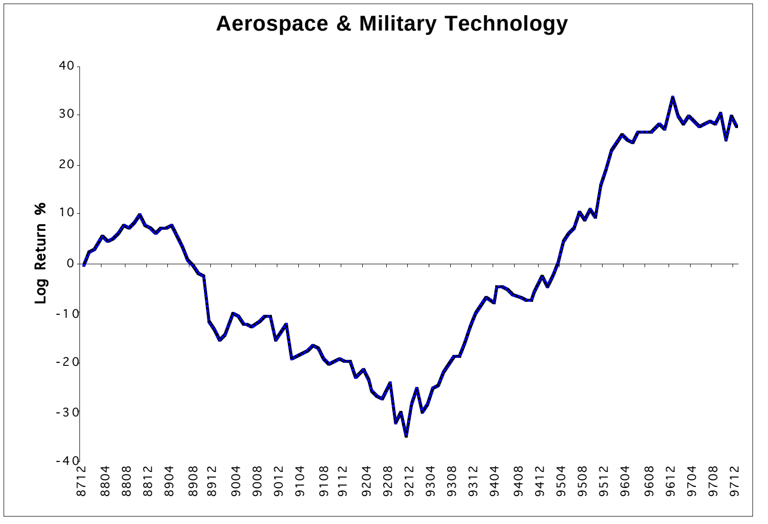
9612
9704
9708
9712


Aerospace & Military Technology
Log Return %
40
30
20
10
0
-10
-20
-30
-40
8712
8804
8808
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8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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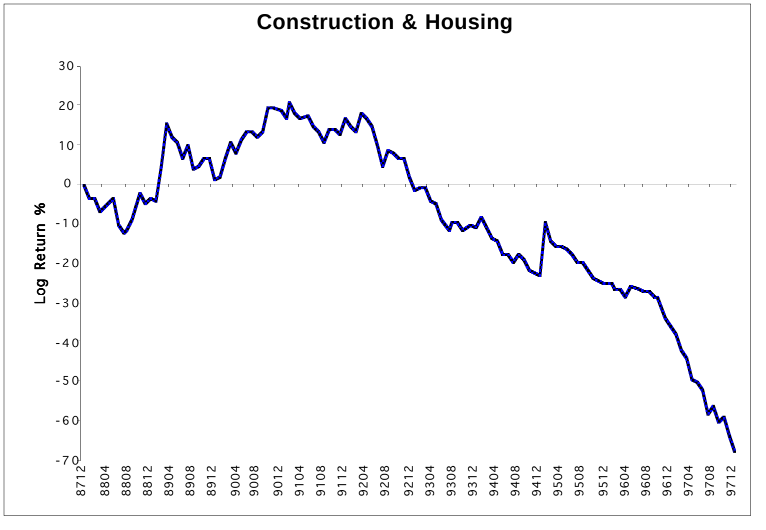
9612
9704
9708
9712


Construction & Housing
Log Return %
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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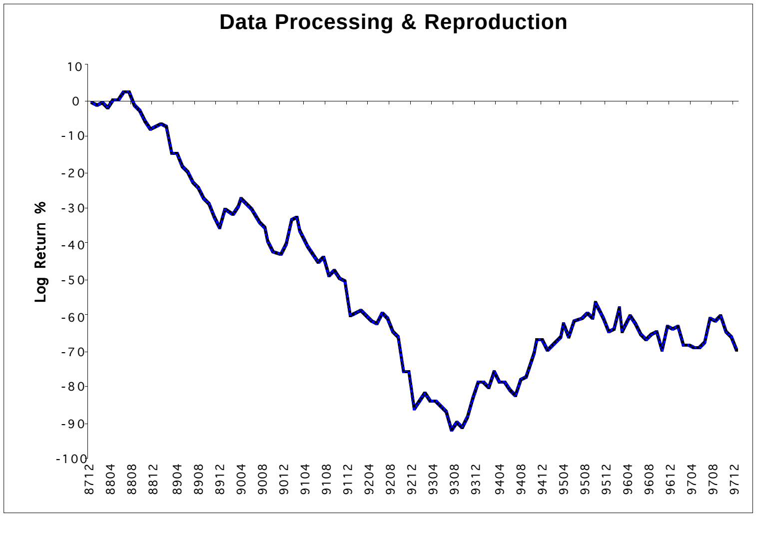
9612
9704
9708
9712


Data Processing & Reproduction
Log Return %
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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9404
9408
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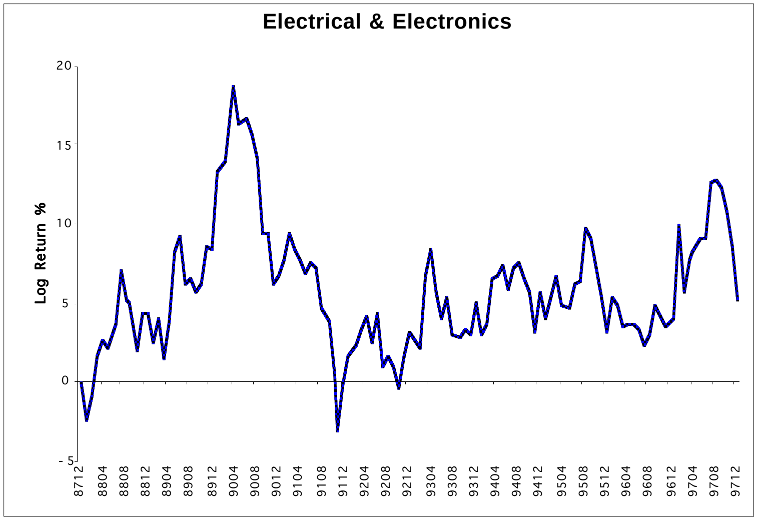
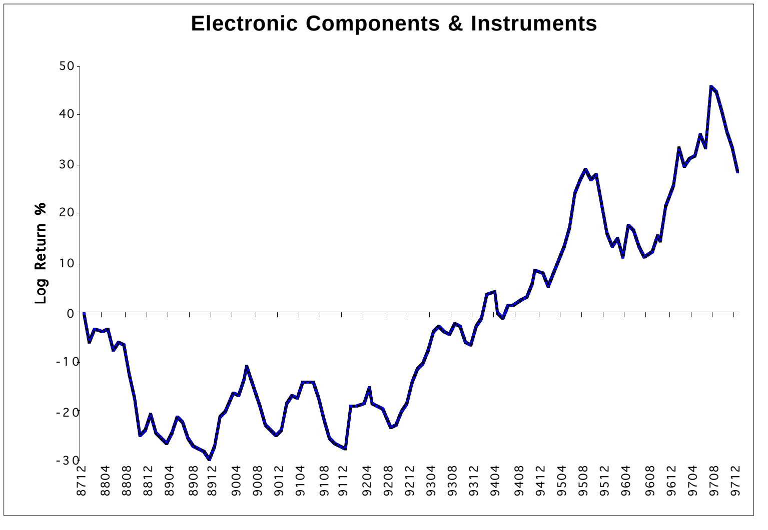
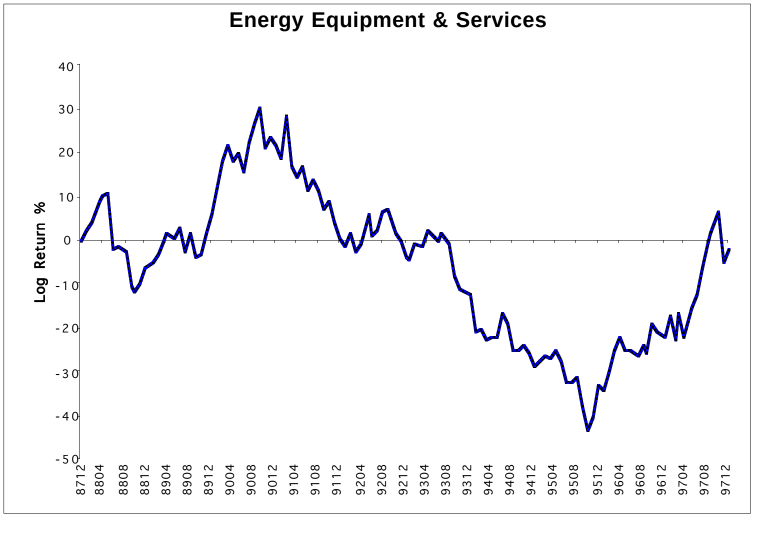
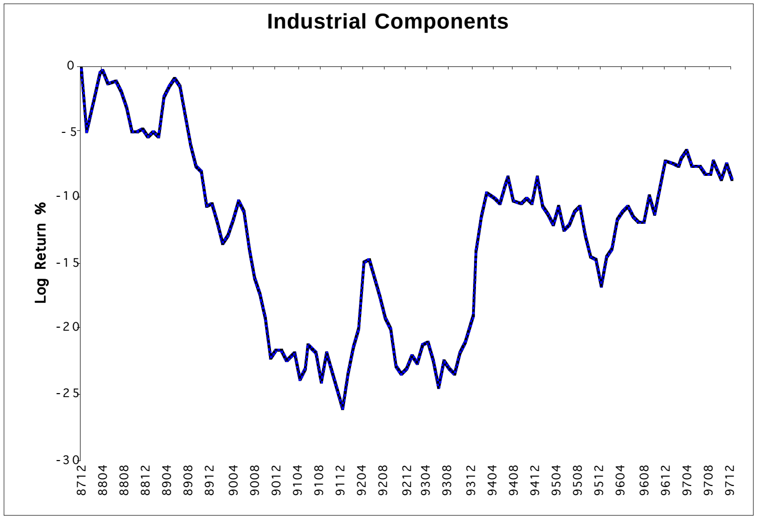
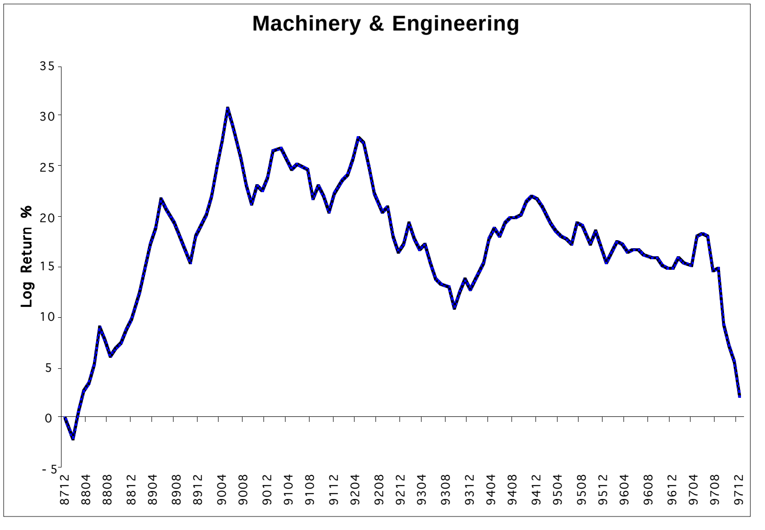
9704
9708
9712


Electrical & Electronics
Log Return %


Electronic Components & Instruments
Log Return %


Energy Equipment & Services
Log Return %


Industrial Components
Log Return %
0
-5
-10
-15
-20
-25
-30
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Machinery & Engineering
Log Return %
35
30
25
20
15
10
5
0
-5
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
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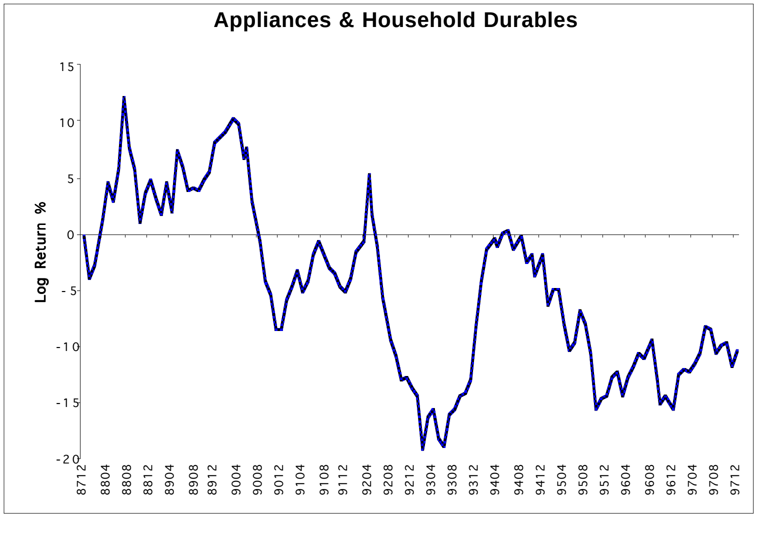
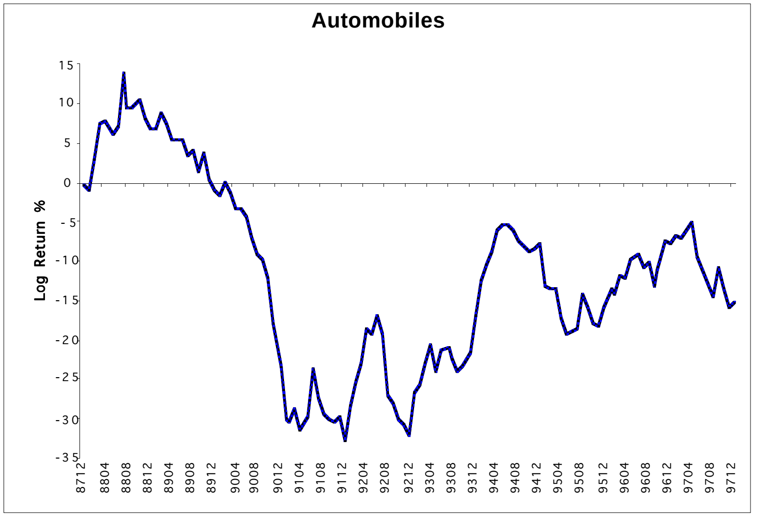
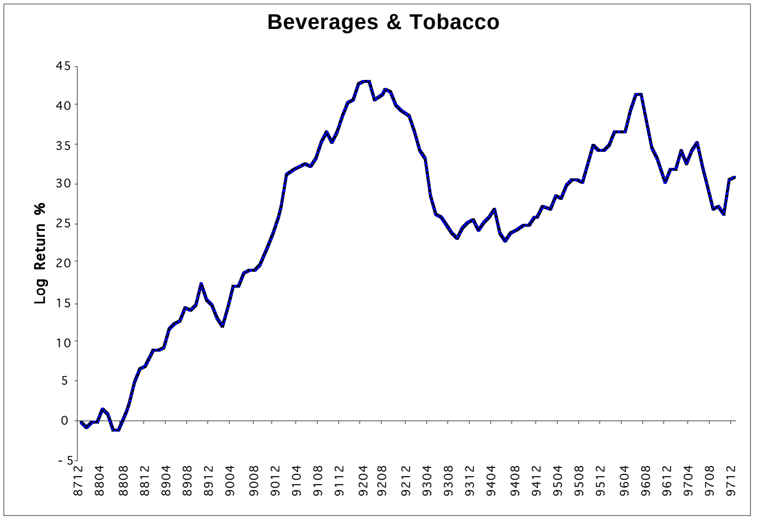
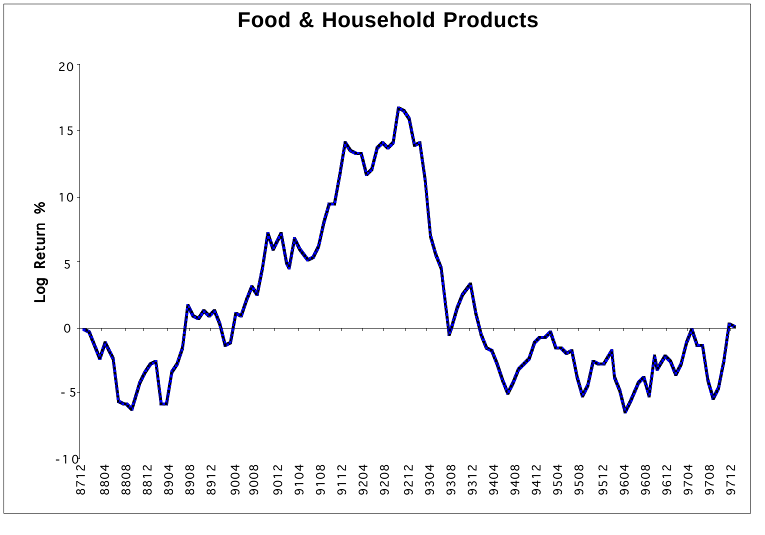
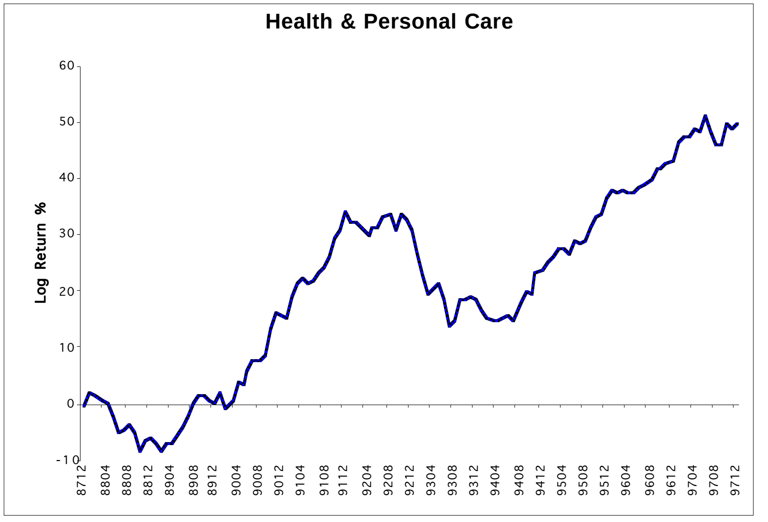
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

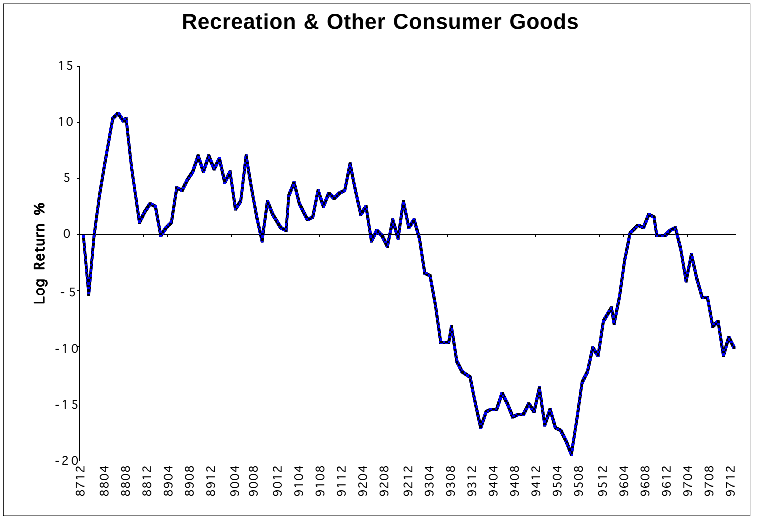

Appliances & Household Durables
Log Return %
15
10
5
0
-5
-10
-15
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

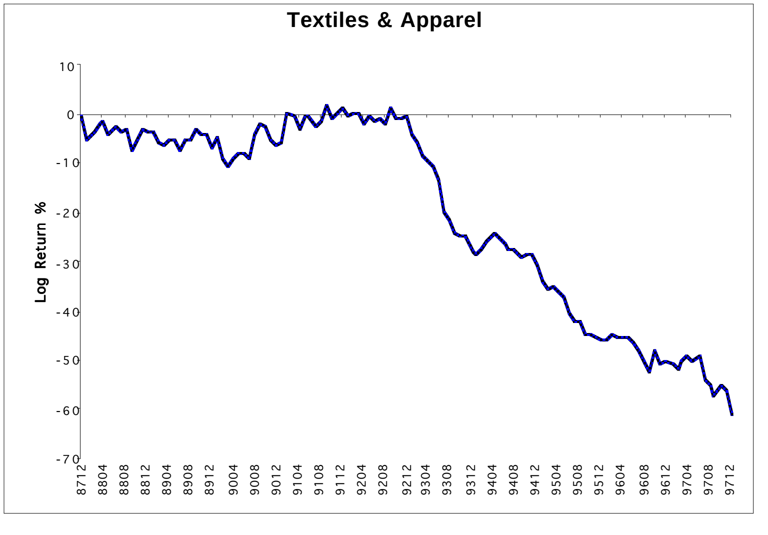

Automobiles
Log Return %
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

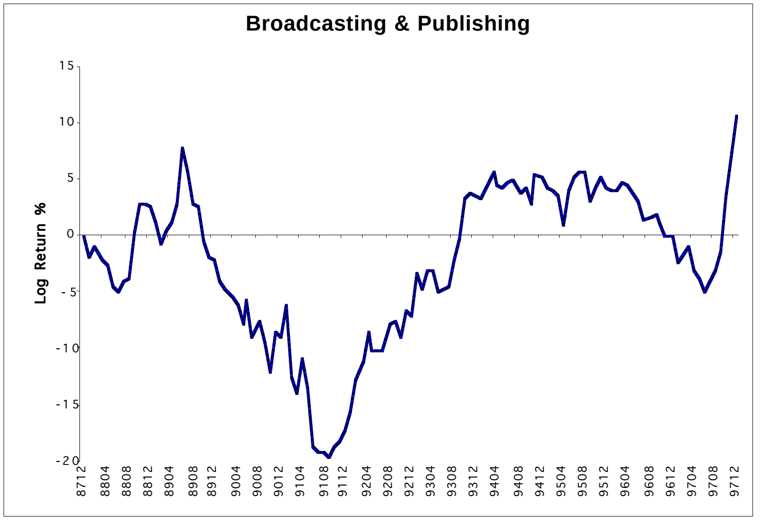

Beverages & Tobacco
Log Return %
45
40
35
30
25
20
15
10
5
0
-5
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

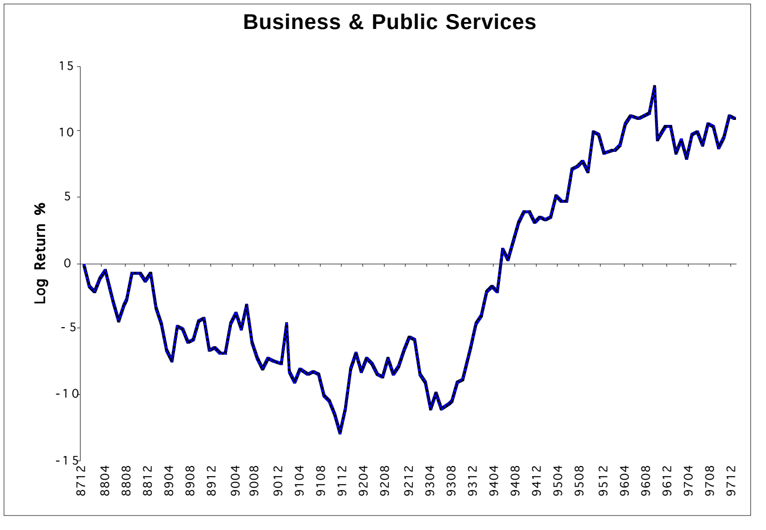

Food & Household Products
Log Return %
20
15
10
5
0
-5
-10
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

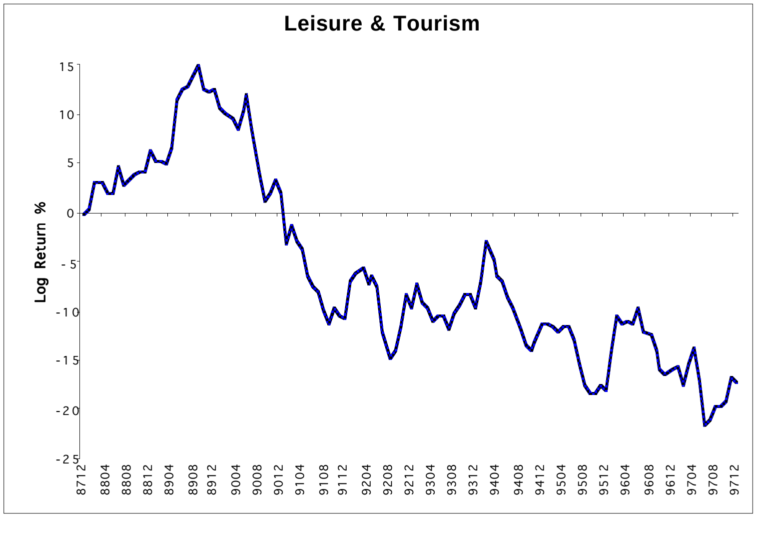

Health & Personal Care
Log Return %
60
50
40
30
20
10
0
-10
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

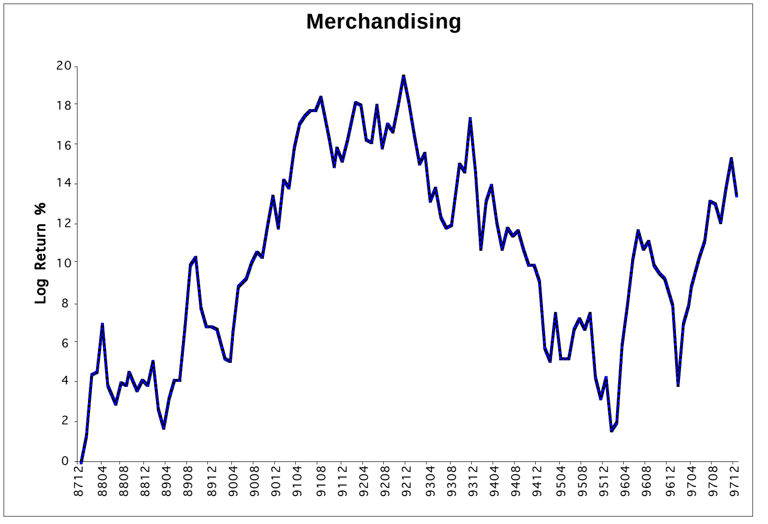

Recreation & Other Consumer Goods
Log Return %
15
10
5
0
-5
-10
-15
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Textiles & Apparel
Log Return %
10
0
-10
-20
-30
-40
-50
-60
-70
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

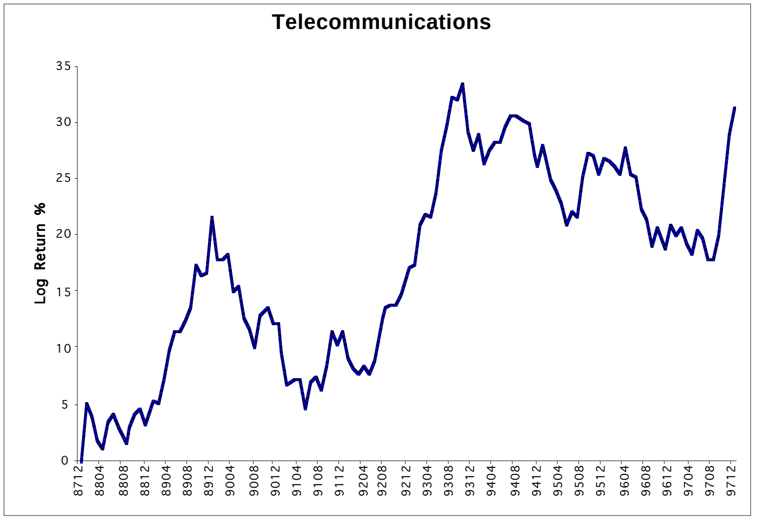

Broadcasting & Publishing
Log Return %
15
10
5
0
-5
-10
-15
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Business & Public Services
Log Return %
15
10
5
0
-5
-10
-15
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

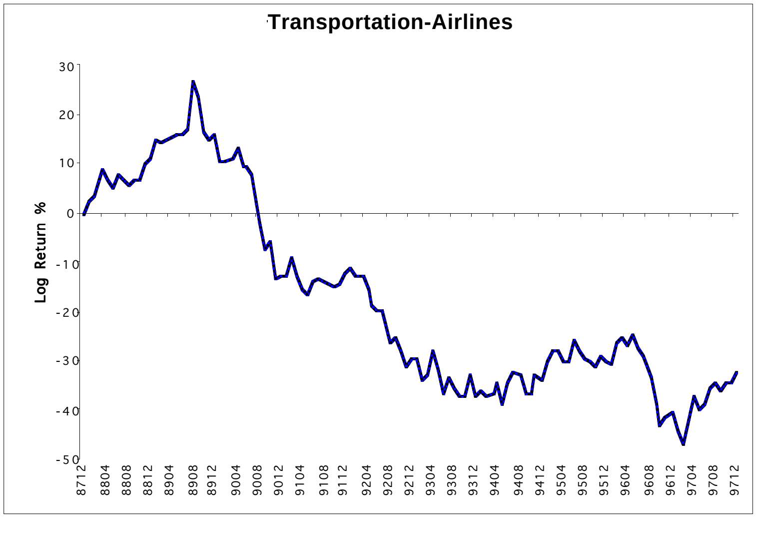

Leisure & Tourism
Log Return %
15
10
5
0
-5
-10
-15
-20
-25
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712



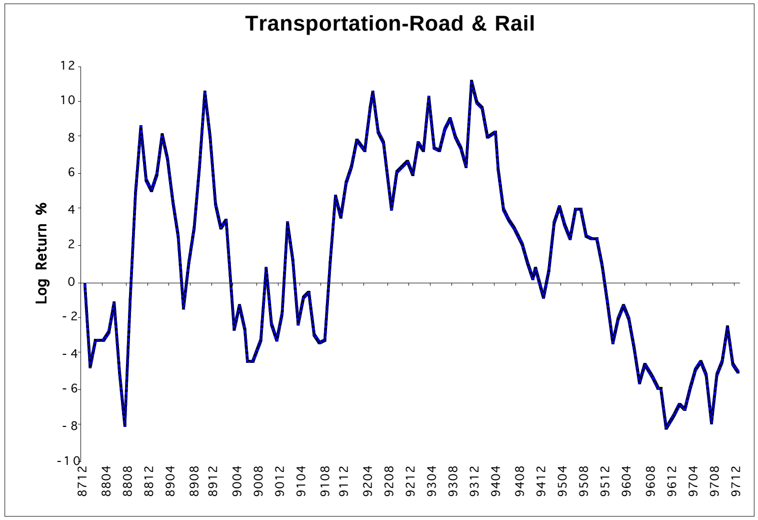
Merchandising
Log Return %
20
18
16
14
12
10
8
6
4
2
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

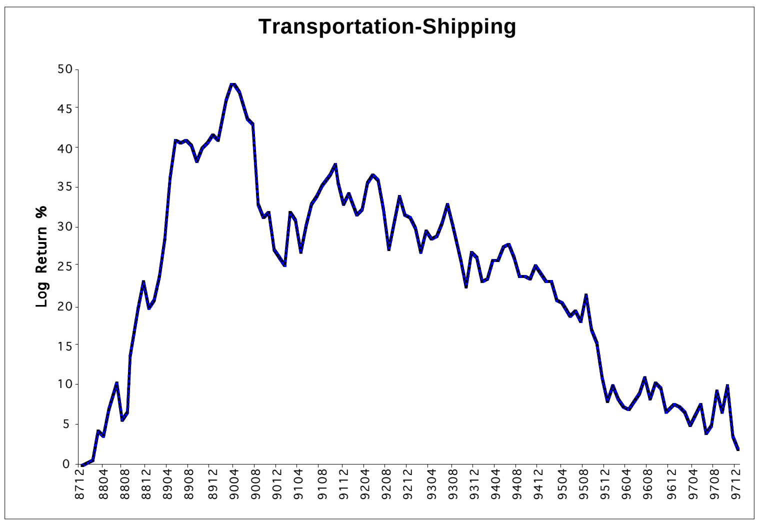


Telecommunications
Log Return %
35
30
25
20
15
10
5
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

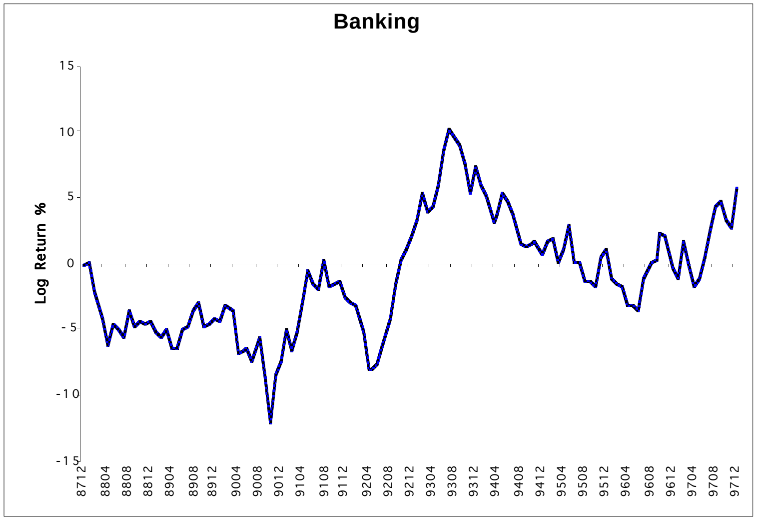


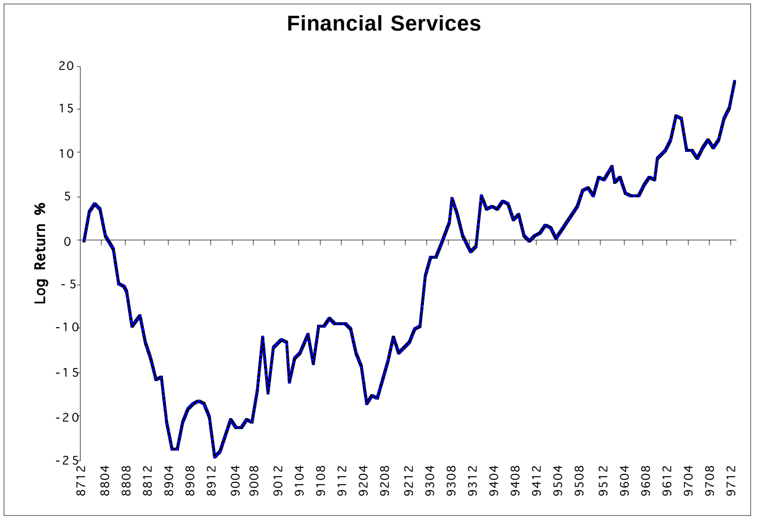
Transportation-Airlines
Log Return %
30
20
10
0
-10
-20
-30
-40
-50
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

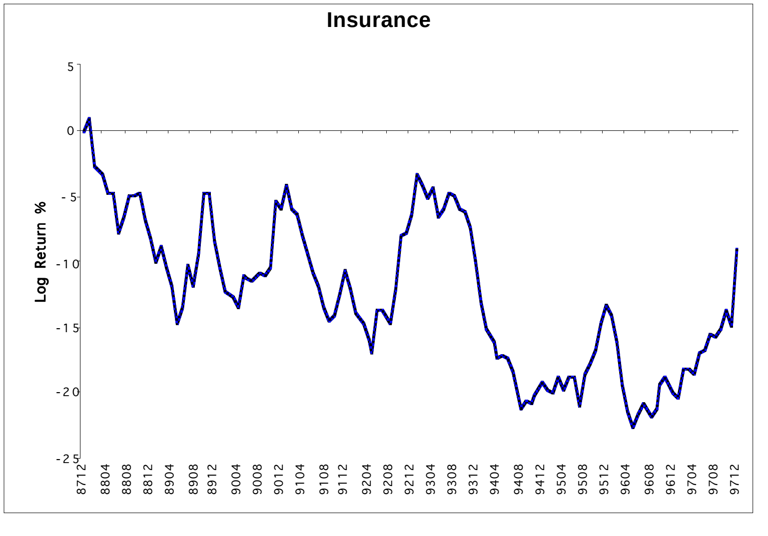

Transportation-Road & Rail
Log Return %
12 10 8 6 4 2 0 -2 -4 -6 -8 -10
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

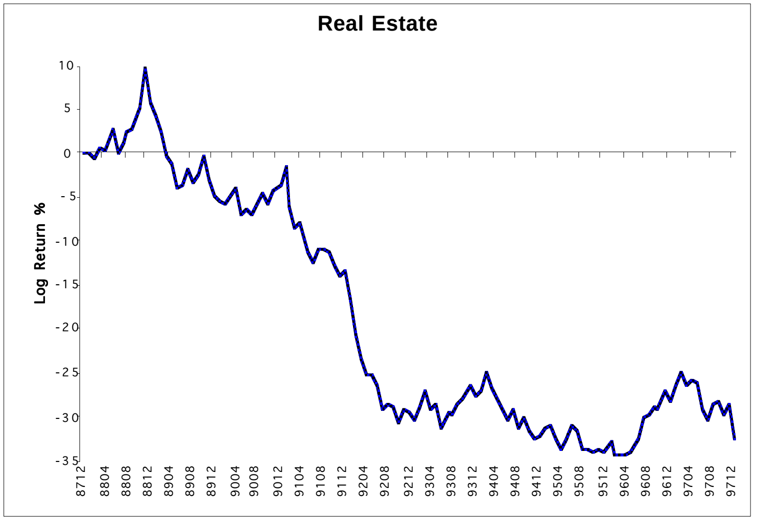

Transportation-Shipping
Log Return %
50 45 40 35 30 25 20 15 10 5 0
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

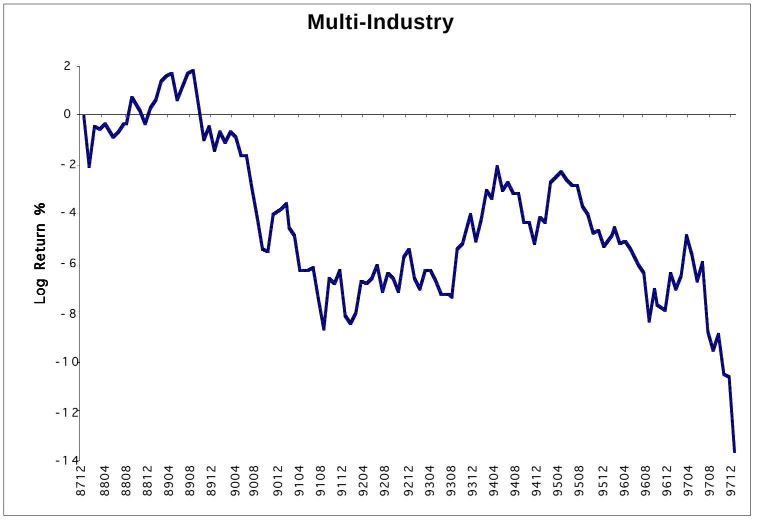

Wholesale & International Trade
Log Return %
40 35 30 25 20 15 10 5 0 -5 -10
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

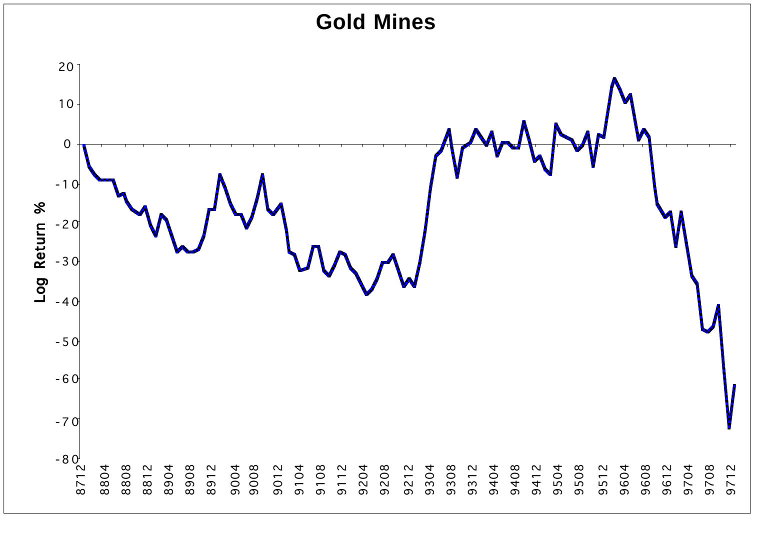

Banking
Log Return %
15
10
5
0
-5
-10
-15
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Financial Services
Log Return %
20
15
10
5
0
-5
-10
-15
-20
-25
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Insurance
Log Return %
5
0
-5
-10
-15
-20
-25
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

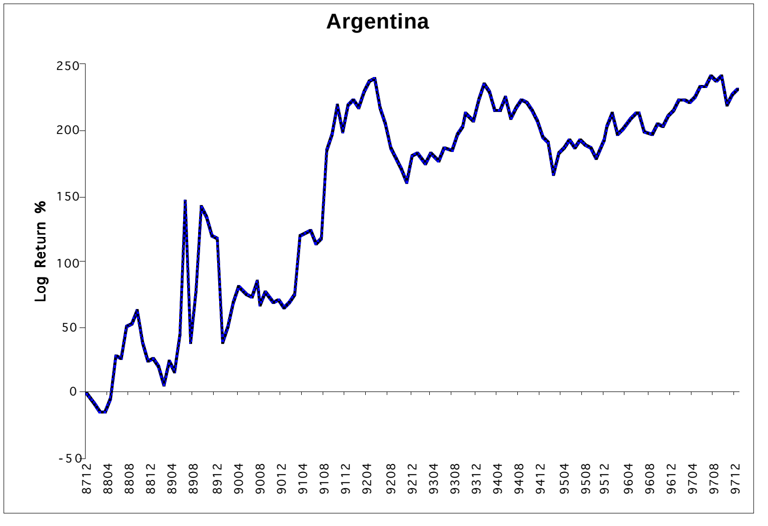

Real Estate
Log Return %
10
5
0
-5
-10
-15
-20
-25
-30
-35
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

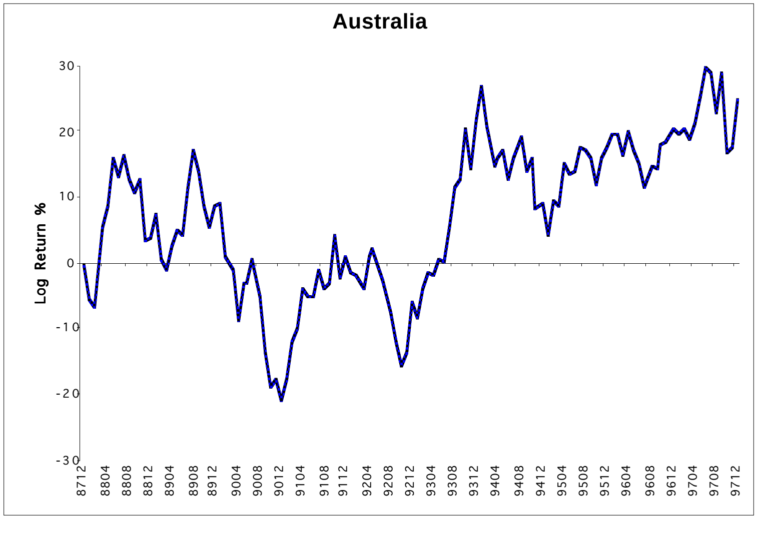

Multi-Industry
Log Return %
2
0
-2
-4
-6
-8
-10
-12
-14
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

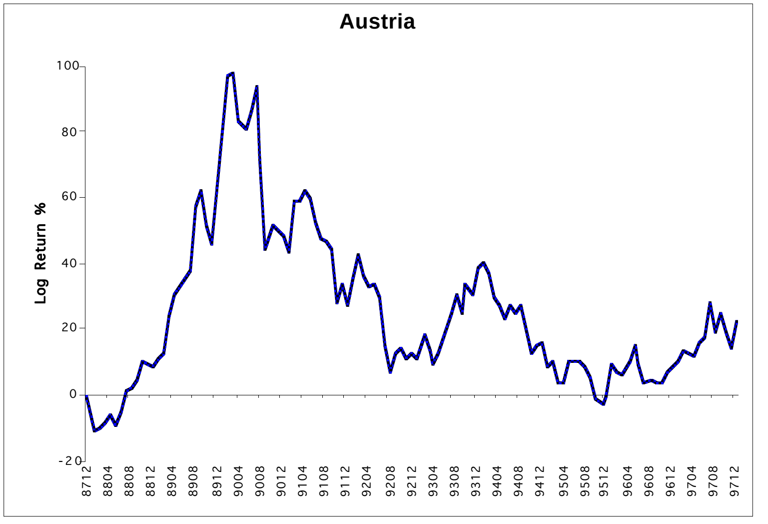

Gold Mines
Log Return %
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

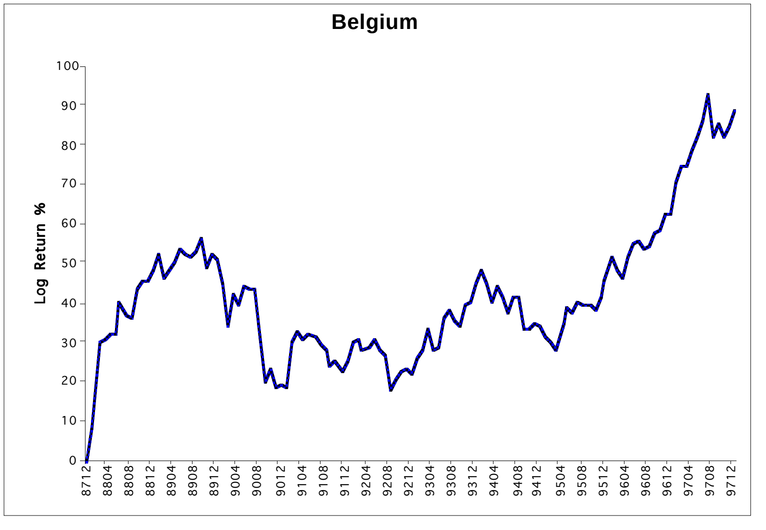
Appendix D:
GEM-MSCI Country Factor Returns

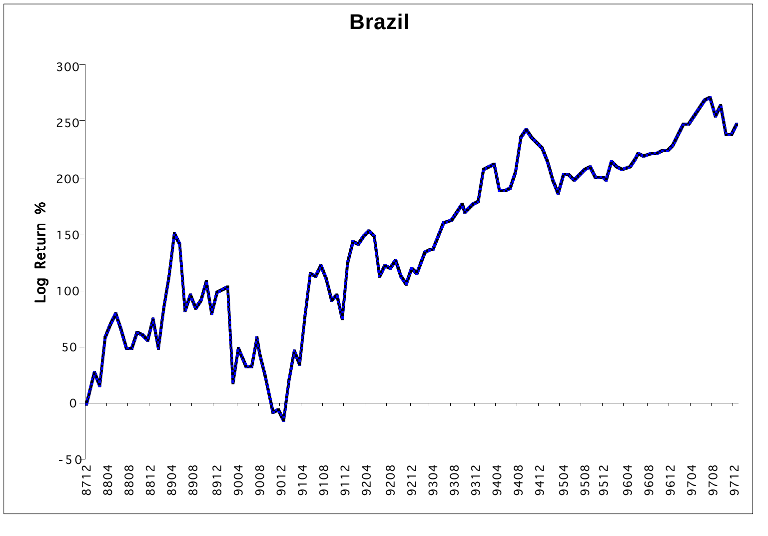
The following pages display factor return charts for GEM-MSCI countries over the period December 1987–December 1997. These represent the cumulative returns to each country factor net of all other common factors.

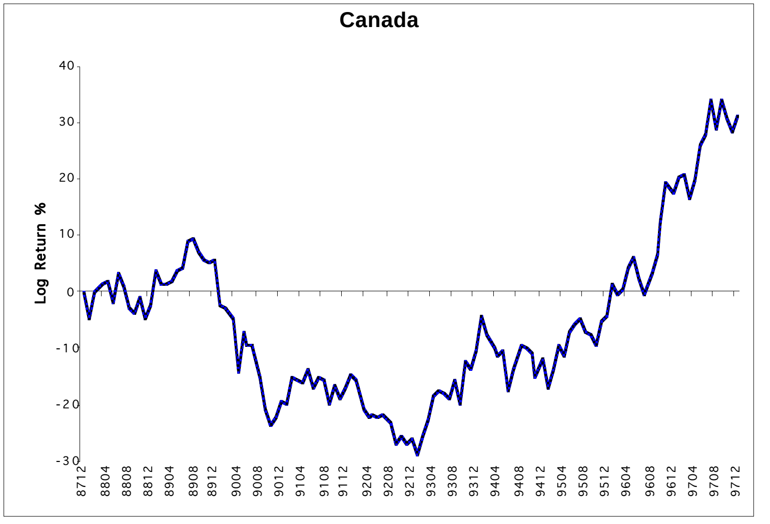


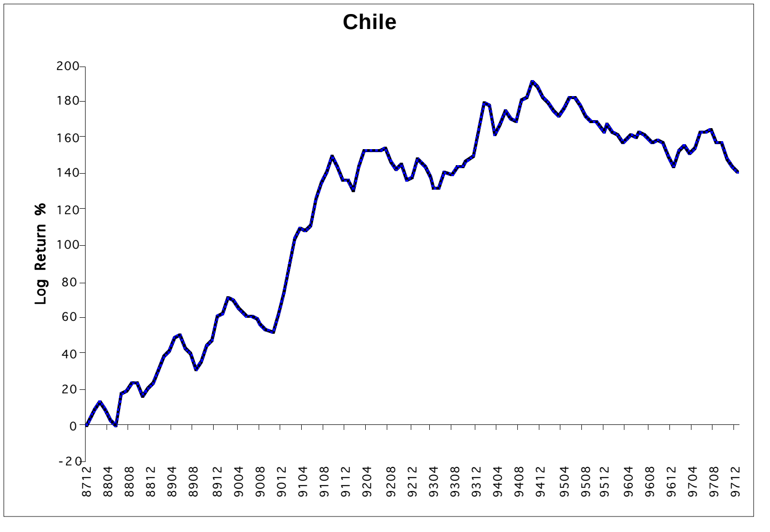



Austria
Log Return %
100
80
60
40
20
0
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Belgium
Log Return %
100
90
80
70
60
50
40
30
20
10
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Brazil
Log Return %
300
250
200
150
100
50
0
-50
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Canada
Log Return %
40
30
20
10
0
-10
-20
-30
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Chile
Log Return %
200
180
160
140
120
100
80
60
40
20
0
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
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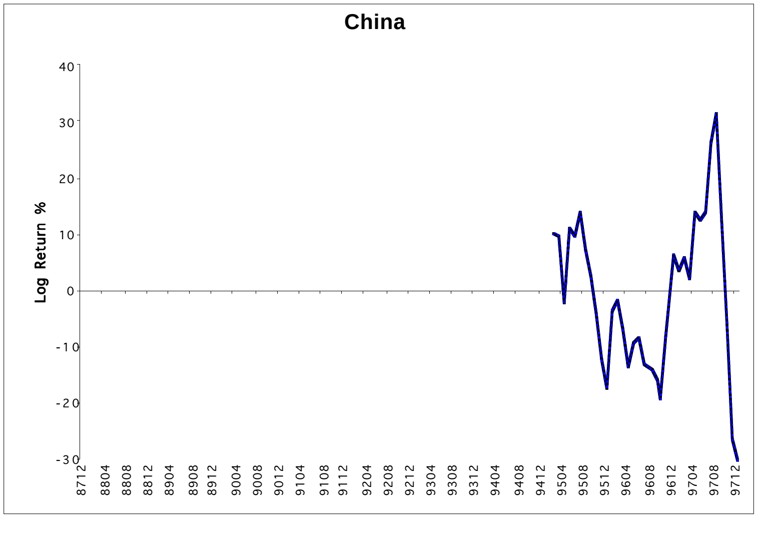
9712


China
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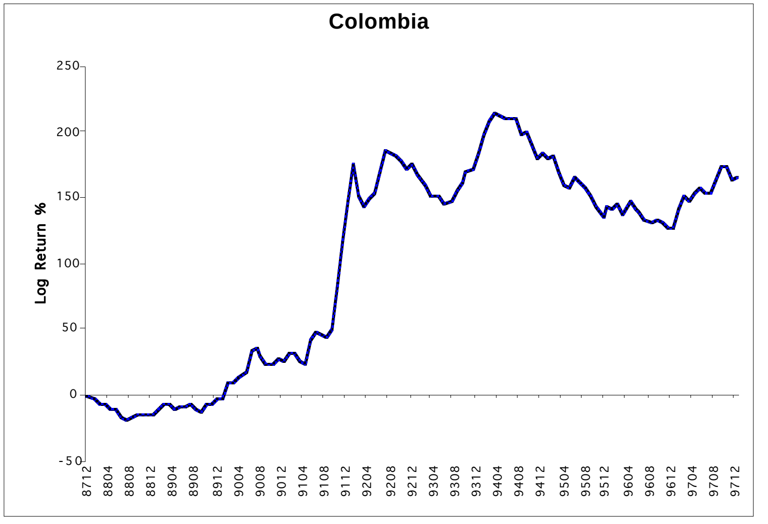
Colombia
Log Return %
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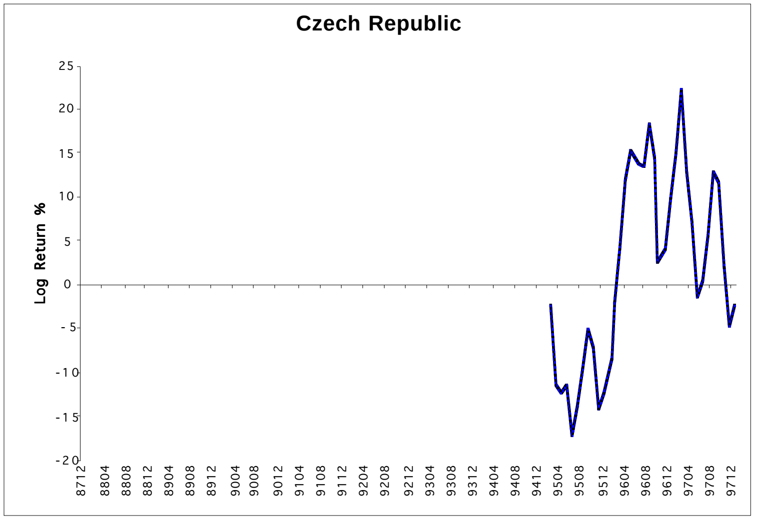
Czech Republic
Log Return %
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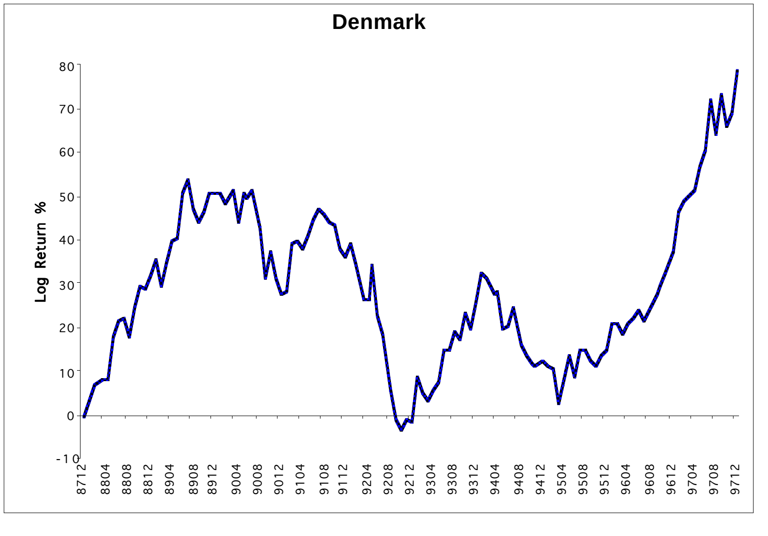
Denmark
Log Return %
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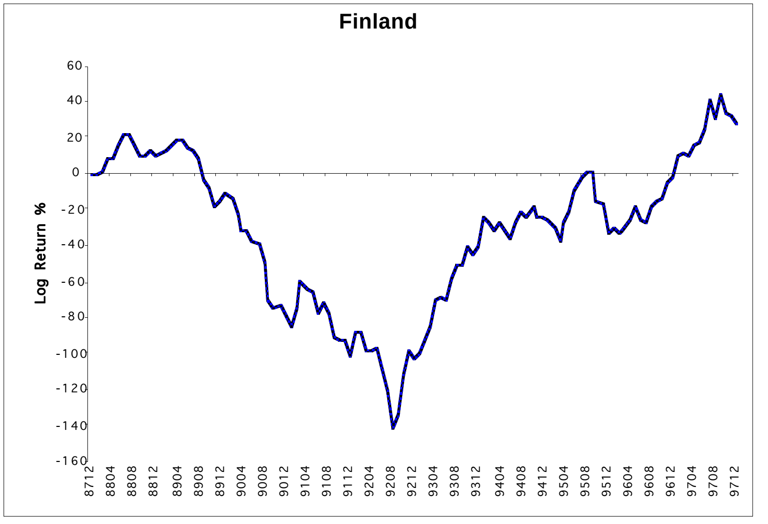
Finland
Log Return %
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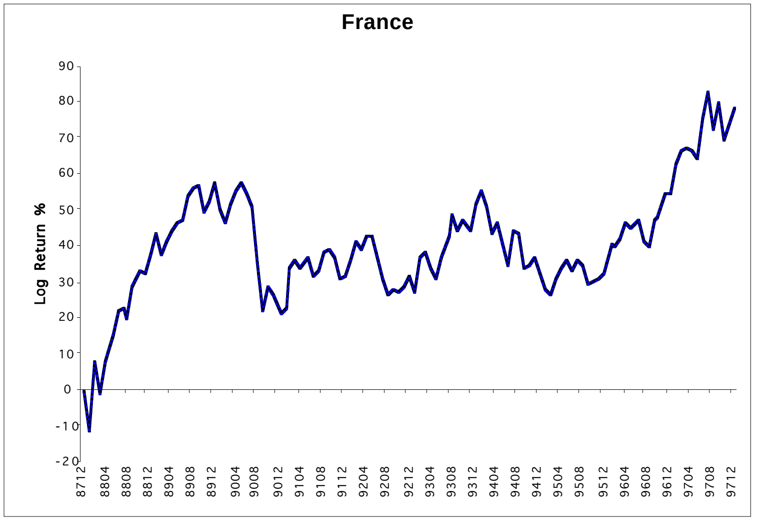
France
Log Return %
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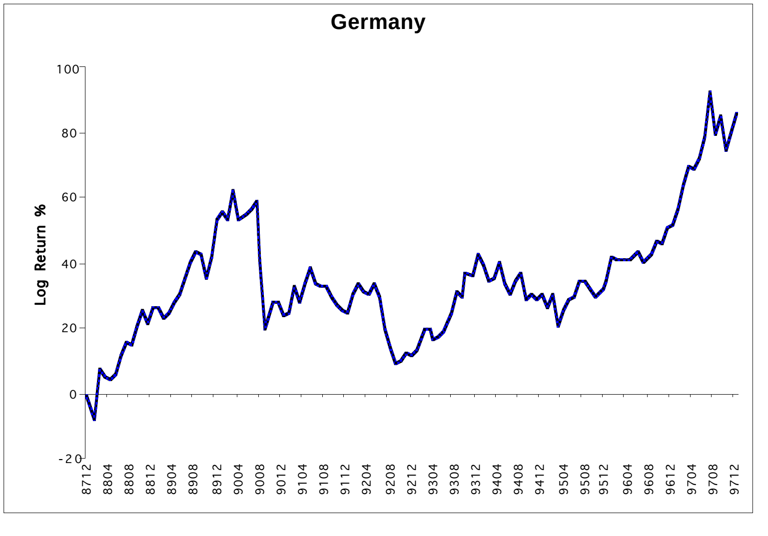
Germany
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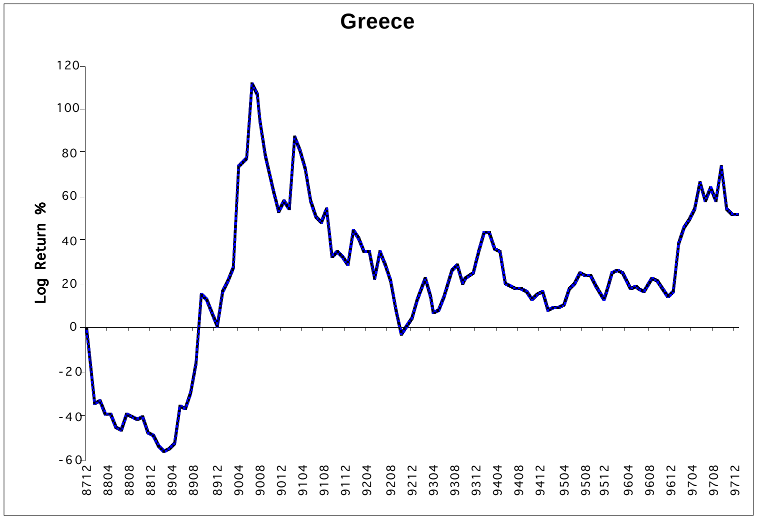
Greece
Log Return %
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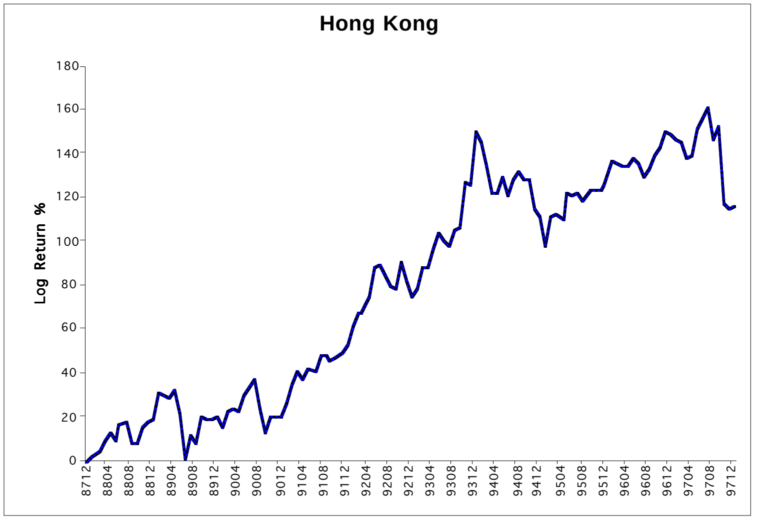
Hong Kong
Log Return %
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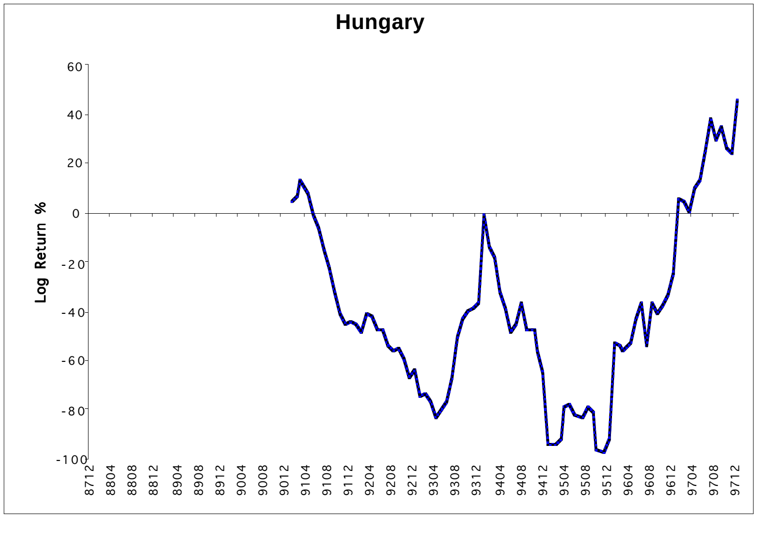
Hungary
Log Return %
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Indonesia
Log Return %
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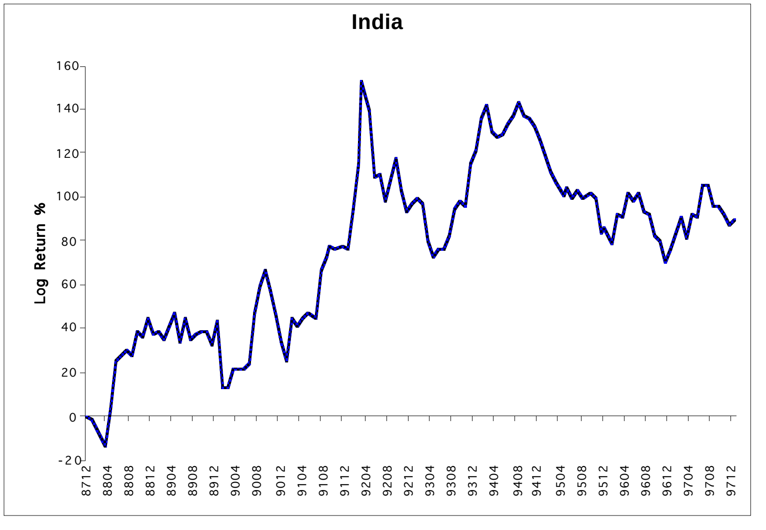
India
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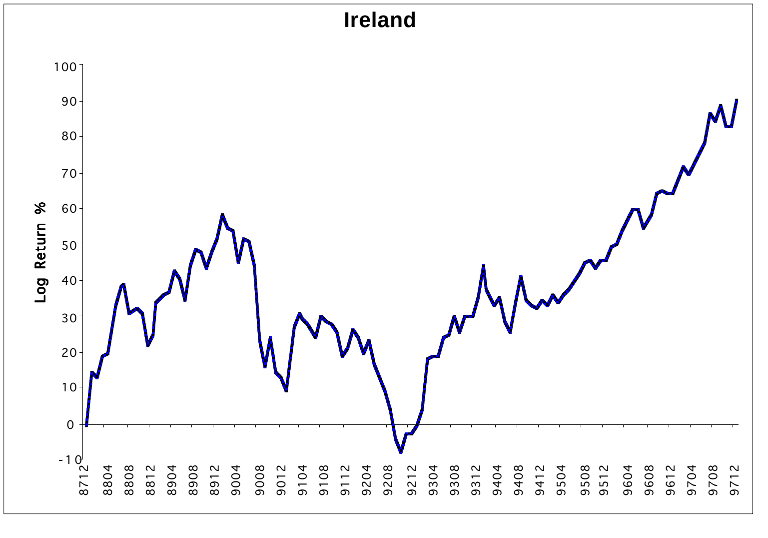
Ireland
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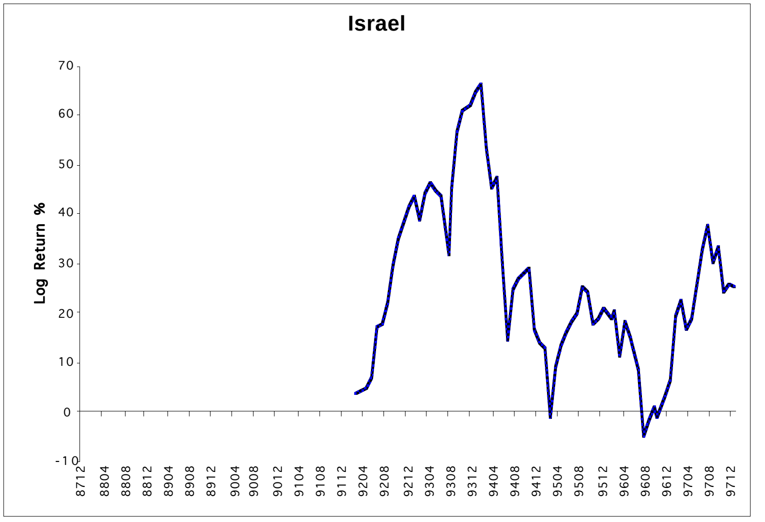
Israel
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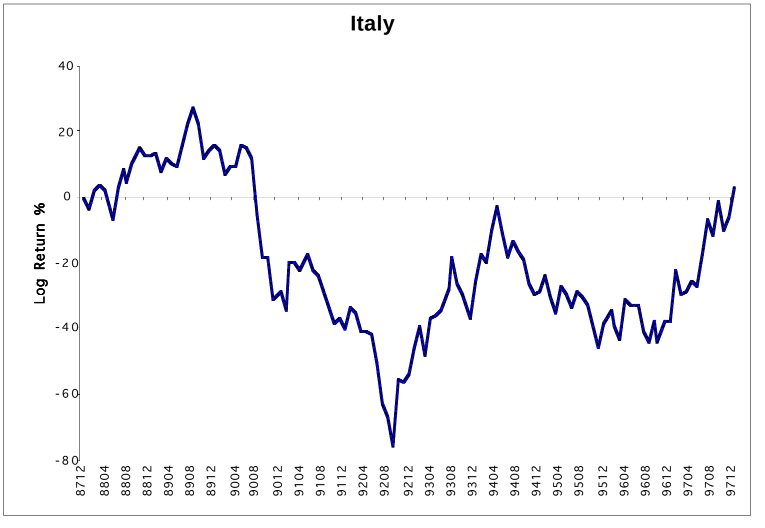
Italy
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Log Return %
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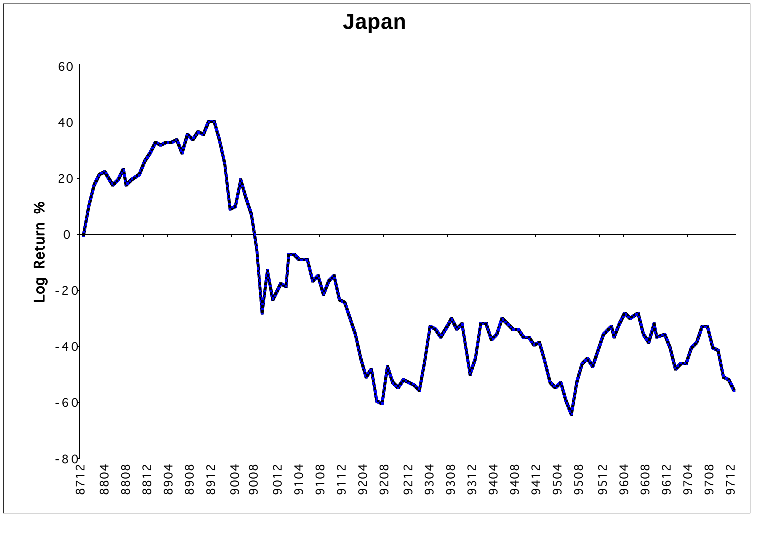
Japan
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Log Return %
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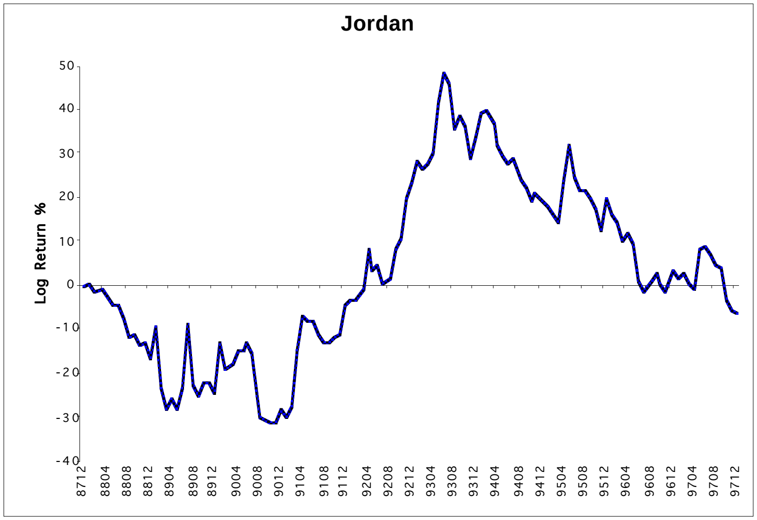
Jordan
Log Return %
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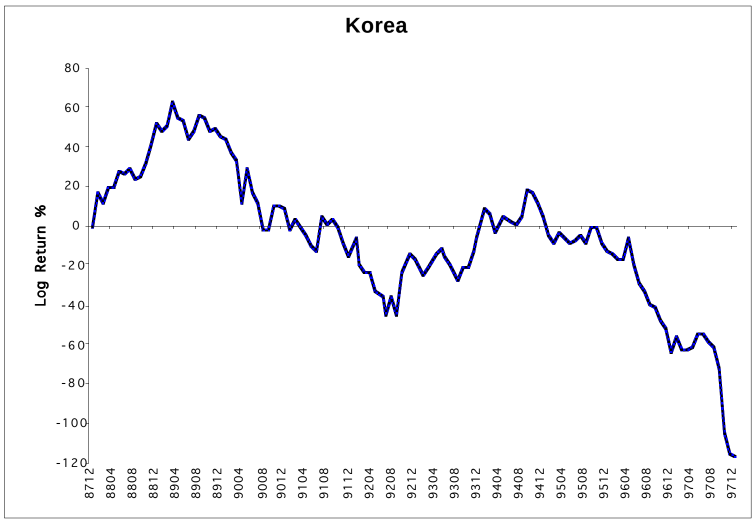
Korea
Log Return %
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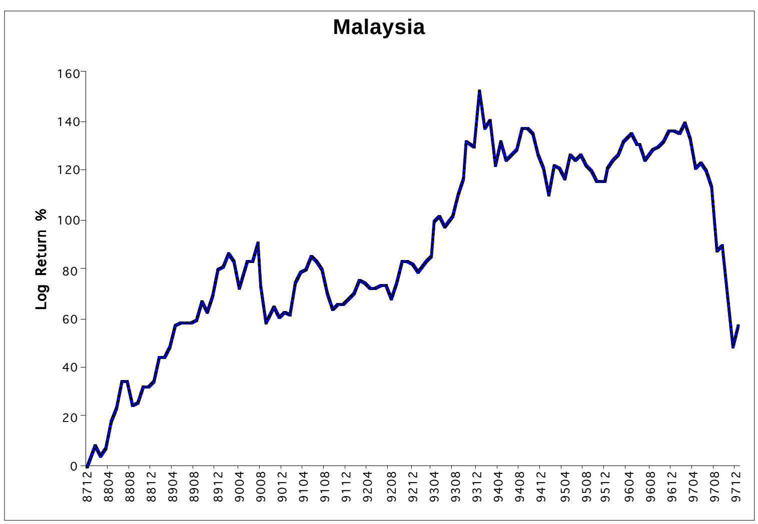
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712


Malaysia
Log Return %
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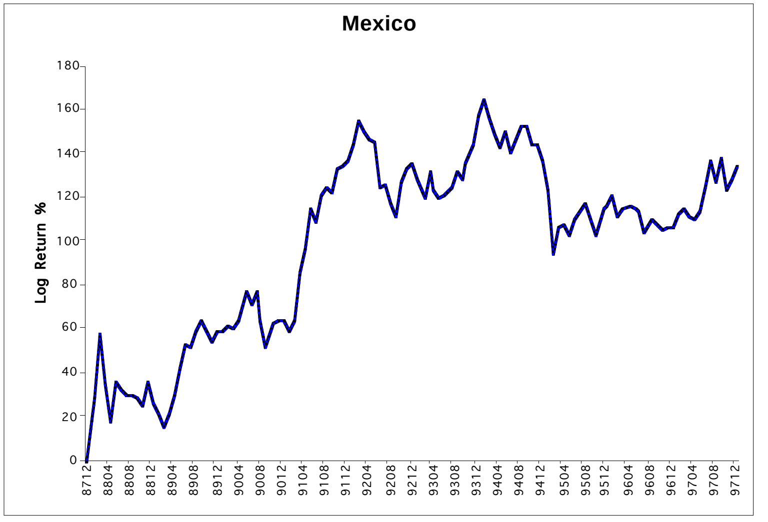
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712


Mexico
Log Return %
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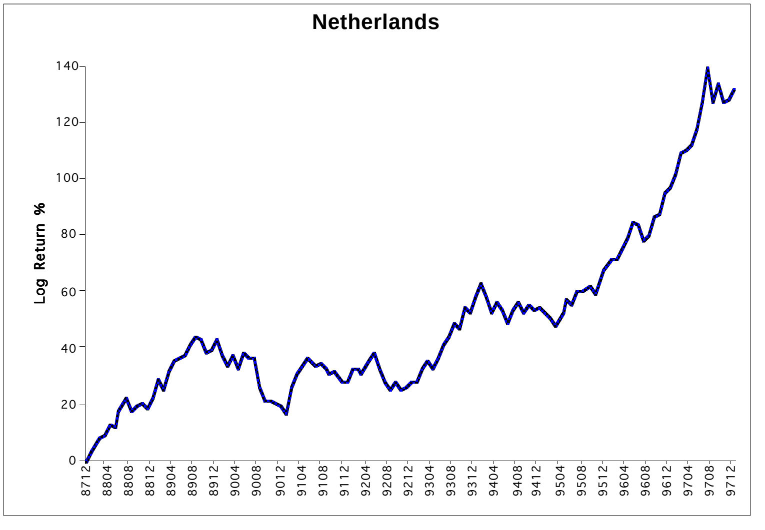
Netherlands
Log Return %
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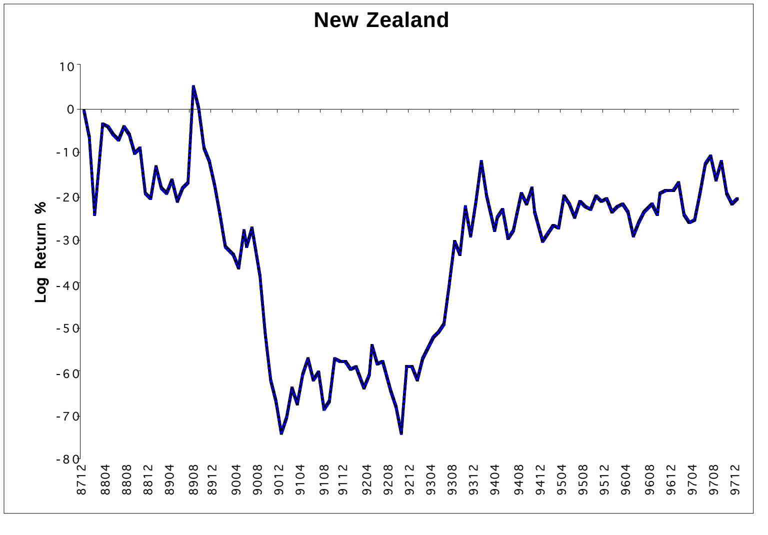
New Zealand
Log Return %
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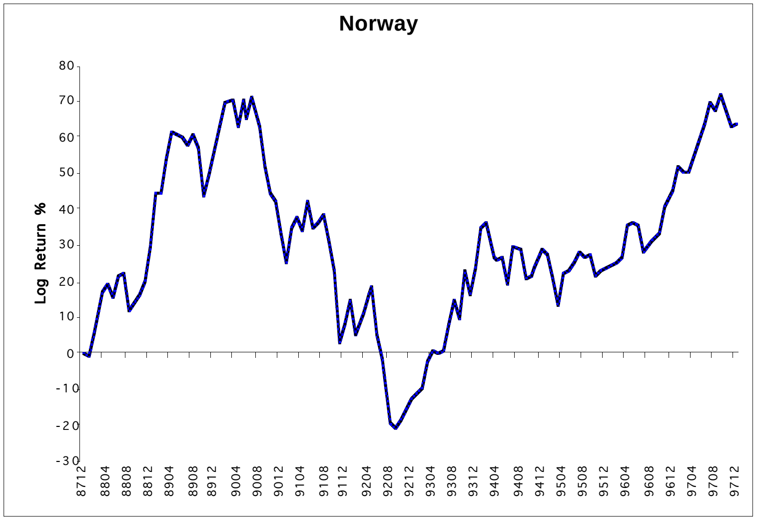
Norway
Log Return %
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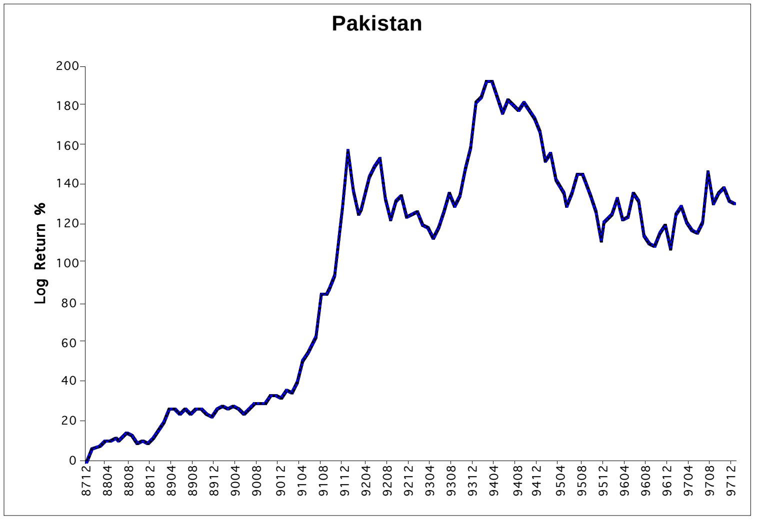
Pakistan
Log Return %
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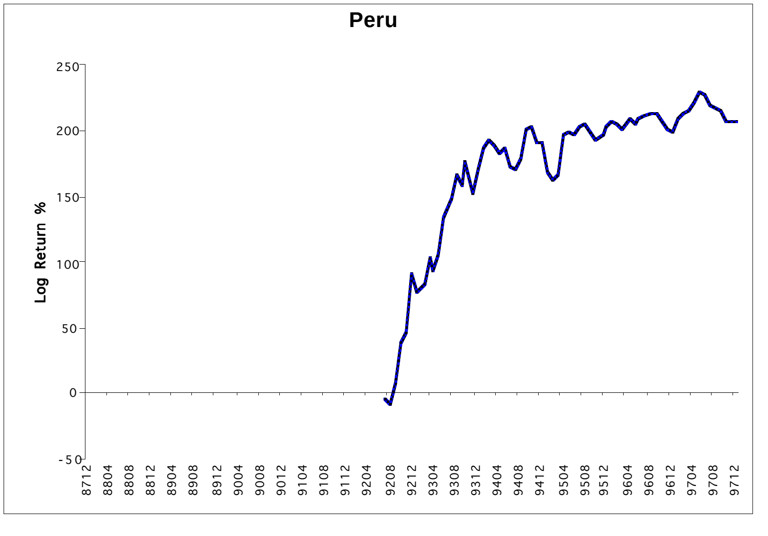
Peru
Log Return %
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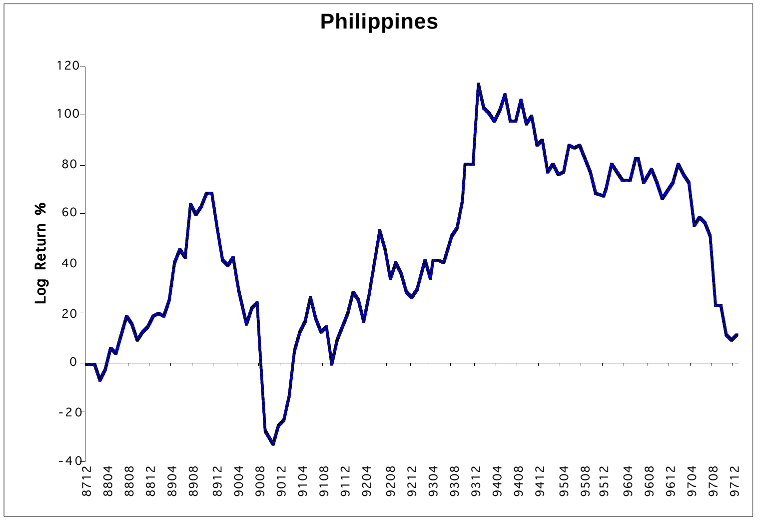
Philippines
Log Return %
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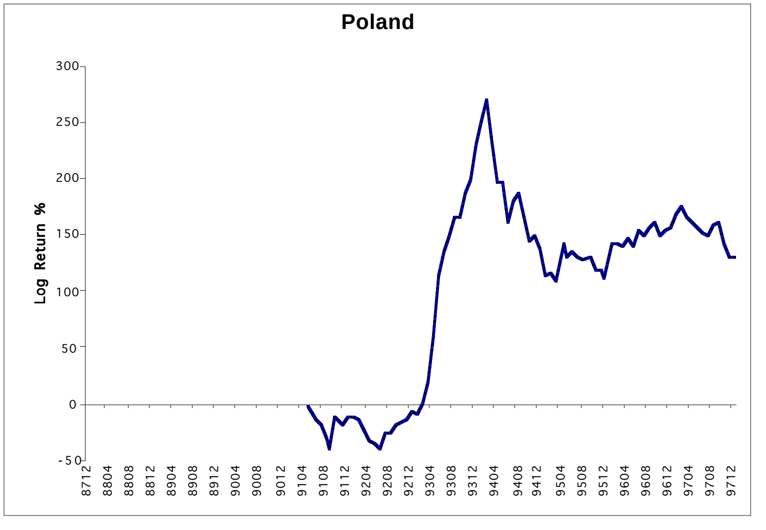
Poland
Log Return %
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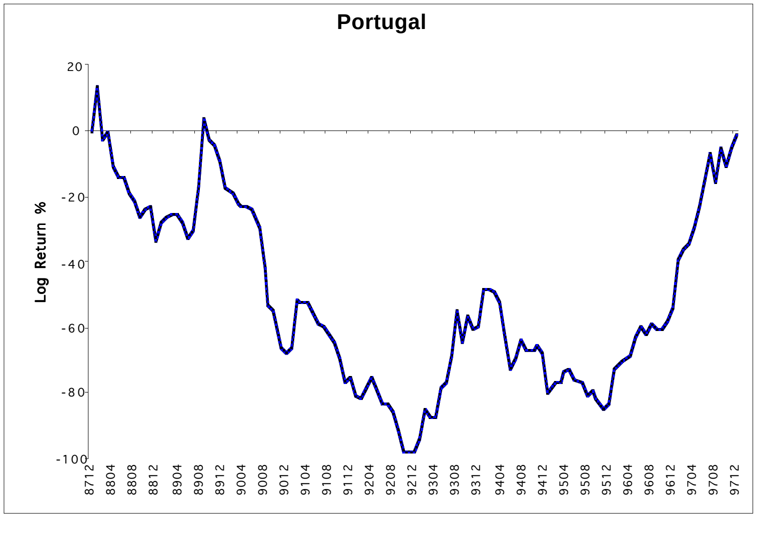
Portugal
Log Return %
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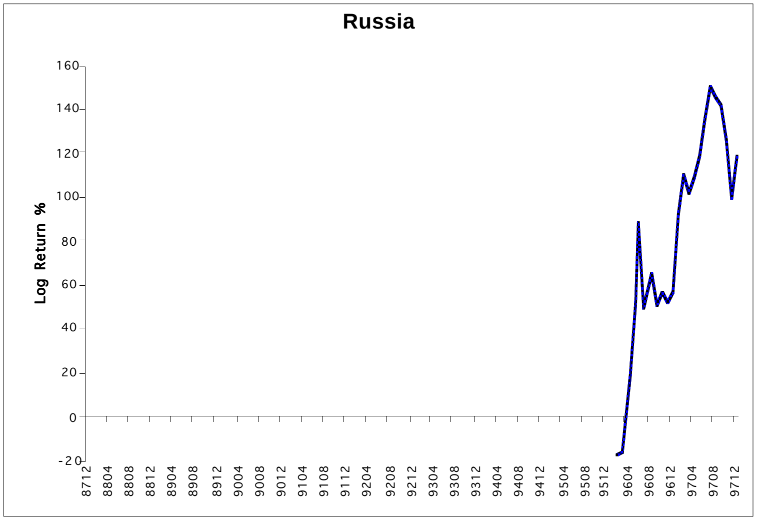
Russia
Log Return %
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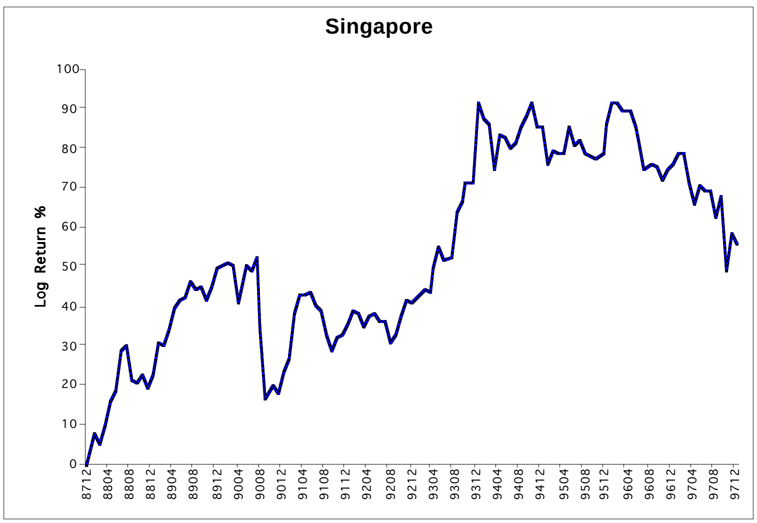
Singapore
Log Return %
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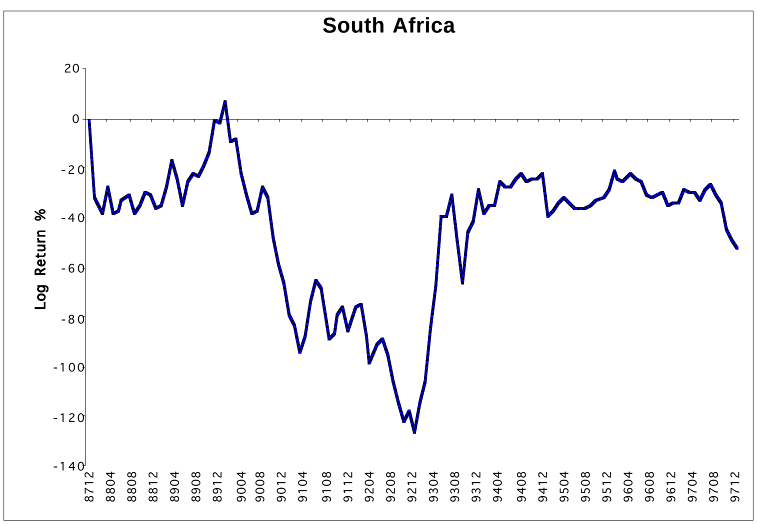
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712


South Africa
Log Return %
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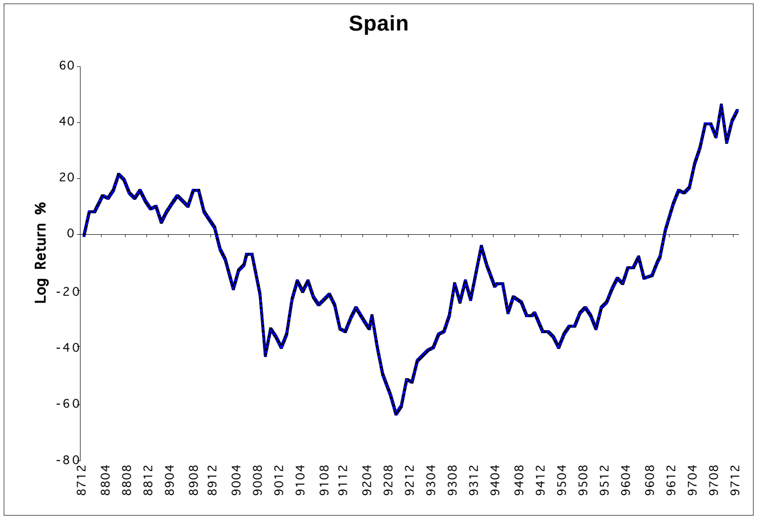
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712


Spain
Log Return %
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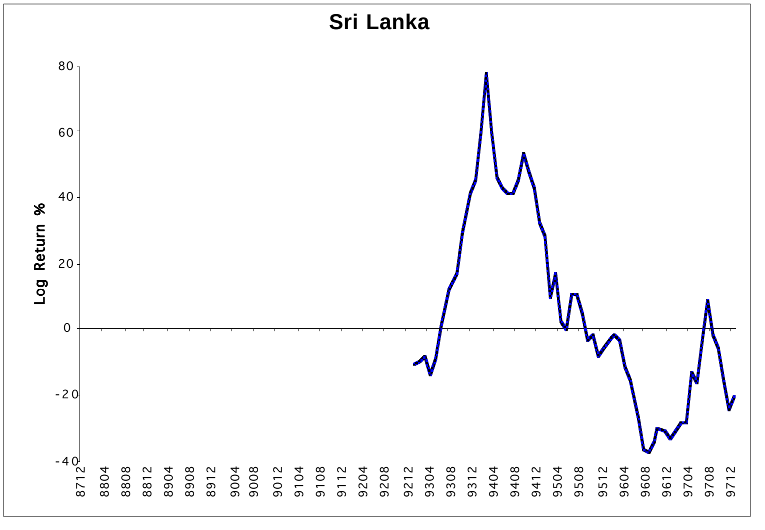
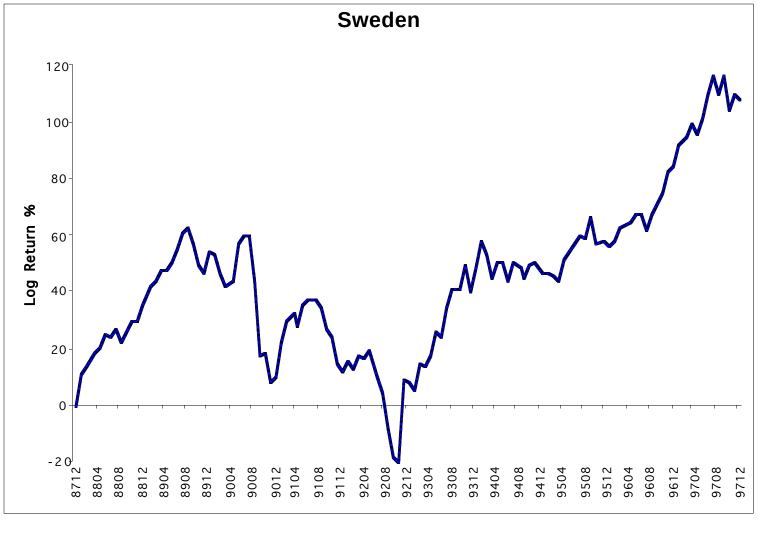
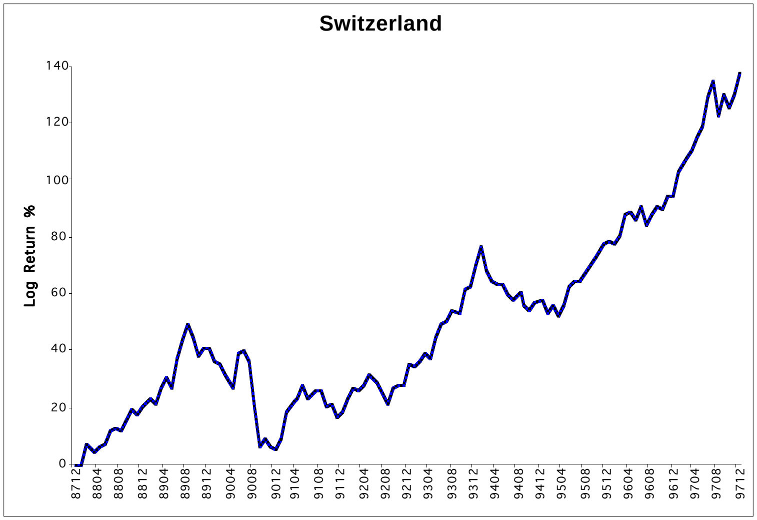
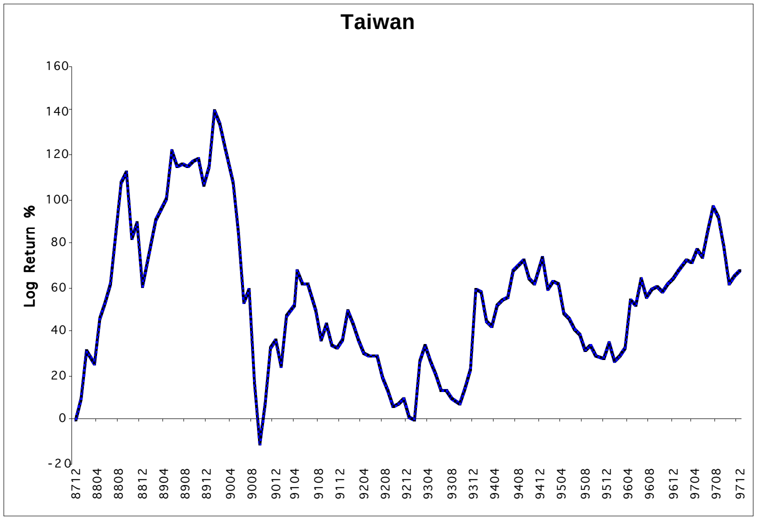
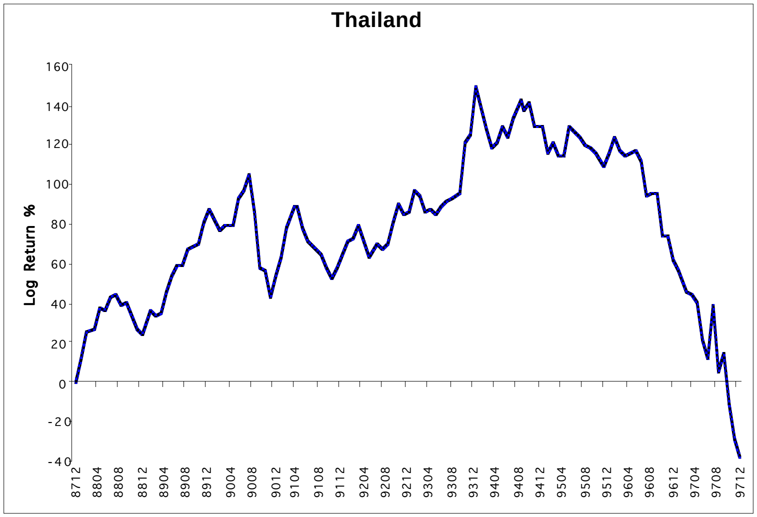
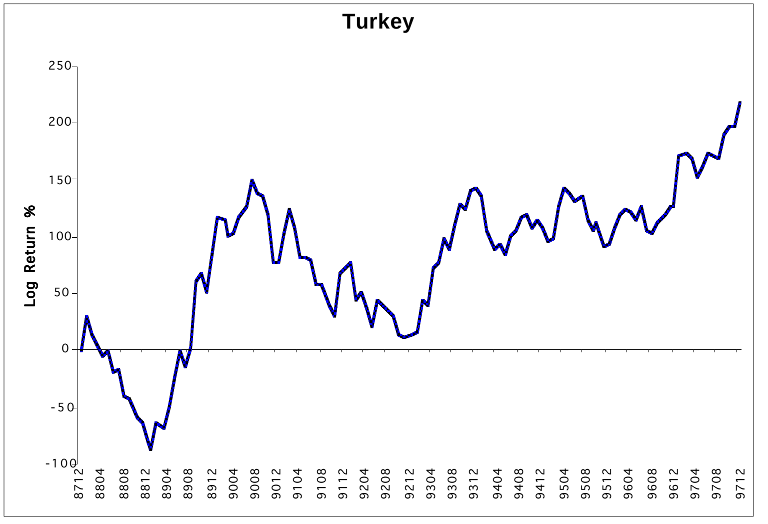

Sri Lanka
Log Return %
80
60
40
20
0
-20
-40
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Sweden
Log Return %
120
100
80
60
40
20
0
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Switzerland
Log Return %
0
20
40
60
80
100
120
140
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712


Taiwan
Log Return %
-20
0
20
40
60
80
100
120
140
160
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712


Thailand
Log Return %
-40
-20
0
20
40
60
80
100
120
140
160
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712



Turkey
Log Return %
250
200
150
100
50
0
-50
-100
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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9504
9508
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9604
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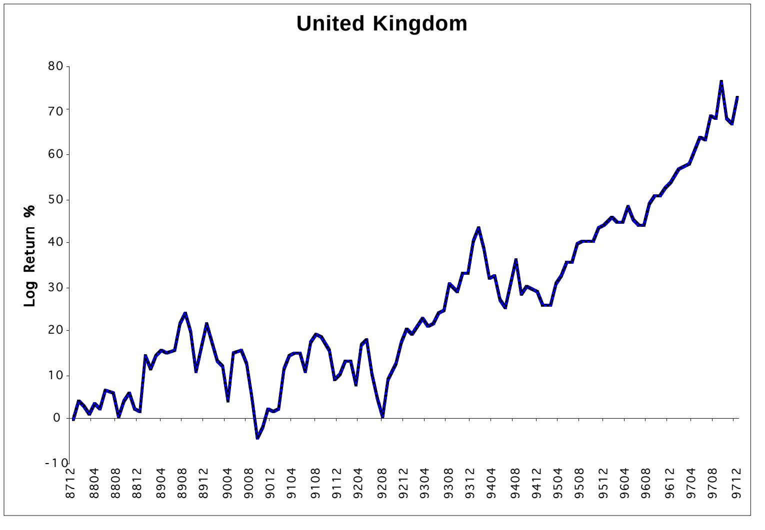
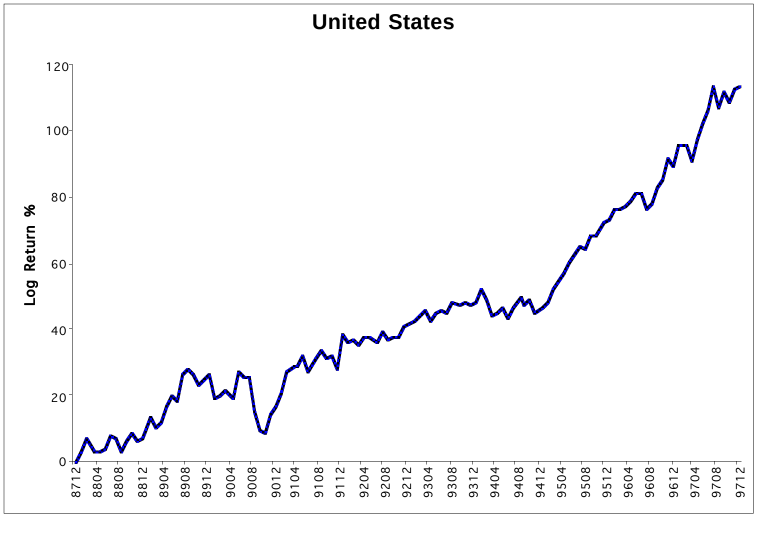
9612
9704
9708
9712



United Kingdom
Log Return %
80
70
60
50
40
30
20
10
0
-10
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712



United States
Log Return %
120
100
80
60
40
20
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
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9508
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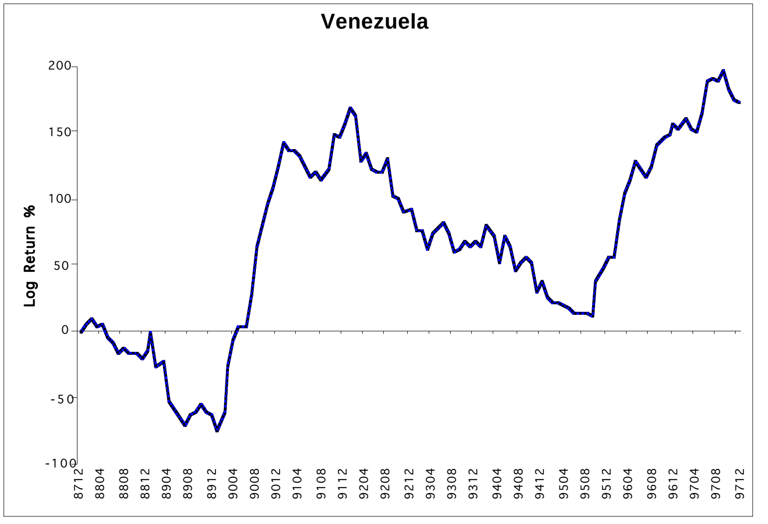
9604
9608
9612
9704
9708
9712


Venezuela
Log Return %
200
150
100
50
0
-50
-100
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
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9612
9704
9708
9712

Appendix E:
GEM-MSCI Specific Risk Summary

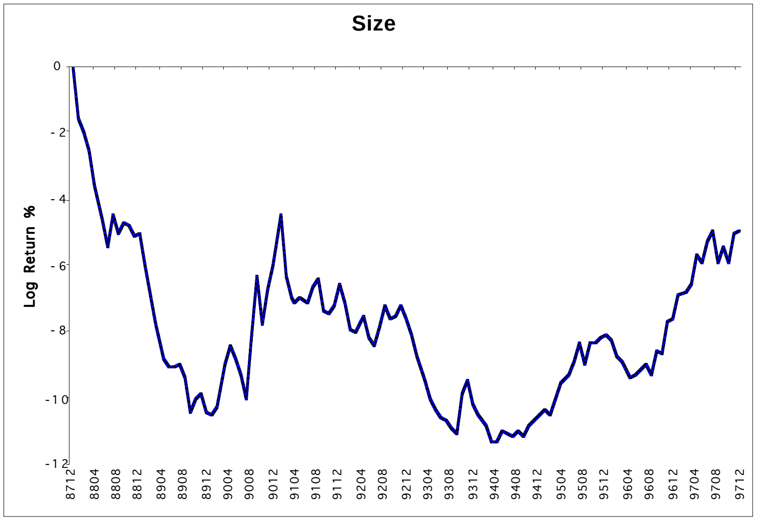
This table summarizes the distribution of annualized specific risk forecasts for each market in the GEM-MSCI model as of December 1997. The specific risk model forecasts the volatility of excess asset returns not explained by common factors.

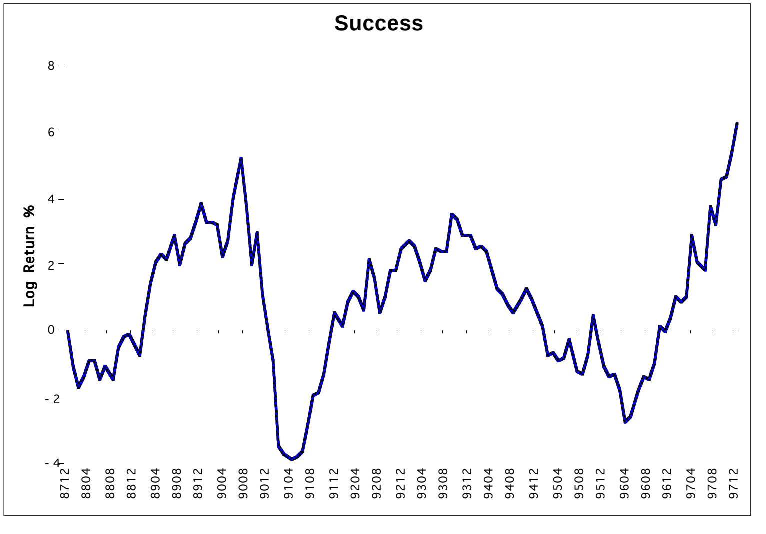
Country	Mean	Median	Minimum	Maximum	Standard Deviation
Turkey	53.29	52.29	39.75	70.00	8.46
Brazil	41.96	39.60	21.73	70.00	11.07
China	39.90	39.96	24.85	64.72	8.52
Indonesia	39.59	39.19	18.55	70.00	9.62
Philippines	38.08	38.68	17.53	70.00	13.43
Thailand	37.80	38.02	13.07	59.13	10.04
Korea	37.49	35.67	22.35	70.00	8.93
Poland	37.37	37.07	27.60	56.52	6.76
Russia	36.31	36.72	29.29	40.00	3.42
Venezuela	36.09	36.19	26.85	46.39	5.57
Peru	34.69	31.65	18.73	55.81	10.34
Pakistan	33.93	30.88	20.51	51.97	8.83
Malaysia	33.26	32.75	17.79	56.22	8.94
Hungary	32.41	32.07	16.82	46.45	9.45
Greece	32.25	30.13	10.61	70.00	14.62
Mexico	31.81	29.82	16.22	62.31	10.23
Israel	31.44	28.29	14.23	63.30	11.45
South Africa	31.31	30.41	18.76	49.98	7.61
Argentina	31.06	27.68	13.35	64.25	11.91
India	30.90	29.07	17.55	51.87	8.67
Czech Republic	29.34	26.25	14.76	70.00	13.05
Taiwan	27.64	27.23	13.68	46.72	7.74
Chile	27.12	25.35	16.58	44.48	7.22

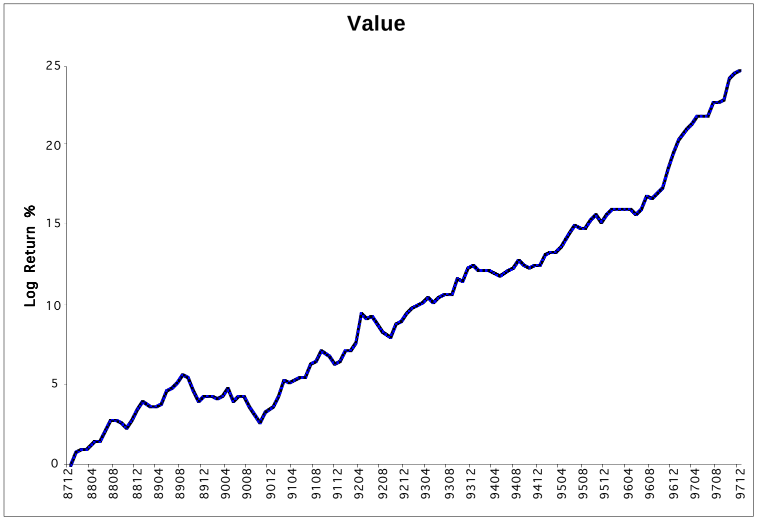
Country	Mean	Median	Minimum	Maximum	Standard Deviation
Sri Lanka	26.85	25.23	20.06	40.94	6.63
Norway	25.75	23.32	11.25	70.00	11.10
Finland	25.58	24.19	21.69	32.83	3.58
Singapore	25.42	22.07	11.66	70.00	11.86
Canada	23.78	21.93	10.64	51.40	9.60
Hong Kong	23.69	22.85	11.83	47.09	7.97
Sweden	23.67	21.84	16.22	50.56	7.43
Italy	23.60	23.14	11.70	39.42	6.42
Austria	22.82	21.26	14.06	38.63	5.63
Japan	22.78	22.34	8.15	53.98	7.06
United States	22.68	20.16	9.52	62.62	8.66
Spain	22.48	20.11	12.05	59.36	10.08
Portugal	21.85	20.71	10.77	39.34	6.93
Jordan	21.58	20.74	11.81	38.82	7.54
Denmark	21.58	19.27	13.09	37.75	7.74
Germany	21.10	20.68	10.96	55.49	7.63
Australia	21.09	18.74	10.57	43.12	8.51
Switzerland	20.93	19.84	11.39	34.18	5.75
Colombia	20.88	18.64	15.27	29.56	5.27
France	20.42	19.14	8.32	42.09	5.58
United Kingdom	19.87	19.03	11.44	37.70	4.86
Netherlands	18.78	17.85	7.05	36.92	6.86
Ireland	18.64	16.31	13.18	32.00	5.80
New Zealand	15.15	15.19	10.61	20.18	3.83
Belgium	14.09	12.67	8.84	23.04	4.31

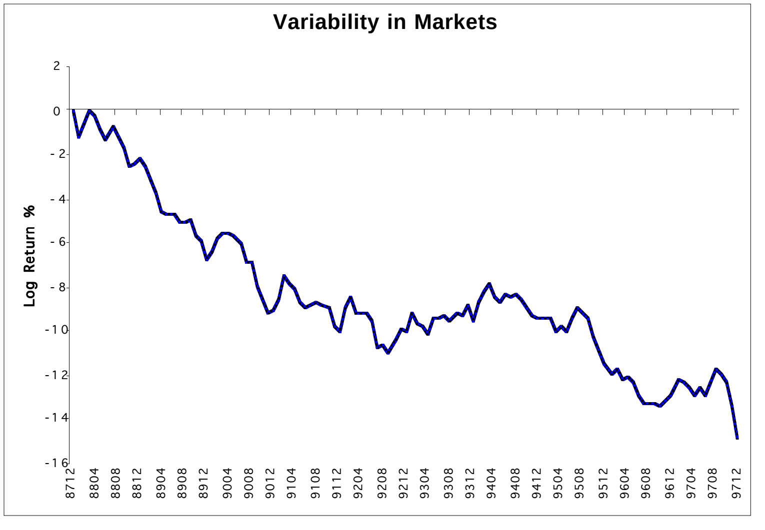
Appendix F:
GEM-FT Risk Index Factor Returns

The following pages display factor return charts for GEM-FT risk indices over the period December 1987–December 1997. These represent the cumulative returns to each risk index net of all other common factors.



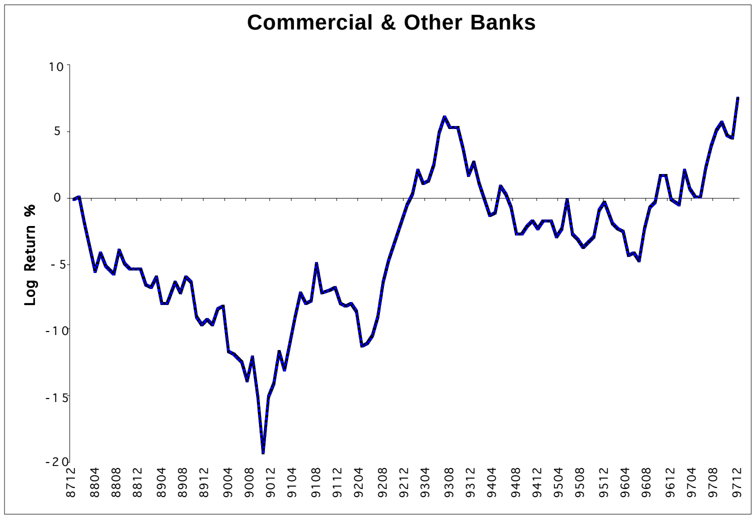


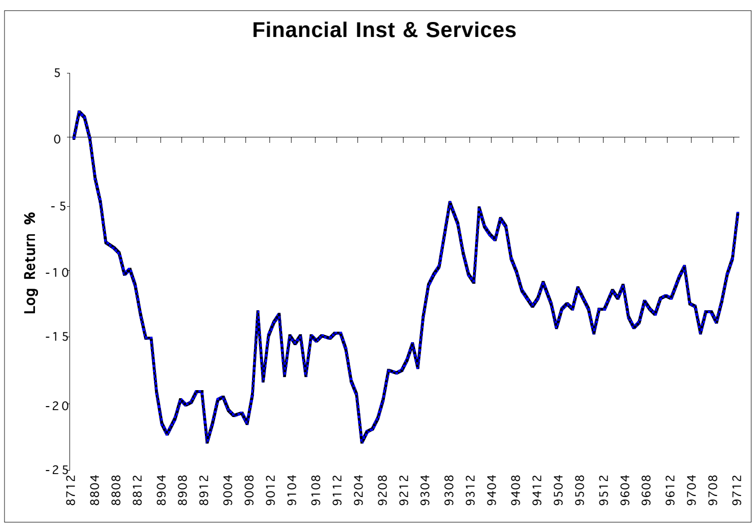

Value
Log Return %
25
20
15
10
5
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

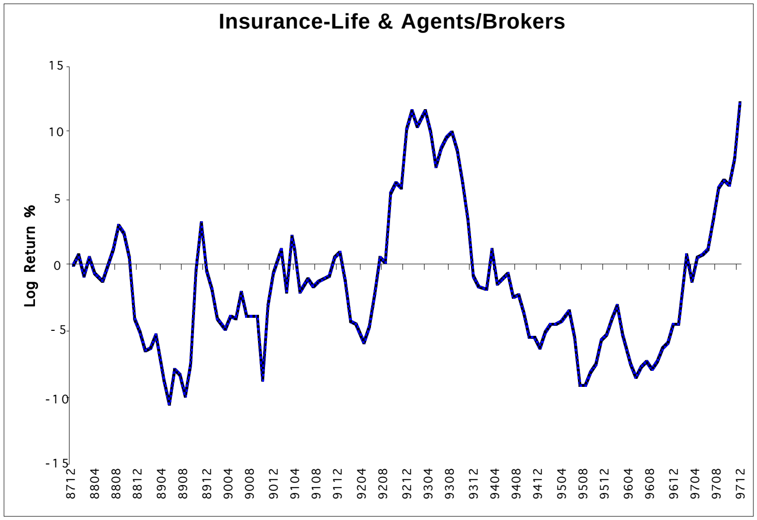

Variability in Markets
Log Return %
2
0
-2
-4
-6
-8
-10
-12
-14
-16
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

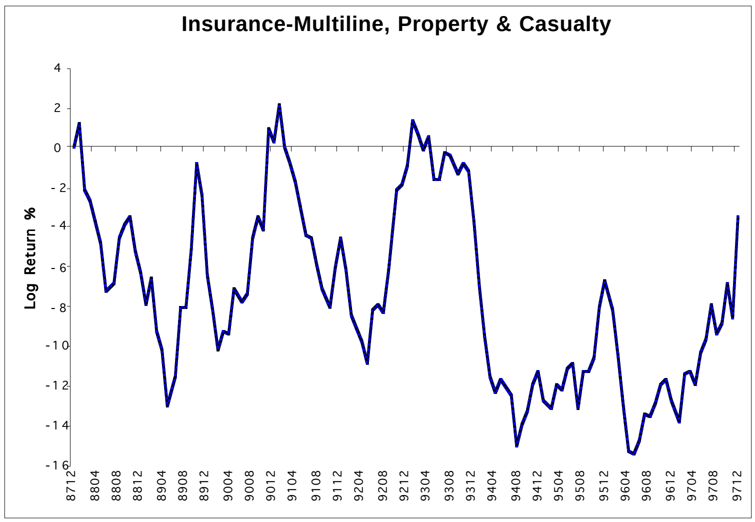
Appendix G:
GEM-FT Industry Factor Returns

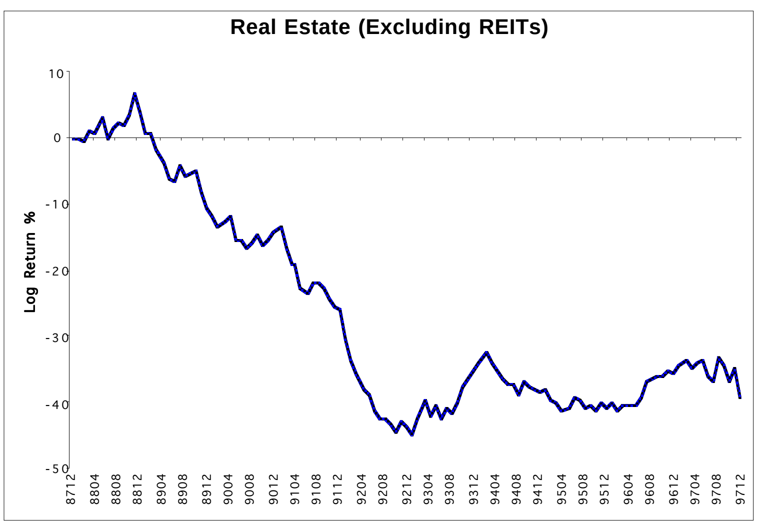
The following pages display factor return charts for GEM-FT industries over the period December 1987–December 1997. These represent the cumulative returns to each industry factor net of all other common factors.

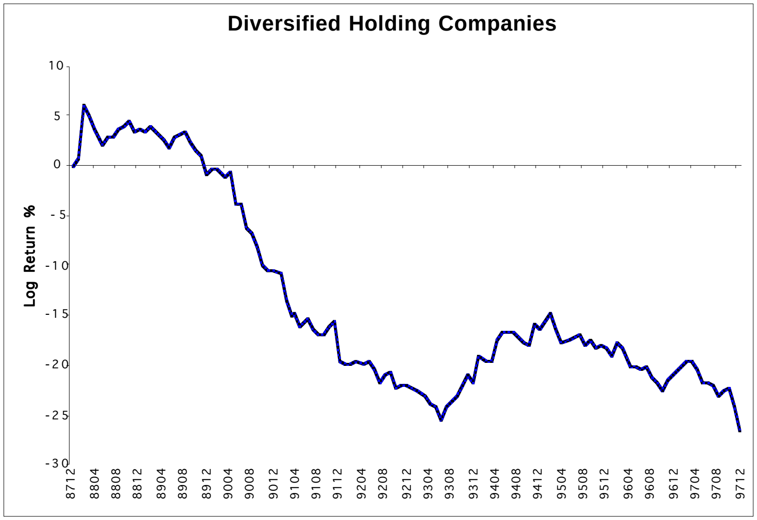


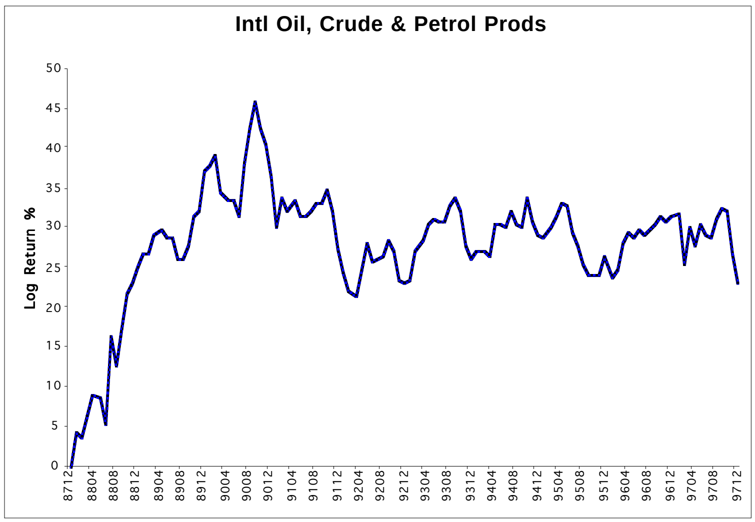


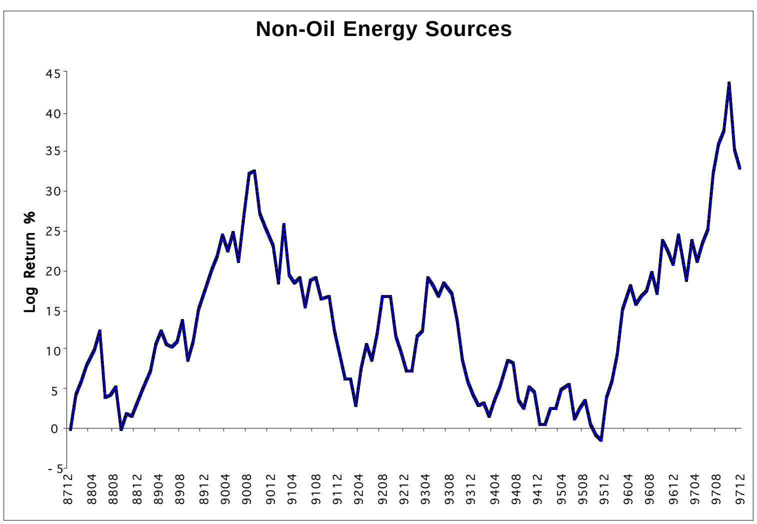

Insurance-Life & Agents/Brokers
Log Return %
15
10
5
0
-5
-10
-15
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

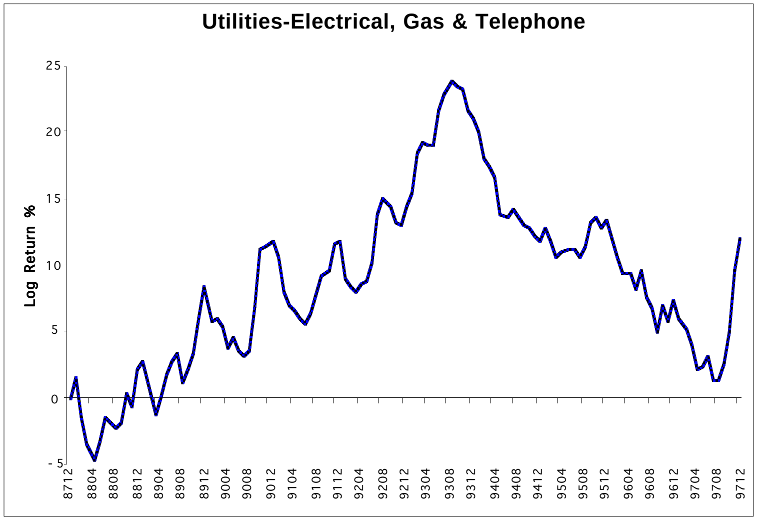

Insurance-Multiline, Property & Casualty
Log Return %
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

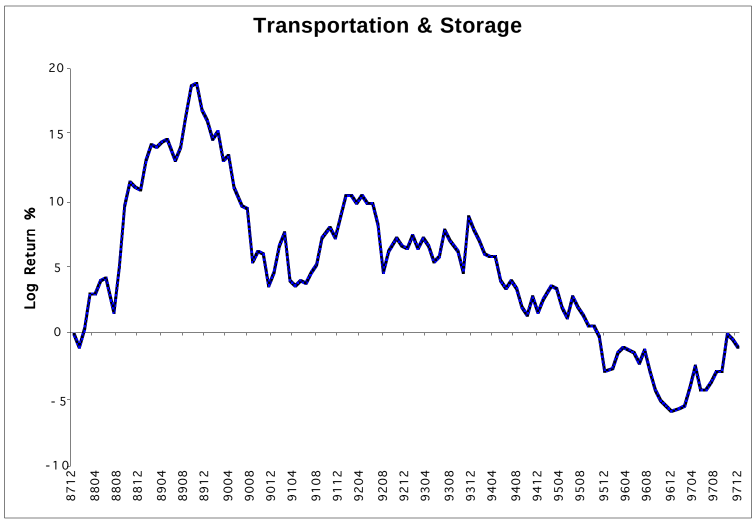

Real Estate (Excluding REITs)
Log Return %
10
0
-10
-20
-30
-40
-50
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

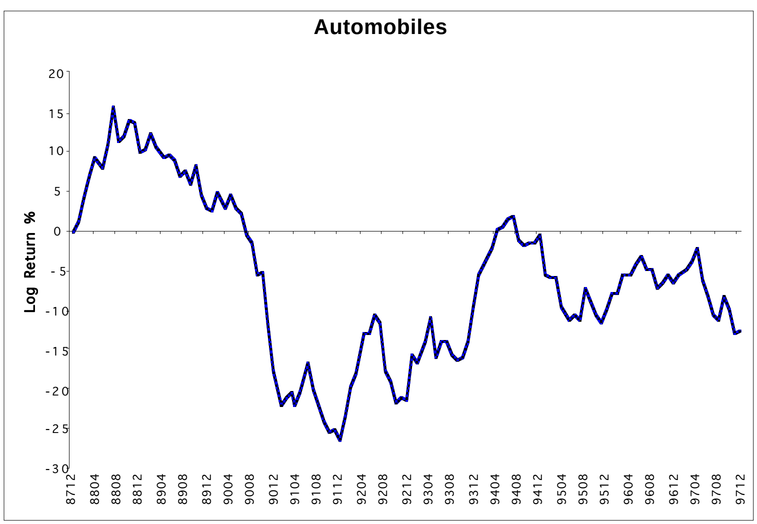

Diversified Holding Companies
Log Return %
10
5
0
-5
-10
-15
-20
-25
-30
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

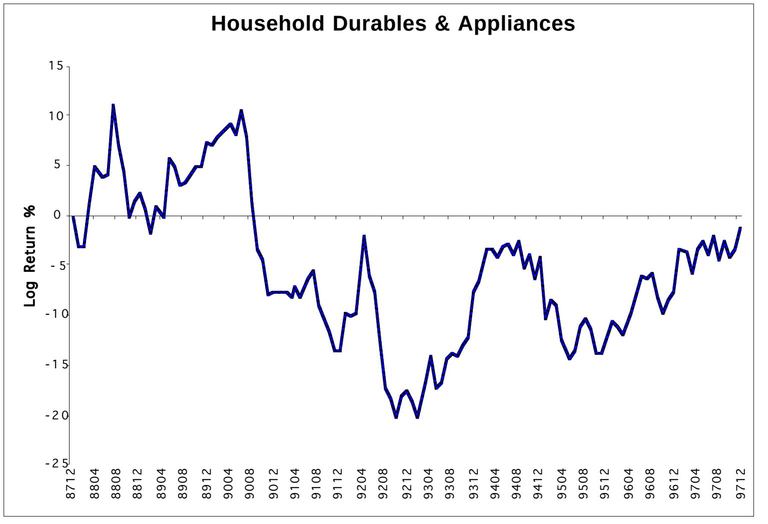

Intl Oil, Crude & Petrol Prods
Log Return %
50
45
40
35
30
25
20
15
10
5
0
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

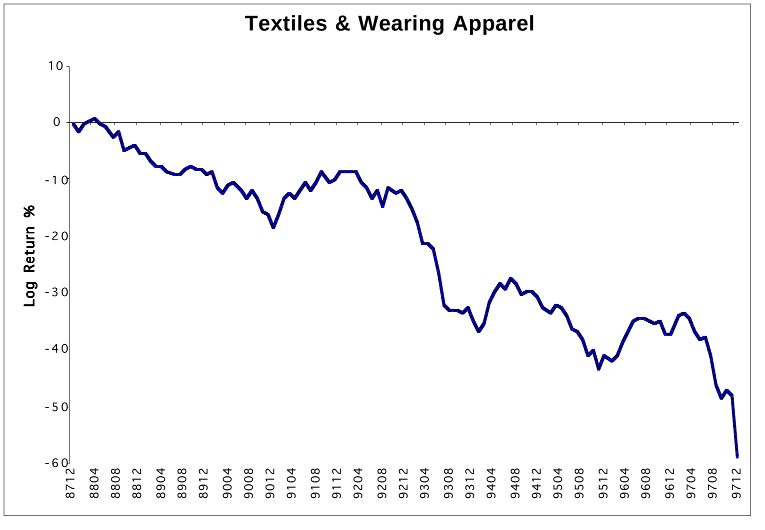

Non-Oil Energy Sources
Log Return %
45
40
35
30
25
20
15
10
5
0
-5
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

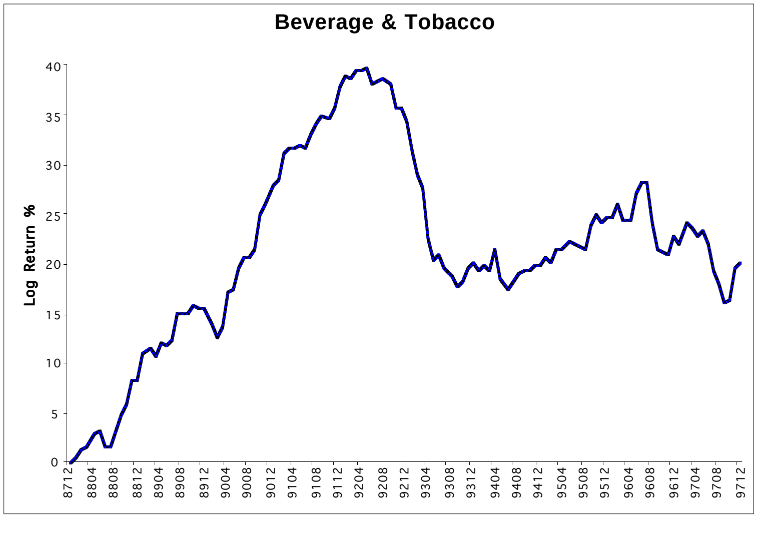

Utilities-Electrical, Gas & Telephone
Log Return %
25
20
15
10
5
0
-5
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

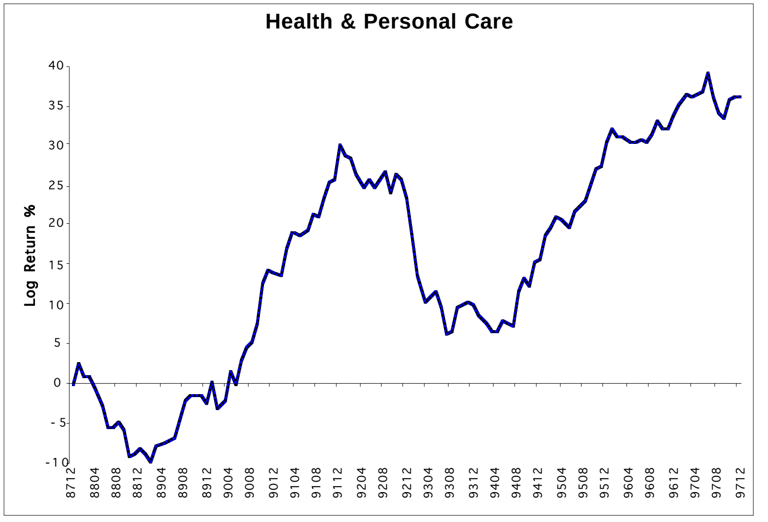

Transportation & Storage
Log Return %
20
15
10
5
0
-5
-10
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

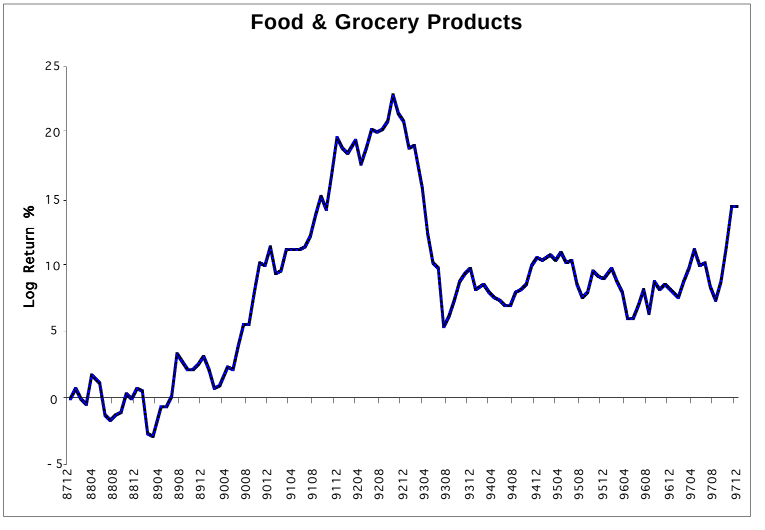

Automobiles
Log Return %
20
15
10
5
0
-5
-10
-15
-20
-25
-30
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

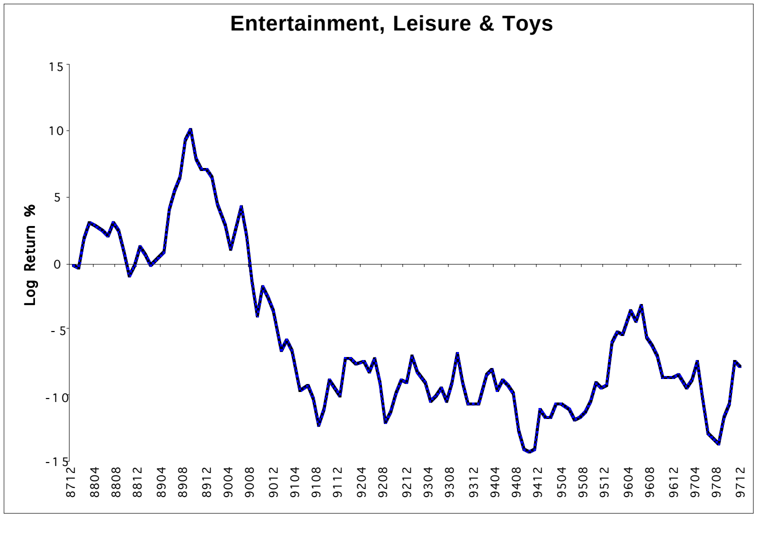

Household Durables & Appliances
Log Return %
15
10
5
0
-5
-10
-15
-20
-25
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

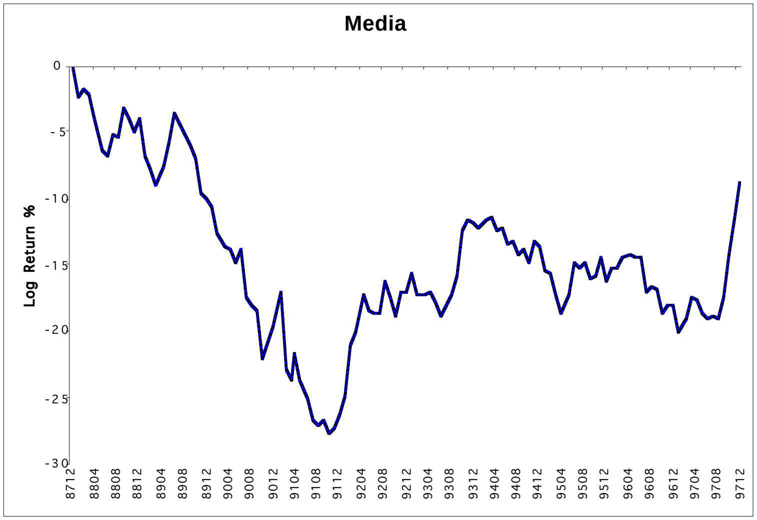

Textiles & Wearing Apparel
Log Return %
10
0
-10
-20
-30
-40
-50
-60
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

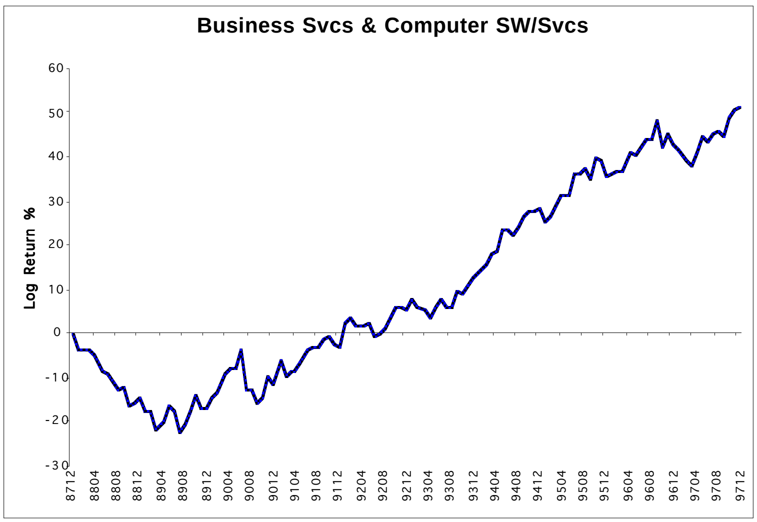

Beverage & Tobacco
Log Return %
40
35
30
25
20
15
10
5
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

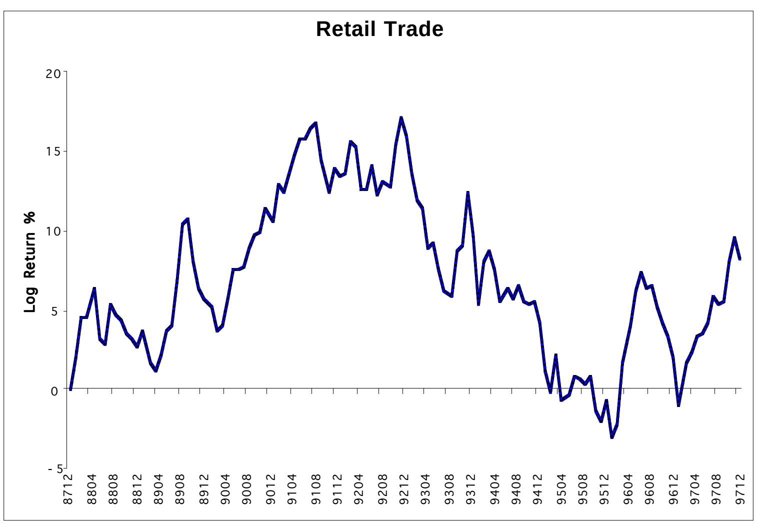

Health & Personal Care
Log Return %
40
35
30
25
20
15
10
5
0
-5
-10
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

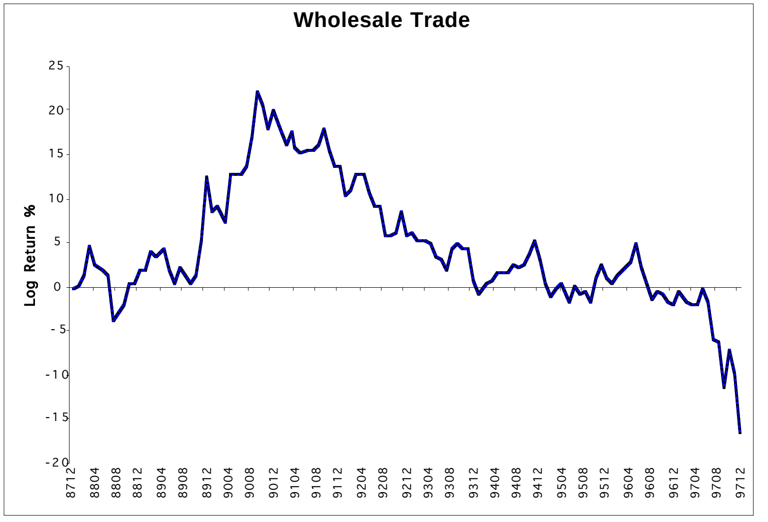

Food & Grocery Products
Log Return %
25
20
15
10
5
0
-5
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

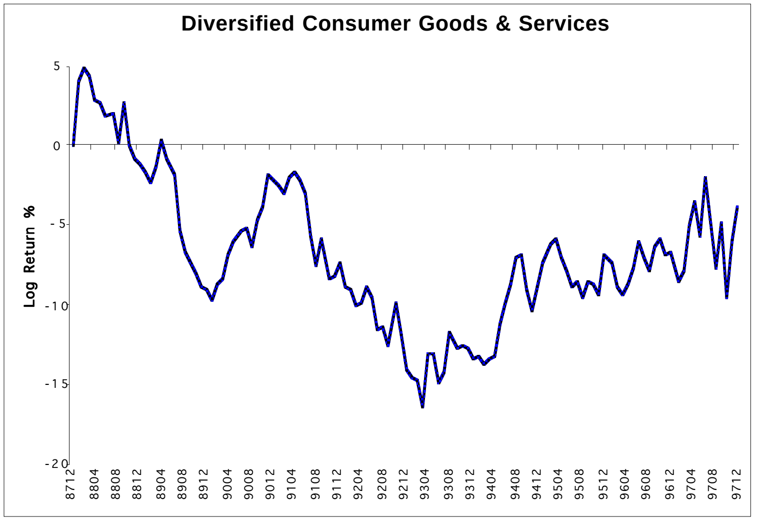

Entertainment, Leisure & Toys
Log Return %
15
10
5
0
-5
-10
-15
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

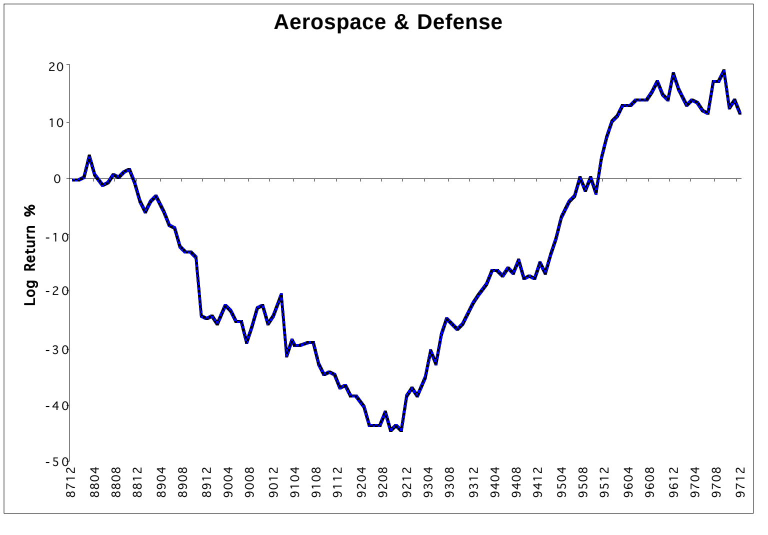

Media
Log Return %
0
-5
-10
-15
-20
-25
-30
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

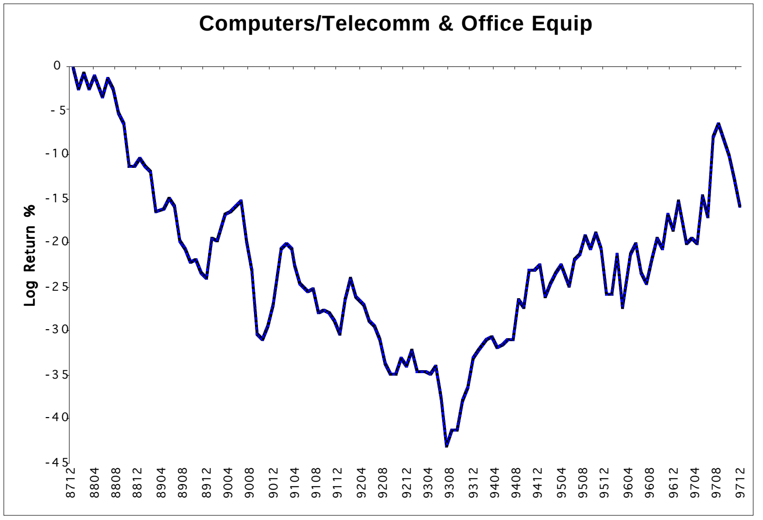

Business Svcs & Computer SW/Svcs
Log Return %
60
50
40
30
20
10
0
-10
-20
-30
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

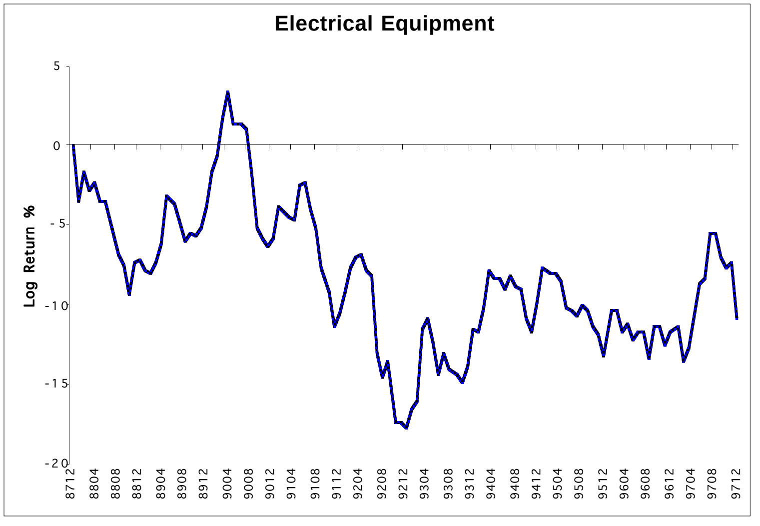

Retail Trade
Log Return %
20
15
10
5
0
-5
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712

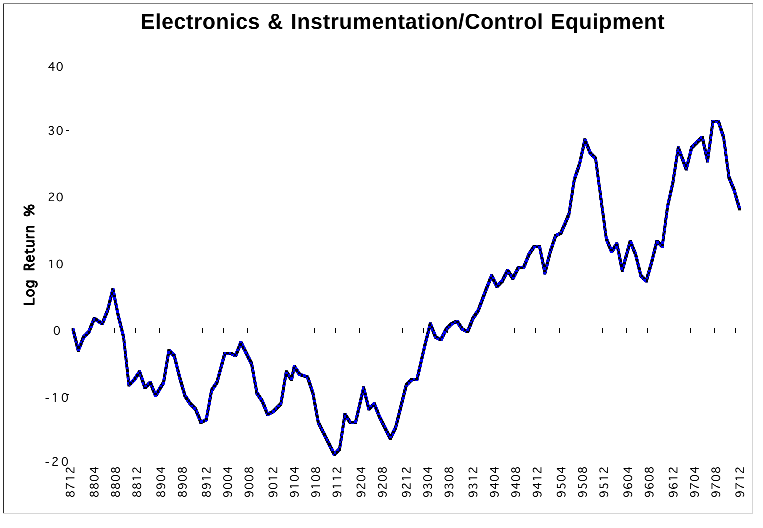

Wholesale Trade
Log Return %
25
20
15
10
5
0
-5
-10
-15
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

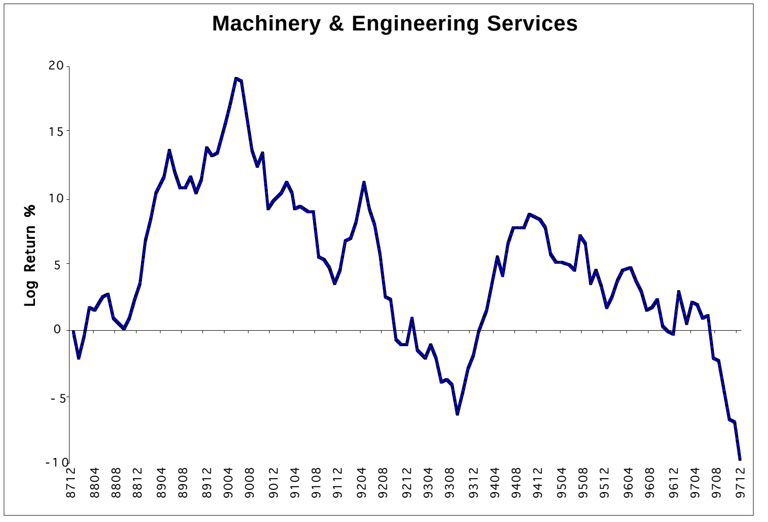

Diversified Consumer Goods & Services
Log Return %
5
0
-5
-10
-15
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

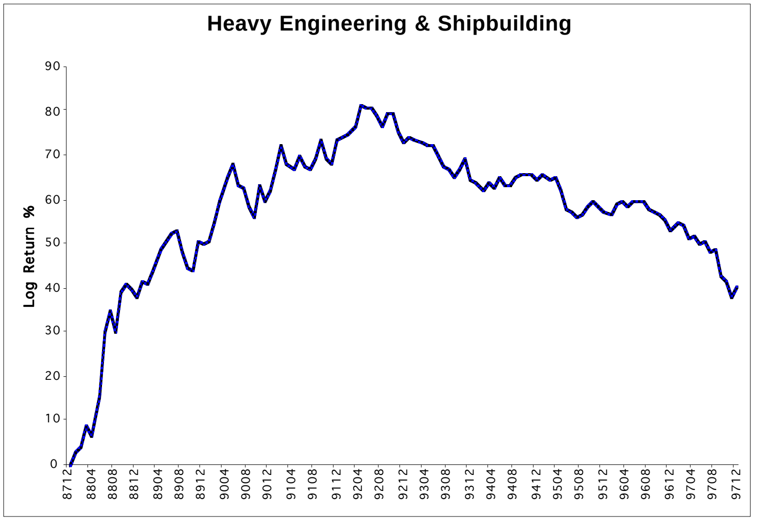

Aerospace & Defense
Log Return %
20
10
0
-10
-20
-30
-40
-50
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

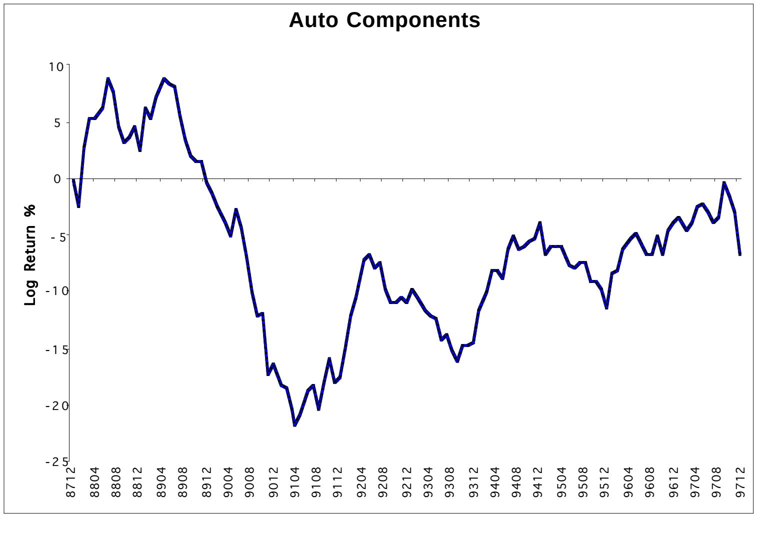

Computers/Telecomm & Office Equip
Log Return %
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

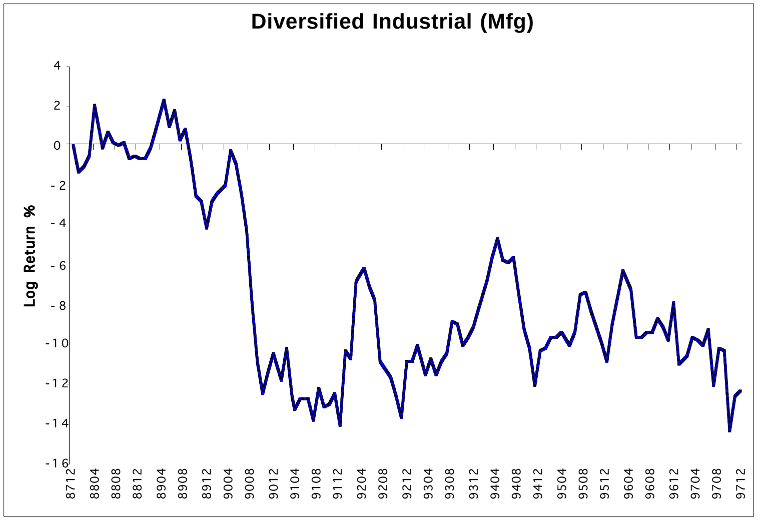

Electrical Equipment
Log Return %
5
0
-5
-10
-15
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

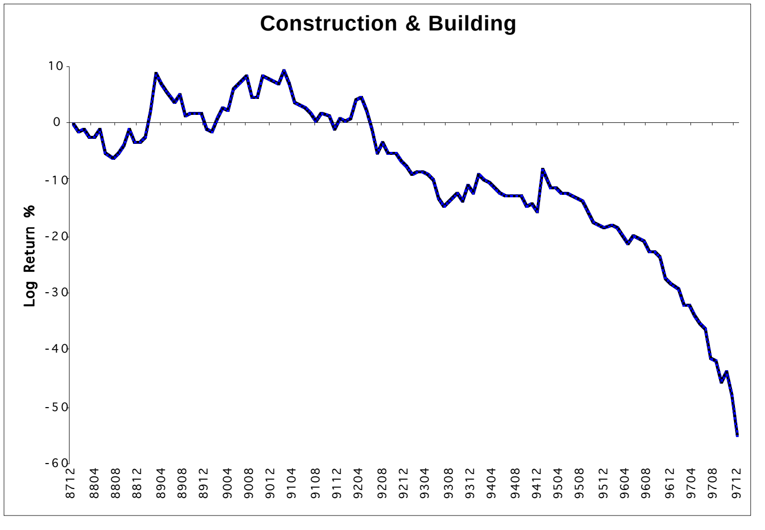

Electronics & Instrumentation/Control Equipment
Log Return %
40
30
20
10
0
-10
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

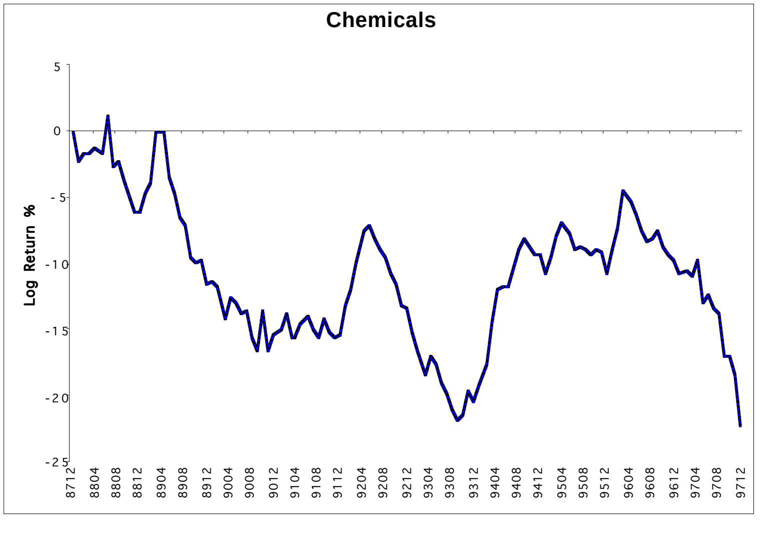

Machinery & Engineering Services
Log Return %
20
15
10
5
0
-5
-10
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

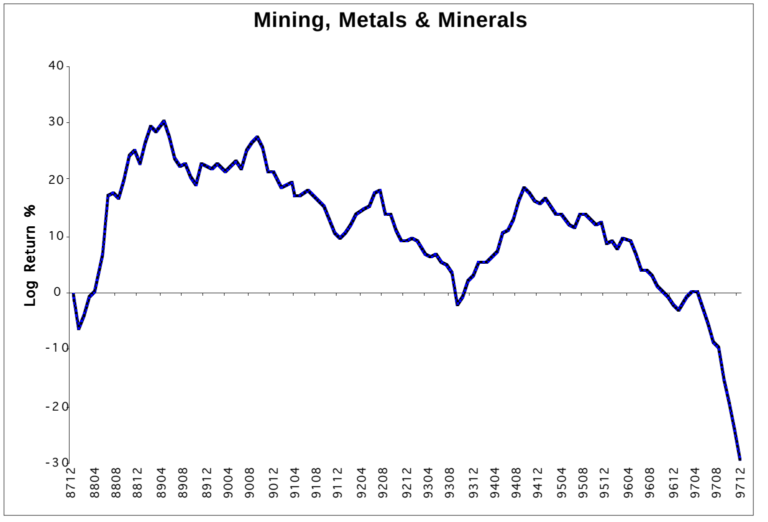

Heavy Engineering & Shipbuilding
Log Return %
90
80
70
60
50
40
30
20
10
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

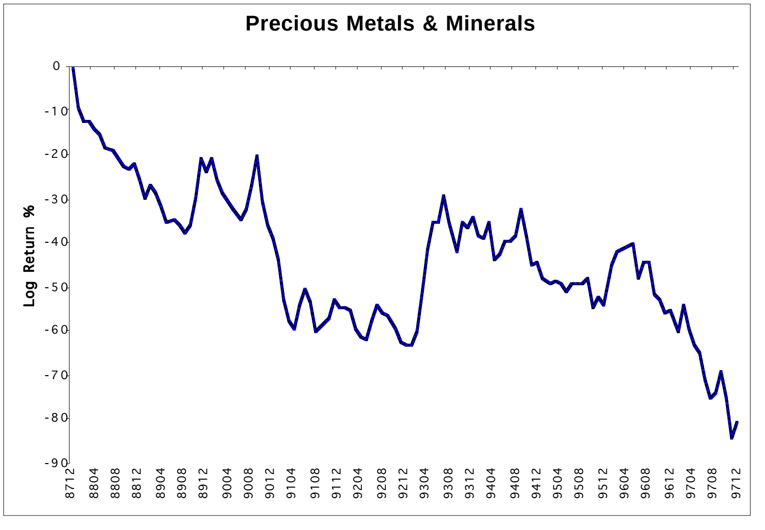

Auto Components
Log Return %
10
5
0
-5
-10
-15
-20
-25
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

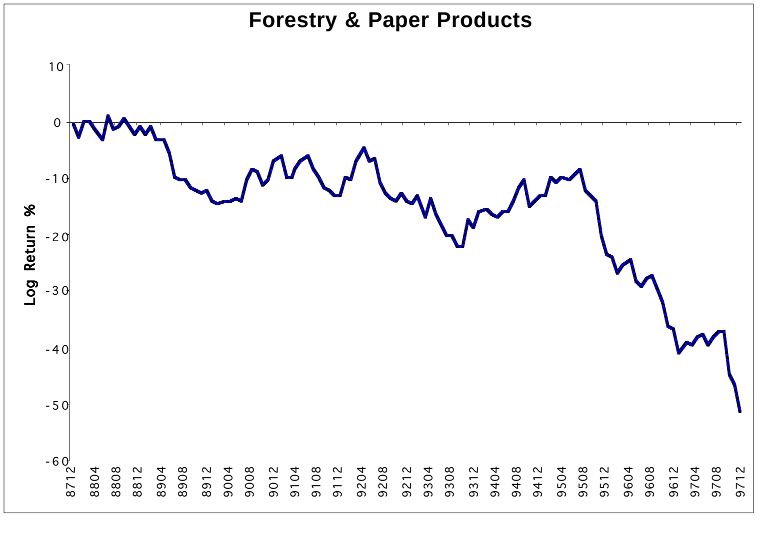

Diversified Industrial (Mfg)
Log Return %

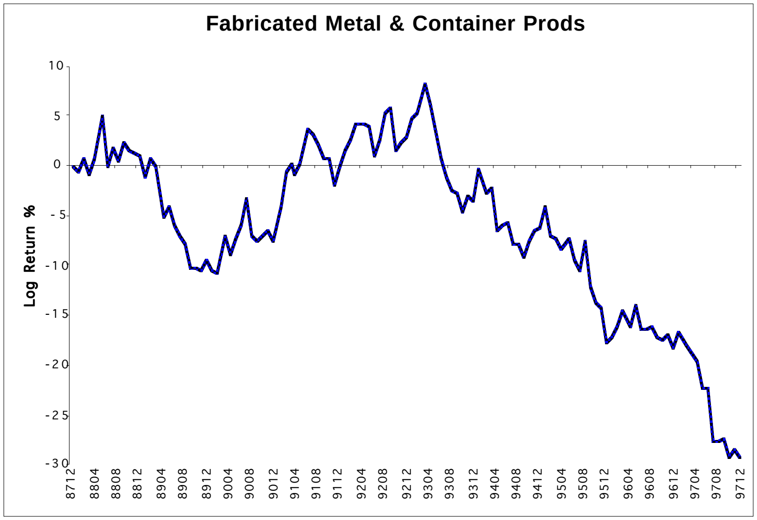

Construction & Building
Log Return %


Chemicals
Log Return %


Mining, Metals & Minerals
Log Return %
40
30
20
10
0
-10
-20
-30
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

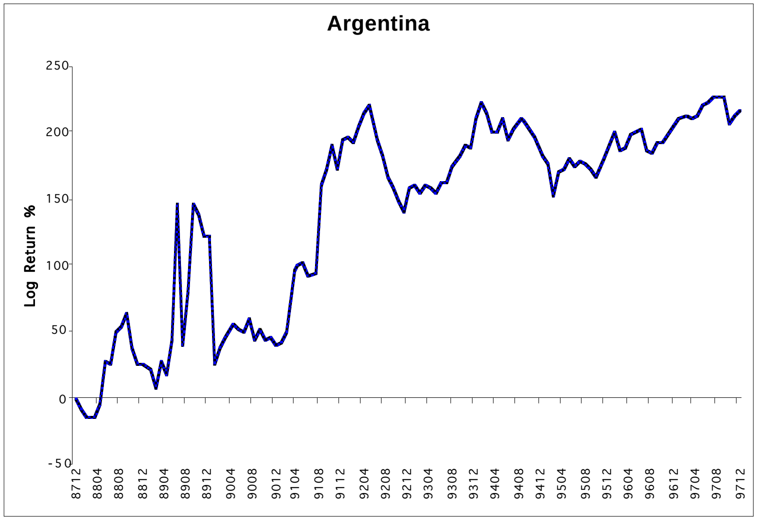

Precious Metals & Minerals
Log Return %
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

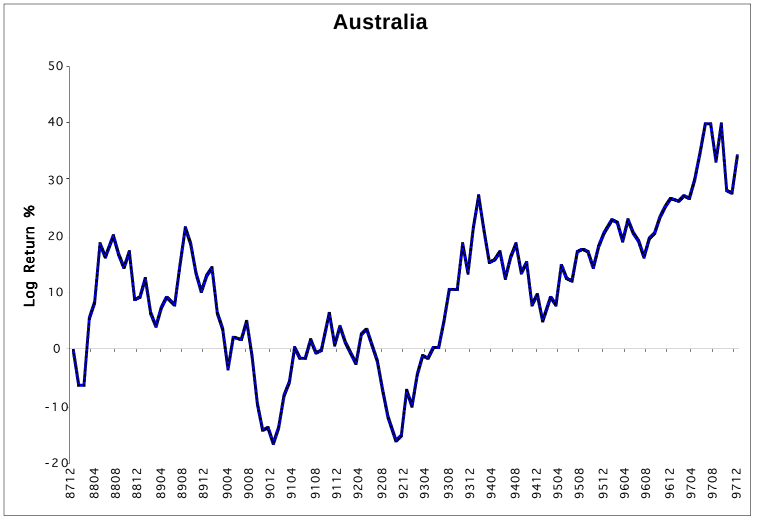

Forestry & Paper Products
Log Return %
10
0
-10
-20
-30
-40
-50
-60
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

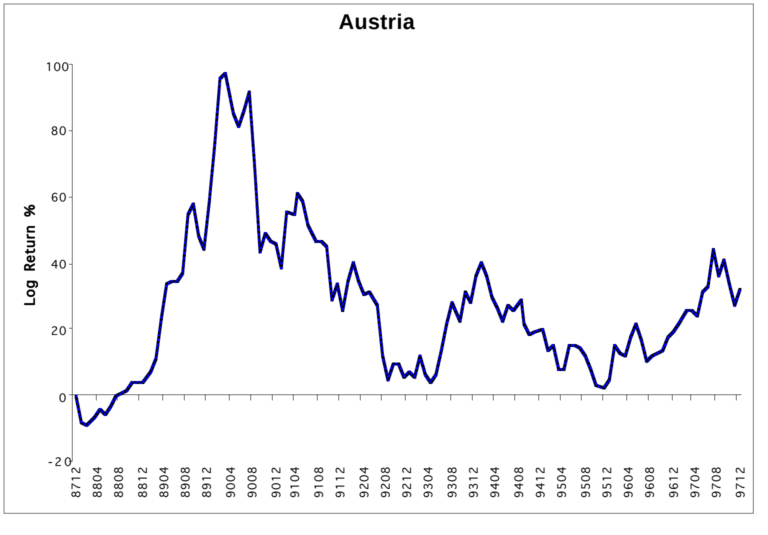

Fabricated Metal & Container Prods
Log Return %
10
5
0
-5
-10
-15
-20
-25
-30
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

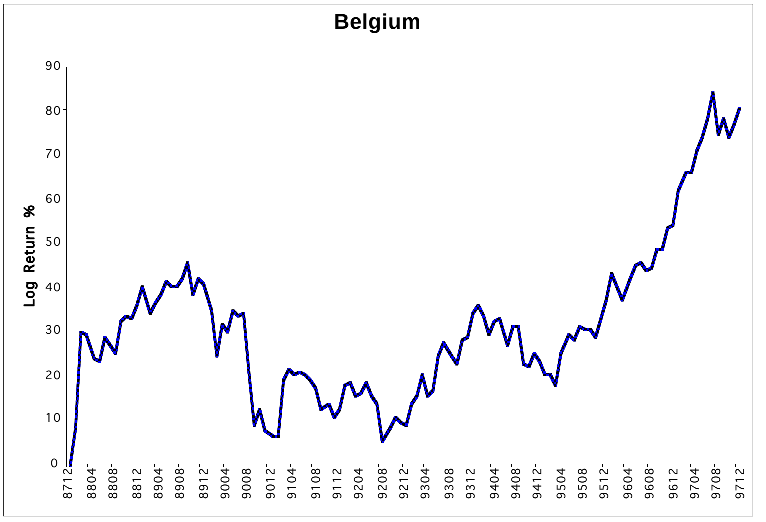
Appendix H:
GEM-FT Country Factor Returns

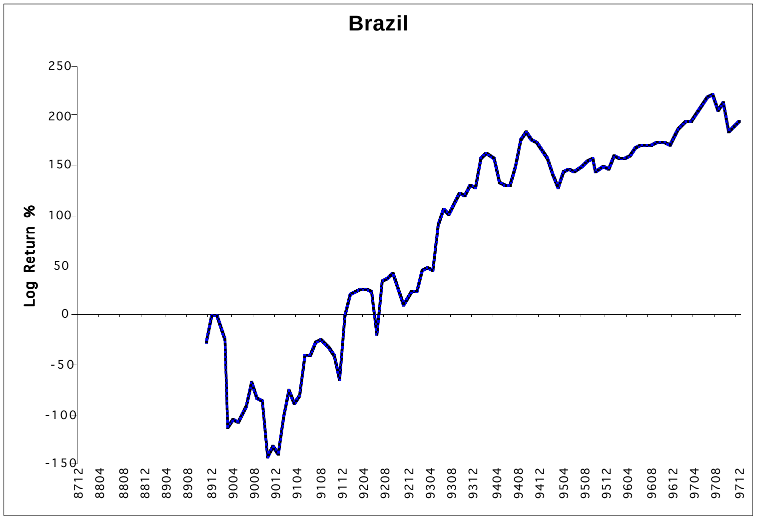
The following pages display factor return charts for GEM-FT countries over the period December 1987–December 1997. These represent the cumulative returns to each country factor net of all other common factors.

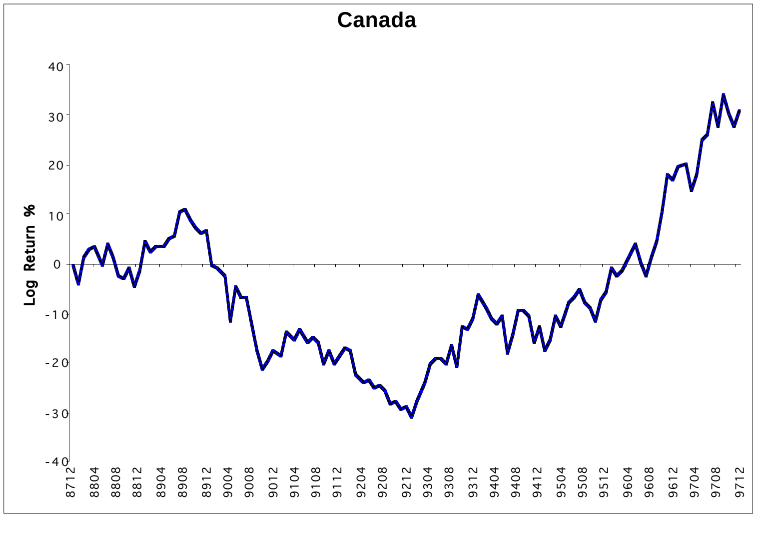

Argentina
Log Return %
250
200
150
100
50
0
-50
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

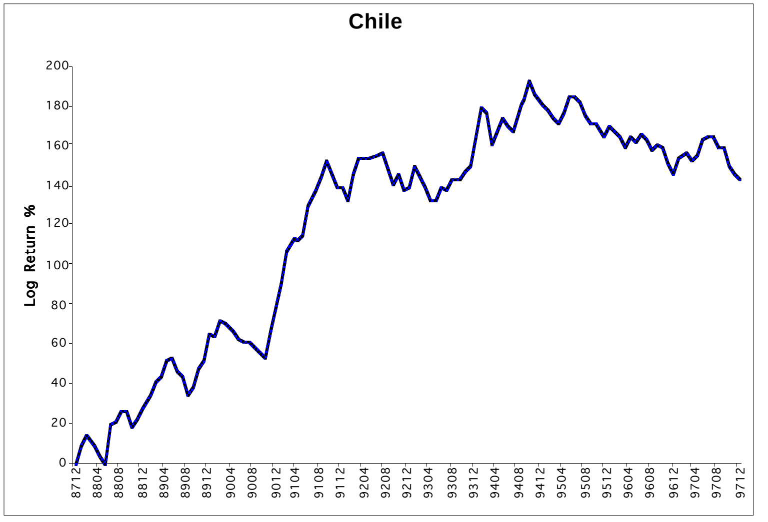

Australia
Log Return %
50
40
30
20
10
0
-10
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

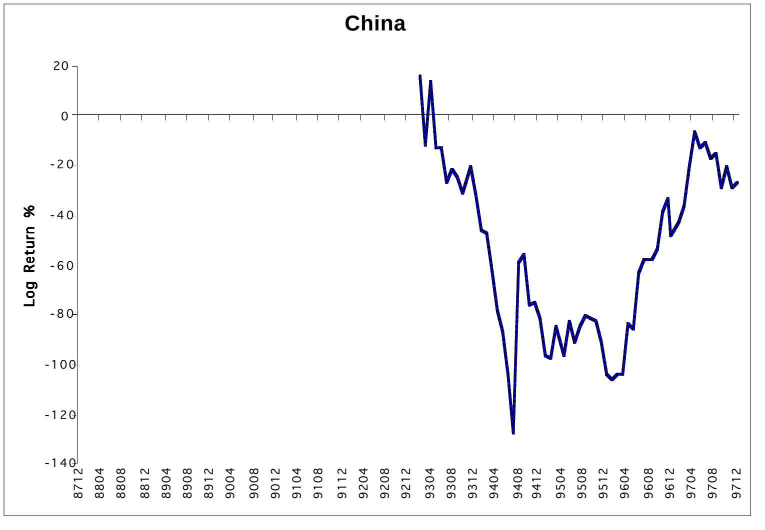

Austria
Log Return %
100
80
60
40
20
0
-20
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

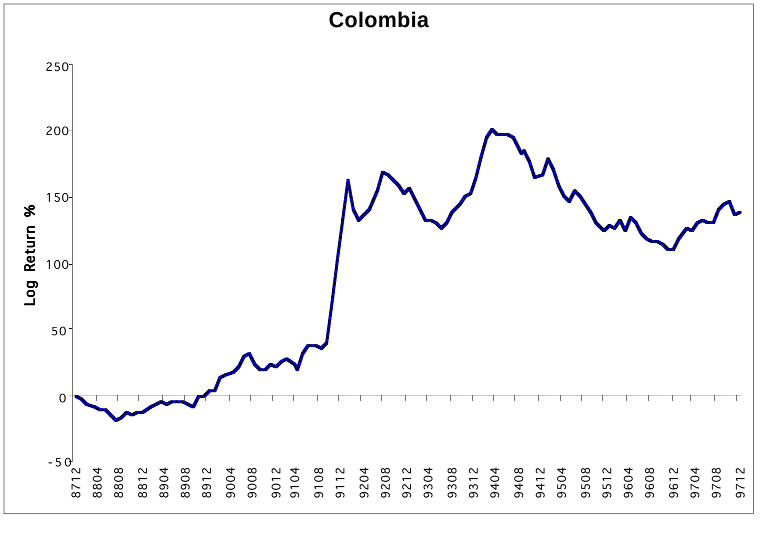

Belgium
Log Return %
90
80
70
60
50
40
30
20
10
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

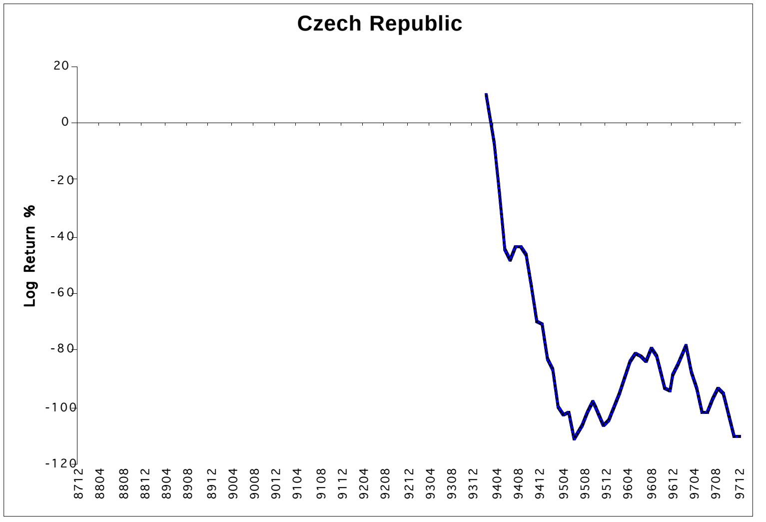

Brazil
Log Return %
250
200
150
100
50
0
-50
-100
-150
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

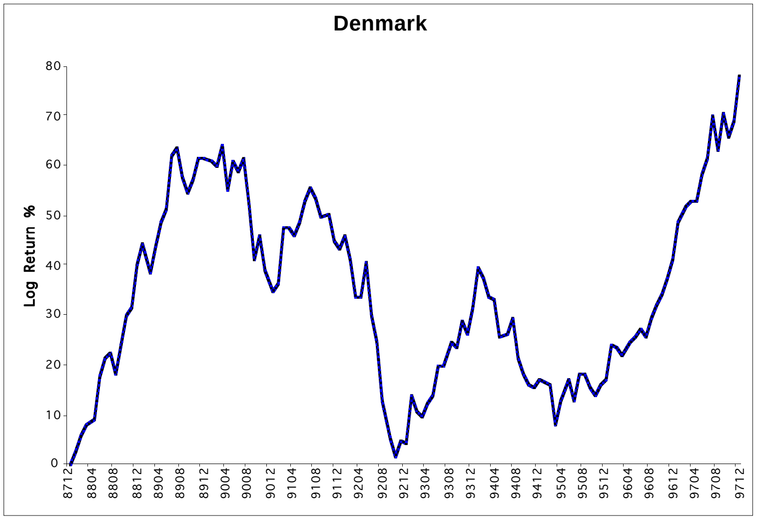

Canada
Log Return %
40
30
20
10
0
-10
-20
-30
-40
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

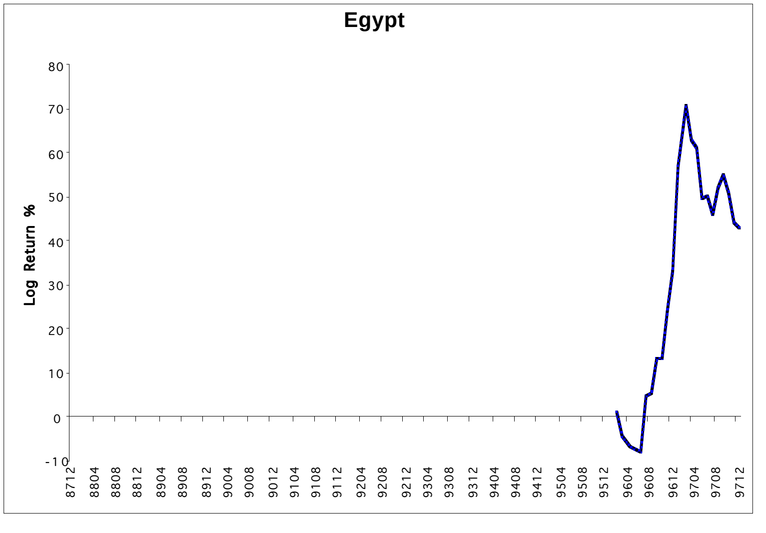

Chile
Log Return %
200
180
160
140
120
100
80
60
40
20
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

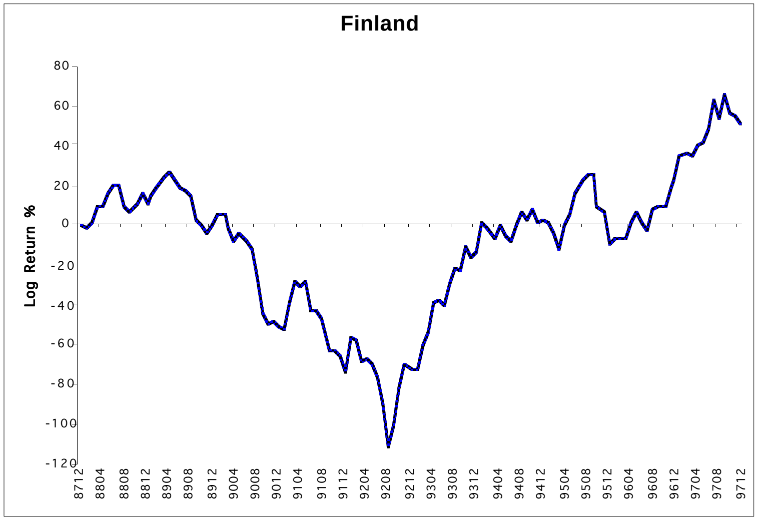

China
Log Return %
20
0
-20
-40
-60
-80
-100
-120
-140
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712

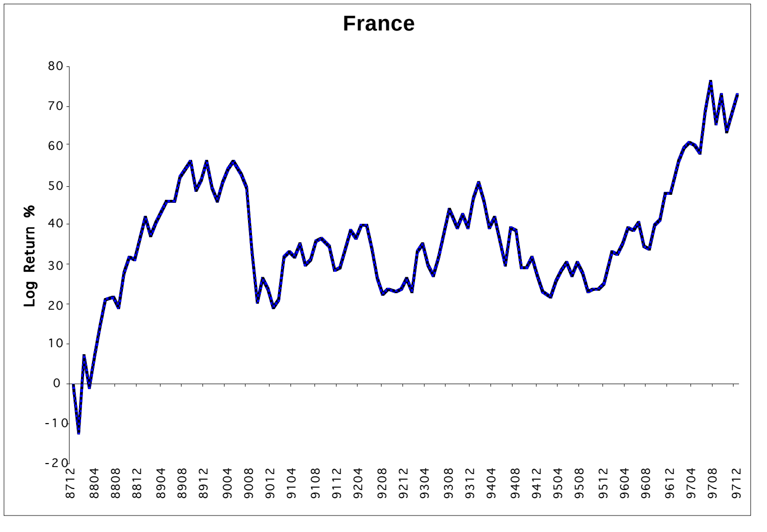

Colombia
Log Return %
250
200
150
100
50
0
-50
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Czech Republic
Log Return %
20
0
-20
-40
-60
-80
-100
-120
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Denmark
Log Return %
80
70
60
50
40
30
20
10
0
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Egypt
Log Return %
80
70
60
50
40
30
20
10
0
-10
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


Finland
Log Return %
80
60
40
20
0
-20
-40
-60
-80
-100
-120
8712
8804
8808
8812
8904
8908
8912
9004
9008
9012
9104
9108
9112
9204
9208
9212
9304
9308
9312
9404
9408
9412
9504
9508
9512
9604
9608
9612
9704
9708
9712


France
Log Return %
80
70
60
50
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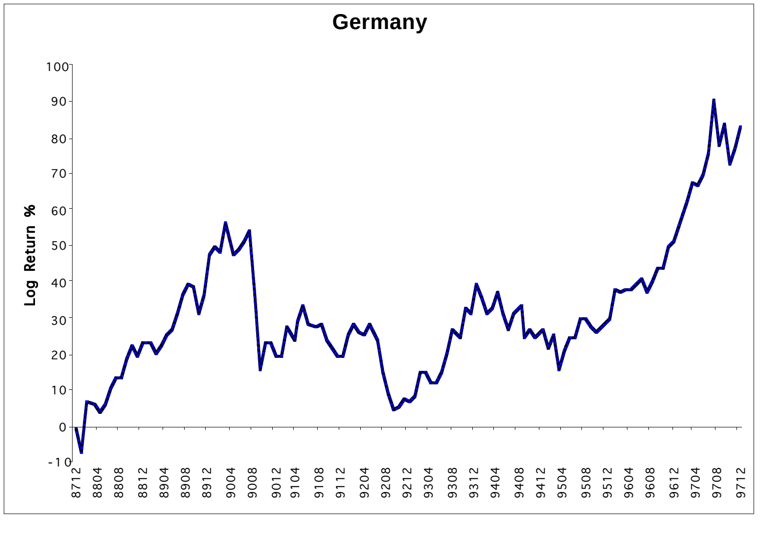
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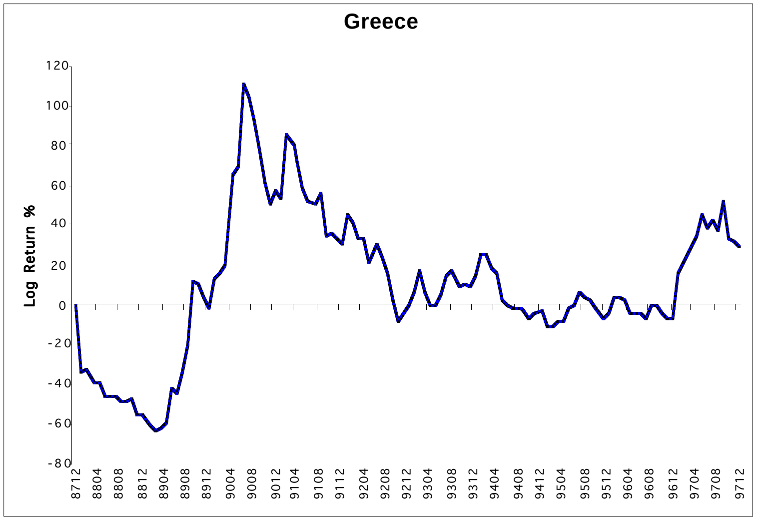
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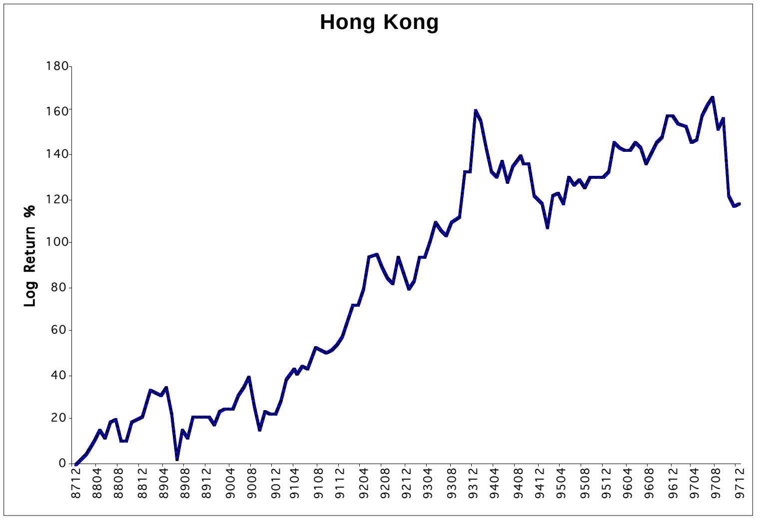
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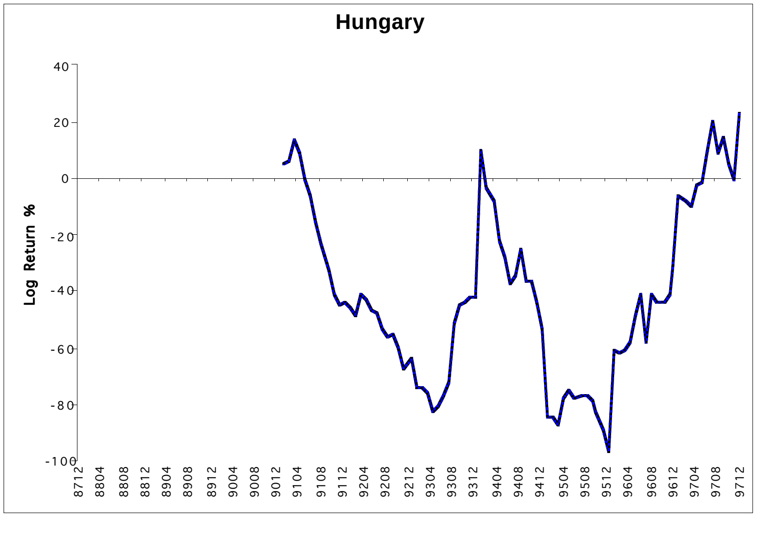
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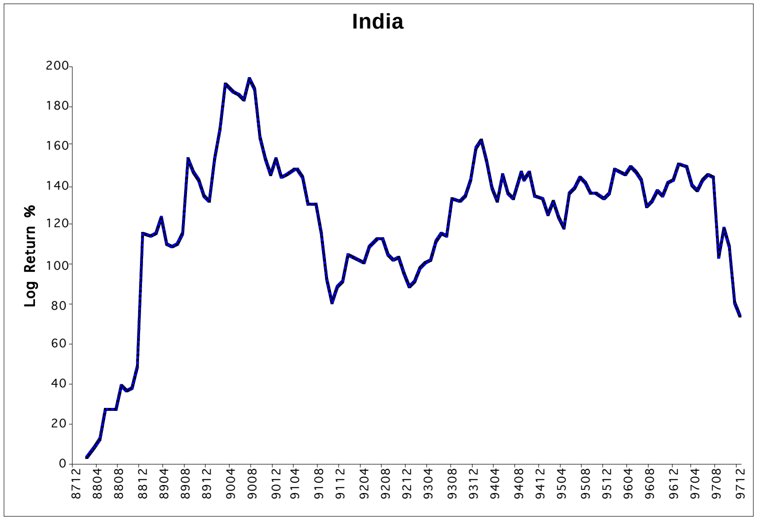
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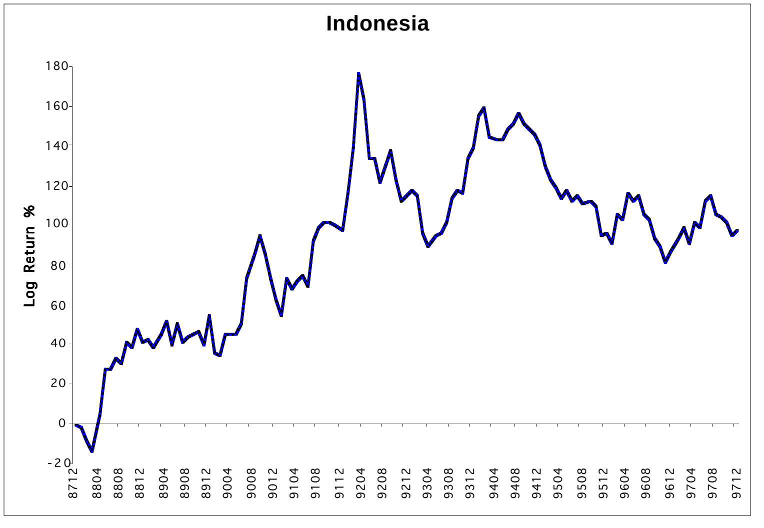
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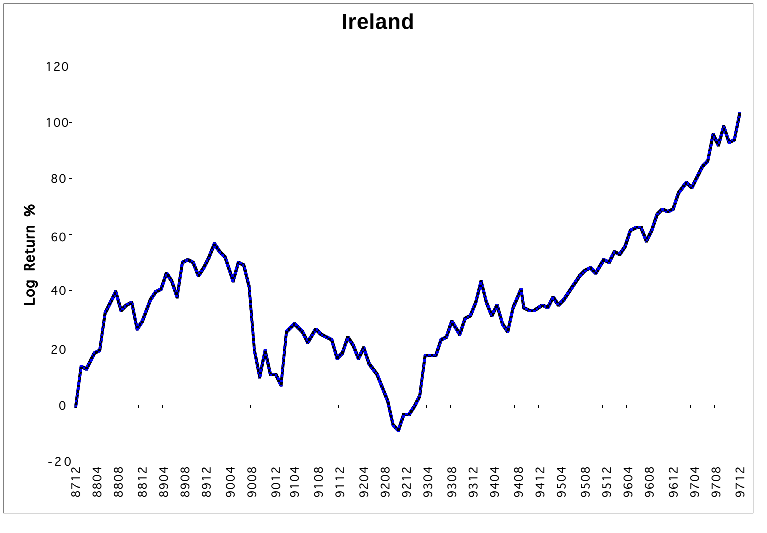
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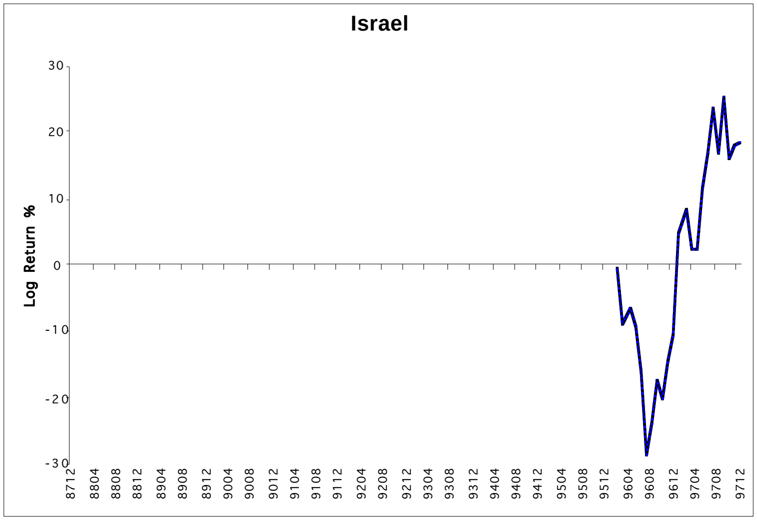
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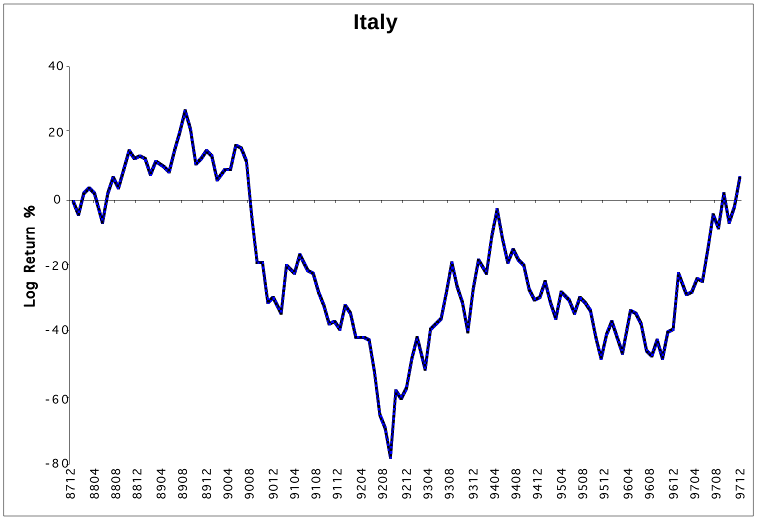
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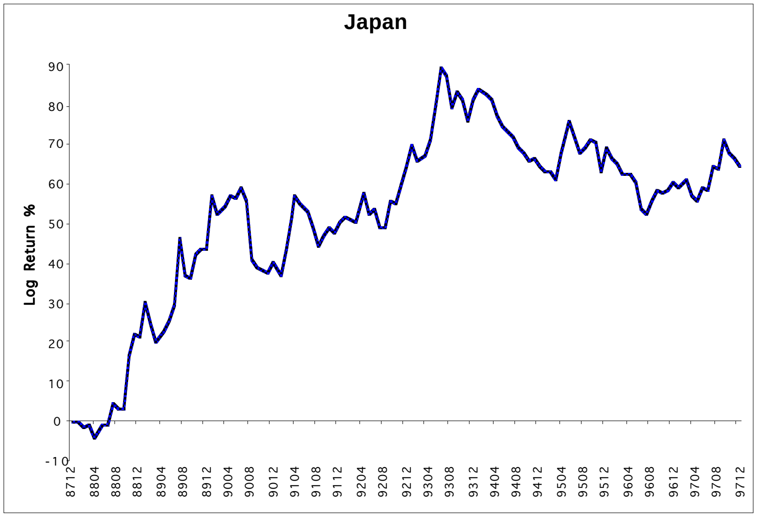
Japan
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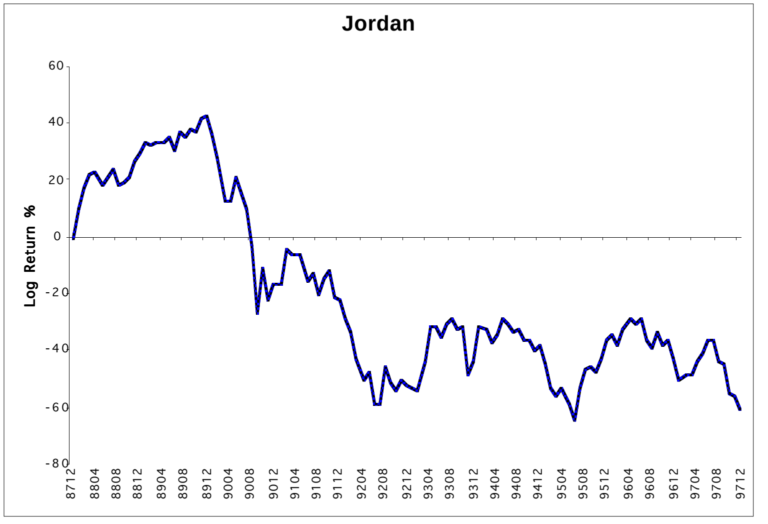
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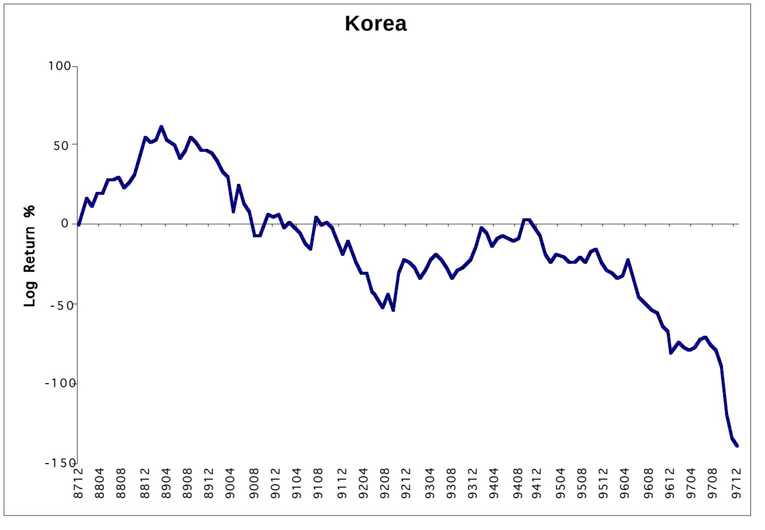
Korea
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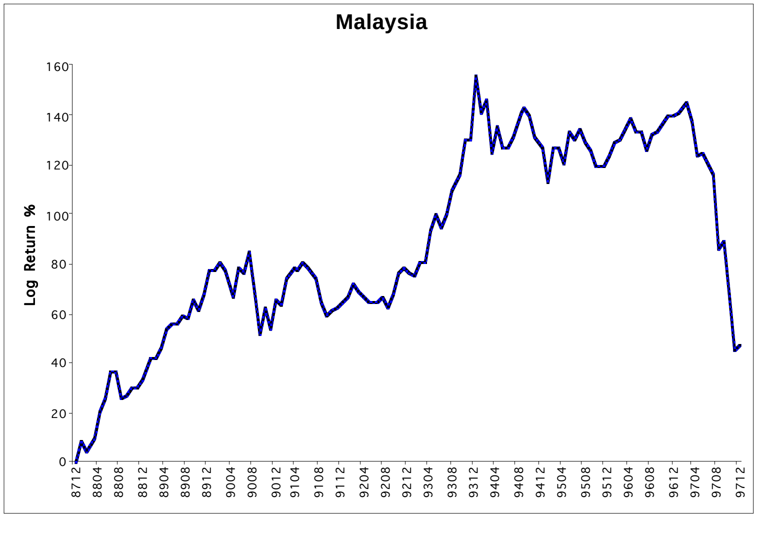
Malaysia
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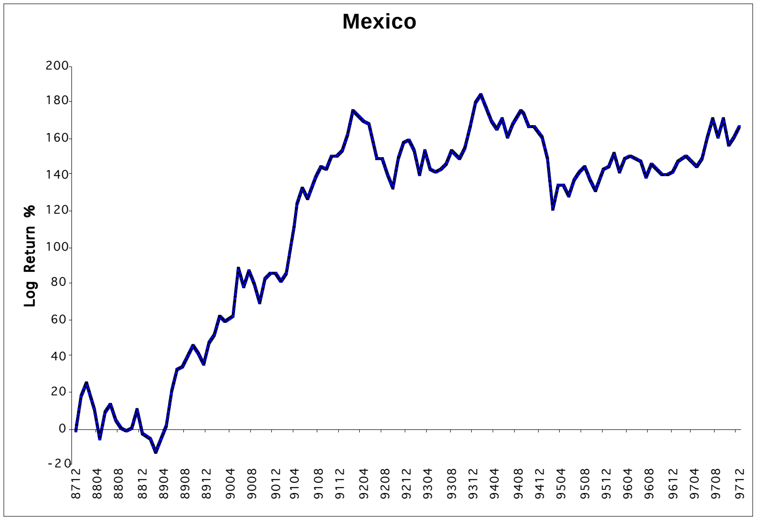
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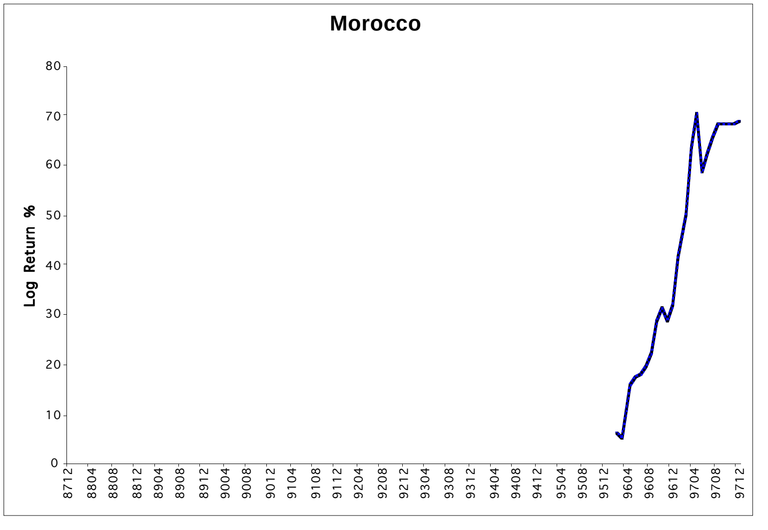
Morocco
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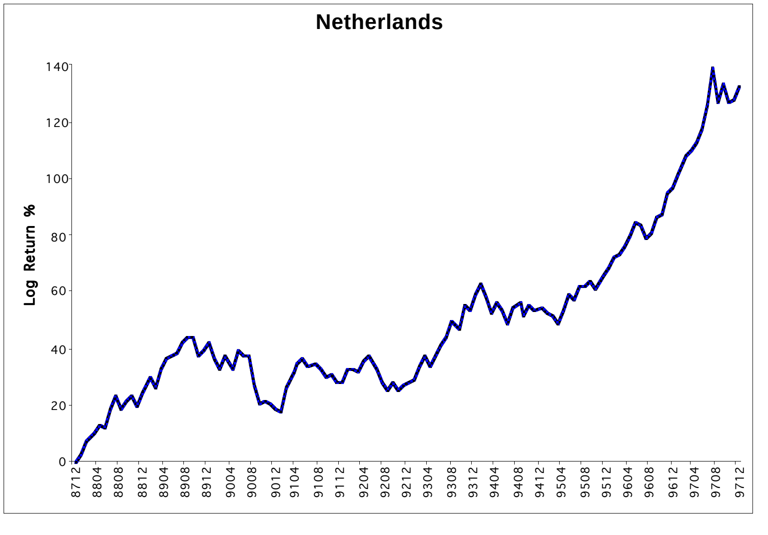
Netherlands
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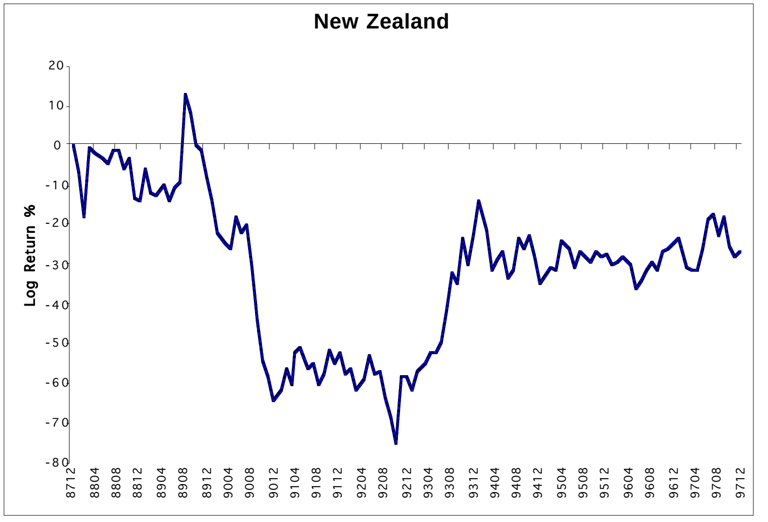
New Zealand
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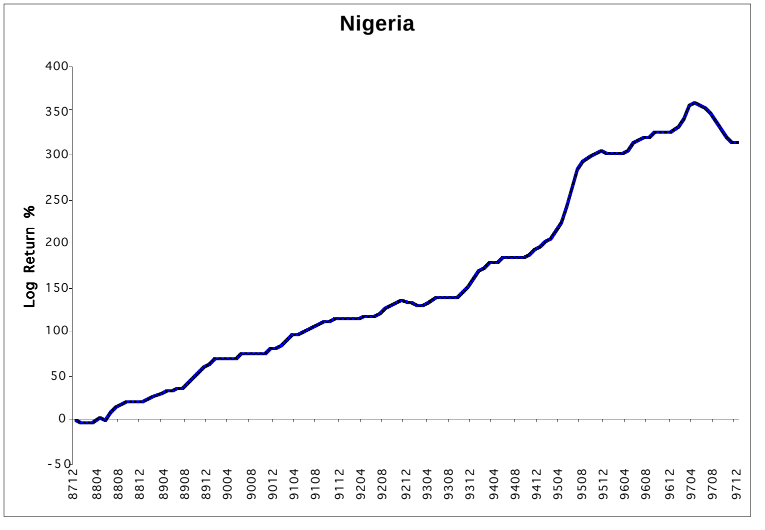
Nigeria
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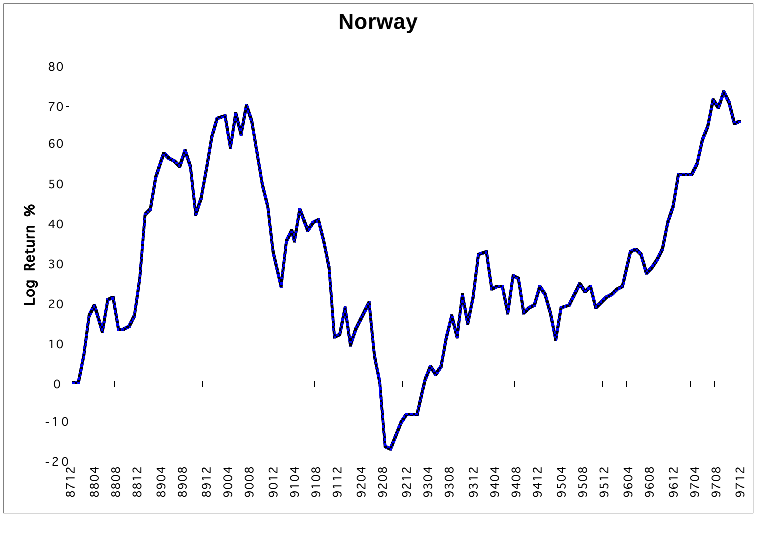
Norway
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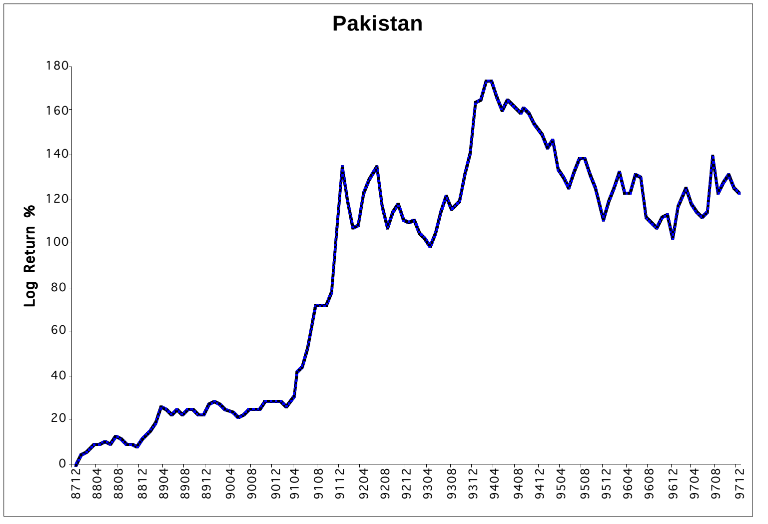
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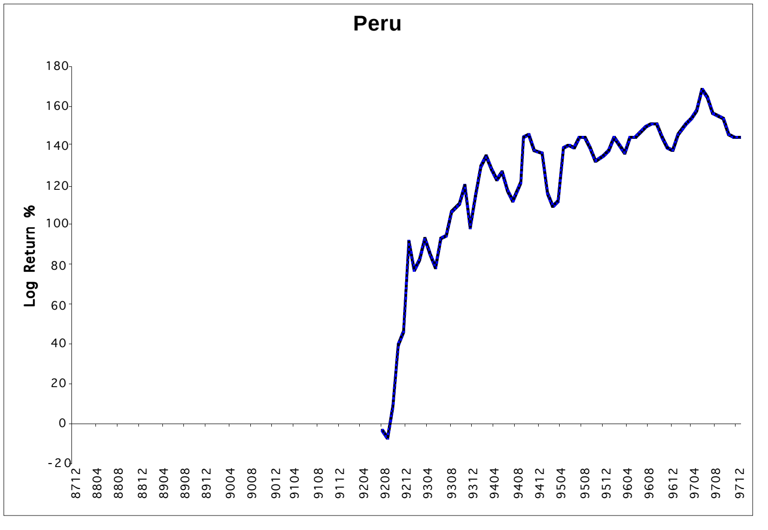
Peru
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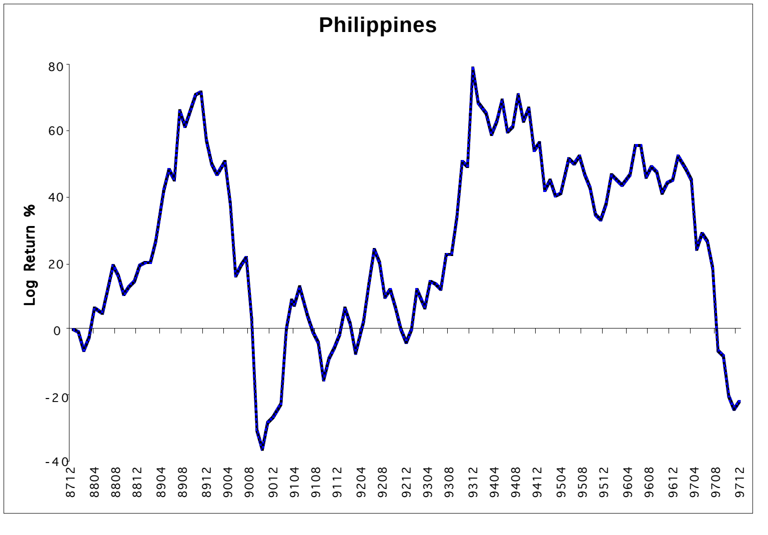
Philippines
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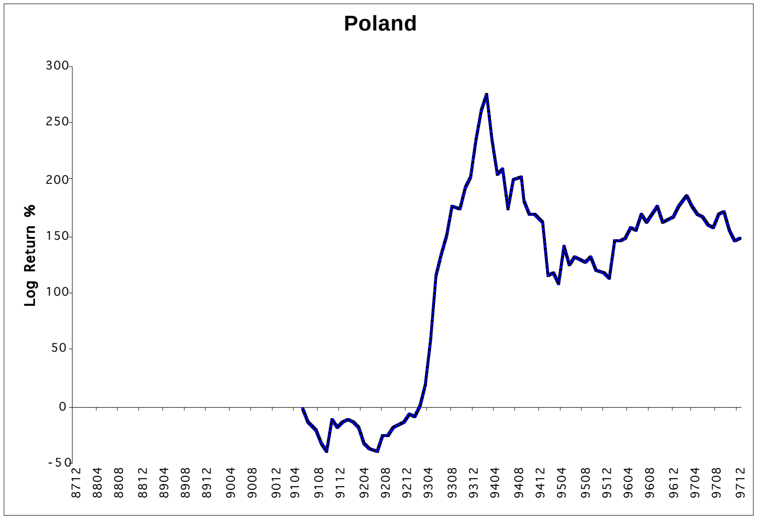
Poland
Log Return %
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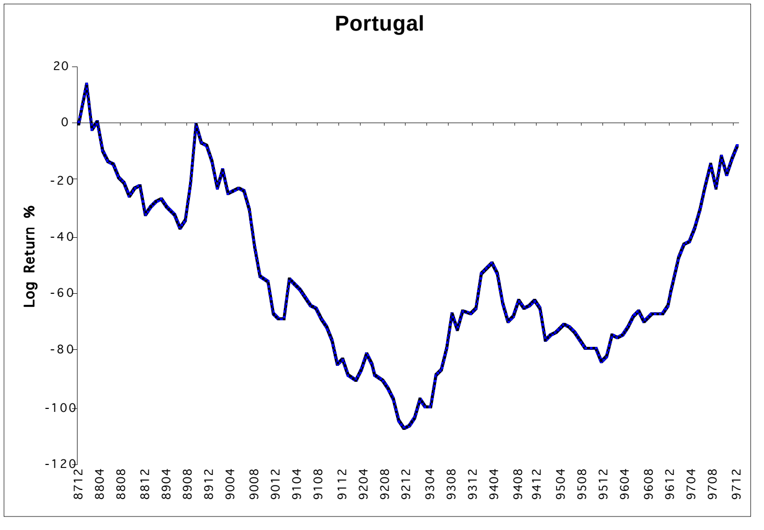
Portugal
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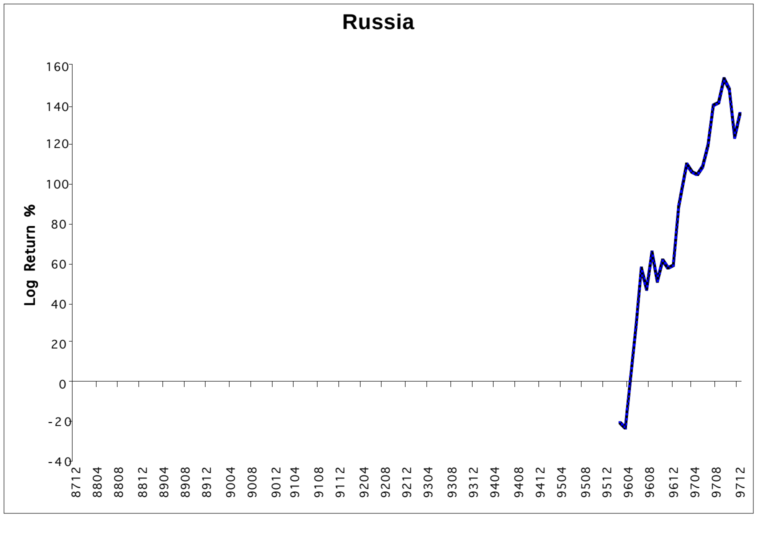
Russia
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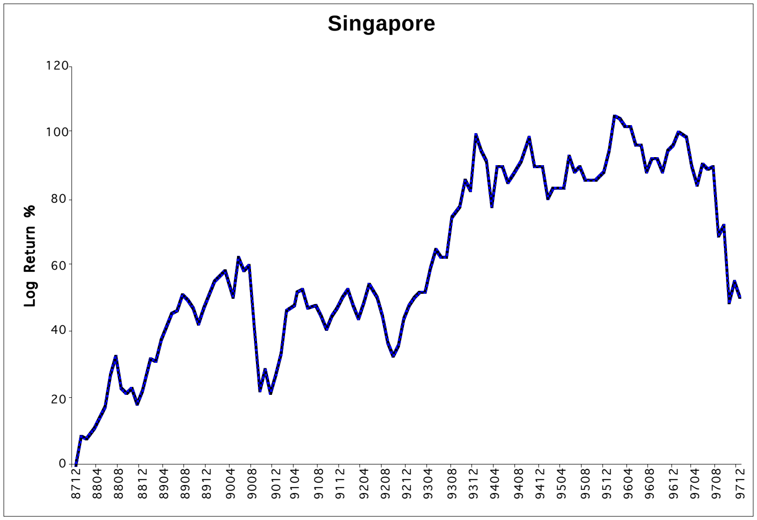
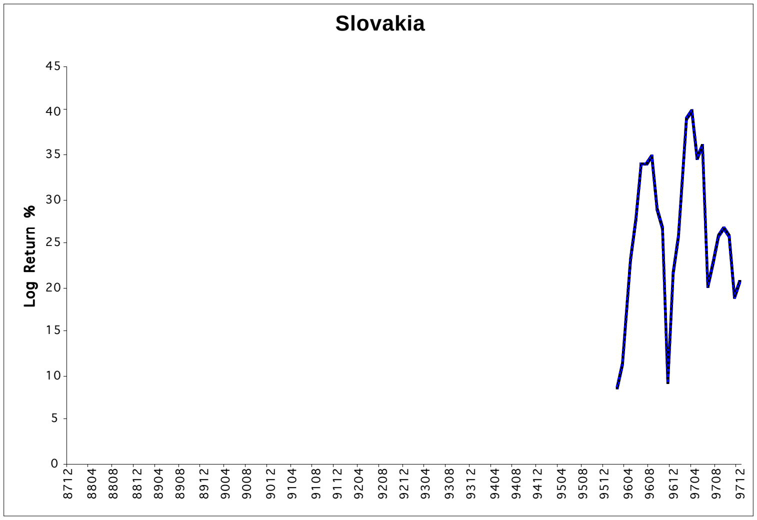
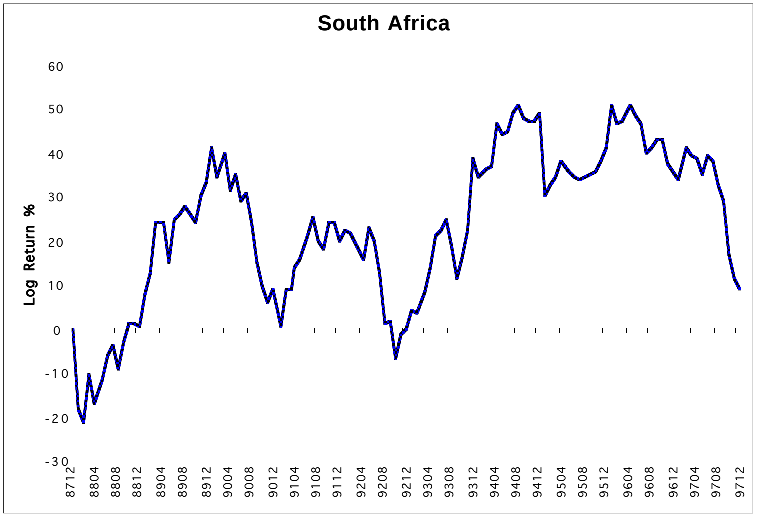


Singapore



Slovakia



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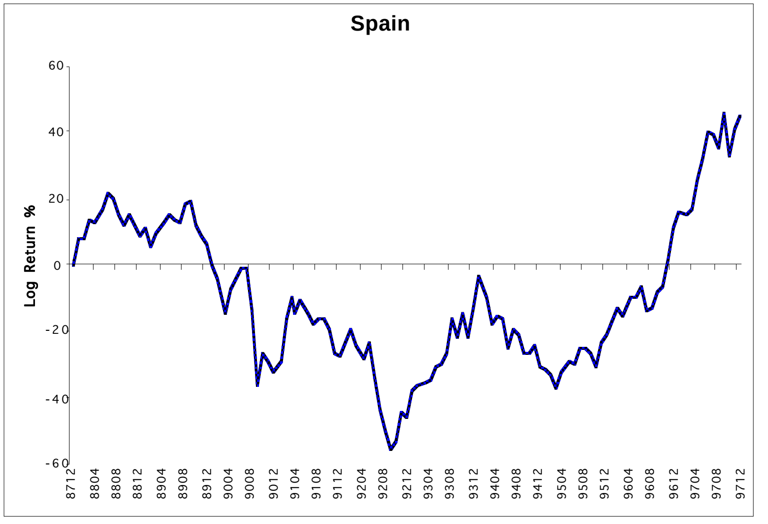
Spain
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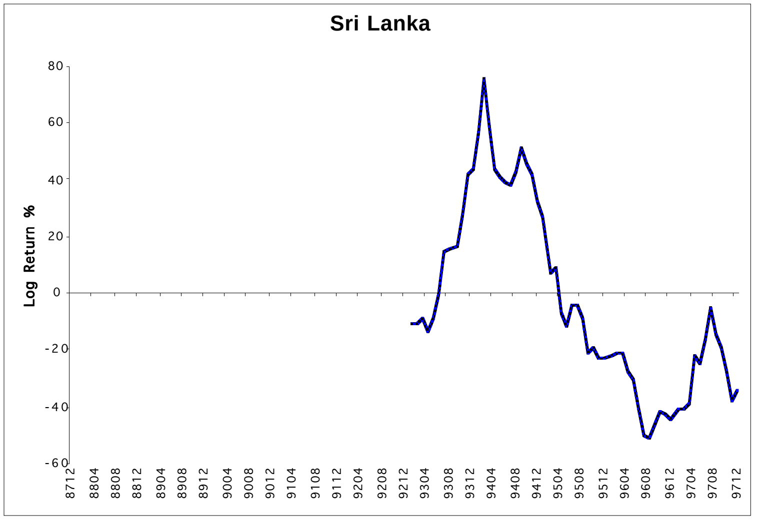
Sri Lanka
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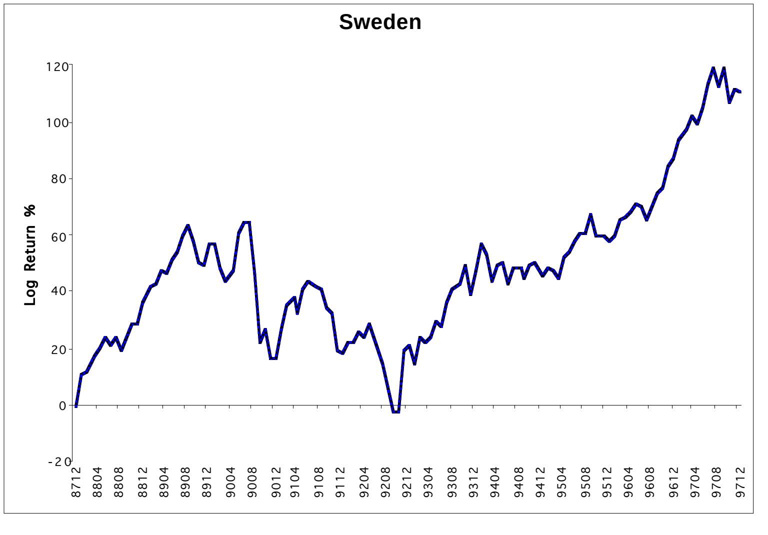
Sweden
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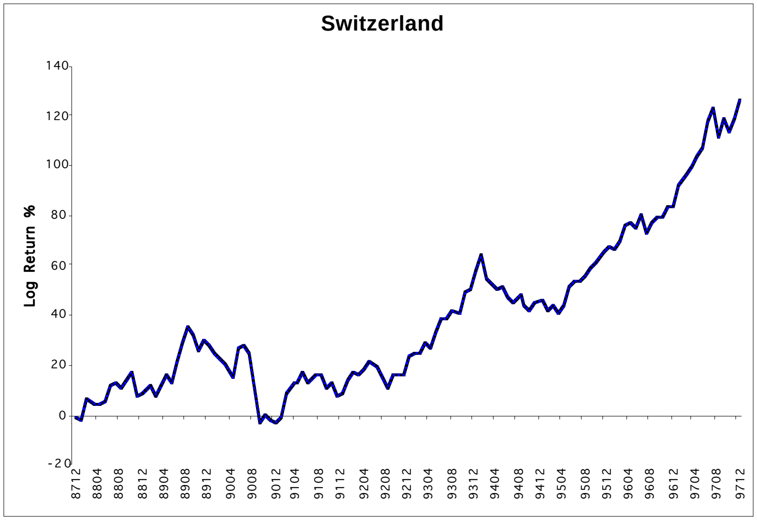
Switzerland
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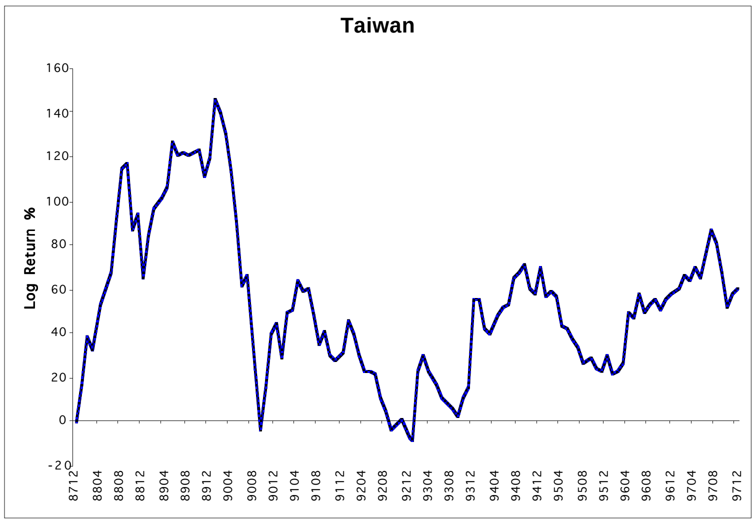
Taiwan
Log Return %
160
140
120
100
80
60
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-20
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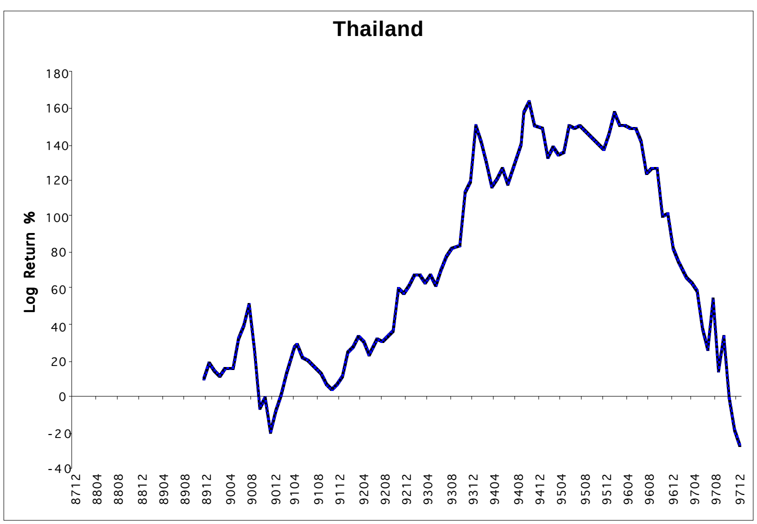
Thailand
Log Return %
180
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120
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80
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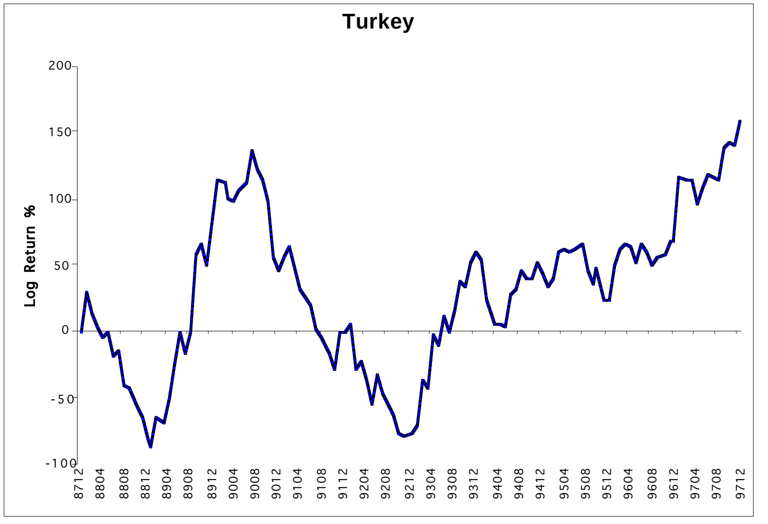
-40
8712 8804 8808 8812 8904 8908 8912 9004 9008 9012 9104 9108 9112 9204 9208 9212 9304 9308 9312 9404 9408 9412 9504 9508 9512 9604 9608 9612 9704 9708 9712


Turkey
Log Return %
200
150
100
50
0
-50
-100
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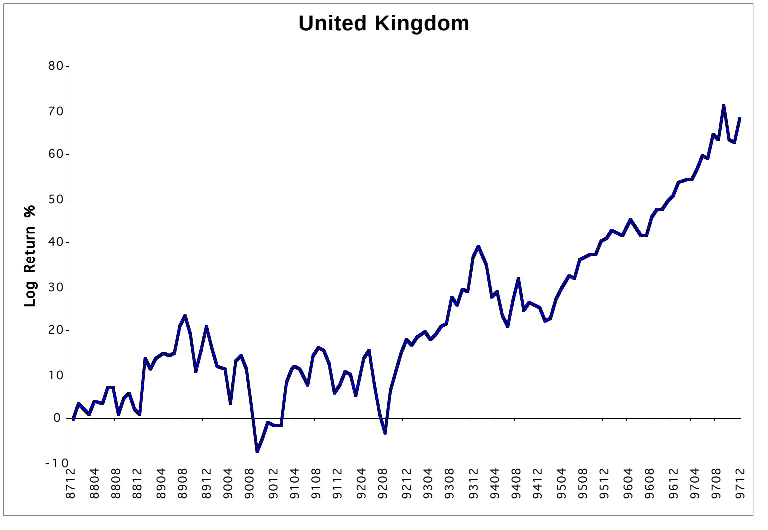
United Kingdom
Log Return %
80
70
60
50
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30
20
10
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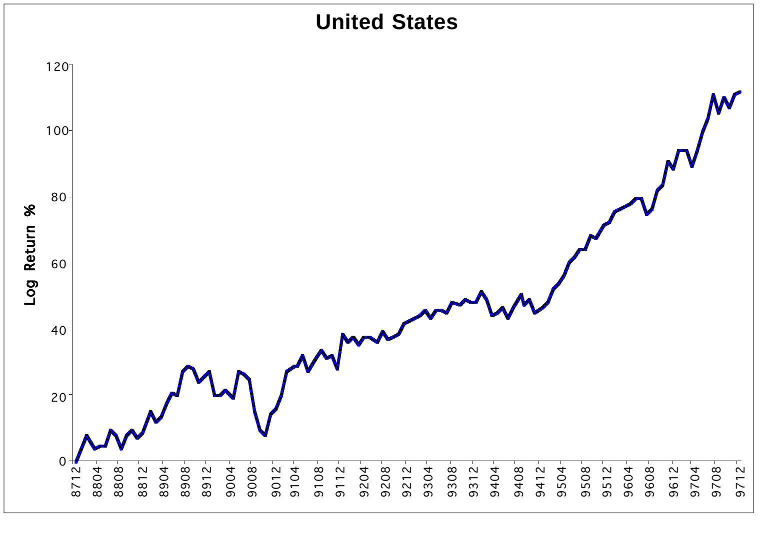
United States
Log Return %
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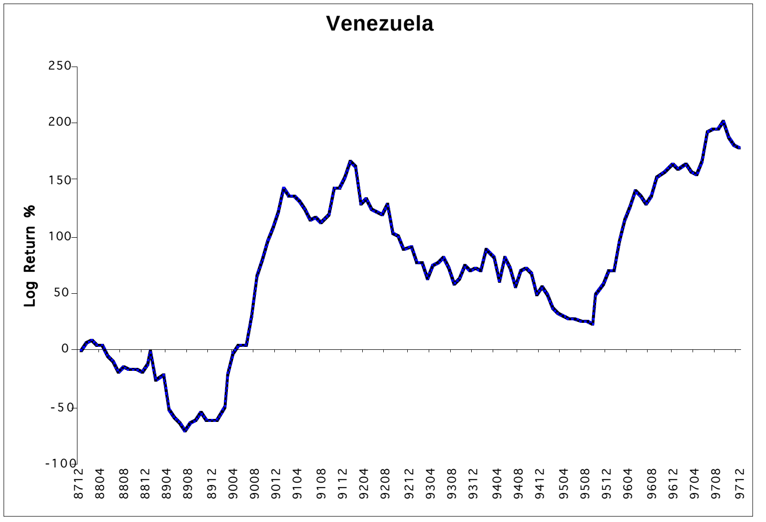
Venezuela
Log Return %
250
200
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-100
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9004
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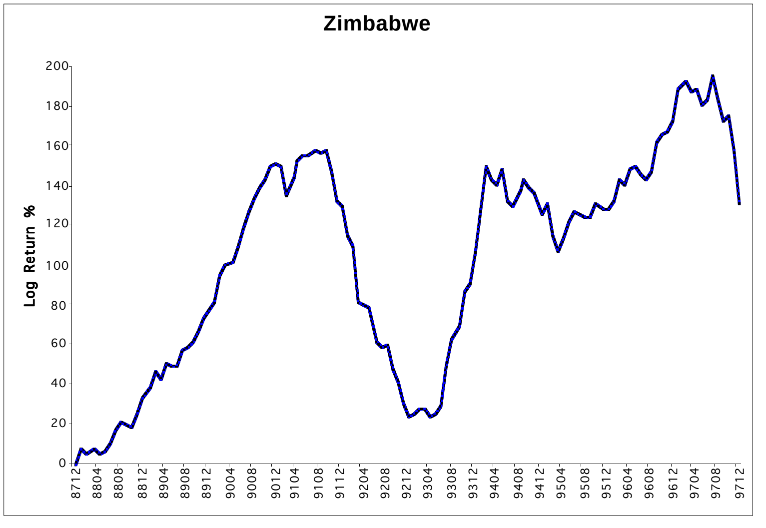
Zimbabwe
Log Return %
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Appendix I:
GEM-FT Specific Risk Summary

This table summarizes the distribution of annualized specific risk forecasts for each market in the GEM-FT model as of December 1997. The specific risk model forecasts the volatility of excess asset returns not explained by common factors.

Country	Mean	Median	Minimum	Maximum	Standard Deviation
Turkey	54.54	52.79	40.00	70.00	10.34
Thailand	44.26	41.16	21.00	69.85	11.87
Zimbabwe	43.82	40.16	24.84	70.00	11.96
India	40.43	39.43	20.57	70.00	11.49
Philippines	39.84	39.21	17.46	70.00	11.81
China	38.97	38.49	21.10	70.00	8.60
Pakistan	38.08	36.78	19.05	70.00	10.61
Poland	38.07	37.72	24.25	65.58	8.09
Venezuela	37.68	37.03	23.40	51.68	6.97
Peru	37.65	33.07	16.98	70.00	12.64
Korea	37.62	36.29	21.69	66.13	8.58
Czech Republic	37.22	36.13	16.88	61.64	11.99
Russia	36.78	38.20	25.23	40.00	3.80
Brazil	35.84	33.45	24.79	52.75	7.75
Slovakia	35.39	36.95	26.60	40.00	4.53
Hungary	33.69	32.40	23.85	41.79	5.66
Malaysia	33.57	32.41	13.48	57.74	9.51
Egypt	33.49	34.53	21.00	40.00	5.05
Indonesia	33.46	32.68	18.27	70.00	9.04
Sri Lanka	33.27	31.87	15.85	68.10	9.59
Israel	32.89	33.92	20.90	40.00	5.62
Argentina	32.48	32.17	14.61	63.43	11.64
Morocco	31.19	30.90	19.32	40.00	5.60

Country	Mean	Median	Minimum	Maximum	Standard Deviation
Taiwan	29.98	28.64	14.87	55.28	8.87
Greece	29.57	26.84	13.63	69.39	11.14
Chile	28.75	27.79	17.46	46.08	6.99
Nigeria	28.65	24.72	13.68	64.20	11.55
Colombia	27.93	26.82	13.24	60.39	11.29
Finland	26.61	24.59	20.98	53.31	6.52
South Africa	26.52	25.34	10.31	45.53	7.67
Norway	26.23	24.46	13.51	70.00	8.90
Mexico	25.42	25.23	14.70	36.35	5.23
Hong Kong	24.61	25.05	9.94	48.83	8.02
Canada	23.98	22.29	9.54	57.20	9.15
United States	23.63	20.85	4.28	68.84	9.63
Jordan	23.11	22.49	8.19	53.20	7.10
Italy	22.81	22.07	11.47	38.85	5.97
Japan	22.65	21.72	7.07	37.90	7.13
Sweden	22.51	20.67	14.14	39.22	6.53
Portugal	22.40	20.78	10.61	44.14	8.27
Singapore	22.13	21.51	13.53	43.76	6.56
Austria	21.50	19.73	12.95	41.61	6.34
Denmark	21.04	19.20	12.57	37.65	7.08
France	20.63	19.66	8.62	44.91	5.74
New Zealand	20.41	19.32	11.54	40.86	8.43
Switzerland	20.24	19.35	11.12	34.21	5.63
Ireland	19.99	19.14	12.07	34.81	6.71
Australia	19.88	17.53	10.21	44.26	7.74
Spain	19.66	19.10	12.21	33.23	5.58
United Kingdom	19.65	19.31	5.02	52.60	6.05
Germany	19.18	17.85	11.03	39.80	5.96
Netherlands	17.17	15.23	7.53	26.29	4.97
Belgium	13.35	12.30	8.10	23.19	3.48

Glossary

active fee	The portion of the management fee that is in excess of the sum likely to be charged for passive management.
active frontier	The set of optimal increments to expected return that are obtainable from active management. It is a path, in the shape of a quadratic curve, rising upward from the optimal passive portfolio to higher levels of reward at higher levels of risk.
active holding	The difference between the total holding in a portfolio and the normal holding in a portfolio. When the normal holding is not clearly defined and the comparison portfolio is the market portfolio, the base from which the active holding is computed is a levered market portfolio with a beta equal to that of the portfolio in question ("equal beta, levered market portfolio").
active management	Portfolio management that uses information to generate transactions with the intent of providing greater returns than the passive strategy of matching a benchmark. Active management is characterized by a process of continued research to generate superior judgment.
active return	The increment in portfolio expected return due to active management. In general, active return can be earned in four distinct ways: transaction effectiveness, market timing, common factor positioning, and specific returns. In each case the return results from an active position differing from the benchmark position.
active risk	The risk arising from active management in excess of the risk that would be incurred at the normal position. The main sources of active risk are market timing, common factors, and specific risk associated with stock selection.
aggressiveness	For a given set of judgments, taking larger positive positions in stocks believed to be undervalued and selling off a larger amount of those stocks believed to be overvalued. The extent to which holdings are enlarged to respond to judgment.

alpha

The "risk-adjusted expected return" or the return in excess of what would be expected from a diversified portfolio with the same systematic risk. When applied to stocks, alpha is essentially synonymous with misvaluation: a stock with a positive alpha is viewed as undervalued relative to other stocks with the same systematic risk, and a stock with a negative alpha is viewed as overvalued relative to other stocks with the same systematic risk. When applied to portfolios, alpha is a description of extraordinary reward obtainable through the portfolio strategy. Here it is synonymous with good active management: a better active manager will have a greater positive alpha at a given level of risk.

For expository purposes, alpha is usually expressed as percentage annual return, that is, 1 percent per annum. For mathematical purposes, alpha is expressed as an adjustment to proportional return (or logarithmic return), again expressed as an annual rate, that is, 0.01.

alpha, historical

The difference between the historical performance and what would have been earned with a diversified market portfolio at the same level of systematic risk over that period. Under the simplest procedures, historical alpha is estimated as the constant term in a time series regression of the asset or portfolio return upon the market return.

alpha, judgmental

The final output of a research process, embodying in a single quantitative measure the degree of under- or overvaluation of the stocks. Judgmental alpha is a product of investment research and unique to the individual or organization that produces it. It is derived from a "forecast" of extraordinary return, but it has been adjusted to be the expected value of subsequent extraordinary return. For example, among those stocks that are assigned judgmental alphas of 2 percent, the average performance (when compared to other stocks of the same systematic risk with alphas of zero) should be 2 percent per annum. Thus, average experienced performance for any category of judgmental alpha should equal the alpha itself. A judgmental alpha is a prediction of future performance, not retrospective evaluation of past performance.

alpha, required

The risk-adjusted expected return required to cause the portfolio holding to be optimal, in view of the risk/reward tradeoff. The required alpha is found by solving for the contribution of the holding to portfolio risk and by applying a risk/reward tradeoff to find the corresponding alpha.

Arbitrage Pricing Theory (APT)	Developed in the 1970s, the theory which asserts that security and portfolio returns are based on the expected returns attributable to an unknown number of underlying factors. APT provides a complementary alternative to its precursor, the Capital Asset Pricing Model.
asset allocation	The process of assigning investments across broad categories or sectors of assets. The sectors typically considered include equities, bonds, real estate, and international investments. The output of asset allocation is a set of normal investment proportions in the various sectors. The decision as to individual assets within the sectors is ordinarily not considered in asset allocation, although broad characteristics, such as the normal beta or the normal yield, in sectoral portfolios can be treated as part of asset allocation.
basis point	A basis point is 1/100 of 1 percent.
Bayes' Law	Named after Reverend Thomas Bayes, the rule whereby various independent sources of evidence are combined to obtain an optimal estimate or prediction. The rule states that each element of evidence should be weighted inversely to its error variance.
Bayesian adjustment	Refers to a statistical procedure in which judgmental data are combined with empirical data. The optimal Bayes estimator is that combination of the individual's prior judgment and the evidence from observations of the process (measurement) which has the smallest mean square error (or error variability) in prediction. A security's judgmental alpha can be viewed as a Bayesian adjustment of the analyst's forecast. The pension sponsor's forecast of the alpha obtained from a money manager is a Bayesian adjustment of the historical performance of the money manager, with adjustment for other evidence on the money manager which influences judgment.
benchmark	A standard of comparison for investment performance and risk control to evaluate and track performance of investment managers. Benchmarks can be generally accepted market-weighted or customized portfolios.

beta

The systematic risk coefficient that expresses the expected response of asset or portfolio excess return to excess return on a market portfolio. For example, a beta of 1.5 implies that if the excess return on the market portfolio is positive, 1.5 times this positive return can be expected, while if the excess return on the market portfolio is negative, 1.5 times this negative return can be expected. The concept of a beta coefficient can be applied to an asset, to a portfolio, or even to one "market portfolio" when compared to another. Various surrogates for the market portfolio can be used when computing the beta coefficient, and it is now the general practice to use the SAP500 as a surrogate. For strictly correct definition, the beta coefficient would have to be computed relative to the true portfolio of all assets (both financial and nonfinancial). The beta coefficient can also be viewed as the regression coefficient of the security return upon the market return.

BARRA risk models compute the predicted, or fundamental, beta for a portfolio. The predicted beta forecasts a portfolio's exposure to market risk using fundamental risk characteristics of assets and market data. Unlike historical beta, predicted beta quickly adapts to changes in a firm and in the market.

beta, historical

Historical measure of the response of a company's return to the market return, ordinarily computed as the slope coefficient in a 60-month historical regression.

beta, long-term

Prediction of the market response of a company's return to the market return over a long horizon (five years).

beta, predicted

Predicted systematic risk coefficients (predictive of subsequent response to market return) that are derived, in whole or in part, from the fundamental operating characteristics of a company. Also called *fundamental beta*.

beta, short-term

Prediction of a systematic risk coefficient in the near future (a horizon of three months, applying to market response over this brief horizon).

bounded influence regression (BIF)

A regression technique that downweights the most influential observations. This helps to ensure that models are robust against outliers.

capital asset pricing hypotheses

Relationships between asset characteristics and asset values that can be expected to obtain over the long term in capital markets. The most prominent hypotheses are derived from features of competitive equilibrium in capital markets that can be expected to persist over the very long term. The most important among these are hypotheses that expected security returns will be increasing functions of security features such as systematic risk, taxable yield, smallness or total risk, or negative skewness.

Capital Asset Pricing Model (CAPM)

The simplest version states that the expected excess return on securities will be exactly in proportion to their systematic risk coefficient, or beta. The CAPM implies that total return on any security is equal to the risk-free return, plus the security's beta, multiplied by the expected market excess return. Extensions of the capital asset pricing model admit other capital asset pricing hypotheses (*see* **capital asset pricing hypotheses**).

capitalization

The product of the market price and the total amount of a security outstanding. It represents the total market value of the security in the hands of its investors.

certain equivalent expected return (CEER)

The total utility of a risky investment, expressed in terms of units of certain reward. The CEER is the expected reward, which, if it were known with certainty, would give the same satisfaction to the investor as the risky investment in question. The CEER can be viewed as equal to the expected reward on the risky investment, less a deduction for the disutility of the variance of that investment.

certain equivalent increase in reward (CEIR)

The difference in expected reward measuring, in units of expected reward, the improvement of a superior portfolio over an inferior one. The construct can be extended to take two portfolios of similar but not identical risk and to apply an adjustment for disutility of variance, to convert the portfolio with higher risk to an equivalent portfolio at the lower risk, and then to compute the CEIR as the difference between the expected reward of the equivalent portfolio and the expected reward of the interior portfolio.

coefficient of determination (R-squared or R^2)
A statistical term describing the fraction of variance in the dependent variable that can be explained by the independent or explanatory variable(s). The coefficient of determination is a pure number ranging from 0 to 1, with 1 giving perfect explanation. It is often used to describe the fraction of investment risk in portfolios that can be associated with market risk. R-squareds (R^2s) for singly managed portfolios typically range from 0.8 to 1, with a median at about 0.95. For multiply managed pension sponsor portfolios, R-squareds presently range from about 0.96 to 1, with a median at about 0.98.

commingled fund
An investment fund in which the manager pools the assets of several trust accounts to permit more efficient management and to reduce administrative costs. Also called *collective investment fund* or *common fund*.

common factor
An element of return that influences many securities and hence is a "common factor" in the returns on those securities. Common factors can be associated with relevant features of stocks that cause them to be exposed. Important features that acquire associated common factors are industry groupings and risk indices. By virtue of their common influence on many stocks, they contribute to market return as well as residual returns of the stocks that they influence most.

common factor, residual
The residual common factor is equal to the "risk-adjusted" common factor, which is obtained by subtracting from the common factor the expected response of that factor to the market portfolio. It is also the contribution to securities' residual return from the common factor, with the common factor's contribution to the systematic return of securities having been deducted. It is the element of securities' residual return that is common across securities.

comparison portfolio
The portfolio used to define the return against which another portfolio is to be evaluated. Present developments are leading toward the substitution of better surrogates for the market portfolio and in some cases a replacement of the market portfolio by the normal universe.

confidence region
A statistical term defining a range of values within which we have a certain degree of confidence that a random variable will fall. The most commonly used region is the 95 percent confidence region, which is such that we can expect 95 percent of values to fall within it. This region approximately spans +2 standard deviations centered on the mean.

constraint In portfolio optimization, a limitation imposed upon the portfolio so that it will have desired characteristics.

continuous return Also called *continuously compounded return*. Defined as the logarithmic return (*see* logarithmic return).

core/noncore Partitioning of funds between a passively managed portfolio (core) which is like an index fund and an actively managed portfolio (noncore). Different clients have different mixtures of these two portfolios, and hence experience combined portfolios with different aggressiveness.

correlation A statistical term giving the strength of linear relationship between two random variables. It is a pure number, ranging from -1 to +1: +1 indicates a perfect positive linear relationship; -1 indicates a perfect negative linear relationship; 0 indicates no linear relationship. For jointly distributed random variables, correlation is often used as a measure of strength of relationship, but it fails when a nonlinear relationship is present.

covariance The tendency of different random investment returns to have similar outcomes, or to "covary." When two uncertain outcomes are positively related, covariance is positive, and conversely, negatively related outcomes have negative covariances. The magnitude of covariance measures the strength of the common movement. For the special case of a return's covariance with itself, the simplified name of variance is used. Covariance can be scaled to obtain the pure number, correlation, that measures the closeness of the relationship without its magnitude.

covenant information ratio An agreement between money manager and client as to the expected information ratio (*see* information ratio) to be produced by the manager. The agreement is intended as a guideline for the appropriate behavior on the part of the manager and for appropriate evaluation practice on the part of the client, and in this sense represents a "covenant."

cumulative return The investment return accumulated over a number of periods, ordinarily expressed as a proportional return.

currency return The exchange return to a currency, from the numeraire perspective, plus the risk-free return of the currency less the risk-free return of the numeraire currency.

currency risk	The risk that arises from being exposed to currencies other than the numeraire currency.
custodian	A depository of securities for purposes of safekeeping. The custodian may collect income and dividends and do simple reporting on the assets without fiduciary responsibility.
dependence-adjustment factor (DAF)	A multiplicative factor applied to the expected reward from a money manager to correct for dependence between the manager's judgmental process and the judgmental processes of other money managers in the client's multiply managed portfolio. If one money manager's judgmental process is entirely independent of the judgmental processes of the others, the adjustment factor will be 1, and no change will occur. Typically, when money managers' judgments are positively interdependent, the dependence-adjustment factor will be less than 1 and will have the effect of scaling down information content. However, peculiar patterns of interdependence can give rise to adjustment factors that are greater than 1 or negative.
descriptor	A variable which is computed by a prespecified formula to describe the individual firm. Approximately 40 descriptors of individual companies are used as a basis for the risk indices and risk predictions in the Fundamental Risk Measurement Service.
directed trust	A custodian with the added capability of fiduciary responsibility. The directed trustee typically has investment responsibility for short-term cash reserves.
discretionary trust	A trust for which the trustee has investment responsibility for the assets.
distribution, lognormal	A probability distribution for which the logarithm of the variable is normally distributed (*see* distribution, normal). The distribution arises when a number of independent random factors are multiplied together, and consequently it is to be expected from a compounding of a series of independent returns.
distribution, normal	The familiar bell-shaped curve which is called the "normal" distribution because it is the distribution that occurs when large numbers of independent factors are added together. It is a symmetrical distribution, with approximately two-thirds of all outcomes falling within ± standard deviation and approximately 95 percent of all outcomes falling within ± 2 standard deviations.

disutility of variance A debit against the desirability or "utility" of an investment that arises from the variability in investment outcomes. Thus, the utility of an investment is reduced by the disutility of its variance.

disutility-of-variance coefficient The coefficient that, when multiplied by the variance of an investment, produces the disutility of that variance. The form of this coefficient is the ratio of the unit of return to a certain number of units of variance. When these units are computed for percentage return, a typical magnitude for the coefficient would be the range of 1/100, that is, the disutility of 100 units of variance is one unit of expected return.

diversification The reduction in risk that is obtained by investing (positive) wealth in assets which are not perfectly positively correlated. Diversification is the spreading of risk among a number of different investment opportunities. Since the assets are not perfectly correlated, losses of any one asset tend to be offset by gains on other assets. In this manner, the risk of a portfolio may well be less than the average risk of its constituent assets. The measure of diversification is either the R (the positive square root of the coefficient of determination) or residual standard deviation (*see* hedging).

efficient frontier A general term for the set of optimal portfolios at differing levels of reward and variance. Each portfolio on the frontier offers the highest possible expected reward at its level of variance, and the lowest possible variance at its level of expected reward. The term is also used for total investment results, the source of which can be decomposed into the efficient frontier from passive management and the active efficient frontier. The total efficient frontier is the "envelope" of combinations of passive and active frontiers (*see* passive frontier and active frontier).

employee benefit trust A trust that holds the assets of a pension, profit-sharing, stock bonus, or thrift plan operated for the benefit of a corporation's employees or a labor union's members.

equity A general term applied to common stock and to other instruments that are highly sensitive to the total value of the firm and hence behave like common stock. The latter category includes warrants and, usually, all convertible senior liabilities, such as preferred stock and convertible bonds. Nonconvertible preferred stock, although technically equity, is sometimes excluded from this group and lumped along with bonds.

estimation	Process that finds the parameters of the model that fit the data best, given the random nature of the data. The estimated model is not "true," but is thought of as a closest approach to the underlying or "true" model. The discrepancy between the estimated model values and these underlying but unknown values is called estimation error.
excess return	The return in excess of a risk-free rate, computed by subtracting the promised risk-free rate from a security's return.
exchange rate return	The return due to the change in the spot exchange rate.
expansion path	A series of investment strategies, each of which is optimal according to an external criterion but which differ along some axis, such as aggressiveness or systematic risk. No point on the expansion path is dominated by any other, so that a separate external criterion must be applied to select the optimal point for any particular investor.
expected return	The average investment return. Expected return is the mean of the probability distribution of investment return.
expected value	A statistical term, also called the *mean* (*see* mean).
exponential weighting	A statistical method in which observations are given exponentially declining weights the further back they are in time.
external information	Information on a process other than observation of the process itself. When applied to the problem of predicting investment performance, external information refers to all information about the skills of the money manager, except historical performance, which is the direct observation of past output of the management process. External information supplements historical performance as a basis for predicting future performance.
extra-market covariance (XMC)	The element of risk in investment returns arising from common factors net of the market or, in brief, from extra-market factors. XMC is one of the four elements of portfolio risk, along with systematic risk, risk from market timing, and specific risk.

fail float	The cash balance arising when security (particularly purchase) transactions are not completed on the settlement date by the delivery of securities. After a transaction has been made, it must be settled in five business days. Master trusts make the cash available on the fifth day, but if the securities are not delivered, the cash can be invested in a short-term investment fund for at least one day.
fiduciary	A person who, by acting for another's benefit, holds a legally enforceable position of trust.
FTEUR	Acronym for the Financial Times-Actuaries Europe Index.
FTWLD	Acronym for the Financial Times-Actuaries World Index.
GARCH	Acronym for Generalized Autoregressive Conditional Heteroskedasticity. A statistical process that captures the degree of persistence in asset return volatilities by modeling asset volatilities as a combination of long-run mean volatility, recent volatility, and recent squared deviations of returns from their mean. BARRA applies a GARCH(1,1) process, so-named because it applies one lag in the forecast variance and one lag in squared return. Hence, we scale the factor covariances each month to reflect GARCH forecasts that respond to recent market volatility.
generalized least squares (GLS)	Regression method used to obtain the most efficient estimates of the model parameters. Conceptually, the weighting can be understood as inverse to the disturbance, or error variance: the greater the error variance, the smaller the weight given to an observation or to a dimension within the observations.
hedging	The process whereby the risks of several opportunities are largely or completely ("perfect hedge") offset. Hedging requires either that the two opportunities be negatively correlated (gold stocks and brokerage firm stocks or a put option and its underlying security), in which case positive amounts are invested in both opportunities, or that the two opportunities are positively correlated (a call option and its underlying security or two very similar securities), in which case one opportunity is short-sold. Hedging is the offsetting of risk; diversification is the spreading of risk (*see* diversification).

historical performance A record of past returns on a managed portfolio, usually monthly or quarterly, which is usually analyzed in connection with a comparison portfolio. Performance is analyzed for accomplishment (measurement of total return) and evidence of ability (attribution of performance to its causes).

holdings, investment The fraction of a portfolio or index in a given asset. For example, a holding of 0.03 corresponds to the investment of 3 percent of the value of the portfolio in that asset. Holdings are usually expressed as percentages for expository purposes. The sum of portfolio holdings is always 1 (*see* investment proportion).

incidental bet An unintended exposure to a risk factor resulting from an active management strategy. For example, a U.S. investor who picks only high-yield stocks may make an incidental bet on utilities.

index fund A particular passive strategy which attempts to match the return on a market index.

indifference curve A line joining all of the situations which are equally satisfying to the investor. An investor's preferences can be described by a collection of indifference curves varying from lower to higher, such that movement from one curve to a higher curve is desirable and movement along a curve is a matter of indifference. One use of the curves is to represent the characteristics of a complicated risky portfolio by the riskless portfolio that is indifferent to it. Another key application is that the slope of the indifference curve, when plotted in mean/variance space, yields the risk/reward tradeoff.

industry grouping A homogeneous collection of business endeavors. Each company is assigned to a single principal industry. Common factors associated with industry groups are an important element in multiple factor risk models. A portfolio's exposure to an industry group, arising from the companies in that group which are held in the portfolio, is a source of common factor exposure. Industry factors are associated with each of the industry groups.

information coefficient A measure of the precision in an analyst's forecast that is imprecisely defined in current practice as the coefficient of determination (*see* coefficient of determination), or its square root, between forecasts and subsequent performance.

information ratio The ratio of the expected excess reward for an activity to the standard deviation of that activity. The more positive the ratio is, the more desirable is the activity. Since it is the ratio of a mean to a standard deviation, the information ratio is conceptually related to a *t*-statistic. An information ratio may also be called a reward-to-variability ratio. For active management, the information ratio equals alpha/omega. For passive investment, the information ratio equals (Excess return on the market)/(Standard deviation of market return).

investment proportion Also called *weight* or *holding*. The ratio of the total invested value in an activity to the total value of the portfolio. Such proportions are usually represented as percentages for exposition, but for mathematical applications are represented by decimal fractions.

isoreward line Also called *isoreward contour.* A line joining all portfolios that offer equal total reward. Since the expected return function is linear in portfolio holdings, the isoreward contours are straight lines. Like the contours on a topographical map, isoreward lines can be used to represent a three-dimensional reward surface in two dimensions.

isovariance contour Lines that represent the collection of portfolios with constant variance. Since variance is a quadratic function of investment holdings, the variance surface is a conic section and isovariance contours are ellipses. When investment is constrained, the isovariance contour is more complex, but retains an elliptical quality.

levered market portfolio Any mixture of the risk-free asset and the market portfolio of all risky assets. In fact, when the investment in the market portfolio is between 0 and 100 percent, it is a mixture of the market portfolio and of lending at the risk-free rate. When the investment in the market portfolio is greater than 100 percent, there is true leverage, in the sense that funds borrowed at the risk-free rate are invested in the market portfolio. The beta of the levered market portfolio is equal to the investment fraction in the market portfolio. Hence, a perfectly diversified portfolio at a given level of beta, the "equal-beta levered market portfolio," is obtained as the mixture of the risk-free asset and the market portfolio, with the investment fraction in the market portfolio equal to that beta.

local market risk The risk, excluding currency risk, that arises from investments within a particular country.

logarithmic return The logarithm of the proportional return, or of 1 plus the rate of return. Since returns are compounded over time by multiplication, and since multiplication corresponds to addition to logarithms, logarithmic returns are added over time to obtain the cumulative logarithmic return. Where the return is relatively small in magnitude, 100 times the logarithmic return approximates the rate of return on the security. Also called *continuously compounded rate of return* (*see* continuous return).

long position An investment holding that is positive (*see* short position).

management fee The fee charged by the money manager for supervision of investment, as distinct from the custodial or trustee fee. The lowest management fee is generally charged for passive management, with higher fees for active management. Each manager's fee schedule generally encourages large pools of money, with a declining fee for each increment of funds added. Aside from the distinction between passive and active management, few, if any, fee schedules now include an increase in cost for greater aggressiveness. However, money managers who charge higher fees are typically more aggressive.

market capitalization The market value of all outstanding shares, whatever their ownership. Thus, a company's closely held shares are included in this count. Market capitalization represents the value of a company's equity to all investors and consequently the portion of a company's value in the total market portfolio.

The difficulty with this definition arises when a company's shares are held by another company whose equities are also included in the market portfolio. If the value of the first company's shares contributes to the value of the second company's shares, the first company's shares will be double-counted. Therefore, for correct definition, market capitalization should exclude shares held by other companies whose common stock is included in the computation of the market portfolio, or, equivalently, the value of the shares held by the other companies should be deducted from their market capitalization. From a computational point of view, the latter procedure is simpler.

market inventory fund A method of using the assets of an index fund to save transaction costs in a multiply managed portfolio. Each of the managers is required to offer a trade to the inventory fund before dealing with outside brokers. The inventory fund is rebalanced periodically while tracking the index.

market portfolio — The portfolio of all assets other than the risk-free asset. For practical purposes, it seems to be impossible to extend this portfolio far beyond the market portfolio of financial assets, and even here, surrogates that include only a fraction of all financial assets are generally used. Since the market portfolio contains all assets, the weight of each asset in the portfolio is in proportion to its outstanding value, or its market capitalization.

market price — Ideally, a market clearing price such that when all participants thoughtfully considered whether or not to demand the asset, the market would be cleared at that price.

master trust — A pooling of one sponsor's assets, which may include multiple managers and multiple plans, into a single-trust entity through which the sponsor can fund all of its employee benefit plans and thereby simplify their administration.

mean — The value that is to be expected on average. Among many repetitions or trials of the random process, this will be the average value.

mean/variance ratio — The ratio of the mean expected excess return on an element of investment to the variance of return. The conditions for optimization of a portfolio across several investment opportunities take the form that mean/variance ratios be equal, or strongly related.

median — A statistical term denoting the value of a random variable, such that 50 percent of all outcomes lie above this value and 50 percent lie below.

mode — A statistical term denoting the most likely value of a random variable. For the normal distribution, the mean, median, and mode coincide; for asymmetric distributions, they may differ.

modern portfolio theory — The theory of portfolio optimization which accepts the risk/reward tradeoff for total portfolio return as the crucial criterion. Derived from Markowitz's pioneering application of statistical decision theory to portfolio problems, optimization techniques and related analysis are increasingly applied to investments.

MSEAFE — An acronym for the Morgan Stanley Capital International Europe Australia Far East Index.

MSEUR An acronym for the Morgan Stanley Capital International Europe Index.

MSWLD An acronym for the Morgan Stanley Capital International World Index.

multiple-factor model (MFM) A specification for the return process for securities. This model states that the rate of return on any security is equal to the weighted sum of the rates of return on a set of common factors, plus the specific return on the security, where the weights measure the exposures (or sensitivity) of the security to the factor. These exposures are identified with microeconomic characteristics, or descriptors of the firms (*see* descriptor).

Several simplifications of this model have been used historically. If there is only one factor, it becomes a single-factor model; if this one factor is identified with an index, it is called a single-index model; if the single-factor is identified with the market factor, it becomes the market model. Depending on the statistical specification, some of these could become a diagonal model, which simply indicates that the covariance matrix between security returns is (or can easily be transformed into) a diagonal matrix.

multiple management The common practice among pension sponsors with larger portfolios of apportioning the funds among several managers, each responsible for one component. Multiple management is a form of decentralized decision making whereby the sponsor provides certain central guidelines and each manager then has decentralized responsibility for acting within them.

normal aggregate portfolio The aggregate portfolio that a pension sponsor determines would be optimal over the long run in the absence of special information. Timely, superior information generated in the course of active management would cause holdings to deviate from this normal position, and as the nature of special information averages out over time, these deviations can be expected to average to zero. Hence, the central tendency of actively managed portfolios over the long run should equal the normal aggregate. The normal aggregate is established with long-run considerations in mind as a portfolio that would be ideal in view of equilibrium rewards in the capital markets that are consistent with capital asset pricing hypotheses accepted by the investor. The extent to which risk is taken in the normal aggregate portfolio reflects the risk/reward tradeoff of the investor.

normal portfolio — Also called *normal universe*. The average position or portfolio to be expected from a given manager over a long horizon. A managed portfolio differs from the normal portfolio as a consequence of active present positions based on special information. The normal portfolio can often be approximated by taking the capitalization-weighted universe of common stocks followed by the manager (the normal universe). Sometimes, however, the manager will follow this universe but establish normal targets with respect to industries and risk indices that differ from the capitalization-weighted average characteristics of the universe. In this case, it is best to establish the normal portfolio by averages of these target values.

normalization — The process of transforming a random variable into another form with more desirable properties. One example is standardization in which a constant (usually the mean) is subtracted from each number to shift all numbers uniformly. Then each number is divided by another constant (usually the standard deviation) to shift the variance.

numeraire — The currency from which international investments are viewed. This is usually the investor's domestic currency.

optimal passive portfolio — The equilibrium passive investment vehicle. Also called *normal portfolio* or *normal aggregate portfolio* (*see* normal portfolio and normal aggregate portfolio).

optimization — The best solution among all the solutions available for consideration. Constraints on the investment problem limit the region of solutions that are considered, and the objective function for the problem, by capturing the investor's goals correctly, providing a criterion for comparing solutions to find the better ones. The optimal solution is that solution among those admissible for consideration which has the highest value of the objective function. The first-order conditions for optimality express the tradeoffs between alternative portfolio characteristics to provide the optimum solution.

ordinary least squares (OLS) — The most common regression method, used to compute parameter values such that the squared differences between data values and fitted values are minimized (*see* generalized least squares).

outlier — A data observation that is very different from other observations. It is often the result of an extremely rare event or a data error.

passive frontier The efficient frontier composed solely from passive (informationless) management. In the case where the optimal passive portfolio is a levered market portfolio, the passive frontier is composed of different mixtures of the risk-free asset and the market portfolio.

passive management Any investment practice that achieves a stated investment goal, on the assumption that security returns are at equilibrium levels, so that disclosure of the assumption will not change expected security returns. In its narrow usage, passive management refers to the maintenance of index funds whose goal is to closely match the return on a fixed index. In this connection, asset management involves the control of portfolio holdings and effective transaction procedures so as to assure that the portfolio return will be near to the index return. In a more general sense, passive management can be applied to any management procedure that does not generate superior information (information that is, by nature, competitive and that would lose its value if it were possessed by others), so that disclosure of the investment procedure in no way reduces its validity. An example of the wider definition of passive management would be a yield-tilted portfolio with an unchanging objective.

performance analysis Evaluation of performance in relation to a standard or benchmark with the purpose of assessing manager skill.

performance attribution The process of attributing portfolio returns to causes. Among the causes are the normal position for the portfolio, as established by the owner of funds or the manager, as well as various active strategies, including market timing, common factor exposure, and asset selection. Performance attribution serves an ancillary function to the prediction of future performance, in as much as it decomposes past performance into separate components that can be analyzed and compared with the claims of the manager.

performance measurement The process of computing experienced performance in a portfolio in order to measure the manager's contribution. The computation of portfolio return should allow for adjustments reflecting contributions and withdrawals by the owner of the funds, and for a procedure to compute the time-weighted rate of return in view of these portfolio flows. In addition, the treatment of dividends and coupons should account for appropriate reinvestment.

prior judgment — A term (from Bayesian statistics) referring to the expectations of the analyst before confronting the data on the case in question. In the context of performance prediction, prior judgment is drawn from the recognition that the money management business is competitive, so that the average money manager, by an accounting identity, earns the average return to all managed portfolios, less the average management fee. Prior judgment is further implemented by the analyst's belief as to the range of skills across the population of money managers. Each money manager subsequently encountered is viewed at first from this prior perspective, and Bayesian modification leads to posterior appraisal of abilities which uses subsequent evidence.

R-squared (R^2) — The square of the multiple correlation coefficient. Also called *coefficient of determination* (*see* coefficient of determination).

rate of return — The change in value of the investment, which includes capital appreciation (or loss) plus cash yield, divided by the initial value. Rate of return is usually expressed, for expository purposes, as a percentage of the annual rate, but for mathematical purposes it is expressed as a decimal fraction (that is, 0.07 for a 7 percent return).

regression — *See* generalized least squares and ordinary least squares.

residual — A statistical term for that part of a variable that is unexplained by some underlying factor. For example, residual return is usually defined as that part of return that is not explained by the systematic factor (often the market portfolio) in a model of systematic and residual return. Similarly, residual risk is that part of risk that arises in addition to risk from the market factor. *Residual* also refers to the difference between actual data and data fitted to the model.

residual common factors — *See* common factors, residual.

residual return — The component of return that is uncorrelated with the return on the market portfolio (or the comparison portfolio). Also called *unsystematic* or *diversifiable return*. All components of active management except market timing contribute to residual return at one point in time.

residual risk — The component of risk associated with residual risk return. Residual risk is composed of extra-market (or common factor) covariance and specific risk.

return	The ratio of the value of an investment at the end of a period, plus any payouts during the period, divided by the initial value. Return is (depending on the length of the period) a number close to 1.0 and represents one plus the rate of return (*see* rate of return).
reward-to-variability ratio (RVR)	A synonym for *information ratio* (*see* information ratio).
reward/variance	Another name for the mean/variance ratio, equal to the ratio of expected excess return to variance of return (*see* mean-variance ratio).
risk	The uncertainty of investment outcomes. Technically, risk defines all uncertainty about the mean outcome, including both upside and downside possibilities. The more intuitive concept for risk measurement is the standard deviation of the distribution, a natural measure of spread. Variance, the square of the standard deviation, is used to compare independent elements of risk.
risk-acceptance parameter (RAP)	The extent to which an investor will accept or tolerate risk in pursuit of expected reward; also called *risk-tolerance parameter*. A larger value for the parameter implies an investor will take greater risks in pursuit of the same opportunity. Thus, an investor with a higher risk-acceptance parameter will ordinarily invest a larger fraction of the portfolio in equities, as opposed to less risky alternatives such as bonds, than will an investor with a lower risk-acceptance parameter.
risk-free return	Also called *risk-free rate*. The certain return promised on the purely "risk-free" investment. Conceptually, such an investment should have guaranteed purchasing power at its termination. In practice, the construct is usually defined by the rate of return on U.S. Treasury securities for the investment period. These securities have no risk in nominal returns but substantial risk in real purchasing power.
risk index	A variable computed for each asset, such that the variable determines the asset's exposure to a common factor. Risk indices include size, success, value, market variability, etc. In each case, a higher value of the index implies a company that is more strongly exposed to the common factor.

risk/reward tradeoff The point where the added benefit from a larger position is just offset by the increased risk. Thus, at the optimum position, a tradeoff between the contribution to reward and the contribution to risk from increased pursuit applies. At optimum, the same tradeoff will apply for all investment opportunities, unless other investment objectives intervene.

sector portfolio A representative portfolio for a group of assets that combine to make up a sector. For example, the EMWLD, or some other equity universe, might be a representative portfolio for the equity sector. Thus, sector is a more precise definition of the misnomer market.

selectivity (stock selection) The pursuit of active holdings in individual stocks, as distinct from market timing. Under this definition, selectivity would include both common factor positioning and individual stock selection. As an intuitively clear reference to positioning for specific returns only we generally refer to selectivity as *stock selection* or *stock-picking*, reserving the term of *common-factor positioning* for exposure to common factors.

Sharpe ratio The square of the information ratio, equal to the squared mean excess return divided by the variance of return. When an investment portfolio is constructed over a wide range of independent opportunities, the Sharpe ratio for the optimum total portfolio is the sum of the Sharpe ratios for the separate opportunities. Thus, the Sharpe ratio, although much less intuitive than the information ratio, is used in determining the benefit from combining separate opportunities.

short position (short-sell) A negative investment holding. Institutional investors (with the exception of certain mutual funds) are prevented from taking short positions. Typically, the closest these investors can get to a short position is to write call options.

short-term investment fund (STIF) A cash management tool designed to maximize income to a master trust. Its principal use in the daily investment of dividends and fail float.

significance (statistical significance)

A statistical term used to suggest that a hypothesis is importantly confirmed (or, more properly, that the opposite hypothesis is importantly denied) by data. The usual criterion for statistical significance is that there is only a 5 percent (or 1 percent) chance that the result could have arisen by chance if the opposite hypothesis were true. For example, abnormal performance is said to be significant when there is only this very small probability that the performance could have arisen by chance if the true hypothesis were that no skill was present.

simulation

The procedure in which a model of a process is built and then operated, so that the characteristics of the true process can be described by the characteristics of the operating model.

simulation, stochastic

The special form of simulation that is required when some of the variables in the model are random (stochastic). In this case, simulation usually requires (particularly when the model is nonlinear) that the model be operated many times, each time using one realization of the possible values of the random variables. The frequency distribution of the model outcomes is then used to approximate the true probability distribution of the process.

Size

A risk index that values total assets and market capitalization of each firm.

specific returns

Returns that are specific to a company and are uncorrelated (or negligibly correlated) with the specific returns on other companies. Specific returns are also called *unique*, *idiosyncratic*, or *independent* returns. The risk and reward arising from these specific company factors are also called *specific risk* and *specific reward*.

standard deviation

A statistical term which measures the spread or variability of a probability distribution. The standard deviation is the square root of variance. Its intuitive meaning is best seen in a simple, symmetrical distribution, such as the normal distribution, where approximately two-thirds of all outcomes fall within ± 1 standard deviation of the mean, approximately 95 percent of all outcomes fall within ± 2 standard deviations, and approximately 99 percent of all outcomes fall within ± 2.5 standard deviations. The standard deviation of return—or, more properly, of the logarithm of return, which is approximately symmetrically distributed—is very widely used as a measure of risk for portfolio investments.

standard error A statistical term defined as the standard deviation of error in an estimate. The error in the estimate arises from disturbances in the data unrelated to the true process. The standard error measures the degree of uncertainty in the estimate of the true process that is caused by the presence of these disturbances. It can be computed, knowing the nature of the data and inferring the amount of uncertainty from the scatter of actual data about the fitted model. One of the important principles of statistical estimation is that attached to every estimate should be a standard error that gives the accuracy of the estimate. When comparing alternative modes of estimation, the one with the lower standard error is the more statistically efficient and is preferred.

standardization The scale of descriptors and risk indices. Standardization entails setting the zero point and scale of measurement for the variable. An example might be taken from temperature, where the centigrade scale is standardized by setting zero at the freezing point of water and establishing the scale (the centigrade degree) so that there are 100 units between the freezing point of water and the boiling point of water. Standardization for risk indices and descriptors sets the zero value at the capitalization-weighted mean of the companies in the universe and sets the unit scale equal to one cross-sectional standard deviation of that variable among the 1,000 largest firms.

Success The risk index that measures the success of a stock over the last year and the last five years. Success is determined by both earnings growth and superior stock market performance.

systematic The component of return that is associated with the broad-based market or sector portfolio. Also, the reward expected from the market portfolio and the risk of that reward are referred to as *systematic reward* and *systematic risk*. More generally, the risk and reward of any asset that can be associated with that asset's exposure to the market are termed *systematic*. *Systematic reward* generally refers to the excess return, rather than to total return, associated with the market.

systematic frontier The reward/risk opportunities from investment in the market portfolio. When unlimited borrowing at the risk-free rate is available, the systematic frontier is a simple quadratic curve, beginning with zero risk at the risk-free asset. When borrowing is precluded, it is a simple quadratic curve through to the market portfolio and tails off thereafter, as the higher-beta strategies can only be obtained by imperfectly diversified portfolios that add residual risk (*see* passive frontier).

systematic portfolio The portfolio that defines systematic risk, and relative to which betas are estimated (*see* sector portfolio).

***t*-statistic** A statistical term for the difference between a random variable and its mean, divided by the standard deviation of the random variable. When the random variable is estimated from a population of n observations and the standard deviation is estimated from the residual variability of that population, the resulting ratio has a well-known distribution called the t-distribution. Consequently, the t-statistic can be used to do a test of whether the random variable differs significantly from the hypothesized mean. Where the number of observations, n, is greater than 30, the distribution is quite close to the normal distribution. When using a t-statistic for skill or information content, we are looking for large positive values of the statistic that urge us to reject the null hypothesis that no skill or information is present (that the mean is zero).

tracking error The annualized standard deviation of the difference between portfolio return and benchmark return. *Predicted tracking error* is also known as *active risk*. *Realized tracking error* is also known as *active return*.

transaction costs The costs incurred for a portfolio when securities are changed for other securities. Transaction costs are deducted from the value of the portfolio directly, rather than paid as fees to the money manager. These costs arise from three sources: (1) commissions and taxes paid directly in cash; (2) the typical "dealer's spread" (or one-half of this amount) earned by a dealer, if any, who acts as an intermediary between buyer and seller; and (3) the net advantage or disadvantage earned by giving or receiving accommodation to the person on the other side of the trade. The third component averages out to zero across all trades, but it may be positive or negative, depending on the extent to which a trader, acting urgently, moves the market against the selected strategy.

trust A fiduciary relationship in which the owner of property transfers legal title to a trustee who keeps or uses the property for the benefit of another person, the beneficiary. The creator of the trust may or may not be the beneficiary or trustee. Moreover, the beneficiaries may be of several classes—for instance, those who receive the income from the property ("income beneficiaries") or those who receive the proceeds from the final distribution of the trust.

trustee

An individual or institution (corporate trustee) that holds legal title to a property and administers it for the beneficiary. In the U.S., ERISA provides that every employee benefit plan shall be managed consistent with a trust instrument which specifies a "named fiduciary" who has the ultimate authority for the plan. Plan trustees, who have exclusive authority and discretion over the management of the fund's assets, are named in the trust instrument or appointed by the named fiduciary.

trust instrument

A written document setting forth the terms of the trust.

universe

The list of all assets eligible for consideration for inclusion in a portfolio. At any time, some assets in the universe may be temporarily ruled out because they are currently viewed as overvalued. However, the universe should contain all securities that might be considered for inclusion in the near term if their prices move to such an extent that they become undervalued. *Universe* also defines the normal position of a money manager, equating the normal holding with the capitalization-weighted average of the securities in the universe or followed list.

unsystematic return

A synonym for *residual return*—that part of return not associated with the market.

utility

A measure of the overall desirability or goodness of a person's situation. In the theory of finance, utility is the desirability of a risky series of outcomes. The utility (or expected utility) of a set of risky outcomes is assumed to measure its goodness, so that a package with higher utility is always preferred to one with lower utility. In portfolio theory, utility is almost always defined by a function of the mean and variance of portfolio outcomes, which is then called a mean/variance utility function. The further assumption that the utility function is linear in its two arguments (mean and variance) results in a linear mean/variance utility function (LMVU).

Value

A risk index based on the firm's forecasted earnings-to-price ratio, reported earnings-to-price ratio, reported book-to-price ratio, and yield.

value relative

The ratio of ending value to the beginning value. Sometimes called a *wealth-relative*.

Variability in Markets	A risk index that measures a company's volatility based on its historical behavior in capital markets as well as option-implied volatility.
variable aggressiveness	*See* aggressiveness.
variance	A statistical term for the variability of a random variable about its mean. The variance is defined as the expected squared deviation of the random variable from its mean—that is, the average squared distance between the mean value and the actually observed value of the random variable. When a portfolio includes several independent elements of risk, the variance of the total arises as a summation of the variances of the separate components.
Winsorization	The process of truncating outliers at a fixed number of standard deviations (usually 3) from the mean. This prevents unusual occurrences from having an undue influence on forecasts.
yield	The return on a security or portfolio in the form of cash payments. Most yield comes from dividends on equities, coupons on bonds, or interest on mortgages. Yield is usually described, for expository purposes, in percentage terms (that is, 7 percent per annum), but for mathematical purposes it is expressed as a decimal fraction (that is, 0.07).

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