CHAPTER 36
USING MULTIFACTOR MODELS

1. (A) The arbitrage pricing theory (APT).

Explanation

The APT is an equilibrium-pricing model; multi-factor models are "ad-hoc," meaning the factors in these models are not derived directly from an equilibrium theory. Rather they are identified empirically by looking for macroeconomic variables that best fit the data.

(Module 36.1, LOS 36.a)

Related Material

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2. (A) 10.68%.

Explanation

The actual return uses the unemployment and interest rate surprises as follows:

The returns for a stock that are correlated with surprises in interest rates and unemployment rates can be expressed using a two-factor model as:

$R_i = a_i + b_{i,1}F_{Int} + b_{i,2}F_{Un} + \varepsilon_i$

where:

R_i = the return on stock *i*

ai = the expected return on stock *i*

$b_{i,1}$ = the factor sensitivity of stock *i* to unexpected changes in interest rates

F_{Int} = unexpected changes in interest rates (the interest factor) = .053–.051 = .002

$b_{i,2}$ = the factor sensitivity of stock *i* to unexpected changes in the unemployment rate

F_{Un} = unexpected changes in the unemployment rate (the unemployment rate factor)
= .072 – .068 = .004

ε_i = a mean-zero error term that represents the part of asset *i*s return not explained by the two factors.

Thus the actual return is: 0.11 + (1.0)(0.002) + (1.2)(0.004) – 0.01 = 0.1068 or 10.68%

(Module 36.2, LOS 36.d)

Related Material

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3.	(A)	No	No

Explanation

Torres reversed the concepts and is thus incorrect on both counts. A factor portfolio is a portfolio with a factor sensitivity of 1 to a particular factor and zero to all other factors. It represents a pure bet on one factor, and can be used for speculation or hedging purposes. A tracking portfolio is a portfolio with a specific set of factor sensitivities. Tracking portfolios are often designed to replicate the factor exposures of a benchmark index like the Russell 2000.

(Module 36.3, LOS 36.f)

Related Material

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4. (C) **Companies' position in the business cycle.**

Explanation

Fundamental factors are factors measured by characteristics of the companies themselves, like price-to-earnings (P/E) ratios or growth rates. Macroeconomic factors are economic influences on security returns. A company's position in the business cycle is dependent on the cycle itself, and cannot be accurately measured by looking at a company's fundamentals – business cycle is a macroeconomic factor. Payout ratios and management tenure are pieces of company-specific data suitable for use in a fundamental factor model.

(Module 36.2, LOS 36.d)

Related Material

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5. (C) **Macroeconomic factor models include explanatory variables such cycle, interest rates, and inflation, and fundamental factor models variables such as firm size and the price-to-earnings ratio.**

Explanation

Macroeconomic factor models include multiple risk factors such as the business cycle, interest rates, and inflation. Fundamental factor models include specific characteristics of the securities themselves such as firm size and the price-to-earnings ratio.

(Module 36.2, LOS 36.d)

Related Material

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6. (C) Systematic.

Explanation

Unsystematic risk can be diversified away. Thus, arbitrage pricing reflects only systematic risk. It is assumed that the portfolio manager will take steps to diversify and reduce risk.

(Module 36.1, LOS 36.a)

Related Material

SchweserNotes - Book 5

7. (A) There are assumed to be at least five factors that explain asset returns.

Explanation

APT is a k-factor model, in which the number of factors, k, is assumed to be a lot smaller than the number of assets; no specific number of factors is assumed.

(Module 36.1, LOS 36.a)

Related Material

SchweserNotes - Book 5

8. (A) 18.0%.

Explanation

In the macroeconomic model, the intercept is the expected return. The expected return of the portfolio is the weighted average of the expected return of the 2 stocks:

$R_p = [(0.6)(20.0\%) + (0.4)(15.0\%)] = 18\%$

(Module 36.2, LOS 36.d)

Related Material

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9. (C) both positive.

Explanation

Since the communications stocks had a negative return while all the other stocks had a positive return, Barefoot's underweighting of those stocks produced a positive tilt return. Since the asset chosen to replace the DJIA stock outperformed the omitted stock, the asset selection return was positive.

(Module 36.3, LOS 36.f)

Related Material

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10. (A) tracking portfolio.

Explanation

A tracking portfolio is a portfolio with a specific set of factor sensitivities designed to replicate the factor exposures of a benchmark index. A factor portfolio is a portfolio with a factor sensitivity of one to a particular factor and zero to all other factors. An arbitrage portfolio is a portfolio with factor sensitivities of zero to all factors, positive expected net cash flow, and an initial investment of zero.

(Module 36.3, LOS 36.f)

Related Material

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11. (B) 30.0%.

Explanation

The expected return on the Freedom Fund is 6% + (10.0%)(1.0) + (7.0%)(2.0) + (6.0%)(0.0) = 30.0%.

(Module 36.1, LOS 36.c)

Related Material

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12. (B) 30% short position in the inflation factor portfolio.

Explanation

To hedge inflation, the fund should take a 30% short position in the inflation factor portfolio. This short position will fully offset the fund's positive exposure to inflation. Tracking portfolios are typically used for active asset selection and have multiple factor exposures which would prevent them from adequately hedging the inflation exposure of the fund.

(Module 36.3, LOS 36.f)

Related Material

SchweserNotes - Book 5

13. (B) 1.0 to the confidence risk factor and 0.0 to the time-horizon factor.

Explanation

She wants to create a confidence risk factor portfolio, which has a sensitivity of 1.0 to the confidence risk factor and 0.0 to the time horizon factor. Because the risk premium on the confidence risk factor is positive, an unexpected increase in this factor will increase the returns on her portfolio. The exposure to the time-horizon risk factor has been hedged away, because the sensitivity to that factor is zero.

(Module 36.3, LOS 36.g)

Related Material

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14. (A) positive and negative respectively.

Explanation

Since the replacement of the asset obviously had a negative effect, the tilting towards financial stocks must have been positive to not only compensate for the loss but produce a portfolio return greater than the DJIA.

(Module 36.3, LOS 36.f)

Related Material

SchweserNotes - Book 5

15.

(C)	2.00%	3.00%

Explanation

Expected return = risk free rate + factor sensitivity x risk premium

For portfolio A: $0.044 = R_f\ 0.8\lambda$ Hence $R_f = 0.044 - 0.8\lambda$

Substituting $R_f = (0.04 - 0.8A)$ for portfolio B, $0.053 = (0.044 - 0.8\lambda) + 1.1\lambda$

$\lambda = 0.03$ or 3% and $R_f = 2\%$.

(Module 36.1, LOS 36.c)

Related Material

SchweserNotes - Book 5

16. (C) marcoeconomic factor model.

Explanation

Macroeconomic factor models use unexpected changes (surprises) in macroeconomic variables as the factors to explain asset returns. One example of a factor in this type of model is the unexpected change in gross domestic product (GDP) growth. In fundamental factor models, the factors are characteristics of the stock or the company that have been shown to affect asset returns, such as book-to-market or price-to-earnings ratios. A statistical factor model identifies the portfolios that best explain the historical cross-sectional returns or covariances among assets. The returns on these portfolios represent the factors.

(Module 36.2, LOS 36.d)

Related Material

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17.

(C)	37.0%	–37.9%

Explanation

$E(R_{Growth}) = 0.035 + 0.03(0.5) - 0.4(0.7) + 0.5(1.2) = 0.035 + 0.015 - 0.28 + 0.6 = 0.37$ or 37.0%

$E(R_{value}) = 0.035 + 0.03(0.2) - 0.4(1.8) + 0.5(0.6) = 0.035 + 0.006 - 0.72 + 0.30 = -0.379$ or –37.9%

(Module 36.1, LOS 36.a)

Related Material

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18. (A) **a specific set of factor sensitivities designed to replicate the factor exposures of a benchmark index.**

Explanation

A tracking portfolio is a portfolio with a specific set of factor sensitivities designed to replicate the factor exposures of a benchmark index. A factor portfolio is a portfolio with a factor sensitivity of one to a particular factor and zero to all other factors. An arbitrage portfolio is a portfolio with factor sensitivities of zero to all factors, positive expected net cash flow, and an initial investment of zero.

(Module 36.3, LOS 36.f)

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19. (C) **36.0%.**

Explanation

The expected return on the Premium Dividend Yield Fund is 3% + (8.0%)(2.0) + (12.0%)(1.0)(5.0%)(1.0) = 36.0%.

(Module 36.1, LOS 36.c)

Related Material

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20. (B) **Security returns are normally distributed.**

Explanation

APT does not require that security returns be normally distributed.

(Module 36.1, LOS 36.a)

Related Material

SchweserNotes - Book 5

21. (C) **greater-than-average exposure to the recession risk factor.**

Explanation

Multifactor models allow us to capture other dimensions of risk besides overall market risk. Investors with unique circumstances different than the average investor may want to hold portfolios tilted away from the market portfolio in order to hedge or speculate on factors like recession risk, interest rate risk or inflation risk. An investor with lower-than-average exposure to recession risk can earn a premium by creating greater-than-average exposure to the recession risk factor. In effect, he earns a risk premium determined by the average investor by taking on a risk he doesn't care about as much as the average investor does.

(Module 36.3, LOS 36.g)

Related Material

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22. (B) an investment that has an expected positive net cash flow but requires no initial investment.

Explanation

One of the three assumptions of the APT is that there are no arbitrage opportunities available to investors among these well-diversified portfolios. An arbitrage opportunity is an investment that has an expected positive net cash flow but requires no initial investment.

All factor portfolios will have positive risk premiums equal to the factor price for that factor. An arbitrage opportunity does not necessarily require a return equal to the risk-free rate, and the factor exposures for an arbitrage portfolio are all equal to zero.

(Module 36.1, LOS 36.a)

Related Material

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23. (B) assumes that arbitrage opportunities are available to investors.

Explanation

The APT assumes that no arbitrage opportunities are available to investors.

(Module 36.1, LOS 36.a)

Related Material

SchweserNotes - Book 5

24. (A) 11.0%

Explanation

The expected return for Stonebrook is simply the intercept return (ai) of 0.11, or = 11.0%.

(Module 36.2, LOS 36.d)

Related Material

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25. (A) The priced factors risks can be hedged without taking short positions in any portfolios.

Explanation

APT does not prohibit short positions.

(Module 36.1, LOS 36.a)

Related Material

SchweserNotes - Book 5

26. (B) 0.85.

Explanation

The portfolio composition is 25% Stonebrook and 75% Rockway. The interest rate sensitivities for Stonebrook and Rockway are 1.0 and 0.8, respectively. Thus, the portfolio's sensitivity to interest rate surprises is:

(0.25)(1.0) + (0.75)(0.8) = 0.85.

(Module 36.2, LOS 36.d)

Related Material

SchweserNotes - Book 5

27. (A) unsystematic risk.

Explanation

Systematic risk reflects factors that have a general effect on the security markets as a whole, and cannot be diversified away. Macroeconomic risk comes in many forms, and it is usually considered systematic risk. Unsystematic risk can be reduced through diversification.

(Module 36.1, LOS 36.a)

Related Material

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28. (C) 3.0%.

Explanation

The general form of the two-factor APT model is: $E(R_{Port}) = RF = \lambda_1\beta_1 + \lambda_2\beta_2$, where the λ's are the factor risk premiums and the β's are the portfolio's factor sensitivities. Substituting the appropriate values, we have:

$R_{Port} = 0.03 + 0.02(-1.2) + 0.03(0.80) = 3.0\%$

(Module 36.1, LOS 36.c)

Related Material

SchweserNotes - Book 5

29. (B) information ratio, which is the average excess portfolio return over the benchmark divided by the standard deviation of the differences between the portfolio and benchmark returns.

Explanation

The information ratio is the measure of active return per unit of active risk. If we let X = (monthly portfolio return – the benchmark return), then the information ratio = (the average of X / the standard deviation of X). It is similar to the Sharpe ratio, which defines the random variable Y as Y = (monthly portfolio return – the risk-free rate). The Sharpe ratio = (the average of Y / the standard deviation of the portfolio return) = the standard deviation of Y if the risk-free rate is constant.

(Module 36.3, LOS 36.e)

Related Material

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30. (C) factor portfolio.

Explanation

A factor portfolio is a portfolio with a factor sensitivity of one to a particular factor and zero to all other factors. An arbitrage portfolio is a portfolio with factor sensitivities of zero to all factors, positive expected net cash flow, and an initial investment of zero. A tracking portfolio is a portfolio with a specific set of factor sensitivities designed to replicate the factor exposures of a benchmark index.

(Module 36.3, LOS 36.f)

Related Material

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31. (A) a portfolio with factor sensitivities equal to that of the index.

Explanation

Enhanced indexing by matching primary risk factors could be implemented by creating a tracking portfolio with the same factor sensitivities as the index but with a different set of bonds. Then any differences in performance between the portfolio and the benchmark index will be the result of bond selection ability and not from different exposures to macroeconomic factors like GDP, inflation, and interest rates.

(Module 36.3, LOS 36.f)

Related Material

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Marianne Belair, CFA, is a wealth manager for a well-known company in Paris, France. She has developed macroeconomic factor models on portfolios Alpha and Bravo.

Equations for the two portfolios:

$R_{Alpha} = 0.08 - 0.7\ F_{INFL} + 1.2\ F_{GDP}$

$R_{Bravo} = 0.13 + 0.6\ F_{INFL} + 2.3\ F_{GDP}$

Belair has asked her colleague Pierre Louboutin to calculate the return attributable to a 1.5% surprise in GDP for an equally weighted portfolio comprising Alpha and Bravo.

Meanwhile, Belair is looking at Merci, a beauty stock for which she has developed a macroeconomic factor model. The arbitrage-pricing model shows a required return of 10% and the company-specific surprise for the year was 2%. Exhibit 1 shows additional information on the model:

Exhibit 1:

variable	Actual Value (%)	Expected Value (%)	Factor Sensitivity
Interest Rate	3.5%	2.5%	–0.3
Unemployment Rate	6.5%	5.5%	–0.7

Emily Grant, a senior manager at the firm, asks Louboutin to analyze the performance of three managers using the information in Exhibit 2.

Exhibit 2: Decomposing Active Risk

Portfolio	Active factor risk squared (%)	Active specific risk squared (%)	Active risk squared (%)	Active factor risk (% of Total Active Risk)	Active specific risk (% of Total Active Risk)	Active risk (%)
EM	0.5	0.5	1	50	50	1
EC	25.2	10.8	36	70	30	6
EV	21.6	14.4	36	60	40	6

Finally, Belair would like to capitalize on her expectation that real business activity will increase over the next year. As a separate concern, she has some existing positive exposure to inflation risk, which she would like to hedge. To achieve her goals she can use the portfolios in the Exhibit 3 which show the five relevant factors and respective factor sensitivities:

Exhibit 3:

Risk Factor	A	B	C	D	E
Confidence	0.10	1.00	0.00	0.70	0.00
Time horizon	0.00	0.00	0.00	0.50	0.00
Inflation	1.00	0.00	0.00	0.30	1.00
Business cycle	0.90	1.00	1.00	0.00	0.00
Market timing	1.00	0.00	0.00	0.90	0.00

32. (C) 2.63%.

Explanation

The combined sensitivity of the GDP factor is 0.5 x 1.2 + 0.5 x 2.3 = 1.75.

The change for 1.5% surprise is 1.5 x 1.75 = 2.625%.

(Module 36.2, LOS 36.d)

Related Material

SchweserNotes - Book 5

33. (C) 11%.

Explanation

Key things to remember are to start with the APT required / expected return, then use surprises rather than actual values for each factor (i.e., actual minus expected), and finally to also add/subtract the company-specific surprise.

actual return = 10 – 0.3 x (3.5 – 2.5) – 0.7 x (6.5 – 5.5) + 2 = 11%

(Module 36.2, LOS 36.d)

Related Material

SchweserNotes - Book 5

34. (C) EV.

Explanation

Asset selection risk is also known as active specific risk. Portfolio EV has the highest risk at 14.4.

(Module 36.3, LOS 36.f)

Related Material

SchweserNotes - Book 5

35. (C) C and E.

Explanation

This question is about factor portfolios (i.e., a portfolio that has a sensitivity of one to a particular factor and zero to all other factors). The only two factor portfolios in Exhibit 3 are C and E having exposure to the business cycle and inflation respectively. A short position in portfolio E would eliminate the inflation risk.

(Module 36.3, LOS 36.f)

Related Material

SchweserNotes - Book 5

36. (C) A market portfolio exists that contains all risky assets and is mean-variance efficient.

Explanation

The APT makes no assumption about a market portfolio.

(Module 36.1, LOS 36.a)

Related Material

SchweserNotes - Book 5

37.	(A)	100%	0%	0%

Explanation

Portfolio Weights			Expected Return	Beta
X	Y	Z		
25%	50%	25%	13.00%	1.13
50%	12%	38%	10.96%	1.00
100%	**0%**	**0%**	**12.00%**	**1.00**

Portfolio weights of 25%, 50%, and 25% yield the highest return, but at a beta of 1.13. Investing 100% in Portfolio X yields the highest return for this risk level (i.e., beta = 1.00).

(Module 36.1, LOS 36.b)

Related Material

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