Problem Set 9

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a) Conceptual questions:

i. The costs of implementing a real-world portfolio would be trading costs, or execution costs, while the cost of failing to implement, is the opportunity cost, or, by definition, the profit/loss one would have if implemented the portfolio. A rational investor should, in equilibrium, trade up to the point where trading cost equals the opportunity cost.

ii. Typically, trading costs for an individual investor would be trading fees collected by intermediaries, bid/ask spreads, or, in some countries, trading taxes. These would be minor, if any, for large institutional traders. Instead, they would be facing costs from:

- Price movements due to the market impact made by trades bigger than the market depth
- Compensation for the inventory risk faced by market maker due to holding on to the asset before shifting it to another entity
- Liquidity issues due to inability to find the counterparty of the position

Among these, costs incurred due to price impact would matter the most to a large institutional investor.

iii. To mitigate these costs, a firm/trader/manager can make their trades gradual; that is, do not make large lumps of trades in just one transaction. This may allow other entities to join the market and fill up the liquidity. To avoid the costs from inventory risk, the firm/trader/manager can deal mainly with a set of more frequently traded assets, and in smaller batches at a time. To mitigate the costs incurred from counterparty issue, the bank may simply hold more cash or other Tier 1 asset in their hands. What's more, trading faster is always a good implementation strategy.

b) The table below lists the trading costs, net returns, and dollar net profits of each strategy, assuming $1 billion assigned.

	SMB	HML	UMD	Combo	STREV
Total dollar costs (million, optimized)	0.41	0.66	1.69	1.47	6.37
Total costs (%, optimized)	0.49	0.79	2.03	1.76	7.64
Net return (annualized %)	1.27	3.26	3.56	5.14	-4.71
Dollar profits ($ million)	12.65	32.59	35.62	51.40	-47.09

c) The table below lists the trading costs, net returns, and dollar net profits of each strategy, assuming $2 billion assigned. Note that the total dollar costs are more than twice in amount; the fraction of cost increased. This illustrates the fact that larger trades have greater impacts on the market price, and thus incur more cost in percentage. Since we have a higher % cost, we have a total dollar that is greater than double that of the original number. The degree of the increase differs by strategies, since different strategies trade on different set of assets, and liquidity – market depth, average turnover, etc. – differs by different set of assets.

	SMB	HML	UMD	Combo	STREV
Total dollar costs (million, optimized)	0.89	1.45	3.88	3.35	15.57
Total costs (%, optimized)	0.53	0.87	2.33	2.01	9.34
Net return (annualized %)	1.22	3.18	3.27	4.89	-6.41
Dollar profits ($ million)	24.42	63.53	65.38	97.80	-128.29

d) The table below lists the break-even capacity of each strategy. Note that the *solver* was unable to find an optimal value for STREV strategy since we imposed a non-negativity constraint.

	SMB	HML	UMD	Combo	STREV
Break-even NAV (billion)	102.21	153.78	26.60	54.64	*NaN*

e) The table below lists the break-even capacity of each strategy using the full sample from 1926 to 2015, and the difference in size when compared to the numbers when using a more recent sample – from 1990 to 2015 – as we did in (d). As we can see, we see the most change in SMB and the least in STREV (we considered *NaN* as simply 0).

	SMB	HML	UMD	Combo	STREV
Break-even NAV (billion)	263.89	215.86	56.16	98.69	0.22
change in size	161.68	62.08	29.56	44.05	0.22

f) The table below shows the fund size that maximizes the dollar profit for each strategy. COMBO strategy has the largest net return in percentage but HML has the largest dollar profit. We observe this discrepancy since dollar profit depends on the profit-maximizing fund size, as well as the net return.
- The HML strategy generates the highest dollar profits, but its net return is not the highest. The reason for this discrepancy is that the dollar profits are a function of net return and fund size. If we only focus on optimizing the net return, the fund size may sub-optimally small since a larger fund will generate a higher trading cost. Therefore, there is a tradeoff between a higher net return and a larger fund size. That's why the highest net return not necessarily lead to the highest dollar profits.

	SMB	HML	UMD	Combo	STREV
NAV (billion)	124.95	102.42	26.42	46.79	0.10
Net return (annualized %)	1.01	1.72	2.62	3.36	0.54
Dollar profits ($ million)	1257.82	1762.56	693.52	1570.74	0.54

g) The table below exhibits the improvements on the net returns and the changes in fund sizes when we decrease the turnover by a fraction of 0.75.

	SMB	HML	UMD	Combo	STREV
Net return (annualized %) - Before	2.46	4.16	6.17	7.95	-1.99
Net return (annualized %) - After	2.59	4.38	6.75	8.45	0.31
net return improvements (annualized %)	0.13	0.22	0.58	0.50	2.30
Break-even NAV (billion) - Before	263.89	215.86	56.16	98.69	0.22
Break-even NAV (billion) - After	558.67	452.54	123.09	207.49	1.26
Break-even NAV increase (billion)	294.78	236.68	66.93	108.80	1.04

h) The table below exhibits the improvements on the net returns and the changes in fund sizes when we decrease the turnover by a fraction of 0.75 and decrease the gross return by ($\times$ $\frac{original\ turnover}{4}$). As we can see, although we have both the costs and benefits decreased, net return improved and the break-even capacity increased overall. This tells us that, in this setting, it is optimal to trade more, since the trading cost decreased by a greater amount than opportunity cost did.

	SMB	HML	UMD	Combo	STREV
Net return (annualized %) - Before	2.46	4.16	6.17	7.95	-1.99
Net return (annualized %) - After	2.52	4.27	6.49	8.22	-0.44
net return improvements (annualized %)	0.06	0.11	0.32	0.28	1.55
Break-even NAV (billion) - Before	263.89	215.86	56.16	98.69	0.22
Break-even NAV (billion) - After	537.70	437.19	116.78	200.24	0.68
Break-even NAV increase (billion)	273.81	221.33	60.62	101.55	0.46

i) The table below exhibits the improvements on the net returns and the changes in fund sizes when we increase the daily volume by twice; we have a more liquid market in each strategy. As we can see, the increase in net return is significantly higher for STREV than all the others, indicating that liquidity matters the most when trading on short-term reversals. This is a reasonable result since the strategy requires frequent trading, by definition. In fact, we observe 2.25 for the turnover, which is approximately at least more than 3 times larger than all other strategies.

	SMB	HML	UMD	Combo	STREV
Net return (annualized %) - Before	2.46	4.16	6.17	7.95	-1.99
Net return (annualized %) - After	2.49	4.22	6.37	8.12	-0.86
net return improvements (annualized %)	0.03	0.06	0.20	0.17	1.13
Break-even NAV (billion) - Before	263.89	215.86	56.16	98.69	0.22
Break-even NAV (billion) - After	527.78	431.73	112.32	197.38	0.44
Break-even NAV increase (billion)	263.89	215.86	56.16	98.69	0.22

j) The table below exhibits the changes in the net returns and the fund sizes when we adjust the gross returns for a more liquid market. Net return decreased for all strategies, while break-even fund size also decreased for all strategies except for UMD. The result tells us that, in the real world, more liquidity does not sufficiently compensate for the decrease in gross returns. The exception in UMD is also quite reasonable since the strategy requires a relatively frequent repositioning. It is quite surprising to see that we do not observe the same in STREV as it also requires frequent turnovers. This may be a result of STREV having a very low return.

	SMB	HML	UMD	Combo	STREV
Net return (annualized %) - Before	2.46	4.16	6.17	7.95	-1.99
Net return (annualized %) - After	1.02	2.57	5.00	4.88	-5.57
net return improvements (annualized %)	-1.44	-1.59	-1.17	-3.07	-3.58
Break-even NAV (billion) - Before	263.89	215.86	56.16	98.69	0.22
Break-even NAV (billion) - After	141.91	213.33	79.82	96.97	0.00
Break-even NAV increase (billion)	-121.98	-2.54	23.66	-1.72	-0.22