SS2 Quant Methods

Friday, June 25, 2021

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# READING 6. THE TIME VALUE OF MONEY

##### a interpret interest rates as required rates of return, discount rates, or opportunity costs;

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##### b explain an interest rate as the sum of a real risk-­free rate and premiums that compensate investors for bearing distinct types of risk;

* Interest rate = real risk-free rate + maturity premium (time) + default risk premium () + liquidity premium(convert to cash$) + inflation risk premium [nominal risk-free rate]

##### c calculate and interpret the effective annual rate, given the stated annual interest rate and the frequency of compounding;

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##### d solve time value of money problems for different frequencies of compounding;

* Effective annual rate (EAR) = (1 + Periodic interest rate)*m* – 1



##### e calculate and interpret the future value (FV) and present value (PV) of a single sum of money, an ordinary annuity, an annuity due, a perpetuity (PV only), and a series of unequal cash flows;

##### f demonstrate the use of a time line in modeling and solving time value of money problems.

An **annuity**: a finite set of level sequential cash flows. A **perpetuity** is a perpetual annuity, or a set of level never-ending sequential cash flows-first cash now.

* An **ordinary annuity** has a first cash flow that occurs one period from now (indexed at t = 1).
* An **annuity due** has a first cash flow that occurs immediately (indexed at t = 0).

calculation for an annuity (A) due: PV=A1−1(1+r)Nr(1+r),

# READING 7. STATISTICAL CONCEPTS AND MARKET RETURNS

##### a distinguish between descriptive statistics and inferential statistics, between a population and a sample, and among the types of measurement scales;

##### b define a parameter, a sample statistic, and a frequency distribution;

* **Descriptive statistics**: study of summarized data effectively to describe the import aspects. **Inferential statistics**: forecasts, estimates, or judgements about a larger group from an observed smaller group. **Sample statistics**: a computed quantity to describe a sample(para
* **Population**: all members of a specified group; **Sample**: subset of pop;

**Parameter**: descriptive measure of a population characteristic, eg mean, range, variance

* **Measurement scales**: nominal (categorical data), ordinal (ranking categorical), interval (differ in ranking is equal), ratio (strongest, true zero point as origin).

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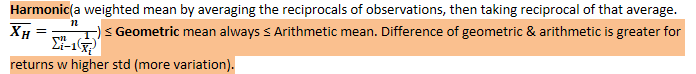
##### d describe the properties of a data set presented as a histogram or a frequency polygon;

* Cumulative frequency distribution: Height of each bar represents the absolute frequency for each return interval. **Frequency polygon**: A graph of a frequency distribution obtained by drawing straight lines joining successive points representing the class frequencies.

##### e calculate and interpret measures of central tendency, including the population mean, sample mean, arithmetic mean(measure of a typical outcome of assets), weighted average or mean, geometric mean, harmonic mean, median, and mode; cross-sectional data, time-series data

* Measure of location include central tendency and other measures of location/distribution. **Modal intervals**: most frequently occurring interval of grouped data.

Center of Gravity Analogy for the Arithmetic Mean 
10 
Fulcrum 
When the fulcrum is placed at 8, the bar is perfectly balanced. 
11 
12 

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##### f calculate and interpret quantiles of [quartiles(1/4), quintiles(1/5), deciles(1/10), percentiles];

##### g calculate and interpret 1) a range and a mean absolute deviation and 2) the variance and standard deviation of a population and of a sample;

* Mean absolute deviation always ≤ standard deviation; arithmetic sum of the deviations around the mean always=0!
* Downside risk dispersion: semivariance(average squared deviation below mean), semistandard deviation(positive square root of semivariance), target semi(below target).

##### h calculate and interpret the proportion of observations falling within a specified number of standard deviations of the mean using Chebyshev’s inequality:



##### i calculate and interpret the coefficient of variation;

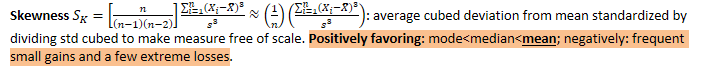
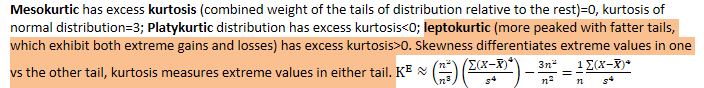
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##### j explain skewness and the meaning of a positively or negatively skewed return distribution;

##### k describe relative locations of mean, median, mode for unimodal, nonsymmetrical distribution;

##### l explain measures of sample skewness and kurtosis;

Distribution Skewed to the Right (Positively Skewed) 
Distribution Skewed to the Left (Negatively Skewed) 

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##### m compare the use of arithmetic and geometric means when analyzing investment returns.

# READING 8. PROBABILITY CONCEPTS

##### a define a random variable, an outcome, an event, mutually exclusive events, exhaustive events;

##### b state the two defining properties of probability and distinguish among empirical(a relative frequency of occurrence), subjective, and priori(logical analysis rather observation judgment);

##### c state the probability of an event in terms of odds for and against the event;

* Exhaustive: Covering or containing all possible outcomes. Pairs arbitrage trade: defined by Dutch Book Theorem, inconsistent probabilities create profit opportunities.



##### d distinguish between unconditional(marginal) and conditional probabilities;

##### e explain the multiplication, addition, and total probability rules;

##### f calculate and interpret 1) the joint probability of two events, 2) the probability that at least one of two events will occur, given the probability of each and the joint probability of the two events, and 3) a joint probability of any number of independent events;

##### g distinguish between dependent and independent events;

##### h calculate and interpret an unconditional probability using the total probability rule;

##### i explain the use of conditional expectation in investment applications;

##### j explain the use of a tree(mutually exclusive but dependent, conditional) diagram represent an investment problem;

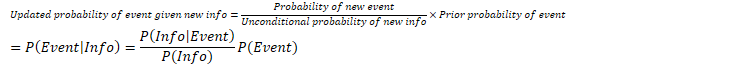
##### k calculate and interpret covariance and correlation and interpret a scatterplot;

##### l calculate and interpret the expected value, variance, and standard deviation of a random variable and of returns on a portfolio;

##### m calculate and interpret covariance given a joint probability function;

* The covariance of returns is positive when the returns on both assets tend to be on the same side (above or below) their expected values at the same time

##### n calculate and interpret an updated probability using Bayes’ formula;



##### o identify the most appropriate method to solve a particular counting problem and solve counting problems using factorial, combination, and permutation concepts.

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# READING 9. COMMON PROBABILITY DISTRIBUTIONS

##### a define a probability distribution and distinguish between discrete and continuous random variables and their probability functions;

##### b describe the set of possible outcomes of a specified discrete random variable; c interpret a cumulative distribution function; d calculate and interpret probabilities for a random variable, given its cumulative distribution function;

##### e define a discrete uniform random variable, a Bernoulli random variable, and a binomial random variable;

##### f calculate and interpret probabilities given the discrete uniform and the binomial distribution functions;

##### g construct a binomial tree to describe stock price movement; h define the continuous uniform distribution and calculate and interpret probabilities, given a continuous uniform distribution; i explain the key properties of the normal distribution;

##### j distinguish between a univariate and a multivariate distribution and explain the role of correlation in the multivariate normal distribution;

##### k determine the probability that a normally distributed random variable lies inside a given interval;

##### l define the standard normal distribution, explain how to standardize a random variable, and calculate and interpret probabilities using the standard normal distribution;

##### m define shortfall risk, calculate the safety-­first ratio, and select an optimal portfolio using Roy’s safety-­first criterion;

##### n explain the relationship between normal and lognormal distributions and why the lognormal distribution is used to model asset prices;

##### o distinguish between discretely and continuously compounded rates of return and calculate and interpret a continuously compounded rate of return, given a specific holding period return;

##### p explain Monte Carlo simulation and describe its applications and limitations; q compare Monte Carlo simulation and historical simulation.

# READING 10. SAMPLING AND ESTIMATION

a define simple random sampling and a sampling distribution;

b explain sampling error;

c distinguish between simple random and stratified random sampling;

d distinguish between time-­series and cross-­sectional data; e explain the central limit theorem and its importance; f calculate and interpret the standard error of the sample mean; g identify and describe desirable properties of an estimator; h distinguish between a point estimate and a confidence interval estimate of a population parameter;

i describe properties of Student’s t-distribution and calculate and interpret its degrees of freedom;

j calculate and interpret a confidence interval for a population mean, given a normal distribution with 1) a known population variance, 2) an unknown population variance, or 3) an unknown population variance and a large sample size;

k describe the issues regarding selection of the appropriate sample size, data-mining bias, sample selection bias, survivorship bias, look-­ahead bias, and time-period bias.

READING 11. HYPOTHESIS TESTING

a define a hypothesis, describe the steps of hypothesis testing, and describe and interpret the choice of the null and alternative hypotheses;

b distinguish between one-­tailed and two-­tailed tests of hypotheses; c explain a test statistic, Type I and Type II errors, a significance level, and how significance levels are used in hypothesis testing;

d explain a decision rule, the power of a test, and the relation between confidence intervals and hypothesis tests;

e distinguish between a statistical result and an economically meaningful result; f explain and interpret the p-value as it relates to hypothesis testing; g identify the appropriate test statistic and interpret the results for a hypothesis test concerning the population mean of both large and small samples when the population is normally or approximately normally distributed and the variance is 1) known or 2) unknown;

h identify the appropriate test statistic and interpret the results for a hypothesis test concerning the equality of the population means of two at least approximately normally distributed populations, based on independent random samples with 1) equal or 2) unequal assumed variances;

i identify the appropriate test statistic and interpret the results for a hypothesis test concerning the mean difference of two normally distributed populations;

j identify the appropriate test statistic and interpret the results for a hypothesis test concerning 1) the variance of a normally distributed population, and 2) the equality of the variances of two normally distributed populations based on two independent random samples;

k formulate a test of the hypothesis that the population correlation coefficient equals zero and determine whether the hypothesis is rejected at a given level of significance;

l distinguish between parametric and nonparametric tests and describe situations in which the use of nonparametric tests may be appropriate.