**Market Efficiency**

* CAPM Assumptions Revisited
	+ Perfect Capital Market
		- Competitive and info efficient market in which there are no market frictions (transaction costs and taxes)
		- No price impact (we are price takers)
		- Assuming no market frictions is a simplification
			* With no transaction costs, traders can take advantage of mispricings
			* Prices should quickly adjust to the “true value”
			* If transaction costs do exist, small mispricings may persist
* Types of efficiency
	+ Allocational
		- Resources are allocated to their highest valued uses
	+ Operational
		- Transaction costs are relatively low
	+ Informational
		- Asset prices reflect new info quickly and correctly
		- Focused on in this chapter: “market efficiency” or “efficient market” means informational
* Efficient Markets Hypothesis (EMH)
	+ Burton Malkiel’s definition: a capital market is said to be efficient if it fully and correctly reflects all relevant info in determining security prices
	+ Formally: a market is said to be efficient with respect to some info set if security prices would be unaffected by revealing that info to all participants
		- Informally, the info is already “priced in”
* 3 Forms of EMH
	+ Need to define the info set
	+ Weak Form EMH
		- Includes the history of all security prices and returns
		- Referred to as including all historical publicly available information
	+ Semi-Strong EMH
		- Includes all publicly available information
		- Referred to as including all present publicly available information
	+ Strong Form EMH
		- All info (public and private) known to any market participant
		- Referred to as including all future publicly available information
	+ Weak fits into semi-strong which fits into strong
* Violations of the EMH
	+ Due to the nature of the relationship between the three forms, any violation of one firm violates any higher forms
	+ Violation of the weak = violation of the semi-strong = violation of the strong
	+ Violation of the semi-strong = violation of the strong
	+ Violation of the strong is only a violation of the strong
* Weak Form EMH
	+ Random Walk Theory
		- Changes in stock prices are statistically random (no pattern)
	+ In an informationally efficient market, stock prices are only sensitive to new information
		- Arrives at random intervals
		- Changes in price must also be random
* Random Walk with Positive Trend
	+ We don’t know when or how the price will change
	+ Properties:
		- Expected price change is positive over time
		- Positive trend, but random around the trend
	+ On a day-to-day basis, the expected price change is close to zero
* Weak Form Example
	+ Coin toss game: you start with $100 and flip a fair coin every week
		- If heads: earn 3% on investment
		- If tails: lose 2.5% on investment
	+ E(r) = (.5 x 3) + (.5 x -2.5) = 0.25%
* Implications of Weak Form EMH
	+ Analysts try to earn abnormal returns by timing the market based on charting techniques
	+ If markets are weak form, they should not be able to earn above average, risk-adjusted returns
		- We are not actually saying that they can’t make any returns
		- Their α must = 0
	+ Weak form states that information in past market data does not predict returns
		- Aka all of the tools that they would be using (prices, returns, volume, etc.)
	+ Illustrated:
* Semi-Strong Form Efficiency
	+ Security prices reflect all publicly available info
		- Financial statements, annual reports, quarterly earnings reports, dividend announcements, and past changes in price and volume
	+ Implications:
		- Casts doubt on usefulness of fundamental analysis
		- Analysts examine info to identify undervalued stocks
		- If semi-strong efficiency holds, analysts should not be able to produce above average, risk-adjusted returns
			* Their α should = 0
* Strong Form Efficiency
	+ Prices reflect all information
		- Public and private
		- Includes information held by corporate insiders
	+ Implications:
		- Even insiders would be unable to earn abnormal, risk-adjusted returns
			* Their α should = 0
* Can markets be perfectly efficient?
	+ A paradox
	+ EMH argues that all information is included in prices and abnormal returns cannot be consistently realized
		- Begs question: if no money is to be made, why would you collect info?
	+ Can explain this based on the speed at which the market adjusts to info
		- Takes a small amount of time for market to price in the info
		- Professional analysts able to earn returns from researching securities but regular analysts are unable to do so
* Are markets efficient/can we ever tell?
	+ Magnitude issue:
		- Can we detect abnormal performance in economic studies?
		- Signal-to-noise ratio low
	+ Selection bias
		- Someone who truly devises a successful method of earning high returns won’t publicize it
	+ Luck or skill?
		- Could be pure chance
* Random walks and autocorrelation
	+ If the market is weak form, security returns in non-overlapping periods should be uncorrelated
		- Correlation between different time periods known as autocorrelation
	+ If market is info efficient, then any info should be properly priced-in as soon as it’s released
		- Any movements in the future should be effectively random from our view today
		- We would expect any autocorrelation to be 0
* Types of Autocorrelation
	+ Negative
		- Periods with positive (-) returns followed by periods with negative (+) returns
		- Reversal effect
		- “winners lose”
	+ Positive
		- Periods with positive (-) returns followed by periods with positive (-) returns
		- Momentum effect
		- “winners win”
* Autocorrelation and Weak Form EMH
	+ If either the reversal effect or the momentum effect exists, this implies a violation of the weak form EMH
	+ Both effects imply that we can’t use a past return to predict a future return
	+ If we find evidence against random walk, it’s evidence against weak form EMH
* Testing Weak Form EMH
	+ Regress today’s return on yesterday’s return:
	+ Two values we care about:
		- α measures trend/average return
		- γ measures autocorrelation (generally only care about this)
* Interpreting γ
	+ 3 cases we are interested in:
		- γ = 0: current return is uncorrelated with previous return, implying a random walk
		- γ < 0: current return has a negative autocorrelation with previous return, suggesting reversal effect
		- γ > 0: current return has positive autocorrelation with previous return, suggesting momentum effect
* Using BA II Plus for γ
	+ Data
		- X = return for each period
		- Y = next period’s return
		- Note: will end up with one less entry than we have total periods since we need two periods for each entry
	+ Stat
		- LIN
		- b = γ
* Example: Autocorrelation Regression
	+ Firm earned returns of 12%, 8%, 9%, 15%, and 11% in years 1-5. Ignoring statistical significance, what conclusions can we make about weak form EMH for this company?
* What does autocorrelation look like?
* Evidence on Weak Form Efficiency
	+ For individual securities, γ is close to 0 (random walk)
	+ For portfolios, γ shows evidence of positive autocorrelation at weekly frequencies
		- Momentum strategies
		- Effect is small in magnitude; economically meaningful?
			* Not always
	+ Over long horizons (3-5 years), γ shows evidence of negative autocorrelation
		- Contrarian strategies
	+ Means evidence of momentum over short term and reversals over long term
		- Referred to as mean reversion
* Momentum Effects
	+ A long literature suggests that markets are weak form efficient
		- Most recent evidence related to momentum trading strategies challenge this
		- Have to consider whether any supposed deviations from efficiency are within arbitrage bonds
	+ Evidence that portfolios display momentum effects over intermediate horizons (3-12 months)
		- Shows that both good and bad performance is persistent over this horizon
* Portfolio Tests of Weak Form EMH
	+ Suggests that we shouldn’t be able to consistently earn abnormal returns using portfolios formed based on past returns
		- Momentum studies tell a different story
		- We will look at how these studies are constructed
	+ In order to test EMH, the researcher must specify a model for expected returns
		- Market or single-index model frequently used in practice
		- FF 3 Factor Model commonly used as well
	+ Methodology:
		- Choose portfolio formation date
		- Form portfolios using trading rule based on past price or return info
			* Typically split firms into groups sorted by the measure we are testing
				+ Usually quintiles or deciles
			* Each month/quarter/year we rebalance portfolio based on that period’s sorting
				+ Common: buy best group and short worst group
				+ Best has the highest returns, worst has the lowest returns
			* Estimate abnormal return of each portfolio (αp) by running regression
* Momentum and Efficiency
	+ The risk-adjusted return (αp) for a momentum strategy that is long winners and short losers is significantly positive
		- May not disprove EMH
	+ 2 main ways to interpret results:
		- Mispricing: positive α implies markets are not weak form efficient
		- Risk premium: model of expected returns not complete
			* Momentum may be related to underlying risk factor not accounted for
	+ Joint Hypothesis Problem: test of market efficiency is simultaneously a joint test of whether the asset pricing model is correct
	+ Means any results we (don’t) find might simply be caused by an incorrect model
	+ Also important: are these strategies profitable after trading costs?
		- Many studies find trading rules that generate much smaller abnormal returns (that would be wiped out by trading costs)
* Alternative: Auto-Regressive Processes
	+ Suppose we want to find middle ground: the market doesn’t follow random walk, but acts like one
	+ Might suggest that the market follows an AR(1) process
		- Fight order auto-regressive
		- Type of model adds some mean-reversion
		- Simplified:
		- Where:
* Random Walk vs. AR(1)
	+ RW equation:
	+ AR(1) equation:
	+ Random walk is a special case of AR(1) where ρ = 1
* Testing Semi-Strong Efficiency: Event Studies
	+ Aim to test if stock prices react quickly and efficiently to new info
		- Measure abnormal returns around certain informational events
	+ Tests for things like overreaction, underreaction, delayed reactions
	+ Examples of event studies: dividend announcements, earnings announcements, mergers, changes in CEOs, security offerings
* Event Study Methodology
	+ Identify a sample of events (e.g. merger announcements)
	+ For each, collect a time series of security returns (and market index returns) surrounding the event date (designated t=0)
		- Event date is usually an announcement
	+ Form “portfolios” by aligning the time series for each security in “event time”
		- Ex. You might analyze data from 10 trading days before and after a merger announcement (-10 ≤ t ≤ 10)
* Event Studies: the Timeline
* Event Studies Calculation
* Cumulative Abnormal Return
* Example: Cumulative Abnormal Return
	+ You collected data on 3 firms whose CEOs were miraculously cured of a disease. You calculated the set of alphas in the following table:
	+ What is the cumulative abnormal return on the event day (day 0)?
* Event Studies: Steve Jobs Example
	+ October 2003: Jobs diagnosed with cancer, no public announcement was made
	+ July 2004: Jobs entered hospital
		- Next day, Apple employees informed, leaked to the press
		- Apple stock fell 2.4%
* Event Studies
	+ Mergers
		- Bad for the acquirers, good for the target company
		- Keown and Pinkerton (1981)
		- Supports semi-strong efficiency
* Event Study Methodology
	+ If the sample size (N) is large, any cross-sectional correlation between alphas should be event-related
	+ If the market is semi-strong efficient, we expect αt = 0 for t > 0
	+ Aka the market response to new info should be quick and accurate
* Joint Hypothesis Problem
	+ Event studies are a test of a joint hypothesis
		- Rejection of the hypothesis may be attributable to the failure of either or both of the joint hypotheses
	+ Recall:
		- We need to calculate alphas in order to start this analysis, so we have used a pricing model
		- We aren’t going to be able to separate the accuracy of the EMH from the accuracy of our pricing model
* Post-Earnings Announcement Drift
	+ What happens when good news is made public?
		- Efficient markets: stock price should increase immediately
		- The increase should be the correct size, there shouldn’t be any other adjustment from this information
	+ Rendleman, Jones, Latane (1982)
		- Found evidence that the market adjusts to earnings info gradually
		- Firms placed into deciles based on their earnings surprise
		- Define “Standardized Unexpected Earnings” (SUE)
* Testing Semi-Strong Efficiency: Performance Evaluation Tests
	+ Evaluation tests examine whether professional money managers can outperform on a risk-adjusted basis
	+ In general, the results show that active managers do not, on average, outperform broad-based indices or passively managed index funds after costs
* Pricing Anomalies
	+ January effect: January has higher positive returns relative to the rest of the months
	+ IPO performance
		- Large underpricing on the day of issuance
		- Long-term underperformance
* Interpreting Anomalies
	+ Mispricing: market inefficiencies with profit opportunities
	+ Mispricing, but still inside arbitrage bounds
		- These are not profitable after costs
	+ Risk premiums
		- Joint hypothesis problem
		- Need a better model for expected returns
	+ Data mining concerns
	+ Behavioral interpretations to explain inefficient mispricings
* Why not just throw darts?
	+ The implications of market efficiency are often misinterpreted
		- “throwing darts” is one such common misconception
		- Any returns earned will be commensurate with risk
		- An investor still needs to pay attention to his/her portfolio decisions
	+ Benefits of portfolio management in an efficient market:
		- Diversification: eliminate firm-specific risk
		- Choosing an appropriate level of systematic risk
		- Maximize expected return for target risk level
		- Tax-management
		- Asset allocation changes with age