Reading Assignments for this Week

Scan
Levich Chap 7 Pages
Foreign Exchange Market Efficiency
Luenberger Chap Pages

Read
Solnik Chap 3 Pages
Foreign Exchange Determination and Forecasting
Mishkin Chap 7 Pages
Rational Expectations, Efficient Market Hypothesis
http://www.pearsonhighered.com/mishkin/

Bernanke Chap 13 Pages
Exchange Rates, Business Cycles, and Macroeconomic Policy in the Open Economy

Thursday July 14, 2009
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Handout #9
Foreign Exchange Markets
Foreign Exchange Market Efficiency

Slides to highlight:

Course web page:
ID: mse247s  PAWWORD: Stanford88

Government Bonds: US, Australia, Brazil, Germany, H.K., Japan, UK


Currency Investing

http://finance.yahoo.com/currency-investing
Currency Futures Hedging


Foreign Exchange Markets

Foreign Exchange Market Efficiency

SPEED

Efficient Market:

Efficient market: a market in which security prices reflect all available information and adjust instantly to any new information.

If the security markets are truly efficient, then it will not be possible for an investor to consistently outperform stock market averages such as the S&P 500, except by acquiring more risky securities.

Significant evidence supports the premise that security markets are very efficient.
The notion of market efficiency and the efficient market hypothesis entered the vocabulary of finance in the 1960s.

Empirical work on the efficiency of foreign exchange markets accelerated after the introduction of floating exchange rates in the early 1970s, and there is now a substantial body of evidence in this field.

Floating exchange rate: an exchange rate between two currencies that is allowed to fluctuate with the market forces of supply and demand.

Floating exchange rates tend to result in uncertainty in the future rate at which currencies will exchange.

This uncertainty is responsible for the increased popularity of forwards, futures, and option contracts on foreign currencies.

As a theoretical matter, prices in a market economy are assumed to efficiently aggregate available information.

Prices function as “sufficient statistics” that lead agents to the same decisions as if they had access to the original raw information.

The models of exchange rate determination rely on the assumption that asset prices are set in efficient markets.

Our preference for equilibrium models of foreign exchange pricing is based on the premise that agents (in efficient markets) act to keep exchange rates at or near their equilibrium levels.

As a practical matter, market efficiency is an important benchmark that has a strong bearing on policies in the private sector pertaining to risk management and forecasting and policies in the public sector pertaining to central bank intervention.

If empirical evidence shows that foreign exchange markets are not efficient, then risk-adjusted profit opportunities are being missed and private agents can formulate strategies to capture them.

When foreign exchange markets are not efficient, exchange rate forecasts that outperform the forecasts implicit in the present market prices can be formulated.
A failure to find market efficiency is probably the most tantalizing possibility that private agents hope to encounter.

Public policymakers, on the other hand, would interpret a lack of foreign exchange market efficiency as a “market failure.”

A failure of markets to set equilibrium prices implies that costs are being incurred somewhere by someone; for example, in the form of reduced output, greater unemployment, or higher prices.

If empirical evidence shows that markets are efficient, then private enterprises can take market prices as the best possible reflection of available information.

Out-forecasting the market will be difficult, as will be earning unusual profits from open, speculative positions.

Open position: an option or futures contract that has been bought or sold and that has not yet been offset or settled through delivery.

In an efficient market, prices accurately capture the available information, so markets are simply the messengers conveying the news of the underlying and anticipated conditions in the exogenous variables, the stickiness of domestic prices, or other factors that determine the pattern of foreign exchange rates.

Interpretation of efficiency draws a distinction between market efficiency and optimality.

Market efficiency concerns the narrow question of whether private agents set prices that fully reflect available information.

An efficient financial market is efficient informationally - a market that removes all unusual profit opportunities.

Market efficiency is a less demanding test than the broader question of whether market prices are optimal in any sense - whether exchange rates are consistent with an efficient allocation of productive resources, targets for internal-external balance, or other public policy objectives.

If markets are efficient, public policy makers may still be “unhappy” with the level or course of exchange rates.

But in this case, policies must deal with the root causes of exchange rates themselves, rather than with exchange rates per se (considered alone) which are more a symptom of these underlying causes.
A capital market is said to be efficient if prices in the market “fully reflect” “available information.”

When this condition is satisfied, market participants cannot earn economic profits (that is, unusual, or risk-adjusted profits) on the basis of available information.

- Eugene Fama (1970)

“fully reflect” implies the existence of an equilibrium model (or benchmark), which might be stated either in terms of equilibrium prices or equilibrium expected returns.

In an efficient market, we expect the actual prices to “conform to” their equilibrium values, and actual returns to “conform to” their equilibrium expected values.

Malkiel’s first sentence repeats Fama’s definition. His second and third sentences expand the definition in two alternative ways. The second sentence suggests that market efficiency can be tested by revealing information to market participants and measuring the reaction of security prices. If prices do not move when information is revealed, then the market is efficient with respect to that information. Although this is clear conceptually, it is hard to carry out such a test in practice (except perhaps in a laboratory).

Malkiel’s third sentence suggests an alternative way to judge the efficiency of a market, by measuring the profits that can be made by trading on information. This idea is the foundation of almost all the empirical work on market efficiency. It has been used in two main ways.

First, many researchers have tried to measure the profits earned by market professionals such as mutual fund managers. If these managers achieve superior returns (after adjustment for risk) then the market is not efficient with respect to the information processed by the managers. This approach has the advantage that it concentrates on real trading by real market participants, but it has the disadvantage that one cannot directly observe the information used by the managers in their trading strategies.

As an alternative, one can ask whether hypothetical trading based on an explicitly specified information set would earn superior returns. To implement this approach, one must first choose an information set. The classic taxonomy of information sets distinguishes among Weak-form Efficiency, Semistrong-Form Efficiency, and Strong-Form Efficiency.

Define \( \hat{r}_{j,t+1} \) as the actual one-period rate of return on asset \( j \) in the period ending at time \( t+1 \), and \( E(\hat{r}_{j,t+1} | I_t) \) as the expected return conditional on available information \( I_t \) at time \( t \). Then the excess market return \( Z_{j,t+1} \) can be written as: \( Z_{j,t+1} = r_{j,t+1} - E(\hat{r}_{j,t+1} | I_t) \).
An efficient market has two defining characteristics: Firstly, the expected excess market return, \( E(Z_{j,t+1} | I_t) \) should equal 0, and secondly, \( Z_{j,t} \) should be uncorrelated with \( Z_{j,t+k} \) for any value of \( k \). That is, 
\[
E(Z_{j,t} \times Z_{j,t+k}) = E(Z_{j,t}) \cdot E(Z_{j,t+k})
\]
for any value of \( k \). Note that \( Z_{j,t} \) and \( Z_{j,t+k} \) are not necessarily independent.

These two properties together implies that the sequence \( \{ Z_t \} \) is a fair game with respect to \( I_t \). In words, the market is efficient if, on average, errors in the formulation of expectations about prices or returns are zero, and these errors follow no pattern that might be exploited to produce profits.

At times, we think about efficiency in terms of the level of prices instead of the rate of return for convenience. The link between today’s price \( (P_t) \) and the expected future price \( E(P_{t+1} | I_t) \) is given by:
\[
E(P_{t+1} | I_t) = [1 + E(\tilde{r}_{t+1} | I_t)]P_t
\]
where \( E(\tilde{r}_{t+1} | I_t) \) is the expected equilibrium yield on spot market speculation.

Again, market efficiency requires that the sequence of expected errors \( (X) \) follow a fair-game process:
\[
X_{t+1} = P_{t+1} - E(\tilde{r}_{t+1} | I_t)
\]

When prices evolve as a random walk, then tomorrow’s price \( (P_{t+1}) \) is equal to today’s price \( (P_t) \) augmented by an error term \( (u_{t+1}) \). The distribution of the error term \( (u) \) is independent and identically distributed over time.
Efficient Market Behavior with a Constant Equilibrium Expected Return

We can write this as:

\[ P_{t+1} = P_t \times e^{(r_0 + u_{t+1})} \]

Taking the natural logarithm, we have

\[ \ln(P_{t+1}) - \ln(P_t) = r_0 + u_{t+1} \]

\[ r_0 = 0 \Rightarrow \text{prices follow a random walk without drift} \]

\[ r_0 \neq 0 \Rightarrow \text{prices follow a random walk with drift} \]

Exchange Rate Levels and Changes Generated Using the Random-Walk (No-Drift) Model

In this experiment, we generated 200 random numbers \((u_t, \ t = 1, \ldots, 200)\), using the random number generator in Excel and placed the numbers in Column A of a spreadsheet. This can be done by clicking on the “TOOLS” menu and then “DATA ANALYSIS” and then “Random Number Generation.” We selected the normal distribution with mean 0 (to demonstrate the “no-drift” case) and standard deviation 1, and used the number 3,388 (an arbitrary choice) as the “random seed” requested by Excel.

Our Excel column B started with an initial exchange rate \((S_0)\) of 50. Each successive exchange rate is the previous rate augmented by the random number: \(S_t = S_{t-1} + u_t\). In Column C, we measured the percentage change in the rate from one observation to the next.

The graph of the level of exchange rates appears in Figure A below. It may look as if there are patterns in the series, but there are none because every successive change is the result of a random number. The graph of percentage changes appears in Figure B below. The time series plot shows little correlation from one observation to the next. The changes are distributed approximately normally as we would expect since the random numbers were generated from a normal distribution. The mean change is not significantly different from zero (representing the no-drift assumption). The standard deviation of the changes in Figure B is about 2.1 percent, which represents the standard deviation of the random numbers \((1)\) divided by the mean of the spot rate series in Figure A (about 4.5).

To see what happens in the case of a linear (or constant) drift, repeat this exercise, but pick random numbers with a mean of 0.1, 0.2, or −0.15 instead of zero.

Figure A: Exchange Rate Levels

Figure B: Exchange Rate Percentage Changes

Source: Brealey, Myers and Marcus, Corporate Finance
Each dot shows the returns on the New York Composite Index on two successive months between January 1968 and January 2007. This scatter diagram shows that there is also no relationship between market returns in successive months.

New York Composite Index Monthly Percentage Changes
Source: Brealey, Myers and Marcus, Corporate Finance

If you are not sure what we mean by "random walk," consider the following example: You are given $100 to play a game. At the end of each week a coin is tossed. If it comes up heads, you win 3% of your investment; if it is tails, you lose 2.5%. Therefore, your payoff at the end of the first week is either $103 or $97.50. At the end of the second week the coin is tossed again. Now the possible outcomes are as follows:

This process is a random walk because successive changes in the value of your stake are independent. That is, the odds of making money each week are the same, regardless of the value at the start of the week or the pattern of heads or tails in the previous weeks. If a stock's price follows a random walk, the odds of an increase or decrease during any day, month, or year do not depend at all on the stock's previous price moves. The historical path of prices gives no useful information about the future—just as a long series of recorded heads and tails gives no information about the next toss.

Can you tell which is which? The top chart shows the real Standard & Poor's Index for the years 1980 through 1984. The bottom chart was generated by a series of random numbers. You may be among the 50% of our readers who guess right, but we bet it was just a guess.

Cycles self-destruct as soon as they are recognized by investors. The stock price instantaneously jumps to the present value of the expected future price.

Efficient Market Behavior with a Constant Equilibrium Expected Return

We can write this as:

\[ P_{t+1} = P_t e^{(r_0 + u_{t+1})} \]

Taking the natural logarithm, we have

\[ \ln(P_{t+1}) - \ln(P_t) = r_0 + u_{t+1} \]

\[ r_0 = 0 \Rightarrow \text{prices follow a random walk without drift} \]

\[ r_0 \neq 0 \Rightarrow \text{prices follow a random walk with drift} \]

Recall our discussion of the International Fisher Effect (IFE), where the future spot exchange rate \((S_{t+1})\) is modeled as the current spot rate \((S_t)\) adjusted by the return differential on the two currencies.

\[
\frac{E(S_{t+1}) - S_t}{S_t} = \frac{i_S - i_f}{1 + i_f} \approx i_S - i_f
\]
If we augment the IFE with an error term \((u)\), we have:

\[ S_{t+1} = S_t \times e^{[(i_d - i_f) + u_{t+1}]} \]

Taking the natural logarithm, we have:

\[ \ln(S_{t+1}) - \ln(S_t) = (i_d - i_f) + u_{t+1} \]

The above equation portrays the spot exchange rate as following a random walk with drift equal to the interest differential.

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When Equilibrium Expected Returns Wander Substantially

Efficient market behavior continues to require that the actual returns oscillate randomly about expected returns to meet the criterion of a fair game.

However, in this case it is clear that the underlying asset prices did not evolve as a random walk with zero drift, or a random walk with constant drift, or a random walk with any other obvious pattern of deterministic drift.

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In the sticky-price version of the monetary model, we saw that in response to an unanticipated increase in the domestic money supply, the exchange rate depreciates immediately by an amount greater than what is required in the long run, and then appreciates asymptotically back to its long-run equilibrium value.

During the adjustment period, exchange rate changes are serially correlated and efficient market behavior requires that the actual exchange rates oscillate randomly about the benchmark.

Again, because the interest differential along the adjustment path always equals the percentage exchange rate change, there are no profit opportunities even though the adjustment path exhibits a trend.

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Interpreting Efficient Market Studies

In Figure 7.1, the series \(r_t\) appears to be priced efficiently against the benchmark \(E(r_{t+1} | I_t) = r_0\) But it would be priced inefficiently versus any other choice. Similarly, in Figure 7.2, the series \(r_t\) appears to be priced efficiently against the benchmark \(E(r_{t+1} | I_t) = r_0\)

But it is priced inefficiently against the benchmark \(E(r_{t+1} | I_t) = r_0\)
This illustrates that all tests of market efficiency are tests of a joint hypothesis:

1. The hypothesis that defines market equilibrium prices or market equilibrium returns as some function of the available information set, and
2. The hypothesis that market participants have actually set prices or returns to conform to their expected values.

Interpreting Efficient Market Studies

For empirical studies that reject market efficiency, it is impossible to determine whether an incorrect specification of the market’s equilibrium benchmark is responsible for the rejection or whether market participants were indeed inefficient information processors.

The theory of exchange rate determination developed in Chapter 6 found that various exchange rate levels and paths of adjustment could be offered as equilibrium paths.

Interpreting Efficient Market Studies

It need not be the case that the equilibrium exchange rate takes on a constant value, or that it follows a simple linear trend, or some other deterministic pattern.

The theoretical criterion of efficiency is for exchange rates to deviate randomly and with mean zero from their equilibrium value, which we have argued could itself wander substantially and in a serially correlated fashion.

Defining the Available Information Set

It is common to distinguish three types of market efficiency depending upon the information set, I:

- Weak form, in which the current price reflects all information in the historic series or prices.
- Semistrong form, in which the current price reflects all publicly available information.
- Strong form, in which the current price reflects virtually all available information, including proprietary and insider information.
Information and the Levels of Market Efficiency

Strong Form: All Public and Private Information
Semistrong Form: All Public Information
Weak Form: Past Prices

Fama (1991) proposed the following taxonomy:

- Tests of return predictability; indicating studies that examine whether returns can be predicted by historic prices or historic information on fundamental variables.
- Event studies, referring to studies that examine how prices respond to public announcements.
- Tests for private information, including studies that examine whether specific investors have information not in market prices.

Fama argues that the new terminology is more descriptive of the empirical work and consistent with the common usage.

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Weak-Form Tests and Tests of Predictive Ability

Given our discussion of equilibrium or benchmark models, it is apparent that weak-form tests of market efficiency (or tests of predictive ability) must be formulated and interpreted with caution.

Specifically, a test of whether the exchange rate follows a random walk or some other time series process cannot be offered as a test of efficiency when divorced from a model of the equilibrium exchange rate.

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Weak-Form Tests and Tests of Predictive Ability

Analysis of the statistical properties of exchange rates, however, may be useful for descriptive purposes.

For example, measuring deviations from PPP is useful for assessing changes in competitiveness across countries.

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Semi-Strong Form Tests and Event Studies

Similarly, semistrong form tests that draw on publicly available information (such as forward exchange rates and interest rates) will be heavily dependent on the model of equilibrium.

Monetary models of the exchange rate assume that financial assets denominated in different currencies are perfect substitutes.

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Semi-Strong Form Tests and Event Studies

With this assumption, we showed in Chapter 6 that the interest differential between domestic and foreign assets should equal the anticipated exchange rate change, and that the forward premium is an unbiased forecaster of the future exchange rate change.
However, within the class of portfolio balance models, financial assets denominated in different currencies are imperfect substitutes. According to this benchmark, the forward premium is a biased forecaster of the anticipated exchange rate change as a result of an exchange risk premium. Clearly, we must agree upon the exchange rate model before we can interpret semistrong form tests of market efficiency.

Empirical tests of the role of news are event studies that illustrate similar joint-hypothesis testing problems. In response to news about the money supply, interest rates, the fiscal budget deficit, and so on, we showed in Chapter 6 that a currency might logically appreciate or depreciate depending on the scenario for the future, which is typically unknown at the time of news release.

Strong form tests of market efficiency examine whether market prices fully reflect information available only to market insiders. This information set could include knowledge of intervention in the market by central bankers that is often kept secret, knowledge of customer orders that is available to interbank market makers, and proprietary models of exchange rate forecasting that have not been published or made available to a wide audience.

When the future spot rate is a random variable, the investor who holds a net (asset or liability) position in foreign currency is exposed to foreign exchange risk. Because a test of market efficiency tests a joint hypothesis, the specification of the expected equilibrium return for bearing exchange risk is critical. However, there is no general agreement on the appropriate model for the equilibrium pricing of foreign exchange risk. So, tests of efficiency under uncertainty will not lead to definitive results.

There are basically two techniques for bearing exchange risk: spot speculation and forward speculation. In either case, the profit depends on the expected future spot rate $E(S_{t+1}|F_t)$ which is uncertain. When interest parity holds, $F_t = S_t \frac{1+i}{1+i^*}$ And spot and forward speculation are equivalent investments that produce the same expected profits. Institutional factors and transaction costs will lead investors to pick the spot or forward market as the preferred venue for speculation.

The long run is a misleading guide to current affairs. In the long run we are all dead. Economists set themselves too easy, too useless a task if in tempestuous seasons they can only tell us when the storm is long past, the ocean will be flat.

- John Maynard Keynes
The primary technique for testing spot market efficiency has been to compute the profitability of various mechanical, or technical strategies.

Most of these studies are examples of weak-form tests (or tests of return predictability) that use only the past series of exchange rates to generate buy and sell trading signals.

A filter rule is defined by a single parameter (f), the filter size. An f percent filter rule identifies trends and generates buy and sell signals according to the following design:

- Buy a currency whenever it rises f percent above its most recent trough;
- Sell the currency and take a short position whenever the currency falls f percent below its most recent peak.

Typically, f is chosen to be a small number (e.g., 1%).

At the start of the process (t₁), the speculator has no foreign exchange positions. But she does have capital that earns interest at the risk-free rate and allows the speculator to enter into the transaction that follow.

Note: An f-percent filter rule generates buy signals when the currency rises f-percent above an interim trough (at points t₂, t₆, and t₁₀), and sell signals when the currency falls f-percent below an interim peak (at points t₄ and t₈). Initially (at t₁), the speculator has a net worth that allows him to execute transactions, but he holds no foreign exchange positions.

After a buy signal, the speculator takes a long position in DM by borrowing US$ and buying DM in the spot market.

After a sell signal, the speculator sells his DM holdings and takes a short position in DM by borrowing DM and buying US$ in the spot market.

The above transactions and positions are described in the following T-accounts.
At time $t_2$, the DM is assumed to have risen by 1%. The filter rule signals an upward trend in
the DM, and so the trading strategy calls for a
spot DM ($) purchase (sale).

The speculator borrows an amount of US$ and
uses it to purchase DM spot, which is invested
in an interest-bearing account.

The speculator’s position (long DM and short
US$) is described by the T-account
corresponding to time $t_2$.

The cost of taking on this position is the interest
differential $(i_{t,S} - i_{t,DM})$. The cost of holding this
position for $m$ days is

$$t_2 + m \sum_{t_2}^1 (i_{t,S} - i_{t,DM})$$

Compounding and Continuous Compounding

$A_0$ - principal; $r$ - interest rate; $t$ - the time period to maturity;
$A$ - principal and interest

If interest is calculated once every period

$$A = A_0(1 + r)^t$$

If interest is calculated $n$ times every period

$$A = A_0\left(1 + \frac{r}{n}\right)^{nt}$$

If interest is compounded continuously

Let $m = n / r$

$$A = A_0\lim_{n \to \infty} \left(1 + \frac{1}{m}\right)^{mnt}$$

Compounding and Continuous Compounding

If the $1,000 is invested for 3
years, the future value, assuming continuous
compounding, is equal to:

$$A = 1,000e^{0.10(3)} = 1,000(2.71828)^{3.0} = 1,349.86$$

The effective rate is

$$\sqrt[n]{\frac{1,349.86}{1,000}} = 1.10517$$

Again, the effective rate is 0.10517.
e = 2.71828 1828 45 90 45

\( e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \ldots \)

\[ \lim_{k \to \infty} (1 + \frac{r}{k})^{kt} = e^{rt} \]

\[ \lim_{k \to \infty} (1 + \frac{1}{x})^x = e \] (we let \( x = \frac{k}{r} = kt \) so that \( rt = 1 \))

The expected return on the currency position is

\[ \tilde{R} = \ln \frac{E(S_{t+m})}{S_t} = \ln E(\tilde{S}_{t+m}) - \ln S_t \]

In Interest Rate Parity, we balance the return on a US$ investment with the covered return on a US$ investment with the covered return on a UK £ investment. Let’s assume that the interest rates on the two securities are in continuous terms, the arbitrage condition becomes:

\[ S_1 \cdot e^{i_S} = S_1 \cdot \frac{1}{S_t} \cdot e^{i_E} \cdot E(S_{t+1}) \]

\[ \frac{S_t}{S_1} \cdot e^{i_E} = S_t \cdot e^{i_S - i_E} \]

\[ \ln \frac{F}{S} = i_S - i_E \]

In Interest Rate Parity, we balance the return on a US$ investment with the covered return on a US$ investment with the covered return on a UK £ investment. Let’s assume that the interest rates on the two securities are in continuous terms, the arbitrage condition becomes:

\[ S_1 \cdot e^{i_S} = S_1 \cdot \frac{1}{S_t} \cdot e^{i_E} \cdot E(S_{t+1}) \]

\[ \frac{S_t}{S_1} \cdot e^{i_E} = S_t \cdot e^{i_S - i_E} \]

\[ \ln \frac{E(S_{t+1})}{S_t} = i_S - i_E \]

Using continuous returns rather than simple returns is especially helpful when analyzing a time series of prices or returns.

Suppose that over \( N \) periods, a security appreciates from price \( P_0 \) to price \( P_N \). The total price change \( (P_N - P_0) \) can be decomposed into a sequence of changes \( (P_N - P_{N-1}) + (P_{N-1} - P_{N-2}) + \ldots + (P_2 - P_1) + (P_1 - P_0) \)

The logarithmic returns over these \( N \) periods: \( \ln(P_n/P_{n-1}), \ln(P_{n-1}/P_{n-2}), \ldots, \ln(P_2/P_1), \ln(P_1/P_0) \), when added together yield the total return \( \ln(P_N/P_0) \).

The simple mean and standard deviation of logarithmic returns result in unbiased estimates of average return and volatility.
Prices, Returns, and Compounding

Let \( P_t \) be the price of an asset at date \( t \) and assume that this asset pays no dividends. The simple net return, \( R_t \), on the asset between dates \( t-1 \) and \( t \) is:

\[
1 + R_t = \frac{P_t}{P_{t-1}} - 1
\]

The simple gross return on the asset is \( 1 + R_t \).

The asset’s gross return over the most recent \( k \) periods from date \( t-k \) to date \( t \), written \( 1 + \prod_{j=0}^{k} R_{t-j} \), is equal to the product of the \( k \) single-period returns from \( t-k+1 \) to \( t \):

\[
1 + \prod_{j=0}^{k} R_{t-j} = (1 + R_{t-k+1}) \cdots (1 + R_{t-1}) (1 + R_{t})
\]

The asset’s net return over the most recent \( k \) periods, written \( R_t^{(k)} \), is equal to its \( k \)-period gross return minus one.

These multiperiod returns are called compound returns.

Multiyear returns are often annualized to make investments with different horizons comparable:

\[
\text{Annualized } [R_t^{(k)}] = \left[ \prod_{j=0}^{k} (1 + R_{t-j}) \right]^{1/\bar{k}} - 1
\]

Since single-period returns are generally small in magnitude, the following approximation based on a first-order Taylor expansion is often used to annualize multiyear returns:

\[
\text{Annualized } [R_t^{(k)}] \approx \frac{1}{k} \sum_{j=0}^{k-1} R_{t-j}
\]

The difficulty of manipulating geometric averages motivates another approach to compound returns.

The continuously compounded return or log return \( r_t \) of an asset is defined to be the natural logarithm of its gross return \((1 + R_t)\):

\[
r_t = \log(1 + R_t) = \log \frac{P_t}{P_{t-1}} = \log p_t - \log p_{t-1}
\]

The advantages of continuously compounded returns become clear when we consider multiperiod returns:

\[
r_t^{(k)} = \log((1 + R_{t}) \cdots (1 + R_{t-k+1})) = \log(1 + R_{t}) + \log(1 + R_{t-1}) + \cdots + \log(1 + R_{t-k+1}) = r_{t} + r_{t-1} + \cdots + r_{t-k+1}
\]

Hence, the continuously compounded multiperiod return is simply the sum of continuously compounded single-period returns.

The expected profit from using the filter rule strategy at time \( t_2 \) is

\[
E(\pi_{t_2}) = \tilde{R} - C
\]

By time \( t_2 \), the DM has hit its peak. But the filter rule does not signal a change till time \( t_3 \). At time \( t_3 \), a sell signal causes the speculator to sell the original DM position (using the proceeds to repay the US$ loan) and short the DM (at \( S_{t_3} \)) [of the assumed size of US$1,000] in anticipation of a further fall in its price. The speculator’s new position (long US$ and short DM) is shown by the T-account corresponding to time \( t_4 \).

The cost of taking on this position is the interest differential \((i_{t_4,\text{DM}} - i_{t_4,\text{US}})\). The cost of holding this position for \( n \) days is

\[
\text{Cost} = \frac{t_{n,\text{DM}}}{t_{n,\text{US}}} \sum_{t_4}^{t_3} (i_{t,\text{DM}} - i_{t,\text{US}})
\]

The expected return on the currency position is

\[
\tilde{R} = \ln \frac{\text{Short-Sell Revenue}}{\text{Short-Sell Cost}} = \ln \frac{\text{S}_{t_3}}{E(S_{t_3})} = \ln S_{t_3} - \ln E(S_{t_3})
\]

This return is positive as \( E(S_{t_3+n}) < S_t \), which is the expected price at which the speculator will cover the short position.
The speculator’s profit (\(\pi\)) represents the incremental return from accepting a foreign exchange risk.

Recall that the speculator has pledged a certain amount of capital (net worth) which allows her access to the borrowing and lending capabilities of the foreign exchange market.

The speculator’s capital is assumed to earn interest at a competitive market rate (\(R_f\)). Thus, the total return from committing this capital to a trading strategy is \(R_f + \pi\).

Currency Futures Markets

Let’s apply the method to the currency futures markets.

In this case, the graph would represent the $/DM price of a DM currency futures contract. A long DM position implies buying the DM futures, and a short DM position implies selling the DM futures.

It would be necessary to take into account the interest cost of any short position or interest earned on any long position because the futures price itself already reflects these interest rates through the interest rate parity condition.

Trend Directions

The position of the moving average plot can be used to indicate the trend direction of a market.

<table>
<thead>
<tr>
<th>Market Signal</th>
<th>Price / Moving Average Relationship</th>
</tr>
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<tbody>
<tr>
<td>Bullish</td>
<td>Prices above moving average &amp; moving average moving up</td>
</tr>
<tr>
<td>Bearish</td>
<td>Prices below moving average &amp; moving average moving down</td>
</tr>
</tbody>
</table>

Buy / Sell Signals

The crossover is considered to be much more significant if both averages are moving in the same direction.

If both averages are moving up, then it is known as a Golden Cross. If both averages are moving down, then it is known as a Death Cross.
### Moving Averages

There are three types of moving averages used widely, all having benefits and drawbacks:

- **Simple Moving Average (SMA)**
- **Weighted Moving Average (WMA)**
- **Exponential Moving Average (EMA)**

**Formula for SMA**

\[
SMA = \frac{P_1 + P_2 + P_3 + \cdots + P_n}{n}
\]

- \(P_i\) = Price or value
- \(n\) = Number of days in period

SMAs provide a simple analytical technique. However, they inherently lag behind the market price action and therefore any signals produced will inevitably lag behind the trend change that caused the SMA to reverse direction. Short-term SMAs are more responsive than long-term ones.

### Moving Averages

**Weighted Moving Average**

This technique uses a mathematical algorithm which assigns a greater weight or importance to the most recent data.

**Exponential Moving Average**

This is similar to a WMA in that the average also assigns a greater weight to the most recent data. However, in this case, instead of using a fixed number of data points (the periodicity), the EMA uses all the data that is available. Each price entry becomes less significant but is still included in the calculation which uses a complicated formula.

### Moving Average Crossover Rule

Moving average crossover rule requires two parameters: the length (S, in trading days) of the shorter moving average (MA_s) and the length (L, in trading days) of the longer moving average (MA_l).

An S/L moving average rule is defined as follows:

- If \(MA_s > MA_L\), buy the foreign currency
- If \(MA_s < MA_L\), sell the foreign currency
- If \(MA_s = MA_L\), take no position.

### Moving Average Crossover Rule

Possible values of S/L are:

- \(1/5\) (representing today’s price relative to the last week)
- \(5/20\) (this week’s price relative to the last month)
- \(1/200\) (today’s price relative to the last 200 trading days)

The intuition of a moving average crossover rule is again to identify trading behavior in exchange rates.

### Illustration of 1/200 Moving Average Crossover Rule

Figure 7.4 illustrates the operation of a 1/200 moving average crossover rule using actual daily prices for the DM/$ rate over a period extending from 1986 to 1992.
Note: A moving average crossover rule generates buy signals when the short-term moving average rises above the long-term moving average (at points like $t_1$, $t_3$, and $t_5$), and sell signals when the short-term moving average drops below the long-term moving average (at points like $t_2$, $t_4$, and $t_6$).

As in our previous example, we assume that the speculator has no initial foreign exchange positions but has capital that permits entry into the transactions that follow.

The first signal appears at time $t_1$ when the spot rate ($M_{AS}$) exceeds the 200-day moving average ($M_{AL}$), thus triggering a buy signal. Since this exchange rate is quoted as DM/S, the speculator borrows an amount of DM and uses it to purchase US$, placing the funds in an interest-bearing account.

The position is closed out at time $t_2$ when the spot rate ($M_{AS}$) falls below the 200-day moving average ($M_{AL}$), thus setting off a sell signal.

We can see that the other transactions triggered by this moving average rule basically has the speculator buying US$ at low prices and selling US$ for DM at high prices, especially the long swings over periods $[t_6, t_7, t_8, t_9, t_{10}]$.

Following the passage of time in Figure 7.4, we can see that the short US$ position taken at time $t_2$ resulted in a positive currency return when closed out at time $t_3$.

The long US$ position taken at time $t_3$ posted a negative currency return when closed out at time $t_4$. But shorting the US$ at time $t_4$ resulted in a sizable currency return when the position was covered by buying US$ at a lower price at time $t_5$.

Profits from speculation using a moving average crossover rule are computed in an identical manner to the filter rule; namely, cumulative currency returns ($R$) minus cumulative interest costs ($C$).

Profits are again interpreted as the incremental return over the rate of interest earned on the speculator’s collateral capital.

The moving average crossover rule could be applied to currency futures as well as interbank spot exchange rates.
Tests of forward market efficiency generally focus on the relationship between the current n-period forward rate, $F_{t,n}$, the expected future spot rate, $E(S_{t+n}|I_t)$, and the actual future spot rate, $S_{t+n}$.

By definition, the forward exchange market is efficient when forward prices fully reflect available information.

The simple efficiency hypothesis reflects:
1. Rational expectations: $E(S_{t+n}|I_t) = S_{t+n}$
2. Forward rate pricing: $F_{t,n} = E(S_{t+n}|I_t)$

(7.6) are also known as “no currency risk premium hypothesis” or “forward rate unbiased condition.”

In the case of simple efficiency, $F_{t,n}$ is an unbiased predictor of $S_{t+n}$.

Other economic models, however, conclude that the equilibrium forward rate reflects a currency risk premium. We call it general efficiency hypothesis. The general efficiency hypothesis reflects:
1. Rational expectations: $E(S_{t+n}|I_t) = S_{t+n}$
2. Forward rate pricing: $F_{t,n} = E(S_{t+n}|I_t) + R_{P,t,n}$

Where $R_{P,t,n}$ represents the currency risk premium at time $t$ for maturity $n$.

In the case of general efficiency, $F_{t,n}$ becomes a biased predictor of $S_{t+n}$.

Most tests of forward market efficiency employ regression methodology to examine the relationship between the future spot rate (or the future spot rate change) and the past forward rate (or the past forward rate premium).

For example, in a regression of the form:

\[
S_{t+n} = a + bF_{t,n} + cX_t + e_t
\]  

(7.8)

We test whether $a=0$, $b=1$ and $c$ (the coefficient of any other variable $X_t$) = 0 under the null hypothesis of simple efficiency.

The residuals, $e_t$, should be free of serial correlation.

If $b \neq 1$ or $c \neq 0$, or if there is serial correlation in $e_t$, we reject the simple efficiency hypothesis.

When we reject simple efficiency, it may be possible to use (the RHS of) equation (7.8) to form forecasts (of future spot rate $S_{t+n}$) that out perform the forward rate ($F_{t,n}$).
We can recast equation (7.8) in rate-of-change form, asking whether the forward exchange premium embodies useful information regarding the future spot exchange change. A regression equation suitable for this equation is:

\[ \ln \frac{S_{t+1}}{S_t} = a + b \ln \frac{F_{t,t+1}}{S_t} + c \ln X_t + \epsilon_t \quad (7.9) \]

Again, simple efficiency requires that \(a=0\), \(b=1\) and \(c=0\). Otherwise, RHS of (7.9) might form a forecast that outperforms the forward premium.

Observations about Perfectly Efficient Markets

1. Investors should expect to make a fair return on their investment but no more.
2. Market will be efficient only if enough investors believe that they are not efficient.
3. Publicly known investment strategies cannot be expected to generate abnormal returns.
4. Some investors will display impressive performance records.
5. Professional investors should fare no better in picking securities than ordinary investors.

Stanford Nobel Laureates in (Financial) Economics

Kenneth J. Arrow
A. Michael Spence
Myron S. Scholes
William F. Sharpe

http://en.wikipedia.org/wiki/Kenneth_Arrow

Assignment for Chapter 7
Exercises 1, 2.
http://pages.stern.nyu.edu/~rlevich/datafile.html
This exercise is based on the simulation of exchange rates in Box 7.1.

a. Using Excel or other statistical software, replicate the graph in Figure A. Recall that the data were generated using a starting exchange rate $S_0 = 50$, and subsequent exchange rates determined by $S_t = S_{t-1} + \mu_t$, where $\mu_t$ are random numbers drawn from a normal distribution with mean $= 0$ and standard deviation $= 1$, and the “random seed” is 3,388.

b. Pick another random seed value, generate another set of $\mu_t$, and plot the new values for $S_t$ and the percentage change in $S_t$. Do you observe any patterns in your new graphs? Would you feel confident building a technical trading rule on the basis of these patterns?

c. Now, select another set of $\mu_t$ but now with a mean $= 0.2$ and a random seed of 3,388. Plot these new values of $S_t$ and the percentage change in $S_t$. Do you observe any patterns in your new graphs? Would you feel confident building a technical trading rule on the basis of these patterns?

It may look as if there are patterns in the series, but there are none because every successive change is the result of a random number. Therefore, I don’t feel confident in applying technical rules to such patterns.
7-2. Examine the daily closing price data on the DM/$ rate in file E07.WK1 that was used to construct Figure 7.5. Suppose you were using a 1% filter rule to trade the DM and USD.

a. On what day would the 1% filter rule have issued its first signal? Was this a buy or a sell signal? At what price did the trade occur?

b. On what day would the 1% filter rule have issued its second signal. Was this a buy or a sell signal? At what price did the second trade occur?

c. Calculate the profit from the first trade. Assume that transaction costs are 0.02% and that the interest rates were constant over the period with iDM = 3.0% and i$ = 5.5%.

d. Repeat questions a, b, and c assuming a 2 percent filter rule.

7.2 HINTS:

a. The price on July 10, 1986 is 2.166. So a 1% rule issues a buy signal at prices above 2.188 DM/$ and a sell signal at prices below 2.144 DM/$. The first signal occurs on July 11, 1986. It is a buy signal, that is Buy $ and Sell DM. The trade price is 2.194 DM/$.

b. On July 11, 1986, the interim high is 2.194, so a sell signal is issued at prices below 2.1721 DM/$. The second signal occurs on July 14, 1986. It is a sell signal, that is Sell $ and Buy DM. The trade price is 2.170 DM/$.

c. Profit has three components: (1) Gain on transaction = \( \frac{2.170}{2.194} - 1 \times 0.02\% = 0.04\% \), (2) Transaction costs = 2 x 0.02% = 0.04%, (3) Interest earned from long $ / short DM position at 2.5% per year for 3 days = 0.02%. Total = -1.1% - 0.04% + 0.02% = -1.12% in four days.

d-a. The price on July 10, 1986 is 2.166. So a 2% rule issues a buy signal at prices above 2.209 DM/$ and a sell signal at prices below 2.123 DM/$. The first signal occurs on July 21, 1986. It is a sell signal, that is Sell $ and Buy DM. The trade price is 2.122 DM/$.
Forecasting in a Fixed-Rate System

**Forecasting Indicators**
- Growth in money supply
- Government deficit
- Financing-level trends
- Domestic wage levels
- Productivity changes

**Environmental Indicators**
- Balance of trade
- Invisibles (tourism, services, etc.)
- Debt servicing requirements
- Capital flows—short term, long term
- Forward currency discount
- Black market or “free” market exchange rate

**Political Factors**
- Key decision makers
- Ideology of ruling party
- Additional economic goals
- Upcoming elections
- External political factors

**Internal**
- Inflation—traded goods sector, non-traded goods sector
- Interest rates—short-term, long term
- GDP growth rate

**External**
- Inflation rates in major trading partners—traded goods sector, non-traded goods sector
- Interest rates in other money markets
- Foreign GNP growth rates

1. Equilibrium Exchange Rate
2. Extent of Balance of Payments Deficit
3. Devaluation Pressure Coefficient
4. Estimate of Government Response
5. Effects of Policy Selected

**Possible Government Responses**
- Austerity (deflation)
- Exchange controls
- Induce capital inflows by a combination of monetary and fiscal policy
- Devaluation

Shapiro: Multinational Financial Management Exhibit 7.15
### Box 7.2 Positions, Profits & Losses Day-by-Day Using a Technical Trading Model

<table>
<thead>
<tr>
<th>Time</th>
<th>Day</th>
<th>Spot Rate $/DM</th>
<th>$\text{i}_S$</th>
<th>$\text{i}_{DM}$</th>
<th>Value of $\text{Position}$</th>
<th>Value of $\text{DM}$ Position</th>
<th>Net $\text{Gain/Loss}^\dagger$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_1$</td>
<td>1</td>
<td>0.5000</td>
<td>8.0%</td>
<td>5.0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$t_2$</td>
<td>10</td>
<td>0.5050</td>
<td>8.0%</td>
<td>5.5%</td>
<td>-$1,000.00</td>
<td>DM 1980.20</td>
<td>0</td>
</tr>
<tr>
<td>$t_3$</td>
<td>30</td>
<td>0.5500</td>
<td>8.5%</td>
<td>5.0%</td>
<td>-1,004.44</td>
<td>1986.25</td>
<td>$87.99$</td>
</tr>
<tr>
<td>$t_{4,P1}$</td>
<td>40</td>
<td>0.5445</td>
<td>8.5%</td>
<td>5.0%</td>
<td>-1,006.82</td>
<td>1989.01</td>
<td>$76.20$</td>
</tr>
<tr>
<td>$t_{4,P2}$</td>
<td>40</td>
<td>0.5445</td>
<td>8.5%</td>
<td>5.0%</td>
<td>1,000.00</td>
<td>-1836.55</td>
<td>0</td>
</tr>
<tr>
<td>$t_5$</td>
<td>70</td>
<td>0.4800</td>
<td>8.0%</td>
<td>5.5%</td>
<td>1,007.08</td>
<td>-1844.20</td>
<td>121.87</td>
</tr>
<tr>
<td>$t_{6,P1}$</td>
<td>80</td>
<td>0.4848</td>
<td>8.0%</td>
<td>5.5%</td>
<td>1,009.32</td>
<td>-1847.02</td>
<td>$113.89$</td>
</tr>
<tr>
<td>$t_{6,P2}$</td>
<td>80</td>
<td>0.4848</td>
<td>8.0%</td>
<td>5.5%</td>
<td>-1,000.00</td>
<td>2062.71</td>
<td>0</td>
</tr>
<tr>
<td>$t_7$</td>
<td>120</td>
<td>0.5300</td>
<td>8.5%</td>
<td>5.0%</td>
<td>-1,008.89</td>
<td>2075.31</td>
<td>91.03</td>
</tr>
<tr>
<td>$t_{8,P1}$</td>
<td>130</td>
<td>0.5247</td>
<td>8.5%</td>
<td>5.0%</td>
<td>-1,011.27</td>
<td>2078.19</td>
<td>$79.16$</td>
</tr>
<tr>
<td>$t_{8,P2}$</td>
<td>130</td>
<td>0.5247</td>
<td>8.5%</td>
<td>5.0%</td>
<td>1,000.00</td>
<td>-1905.85</td>
<td>0</td>
</tr>
<tr>
<td>$t_9$</td>
<td>135</td>
<td>0.5220</td>
<td>8.0%</td>
<td>5.5%</td>
<td>1,001.18</td>
<td>-1907.17</td>
<td>5.64</td>
</tr>
<tr>
<td>$t_{10,P1}$</td>
<td>145</td>
<td>0.5272</td>
<td>8.0%</td>
<td>5.5%</td>
<td>1,003.41</td>
<td>-1910.09</td>
<td>$-3.63$</td>
</tr>
<tr>
<td>$t_{10,P2}$</td>
<td>145</td>
<td>0.5272</td>
<td>8.0%</td>
<td>5.5%</td>
<td>-1,000.00</td>
<td>1896.74</td>
<td>0</td>
</tr>
</tbody>
</table>

Cumulative sum of profits (losses) on transactions $\$265.62$

$^\dagger$A bold entry indicates where a position is closed out and profit (or loss) is realized.

<table>
<thead>
<tr>
<th>$t_1$ = 1</th>
<th>0.5000 $/DM; \text{i}<em>S=8.0%; \text{i}</em>{DM}=5.0%$</th>
</tr>
</thead>
</table>
| $t_2 = 10$ | 0.5050 $/DM; \text{i}_S=8.0\%; \text{i}_{DM}=5.5\%$  
**Spot rate is up by 1\% ⇒ invest in DM**  
**Borrow $1000 to buy 1000/0.5050 DM**  
$+1980.20$ |
| $t_3 = 30$ | 0.5500 $/DM; \text{i}_S=8.5\%; \text{i}_{DM}=5.0\%$  
**Spot rate reaches $0.5500$ (peak)**  
**US$ liability totals $1000x(1 + 0.08 \times 20/360)$**  
$-1004.44$  
**Value of DM position becomes $1980.20x(1 + 0.055 \times 20/360)$**  
$+1986.25$  
**Net gain = $-1004.44 + 1986.25 \times 0.5500 = 87.99$** |
| $t_4 = 40$ | 0.5445 $/DM; \text{i}_S=8.5\%; \text{i}_{DM}=5.0\%$  
**DM has fallen by 1\% from its peak ⇒ sell DM**  
$0.5500 \times 0.99 = 0.5445$  
**Pays off US$ liability**  
**US$ liability totals $1004.44x(1 + 0.085 \times 10/360)$**  
$-1006.81$  
**Value of DM position becomes $1986.25x(1 + 0.050 \times 10/360)$**  
$+1989.01$ |
CFA (level II, 1995)

a. Briefly explain the concept of the efficient market hypothesis (EMH) and each of its three forms - weak, semistrong, and strong - and briefly discuss the degree to which existing empirical evidence supports each of the three forms of the EMH.

b. Briefly discuss the implications of the efficient market hypothesis for investment policy as it applies to:
   i. technical analysis in the form of charting, and,
   ii. fundamental analysis.

c. Briefly explain two major roles or responsibilities of portfolio managers in an efficient market environment.

d. Briefly discuss whether active asset allocation among countries could consistently outperform a world market index. Include a discussion of the implications of integration versus segmentation of international markets as it pertains to portfolio diversification, but ignore the issue of stock selection.

---

a. Efficient market hypothesis (EMH) states that a market is efficient if security prices immediately and fully reflect all available relevant information. “Efficient” means informationally efficient, not operationally efficient. Operational efficiency deals with the cost of transferring funds. If the market fully reflects information, the knowledge of that information would not allow anyone to profit from it because stock prices already incorporate the information.

i. **Weak** form asserts that stock prices already reflect all information that can be derived by examining market trading data such as the history of past prices and trading volume. *Empirical evidence supports the weak-form.*

   A strong body of evidence supports weak-form efficiency in the major U.S. securities markets. For example, test results suggest that technical trading rules do not produce superior returns after adjusting for transactions costs and taxes.

ii. **Semi-strong** form says that a firm’s stock price already reflects all publicly available information about a firm’s prospects. Examples of publicly available information are annual reports of companies and investment advisory data. *Empirical evidence mostly supports the semi-strong form.*

   Evidence strongly supports the notion of semi-strong efficiency, but occasional studies (e.g., those identifying market anomalies including the small-firm effect and the January effect) and events (e.g., stock market crash of October 19, 1987) are inconsistent with this form of market efficiency. Black suggests that most so-called "anomalies" result from data mining.

iii. **Strong** form of the EMH holds that current market prices reflect all information, whether publicly available or privately held, that is relevant to the firm. *Empirical evidence does not support the strong form.*

   Empirical evidence suggests that strong-form efficiency does not hold. If this form were correct, prices would fully reflect all information, although a corporate insider might exclusively hold such information. Therefore, insiders could not earn excess returns. Research evidence shows that corporate officers have access to pertinent information long enough before public release to enable them to profit from trading on this information.
b. i. **Technical analysis** in the form of charting involves the search of recurrent and predictable patterns in stock prices to enhance returns. The EMH implies that this type of technical analysis is without value. If past prices contain useful information for predicting future prices, there is no point in following any technical trading rule for timing the purchases and sales of securities. According to weak-form efficiency, no investor can earn excess returns by developing trading rules based on historical price and return information. A simple policy of buying and holding will be at least as good as any technical procedure. Tests generally show that technical trading rules do not produce superior returns after marking adjustments for transactions costs and taxes.

ii. **Fundamental analysis** uses earnings and dividend prospects of the firm, expectations of future interest rates, and risk evaluation of the firm to determine proper stock prices. The EMH predicts that most fundamental analysis is doomed to fail. According to semi-strong-form efficiency, no investor can earn excess returns from trading rules based on any publicly available information. Only analysts with unique insight receive superior returns. Fundamental analysis is no better than technical analysis in enabling investors to capture above-average returns. However, the presence of many analysts contributes to market efficiency.

In summary, the EMH holds that the market appears to adjust so quickly to information about individual stocks and the economy as a whole that no technique of selecting a portfolio - using either technical or fundamental analysis - as those making up the popular market averages.

c. Portfolio managers have several roles or responsibilities even in perfectly efficient markets. The most important responsibility is to:

1. **Identify the risk/return objectives for the portfolio given the investor's constraints.** In an efficient market, portfolio managers are responsible for tailoring the portfolio to meet the investor's needs rather than to beat the market, which requires identifying the client's return requirements and risk tolerance. Rational portfolio management also requires examining the investor's constraints, such as liquidity, time horizon, laws and regulations, taxes, and such unique preferences and circumstances as age and employment.

Other roles and responsibilities include:

2. **Developing a well-diversified portfolio with the selected risk level.** Although an efficient market prices securities fairly, each security still has firm-specific risk that portfolio managers can eliminate through diversification. Therefore, rational security selection requires selecting a well-diversified portfolio that provides the level of systematic risk that matches the investor's risk tolerance.

3. **Reducing transaction costs with a buy-and-hold strategy.** Proponents of the EMH advocate a passive investment strategy that does not try to find under- or overvalued stocks. A buy-and-hold strategy is consistent with passive management. Because the efficient market theory suggests that securities are fairly priced, frequently buying and selling securities, which generate large brokerage fees without increasing expected performance, makes little sense. One common strategy for passive management is to create an index fund that is designed to replicate the performance of a broad-based index of stocks.

4. **Developing capital market expectations.** As part of the asset-allocation decision, portfolio managers need to consider their expectations for the relative returns of the various capital markets to choose an appropriate asset allocation.
5. **Implement the chosen investment strategy and review it regularly for any needed adjustments.** Under the EMH, portfolio managers have the responsibility of implementing and updating the previously determined investment strategy for each client.

d. Whether active asset allocation among countries could consistently outperform a world market index depends on the degree of international market efficiency and the skill of the portfolio manager. Investment professionals often view the basic issue of international market efficiency in terms of cross-border financial market integration or segmentation. An integrated world financial market would achieve international efficiency in the sense that arbitrage across markets would take advantage of any new information throughout the world. In an efficient integrated international market, prices of all assets would be in line with their relative investment values.

Some claim that international markets are not integrated, but segmented. Each national market might be efficient, but factors might prevent international capital flows from taking advantage of relative mispricing among countries. These factors include psychological barriers, legal restrictions, transaction costs, discriminatory taxation, political risks, and exchange risks.

Markets do not appear fully integrated or fully segmented. Markets may or may not become more correlated as they become more integrated since other factors help to determine correlation. Therefore, the degree of international market efficiency is an empirical question that has not yet been answered.