REVIEW SESSION

15.439 Quantitative Investment Management

MIT MANAGEMENT
SLOAN SCHOOL

AGENDA

- Homework

- Final Exam

- Regressions (time series vs cross sectional, Fama- Macbeth, Fama-French 1992, Python demo)

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HOMEWORK SUMMARY

- Some common mistakes:

1. HW1 – Not making appropriate transformations to MSCI data and unemployment data (regressing levels on levels….)
2. HW2 – Calculating drawdown (Failure to capture High Water Mark at every day), calculation of Up-Down ratio (derive or use Monte Carlo approach)

- Overall standard high, please read feedback!
- Any questions?

TOPIC BREAKDOWN

- Market Efficiency and Empirical Testing
- Event Studies
- Behavioral Finance
- Limits of Arbitrage
- Anomalies and Factors
- Short Selling
- Portfolio Construction
- Risk Models
- Market Microstructure and Trading
- Active vs Passive

FINAL EXAM

- **Wednesday 24th May; 1.30pm – 4.30pm** in usual classroom.
- Closed book exam (no cheat sheets, outside notes etc.)
- Some tips for success:

1. Don't procrastinate!
2. First understand key ideas in each topic to ground study, review homeworks
3. Questions at the end of lecture notes WILL be on exam, be strategic and revolve study around them
4. **Quality > quantity**
5. Any answer should be reinforced to get top mark (most suitable are references to material discussed in class, readings and examples)
6. Being able to look at question from more than one perspective (pros/cons, one side of argument vs opposing)

SAMPLE ANSWER 1 – SHOULD HEDGE FUNDS BE EXEMPT FROM REGULATION?

One's opinion on this question is often shaped by their own personal political views as well as their economic status. Nevertheless, common arguments in favor of regulation are the following:

Firstly, regulation can mitigate the risk of fraud and systematic risk, enhancing long run market stability and ensuring that investors are fairly treated. History shows that increased regulation is often demanded after such events (for example the Dodd-Frank Act after the financial crisis), in order to prevent a similar occurrence from happening again in the future. Furthermore, transparency as a result of regulation may enhance the general public's perception of financial markets and as a result promote healthy market participation among institutional and particularly household investors. Another argument for regulation is that it levels the playing field versus more heavily regulated investment vehicles such as mutual funds.

On the other side of the argument, one may argue that allowing hedge funds to be exempt from any regulation will improve market efficiency (as they are completely free to trade as they want, eliminating inefficiencies quicker than if they were regulated). Ironically, market efficiency is one of the main three goals of the SEC! By having greater strategy flexibility, technologies can also innovate at a faster rate. Not to mention from the hedge fund's perspective itself, they now directly cut compliance costs and can effectively deploy more capital. Finally, one may counter the argument aforementioned that investors need to be protected by stating that typically only sophisticated investors invest in hedge funds, who by default possess the resources and knowledge to make their own informed decisions on where to allocate their capital.

SAMPLE ANSWER 2 - HOW MIGHT ONE DETERMINE THE SIZE OF A STOCK POSITION IN ONE'S PORTFOLIO? WHAT IS IMPORTANT TO CONSIDER?

In the context of an overall portfolio, stock position sizing needs to be driven by its relationship with the other stocks in the portfolio. Some individual stock-level data in isolation can help us roughly gauge sizing by looking at liquidity/market impact when trading and forecasted price direction (i.e. are we long or short the stock). However, in order to have an understanding of optimal position sizing at the portfolio level, it is not as simple as making sizing proportional to the expected upside of a stock, something commonly misperceived as an acceptable methodology as discussed in class. Instead, the following metrics are be more useful to look at:

Incremental portfolio risk and return as we change position size, holding all other factors constant in the portfolio. Hence, we must also define what our measure of 'risk' is; this may be entirely based on portfolio standard deviation, sector/country exposure, any style (size/value/etc.) biases we have, relative weighting to a benchmark for a long only fund, a combination of all, etc… Thus, the calibration and choice of our risk model becomes a key factor to consider.

Institutional constraints and client preferences may also determine the final position sizing of a portfolio. Quite often the range of possible values we can hold in a stock is immediately constrained due to current weighting in the portfolio, meaning that we need to further consider altering existing position sizes along with estimating new ones.

REGRESSIONS REVISITED

FACTOR MODEL RECAP

- Careful differentiation needed here between predicting (one period lagged prior on RHS) and explaining (same period on RHS, as done here)

$$r_t - r_{t,f} = \alpha + \beta_{mkt}\left(r_{t,mkt} - r_{t,f}\right) + \beta_{SMB} r_{t,SMB} + \beta_{HML} r_{t,HML} + \varepsilon_t$$

Alpha; Return not explained by factor model

Factor premium; extra return as compensation for taking exposure

Factor loading; measure of exposure to risk factor

REGRESSION TYPES

Time Series

- Data collected from multiple points in time, from one source
- Widely seen in forecasting – ARMA, GARCH..
- Example: Can I explain Microsoft stock returns since 2000 with trading volume from the day before?

Cross Sectional

- Data collected at a single point in time, from multiple sources
- Looking at relationship between variables at that specific point
- Cross section: An industry, group of peers, etc.
- Given a metric, which company will perform best
- Example: Will stocks that have a high book-to-market ratio today perform better than those who don't?

Panel

- Also called time series cross section
- Data collected from multiple points in time, from multiple sources
- Two ways to implement, each slightly different:

1. Fama – Macbeth (each period equal weighted)
2. Single panel regression (greater weighting to periods with more observations/variation in explanatory variables)

TABLE III – FAMA FRENCH 1992 FM RESULTS

Table III

Average Slopes (*t*-Statistics) from Month-by-Month Regressions of Stock Returns on β, Size, Book-to-Market Equity, Leverage, and E/P: July 1963 to December 1990

Stocks are assigned the post-ranking β of the size-β portfolio they are in at the end of June of year t (Table I). BE is the book value of common equity plus balance-sheet deferred taxes, A is total book assets, and E is earnings (income before extraordinary items, plus income-statement deferred taxes, minus preferred dividends). BE, A, and E are for each firm's latest fiscal year ending in calendar year $t-1$. The accounting ratios are measured using market equity ME in December of year $t-1$. Firm size ln(ME) is measured in June of year t. In the regressions, these values of the explanatory variables for individual stocks are matched with CRSP returns for the months from July of year t to June of year $t+1$. The gap between the accounting data and the returns ensures that the accounting data are available prior to the returns. If earnings are positive, E(+)/P is the ratio of total earnings to market equity and E/P dummy is 0. If earnings are negative, E(+)/P is 0 and E/P dummy is 1.

The average slope is the time-series average of the monthly regression slopes for July 1963 to December 1990, and the *t*-statistic is the average slope divided by its time-series standard error.

On average, there are 2267 stocks in the monthly regressions. To avoid giving extreme observations heavy weight in the regressions, the smallest and largest 0.5% of the observations on E(+)/P, BE/ME, A/ME, and A/BE are set equal to the next largest or smallest values of the ratios (the 0.005 and 0.995 fractiles). This has no effect on inferences.

β	ln(ME)	ln(BE/ME)	ln(A/ME)	ln(A/BE)	E/P Dummy	E(+)/P
0.15 (0.46)						
	−0.15 (−2.58)					
−0.37 (−1.21)	−0.17 (−3.41)					
		0.50 (5.71)				
			0.50 (5.69)	−0.57 (−5.34)		
					0.57 (2.28)	4.72 (4.57)
	−0.11 (−1.99)	0.35 (4.44)				
	−0.11 (−2.06)		0.35 (4.32)	−0.50 (−4.56)		
	−0.16 (−3.06)				0.06 (0.38)	2.99 (3.04)
	−0.13 (−2.47)	0.33 (4.46)			−0.14 (−0.90)	0.87 (1.23)
	−0.13 (−2.47)		0.32 (4.28)	−0.46 (−4.45)	−0.08 (−0.56)	1.15 (1.57)

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FAMA MACBETH STYLE EXAMPLE

Source Empirical Data – Returns and Factors

Ken French's Data Library https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Under "30 Industry Portfolios" we obtain returns of such portfolios, also size and book-to-market data that we hypothesise are our factors

Risk free rate – can take as equivalent period T bill (1 month also on same website above in "Fama/French 3 Factors")

Run cross sectional regression

For each asset, we regress excess returns on our corresponding risk factors/characteristics to obtain factor premium/returns for that period

Repeat for every period in sample

Average over time

Coefficient estimate is just average over number of periods

Statistical significance? Need to use Newey West method to get appropriate standard errors (this accounts for autocorrelation in the time series)

THANK YOU AND GOOD LUCK IN THE FINAL!

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