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Methods for Joint Optimization of Multiple Related Portfolios: Householding and Beyond

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Introduction

- In many cases both investors and asset managers would benefit from the ability to *jointly optimize over an entire set* of related portfolios. In this presentation will focus on the theory and implementation of three applications of joint optimization.
- In today's presentation we will focus on three practical applications of joint optimization over multiple portfolios
  - Wealth management for multi-portfolio households or family offices
  - Multi-line or multi-jurisdiction insurance companies that maintain separate pools of invested reserves for each activity
  - An asset manager that must allocate participation in a particular security trade across a large number of separate portfolios, when the available amount of units to be transacted is smaller than would be optimal if the portfolios were optimized separately.
- We will present three different analytical approaches to this problem with particular emphasis on the one that Northfield has implemented.

Wealth Management: Householding

- In the wealth management area, the multiple portfolios by various members of a specific household (parents, children, retirement accounts, education savings, trust funds) can separately optimized to reflect the differences in financial goals, risk aversion and tax circumstances.
- Any synergies across portfolios are lost
  - Fowler and deVassal, *Journal of Wealth Management*, 2006).
- Alternatively, the wealth from these many accounts could be pooled into a family fund to be optimized as a single larger portfolio. However, the rational parameters of the pooled problem will be dominated by the higher value sub-portfolios within the set, while being less influenced by the smaller value portfolios.
  - As such, the pooled solution may be "unfair" to some members of the household even if Pareto optimal for the family as a whole.
  - The objective of the optimization problem is to maximize the joint benefit of holistic optimization, while limiting potential "unfairness" to some level acceptable to the participants.

Asset Location: A Baby Step Toward Householding

- Since 2005, various wealth management firms have asserted some aspect of "householding" concept is present in their investing practices.
  - Most of these try to consider issues like "asset location" (i.e. does a particular asset type belong in a taxable or tax deferred account?) in defining strategic asset allocation decisions.
  - The joint problem of asset location and asset allocation is covered extensively in the book Investment Management of Private Taxable Wealth by diBartolomeo, Horvitz and Wilcox (published by CFA Research Foundation, 2006).
- However, we are unaware of any successful effort to provide the analytical capability for household level optimization down to the level of individual tax lots of securities, while addressing the three key differences across portfolios held by the various members of a household (legacy portfolios, tax circumstances, risk tolerance).
- There are also a lot of associated operational details (e.g. management of wash sales, tax lot ID tags).

Multi-line or Multi-jurisdiction Insurers

- A second important application of joint optimization capability is the formation of investment portfolios of complex corporate entities, such as multi-line insurance companies.
- Such companies may have dozens or even hundreds of separate portfolios designated as the investments for a particular line of insurance in a particular jurisdiction (e.g. car insurance in Texas).
  - Each of the separate portfolios may have its own tax, financial and regulatory considerations. Insurance regulators will often constrain the transfer of capital reserves from one subsidiary to another.
- Multiple portfolio joint optimization allows for the many portfolios to be optimized in a holistic fashion, maximizing tax and other synergies across the entire enterprise, while conforming to constraints associated with the separate sub-portfolios.
- A "fairness" issue may also arise if employee compensation (i.e. bonuses) is contingent on business line level operating profits.

Traditional Asset Managers

- A third use case is that of a traditional asset manager who may manage “similar not identical” portfolios for related (or even unrelated) parties.
  - For example, many large state pension funds also manage money on behalf of smaller units of government such as towns or counties.
- Another application is that multiple portfolio joint optimization can be usefully applied to many common problems such as how to allocate an equity share purchase across investors when the optimal total number of shares cannot be obtained due to liquidity limitations.
  - Given a non-linear market impact function, the total number of shares to be jointly purchased will be lower than the sum of the optimal account level trades, as the larger the aggregate trade the higher the per unit cost.
  - The US SEC has rather vague rules stating that allocations of a block trade across multiple investors must be done in a “fair” way.
  - Asset management firms handle this problem in a variety of ways ranging from simple apportionment to various “randomized” prioritization of “fills”.

Plan A - Householding Circa 2005

- Our first idea was for *Household Optimization* in which all the different accounts of a family (both taxable and tax advantaged) could be *jointly optimized in a holistic fashion* so as to maximize after-tax returns while respecting the many heterogenous aspects of the sub-accounts accounts (legacy portfolios, tax circumstances, risk aversion).
- The proposed methodology was presented in our newsletter in May 2005, (https://www.northinfo.com/Documents/133.pdf) which handled all the basic requirements plus presented some heuristic methods for addressing some exogenous complexities (e.g. wash sales across two accounts held by different members of the same household).
  - The set up of this optimization was particularly complex as it required defining separate assets for each account. For example, "IBM for dad" was a separate asset from "IBM for mom" in order to account for differences in risk tolerance.
  - While analytically functional, clients felt the complexity limited both the transparency and "scalability" of the process.

Lets Consider a Real World Problem

- Let's consider a hypothetical household problem: a family household is known to have ten different portfolios. Two taxable accounts are held in the name of the father and another two taxable accounts are held in the mother's name.
  - There are also two tax-deferred accounts (IRA, Roth IRA), a single 529 college savings plan for older of two children, one small taxable portfolio in the name of each of the two children, and a trust fund for the children established by a grandparent.
- Each of the ten accounts will be of different portfolio value, have different existing positions (with existing cost basis) and possibly different levels of risk tolerance. In addition, it is likely that the children would be in lower tax brackets than their parents.
- In the event of divorce or other separation of the family members there could even be differential taxation caused by residences in different states or countries. Up to this point, typical wealth management practice would be to consider the ten accounts *entirely separately and conduct whatever optimization operations are deemed appropriate for each particular portfolio.*

The Mechanics of a Merged Solution

- At the other end of spectrum would be the case where all of the household portfolios are merged together and optimized as if they were one big portfolio. A single degree of risk tolerance and a single set of tax rates that would be applied to the household as a whole, *with an accompanying loss of accuracy.*
  - The first problem is that the various members of the household don't have the same tax rates in the real world. As described in our 2005 article, the Northfield tax optimization system has always had the ability to address this aspect of the problem.
  - Our systems allow two values for the cost basis of a tax lot. The first value is the true value used to calculate actual taxes payable. The second is a "user adjusted" value that allows the user to effectively trick the optimization into doing a desired behavior.
  - For example, if a household optimization included both taxable and tax deferred assets, the cost basis of positions in the tax deferred account could be reset to be equal to the current market value. As such, no capital gain taxes would arise from transactions *making the capital gain tax rate effectively zero on trades in this account only.*

Simple Merging Isn't the Answer

- There are multiple considerations that make the simple "merge the portfolios" concept grossly inadequate.
  - Given that the underlying sub-accounts belong legally to different people and the portfolios have different values, maximizing the utility of the merged household portfolio would naturally ascribe more importance to the sub-accounts that are large in value.
  - The small sub-accounts (e.g. children) held in the children's names in my hypothetical example would have less influence in the solution of the household problem. As such, the merged portfolio could be optimal for the household as a whole, while being "unfair" in some way to those household members who legally hold less wealth.
  - One could easily imagine divorce cases in which one of the parties asserts that their personal portfolio was disadvantaged relative to the other spouse in pursuing the best outcome for the unified family which is unfortunately no longer unified. The issue of how investment policies should change as a function of the probability of divorce has been studied in Scherer (*LQG Conference Proceedings,* September 2014).

Adding In Fairness: The Wrong Way

- A simplistic and inefficient way to handle the fairness issue is would be to first optimize the ten accounts separately (no concern for the household) and sum those separate sub-portfolios up to form a household portfolio.

- You could then do one more optimization of the merged portfolio (no concern for fairness to the individual).

- Once we have two renditions of the household portfolio we could form any weighted average that we wanted (e.g. 50/50, 30/70, 70/30) as a compromise between what is best for the household and what is separately best for the individuals.

- Unfortunately, this sort of simple compromise is apt to be very sub-optimal as there are many non-linear aspects to the problem (e.g. tax lots, constraints, wash sales) as well as the issue of the sub-portfolios being of different value and hence influence in the merged optimization.

Plan B: The Two Benchmark Solution

- In this process, we first optimize each sub-account separately.
  - All optimal portfolios are aggregated into a "multiple account benchmark".
- We then merge the problem using the previously described "optimizer tricks" to adjust for differences in tax circumstances and risk tolerance.
  - The merged problem will have its own traditional benchmark as prescribed (e.g. 60/40 S&P 500, Barclay's Aggregate).
  - The "multiple account benchmark" is then added as a second benchmark. Analytical details for solving dual benchmark problems are provided in this presentation, https://www.northinfo.com/Documents/110.pdf
- By having different risk tolerances (RAP) with respect to tracking variance against the traditional benchmark and against the "multiple account benchmark" controls the relative emphasis on synergies versus fairness.
- A drawback of this process is that if the two benchmarks are highly correlated the optimal solution of the merged problem may be unstable, so accurate representations of transaction costs and taxes are key.

Plan C: What We Actually Implemented

- The current Northfield multi-portfolio (household) optimization allows the sub-portfolios to be merged into one big portfolio using the aforementioned adjustments to cost basis data to account for different tax circumstances of the sub-portfolios.
- Unlike the 2005 conception, the current process uses all of the usual Northfield constraints and optimization parameters (risk tolerance, turnover limits, trading round lots) so the set-up of household problems is not more difficult than for a single account. Almost all of complexity of the household level optimization is handled automatically behind the scenes.
  - During the household optimization, position weights in the sub-accounts can be constrained so no new violations of sub-account weight constraints can arise by virtue of the household optimization.
  - These position weight constraints can be specified as relative to the sub-account's own benchmark. This function allows the household optimization to maintain the desired degree of fairness by constraining each sub-portfolio to not stray too far from its respective benchmark, *similar to putting "guard rails" on a highway.*

Getting Synergies and Fairness

- It is also possible to pre-optimize each sub-portfolio individually and use those optimal portfolios as the reference point for position size constraints for the respective sub-portfolio during the household optimization.
- *In effect, we are able to ensure that each sub-portfolio has any desired level of similarity to their respective individual optimal portfolios* so that different levels of risk tolerance can be accommodated.
- By using the individual sub-account optimal portfolios as the basis of position constraints we can put any desired emphasis on synergies versus fairness.
  - For example, if individual positions in all sub-accounts can be +/- 1% active weight relative to the sub-account optimal portfolio, that will offer some room for the merged optimization to find synergies *in a uniform fashion.*
  - If the constraint is narrowed or increased(e.g. .5% or 2% active weight), the relative emphasis on individual objectives versus the collective objective can be varied.
  - Constraints can be specified differently across securities or sub-accounts if desired (contrary to the fairness concept).

Needed Analytical Nuances: Buy List

- The first is that our concept of a "buy list" can be set for each individual sub-portfolio even during the merged household optimization.
  - For example, if "mom" has concerns about the environment and so restricts her sub-portfolio to environmentally friendly companies, that will be respected in the household optimization but will not inhibit "dad" from ignoring this restriction for his sub-portfolio.
  - Similarly, one could restrict a trust fund to only stocks that paid high dividends (for distributable income) while not imposing such a restriction on the household as a whole.
  - You can think of this problem sort of like "pairs trading". At each point in the merged optimization, any "sell" from any sub-account must match to a "buy" that is included in the "buy list" for that sub-account.

Needed Analytical Nuances: Effective Tax Rates

- Another subtle ability is to set different "alphas" or expected returns for the same security when present in different sub-accounts.
  - The purpose of this capability is to allow managers to differentiate between different accounts *where long-term strategic tax considerations come into play.*
  - For example, one might want to differentiate between IBM held in a taxable account, a Roth IRA (no tax on capital gains or eventual distributions), and a regular IRA where there would be no tax on realizing a capital gain while funds are within the IRA, but there would be some taxation of the gain when the profits became part of eventual retirement distributions.
  - The methodology is consistent with the approach of Markowitz and Blay (2016).
  - Finally, the joint optimization problem is structured so that *any chosen combination of the accounts of the household* can be designated as part of a group that should be treated as one taxpayer for the purposes of the "wash sale" rules.

The Complex Insurer

- Conceptually, the problem of the "multi-line, multi-jurisdiction" insurance company is very similar to the household problem.
  - No money can move between sub-accounts
  - The various sub-accounts will have heterogenous tax circumstances, risk tolerance and legacy portfolios.
  - But there may be hundreds of included sub-portfolios.
- An important difference is that with insurance companies operating across national borders, the flexibility to "trick" the optimization into incorporating differences in tax rules in a key function.
- Under the accounting rules used by many insurance companies, net realized capital gains are included in operating profits.
  - As such, insurances wishing to appear more profitable may wish to realize net capital gains to "window dress" earnings, even if it means increasing the company's tax liabilities. Again, our solution can handle this economically perverse behavior.

Allocation of Liquidity Constrained Trades

- As part of the merged portion of a multi-portfolio optimization, our extensive functionality in non-linear transaction costs becomes useful.
  - When optimized separately, each sub-account will estimate transaction costs appropriately for that account only.
  - For more information on our non-linear transaction cost process see https://www.northinfo.com/Documents/538.pdf and https://www.northinfo.com/Documents/500.pdf
  - When the merged account is optimized (say 50 portfolios all wanting participate in a buy of an illiquid stock) the perceived cost of the aggregate trade will be higher and the aggregate trade size optimally reduced.
  - For the Pareto optimal solution, the multiple accounts are merged with their actual market values.
  - For a "maximum fairness" solution, the multiple accounts are merged assuming they are of equal market value (i.e. 50 accounts = 2% each)

Conclusions

- The practical implementation of realistic multi-portfolio optimization is a major step forward in the effort to serve investors well.
- The ability to do a holistic joint optimization of all the financial accounts of a household (or a corporate entity) is an unprecedented capability that can now be brought forward to benefit investors.
- Applying the multi-portfolio capability in conjunction with our sophisticated non-linear transaction cost functions and the underlying transaction cost estimates allows a very efficient resolution to the problem of optimal trade size across a set of portfolios, whether related or unrelated.
- The new capabilities described herein are available in all variations of the Northfield optimizer from our desktop version, our LD version (large deployment), MARS (industrial size) and the various third-party partner deployments of our optimization computation library.