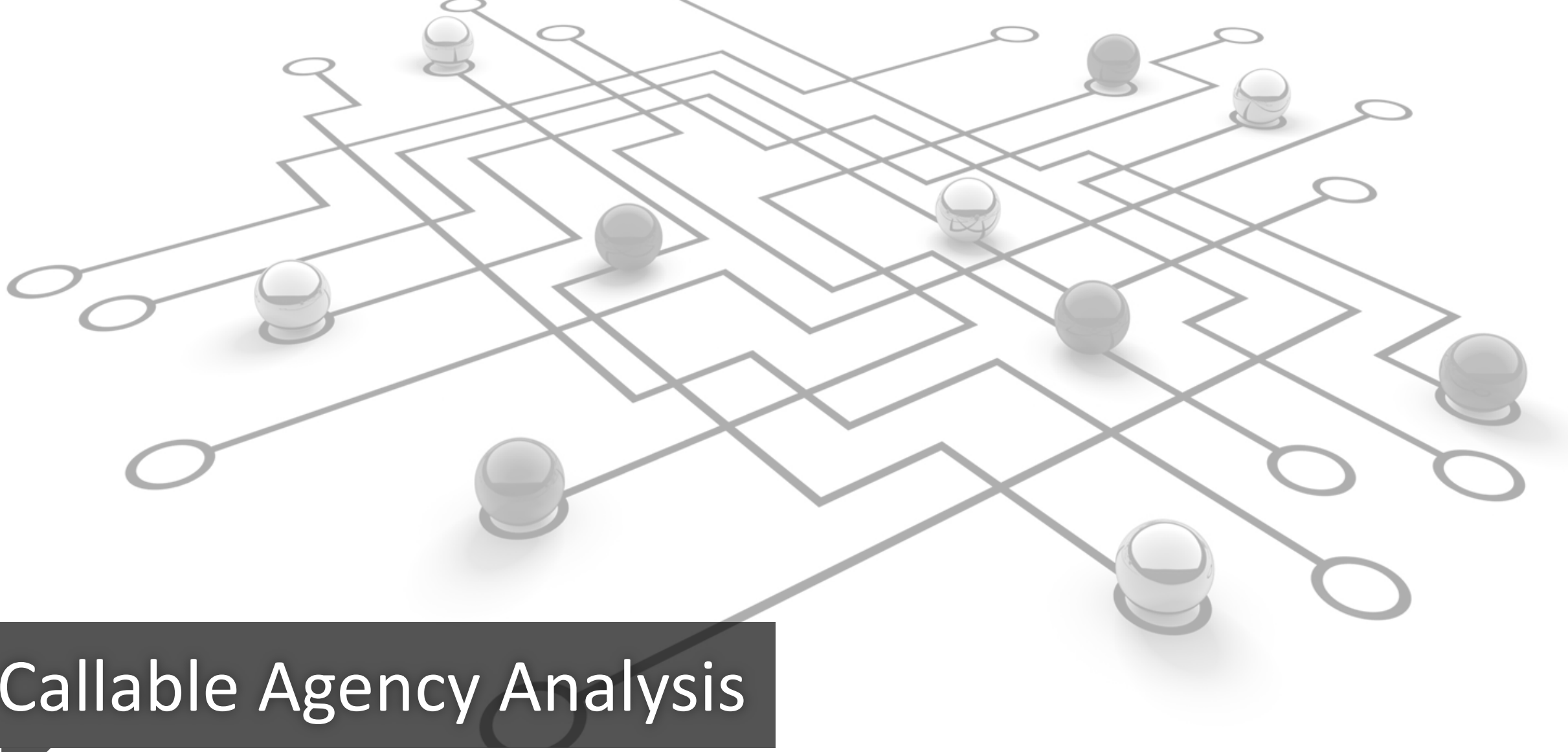


Callable Agency Analysis

Kevin Webb, CFA
Managing Director
RW Baird
KpWebb@RwBaird.com

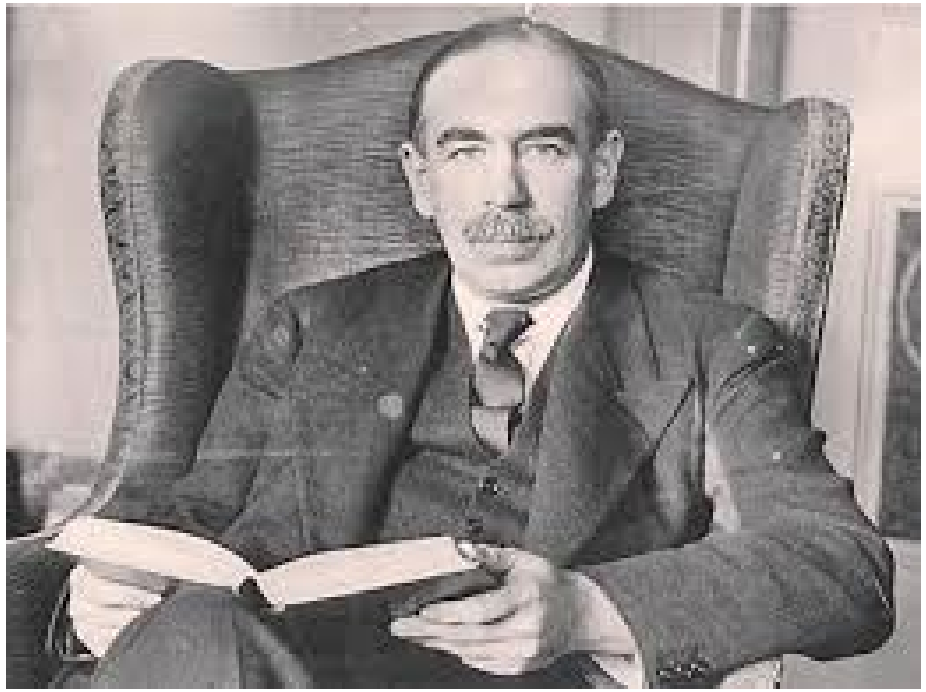
Callable GSE Deep Dive - 5 items

How to achieve sleep-adjusted returns

1. **Philosophical Overview**
2. What are they?
3. Why do they exist?
4. How should they be analyzed?
5. A Digression on OAS and Volatility

Economic Words of Wisdom 1

"The Theory of Economics does not furnish a body of settled conclusions immediately applicable to policy. **It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking, which helps its possessor to draw correct conclusions.**"



John Maynard Keynes writing in the introduction of
H.D. Henderson, Supply and Demand (New York: Harcourt, Brace and Company, 1922), v. Emphasis added.

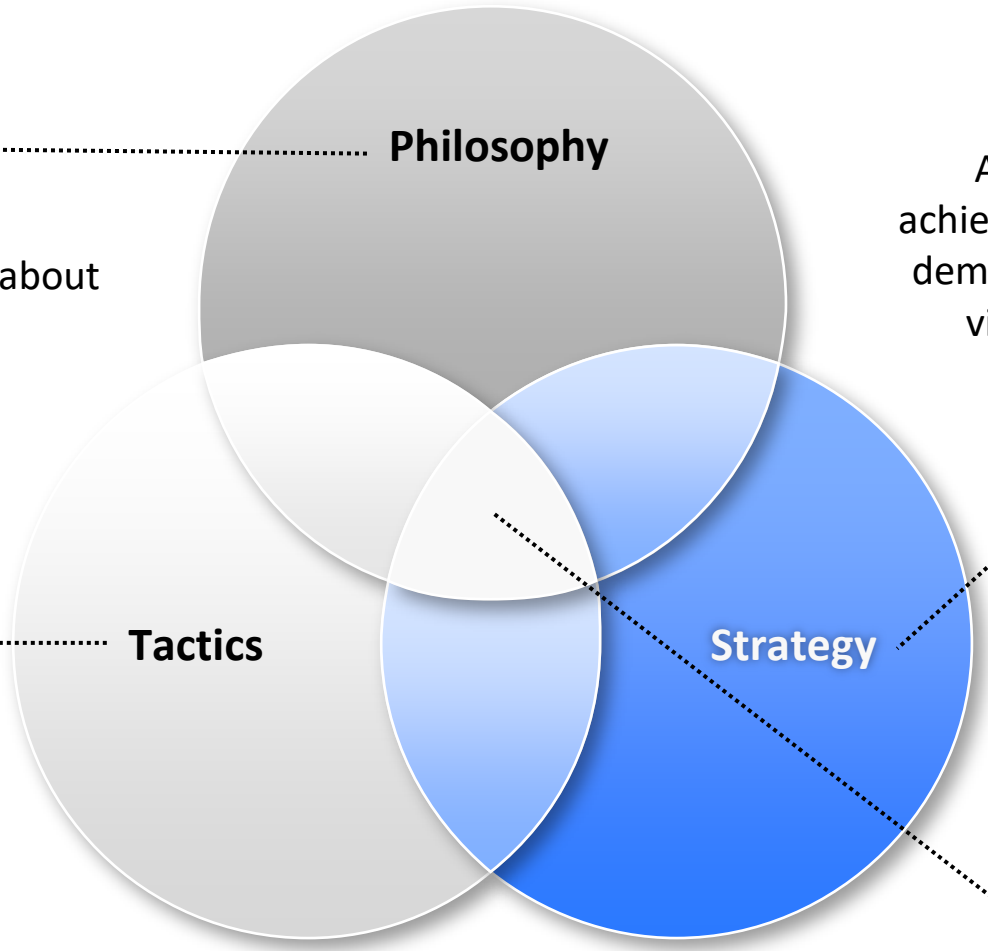
Economic Words of Wisdom 2

“Nobel laureate Kenneth Arrow has warned, **"[O]ur knowledge of the way things work, in society or in nature, comes trailing clouds of vagueness. Vast ills have followed a belief in certainty."**”

Peter L. Bernstein. Against the Gods: The Remarkable Story of Risk (Kindle Location 126). Kindle Edition. Emphasis added.

Philosophy, Strategy & Tactics

Sleep-Adusted returns via Suitability Benchmark using evidence based methods.



Investment philsophy is a coherent way of thinking about the markets, risk, return, investor behaviour, etc.

A plan of action or policy to achieve one or more goals (e.g., demonstrate good stewardship via a suitability benchmark).

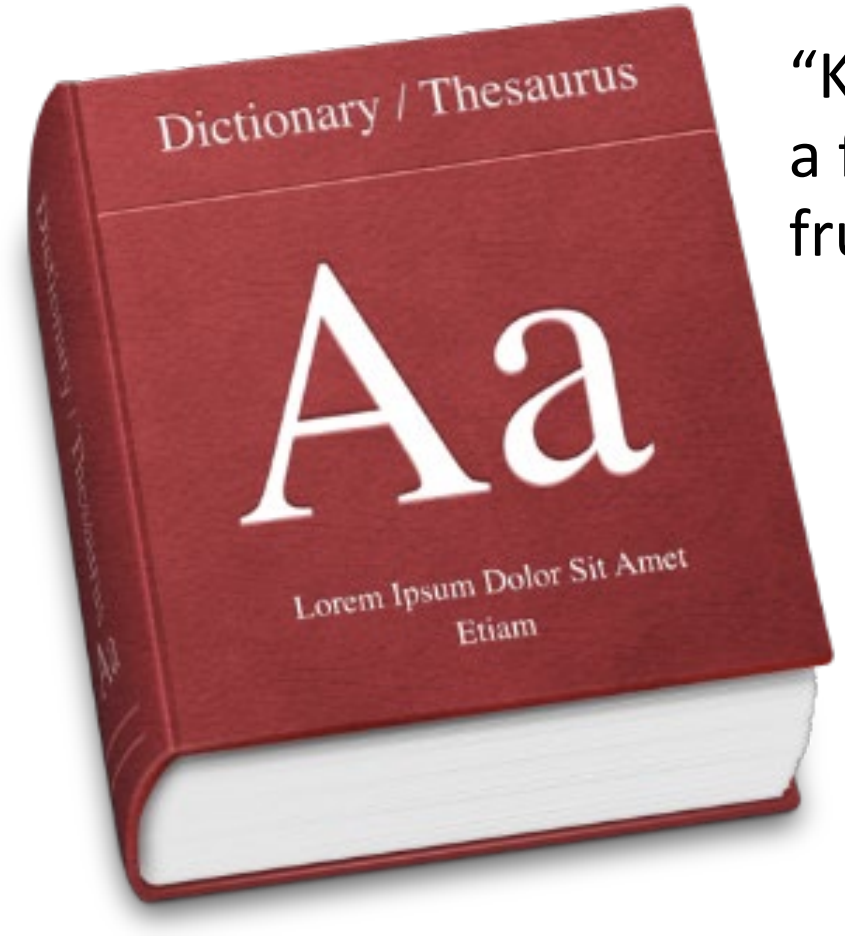
Resources, skills & methods used to achieve the goal of a strategy (e.g., education, formulas, data, software, etc.)

The intersection of philosophy, strategy & tactics is the world of portfolio management

The difference between strategy and tactics: Strategy is done above the shoulders, Tactics are done below the shoulders.


WARNING
ASSUMPTIONS
AHEAD

Definitions



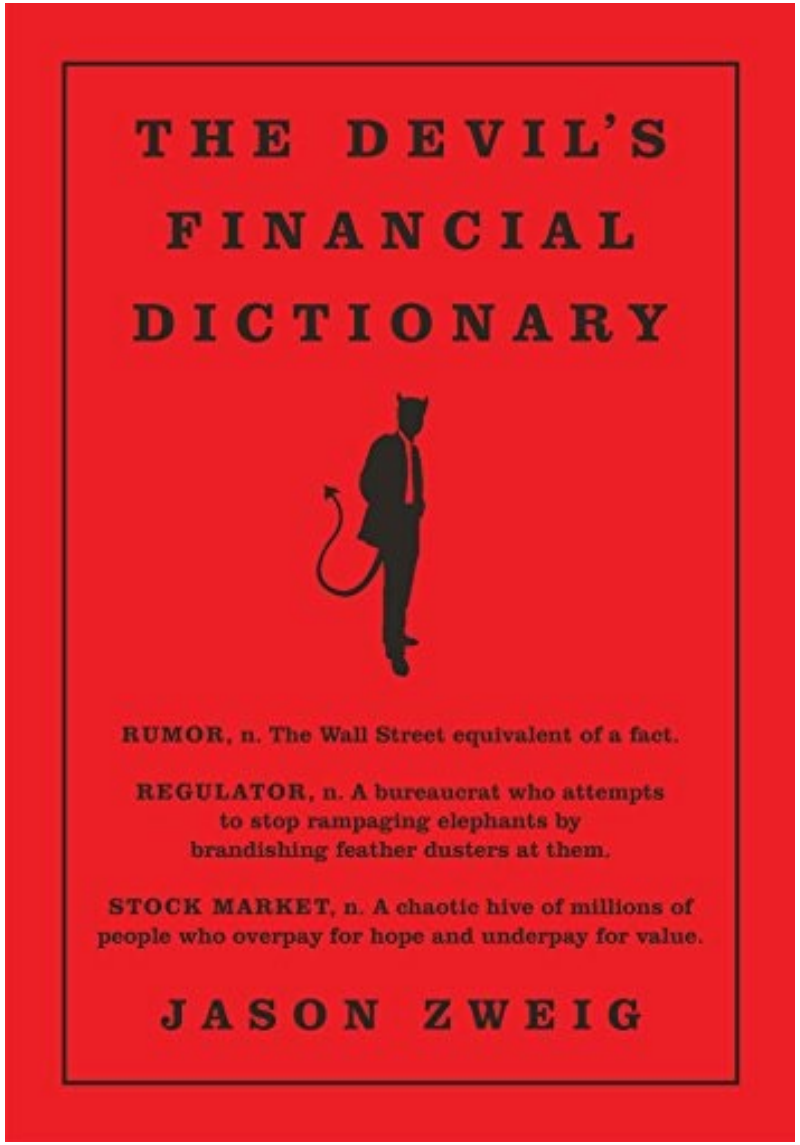
"Knowledge is knowing a tomato is a fruit; Wisdom is not putting it in a fruit salad."

Brandreth, Gyles. Oxford Dictionary of Humorous Quotations (Kindle Location 4265). OUP Oxford. Kindle Edition.
See this useful Microsoft Help page for Microsoft Word on the definition/history of "Lorem Ipsum Dolor Sit Amet Etiam":
https://support.microsoft.com/en-us/kb/114222

Risk Defined

More things can happen than will happen.

… It has been philosophically defined by finance professor Elroy Dimson of London Business School this way: ***"Risk means more things can happen than will happen."*** In the end, risk is the gap between what investors think they know and what they end up learning— about their investments, about the financial markets, and about themselves.

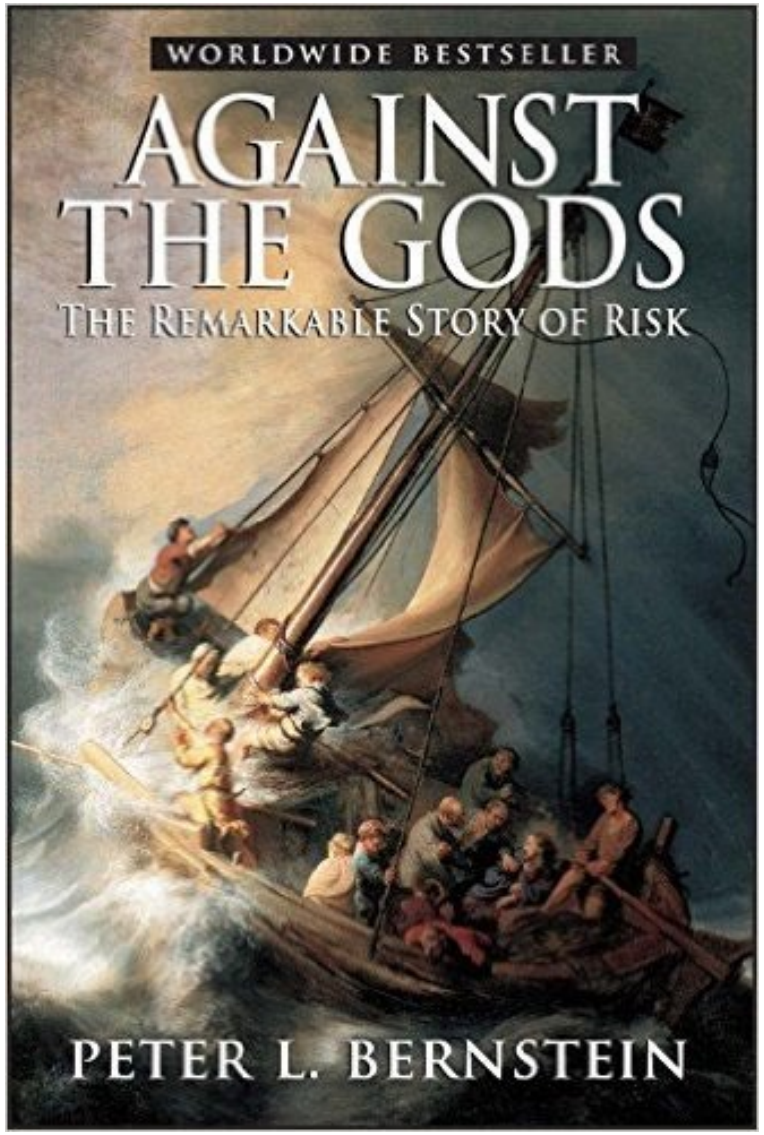


Zweig, Jason. The Devil's Financial Dictionary (p. 182). PublicAffairs. Kindle Edition. Emphasis added.

Risk & Return are Related

Finding the right trade-off is the key

*The scientist who developed the Saturn 5 rocket that launched the first Apollo mission to the moon put it this way: ***"You want a valve that doesn't leak and you try everything possible to develop one. But the real world provides you with a leaky valve. You have to determine how much leaking you can tolerate."*** (Obituary of Arthur Rudolph, in The New York Times, January 3, 1996.)



Peter L. Bernstein. Against the Gods: The Remarkable Story of Risk (Kindle Locations 69-71). Kindle Edition. Emphasis added.

What Should I Benchmark?

Prudent Person

Investments shall be made with judgment and care, under circumstances then prevailing, which persons of prudence, discretion and intelligence exercise in the management of their own affairs, not for speculation, but for investment, considering the probable safety of their capital as well as the probable income to be derived.

Prudent Investor

A U.S. law that sets the standard of fiduciary duty for those entrusted with the responsibility of managing others' money, such as trustees and estate administrators. It requires that a trustee weigh risk versus reward when making investment decisions, taking into account the income that may be generated by the investment as well as the probable safety of the invested capital.

Prudent Investor vs Prudent Man/Person

1. Trust accounts are judged on their entire portfolio, rather than whether the investment was prudent at the time of purchase.
2. Diversification is explicitly required under the Prudent Investor Act
3. Suitability is deemed more important than individual investments
4. Fiduciaries are allowed to delegate investment management to qualified third parties

https://www.investopedia.com/terms/p/prudent-investor-rule.asp & https://www.investopedia.com/terms/p/prudentmanrule.asp

What Should I Benchmark?

General Objectives

"The primary objectives, in priority order...

1. Safety

Safety of principal is the foremost objective… ***The goal will be to mitigate credit risk and interest rate risk.***

2. Liquidity

The investment portfolio shall ***remain sufficiently liquid*** to meet all operating requirements that may be reasonably anticipated.

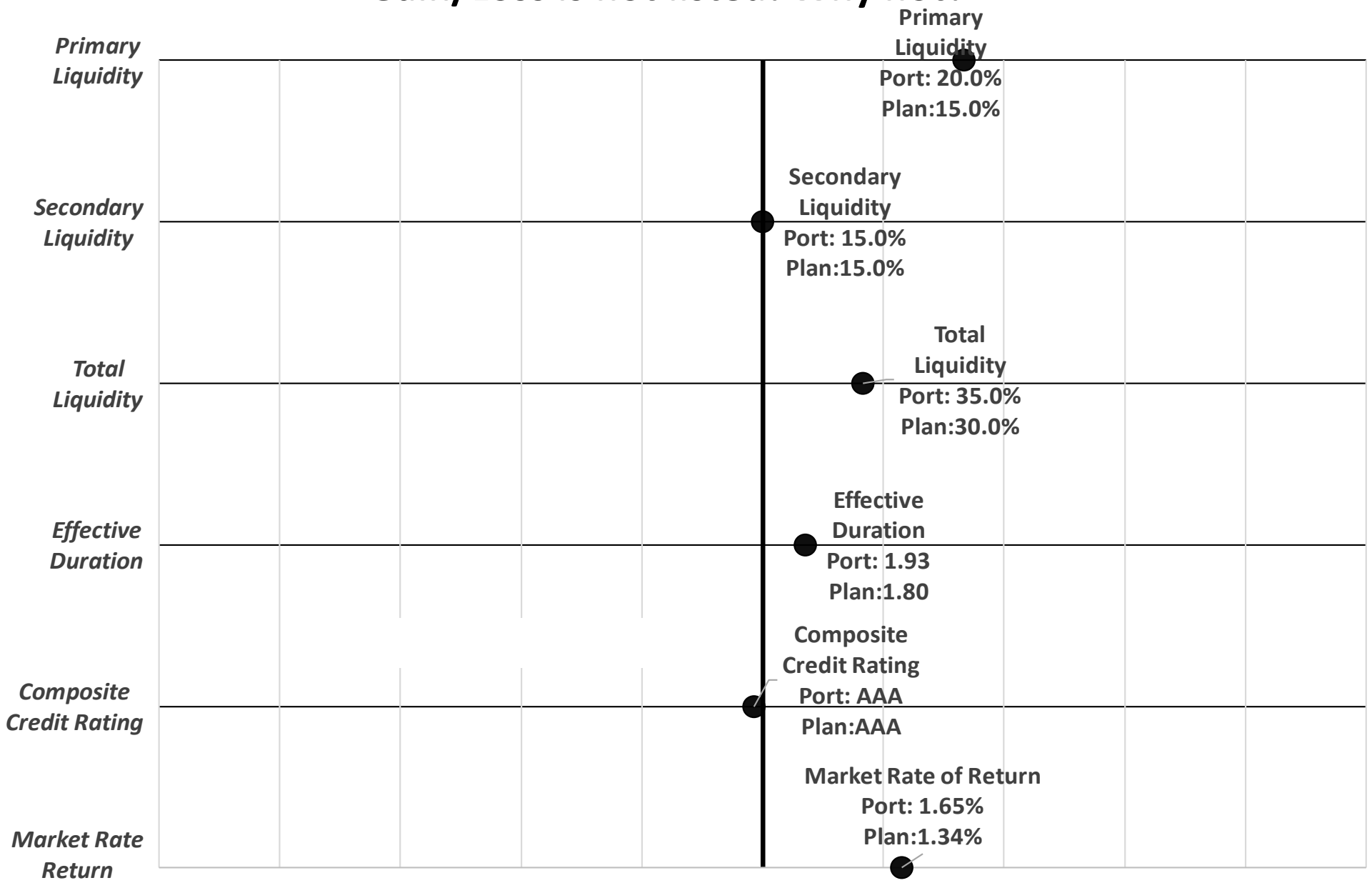
3. Return

The investment portfolio shall be designed with the objective of attaining a ***market rate of return throughout budgetary and economic cycles***, taking into account the investment risk constraints of safety and liquidity needs."

GFOA Sample Investment Policy, accessed 12/31/16, pages 1-2. Emphasis added.

Benchmark Suitability

Gain/Loss is not listed! Why not?

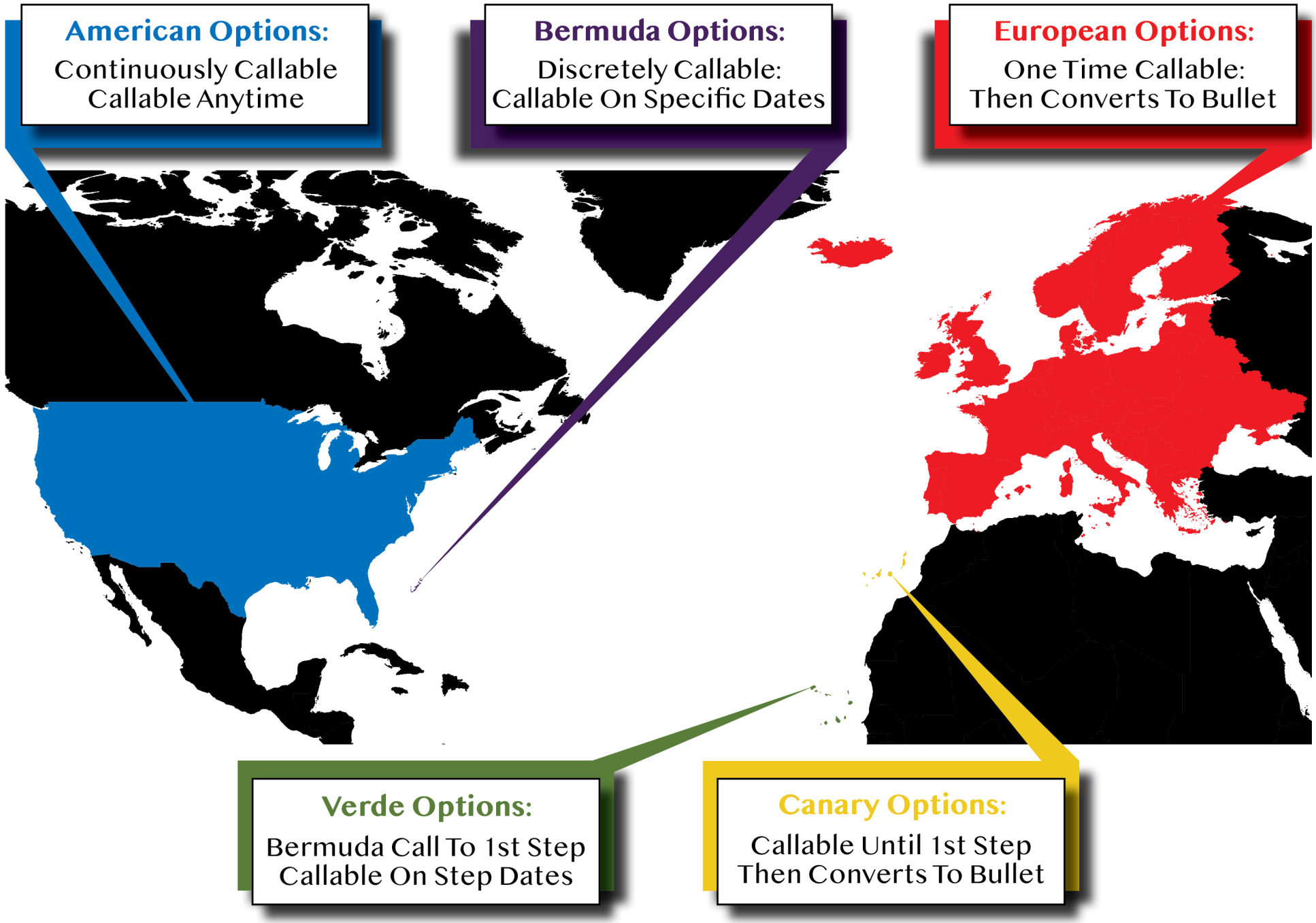


For the background and concepts behind this visualization see the presentation “Understanding Benchmarks: Concepts” by Kevin Webb, CFA

What & why?

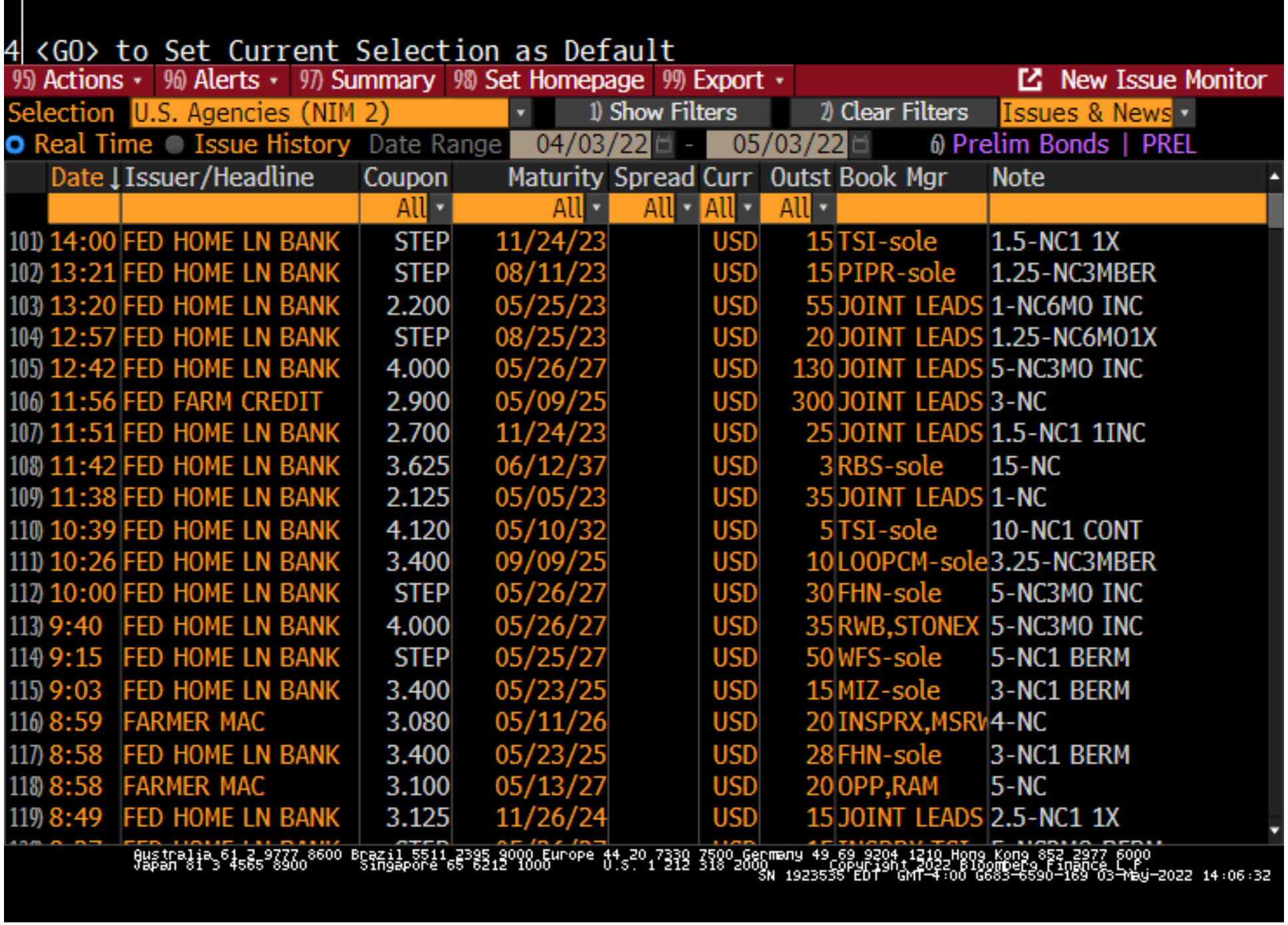
Callable bonds: What are they?

- ***A bond where the issuer has the option to call (buyback) the bond*** from an investor at a pre-determined price on a pre-specified date.
- The option to call the bond is usually one of the following kind:
  - **European**: One time only
  - **Bermudan**: Multiple times quarterly or semi-annually usually on coupon payment dates
  - **American**: Any time after a specified date
- In return for the option to call, the issuer pays a higher coupon than a non-callable bond of similar maturity.
- **The value of the call option depends on**:
  - *How often* and at what price the issuer can call the bond (exercise option)
  - *Time to the call date*
  - ***Volatility of interest rates***



GIOA Certified Government Investment Professional training course 10: "Options and Volatility – Callables & Prepayments" by Kevin Webb, CFA. https://www.gioa.us/cgip/

Visualization designed & created by Catherine Webb | catgraphiks@me.com



Source: Bloomberg on 5/3/22

Callable bonds: Data/Information

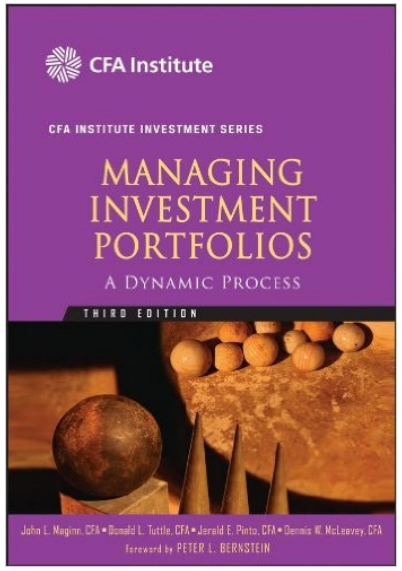
- FHLMC (Freddie Mac) Bond Data:
  http://www.freddiemac.com/debt/html/sactivitymain.html
- FNMA (Fannie Mae) Bond Data:
  http://www.fanniemae.com/portal/funding-the-market/debt/reports/
- FHLB (Federal Home Lone Bank) Bond Data:
  http://www.fhlb-of.com/ofweb_userWeb/pageBuilder/debt-securities-21
- FFCB (Federal Farm Credit Bank) Bond Data:
  https://www.farmcreditfunding.com/ffcb_live/activitySummary.html
- FRB (Federal Reserve Bank) Call Notices:
  https://www.frbservices.org/app/callnotices/CallNotices.action
- TRACE (FINRA Trade Reporting and Compliance Engine):
  http://finra-markets.morningstar.com/BondCenter/Default.jsp

Callable bonds: Why are they?

- **Agencies buy mortgage loans** and assets backed by mortgage loans.
- **Home owners usually have the right to pre-pay** the mortgage loan at any time:
  - When rates drop home owners are likely to pre-pay loans and “re-finance” at lower rates.
  - When rates rise home owners are likely to keep the low rate loan rather “re-finance” with a higher rate loan.
- Therefore, Agencies are short options to homeowners
- **The issuance of callable bonds allows the Agencies to match the characteristics of the mortgage loan** (asset/liability management):
  - When interest rates drop, mortgage loans (assets) pre-pay, Agencies can redeem their callable bonds (liabilities).

How should they be analyzed @ the sector level?

Return: Total Return or Book Yield?

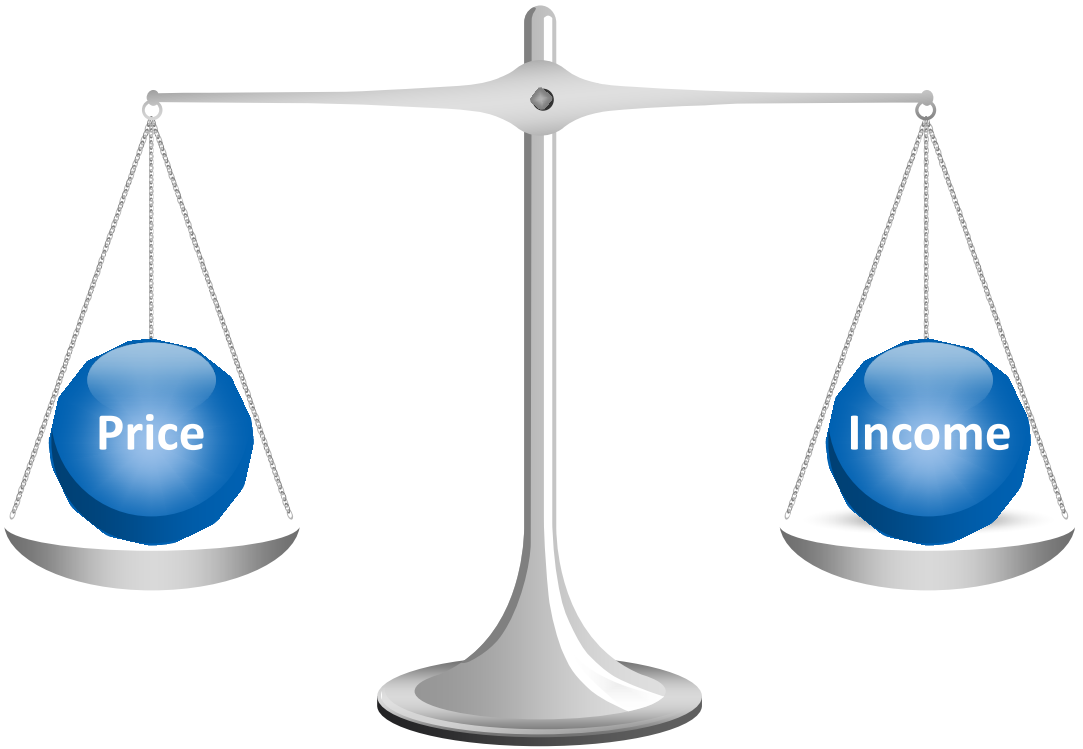


"Total rate of return measures the increase in the investor's wealth due to both investment income (for example, dividends and interest) and capital gains (both realized and unrealized). ***The total rate of return implies that a dollar of wealth is equally meaningful to the investor whether that wealth is generated by the secure income from a 90-day Treasury bill or by the unrealized appreciation in the price of a share of common stock."***

$$HPR = \frac{I_t + P_t - P_{t-1}}{P_{t-1}}$$

where HPR = holding period return
I_t = income
P_t = ending price
P_{t-1} = beginning price

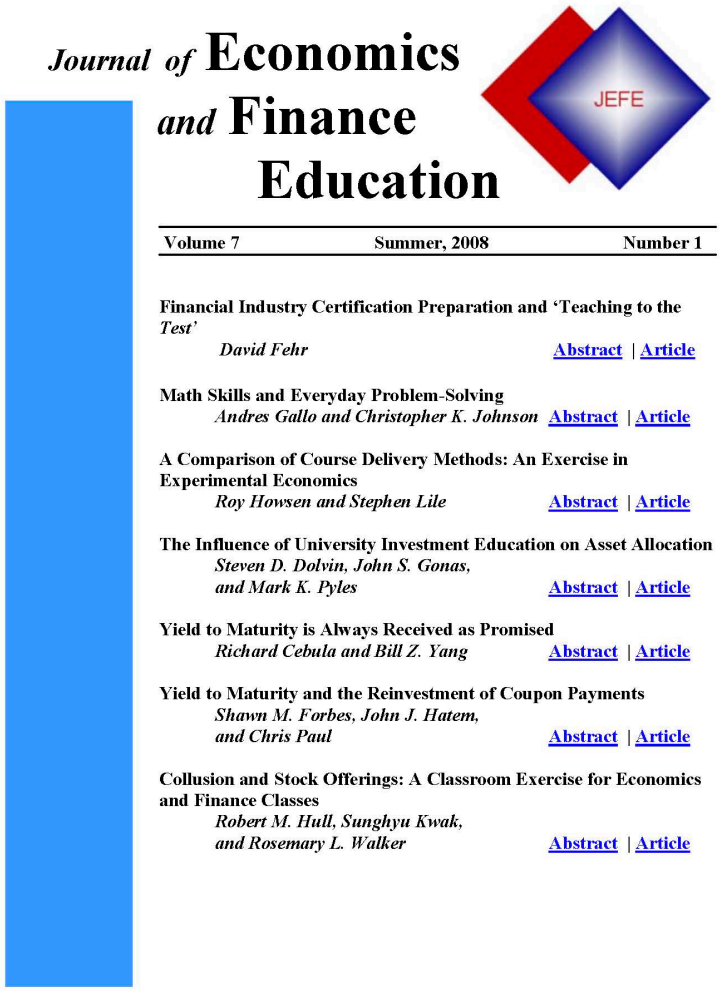
$$Total\ Return = \frac{(EndingMarketValue - BegMarketValue) + CashFlow}{BegMarketValue}$$



Managing Investment Portfolios: A Dynamic Process (CFA Institute Investment Series) (p. 723). Wiley. Kindle Edition. Emphasis added.
Mark P. Kritzman. The Portable Financial Analyst: What Practitioners Need to Know (Wiley Finance) (Kindle Locations 452-454). Kindle Edition.

Yield To Maturity (Book Yield) is always received as promised

This note points out that the above-mentioned common treatment in many textbooks turns out to be a fallacy. The truth is that YTM on a (coupon) bond is always received regardless of how coupon payments are re-invested, provided that the bond is held until maturity without default. It addresses a basic question in bond theory: between YTM and realized compounding yield (RCY hereafter), which concept measures the true rate of return from holding a coupon bond until maturity? It is well accepted that YTM measures the rate of return from holding a bond until maturity for both coupon bond and zero-coupon bond as well. By definition, the YTM received from holding a bond is independent of how coupon payments are allocated, as long as they are paid on time as contracted. By comparing the initial investment and the final value accumulated over the investment horizon, on the other hand, RCY on a bond measures the rate of return from an account (or trust) that holds the bond and the interests paid. Of course, it depends on how coupon payments are reinvested. We demonstrate that the RCY actually measures the YTM from a combined investment - holding a coupon bond plus an additional periodic investment with each coupon payment received. Not surprisingly, YTM and RCY would be normally unequal; RCY equals YTM if and only if coupon payments are reinvested at the same rate as the initial YTM. However, this conclusion should not be interpreted as "the yield to maturity is actually received only if coupon payments are reinvested at the yield to maturity".



Journal of **Economics** *and* **Finance Education**

JEFE

Volume 7 Summer, 2008 Number 1

Financial Industry Certification Preparation and 'Teaching to the Test'
David Fehr Abstract | Article

Math Skills and Everyday Problem-Solving
Andres Gallo and Christopher K. Johnson Abstract | Article

A Comparison of Course Delivery Methods: An Exercise in Experimental Economics
Roy Howsen and Stephen Lile Abstract | Article

The Influence of University Investment Education on Asset Allocation
Steven D. Dolvin, John S. Gonas, and Mark K. Pyles Abstract | Article

Yield to Maturity is Always Received as Promised
Richard Cebula and Bill Z. Yang Abstract | Article

Yield to Maturity and the Reinvestment of Coupon Payments
Shawn M. Forbes, John J. Hatem, and Chris Paul Abstract | Article

Collusion and Stock Offerings: A Classroom Exercise for Economics and Finance Classes
Robert M. Hull, Sunghyu Kwak, and Rosemary L. Walker Abstract | Article

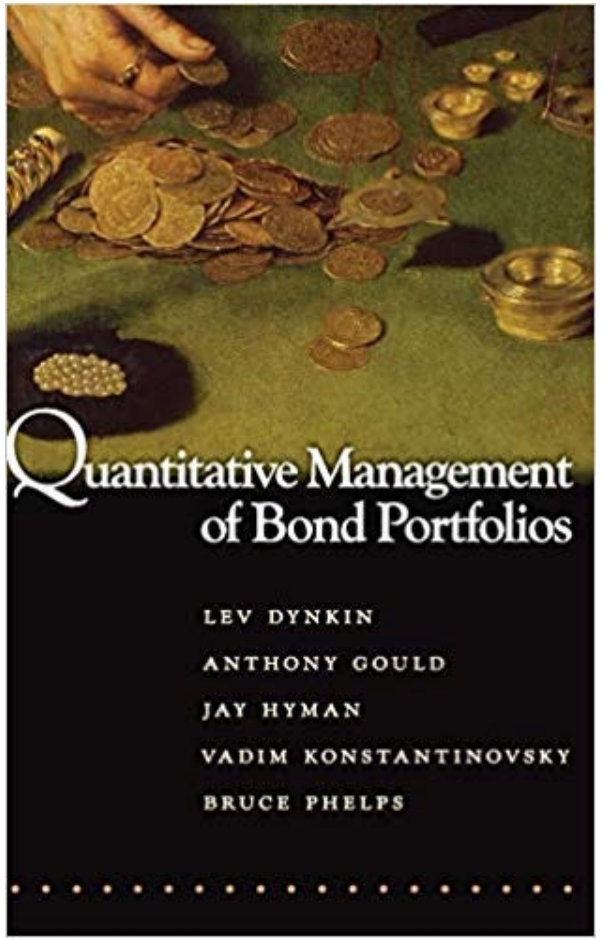
Don’t let Tactics drive Philosophy

Don’t let Wall Street make you over in their image and likeness…

...investors, who are predominantly concerned with book yield and risk adjusted book returns, can benefit from performance benchmarks that also use book accounting.

Because the book accounting performance of an index depends on the timing and amounts of cash inflows and outflows (and the particular rules for handling such cash flows) preceding the current performance month, no two investors will likely have the same book benchmark even if their underlying index is the same. By its very nature, a book benchmark must be customized for each investor to allow him or her to input their historical vector of cash inflows and outflows (including rules) so as to produce proper book accounting values in the current month. ...

The benchmark book yield and book income are indications of what could be achieved if the manager followed a passive strategy. ...

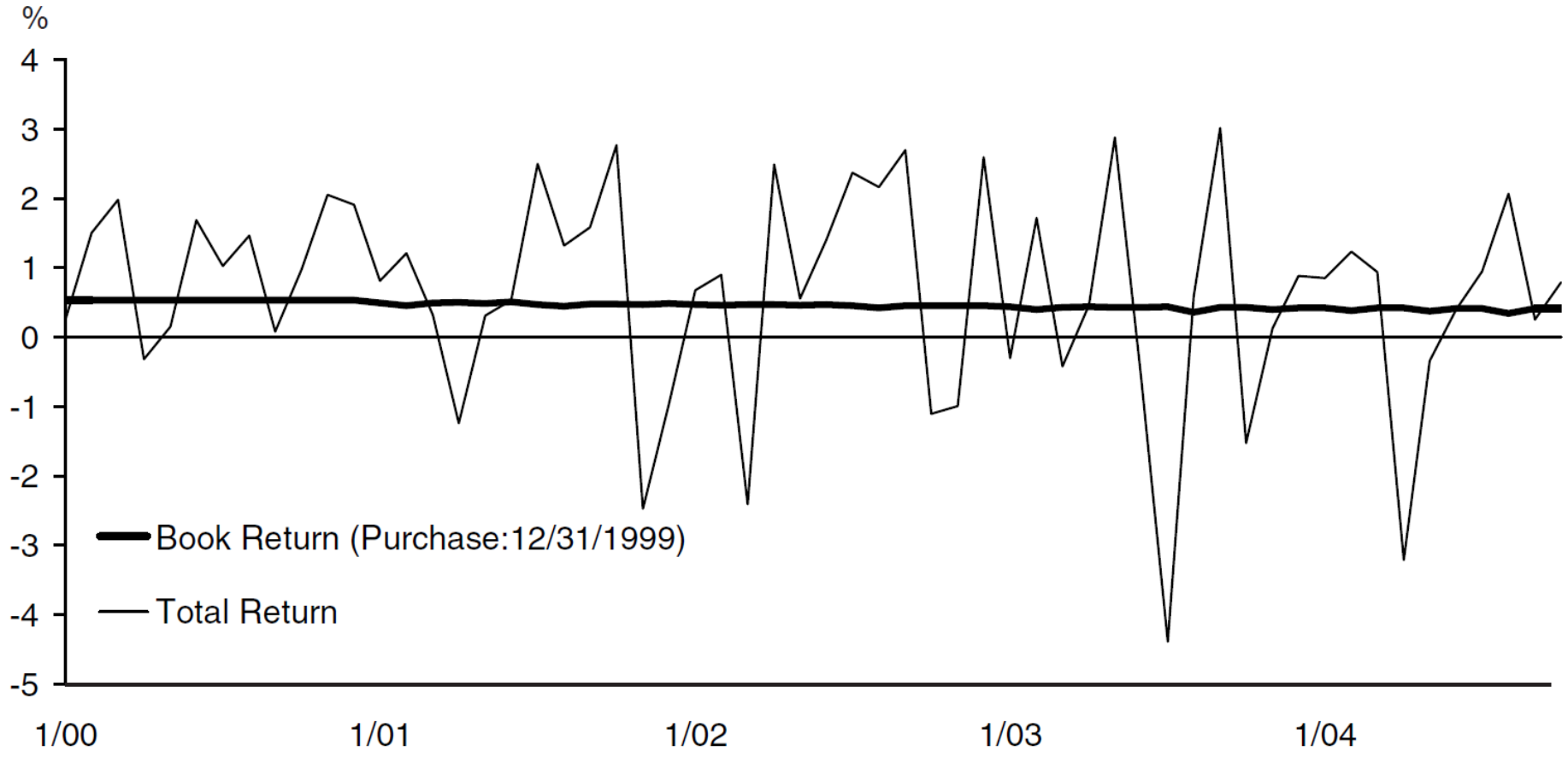


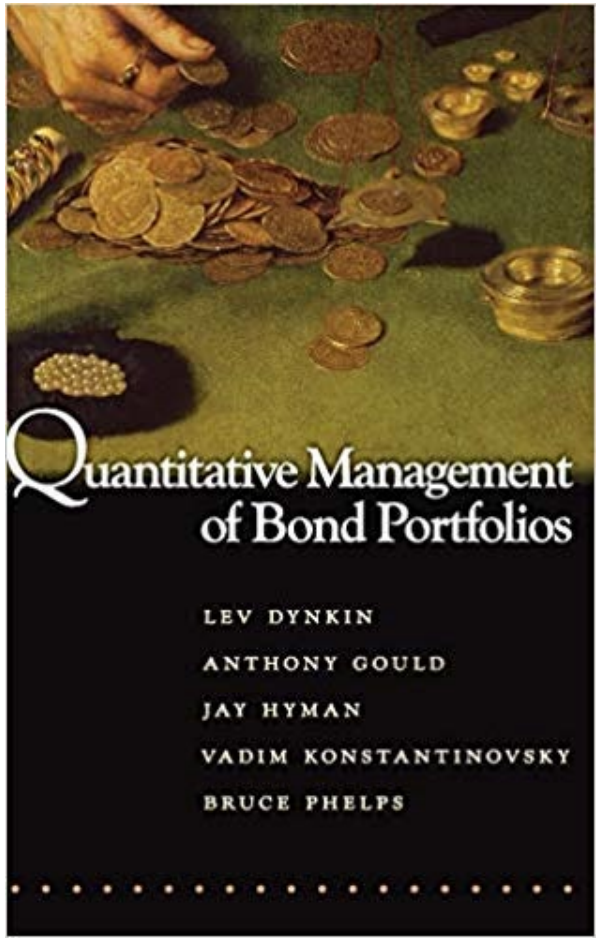
Bruce Phelps, et. al. Quantitative Management of Bond Portfolios. Emphasis added.

Don’t let Tactics drive Philosophy

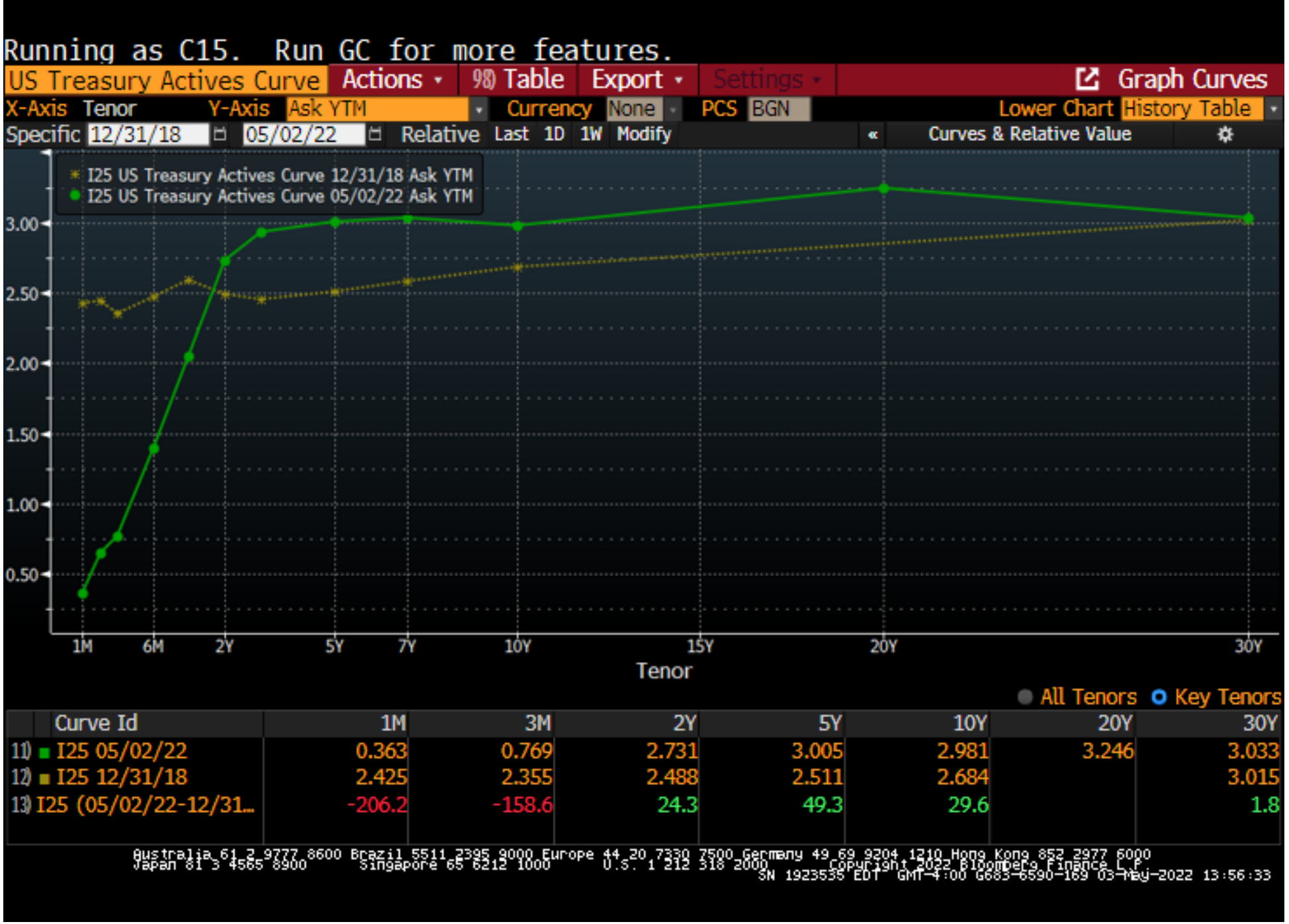
Don’t let Wall Street make you over in their image and likeness…

Figure 1. **Book Return versus Market Return: A Portfolio of the Lehman Brothers U.S. Treasury Index,** Purchased on December 31, 1999



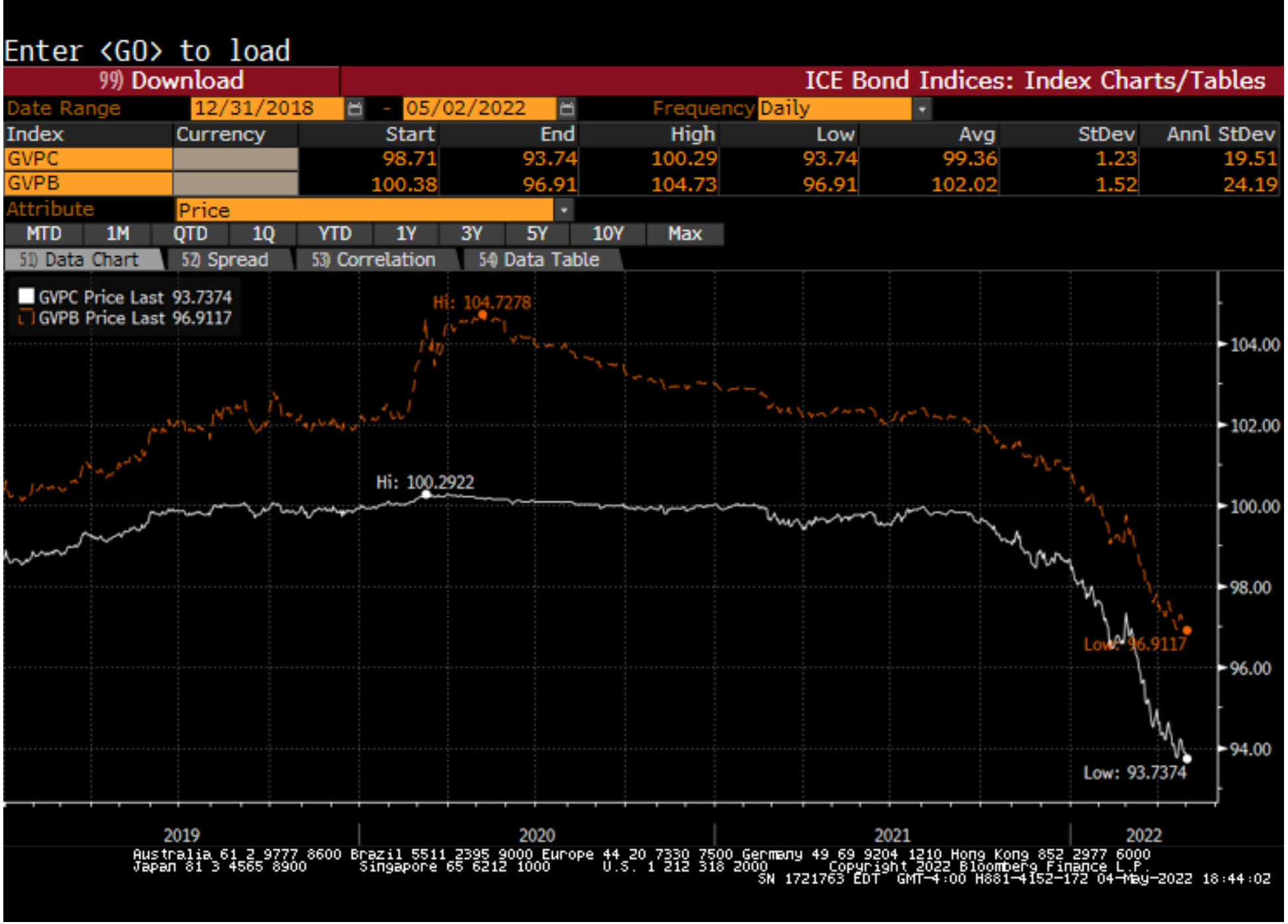


Bruce Phelps, et. al. Quantitative Management of Bond Portfolios. Emphasis added.

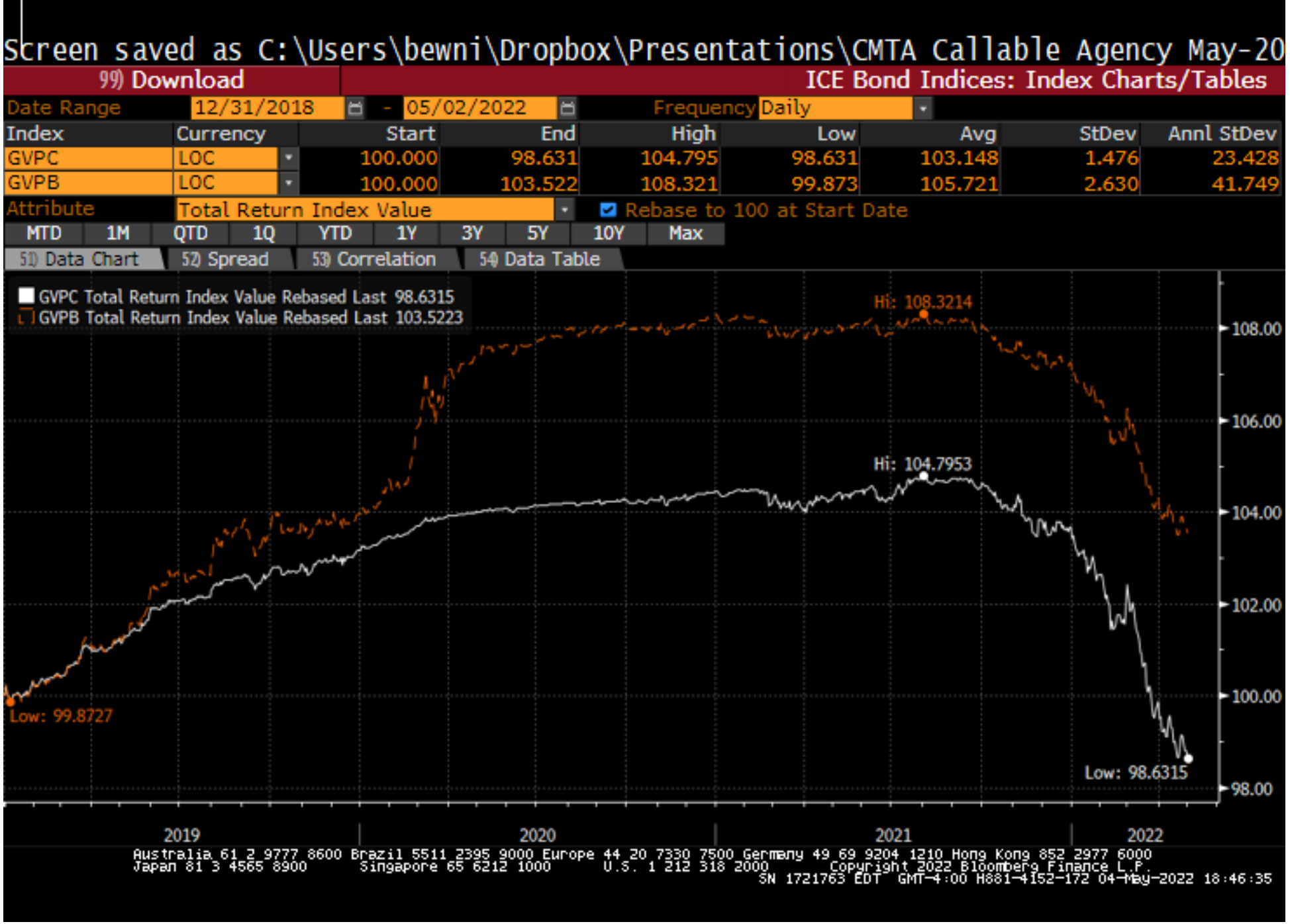


Source: Bloomberg on 5/3/22

Source: Bloomberg on 5/3/22



Source: Bloomberg on 5/3/22. Data & calculations by ICE.



Source: Bloomberg on 5/3/22. Data & calculations by ICE.

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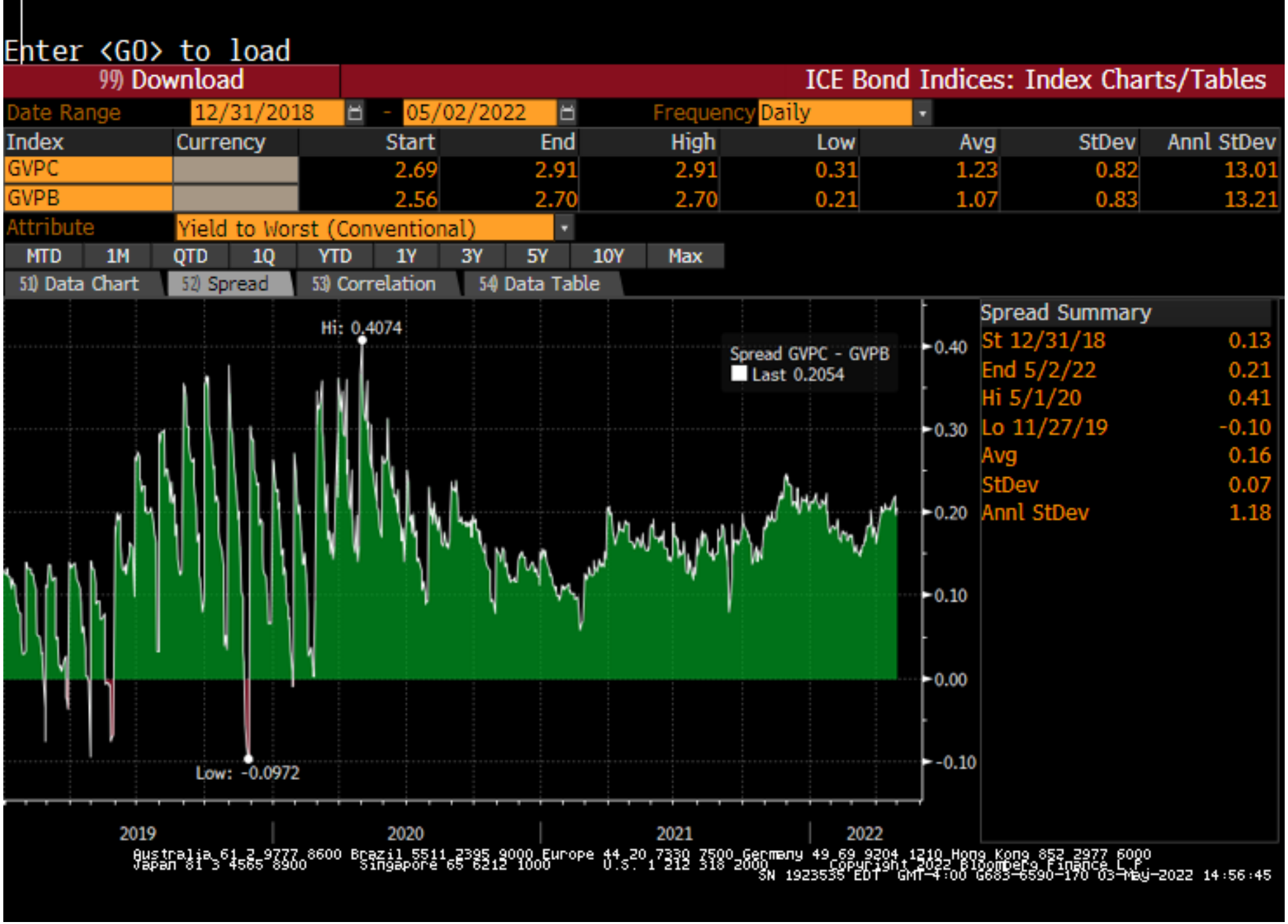

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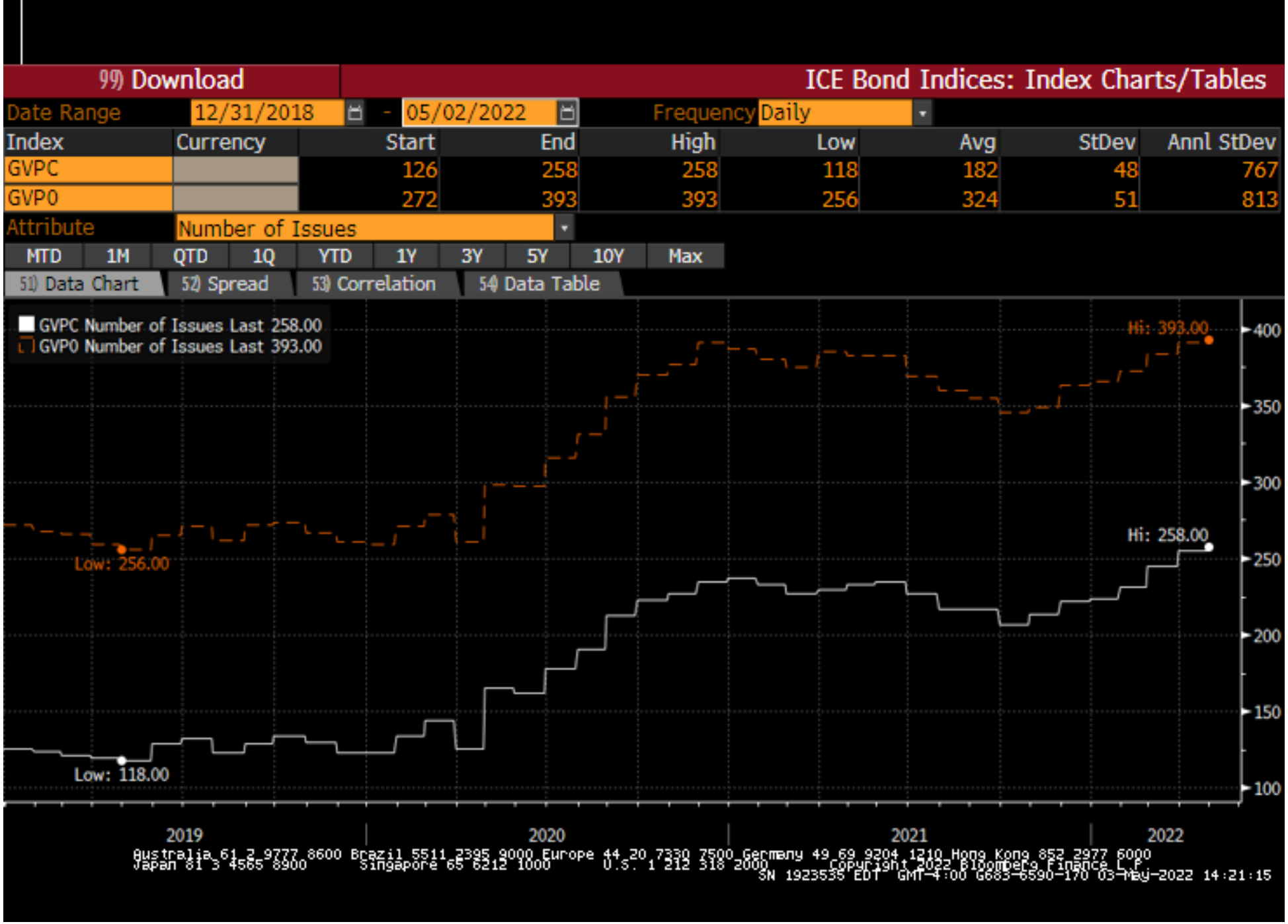

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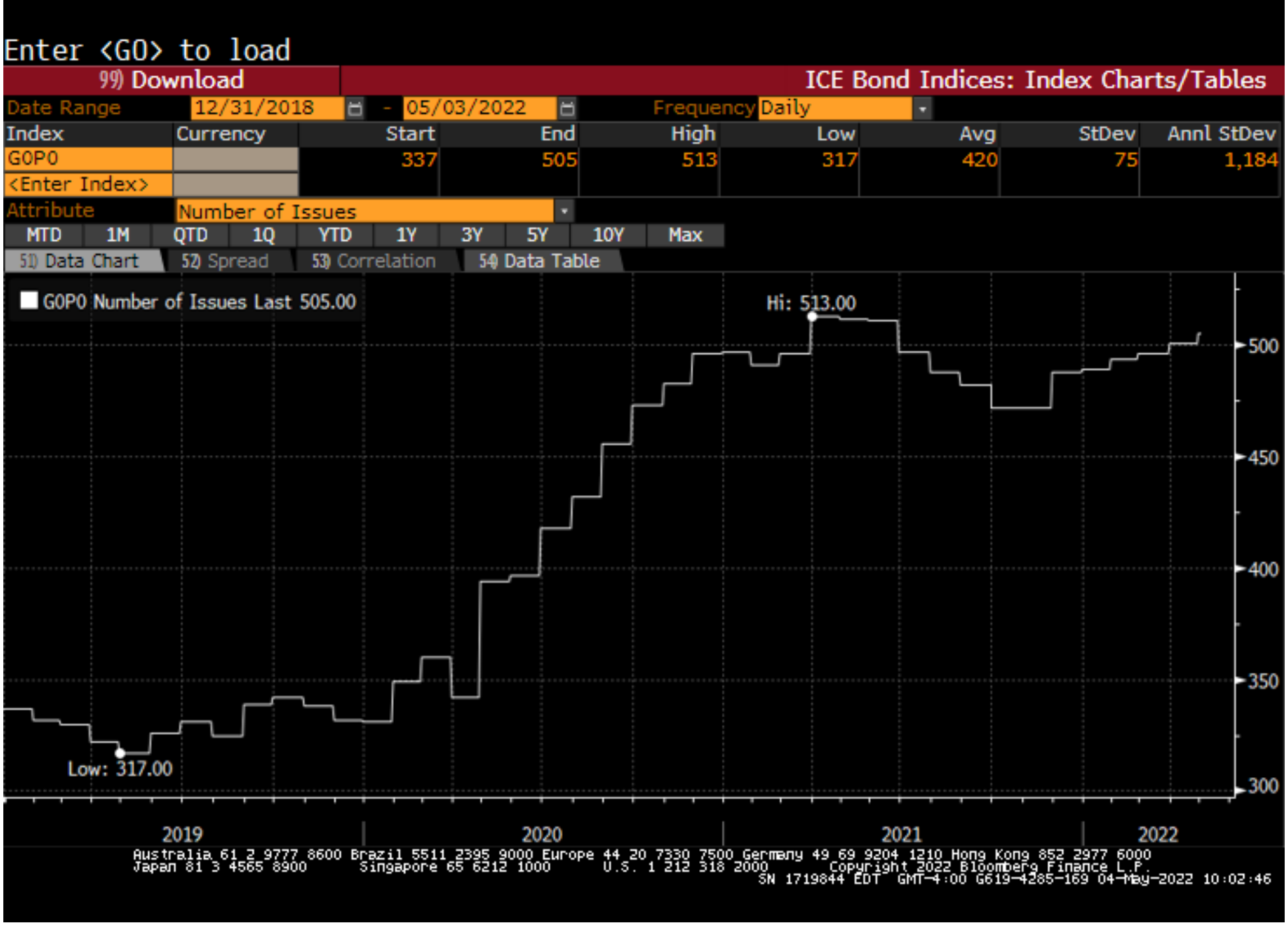
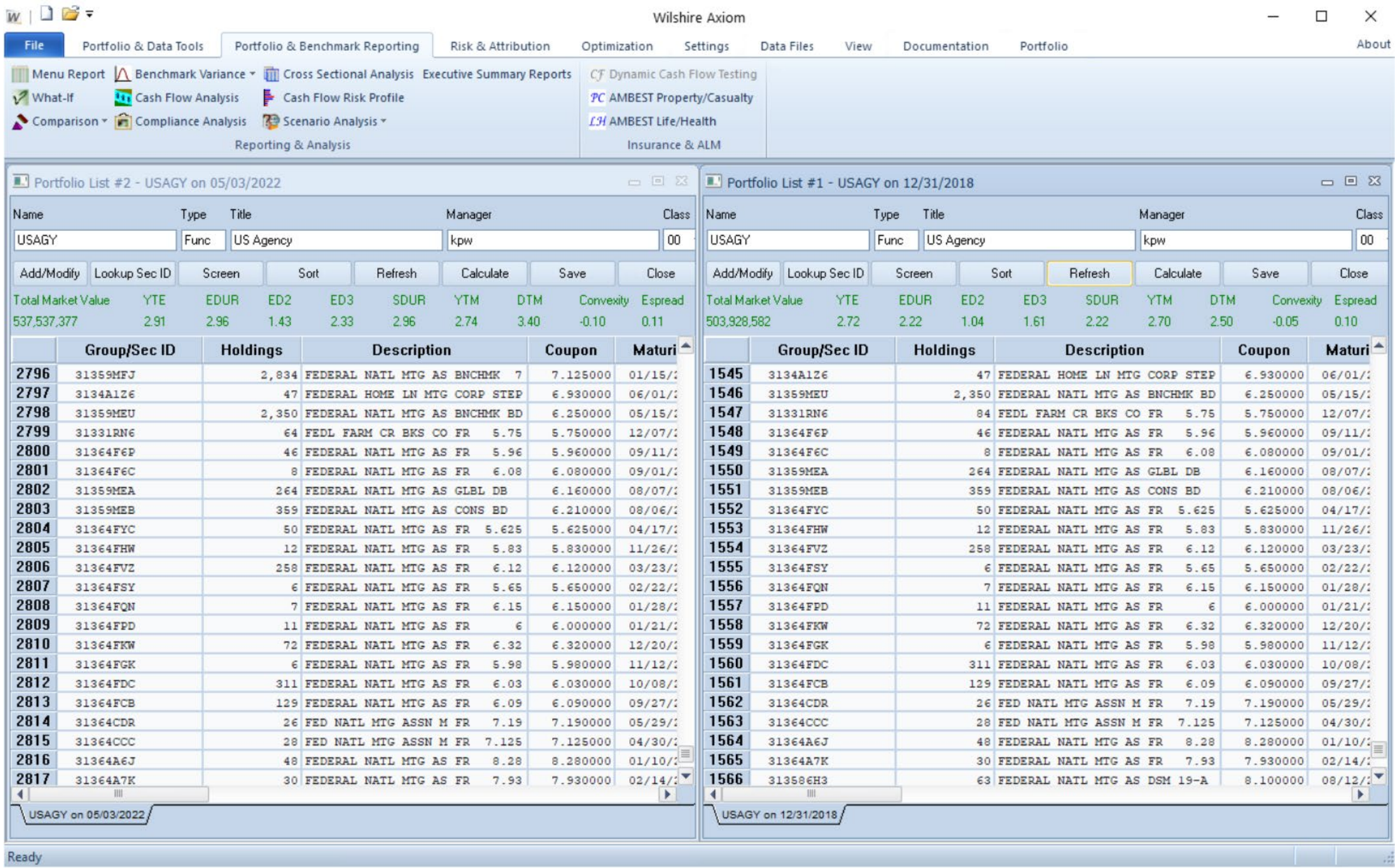


Source: Bloomberg on 5/3/22. Data & calculations by ICE.



Source: Wilshire Axiom on 5/3/22

How should they be analyzed @ the bond level?

More Analysis & Information Here…

CDIAC

CALIFORNIA DEBT AND INVESTMENT ADVISORY COMMISSION

Investing in Callable Securities - September 2020 Update

In recent years, "callable" securities, which contain options that allow issuers to retire them prior to their final maturity dates, have gained usage among public fund investors. Their greater usage as a tool for state and local investment officials largely can be seen in the wide variety of bonds containing call features that are available for public fund investment. For example, corporations and U.S. Agencies both issue a variety of different types of callable bonds. The increased use of callable securities is due, in part, to the growing sophistication of financial markets. Over the past twenty years, methods for comparing intricately structured investments have been developed and refined, thus allowing public fund investors to be able to more easily compare and better understand the risks and value of these potential investment alternatives. Moreover, during times of lower returns on investment, callable bonds provide relatively higher returns than noncallable bonds because investors are compensated for the potential call risk they face without incurring additional credit risk.

However, while the higher yields available on callable securities can be attractive for investors who can accept call risk in their fixed-income portfolios, these instruments can introduce other types of risk that public investors should consider. Most notably, investment in callable securities can increase a portfolio's "reinvestment risk" (that is, the risk of having to reinvest money in a lower interest-rate environment if the original investment is called); consequently, investors need to weigh the potential benefits and drawbacks of such an investment.

This *Issue Brief* seeks to provide public investment officials with information to assist them in evaluating callable securities relative to noncallable securities. It provides information on the key characteristics of callable securities, the potential advantages and disadvantages of incorporating them into an investment portfolio, and how to assess their value compared to noncallable securities. It concludes with recommendations to consider when deciding whether to invest in callable securities.

I. AN OVERVIEW OF CALLABLE SECURITY FEATURES

Callable securities are term bonds within which the issuer has the option to redeem the bonds prior to the final maturity of the issue. In such cases, the issuer is enabled, during specific time periods, to "call", or repurchase, a bond away from the investor at a specified price. The action is entirely at the election of the issuer, with no recourse by the investors in the bonds. The call feature has a noticeable impact on the issuer's cost of borrowing, and hence the returns achieved by public fund investors. To compensate for the maturity uncertainty that an investor is assuming, the yields on callable securities are at a premium over those obtainable from fixed maturity debt with the same final maturity.

Diversity of Call Types

Corporations and U.S. Agencies issue callable debt in a variety of forms. Final maturities typically range from one to thirty years. In addition, all callable bonds have a period of time during which the issuer cannot call the bond – the "lockout period". The lockout period can be any time after issuance to any time before maturity and at any frequency. The securities can be issued with either single or multiple call provisions. Popular call provisions include the following three types:

- EUROPEAN CALL. The bonds may be called one time only on a pre-specified date after the initial lockout period.
- BERMUDAN CALL. The bonds may be called according to a pre-specified schedule (e.g. monthly, quarterly, or semi-annually) after the initial lockout period. A bond with a Bermudan call option is also known as a discretely-callable bond.
- AMERICAN CALL. The bonds are continuously callable after the initial lockout period. That is, they are callable at any time on or after the first call date.

As is the case with investment products generally, the variations on the basic call structures continue to grow. For example, one variation includes the "step-up" call structure. A step-up call will have a call date at which point the issuer may retire it or the security will "step up" to a higher coupon rate.

Regulations Regarding Disclosure of Call Features

Municipal Securities Rulemaking Board (MSRB) Rule 12 and Rule 15a require broker/dealers to inform investors that an investment has a call option and to provide information about whether/how that option may impact the investment's value. Specifically, in the case of callable securities, the broker/dealer must provide the yield/price of the lower of the following two scenarios:

1. The bond's yield/price to call, which assumes the bond is called, typically at the next/first call date.

https://www.treasurer.ca.gov/cdiac/publications/issue-brief/2020/20-07.pdf

CDIAC

CALIFORNIA DEBT AND INVESTMENT ADVISORY COMMISSION

Issue Brief: Benefits and Limitations of Option-Adjusted Spread Analysis

INTRODUCTION

Public fund managers want to ensure that their investment practices are consistent with their investment policy, and accomplish the main objectives of optimizing safety, liquidity, and return on agency assets. These goals charge public agencies with thoughtfully choosing investments that mitigate risk, ensure sufficient liquidity to meet ongoing obligations, and also generate income for the portfolio over budgetary and economic cycles. These different objectives often come into contention with one another, as assets considered the safest usually produce the smallest returns and assets with higher returns also tend to have more risk.

Yield spread is an important indicator that investors consider when acquiring investments for their portfolios, as it measures additional return for an asset above a risk-free rate. Absolute yield spread for a bond is calculated by subtracting the yield of a "risk-free" bond[1] from the yield of that bond. Although the yield spread for a bond provides important information about the return on the investment, it does not account for embedded redemption structures, such as call options, which allow the issuer to redeem, or call, the bond prior to maturity.

Option-adjusted spread (OAS) is a measure of yield spread for a bond that accounts for embedded redemption structures. OAS is an improvement on the standard calculation of yield spread for a bond because it accounts for the possibility of a change in the bond's cash flows due to changes in interest rates. This issue brief discusses what OAS is, how to interpret OAS values, modeling assumptions, and the limitations of applications of OAS in public portfolio management.[2]

WHAT IS OAS?

OAS is a measure of yield spread that accounts for embedded call options in the valuation of bonds. The OAS for a bond is computed using price and projections of interest rate volatility to account for the possibility of early redemption. The OAS value is interpreted as the constant spread that can be earned on the asset compared to the risk-free option. Most commonly, the OAS is expressed as a spread over the Treasury curve.[3]

The main benefit and purpose of OAS is that it allows for comparability between bonds with different redemption structures. For the majority of public agencies, the most common application of OAS relates to agency investments in callable bonds. For example, an agency might want to compare the yield for a callable bond with the yield for a noncallable, or bullet, bond. Without OAS, an investor can only compare the nominal rate of return for each bond without being able to consider a potential lower return in cases where the callable bond is redeemed before maturity. When used correctly, OAS can help investors make more informed decisions about which assets to include in their portfolios that balance their different investment objectives of safety, liquidity, and return.

EFFECTIVE DURATION

Additional benefits of OAS include applications to calculating duration for a bond in a way that accounts for an embedded option. Duration is a measure of estimating the price (market value) change in a bond given a change in interest rates. Effective duration is a byproduct of the option models that produce OAS and it accounts for ways that changes in interest rates have the potential to change a bond's cash flows. Similar to how OAS is an improved measure of yield spread, effective duration is an improvement over modified duration, as it is a more reliable indicator of a callable bond's price sensitivity to changes in interest rates.

INVESTMENT RISKS OF CALLABLE BONDS

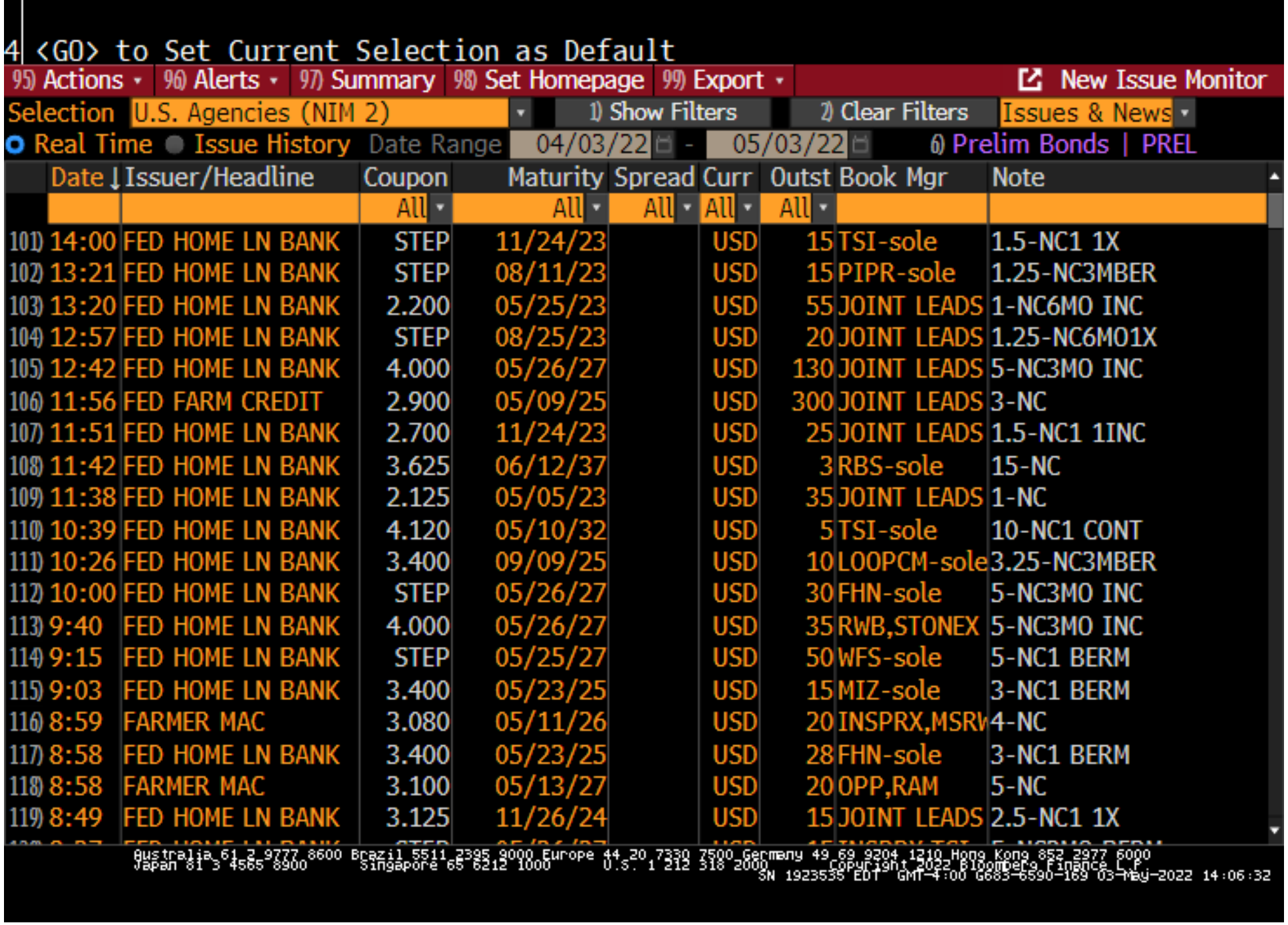
Callable bonds have an embedded option for early redemption, which is associated with additional investment risks. For example, one of the main risks of investing in callable bonds is the possibility that the bond could be redeemed, or "called," earlier than its

[1] A common benchmark security for calculating yield spread is an on-the-run Treasury issue with the same maturity as the bond being compared.

[2] This issue brief is meant to be used as general guidance about what OAS is and how to interpret OAS values. It is not intended to be used as investment advice.

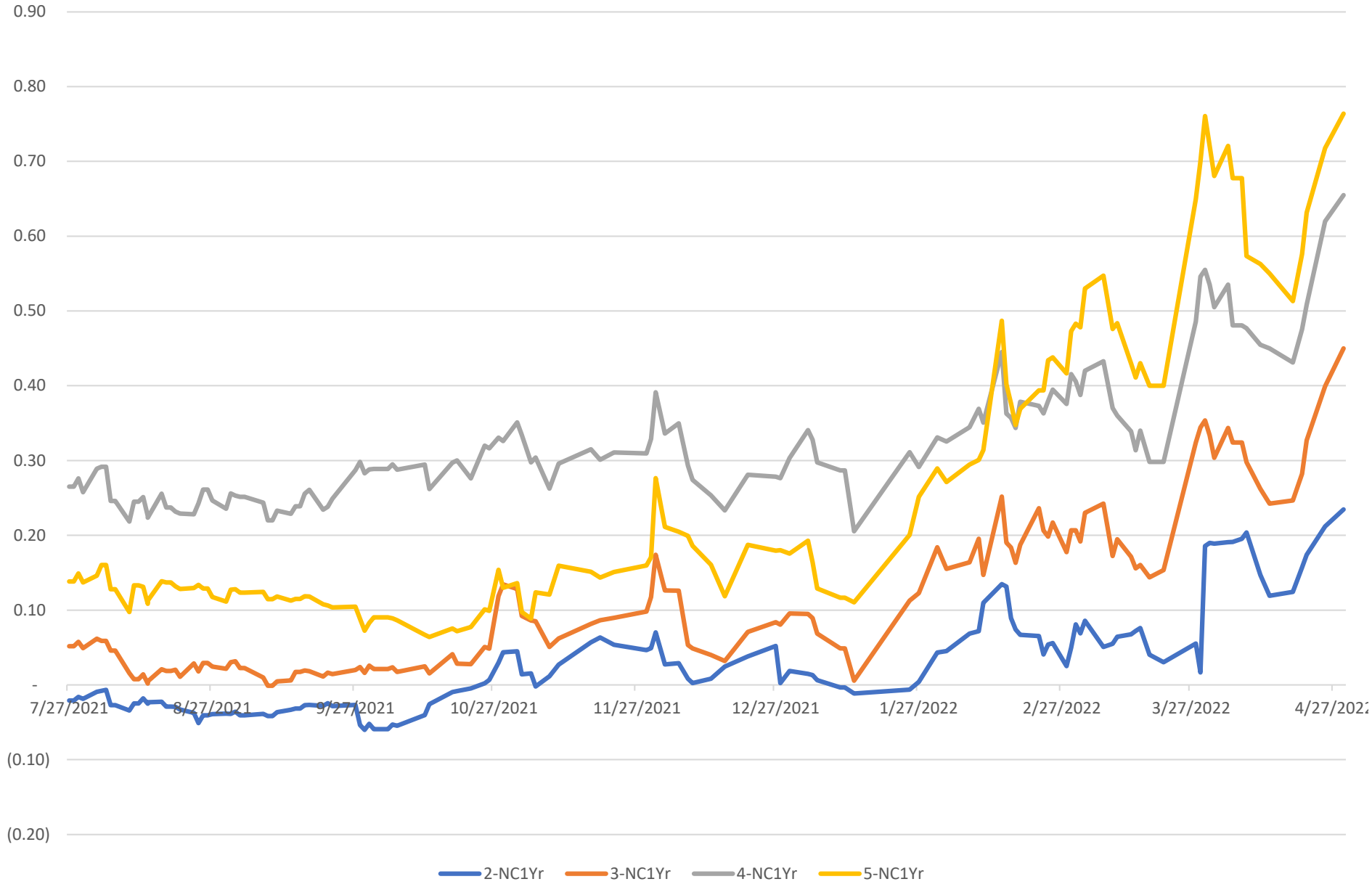
[3] Robert Ingenito, Kelly Joy, and Kevin Webb, "Issue Brief: Investing in Callable Securities – September 2020 Update," California Debt and Investment Advisory Commission, 5, Published September 2020, Accessed September 23, 2020, www.treasurer.ca.gov/cdiac/publications/issue-brief/2020/20-07.pdf.

https://www.treasurer.ca.gov/cdiac/publications/issue-brief/2020/20-10.pdf



Source: Bloomberg on 5/3/22

2nc1 | 3nc1 | 4nc1 | 5nc1 Berm Call Nominal Spread History
7/27/21 to 4/29/22



Source: RW Baird Agency Desk 4/29/22

Yield Spread Analysis

"Given that Treasury securities do not expose investors to credit risk, market participants look at the yield offered on an on-the-run Treasury security as the minimum interest rate required on a non-Treasury security with the same maturity. … it is commonplace to refer to the additional yield over the benchmark Treasury issue of the same maturity as the yield spread.

yield spread = yield on bond X - yield on bond Y

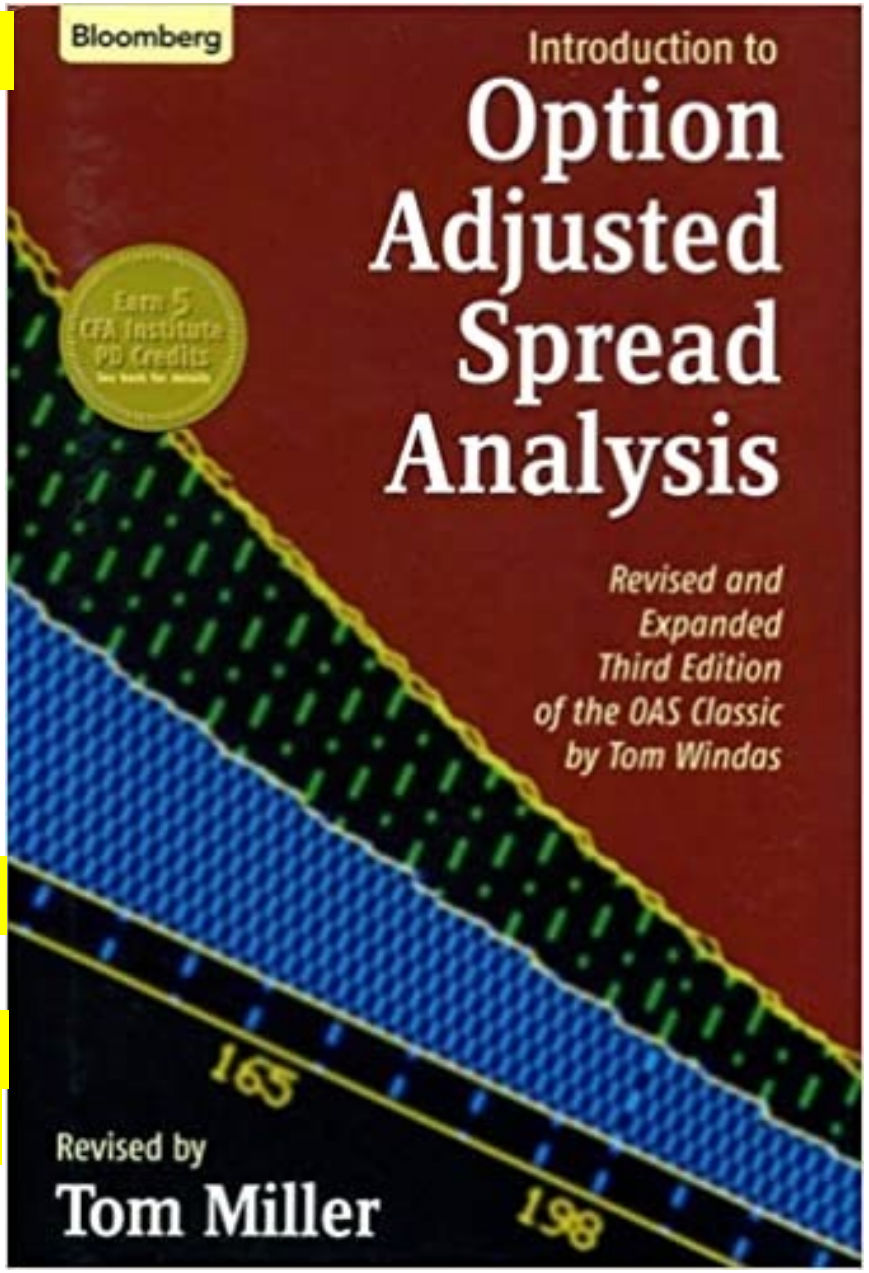
where bond Y is considered the reference bond (or benchmark) against which bond X is measured.
When a yield spread is computed in this manner it is referred to as an absolute yield spread and it is measured in basis points."

[Fabozzi CFA, Frank J. (2010-05-13). Fixed Income Analysis (CFA Institute Investment Series) (Kindle Locations 1590-1591, 1673, 1676-1678). Wiley. Kindle Edition]

Option Adjusted Spread Analysis

"Unlike yield analysis, OAS analysis does not attempt to predict a bond's likely redemption date. Instead, it treats a bond's early-redemption provisions—whether puts, calls, sinking funds, or a combination of the three—as options on its cash flows. Since such provisions are built into the cash-flow structure of a bond, they are referred to as the embedded options of a bond. Specifically, the OAS model measures the issue's spread, in basis points, relative to risk-free rates of return, after adjusting for the effects of any embedded options.

...the spread says nothing about whether the bond is rich, cheap, or appropriately priced; instead, it measures the extent to which the issue's expected rate of return exceeds risk-free returns. Ultimately, it is the investor who must decide whether the magnitude of such incremental returns provides adequate compensation for the risks contained in the bond."



Introduction to Option-Adjusted Spread Analysis (Bloomberg Financial) (pp. 15-16). Wiley. Kindle Edition.

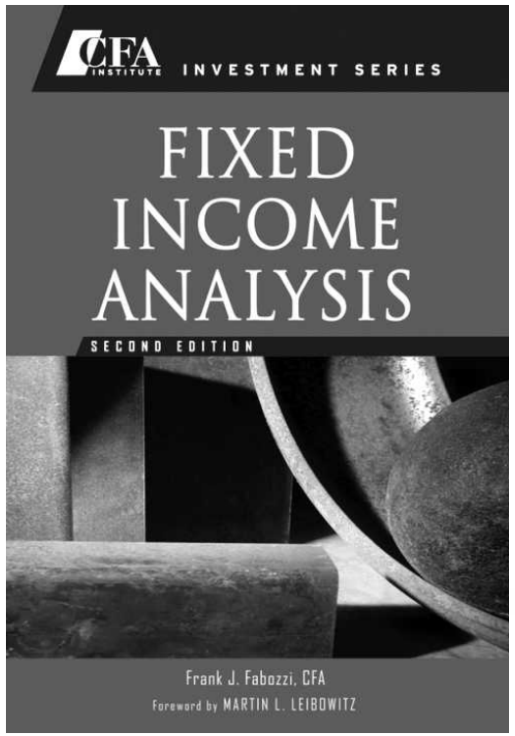
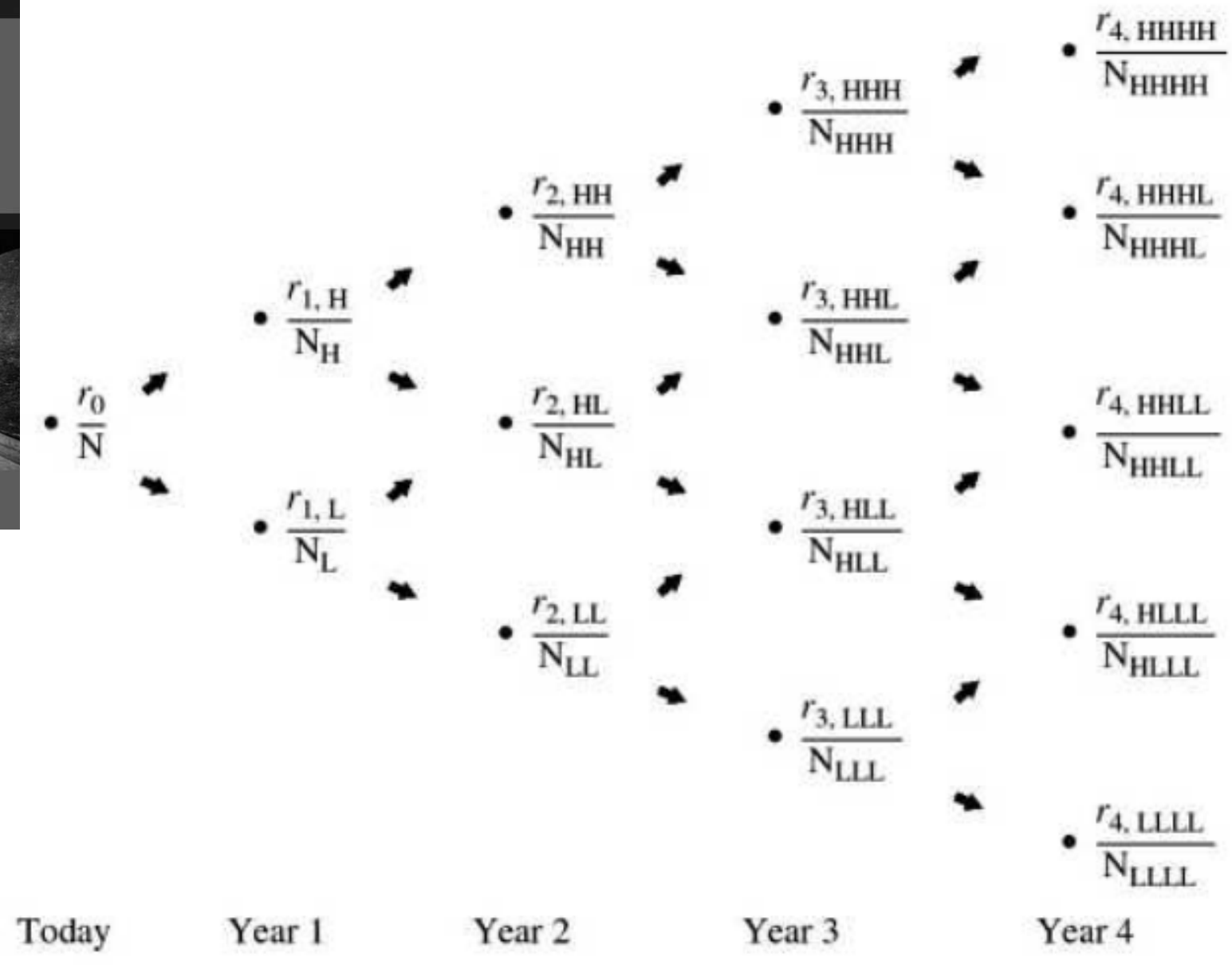


EXHIBIT 3 Four-Year Binomial Interest Rate Tree



Frank J. Fabozzi. Fixed Income Analysis (Kindle Location 3869). Kindle Edition.

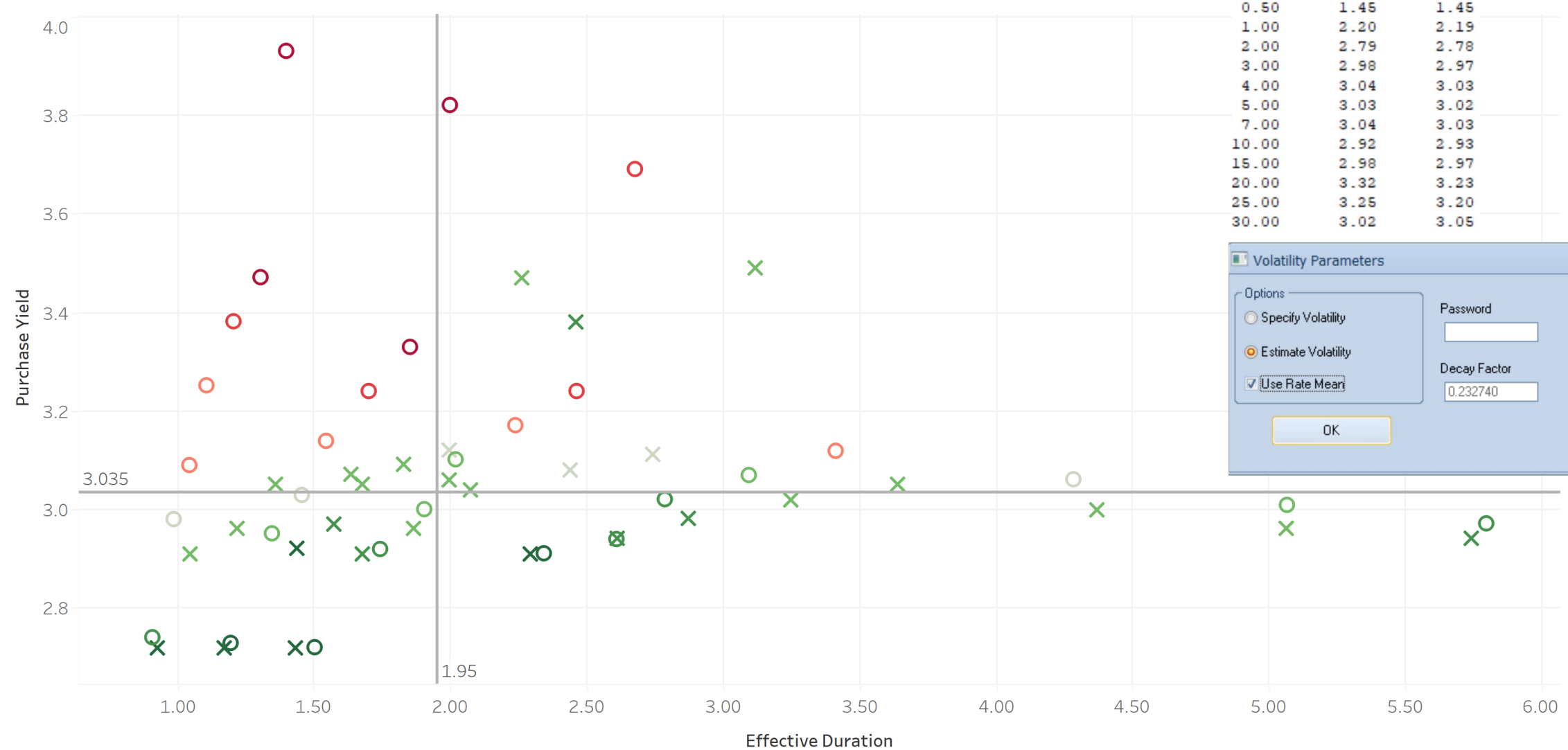
Generic New Issue Agency Webb: 5/3/2022

Years To Maturity: 2.00 to 15.00 | Years To Call: 0.25 to 5.00

These are estimates of where new issue callables could potential be issued.

These levels are indications only and continually subject to change.

Time (yrs)	Spot Yield (%)	Par Yield (%)
0.25	0.92	0.92
0.50	1.45	1.45
1.00	2.20	2.19
2.00	2.79	2.78
3.00	2.98	2.97
4.00	3.04	3.03
5.00	3.03	3.02
7.00	3.04	3.03
10.00	2.92	2.93
15.00	2.98	2.97
20.00	3.32	3.23
25.00	3.25	3.20
30.00	3.02	3.05



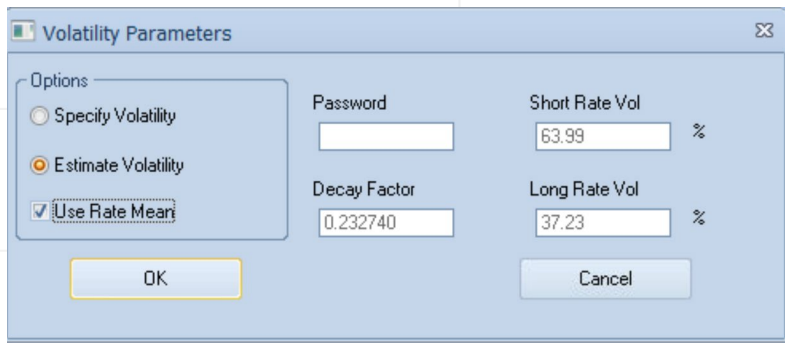
Call Type

DBer

DEur

OAS(bp)

(232.9) (27.0)

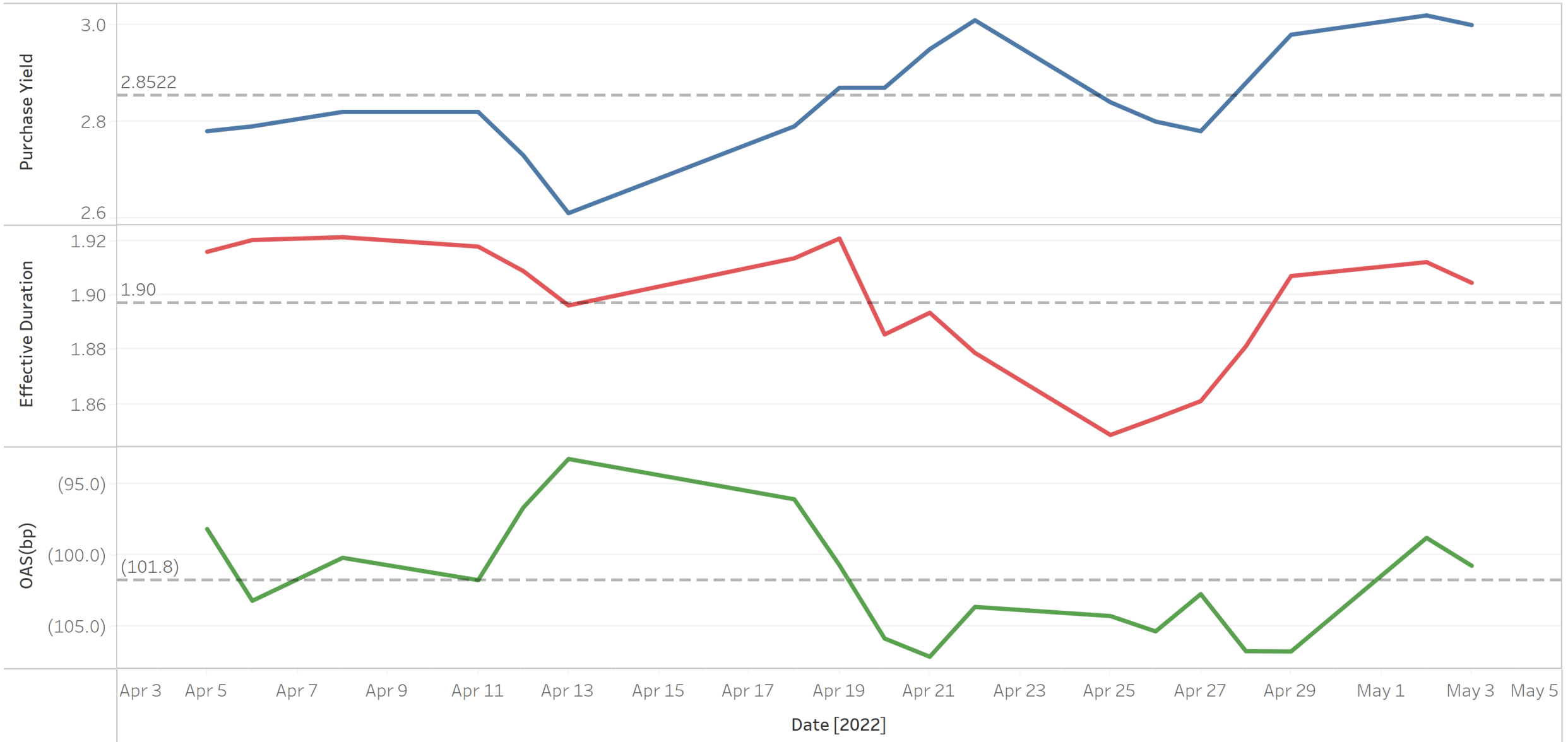


Source: New Issue Indication spreads from RW Baird Agency Desk. Analytics from Wilshire Axiom. Designed & Created by Kevin Webb, CFA

Generic New Issue Agency 04Y1YB
4/5/2022 to 5/3/2022

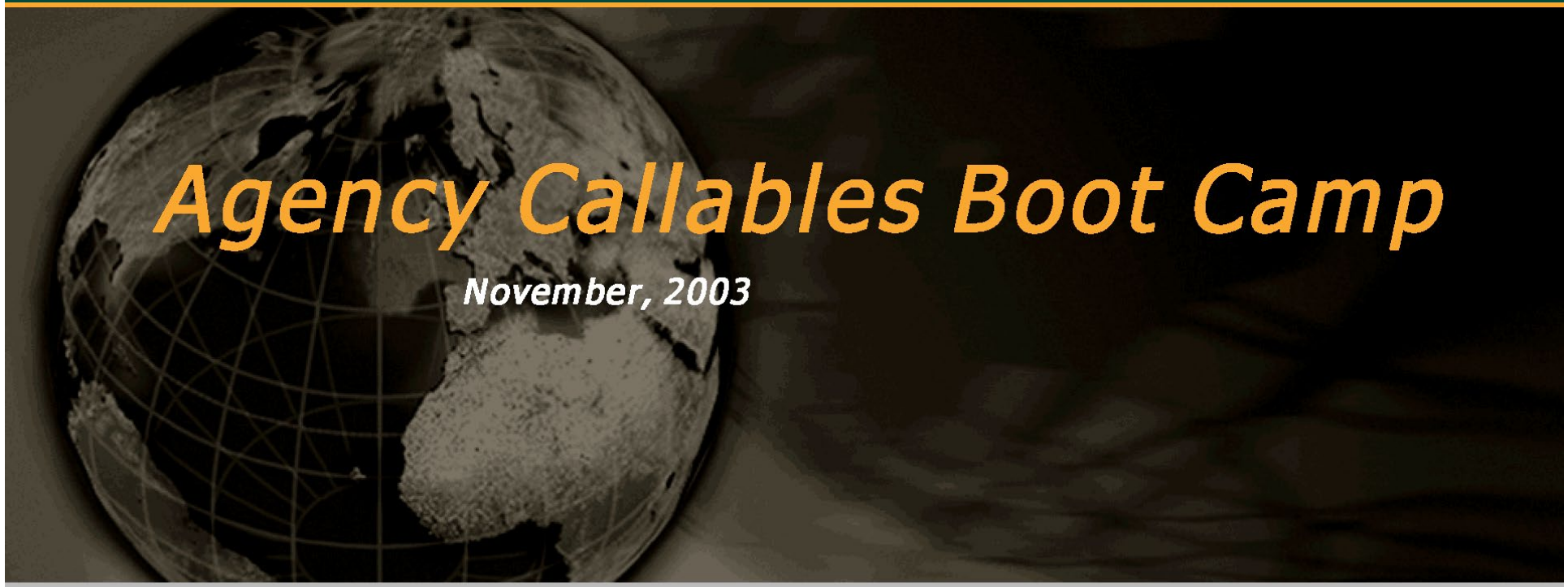
This is a historical estimate of where new issue 04Y1YB could have been issued.

These levels are indications only and continually subject to change.



Source: New Issue Indication spreads from RW Baird Agency Desk. Analytics from Wilshire Axiom. Designed & Created by Kevin Webb, CFA

A bit about OAS and Volatility



Agency Callables Boot Camp

November, 2003

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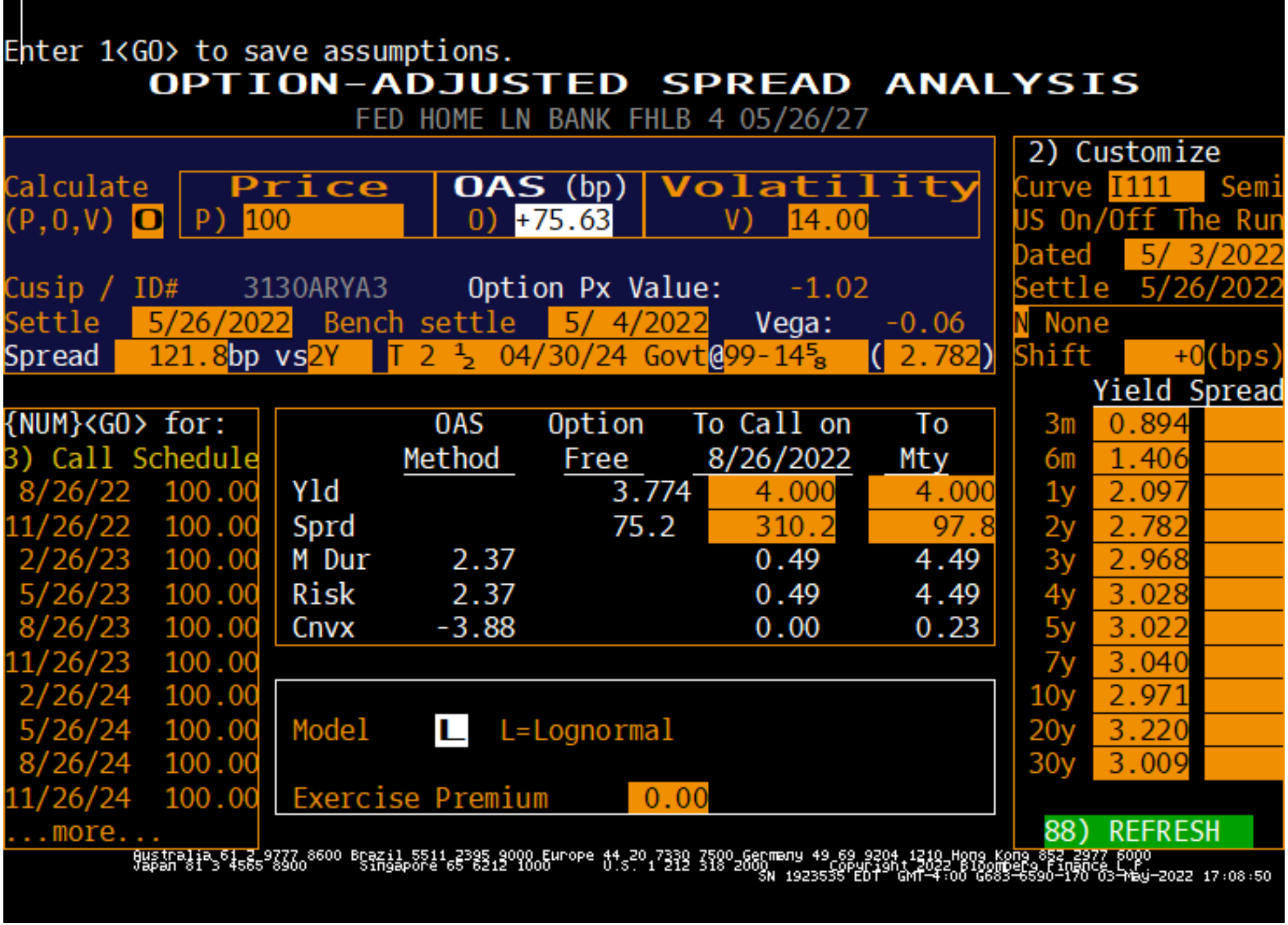
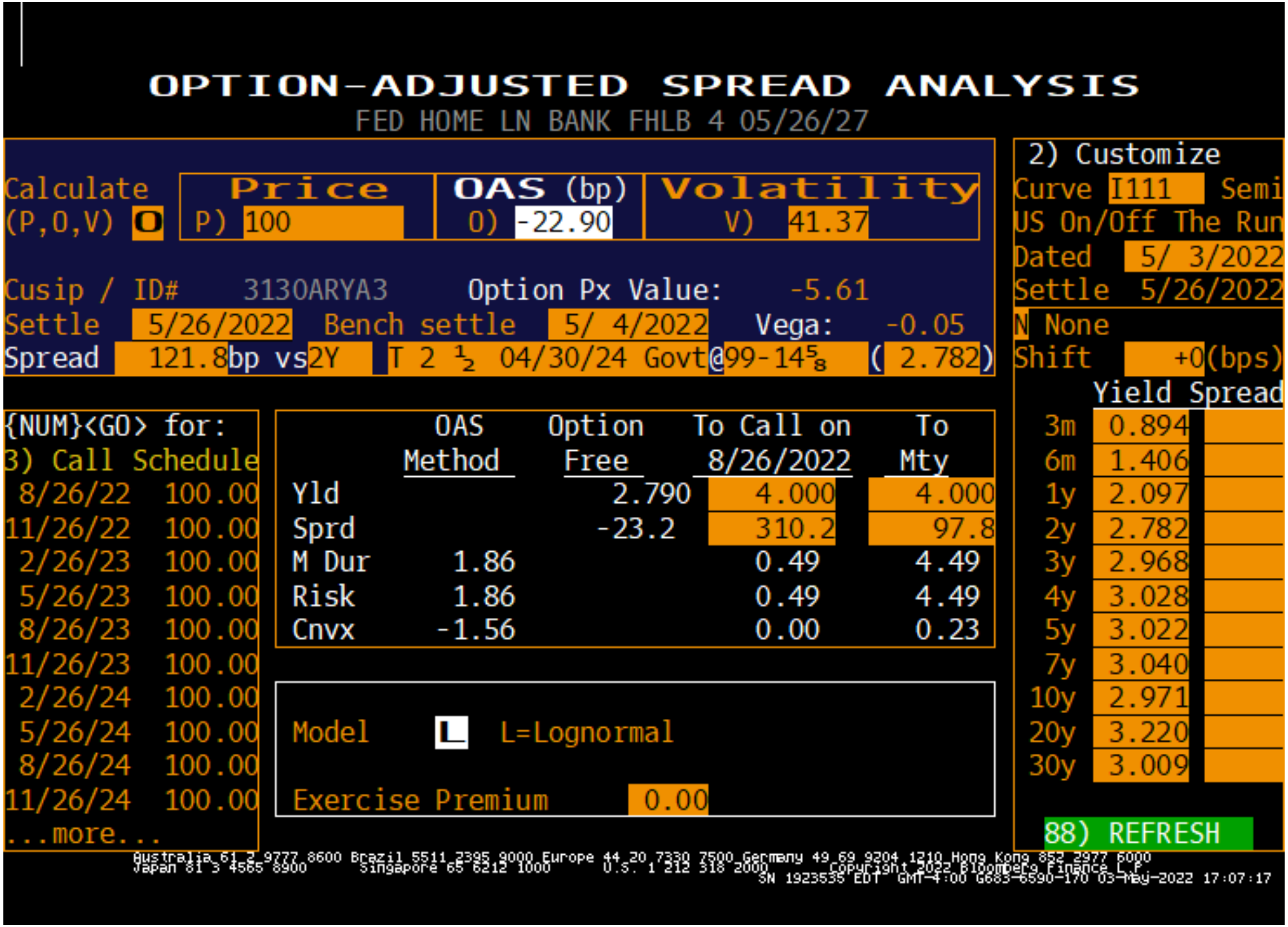
Valuing callables on an OAS1 14 vol on Bloomberg: Why 14 vol?

- **Most common method** of quoting Bermudan and American callables.
- American and Bermudan callables **contain more than one call option**.
  - Hence require multiple volatility inputs
- Bloomberg pricing analytics **can handle only 1 volatility input.**
- Over the past 10 years, market players have come to use **14% volatility as a standard** to quote all callables
  - Vols used to be around 14% across the board when the curve was more flat and rates higher
- While 14% volatility is not currently close to market vol, it has been **universally adopted** as the standard by market participants
- Since 14% volatility is well below current market levels, **the call option is undervalued** hence 0AS1 14% overstates the Option Adjusted Spread of the bond

Source: Bloomberg on 5/3/22



Source: Bloomberg on 5/3/22



Source: Bloomberg on 5/3/22

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