

2021



Asset Allocation Study

Economic and Social Stabilization Fund



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1.0 Introduction

RVK, Inc. (“RVK”) was hired by the Ministry of Finance (“MoF”) to conduct an asset allocation study for the Economic and Social Stabilization Fund (“ESSF”). The project was conducted to provide recommendations on the asset allocation and portfolio construction of the ESSF including analysis of:

1. Defining investment objectives
2. Development of Capital Markets Assumptions (“CMAs”)
3. Mean variance optimization
4. Cash flow and asset projections and modeling
5. Projection of the ability of the ESSF to provide support for fiscal deficits through volatility of revenues from copper
6. Recommended strategic asset allocation target for the ESSF

This project was initiated in 2019, but was delayed due to the onset of the COVID-19 induced global pandemic and recession. Global capital markets reacted sharply to the pandemic with both equity prices and bond yields falling rapidly due to uncertainty surrounding future economic growth. It was decided by the Finance Committee (“FC”) to delay the project until economic stability allowed for better assessment of future capital markets conditions. The project was restarted in the first quarter of 2021 corresponding with the release of RVK’s annual CMAs. While the pandemic is not over at the time of writing, capital markets have largely stabilized and the FC and RVK agreed it was appropriate to complete the project. All CMAs used in this report are as of December 31, 2021.

Near the late stages of the project, large withdrawals were made from the ESSF. Specifically, \$1.75 billion USD was withdrawn in April, \$2 billion USD in June, and \$2 billion USD between July and August. At the end of May 2021, the market value of the ESSF was estimated at \$6.99 billion USD. After the recent and planned withdrawals, the estimated market value will fall below \$3 billion USD. This compares to a \$12.23 billion USD market value at the end of 2019 as the pandemic began spreading globally. This shift in portfolio size alters the optimal allocation of asset for the ESSF on a go forward basis.

At the outset, the objective of this project was to recommend a single strategic target asset allocation for the ESSF. In light of the changes in absolute portfolio size, we have determined the best course is to recommend three separate strategic targets that vary based on the level of assets in the ESSF. The first portfolio is RVK’s recommendation when assets are below \$3 billion USD. The second portfolio would go into effect should assets increase to a range of \$3 billion to \$5 billion USD. Finally, the third portfolio is the long-term strategic portfolio should assets increase above \$5 billion USD.

Based on past and current withdrawal rates, when assets are withdrawn from the ESSF for the purposes of stimulus, the amounts tend to range between \$1 billion and \$2 billion USD. When assets were several times larger than the typical withdrawal amount, the

ESSF maintained a level of flexibility surrounding liquidity that no longer exists given asset levels. Should additional assets be needed from the ESSF in a magnitude similar to recent withdrawals, a large percentage of remaining assets would need to be sold. For example, an additional \$1 billion withdrawal would result in approximately 33% of the portfolio being called for liquidation. This precludes the ESSF from taking the same level liquidity risk as it did when portfolio assets were much larger.

The potential liquidity demands of future withdrawals eliminates the ability of the ESSF to invest in credit, which was included in RVK's original recommendation. Credit securities, particularly high yield fixed income and bank loans, are less liquid instruments and can see periods of very low liquidity, often in times of economic and/or market stress. This makes credit an inappropriate asset class for consideration at low asset levels. The liquidity challenges also make equity less desirable as it could result in the forced sale of securities during a market draw down. When assets were larger, other sources of liquidity could be found to protect against the forced selling of equity at depressed values. This is no longer the case.

Credit also becomes less attractive at the lower asset level due to portfolio construction considerations. RVK recommends a 5% allocation to credit in our analysis; a 5% allocation of a \$3 billion USD portfolio would correspond with a credit portfolio of \$150 million USD. Managing a diversified credit portfolio with sub-allocations as small as 5% in high yield, banks loans, and EMD corporate becomes challenging from an implementation standpoint.

The reduced asset levels also impact our recommendations relating to duration. In our baseline recommendation - Portfolio D - the overall duration of the portfolio was set to increase. With lower asset levels, and an associated higher probability of completely depleting assets, there becomes a duration mismatch between assets and expected cash flows. This would likely prevent us from recommending a much higher allocation to bank deposits and treasuries.

Finally, currency mismatch also becomes more challenging with a lower asset base. Fluctuations in currency valuations could be withstood over time with the larger asset base. With all assets potentially needed in the near future, short-term currency fluctuations may play a significant role in the value of the portfolio at any given point that assets may be needed.

Should withdrawals cease and the size of the portfolio can be maintained with reasonable certainty going forward, there may be an opportunity to begin phasing in some of the recommendations for the larger asset size portfolios. We examine this in further detail in Appendix 4.

2.0 Summary and Recommendations

This study provides a comprehensive analysis of the asset allocation of the ESSF. The key takeaways from our analysis are as follows:

1. With the large reduction in assets RVK recommends a three tiered approach to asset allocation for the ESSF based on asset levels. Figure 2.1 highlights our recommended portfolio at given asset levels. The reduction in asset levels materially reduces expected returns in favor of preserving liquidity. See Appendix 4 for further discussion.

Figure 2.1 – Recommended Asset Allocations by Asset Level

	Less than \$3 Billion USD	Between \$3 and \$5 Billion USD	Greater than \$5 Billion USD
Bank Deposits	-	12.0	12.0
Treasury Bills	100.0	48.0	10.0
Sovereign Bonds	-	30.0	60.0
Inflation Linked	-	5.0	8.0
Credit	-	-	5.0
Global Equity	-	5.0	5.0
Total	100	100	100
Expected Arithmetic Return	-3.08	-2.56	-2.28
Expected Risk (Standard Deviation)	11.08	10.99	10.91

2. Given the current state of capital markets, with high equity valuations and low yields across the fixed income universe, asset returns are likely to be below historically observed returns and the expectations of many institutional investors. This is true of even the most aggressive recommended portfolio associated with higher asset levels. This severely limits the probability of growing assets in a portfolio with strict liquidity demands and large exposure to cash related and fixed income securities. Section 4 of the analysis outlines the capital markets assumptions used in this study. Return expectations for all asset classes are depressed and far lower than what global institutional investors have experienced since the Global Financial Crisis. When we examine risk expectations it is important to highlight that expected volatility is largely being driven by currency, not the underlying securities or asset classes. This can be seen by comparing the baseline assumptions as shown in Figure 4.9 in Section 4 to those in Figure A3.14 in Appendix 3. The baseline assumptions are based in CLP while those in the appendix are based in USD.
3. Long-term outcomes (once the ESSF has a larger asset base) can be materially improved through updates to asset class structures, as recommended. Figure 5.2 in Section 5 shows the move from Portfolio A to Portfolio B results in 59 basis points of additional return. These portfolios have the same broad asset allocations, but vary in some the underlying asset class structures. Portfolio A utilizes current policy for asset class structures, while Portfolio B utilizes RVK's

recommended asset class structures. When comparing the two portfolios risk also increases by 69 basis points, while compound return, which adjusts return for risk, improves by 52 basis points, more than offsetting the increase in risk. Recommended asset class structures are discussed in Appendix 2 and shown in Figures A2.5 (bank deposits), A2.11 (treasury bills), A2.13 (sovereign bonds), A2.17 (inflation linked), A2.21 (credit), and A2.24 (equity).

4. Further improvements in portfolio outcomes can be made via changes in asset allocation. Portfolio C, in the same Figure 5.2 as noted above, optimizes asset allocation based on the recommended asset class structures. While the improvements, when compared to Portfolio B, are not as substantial as those outlined in the previous bullet point, they are incremental improvements.
5. With the consideration of a new asset class, credit, we can see even further improvements in outcomes. Specifically, RVK recommends adopting Portfolio D as outlined in Figures 5.5 and 5.9 in Section 5 as the strategic long-term asset allocation when assets exceed \$5 billion USD. This portfolio optimizes all asset classes inclusive of credit. When we compare Portfolio D to Portfolio A in Figure 5.9 we see similar drawdown statistics between the two portfolios. We also note the improved yield of Portfolio D. Finally, in Figure 5.16 we see similar correlations to copper between the two portfolios. The similarities in risk, combined with enhanced return potential, lead us to recommend Portfolio D.
6. RVK's recommendation is further supported by the outcomes of the simulations based analysis presented in Section 6. Figures 6.11 and 6.14 show the results of the Monte Carlo analysis using two different cash flow projections. Figure 6.11 assumes no future cash flows, while Figure 6.14 assumes future withdrawals based on the price of copper. Both show Portfolio D as having the highest expected market value in the future. This commentary excludes Portfolio F which we find unsuitable for the ESSF. Portfolio F has a 40% allocation to equity and a 31% allocation to credit. While its return potential is enticing, there is a clear mismatch between this portfolio and broader objectives and constraints for the ESSF. Portfolio F was shown to illustrate how much market risk would need to be taken in order to generate an expected real return in CLP terms equal to zero. Our recommendations are further supported by additional analysis stress testing our assumptions and asset class structures in Appendix 3. The results of this section do not alter our overall recommendations.
7. In Appendix 3 we stress test various sets of capital markets assumptions. While these are useful for analyzing the impact of various changes, RVK's recommendations are based on the baseline set of assumptions used in the study. These assumptions utilize a real return based in CLP.

3.0 About ESSF

3.1 ESSF Background

The ESSF was established in 2007 to accumulate resources to finance potential deficits and amortize public debt. The objective was to cushion fiscal spending against fluctuations in the business cycle and volatility of revenues from taxes and copper. The ESSF can also be used to fund the Pension Reserve Fund (“PRF”) as needed. The ESSF is governed by the Minister of Finance, who is supported by the FC. The FC is a group of experts hired by the MoF to advise the Minister.

As of December 31, 2020, the ESSF investment portfolio was valued at \$9.0 billion USD. This is down significantly from the end of 2018 when the portfolio was valued at \$14.1 billion USD as almost \$6.7 billion USD was withdrawn in 2019 and 2020. These withdrawals came in response to the 2019 unexpected economic contraction (social unrest), and for stimulus provided in the wake of the COVID-19 pandemic and associated recession. See Section 6 for a more detailed discussion on historical and projected cash flows from the ESSF.

3.2 ESSF Objectives

We understand that the objectives and uses of the ESSF portfolio are undergoing an evolution as fiscal needs are being reexamined in the wake of COVID-19. Based on data provided, significant capital was drawn from ESSF in 2020 to provide stimulus to support the economy. At the start of this project an additional \$1 billion USD (\$553 million USD for stimulus and \$447 million USD for debt amortization) was expected to be withdrawn for in 2021. However, as discussed in Section 1, withdrawals of \$1.75 billion USD were made in April and \$2 billion USD were made in June of 2021 with an additional \$2 billion USD expected between July and August 2021 for a total of \$5.75 billion USD in 2021 withdrawals. No transfers to the PRF occurred in 2020 or 2021 but are projected to resume in 2022. These facts, combined with past withdrawals, leave the corpus significantly smaller than in the past and must be considered when setting future asset allocation.

Per the FC’s 2019 Annual Report:

The main goal of the FEES is to maximize the fund’s accumulated value in order to partially cover cyclical reductions in fiscal revenues while maintaining a low level of risk. Its aversion to risk is reflected in the choice of an investment portfolio with a high level of liquidity and low credit risk and volatility thereby ensuring the availability of resources to cover fiscal deficits and avoiding significant losses in the fund’s value. The Ministry established that the resources of the fund ought to be invested abroad in order not to damage the competitiveness of the Chilean economy.

RVK takes the following key points from this statement:

1. **Maximize accumulated value** – implies a total return approach to portfolio management is and the desire for asset growth through investment returns.
2. **Cover cyclical reductions in fiscal revenues** – portfolio should be negatively correlated with cyclical drivers of fiscal revenue, primarily highly cyclical copper revenue.
3. **Low level of risk** – expected volatility should be low, limiting the ability of the portfolio to invest heavily in equities.
4. **High liquidity** – assets should be invested in daily valued securities in vehicles without lock-up periods. This excludes the use of investments in private markets.
5. **Low credit risk** – minimal, but not zero, tolerance for credit risk in fixed income markets.
6. **Low volatility to avoid significant losses** – Maximum expected drawdown should be minimized.
7. **Fully invested abroad** – no domestic investments in Chile.

These objectives are consistent with a portfolio heavily invested in government issued fixed income with low levels of equity beta. This report will analyze potential portfolios in the context of these objectives.

3.3 Existing Policy Portfolio

The existing ESSF strategic asset allocation policy weights were last modified in April 2020, when equities were reduced as reflected in Figure 3.1 below. The objective of this report is to determine if the current asset class structures are still appropriate and to identify if shifts in asset allocation would be beneficial to the expected outcomes of the ESSF.

Figure 3.1 – ESSF Strategic Asset Allocation Policy Weights

Asset Class	Sub-Asset Class	Benchmark	Policy Weight	
Bank Deposits	US Dollar-Denominated Deposits	ICE BofA US Dollar 3 Month Deposit Bid Rate Average Index	15.50%	5.25%
	Euro-Denominated Deposits	ICE BofA Euro Currency 3 Month Deposit Bid Rate Average Index		6.25%
	Yen-Denominated Deposits	ICE BofA Japanese Yen 3 Month Deposit Bid Rate Average Index		4.00%
Treasury Bills	US Treasury Bills	ICE BofA US Treasury Bills Index	19.50%	6.00%
	German Treasury Bills	ICE BofA German Treasury Bills Index		7.25%
	Japan Treasury Bills	ICE BofA Japan Treasury Bills Index		6.25%
Sovereign Bonds	US Sovereign Bonds	Bloomberg Global Aggregate - Treasury: U.S. 7-10 Yrs	56.50%	27.25%
	German Sovereign Bonds	Bloomberg Global Aggregate - Treasury: Germany 7-10 Yrs		11.25%
	Japanese Sovereign Bonds	Bloomberg Global Aggregate - Treasury: Japan 7-10 Yrs		10.25%
	Swiss Sovereign Bonds	Bloomberg Global Aggregate - Treasury: Switzerland 5-10 Yrs		7.75%
Inflation Linked	US Inflation-Indexed Sovereign Bonds	Bloomberg Global Inflation-Linked: U.S. TIPS 1-10 Yrs	3.50%	2.50%
	German Inflation-Indexed Sovereign Bonds	Bloomberg Global Inflation-Linked: Germany 1-10 Yrs		1.00%
Equities	Equities	MSCI All Country World Index ex Chile GR UH USD	5.00%	5.00%

4.0 Capital Markets Assumptions

4.1 Background

Numerous academic studies have shown that expected returns are largely driven by a portfolio's strategic asset allocation and the capital markets environment. Capital markets assumptions ("CMAs") play two important roles in estimating future expected returns. First, they are used in asset allocation modeling to determine an optimal allocation of assets between various asset classes (equities, bonds, real estate, alternatives, etc.). Setting the strategic asset allocation target is an attempt to position asset class weightings to generate the maximum level of expected return at a given level of risk. Once the asset allocation has been set, the portfolio will generate returns based on what markets do going forward, regardless of whether the CMAs were correct or not. The second role of CMAs is to estimate the future expected returns of the portfolio in absolute terms to assist in setting policy for future distributions, as well as analyzing future market values of the portfolio.

CMAs are forward-looking estimates of the behavior of investment asset classes (i.e., groups of closely related investment opportunities). Examples include stocks, real estate, government bonds, etc. CMAs estimate three behaviors of these asset classes: expected return, expected risk or volatility, and the correlation of returns between the asset classes. CMAs (in the form of a "set" of risk, return, and correlation parameters for every asset class) are the most pervasively used tools in the management of institutional portfolios and are generally long-term in nature (at least seven years or longer).

The accuracy of CMAs can be evaluated in two ways: relative accuracy and absolute accuracy. Relative accuracy (well distributed) across the assumptions set is far more important than barbell accuracy, where some assumptions are "spot on" and others are far off. Relative accuracy leads to well-diversified portfolios; barbell accuracy typically produces unbalanced and poorly diversified portfolios. Achieving relative accuracy across a CMA set, requires that every risk and return assumption needs to be "triangulated" to all other assumptions—particularly those which are closely related.

Absolute accuracy matters as well, but is a secondary consideration in the set of CMAs. Having CMAs that are too low across the board can cause a perpetual fund to believe it must restrict distributions to a greater degree than necessary. Having CMAs that are too high across the board is an even worse problem, as it leads funds to believe they can distribute more than can actually be afforded.

Using excessively high CMAs across the board is one way to win business by suggesting clients will earn high returns. It is important to remember, these are forecasts only, and their chief purpose is to optimally structure the portfolio. Well-structured funds are produced by "well-distributed accuracy" not simply "forecasting" higher returns. Well-structured funds typically end up with higher long-term returns and lower risk.

A well-structured and well-executed fund should produce the highest returns the markets will allow over time—regardless of what a consultant forecasts for the expected total return of a portfolio.

CMA expectations have generally fallen across most asset classes for the past several years as a variety of factors have driven down future expected returns. First, public equities are highly valued, even after the COVID-19 crash experienced in 2020, as the subsequent rise in stock prices, coupled with falling earnings expectations, have pushed valuations back towards all-time highs. High equity valuations tend to produce lower future returns. While in the fixed income space, future return expectations have fallen as a result of lower yields across the yield curve, as governments and central banks across the globe have attempted to stimulate the economy during the recession. Yields have shown to be a strong indicator of future return expectations for fixed income.

The result of reduced return expectations going forward is lower distribution rates, as the portfolios are not expected to generate the same level of returns they have in the past. One path some institutional investors have taken in their quest for higher returns is to increase the risk profile of the portfolio with the expectation that this will deliver higher returns in the future. This prospect will be discussed in Sections 5 and 6 of this report.

4.2 Asset Classes Considered for ESSF

RVK analyzed the entire institutional investment landscape for potential asset classes for consideration for inclusion in the ESSF analysis. Several factors guided our recommendations on each asset class as detailed below.

Private Asset Classes

Based on potential liquidity demands, as well as the stated liquidity objectives of the fund we immediately excluded all private asset classes including private real estate, private equity, private credit, and hedge funds. Additional factors, including the aforementioned liquidity demands, that make private asset classes unattractive for ESSF include:

- Liquidity – The potential sudden need for large cash withdrawals make illiquid investments inefficient for ESSF
 - For example, the recent stimulus required to fight the COVID-19 crisis could have been delayed, or resulted in undue withdrawals from more liquid assets, had ESSF been invested in assets subject to lock-ups, gates, or redemption queues
- Implementation Constraints – Many of these asset classes require investment structures difficult for ESSF to implement
- Transparency – Private asset classes do not typically offer the transparency needed for a government entity
- Potential for Significant Loss – While these asset classes typically offer expected returns in excess of most public asset classes, they also carry with them the potential for large permanent losses

- **Headline Risk** – Depending on structure, headline risk can be a large concern if an issue arises at the fund level
- **Resources** – The resources and infrastructure required to implement these asset classes are significant

Publicly Traded Asset Classes

Within fixed income, cash equivalents, treasury bills, treasury bonds, and inflation linked bonds were already existing parts of the ESSF portfolio. The only broad exposure missing were credit related securities including corporate investment grade credit, high yield, bank loans, MBS, and emerging markets debt. Public equities are well represented in the existing portfolio through a broad MSCI ACW Index approach. A discussion of potential new asset classes follows below.

Credit

For purposes of this analysis we define credit to include the following:

- Investment grade corporate credit
- Non-investment grade corporate credit (high yield)
- Bank loans
- Mortgage backed securities (MBS)
- Emerging markets corporate debt (EMD)

Each of these credit sub-sectors exhibit a high degree of liquidity during normal market environments and are traded on open markets. In addition to interest rate risk – the primary risk of the sovereign bond allocation – investors in credit take on an additional risk: default loss. To compensate for the additional risk yields on credit bonds trade at a premium, known as spread, to government bonds. Each sub-sector is discussed below.

Investment Grade

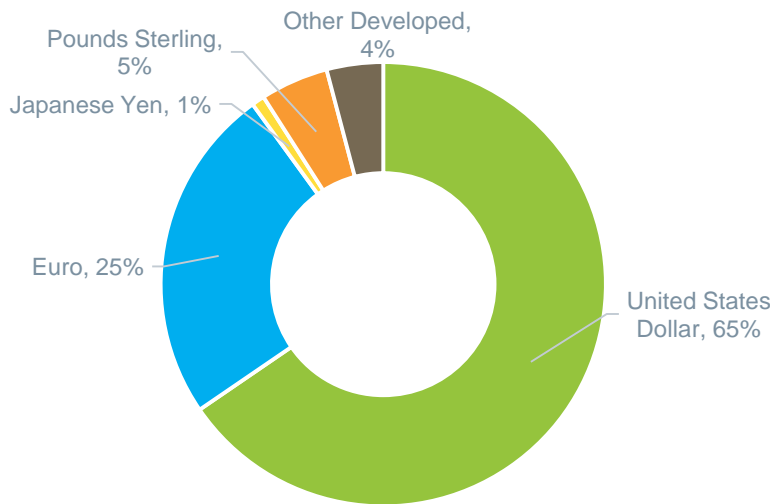
Investment grade corporate bonds are one of the largest most liquid markets in the world and represent loans to credit worthy corporations around the world. RVK recommends utilizing the Bloomberg Global Aggregate Corporates Index for this asset class. Given the high credit quality of issuers, default losses are expected to be low. However, risk is higher than government bonds and therefore yields are higher and trade at premium or spread. Yields and option-adjusted spreads (“OAS”) are shown in Figure 4.1 and currency exposure is shown in Figure 4.2.

Figure 4.1 – Bloomberg Global Aggregate Corporates Index Yield to Worst and OAS



Source: Bloomberg. (2021)

Figure 4.2 – Bloomberg Global Aggregate Corporates Index Currency Exposure

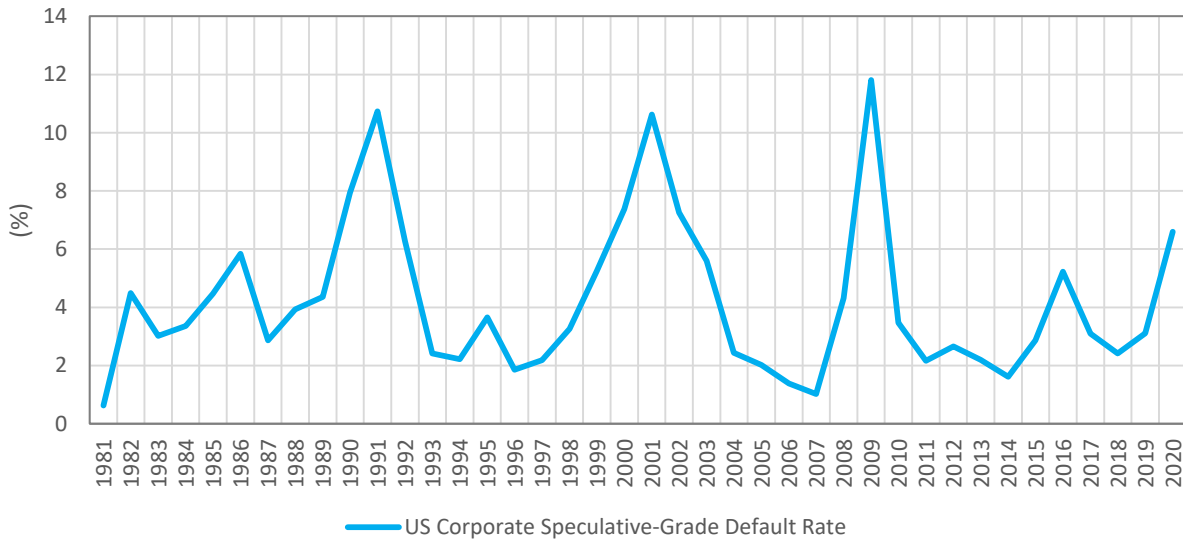


Source: Bloomberg. (2021)

High Yield

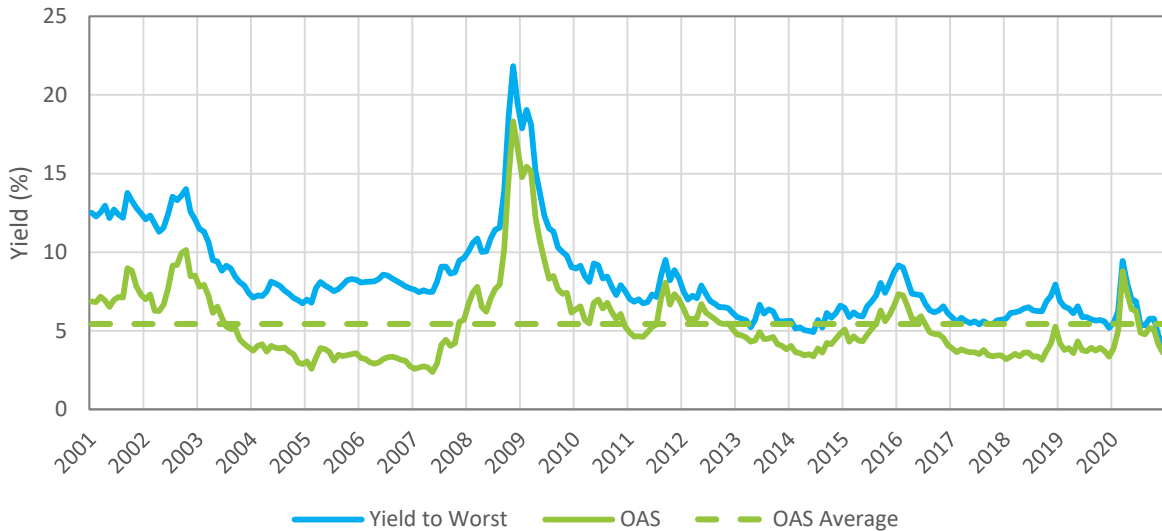
High yield bonds are issued by organizations that do not qualify for an investment grade rating. RVK recommends using the Bloomberg US Corporate High Yield Bond Index for this asset class. While a non-US high yield market exists, it is dominated by the US market. As a result of their lower credit rating these securities offer higher coupons and yields than their investment grade counterparts. The primary risk of high yield bonds is default risk where the bond issuer is unable to pay bond holders. Historical default levels have begun to elevate and are expected to increase as the global economy recovers from the COVID-19 induced recession and government stimulus slows. Figure 4.3 shows historical default rates and Figure 4.4 shows yield and spread information.

Figure 4.3 – Annual U.S. Corporate Speculative-Grade Default Rate



Source: S&P Global Ratings Research. (2021)

Figure 4.4 – Bloomberg US Corporate HY Bond Index Yield to Worst, and OAS



Source: Bloomberg. (2021)

Bank Loans

Bank loans (also known as leveraged loans, senior secured loans, or floating-rate loans) are issued by banks to non-investment grade companies. These loans feature floating interest rates typically tied to LIBOR. Bank loans offer downside protection relative to equity and high yield bonds as they have seniority in the capital structure and are also typically secured by assets including inventories, real estate, or equipment. Default and recovery rates tend to be better for bank loans than high yield bonds as well, again providing superior downside protection. Figure 4.5 shows default and recovery characteristics compared to the high yield investment universe.

Figure 4.5 – Bank Loan Default and Recovery Rates 10 Years Ending 2019

	Bank Loans	High Yield
Default Rate	2.0%	2.4%
Recovery Rate	59%	40%

Source: JPMorgan, Moody's. (2021)

The downside protection comes with upside limits as most bank loans are callable at par, allowing credit worthy borrowers to retire or refinance their loans. Given their floating rate structure, and associated low duration, bank loans also provide protection against rising interest rates. Finally, bank loans offer low correlations with equities and high yield bonds providing diversification benefits for the portfolio. We also note the primary bank loan market is in the US.

MBS

Mortgage backed securities are pools of individual mortgages packaged together to form securities that institutional investors can purchase. While MBS can come in many forms including both residential and commercial back loans, RVK recommends utilizing the Bloomberg US Mortgage Backed Securities Index. This tracks agency fixed-rate residential mortgages in the US guaranteed by Ginnie Mae (GNMA), Fannie Mae (FNMA), and Freddie Mac (FHLMC).

EMD Corporate ex Chile

Emerging markets corporate debt are bonds issued by companies located in emerging markets. RVK recommends utilizing the JPMorgan Corporate Emerging Markets Bond Index Broad Diversified ex Chile (CEMBI) in this space. The primary advantage of investing in EMD is to capture higher growth prospects of these economies. As shown in Figure 4.6 below, EMD yields tend to be higher than their developed counterparts to offset additional potential risks. EMD also provides diversification compared to other fixed income and credit market segments.

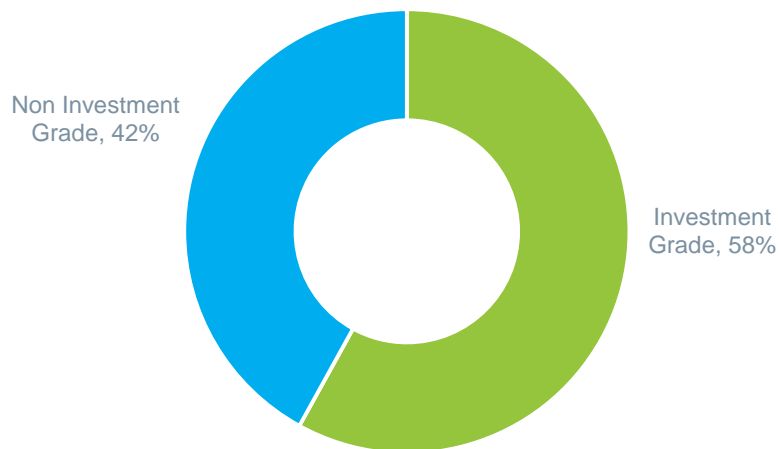
Figure 4.6 – JPM CEMBI Yield to Worst



Source: JPMorgan. (2021)

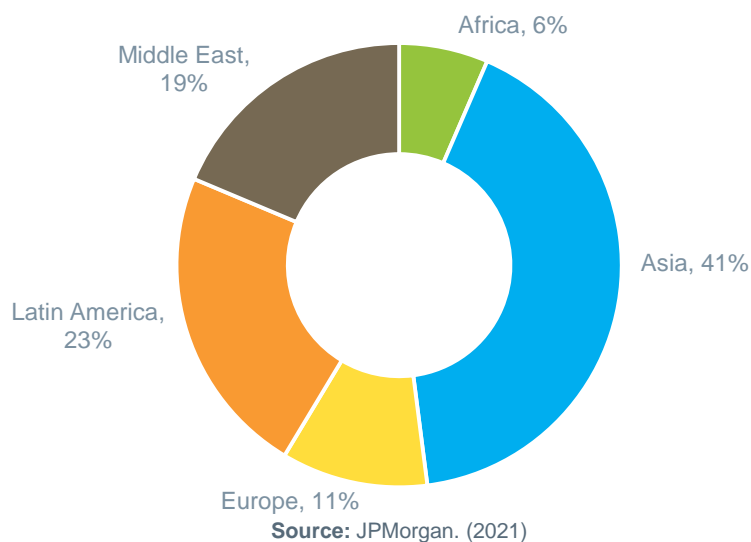
The market consists both of investment grade and non-investment grade issues and is geographically diverse as shown in Figure 4.7 and Figure 4.8 respectively.

Figure 4.7 – JPM CEMBI Broad Diversified Credit Breakout



Source: JPMorgan. (2021)

Figure 4.8 – JPM CEMBI Broad Diversified (ex-Chile) Region Exposure



Geopolitical risk is one of the primary risks of investing in EMD. Unforeseen political events and economic volatility of emerging nations increases the risks associated with these investments. Additionally, exchange rates can be more volatile than developed peers making the overall investment more volatile, however this is mitigated by the fact that most of corporate debt in this space is denominated in USD. Liquidity can also be lower in the EMD space during periods of market distress as investors seek safe haven assets like US Treasuries. Although some emerging markets historically have been fraught with poor government regulation and volatile currency exchange levels, much has changed in the developing world over the last decade. Many developing nations have improved their fiscal policies, driven down inflation levels, and seen expansive growth. Emerging and developing countries continue to improve their lending standards as transparency plays a larger role in the marketplace. These trends give us comfort with the asset class.

One of the objectives of the ESSF is low credit risk. With the existing policy targets there exists minimal credit exposure. RVK believes adding a small allocation to credit is consistent with the objective, can add marginal return, and provide diversification from both interest rates and equity risk.

REITs/Listed Infrastructure

Real Estate Investment Trusts (“REITs”) are companies that buy, develop, manage, and sell real estate assets. RVK recommends utilizing the MSCI World Real Estate Index for REITs. They provide an investor easier access to commercial real estate exposure without the cost or illiquidity that generally comes with direct property ownership. REITs are publicly traded and operate in highly liquid markets. The underlying assets generate higher levels of income, which is required to be distributed to shareholders leaving REITs with attractive levels of income. REITs are subject to restrictions around

operations, organization, and ownership but as a result generally do not pay taxes at the corporate level.

REITs often specialize in certain commercial categories such as office buildings or apartments, and many also focus in particular geographical areas. REITs generally fall into one of three categories, equity, mortgage, or hybrid.

- Equity REITs– Purchase, own, and manage commercial properties. Equity REITs seek to develop/operate properties as part of their long-term portfolios rather than developing real estate for disposition or resale (unlike typical real estate developers).
- Mortgage REITs – Loan money for mortgages to real estate owners or purchase existing mortgages or mortgage-backed securities. Mortgage REIT revenue is generated primarily by interest they earn on mortgage loans, and thus they are more correlated with changes in interest rates than equity REITs. These are less common.
- Hybrid REITs– Combined strategies of Equity and Mortgage REITs.

REITs offer investors sector diversification compared to traditional global equity and would provide access to markets which may not be practical for ESSF via a private structure. However, there are also drawbacks to REITs which make them less attractive to ESSF. First, REITs are already included to some degree in the equity portfolio. Second, given REITs operate as equity in public markets there is potential for higher volatility relative to the global equity market. Additionally, REITs can exhibit high correlation to global equities potentially diminishing sector diversification benefits.

Infrastructure is typically defined as basic facilities needed for the functions of a community or society and demonstrates the following characteristics:

- Essential to society or the economy
- Long useful life
- Monopolistic or quasi-monopolistic market position
- High barriers to entry
- Operates in a regulated environment and/or exhibits resistance to business cycles
- Stable, predictable cash flows that are often linked to inflation
- Difficult to replicate due to high construction costs and scarcity of resources (i.e., land, equipment, planning restrictions)
- Examples include bridges, toll roads, airports, schools, hospitals, etc.

Traditional infrastructure is highly illiquid, however listed infrastructure offers exposure to infrastructure via publicly traded equity, through sectors including construction, utility, and communications companies. This provides easy diversification and liquidity. However, given the equity nature of the investments it tends to be highly correlated to other equities, with volatility higher than that of broad global equity. An important consideration specific to the ESSF is the potential for correlation between listed

infrastructure securities and the price of copper. For these reasons we do not advise on proceeding with this asset class.

RVK discussed both REITs and listed infrastructure with the FC during early stages of this process. Ultimately, it was decided to not proceed with either asset class.

Commodities

Commodities may be able to provide diversification benefits to investors in the event of inflation. During periods of unexpected inflation, commodities are particularly effective assets when compared to other inflation-correlated options. In contrast to traditional stocks and bonds, where values are driven by future expected cash flows, commodity prices are driven by both supply and demand in a given commodity market. While commodities may be attractive for many institutional investors, the ESSF objective of reducing the impact of cyclical revenue declines related to the price of copper makes broad commodities inappropriate the ESSF.

4.3 Return Assumption Methodology

After discussion with the FC, the Committee has instructed RVK to use CMAs in this study based on the following characteristics:

- Developed in Chilean Pesos and not hedged
- Utilize real as opposed to nominal returns

Additionally, RVK's CMAs:

- Represent market or beta exposure with no active management decisions
- Are net of investment management fees
- Are long-term, representing a period 20 years, or multiple market cycles
- Are based on December 31, 2020 data

Figure 4.9 summarizes the capital markets assumptions RVK has used in this report. Following sections describe the methodology and data we utilized to develop these assumptions.

Figure 4.9 – RVK Assumptions (Real CLP)

	Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities
Expected Return - Real	-3.08%	-3.08%	-2.39%	-3.13%	-1.50%	3.24%
Expected Standard Deviation	11.08%	11.50%	12.00%	9.75%	8.50%	15.00%
Return/Risk Ratio	-0.28	-0.27	-0.20	-0.32	-0.18	0.22

4.4 Inflation Methodology

As previously mentioned, all returns presented in this analysis are in real terms, and therefore do not include inflation. In order to adjust returns from real returns in the investment's local currency it is necessary to establish assumptions regarding inflation expectations within Chile compared to other regions of the world economy.

Broadly speaking RVK generalizes inflation into three regions US, developed non-US, and emerging markets.

US

Market expectations for US inflation, as measured by breakeven inflation, have recovered off their lows following the COVID-19 crisis, and as of December 31, 2020 were right at 2% for all time horizons as shown in Figure 4.10. These levels are consistent with expectations just prior to COVID-19. Specifically the 20-year breakeven inflation rate was 2.06% as of December 31, 2020 compared to 1.86% one year earlier.

Figure 4.10 – US Breakeven Inflation Rates

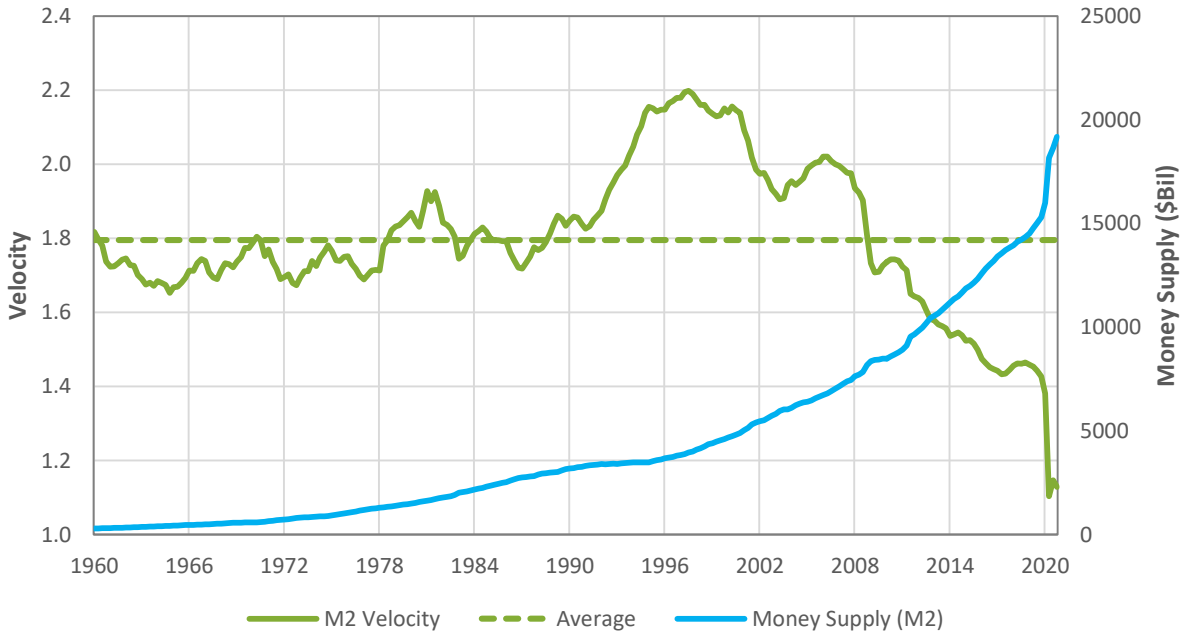
	5-Year	7-Year	10-Year	20-Year	30-Year
Treasury Yield	0.36%	0.65%	0.93%	1.45%	1.65%
TIPS Yield	-1.59%	-1.31%	-1.06%	-0.61%	-0.37%
Implied Expected Inflation	1.95%	1.96%	1.99%	2.06%	2.02%

Source: FactSet. (2021)

Like many other countries, the US passed multiple rounds of stimulus as a result of the COVID-19 induced economic recession. This stimulus came in many forms including direct payments to citizens, liquidity provisions for fixed income markets, and asset purchases by the Federal Reserve. In total, the magnitude of stimulus was unlike anything seen before. These actions significantly increased the Federal Reserve’s balance sheet, as well as the supply of money in the economy. In isolation we would view these outcomes as highly inflationary. However, we believe there are multiple mitigating factors and as a result believe inflation will be muted over the long-term and will approximate the Federal Reserve’s target of 2%. Short-term inflation may run higher but we believe the factors discussed below will contain a longer-term inflation breakout.

The primary rationale for lower long-term inflation is the rapidly falling velocity of the money supply. We believe this largely offsets the substantial increase in money supply. This is shown in Figure 4.11.

Figure 4.11 – Money Supply (M2) and Velocity of M2



Source: FactSet. (2021)

Economic utilization remains below long-term capacity which should also contribute to lower long-term inflation. While certain sectors are supply constrained in the wake of the COVID-19 pandemic, we believe these will be transitory and return to normal levels as the Pandemic wanes. This may take longer than many expect but is not a sustainable rationale for long-term inflation. Figure 4.12 shows utilization rates for select US factors. We generally assume these rates mean-revert towards their long-term average.

Figure 4.12 – US Utilizations Rates

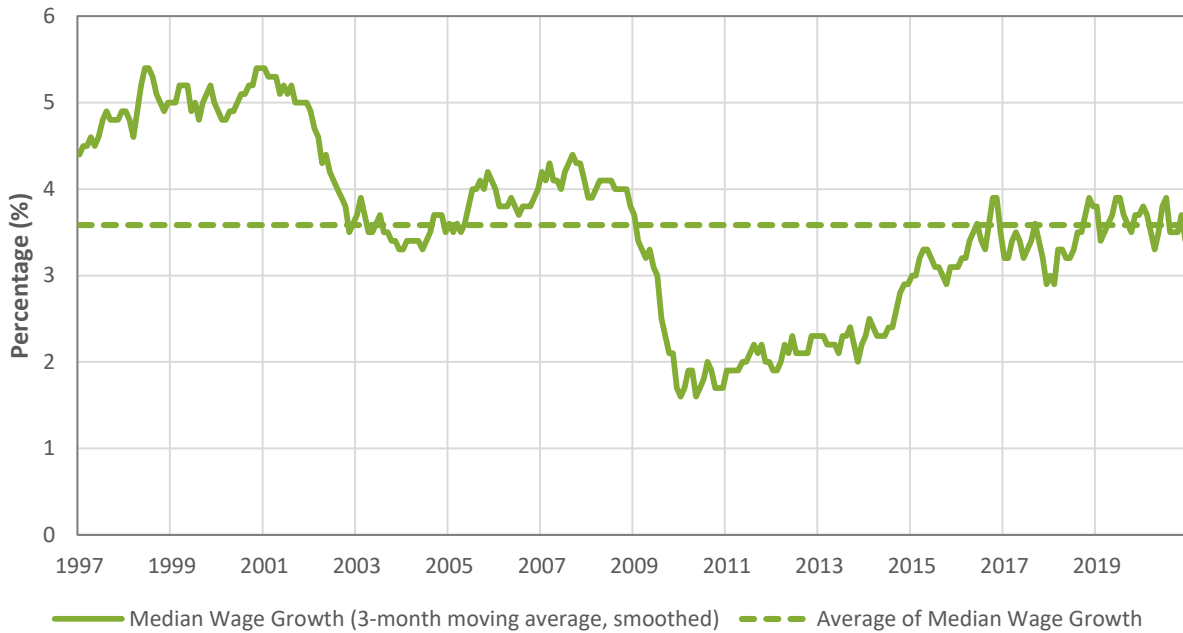
	Current Level	Long-Term Average	Standard Deviation
Goods Sector			
Manufacturing capacity utilization	72.7	79.8	5.4
Mining capacity utilization	78.7	86.9	4.0
Services Sector			
Utilities capacity utilization	72.8	85.9	5.7
Labor Market			
US Unemployment Rate (U-3)	6.7	5.8	1.7
US Labor Force Non-Participation Rate	38.5	37.1	3.0
US Employment to Population Rate	57.4	59.2	2.8
Oil Sector			
Weekly US Field Production of Crude Oil	11000.0	7262.9	1842.5
US Stock Crude Oil (Million Barrels)	493.5	335.7	60.5

Source: FactSet. (2021)

Another important factor when examining inflation is wage growth. As Figure 4.13 shows, wage growth has remained muted in the US since the GFC. While there are currently indications that wage growth may be increasing, we believe this is transitory as

a result of COVID-19. Expanded unemployment benefits as a result of stimulus packages passed in the US have made it harder for employers to entice workers back to the workplace. This has led to increased wages in some sectors but is not sustainable.

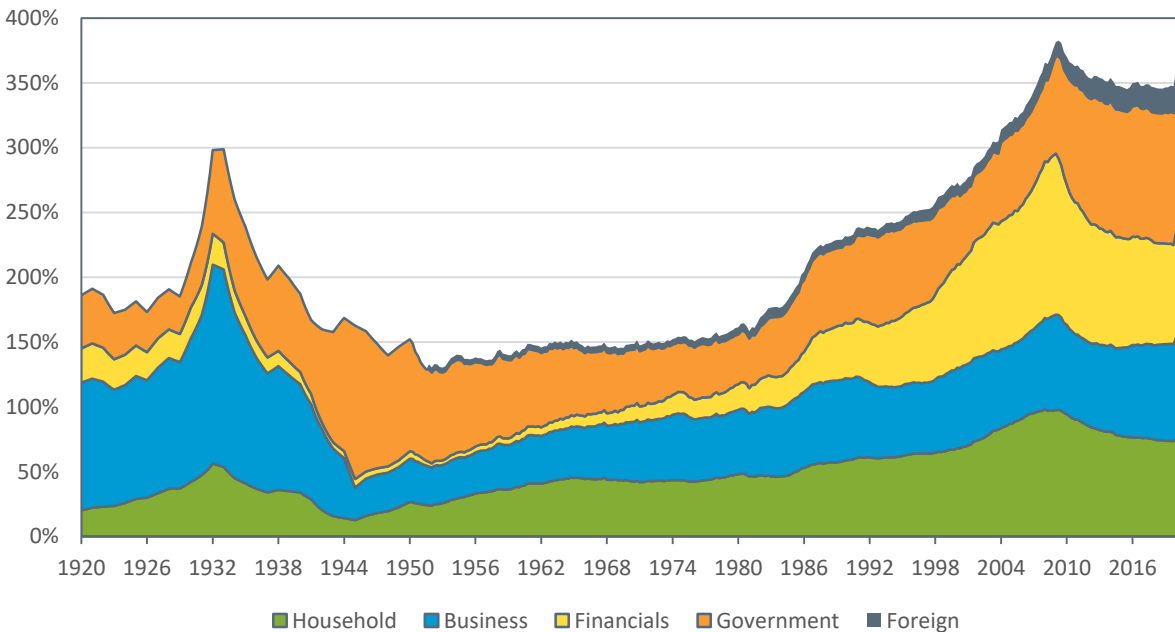
Figure 4.13 – US Wage Growth



Source: FactSet. (2021)

Significant increases in government debt following the GFC, and now the COVID-19 crisis, suggests the potential for lower growth in the future. Diminishing marginal returns on increasing levels of debt, result in less productive debt that could lower potential future economic growth. It should also be noted that this government spending reduces net savings – and thus investment through crowding – which can also reduce potential future growth. US Debt spiked from 350% of GDP to 400% with the onset of COVID-19 as shown in Figure 4.14.

Figure 4.14 – US Debt



Source: FactSet. (2021)

We believe that despite accommodative monetary and fiscal policy; debt levels, demographic shifts, and structural changes to the US economy will continue exerting downward pressure on inflation for the foreseeable future. For these reasons we believe an appropriate long-term expectation for inflation in the US is 2.00%.

Non-US Developed Markets

The story for developed markets outside of the US is largely similar to what we have seen in the US. Target rates for developed economies generally range from 1-3%, with a large number targeting 2%, such as the European Central Bank, and the Bank of England. Generally speaking we believe inflation to be modestly lower than our expectations for the US, falling between 1.50% and 2.00%. Demographics and debt tend to be less favorable for long-term inflation outside of the US. Lower interest rates also signal lower inflation expectations when compared to the US market.

Emerging Markets

Inflation expectations in emerging markets tend to be higher than their developed counterparts. When reviewing the current inflation targets set by emerging market central banks we observe a target range of 1-8%, with most countries setting inflation targets between 2-5%, resulting in a simple average of a 3.52% target rate. When calculating a GDP-weighted average we observe a 3.22% target rate, although this is heavily influenced by the larger emerging economies, such as China and India. Emerging market inflation rates have seen a significant decline from high levels historically, RVK believes that this trend will continue as emerging central banks continue to improve on anchoring inflation expectations. RVK uses an assumed inflation rate of 3.00% for emerging markets across the globe.

Chile

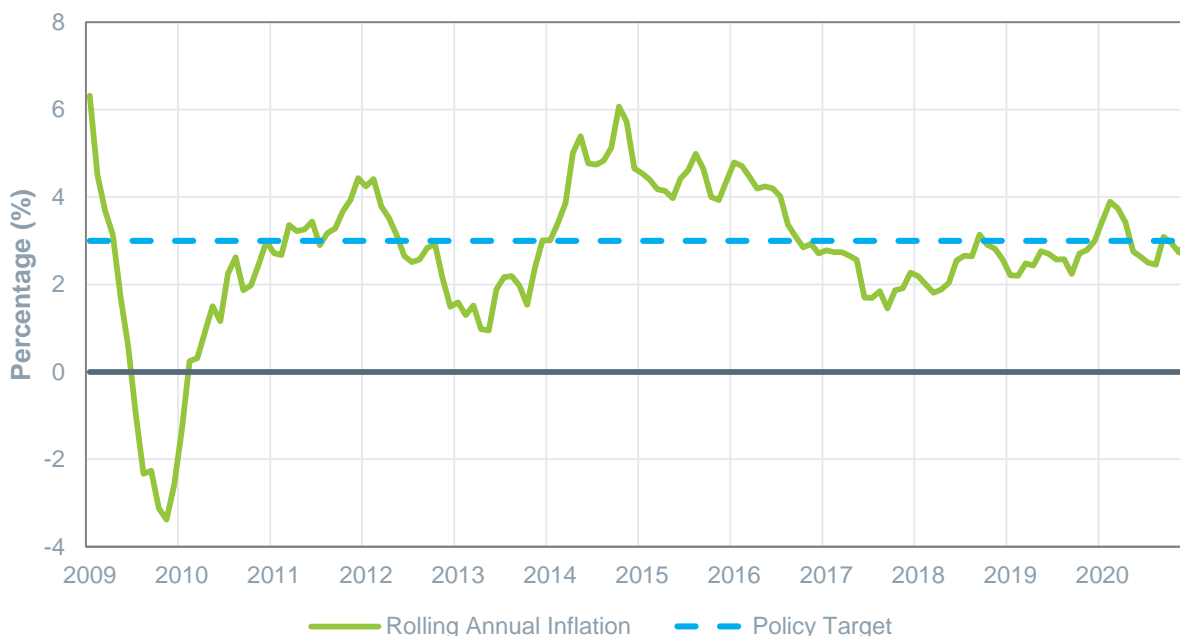
As shown in the Figure 4.15 below, inflation in Chile has been relatively stable since the end of the Great Financial Crisis in 2009. For the period 2010-2020 inflation has averaged 3.0%, matching the policy target. Over the 20-year period ending in 2020, average inflation has been slightly higher at 3.1%.

The Central Bank of Chile currently targets an annual inflation rate of 3%. As of December 31, 2020, market expectations were just below the 3% target with a 5 year breakeven rate of 2.64% and a 10 year figure of 2.69%. The 10 year breakeven inflation has remained consistent ranging between 2.50% and 3.50% over the last 10 years.

As reported in the June 2021 Monetary Policy Report, the Central Bank of Chile states “In Chile, inflation has performed as expected, with annual CPI variation rising to 3.6%. Expectations are aligned with the two-year target. The annual variation of the CPI has continued to be largely determined by the evolution of the prices of goods and energy. The former are still pressured by tight inventories in a context of high demand. The latter have been influenced by the oil price hikes and the low comparison base. The core CPI stands today at 3.4%.”

This is in-line with earlier comments as reported in the March 2021 Monetary Policy Report, the Central Bank of Chile expects short-term transitory inflation near 4% as a result of energy and other volatile items. However, the Central Bank expects inflation will “*begin converging to the policy target in the second half of the year [2021].*” Additionally, the Central Bank states “*Inflation insurances anticipate annual inflation close to 4% at mid-year and 3.4% in December 2021. In the twelve-month term, they have remained at 3.3% with respect to the previous statistical close. One-year and two-year breakeven inflation, as contained in the swaps, exhibit values not very different from the December statistical close, and fluctuate at around 3%.*” This is consistent with RVK’s views on inflation globally. We may experience short- to mid-term transitory inflation but long-term expectations remain muted at or below central bank targets.

Figure 4.15 – Historical and Targeted Inflation in Chile



Source: FactSet. (2021)

Given the consistency of experienced inflation, global expectations for lower inflation going forward, and the stated policy target of 3%, we assume a going forward inflation rate of 3% for Chile. This value is used to adjust all nominal returns to real returns for use in the asset allocation model described in later sections of this report.

4.5 Currency Methodology

The analysis in this report is conducted in Chilean Pesos, however assets are invested in multiple currencies including the US Dollar, Euro, Japanese Yen, Chinese Yuan, British Pound, and Swiss Franc among others. Currency fluctuations will alter future returns when viewed in Chilean Pesos. Figure 4.16 below shows the value of each of these currencies, as of December 31, 2020, compared to their 10 year averages. The Peso is above its long-term average compared to each currency shown ranging from 10% compared to the Pound, to almost 24% compared to the Franc. RVK believes exchange rates are mean-reverting over the long-term. Multiple approaches can be taken to determine the effect relative currency valuations will have going forward under a mean-reverting assumption. However, we do not believe in the ability to reliably predict short-term movements, therefore we utilize a straight-line regression to the mean technique to determine the annual currency valuation effect. Figure 4.16 highlights RVK’s assumed currency return for select major currencies to convert asset classes into Pesos. Return assumptions are developed in local currency and then converted to Pesos by applying the expected change in currency valuations. Given the uncertainty in future exchange rates we stress test these assumptions in Appendix 3, where we assume exchange rates remain constant. Figure 4.16 also shows the correlation of each currency’s exchange rate with the Peso to copper prices over the last 10 years. Correlations for each of the major currencies are relatively similar, all falling between -0.24 and 0.15.

Figure 4.16 – December 31, 2020 Currency Exchange Rates

	US Dollar \$	Euro €	Switzerland Franc CHF	Japanese Yen ¥	Chinese Yuan Renminbi ¥	British Pound £
Current / Peso	710.5	869.3	803.8	6.9	108.6	971.2
10 Year Average	617.0	739.3	648.6	6.0	94.3	882.2
Relative Value	-15.2%	-17.6%	-23.9%	-14.9%	-15.2%	-10.1%
Annual Impact to Assumptions – 20 Year Mean Reversion	-0.82%	-0.96%	-1.36%	-0.80%	-0.82%	-0.53%
Correlation to Copper	-0.11	0.05	-0.05	-0.24	-0.07	0.15

Source: FactSet. (2021)

4.6 Fixed Income Return Methodology

The factors we utilize for estimating fixed income returns include, but are not limited to, yield and the yield curve, changes in interest rates and spreads, as well as duration. Our process is outlined in Figure 4.17 below.

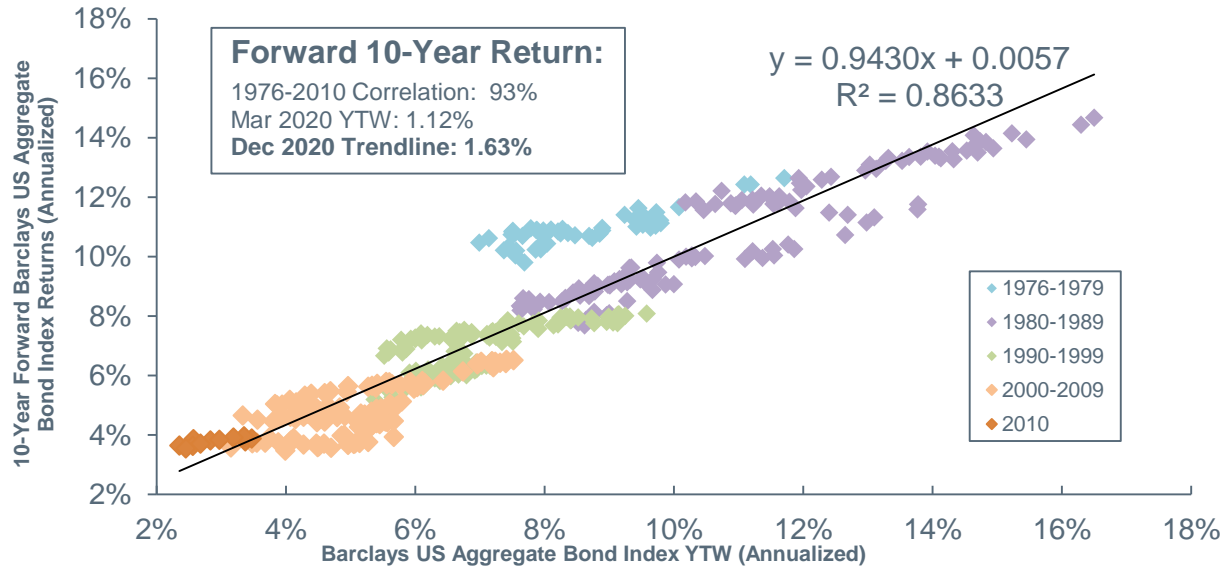
Figure 4.17 – Fixed Income Return Decomposition Model



Yield

The yield (to worst) of a fixed income security is the anticipated return to an investor based on interest payments, and other factors including call options. Therefore, as Figure 4.18 illustrates, initial period yields (as illustrated by the Bloomberg US Aggregate Bond Index) have historically been a reasonable starting point when forecasting future fixed income returns. Low bond yields typically indicate low bond returns in the future, and vice versa.

Figure 4.18 – Relationship between YTW and Forward 10 Year Returns



Source: FactSet. (2021)

Rate Changes

In addition to yield levels, future interest rate expectations also play an important role in setting future fixed income return assumptions. Interest rate changes affect fixed income investments in multiple ways. In the short-term, if interest rates rise, fixed rate bonds will incur price losses; and if rates fall, the opposite will occur. However, in the long-term, rising interest rates result in higher yields/incomes for re-investment. We consider this trade-off between short- and long-term effects of interest rate changes, and the timing of such changes, on future fixed income returns when deriving our assumptions.

The prices of longer-maturity bonds are more sensitive to changing interest rates because the income on a fixed income security is fixed. For example, consider a 10-year bond with a 2% yield and a scenario where the interest rate increases in two years by 2%, resulting in a similar newly issued bond paying 4% interest. This means that the old bond is less valuable now if sold, because for the remaining eight years of the bond's life it will pay 2% interest versus the newly issued bond paying 4% interest. However, if your initial bond matured in three years instead of 10, then the impact is less severe as your old bond only has one year of inferior payments.

In addition to the yield level at a particular duration, we also examine the shape of the yield curve when evaluating future return outcomes for fixed income investments. Not only have yields fallen in recent years, the yield curve has become flatter and even recently inverted for the first time since prior to the Great Financial Crisis. The relatively flat yield curve along with reduced inflation expectations has caused RVK to significantly reduce expected returns for many fixed income segments.

When we project fixed income returns forward we have to make assumptions about several factors including when rates will change, how much rates will change by, and whether or not the shape of the yield curve will change. Our assumptions include a parallel shift up of the yield curve in the future. We believe it will be several years before major central banks increase rates. We also believe due to extensive government debt loads, and other factors that could potentially slow future economic growth, central banks will only moderately increase rates when the time comes. For the US we assume rates will increase by 2.0% in 7 years. For other developed markets we assume smaller increases. Specifically we assume the ECB will increase rates by 1.5% and Japan by 1.0%. These shifts in the yield curve are modeled for each asset class based on yields and duration.

Duration

The example in the above “Interest Rates” section shows the significance of the duration of a fixed income investment to its future returns. Duration is a measure of how long (in years) it takes for the price of a bond to be repaid by its cash flow, as well as an indicator of interest rate sensitivity. Therefore, duration is a relevant consideration that impacts both return and risk assumptions.

While the assumption timeframe is long-term, the horizon period is still finite. Rising rates have the potential to increase long-term fixed income returns through additional future income, but they can also cause (be offset by) short-term market impairment of prices. Therefore, the closer the asset class duration is to the investment horizon (the longer the duration), the closer the return assumption (generally) is to the market yield – all else equal.

Spread

We also consider credit conditions and the spread (option adjusted) of yields over US Treasuries when forecasting return assumptions. We compare the level of spread for a particular asset class to its long-term average to estimate the impact of potential spread level movements on future returns.

It is also important to note that while the above stated factors generally inform the direction and magnitude of our decisions, we also consider qualitative issues as well as additional factors as needed (i.e. currency impact on international bonds), when arriving at final assumption values.

2021 Market

Falling interest rates have resulted in historically low yields across almost all fixed income categories. While falling interest rates result in short-term price gains for fixed income securities, in the long-run they provide lower income for re-investment. Overall, the prospects for fixed income deteriorated, and given yields, spreads, and inflation, we expect future fixed income returns to remain materially lower than long-term historical average returns. In fact, we expect long-term real returns to be flat to negative for many fixed income sectors.

4.6.1 Bank Deposits Return Assumption

Bank deposits represent cash held at banks across the globe, and are largely driven by central bank short-term interest rates and other market manipulations. These short-term holdings of cash provide immediate liquidity and preservation of capital during periods of market stress. Given current central bank policy rates near, or even below, zero across much of the developed world, interest earned on cash is substantially below the rate of inflation leaving assets exposed to inflation risk and real returns that are negative. This is in spite of low long-term inflation expectations.

Figure 4.19 below highlights RVK's expectations for bank deposits for the US, the Euro area, and Japan as of December 31, 2020. Included in the figure is RVK's recommendation related to allocation exposure of deposits across geographies. See Appendix 2 for additional information on the derivation of these allocations.

Figure 4.19 – Bank Deposits Data (Real CLP)

Sub-Asset Class	Proposed Allocation	Inflation	Yield	Spread	Rate/Yield Curve	Currency	Total
US Dollar-Denominated Deposits	50.0%	-3.00%	0.10%	0.00%	1.25%	-0.82%	-2.47%
Euro-Denominated Deposits	25.0%	-3.00%	-0.65%	0.00%	1.00%	-0.96%	-3.61%
Yen-Denominated Deposits	25.0%	-3.00%	-0.23%	0.00%	0.25%	-0.80%	-3.78%
Weighted Average	100.0%	-3.00%	-0.17%	0.00%	0.94%	-0.85%	-3.08%

Source: Yield data provided by ICE BofA ML. (2021)

Yields are reported in nominal terms in local currency, we therefore adjust for expected inflation in Chile. Given these assets are bank deposits invested primarily in short dated government bonds we assume no spread adjustments going forward. The combined expected return for the asset class works out to -3.08% in real Chilean Peso terms.

We assume a duration of 0.0 years for bank deposits. Therefore, when the yield curve rises, as discussed in section 4.6, returns are not penalized due to price depreciation, but do benefit from higher earnings for remaining years in the model. The rate/yield curve impact is driven by higher projected yields for the latter part of the period. As an example, we expect US rates to increase by 2% in year 7 of our 20 year model. This equates to 29.4% in additional cumulative return over the 13 year period with higher rates. When we annualize this over the entire 20 year period the resulting annual increase in return is 1.29%, which we round to 1.25%. We apply the same approach to the other currencies and, where appropriate, also include any loss due to duration exposure.

4.6.2 Treasury Bills Return Assumption

Similar to bank deposits, global treasury rates remain muted. Given relatively flat yield curves, and limited duration of bills, the return data for treasury bills is almost identical to bank deposits. The weighted average duration is 0.3 years. The expected return equates to -3.08% as shown in Figure 4.20.

Figure 4.20 – Treasury Bills Data (Real CLP)

Sub-Asset Class	Proposed Allocation	Inflation	Yield	Spread	Rate/Yield Curve	Currency	Total
US Treasury Bills	50.0%	-3.00%	0.07%	0.00%	1.25%	-0.82%	-2.50%
German Treasury Bills	25.0%	-3.00%	-0.68%	0.00%	1.00%	-0.96%	-3.64%
Japan Treasury Bills	25.0%	-3.00%	-0.11%	0.00%	0.25%	-0.80%	-3.66%
Weighted Average	100.0%	-3.00%	-0.16%	0.00%	0.94%	-0.85%	-3.08%

Source: Yield data provided by FactSet. (2021)

4.6.3 Sovereign Bonds Return Assumption

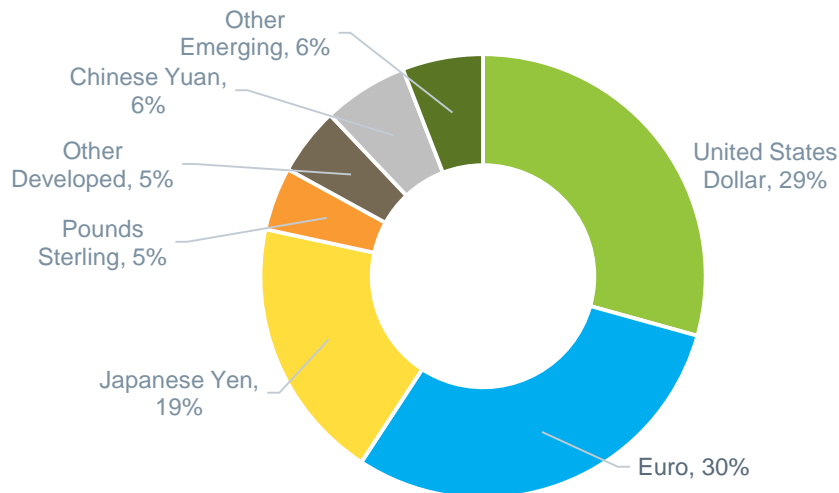
The sovereign bonds assumption is based on the Bloomberg Global Aggregate – Treasury 5-7 Year Index (discussed further in Appendix 2). This index has a positive nominal yield of 0.37%. However this turns negative when we adjust for expected inflation. The duration of the index is 5.7 years. Based on this duration, future interest rates are expected to add 1.00% of additional return. After factoring in currency, reflecting the exposures shown in Figure 4.22, we expect a real return of -2.39% for the asset class as shown in Figure 4.21.

Figure 4.21 – Sovereign Bonds Data (Real CLP)

Sub-Asset Class	Proposed Allocation	Inflation	Yield	Spread	Rate/Yield Curve	Currency	Total
Sovereign Bonds	100.0%	-3.00%	0.37%	0.00%	1.00%	-0.76%	-2.39%

Source: Yield data provided by FactSet. (2021)

Figure 4.22 – Sovereign Bonds Currency Exposure



Source: Bloomberg. (2021)

4.6.4 Inflation Linked Bonds Return Assumption

The inflation linked bond assumption is based on the Bloomberg Global Inflation-Linked Index. The real yield of the index, as of December 31, 2020, is -1.42%. We deduct from this an additional 1.00%, as we expect inflation to be higher in Chile than in developed markets. When currency is considered the expected real return in Pesos is -3.13% as

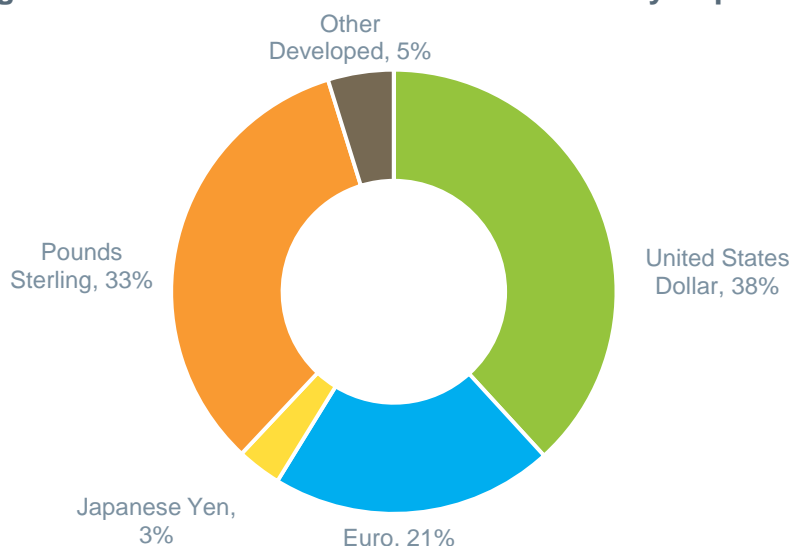
shown in Figure 4.23. The rate/yield curve component is 0.00 as the additional return from increased yields exactly offset the loss from duration. This is a coincidence.

Figure 4.23 – Inflation Linked Bonds Data (Real CLP)

Sub-Asset Class	Proposed Allocation	Real Yield	Chile Inflation Adjustment	Rate/Yield Curve	Currency	Total
Global Inflation Linked Sovereign Bonds	100.0%	-1.42%	-1.00%	0.00%	-0.71%	-3.13%

Source: Yield data provided by FactSet. (2021)

Figure 4.24 – Inflation Linked Bonds Currency Exposure

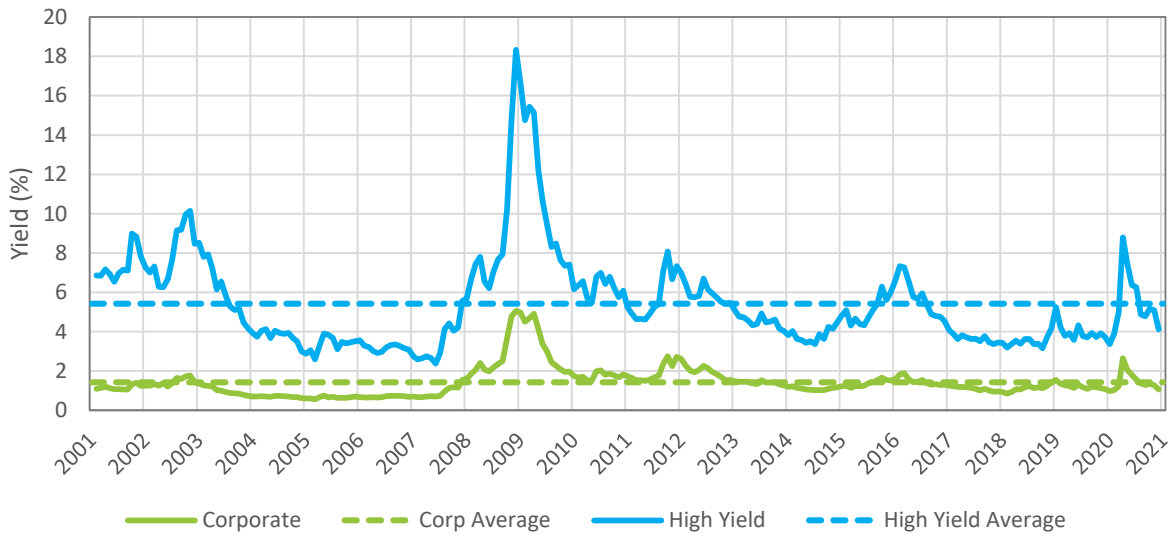


Source: Bloomberg. (2021)

4.6.5 Credit Return Assumption

Credit offers both increased yield and diversification to government bonds. The blended yield for the proposed structure is 1.70%, significantly higher than any other fixed income asset class discussed to this point. Two factors are added to our model when developing return assumptions for credit that were not discussed for government bonds. First, we examine spread levels relative to long-term expectations. Generally speaking, we believe spreads are in-line with normal ranges and will only marginally detract from return over the long-run. See Figure 4.25 for corporate and high yield spreads. The second is default loss. We examine this for high yield bonds and bank loans. While default rates are low, RVK expects them to increase over the next few years as effects of the COVID-19 induced recession work their way through the economy. However, given low absolute interest rates, overall defaults should remain lower than past recessions. We expect defaults to detract 1.00% per year from high yield and bank loans. Historical default rates in the US high yield market have averaged approximately 3.2% based on data provided by JPMorgan. Average recovery rates over the same time period are approximately 39.7%. When combined this equates to a default loss of approximately 1.00% per year.

Figure 4.25 – Historical Spreads



Source: Bloomberg. (2021)

Durations in the credit space equal 5.0 years on a weighted average basis, although they vary substantially between the various sub-asset classes. On the high end, corporate credit has a duration of approximately 7.8 years and on the low end, bank loans have very little duration given their largely floating rate structure. Overall we expect rates to contribute 0.80% to the long-term expected return.

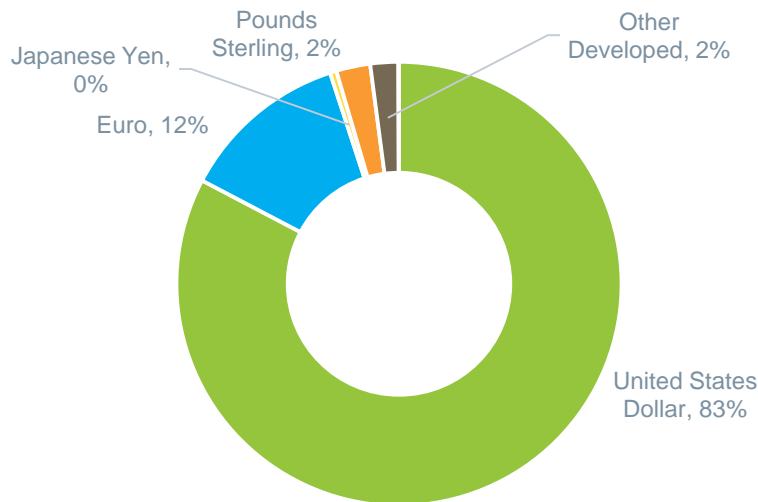
Combining the above we expect a real return of -1.50% from credit in real Chilean Peso terms as shown in Figure 4.26.

Figure 4.26 – Credit Data (Real CLP)

Sub-Asset Class	Proposed Allocation	Inflation	Yield	Spread	Rate/Yield Curve	Currency	Default	Total
Global Investment Grade Corporate Credit	50.0%	-3.00%	1.34%	-0.13%	0.75%	-0.81%	0.00%	-1.85%
US Corporate High Yield	5.0%	-3.00%	4.18%	-0.32%	0.75%	-0.82%	-1.00%	-0.21%
Bank Loans	5.0%	-3.00%	4.24%	0.00%	0.00%	-0.82%	-1.00%	-0.58%
MBS	35.0%	-3.00%	1.25%	-0.04%	1.00%	-0.82%	0.00%	-1.61%
EMD Corporate	5.0%	-3.00%	3.42%	-0.10%	0.75%	-0.42%	0.00%	0.64%
Weighted Average	100.0%	-3.00%	1.70%	-0.10%	0.80%	-0.79%	-0.10%	-1.50%

Source: Yield data provided by FactSet and JPMorgan. (2021)

Figure 4.27 – Credit Currency Exposure

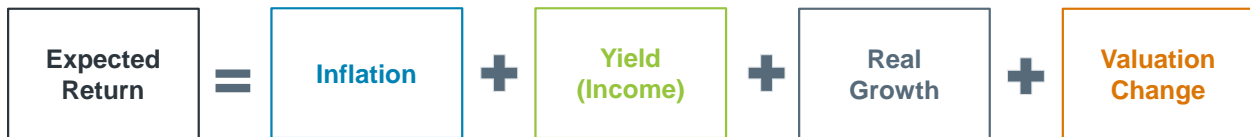


Source: FactSet, JPMorgan. (2021)

4.7 Equity Return Methodology

The fundamental methodology RVK utilizes for forecasting public equity returns is a bottom-up decomposition model, whereby we analyze long-term data regarding key equity return drivers, including dividend yield, projected real earnings growth, and projected changes in valuations. This is summarized in Figure 4.28 below.

Figure 4.28 – Equity Return Decomposition Model



Our return decomposition methodology is similar to the Grinold & Kroner model, which is a methodology included in the CFA Institute’s Candidate Body of Knowledge (“CBOK”) and decomposes equity return expectations into the fundamental drivers of return. However, RVK excludes share repurchase yield from the model as we believe there is evidence suggesting it is not additive to long-term returns.

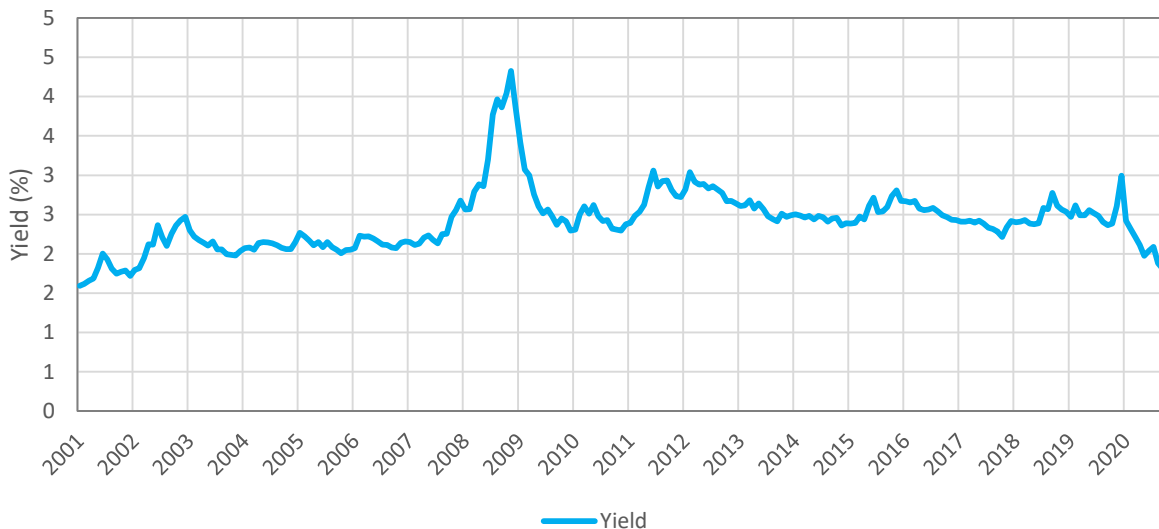
It is also important to note that while the above stated factors generally inform the direction and magnitude of our decisions, we also consider qualitative and triangulation issues, as well as additional factors as needed, when arriving at final assumption values. Additional factors include multiple valuation metrics (as well as long-term valuation reversion points), assessment of alternate future growth parameters, and profit margin reversion (and associated potential changes to dividend rates).

The below process is completed for each US large-Cap, US small-cap, developed ex-US large-cap, developed ex-US small-cap, and emerging markets equity and the results combined at market weight to produce a global equity return assumption.

Yield

Dividend yield represents the income that investors earn on their equity investment. As shown in Figure 4.29, the average dividend yield for the MSCI ACWI has been 2.4% since 2001. However, in the last 20 years the dividend yield has fallen to an average of only 1.8%, which may suggest lower income returns in the future. We use current dividend yield in the return decomposition model to estimate future yields to better reflect ongoing economic environment and trends. Given strong returns and falling corporate profitability in 2020, yields fell for public equities as shown below, resulting in reductions to our expected future returns.

Figure 4.29 – MSCI ACWI Historical Yield



Source: FactSet. (2021)

Real Growth

Generally, as the economy expands corporations benefit from higher sales/earnings. Therefore, we assume that corporate sales (and earnings) grow at roughly the same pace as the economies from which their sales (and earnings) are derived – adjusted for market based regional revenue exposures within each asset class. We utilize multiple forecasts of future real GDP growth worldwide to arrive at an estimated future real earnings growth rate for each equity asset class.

Earnings growth expectations have improved since the beginning of the COVID-19 induced recession given the prospect for stronger economic growth. However, growth expectations remain low relative to long-term history making it difficult to achieve returns comparable to past experience.

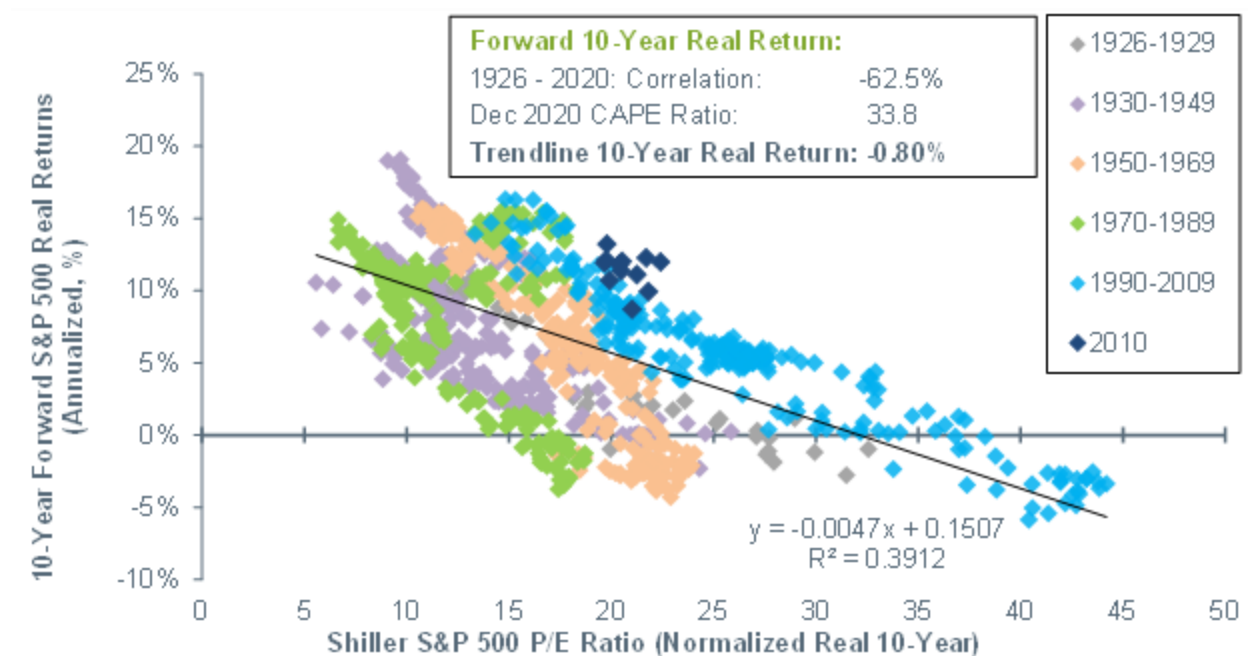
Valuations

There exist numerous ratios that can provide a valuation measure for equities – Shiller Cyclical Adjusted Price-to-Earnings (“CAPE”), Siegel National Income and Product Account (“NIPA”), trailing or forward-looking Price-to-Earnings (“P/E”), the price-to-dividend ratio, and total public equity value to GDP, to name a few. In our main analysis

we focus our valuation efforts on CAPE. Several attributes of CAPE make it attractive as the primary measure for estimating future equity returns. CAPE encompasses a long history going back to 1926 which includes multiple market cycles, is easily understood, is commonly used in the industry, employs a simple calculation methodology, and has historically shown predictive power for future equity returns as shown in below in Figure 4.30. While the example is for the S&P 500, we have found the relationship holds for major public equity indices across the globe.

The Shiller CAPE ratio is negatively correlated with long-term equity returns. Yale professor Robert Shiller argued that one-year earnings are highly volatile, affected by short-run considerations, and likely mean-reverting over longer periods. He proposed using the cyclically adjusted P/E ratio (i.e. CAPE or Shiller P/E), which averages the prior 10 years of real earnings.

Figure 4.30 – S&P 500 CAPE Ratio vs. 10-Year Forward S&P 500 Return



December 2020 CAPE ratio uses the S&P 500 earnings estimate for the fourth quarter of 2020.

Source: RVK, based on data from the Robert Shiller Database. (2021)

Valuation tends to be the most volatile decomposition input, given its underlying components, and thus often has the largest influence on year to year changes in return assumptions. Therefore, the mean reversion point estimate is a critical component when estimating future returns. The long-term average makes a reasonable starting point for the reversion point. Given current interest rates (used to discount equity cash flows), and our view that lower rates are likely to persist, we believe a reversion point higher than the long-term average is appropriate.

In our analysis we assume CAPE reverts to its median since 2005. Given CAPE is a 10-year measure this implies we include data back to 1995 in our calculations. For

perspective looking at the S&P 500 this implies a reversion CAPE point of 25.7, substantially higher than the long-term average of 16.6 if we go back to 1926. While large-cap US equities are the most overvalued based on CAPE, all other major subsets of the global equity markets are also overvalued even when comparing to data since 1995.

Other valuation measures we monitor include price to book, price to dividend, price to sales, price to earnings, Sigel's National Income and Product Account P/E, Hussmann Margin Adjusted CAPE, Tobin's Q, and market cap to GDP. Each of these measures share the common trait that they are highly correlated with long-term future equity returns. Additionally, all are currently in the top 10% (many in the top 2%) of values compared to their own long-term history. This indicates no matter which valuation measure is utilized, future equity returns are likely to be reduced as valuations normalize. Figure 4.31 highlights the recent readings compared to historical values for each of these measures as well as their correlation with long-term future equity returns.

Figure 4.31 – Equity Valuation Measures

								Regression with 10-year Forward S&P500 returns	
		Latest Value	As of Date	Percent Rank	Standard Deviation from Mean	Average (Longest Available)	Starting Date	Corr from the Starting Date	R-Square (starting date)
Real	Real TTM CAPE	33.6	Dec-20	98%	2.3	17.0	Jan-26	-38%	15%
	Shiller CAPE 10-year	33.8	Dec-20	97%	2.3	18.3	Jan-26	-63%	39%
	Margin Adj Shiller CAPE10 ⁽¹⁾	53.3	Sep-20	98%	2.5	22.6	Dec-39	-70%	49%
	Shiller CAPE 20-year	42.2	Dec-20	98%	2.5	20.0	Jan-26	-61%	37%
Nominal	S&P 500 Price / Dividend ⁽²⁾	63.4	Dec-20	95%	1.8	33.0	Jan-26	-50%	25%
	S&P 500 Price / Book	4.2	Dec-20	91%	1.8	2.9	Jan-90	n/a	n/a
	S&P 500 Forward P/E (CY) ⁽³⁾	27.0	Dec-20	100%	3.0	17.2	Jan-90	n/a	n/a
	S&P 500 Price / Sales	2.8	Dec-20	100%	2.6	1.5	Jan-90	n/a	n/a
	Tobin's Q	155.1	Sep-20	99%	2.5	74.7	Dec-45	-83%	69%
	Total Market Cap / GDP	2.2	Dec-20	100%	3.0	0.7	Mar-71	-76%	58%
	Total Price Index / GNP	1.6	Sep-20	100%	2.3	0.8	Mar-71	-87%	77%

* Regression analysis is run against Real 10-year forward S&P500 annualized returns

(1) Margin adjusted Shiller CAPE calculation is on Dr. Hussman methodology as stated on <https://www.hussmanfunds.com/knowledge-center/>

(2) Based on Robert Shiller data

(3) "CY" stands for "Current year EPS estimate" and "NY" stands for "Next year EPS estimate"

Data: Bloomberg, The Board of Governors of the Federal Reserve System, Bureau of Economic Analysis, Dimensional Fund Advisors, Federal Reserve Economic Database, Standard & Pooors, Robert Shiller

The other component to determining valuations impact on future return is the time it takes for reversion to occur. RVK believes valuations relay significant information about long-term future returns, but very little about short- to mid-term returns. As such, we assume it can take multiple market cycles for equity valuations to revert to average long-term estimates. The choice of reversion period is an attempt to include multiple market cycles. Typically these have occurred every 5-10 years in the past so 20 years almost always covers at least 2 market cycles. The last market cycle beginning after the GFC and ending with COVID-19 lasted around 12 years, one of the longest cycles on record. By this measure we believe a 20 year period is appropriate for mean reversion.

4.7.1 Global ex-Chile Public Equity Return Assumption

RVK develops our equity assumption based on the MSCI All Country World Index ex Chile (GR un-hedged). We complete a build-up model for each underlying equity asset class and then take a market weighted average to develop our global assumptions. RVK's standard global equity return assumption is 7.05% (USD, nominal). The below exercise is designed to guide how much our standard assumption should change based on converting it to a real CLP assumption.

The assumption is developed in real terms but we expect higher inflation in Chile than in the developed world so must make an adjustment to for this to convert the return to a real Peso assumption. This adjustment is -1.00%.

Yield

Given low yields across most fixed income sectors, as of December 31, 2020, equity actually offers a higher yield than fixed income generally speaking at 1.81%.

Earnings Growth

We expect earnings to grow in-line with global GDP growth expectations (as shown in Figure 4.32), weighted for region-level sales exposure. Historically, small cap companies have exhibited higher levels of growth than their large cap counter parts. We account for this through a 33% premium applied to the weighted sales growth estimate for small cap asset classes. The premium tends to be highly cyclical but has averaged 48% since 1995. We assume a lower figure going forward of 33% to be conservative. This exercise suggests a 2.65% addition to return going forward for global equity as shown in Figure 4.33.

Figure 4.32 – GDP Expectations

	US	Developed ex US	Emerging Markets
IMF	2.6%	2.4%	5.2%
Conference Board	1.8%	1.7%	3.4%
World Bank	2.3%	2.0%	4.4%
USDA	2.4%	2.1%	4.6%
JPMorgan	1.8%	1.6%	3.9%
Average	2.2%	2.0%	4.3%

Source: IMF, Conference Board, World Bank, USDA, JPMorgan, RVK. (2021)

Figure 4.33 – Earnings Growth Expectations

Sub Asset Class	Global Weight	Regional Sales Exposure				Weighted Sales Growth	Growth Premium	Sales Growth
		US	Emerging Markets	Non-US Developed	Other Countries			
Large/Mid Cap US Equity	52.9%	60%	15%	20%	5%	2.46%	--	2.46%
Small Cap US Equity	3.7%	77%	7%	12%	4%	2.30%	33%	3.07%
Devd Large/Mid Cap Int'l Equity	25.8%	18%	19%	57%	6%	2.45%	--	2.45%
Devd Small Cap Int'l Equity	4.5%	10%	11%	74%	5%	2.25%	33%	3.00%
Emerging Market Equity	13.1%	9%	69%	16%	6%	3.59%	--	3.59%
Global Equity								2.65%

Source: FactSet and MSCI. (2021)

Valuation

As previously discussed, and shown in Figure 4.31, valuations are higher than long-term equilibrium expectations meaning future returns will be impeded as valuations normalize. This reduces return expectations by -1.02% per year as shown in Figure 4.34.

Figure 4.34 – Equity Valuations

Sub Asset Class	Weight	Current CAPE	Long-Term Reversion Estimate	Current/Long-Term	Annual Valuation Return
Large/Mid Cap US Equity	52.9%	33.4	25.7	130%	-1.31%
Small Cap US Equity	3.7%	66.3	48.0	138%	-1.60%
Devd Large/Mid Cap Int'l Equity	25.8%	17.2	14.6	117%	-0.80%
Devd Small Cap Int'l Equity	4.5%	26.4	23.0	115%	-0.69%
Emerging Market Equity	13.1%	15.9	15.2	105%	-0.24%
Global Equity					-1.02%

Source: FactSet. (2021)

Currency

When we add the currency adjustment we expect a real Peso return of 1.63% from equities as shown in Figure 4.35. Admittedly, this is significantly below historical long-term averages. However, when we look at other periods where valuations have started the period well above long-term averages we tend to see depressed equity returns for extended periods of time. Additionally, even if the valuation component of the model is removed, future equity return expectations remain muted given low yields, inflation expectations, and potential earnings growth.

Figure 4.35 – Equity Data (Real CLP)

Sub-Asset Class	Chile Inflation Adjustment	Yield	Earnings	Valuation	Currency	Total
Global Equities	-1.00%	1.81%	2.65%	-1.02%	-0.81%	1.63%

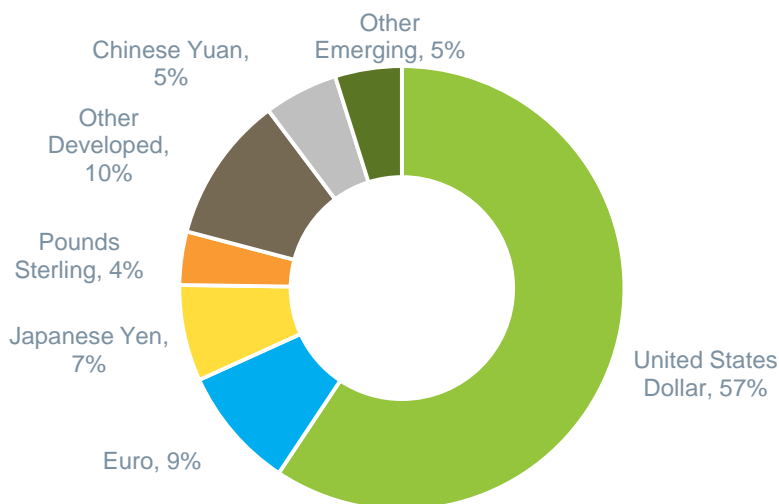
Source: Yield data provided by FactSet. (2021)

Adjustments

We qualitatively adjust our actual return expectation to **3.24%** in real Peso terms for several reasons. First, given other valuation measures are slightly less overvalued than CAPE, we temper the valuation impact. Second, our expectations for lower interest rates over the long-term should help reduce the valuation impact as well. Third, a higher return assumption also allows for a period of growth higher than long-term expectations as we exit the COVID-19 induced recession into a market environment expected to have upward pressure on yield and earnings in the near-term. These adjustments add 1.61% to the final return assumption with valuation representing the majority of this figure.

The result corresponds to a 7.05% nominal USD based return which is RVK's standard assumption for global equity and we believe the two numbers should only differ by the differences in USD vs. CLP models. Notably, this equates to the Chile Inflation Adjustment plus the currency effect which combine to equal -1.81%. RVK's standard assumption of 7.05% minus the difference in models equals a nominal return of 5.24%. When we then subtract global inflation expectations of 2.00% we get to the 3.24% stated above.

Figure 4.36 – Equity Currency Exposure



Source: FactSet. (2021)

4.8 Risk Assumption Methodology and Analysis

Asset class volatility measures the consistency with which asset class returns are generated. Standard deviation is the most commonly utilized measure of risk in the investment industry and is a statistical measurement used to calculate the volatility of returns.

In the framework of capital markets assumption setting, we care about understanding how asset class returns may vary over long holding periods, and thus are not as concerned with monthly variability in returns. Therefore, the RVK methodology for developing volatility assumptions has historically focused more intently on the annual

standard deviation calculation. However, focusing too intently on annual standard deviations presents a variety of issues, particularly for asset classes with shorter time horizons.

Annualized standard deviation (a standard deviation of monthly data multiplied by $\sqrt{12}$) is another commonly utilized measure of volatility in the industry. However, we believe it is often not an appropriate volatility measure for assuming risk levels in institutional investor portfolios for a variety of reasons. As an example, the mathematical process of annualizing monthly returns assumes that monthly data is normally distributed. As history has proven many times, many asset class returns are not normally distributed, but instead tend to have a fat left tail.

Recognizing the shortfalls of both methodologies when used in isolation, RVK has chosen to enhance its historical distribution analysis and more directly focus on distribution information as it relates to reviewing both annual and monthly calculation methodology outcomes. This process involves additional quantitative analysis, but given the broader set of information, it also requires a qualitative determination to balance all the factors under consideration. Figure 4.37 outlines RVK's volatility assumption for each asset class.

Figure 4.37 – Volatility Data (Real CLP)

	Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities
Implied	8.78	7.86	10.73	8.27	6.50	13.96
Monthly	11.14	11.51	11.53	10.99	11.33	14.61
Annual	11.13	11.16	12.26	9.78	7.84	16.76
Average	10.35	10.18	11.51	9.68	8.56	15.11
RVK Assumption	11.08	11.50	12.00	9.75	8.50	15.00

It is worth noting the volatility assumption for equities is closer to the other asset classes than might seem reasonable at first. Global equities have very low correlation with the Chilean Peso. Over the last 10 years the correlation has averaged 0.02. Therefore, when we examine the volatility of equities in Pesos the currency effect dampens the natural volatility of equities acting as a source of diversification.

4.9 Correlation Matrix Assumption Methodology and Analysis

Correlation can take on values between 1.00 and -1.00. If returns of two asset classes rise or fall at the same time in proportional magnitude they are said to be perfectly correlated and have a correlation value of 1.00. Conversely, two asset classes that simultaneously move in opposite directions are said to be perfectly negatively correlated and have a correlation value of -1.00. A correlation of 0 indicates no relationship between the returns. It is imperfect correlations between asset classes that enable an investor to create efficient portfolios; that is, those with the highest amount of return at a given level of risk.

Long-term historical index values and interrelationships constitute the foundation of our analysis, while more recent trends function as a forecasting tool. Specifically, a 90% weight is placed on since inception data and a 10% weight is applied to the last 5-year

period. This methodology yields a manageable matrix of assumptions that incorporates both long-term and recent trends. Monthly returns converted into Chilean Pesos were used for all calculations. The results are shown in Figure 4.38. The fixed income asset classes are all highly correlated with each other. The correlation of the fixed income asset classes to equities is lower but still positive. Equity and credit exhibit a higher correlation given that high yield and bank loans have much higher correlations to equity than they do other, more rate sensitive, fixed income asset classes.

Figure 4.38 – Correlation Table (Real CLP)

	Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities
Bank Deposits	1.00	1.00	0.95	0.86	0.93	0.25
Treasury Bills	1.00	1.00	0.96	0.87	0.93	0.25
Sovereign Bonds	0.95	0.96	1.00	0.90	0.92	0.21
Inflation Linked	0.86	0.87	0.90	1.00	0.93	0.36
Credit	0.93	0.93	0.92	0.93	1.00	0.46
Equities	0.25	0.25	0.21	0.36	0.46	1.00

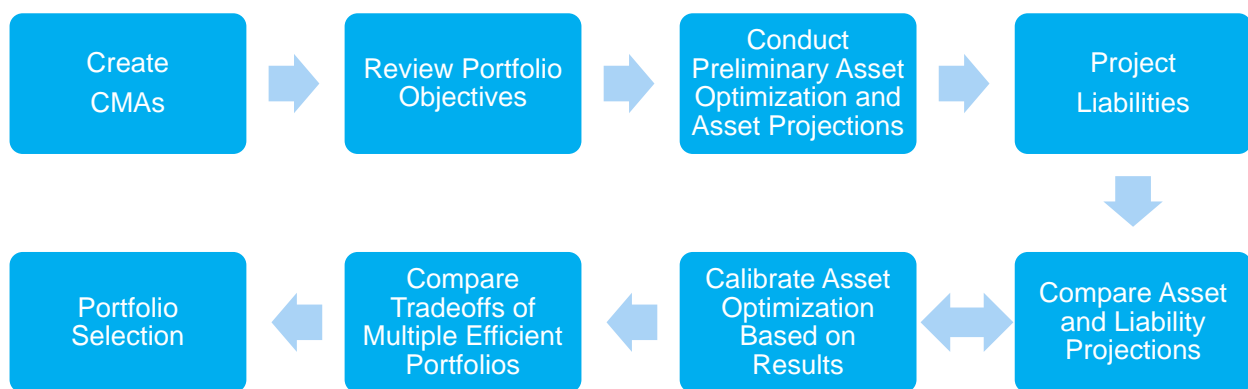
5.0 Asset Allocation Analysis

There are many factors that drive the ultimate asset allocation decision. These include investment objective and purpose, time horizon, risk tolerance, liquidity needs, legal constraints, implementation considerations, among many other considerations. In this section we examine the efficiency of the existing policy target and look for potential improvements. These improvements are measured in several ways but focus on:

- Reducing expected risk – including volatility, drawdown potential, and equity beta
- Enhancing expected risk-adjusted return – while increasing the expected return of the portfolio may allow for increased distributions in times of strong markets, it can also cause periods of lower distributions due to larger asset losses when markets fall. Therefore, the objective of the asset allocation analysis is not to maximize expected return, but maximize expected return at a given level of risk.
- Reducing correlation to copper prices and revenue
- Maintaining alignment with the objectives and constraints of the ESSF

RVK followed the framework as shown in Figure 5.1 for developing the potential policy targets. This iterative process allows for risk-adjusted return asset optimization followed by projection analysis of both assets and liabilities. Liabilities in the case of ESSF represent future potential payouts. This topic is discussed in detail in section 6. Feedback from the projection phase can be used to enhance the asset optimization to improve overall outcomes of the ESSF. Step 1 – Create CMAs is discussed in Section 4. Review Portfolios Objectives is Section 3. Asset Optimization follows in this section while the remainder of the report focuses on the final steps within the process.

Figure 5.1 – Efficient Portfolio Process



5.1 Mean-Variance Optimization

An asset allocation study utilizes an optimization model that incorporates capital markets assumptions (return, risk, and correlation) to suggest optimal, or efficient, allocations. The analysis is intended to capture the expected return, risk, and correlation with other asset classes over the long-term, in order to select a target or policy portfolio that best meets the needs of the portfolio. Optimal allocations consist of portfolios that achieve the highest level of return for a given level of risk, or the lowest level of risk for a

given level of return. Linking of each of the optimal, or efficient, portfolios creates the “Efficient Frontier” of portfolio structure (asset allocation) choices.

MVO, the primary optimization algorithm used today, was introduced by Nobel Laureate, Harry Markowitz in 1952. The model uses the provided CMAs to build many portfolios with different proportions of each asset class, subject to whatever constraints are placed upon it. The model then determines which of these hypothetical portfolios are most "efficient" – that is, those that achieve the best combination of return and risk. Allocations achieving a given rate of return at the least amount of risk, or the highest amount of return at a specific level of risk, are known as "efficient" or "optimal" portfolios. We constrain the model to take into account reasonable minimum or maximum allocations to each asset class or groups of asset classes.

Mean Variance Optimization powerfully demonstrates and guides the use of diversification – an unquestioned principle of prudent investing. Only by investing portfolio assets across multiple asset classes – preferably those whose return patterns differ one from another – can the highest returns possible be pursued with the least amount of risk to the total fund. Additionally, MVO focuses portfolio management activities on asset allocation, which is the most important driver of overall portfolio risk and return. This enables better comprehension of diversification benefits resulting from the mixing of different asset classes under different constraints.

MVO suffers from several shortcomings which should be understood prior to interpreting results. Below we discuss the primary criticisms of MVO as well additional tools RVK has developed to enhance the usefulness of traditional MVO analysis and ongoing portfolio monitoring.

1. **Volatility is viewed as the only proxy for risk – In reality, an investment portfolio faces risks beyond volatility.** RVK has included equity beta sensitivity and liquidity metrics to provide additional information regarding potential portfolio risks.
2. **Simplified assumption of risk/return trade-off fails to capture fully how real world investors weight gains versus losses (i.e. do losses matter more than gains?).** Detailed Monte Carlo analysis examining the tradeoff between worst and median outcomes allows for potential outcomes of each portfolio compared to portfolio objectives.
3. **Non-normal attributes of return distributions often ignored (i.e. are the potential for gains and losses symmetrical?).** RVK utilizes a non-normal (fat left-tail) distribution to better simulate adverse portfolios outcomes for equity related asset classes.
4. **Correlation is treated as static instead of dynamic.** During periods of market stress observed correlation has significantly increased among most asset classes. RVK includes a correlation stress test Appendix 3 where the correlation between all asset classes is 1.00.
5. **Models are highly sensitive to small changes to input values (“robustness” lacking).** MVO simply selects the mathematically best solution in terms of risk-

adjusted return and does not account for potential solutions that should the inputs be even incrementally altered. RVK includes CMA stress tests in Appendix 3.

6. **Unconstrained output can yield highly concentrated portfolios.** RVK has utilized appropriate constraints for each asset class to focus our analysis on the section of the efficient frontier that is diversified and implementable.

RVK believes that modern portfolio theory and mean variance optimization together remain relevant tools to aid in the construction of a diversified portfolio customized to a particular risk/return objective.

5.2 Monte Carlo Analysis

MVO is a single time period analysis, whereas the ESSF exists in a world with infinite time periods, so long as the fund continues to exist. A Monte Carlo analysis, or simulations, allows us to project the outcomes of a portfolio into the future using multiple time periods to help us understand the impact of volatility on long-term returns.

Monte Carlo simulations use a random sampling of asset class returns, based on the probability distribution implied by the empirical returns, to create thousands of estimates of portfolio performance. Undergoing a Monte Carlo simulation provides insight into the performance of the asset allocation by examining many randomly sampled return outcomes.

An asset allocation study allows for the construction of an "efficient," or return-maximizing, portfolio of asset class investments at each given level of portfolio volatility. These calculations are based on expected return, risk, and correlations for each asset class. The asset allocation process provides a snapshot of portfolio performance that is, as discussed above, highly dependent on the mean return expectations. A Monte Carlo simulation process "stress tests" these assumptions, and asset allocation recommendations that stem from them, through thousands of independent samplings of portfolio returns, based on the assumptions and indicated asset allocations. Through the Monte Carlo simulation process, we are better able to ascertain the real-world probability of achieving various return targets over time.

Our Monte Carlo simulation model assumes a non-normal (downside log-stable (DLS), or "fat-tailed") distribution of returns for the equity asset class which we believe provides a more realistic representation of historical market experience than the typically used normal or log-normal (LN) distribution. Given this non-normal distribution of random returns derived from our assumption inputs and empirical return dispersion, we can estimate the potential return for a given portfolio over the indicated time period. For the other asset classes included in this study we assume a normal distribution. Historically most fixed income asset classes have exhibited a normal left tail, and some even skew to have a positive right tail. The exception to this is high yield fixed income and bank loans, which tend to behave more like equity in their return distributions. However, high

yield and banks loans represent only 10% of the proposed credit portfolio and therefore we have used a normal distribution for credit in our Monte Carlo modeling.

It is important to note that the output from Monte Carlo analysis refers to geometric (compound) return, rather than the arithmetic return assumptions used in the asset allocation analysis. The geometric return of a portfolio will be less than (or equal to) its arithmetic return over time, because geometric return accounts for the dampening effect of volatility.

5.3 Development of Candidate Portfolios

In order to utilize MVO we must provide the model constraints on the minimum and maximum allowable investment in each asset class. Without such constraints the model will provide solutions that are mathematically optimized but fail to capture real world limitations on the portfolio. For example, in order to control the overall maximum volatility risk of the portfolio we place a limit on the amount of equity we will allow the model to allocate to.

In this section we walk through various efficient frontiers and potential policy portfolios based on prudent constraints for each asset class given the objectives of the ESSF. The below portfolios, selected for full evaluation, are discussed in later sections of this report and have been refined such that they are optimized from an MVO perspective, and have enhanced attributes relative to fiscal copper revenue. This iterative process follows the methodology detailed in the introduction discussion of this section of the report.

- **Portfolio A** – Existing policy allocation with existing policy asset class structures
- **Portfolio B** – Existing policy allocation with recommended asset class structures
- **Portfolio C** – Optimized portfolio utilizing only existing asset classes, uses recommended asset class structures
- **Portfolio D** – Optimized portfolio with the introduction of credit, uses recommended asset class structures
- **Portfolio E** – Optimized portfolio with reduced duration, uses recommended asset class structures
- **Portfolio F** – Optimized portfolio with a 0% expected real return, uses recommended asset class structures

To begin analysis of potential policy portfolio we first look at the existing policy portfolio as constructed now, Portfolio A. Figure 5.2 plots an efficient frontier and Figure 5.3 shows the allocations to each portfolio. Both figures include Portfolio A for analysis. Portfolio A is compared to the same portfolio, but with the recommended asset class structures implemented (Portfolio B). The shift from Portfolio A to B represents only the changes in asset class structure. No changes have been made to the target allocation to each asset class. Finally, we include Portfolio C which optimizes the portfolio utilizing only existing asset classes. The shift from Portfolio B to Portfolio C represents efficiencies by optimizing the ESSF without introducing new asset classes.

Figure 5.2 – Efficient Frontier with Existing ESSF Asset Classes

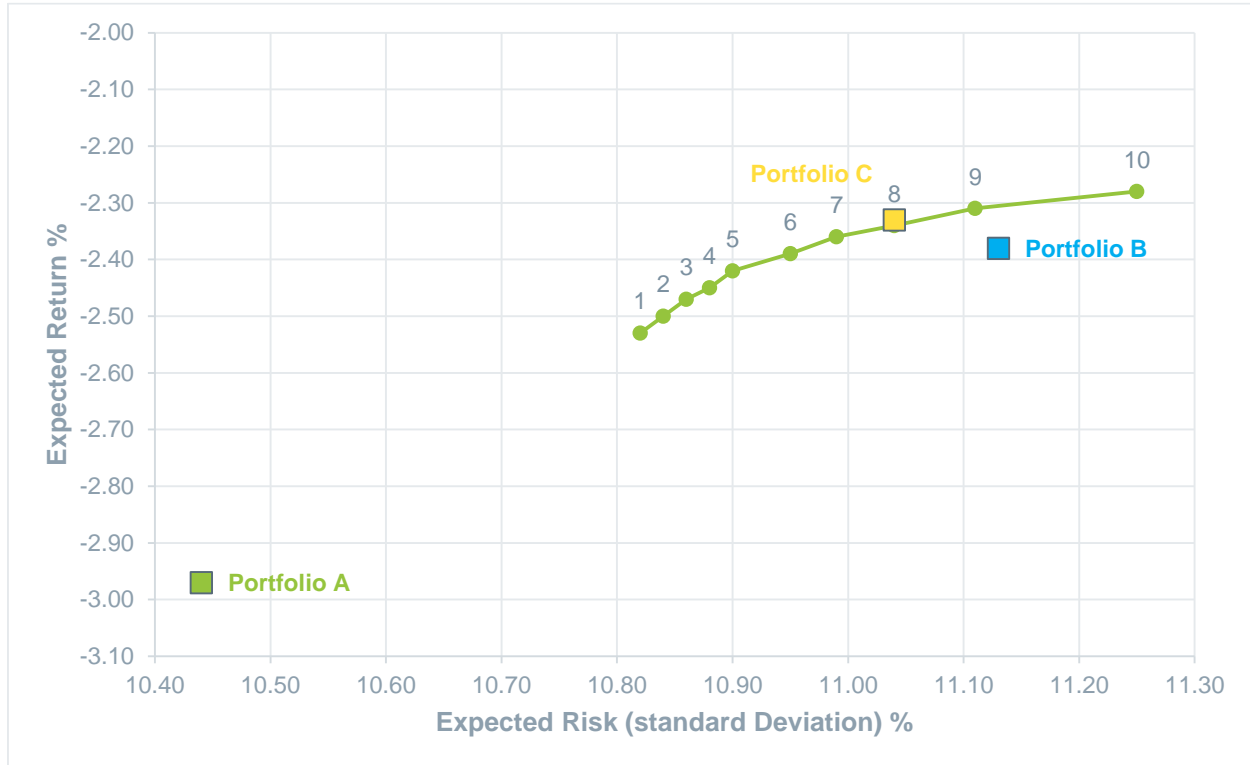


Figure 5.3 – Efficient Portfolios with Existing ESSF Asset Classes

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio A	Portfolio B	Portfolio C
Bank Deposits	10%	25%	25%	25%	25%	25%	24%	20%	16%	12%	10%	12%	15.5%	15.5%	12.0%
Treasury Bills	10%	25%	25%	21%	17%	13%	10%	10%	10%	10%	10%	10%	19.5%	19.5%	10.0%
Sovereign Bonds	30%	70%	35%	39%	43%	47%	51%	55%	59%	63%	66%	70%	56.5%	56.5%	63.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	9%	3%	3.5%	3.5%	10.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Capital Preservation		85%	85%	85%	85%	85%	85%	85%	85%	85%	86%	92%	92%	92%	85%
Alpha		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation		10%	10%	10%	10%	10%	10%	10%	10%	10%	9%	3%	4%	4%	10%
Expected Arithmetic Return		-2.53%	-2.50%	-2.47%	-2.45%	-2.42%	-2.39%	-2.36%	-2.34%	-2.31%	-2.28%	-2.28%	-2.97%	-2.38%	-2.33%
Expected Risk (Standard Deviation)		10.82%	10.84%	10.86%	10.88%	10.90%	10.95%	10.99%	11.04%	11.11%	11.25%	10.44%	11.13%	11.04%	11.04%
Expected Compound Return		-3.13%	-3.10%	-3.07%	-3.05%	-3.02%	-3.00%	-2.97%	-2.96%	-2.94%	-2.92%	-3.53%	-3.01%	-2.95%	
Expected Return (Arithmetic)/Risk Ratio		-0.23	-0.23	-0.23	-0.23	-0.22	-0.22	-0.21	-0.21	-0.21	-0.2	-0.28	-0.21	-0.21	
Expected Global Equity Beta		0.23	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.19	0.22	0.22	
RVK Liquidity Metric (T-Bills = 100)		97	97	96	96	96	96	96	95	95	96	96	96	96	95

If we then allow for the introduction of credit per the discussion in Section 4, the efficient frontier shifts out as shown in Figure 5.4. The blue efficient frontier reflects the set of efficient portfolios that include credit, while the green line represents the same efficient frontier shown above in Figure 5.2 that includes only existing asset classes. The addition of credit allows for further incremental improvements in expected portfolio characteristics. Specifically, we examine two portfolios for the FC’s consideration. Portfolio D reduces the expected risk with a slightly higher level of return compared to Portfolio C. Portfolio E reduces expected volatility further in exchange for a slight

reduction in return. This is accomplished through a reduction in portfolio duration by shifting assets from sovereign bonds to bank deposits.

Figure 5.4 – Efficient Frontier with Credit

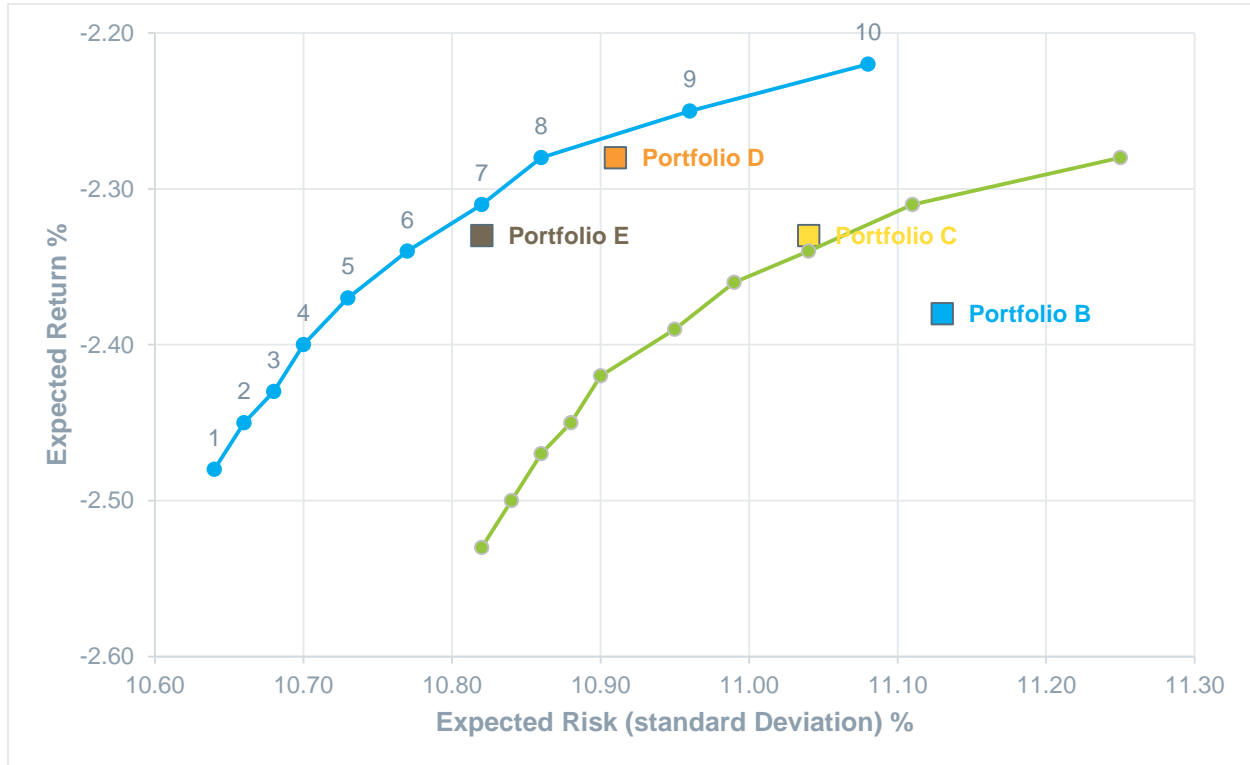


Figure 5.5 – Efficient Portfolios with Credit

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	23%	19%	15%	11%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	21%	17%	13%	10%	10%	10%	10%	10%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds	30%	70%	30%	34%	38%	43%	47%	51%	55%	59%	63%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation		80%	80%	80%	80%	80%	80%	80%	80%	83%	87%	92%	85%	82%	82%	82%
Alpha		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation		10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	4%	10%	8%	8%
Expected Arithmetic Return			-2.48%	-2.45%	-2.43%	-2.40%	-2.37%	-2.34%	-2.31%	-2.28%	-2.25%	-2.22%	-2.38%	-2.33%	-2.28%	-2.33%
Expected Risk (Standard Deviation)			10.64%	10.66%	10.68%	10.70%	10.73%	10.77%	10.82%	10.86%	10.96%	11.08%	11.13%	11.04%	10.91%	10.82%
Expected Compound Return			-3.06%	-3.03%	-3.01%	-2.98%	-2.95%	-2.93%	-2.90%	-2.88%	-2.86%	-2.84%	-3.01%	-2.95%	-2.88%	-2.92%
Expected Return (Arithmetic)/Risk Ratio			-0.23	-0.23	-0.23	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.20	-0.21	-0.21	-0.21	-0.22
Expected Global Equity Beta			0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22
RVK Liquidity Metric (T-Bills = 100)			96	96	96	95	95	95	95	95	95	95	96	95	95	95

Finally, we have included Portfolio F as shown in Figure 5.6 and Figure 5.7 in the analysis that optimizes to a 0% real CLP return. While this portfolio may be unrealistic, it allows for analysis of how much equity would need to be included in the portfolio to significantly change the long-term expected return of the portfolio.

Figure 5.6 – Efficient Frontier with Increased Equity

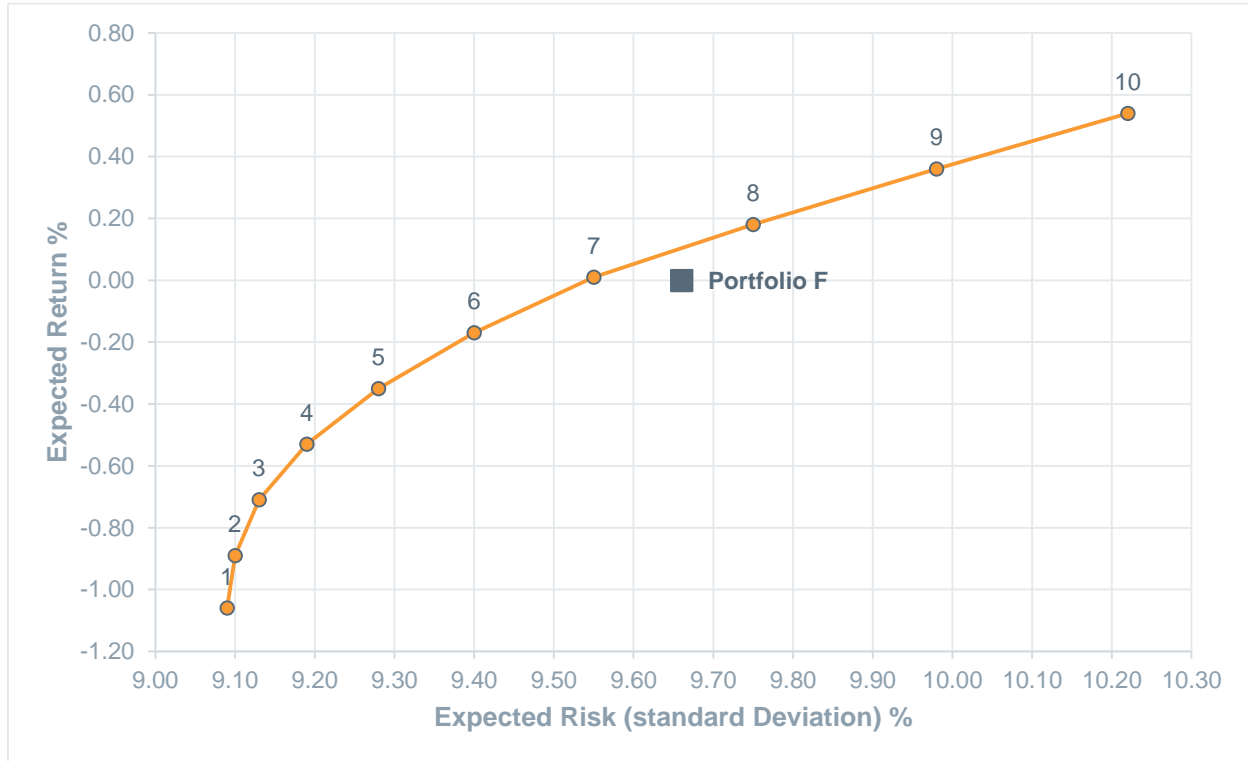


Figure 5.7 – Efficient Portfolios with Increased Equity

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio F
Bank Deposits	10%	25%	19%	16%	13%	10%	10%	10%	10%	10%	10%	10%	10.0%
Treasury Bills	5%	25%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%
Sovereign Bonds	5%	100%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	9.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	7%	5%	3%	3%	3%	3%	5.0%
Credit	0%	40%	40%	40%	40%	40%	40%	40%	38%	35%	31%	27%	31.0%
Global Equity	0%	50%	21%	24%	27%	30%	33%	35%	39%	42%	46%	50%	40.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation			61%	64%	67%	70%	73%	75%	77%	77%	77%	77%	71%
Capital Preservation			29%	26%	23%	20%	20%	20%	20%	20%	20%	20%	24%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			10%	10%	10%	10%	7%	5%	3%	3%	3%	3%	5%
Expected Arithmetic Return			-1.06%	-0.89%	-0.71%	-0.53%	-0.35%	-0.17%	0.01%	0.18%	0.36%	0.54%	0.00%
Expected Risk (Standard Deviation)			9.09%	9.10%	9.13%	9.19%	9.28%	9.40%	9.55%	9.75%	9.98%	10.22%	9.66%
Expected Compound Return			-1.47%	-1.31%	-1.13%	-0.95%	-0.78%	-0.61%	-0.44%	-0.29%	-0.13%	0.02%	-0.46%
Expected Return (Arithmetic)/Risk Ratio			-0.12	-0.10	-0.08	-0.06	-0.04	-0.02	0.00	0.02	0.04	0.05	0.00
Expected Global Equity Beta			0.39	0.42	0.44	0.46	0.48	0.51	0.53	0.56	0.59	0.61	0.53
RVK Liquidity Metric (T-Bills = 100)			89	88	88	88	88	88	88	88	89	89	89

Figure 5.8 summarizes each of the portfolios.

Figure 5.8 – Portfolios

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Bank Deposits	15.5%	15.5%	12.0%	12.0%	20.0%	10.0%
Treasury Bills	19.5%	19.5%	10.0%	10.0%	10.0%	5.0%
Sovereign Bonds	56.5%	56.5%	63.0%	60.0%	52.0%	9.0%
Inflation Linked	3.5%	3.5%	10.0%	8.0%	8.0%	5.0%
Credit	0.0%	0.0%	0.0%	5.0%	5.0%	31.0%
Global Equity	5.0%	5.0%	5.0%	5.0%	5.0%	40.0%
Total	100%	100%	100%	100%	100%	100%

5.4 Efficient Portfolios – Additional Characteristics

Figure 5.9 shows additional characteristics about the portfolios discussed above. There are many tradeoffs between each portfolio. Comparing Portfolio B to Portfolio D we note several improvements. As a reminder, Portfolio B is the existing policy portfolio adjusted for recommended asset class structures. Portfolio D is optimized and includes exposure to credit.

- Portfolio D has lower expected standard deviation compared to Portfolio B and a higher expected return.
- Equity beta is the same between the two portfolios so these risk-adjusted return improvements come without additional equity risk.
- The potential worst-case drawdown is slightly higher for Portfolio D, we do note however that potential drawdown for all portfolios is being primarily driven by currency rather than asset losses. This can be seen more clearly by comparing the results in this section to those Appendix 3 where we utilized USD based assumptions.
- Portfolio D has a higher duration than Portfolio B. As discussed elsewhere in this report RVK recommends reducing the duration of the sovereign bond portfolio. However, Portfolio D has a higher overall duration for three reasons:
 - First, a lower allocation to bank deposits and treasury bills naturally increase overall duration
 - Second, an increase in allocation to sovereign bonds also increases duration.
 - Third, an increased allocation to inflation linked bonds also contributes to an increase in overall portfolio duration as these securities tend to be highly correlated to interest rates.
 - RVK’s recommendation to reduce the duration of the sovereign bond portfolio was, in part, to offset the increased allocation to sovereign bonds. Given sovereign bonds have the highest duration of asset classes included in this study, by reducing the duration of the sovereign bond portfolio, we limit the duration increase of the total ESSF of increasing the allocation to sovereign bonds. If the duration of the sovereign bonds portfolio was not reduced the total portfolio duration exposure would be

even higher. By reducing cash exposure total portfolio duration must increase.

- Portfolio D materially increases expected yield. This helps protect against the increase in duration.

Figure 5.9 – Portfolio Characteristics

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Expected Arithmetic Return	-2.97%	-2.38%	-2.33%	-2.28%	-2.33%	0.00%
Expected Compound Return	-3.53%	-3.01%	-2.95%	-2.88%	-2.92%	-0.46%
Expected Risk (Standard Deviation)	10.44%	11.13%	11.04%	10.91%	10.82%	9.66%
Expected Global Equity Beta	19.00%	22.00%	22.00%	22.00%	22.00%	53.00%
99% VaR	7.80%	8.50%	8.35%	8.24%	8.19%	7.62%
99% C-VaR	8.38%	8.77%	8.59%	8.45%	8.40%	9.56%
Expected 1 Year 95th Percentile Drawdown	-13.7%	-13.7%	-14.4%	-13.8%	-12.8%	-10.6%
Expected 1 Year 99th Percentile Drawdown	-17.9%	-17.5%	-18.8%	-17.6%	-16.3%	-17.0%
Fixed Income Duration (Years)	4.8	3.9	5.1	5.0	4.5	4.5
Portfolio Yield	0.13%	0.30%	0.45%	0.49%	0.44%	1.34%

Currency Exposure

Figure 5.10 shows the resulting currency exposure of each portfolio. Comparing Portfolio A and Portfolio B, we can see a majority of currency shifts are a result of asset class structure changes, not asset allocation changes. The largest change is the introduction of the Pound and Yuan and a material reduction in the Swiss Franc (included in “Other Developed”).

Figure 5.10 – Portfolio Currency Exposure

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
United States Dollar	44%	38%	36%	39%	40%	61%
Euro	26%	27%	27%	26%	26%	15%
Japanese Yen	21%	20%	18%	18%	18%	8%
Pounds Sterling	0%	4%	6%	6%	5%	4%
Other Developed	8%	3%	4%	4%	4%	5%
Chinese Yuan	0%	4%	4%	4%	3%	3%
Other Emerging	0%	4%	4%	4%	3%	4%

5.5 Monte Carlo Return Analysis

Figures 5.11 through 5.14 show various projected return information for each of the portfolios for a one year and 10 year period. The 1 year period represents the outcomes that could be expected in any given year, while the 10 year period is useful for gauging compound expectations over a long time period. RVK’s observations include the following:

- The move from Portfolio A to Portfolio B improves the median outcomes for both time periods shown, while the one year loss potential is roughly the same for both portfolios. Additionally, the long-term drawdown for Portfolio B is superior to that of Portfolio A. This supports the move in asset class structures. The probability of achieving various return levels is also higher for Portfolio B compared to Portfolio A.
- Next we compare Portfolio B to Portfolio C, which is optimized from an MVO perspective using existing asset classes with updated asset class structures. The Monte Carlo distribution of returns shows similar median return expectations between the two portfolios. The tradeoff is between better upside potential for Portfolio C versus better downside outcomes for Portfolio B. Based solely on the Monte Carlo analysis, we do not see a significant advantage between these two portfolios. Again, the probability of achieving given returns are improved for Portfolio C when compared to Portfolio B.
- Portfolio D, with its allocation to credit, exhibits an improvement over Portfolio C in both downside and median outcomes, albeit with slightly lower best case results. The probability of achieving given returns is nearly identical for these two portfolios.
- Portfolio E, with its reduced overall portfolio level duration, shows results similar to Portfolio D although with shorter tails on both the up and down side of the return distributions. Portfolio E also exhibits reduced probabilities of achieving given return levels compared to Portfolio D.
- Portfolio F does appear to have the most attractive results in the Monte Carlo analysis. However, the level of equity and credit exposure in the portfolio is outside of realistic implementation considerations for the ESSF. As previously discussed, it is only included in the analysis to answer the question of what would be needed to target a flat real return.
- Figure 5.13 and Figure 5.14 show the cumulative annual returns for each period for the 5th and median outcomes. These figures confirm the above thoughts.

Figure 5.11 – Monte Carlo Return Distribution (Real CLP)

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
1 Year						
1st Percentile	-17.9%	-17.5%	-18.8%	-17.6%	-16.3%	-17.0%
5th Percentile	-13.7%	-13.7%	-14.4%	-13.8%	-12.8%	-10.6%
25th Percentile	-8.0%	-7.4%	-7.7%	-7.5%	-6.9%	-3.9%
50th Percentile	-3.4%	-2.7%	-2.7%	-2.6%	-2.6%	0.2%
75th Percentile	1.6%	2.5%	2.8%	2.7%	2.0%	4.9%
95th Percentile	9.3%	9.9%	10.7%	10.2%	9.4%	11.8%
99th Percentile	14.6%	16.3%	17.1%	15.7%	13.8%	15.4%
10 Years						
1st Percentile	-8.1%	-8.0%	-8.2%	-7.7%	-7.3%	-6.2%
5th Percentile	-6.8%	-6.4%	-6.6%	-6.4%	-6.0%	-4.1%
25th Percentile	-4.7%	-4.3%	-4.3%	-4.1%	-4.0%	-1.6%
50th Percentile	-3.2%	-2.7%	-2.7%	-2.6%	-2.6%	0.0%
75th Percentile	-1.7%	-1.1%	-1.0%	-0.9%	-1.1%	1.5%
95th Percentile	0.6%	1.3%	1.4%	1.3%	1.0%	3.6%
99th Percentile	2.2%	2.8%	3.2%	3.1%	2.6%	5.2%

Figure 5.12 – Probability of Achieving Given Return (Real CLP)

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
1 Year						
Target -1.0%	37%	41%	41%	42%	41%	58%
Target 0%	32%	36%	37%	37%	36%	51%
Target 0.5%	29%	34%	35%	34%	33%	49%
Target 1%	27%	32%	33%	32%	30%	45%
10 Years						
Target -1.0%	9%	13%	14%	14%	12%	51%
Target 0%	8%	12%	13%	13%	11%	50%
Target 0.5%	8%	12%	13%	13%	10%	49%
Target 1%	7%	11%	12%	12%	10%	48%

Figure 5.13 – 5th Percentile Cumulative Returns (Real CLP)

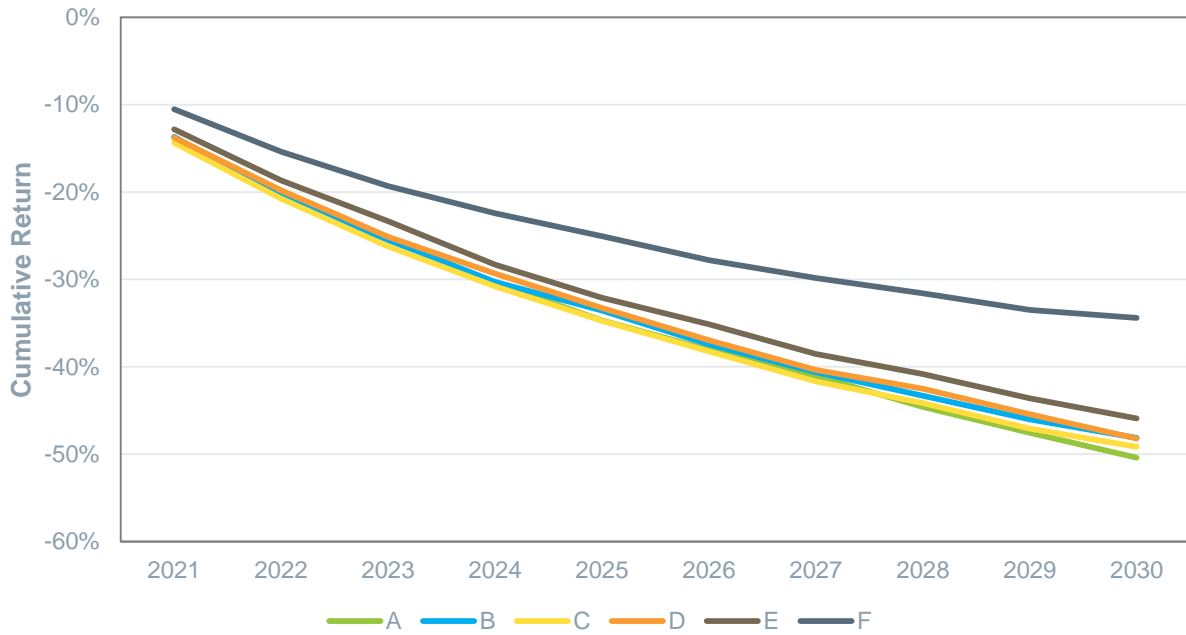
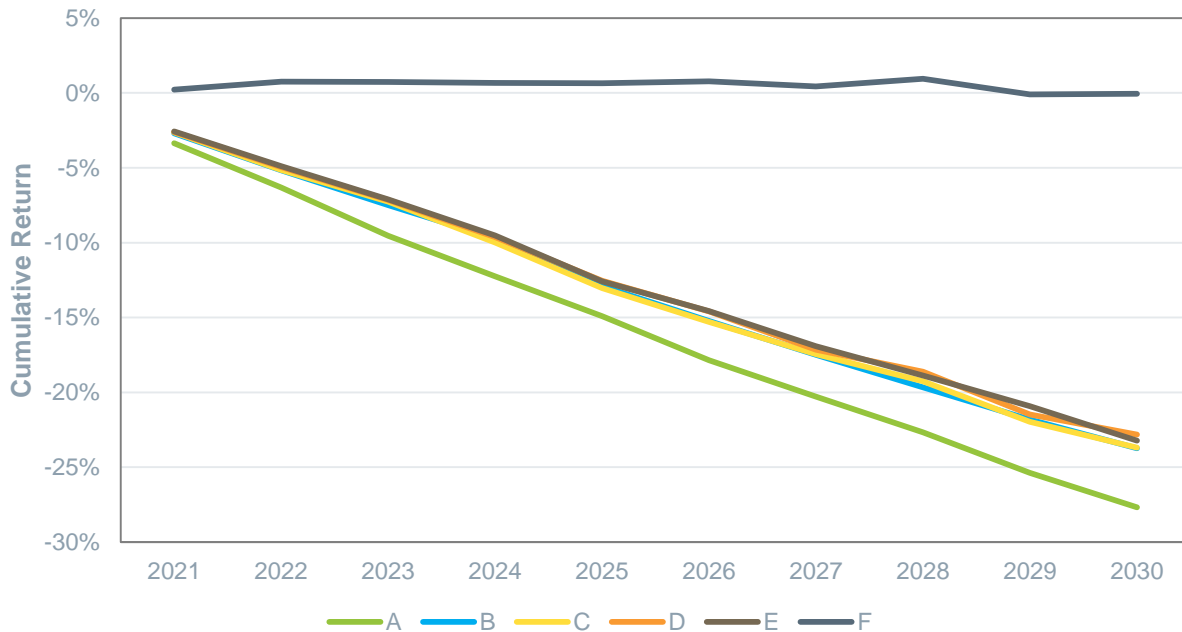


Figure 5.14 – Median Cumulative Returns (Real CLP)



5.6 Efficient Portfolios vs. Copper Prices

In this section we analyze the portfolio’s historical relationship to both copper prices as well as copper revenue. In Section 6 we analyze projections of the ESSF’s market value compared to copper prices and revenue.

Figure 5.15 – Copper Sensitivities – Asset Classes

	Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities
Correlation to Copper	-0.11	-0.11	-0.14	0.04	0.00	0.40

We have examined the relationship of each portfolio to the price of copper using both correlation and beta. The analysis looks at both historical copper prices, as well as copper price expectations as estimated by the Advisory Copper Price Committee. As shown in Figure 5.16, correlations to historical copper prices do not materially differ between the portfolios analyzed. This is primarily due to the fact that bank deposits, treasury bills, and sovereign bonds have all exhibited very similar correlations to copper prices over the last decade plus. Figure 5.15 shows the correlation of each asset class to copper prices and copper revenue since January 2008. As shown, the correlation of copper prices to both bank deposits and treasury bills has been -0.11 while the correlation to sovereign bonds has been -0.14. With the exception of Portfolio F, these three asset classes make up at least 82% of the portfolio allocations. This makes shifting the correlation of the ESSF to copper prices difficult. In Appendix 3 we examine alternate sovereign bond portfolio structures, and demonstrate that shifts to this structure still do not allow for meaningful changes in copper price correlations.

This is only exacerbated when we combine the above with the fact that inflation linked bonds and credit have correlations of 0.04 and 0.00, respectively, when compared to

copper prices. The only asset class that materially differs is equities, with a correlation of 0.40. Increasing the allocation to equities does not allow for an overall reduction of portfolio level correlation to copper prices as its correlation is positive.

Figure 5.16 – Copper Sensitivities – Portfolios

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Historical Correlation to Price of Copper	-0.10	-0.09	-0.09	-0.08	-0.08	0.20
Historical Beta to Price of Copper	-0.05	-0.05	-0.05	-0.04	-0.04	0.10

5.7 Summary

Summarizing the above analysis, several observations stand out to us as we examine the output of the MVO model through the efficient Frontier and Monte Carlo outcomes.

- Simply by enhancing asset class structure, the risk/return tradeoff can be improved.
- Expected risk can be reduced without sacrificing expected return. In fact, return may also be able to be slightly enhanced in the process.
- The pursuit of a significantly higher returning portfolio falls outside of the current objectives and constraints of the ESSF given the relatively flat capital markets line and associated efficient frontier.
- Worst-case outcomes, particularly over the long-term, can be improved via risk reduction.
- It is difficult to change overall correlations to the price of copper without a significant change in implementation.

In Section 6 we analyze future projections of the ESSF under each of the portfolios developed in this section.

6.0 Projections

In this section we use a Monte Carlo analysis to project the future outcomes of each of the portfolios as developed in Section 5. In addition to projecting the market value of each portfolio, we also project fiscal copper revenue as a liability proxy. This allows us to analyze how well each portfolio responds to changes in copper revenue in order to meet the ESSF's objective of covering cyclical reductions in fiscal revenues. Using the copper revenue projections as a baseline, we then add simulated withdrawals from the ESSF in the form of stimulus payments to support decreased fiscal revenue, further allowing us to assess each portfolio's ability to meet the objective of the ESSF.

6.1 Copper Revenue Modeling

In order to test the potential portfolios against the objective of offsetting fiscal revenue from reduced copper prices, we have developed a model to simulate copper prices in the context of the Monte Carlo analysis. As discussed in Section 4, we have developed a set of capital markets assumptions related to the behavior of each investment asset class. We add to this model and assumption set to simulate future fiscal revenue derived from copper based on data provided by the MoF. Fiscal revenue is assumed to be the product of copper production, copper price, and the percentage of overall revenue the State receives. Figure 6.1 shows the average historical share of overall copper revenue received by Chile by year. The 10 year average has been 11.8%, but falling in recent years. Over the last 5 years it has averaged 7.7% and was 7.5% in 2020. For the purposes of this study we have assumed fiscal revenue equal 7.5% of copper revenue, reflecting the more recent trends.

Figure 6.1 – Fiscal Revenue as Percent of Copper Revenue

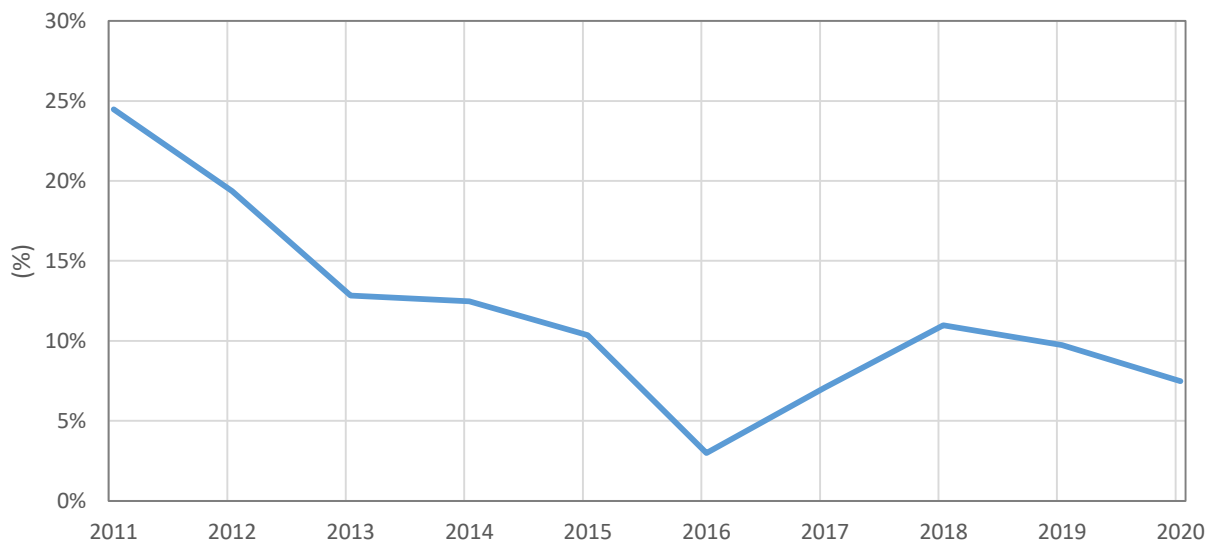
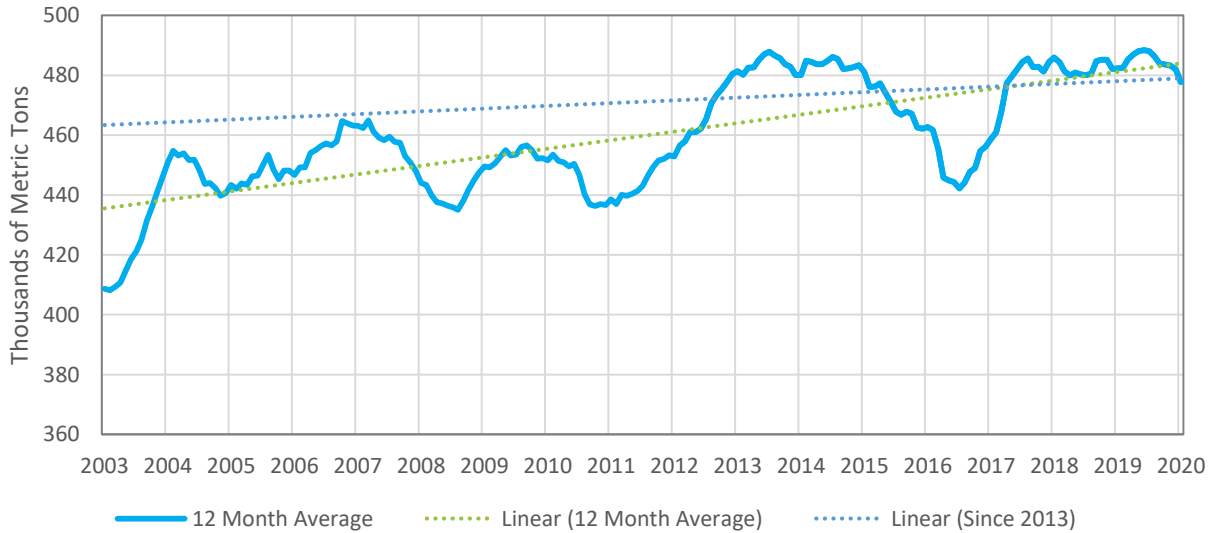


Figure 6.2 shows the average trailing 12 month copper production in Chile since 2003. Copper production has averaged 459,000 metric tons on a monthly basis over this 18

year period. This represents a 1.4% annual growth rate, although recent production has been relatively flat, with a -0.2% annualized growth rate since 2013.

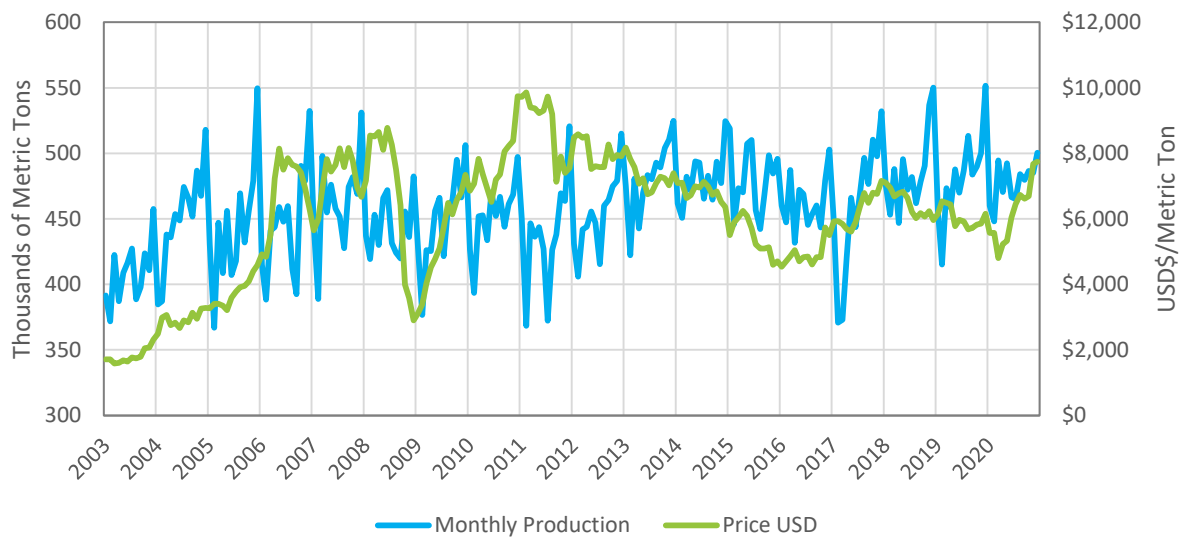
Figure 6.2 – Historical Chile Monthly Copper Production – Rolling 12 Month Average



Source: MoF. (2021)

Figure 6.3 shows monthly copper production and prices. Historically the price of copper has had little correlation with production levels, as reflected in the 0.38 correlation since 2003. In fact, over the last 10 years the correlation has actually been lower at 0.06. While not shown, the lack of relationship holds even when we examine lags in the production variable, relative to prices, in order to account for delayed changes to production levels that may result from price variability. Based on our analysis we assume a correlation between price and production equal to the long-term observation of 0.38. While this differs from recent trends, we believe that a higher correlation is more intuitive. As price increases, economic theory would suggest production is also increased. We assume that production continues to increase at 1.4% per year. This is consistent with both historical observations of copper production in Chile, as well as with the levels of future global growth rates discussed in Section 5.

Figure 6.3 – Historical Monthly Chile Copper Production and Price



Source: MoF and FactSet. (2021)

Monthly copper production is highly cyclical. Therefore to examine the volatility of long-term changes in production levels we analyze annual production levels. Using annual data starting in 2003, the annual change in copper production has had a standard deviation of 3.9%. We use this as our estimate for future production volatility.

Future real copper prices are forecasted by the Advisory Copper Price Committee (“Committee”). The most recent projections are shown in Figure 6.4. As of December 31, 2020, the price of copper (US Cents/Pound) was 351.1. All 14 members of the Committee project the 2021 year end price to be below this price, with the highest observation falling just short of the December 31, 2020 price. In aggregate, the Committee expects prices to fall 18.6% in 2021, with a slight rebound in 2022. After 2022 the Committee projects lower prices in general, ranging between 285 and 295 on average over the next 10 years. At the end of 2030 the average price, excluding the low and high forecast, averages 289.0. This represents a 17.7% loss from December 31, 2020 levels over the 10 year projection period, or 1.93% loss on a compound annualized basis. We then convert this from USD to CLP (see Section 4 for further discussion) which results in a -2.75% annual compound return assumption. Finally, we adjust for the difference between US inflation and inflation in Chile which requires a reduction of 1.00%, resulting in a return of -3.75%. This must then be converted to an arithmetic return assumption for input into our model. Based on the volatility assumption of 23.00% (see below) this equates to an annual arithmetic return of -1.81%.¹

¹ “Geometric Return and Portfolio Analysis”, Brian McCulloch. New Zealand Treasury working paper December 2003.

Figure 6.4 – Real Copper Price Projections (USD Cents/Metric Ton)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Low Projection	265.0	263.3	257.4	219.5	219.1	258.9	235.6	238.9	241.9	244.6
High Projection	350.0	340.0	350.0	350.0	330.0	320.0	310.0	310.0	310.0	330.0
Average Projected Price - ex Low and High	285.7	296.6	295.1	290.7	288.8	285.3	285.4	287.8	287.8	289.0
Average Projected Price - All	288.9	297.3	296.3	289.9	286.8	285.9	283.6	285.9	286.1	288.7
Projected Annual Return	-18.6%	3.8%	-0.5%	-1.5%	-0.7%	-1.2%	0.1%	0.8%	0.0%	0.4%

Projected Cumulative Return

-17.7%

Projected Annualized Return

-1.9%

Source: MoF and Advisory Copper Price Committee. (2021)

For our volatility assumption we analyze the actual historical price volatility of copper. We follow a methodology similar to the process we outlined in Section 4 for asset class volatility assumptions. Figure 6.5 shows observed volatility since January 2008. This analysis leads us to an assumption of 23.00% for the volatility of the price of copper.

Figure 6.5 – Historical Copper Price Volatility (Real CLP)

	Copper
Implied	22.51
Monthly	22.35
Annual	35.47
Average	26.78
RVK Assumption	23.00

Source: FactSet. (2021)

We take the above assumptions for copper production levels and prices to project fiscal revenue derived from copper in our model. As a reminder, fiscal copper revenue is equal to the product of production, price, and the percentage which the State receives which we have assumed to be 7.5%. Figure 6.6 summarizes the results of copper price, production and revenue projections which are then used in the following analysis of each potential portfolio.

Figure 6.6 – Copper Price Projections – Year 10 (Real CLP per Pound)

	CLP/Pound	Metric Tons	CLP (billions)
25th Percentile	\$ 1,039.94	6,017,748	\$ 1,131.75
Median	\$ 1,712.91	6,536,021	\$ 1,876.34
75th Percentile	\$ 2,723.13	7,117,930	\$ 3,006.20

6.2 Cash Flows

In addition to simply projecting assets forward based on the current portfolio value of the ESSF we have also included various scenarios of future withdrawals from the portfolio. This allows us to better assess a given portfolio's ability to serve the liabilities.

Contributions

We do not include any scenario where additional assets are deposited into the ESSF. As shown in Figure 6.7, no contributions have been made to ESSF since 2013 and

none are projected by the MoF through 2024. Given the strong possibility of additional required stimulus and decreased fiscal revenue as a result of the global recession caused by COVID-19, we believe it is not prudent to assume future contributions.

Withdrawals

There are three types of withdrawals from the ESSF including: PRF transfers, debt amortization, and stimulus. We model each separately to better estimate future calls on ESSF assets.

PRF transfers were halted for 2020 and 2021, given the need for large stimulus, but are projected to resume in 2022. Projections show a \$624 million USD PRF transfer in 2022 growing at just over 9% per year for the following two years at \$682 million USD in 2023 and \$746 million USD in 2024.

Prior to 2020, debt amortization only occurred once in the 14 years history of the ESSF, with a \$441 million USD payment in 2009. 2020 saw a payment of \$1,105 million USD and the MoF projects payments of \$447 and \$428 million USD in 2021 and 2022 respectively, with no further payments projected after 2022. We have included the 2021 and 2022 amortization payments as given in our analysis, but have assumed no further payments in any projections.

Stimulus is the most volatile and unpredictable component of future withdrawals from the ESSF. Stimulus is tied to both the economic cycle, as well as the fiscal revenues derived from copper. \$5,303 million USD of stimulus has been committed in 2021 and included in all our projections.

**Figure 6.7 – Historical ESSF Cash Flows
(Millions USD)**

Year	Withdrawals				Contributions	Market Value
	PRF Transfers	Debt Amortization	Stimulus	Total		
2007	\$ -	\$ -	\$ -	\$ -	\$ 13,100	\$ 14,033
2008	\$ -	\$ -	\$ -	\$ -	\$ 5,000	\$ 20,211
2009	\$ 837	\$ 441	\$ 8,000	\$ 9,278	\$ -	\$ 11,285
2010	\$ 150	\$ -	\$ -	\$ 150	\$ 1,362	\$ 12,720
2011	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 13,157
2012	\$ -	\$ -	\$ -	\$ -	\$ 1,700	\$ 14,998
2013	\$ -	\$ -	\$ -	\$ -	\$ 603	\$ 15,419
2014	\$ 499	\$ -	\$ -	\$ 499	\$ -	\$ 14,689
2015	\$ 464	\$ -	\$ -	\$ 464	\$ -	\$ 13,966
2016	\$ 462	\$ -	\$ -	\$ 462	\$ -	\$ 13,772
2017	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 14,739
2018	\$ 542	\$ -	\$ -	\$ 542	\$ -	\$ 14,134
2019	\$ 564	\$ -	\$ 2,000	\$ 2,564	\$ -	\$ 12,233
2020	\$ -	\$ 1,105	\$ 2,985	\$ 4,090	\$ -	\$ 8,955
2021	\$ -	\$ 447	\$ 5,750	\$ 6,197	\$ -	\$ 2,541
2022	\$ 624	\$ 428	\$ -	\$ 1,052	\$ -	
2023	\$ 682	\$ -	\$ -	\$ 682	\$ -	
2024	\$ 746	\$ -	\$ -	\$ 746	\$ -	

Market value for 2021 as of June 30, 2021 and adjusted for expected cash flows that have not occurred as of June 30, 2021. All data and projections provided by the MoF.

Source: MoF. (2021)

6.3 Projection Scenarios

In order to test the robustness of various potential policy portfolios we have modeled the future under two sets of forecasting methodologies. The first is based on deterministic analysis, assuming each portfolio generates its expected annual return each year, and copper revenue grows at the implied rate based on the baseline copper price projection and production levels. This allows us to analyze outcomes in a simple framework with a single outcome for each portfolio, resulting for easy comparison between portfolios.

The second is based on stochastic analysis, using Monte Carlo simulation to test the range of potential outcomes for each portfolio simulating both portfolios returns going forward, as well as copper revenue based on the assumptions described in this report. This analysis is more complex but also more realistic as it accounts for volatility in both asset markets as well as copper revenue.

For each analysis, deterministic and stochastic, we analyze four cash flow scenarios. The details of each scenario are shown in Figure 6.8. All scenarios include projected 2021 debt amortization payments, but no further debt amortization payments are included in any of the scenarios.

1. Scenario 1 assumes no PRF transfers beyond 2021 and no debt service beyond 2022.
2. Scenario 2 incorporates the projected PRF transfers as discussed above. It assumes PRF transfers remain at \$746 million USD beyond 2024, the year in the projection data provided.
3. Scenario 3 cuts the PRF transfers in scenario 2 by 50%.
4. Finally, scenario 4 builds on scenario 2 by adding stimulus withdrawals. These withdrawals are based on projected copper revenue and follow a simple rule. If copper revenue falls between 25% and 50% in a given year a withdrawal of one-third of the market value of the portfolio is triggered. If copper revenue falls by more than 50% a withdrawal of 50% is triggered. This scenario is not applicable to the deterministic analysis.

**Figure 6.8 – Cash Flow Scenarios
(Millions USD)**

Scenario	Description	PRF Transfers	Debt Service	Stimulus Withdrawals
Scenario 1	Base Case	None	<ul style="list-style-type: none"> • \$447 million in 2021 • None thereafter 	<ul style="list-style-type: none"> • \$5,750 million in 2021
Scenario 2	Base Case + Projected PRF Transfers	<ul style="list-style-type: none"> • 2021 = None • 2022 = \$624 million • 2023 = \$682 million • 2024 + = \$746 million 		
Scenario 3	Lower PRF Transfers	50% of Scenario 2		
Scenario 4	Stimulus Withdrawals	Same as Scenario 2		Same as Above + Additional Withdrawals Based on Copper Revenue

6.4 Projection Results

For each portfolio we analyze several metrics to assess how well it meets the objectives of the ESSF. The projected market value of the portfolio serves as the basis for projections and represents the ability to make stimulus withdrawals on an absolute basis. We compare this value to the projected copper revenue and examine the correlation between copper revenue and market value to determine each portfolio's ability to offset declines in fiscal revenue from copper. The lower the correlation the better the likely future outcomes. Given the large calls on the ESSF over the last several years it is increasingly likely, without significant contributions, that assets are completely depleted at some point in the future. We model both the probability of asset depletion as well as timing of when it may occur for cash flow scenario and portfolio.

All values shown in the following figures are in real Chilean Pesos. As a reminder, the value as of December 31, 2020 was \$6.5 trillion (CLP).

Figure 6.9 shows the projected market values in 10 years of the ESSF for each portfolio and each cash flow scenario using the deterministic model. Negative values imply the portfolio has fully depleted assets. Figure 6.10 indicates the year in which the ESSF depletes assets.

Under scenario 1, where there are no cash flows beyond 2021, the ESSF remains solvent for at least the next 20 years although at a fraction of current assets. Not surprisingly, the higher the expected return of the portfolio, the higher the projected market value in the future. Examining scenario 2, all portfolios show asset depletion in 2025.

**Figure 6.9 – Deterministic Market Values – 10 Years
(Billions CLP)**

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Scenario 1	\$1,266	\$1,353	\$1,361	\$1,369	\$1,361	\$1,764
Scenario 2	(\$2,871)	(\$2,877)	(\$2,878)	(\$2,878)	(\$2,878)	(\$2,874)
Scenario 3	(\$802)	(\$762)	(\$758)	(\$755)	(\$758)	(\$555)

Figure 6.10 – Asset Depletion – 20 Year Forecast

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Scenario 1	--	--	--	--	--	--
Scenario 2	2025	2025	2025	2025	2025	2025
Scenario 3	2027	2028	2028	2028	2028	2028

The next series of tables (Figures 6.11 through Figure 6.14) show the results of the stochastic modeling 10 years from the start date of the analysis, December 31, 2030.

The tables show the result for each of the six portfolios, with each table representing one of the four cash flow scenarios. Each table includes the range of projected market values, when asset depletion occurs, and the correlation between projected copper revenue and the end market value of the portfolio.

Assuming any level of significant cash outflows subjects the ESSF to a significant probability of asset depletion over the next 10 years or so. Only scenario 1, where there are no cash flows assumed, does the market value remain positive. However, even under this scenario, projected median markets values are well below current levels. Even under the most optimistic scenarios, the market value only remains near current levels. This is true regardless of asset allocation. At a high level, only two of the six portfolios suggest outcomes materially different than the others. The shift from the existing asset class structures to the proposed structures (as shown via the difference between Portfolio A and Portfolios B), results in improved projected market values across all cash flow scenarios. Optimizing the portfolio utilizing the only existing asset classes (Portfolio C) but with the proposed asset class structures marginally improves outcomes compared to the existing asset allocation (Portfolio B). Additional marginal improves are shown when credit is added to the portfolio via Portfolio D.

Portfolio E (with decreased duration) shows lower median outcomes compared to Portfolio D but slightly improved downside protection. However, both Portfolio D and Portfolio E have nearly identical estimated depletion dates in cash flow scenarios 2, 3, and 4.

Portfolio F does suggest higher projected market values; however, we believe the level of equity required to reach these outcomes is higher than appropriate for the ESSF. The results are highly dependent on the negative correlation between equity prices and the Chilean Peso. If this relationship failed to hold during an equity market downturn it would leave the ESSF with depressed assets at the exact time assets would likely be called upon to provide economic stimulus.

When looking at correlation to copper revenue, there is minimal differences between all portfolios. The change in portfolio composition being considered in the portfolios analyzed does not leave room for material changes. This is analyzed further in Appendix 3 where portfolios with different currency exposure are examined however, the results still do not lead to a material change in the ability of the portfolios to hedge copper revenues. To change this metric in a meaningful way would require changes in portfolio composition outside the range of what we deem appropriate, given the risk and volatility tolerance stated for the ESSF.

The correlation to copper revenue does change materially based on cash flow assumptions. Notably, in cash flow scenario 4 the correlations are significantly higher than the other scenarios. This result is not surprising given that in this scenario cash outflows are correlated with the price of copper. The lower the price of copper, the higher the expected cash outflows are, thus resulting in lower projected markets values.

These results suggest updating several asset class structures is prudent. Slightly modifying asset allocation can also improve results. However, within the constraints of the ESSF there is no reasonable approach to alter the outcomes of the portfolio. We discuss overall outcomes and conclusions in Section 2.

Figure 6.11 – Stochastic Analysis Scenario 1

Scenario 1		Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
12/31/2030 Projected Market Value (CLP, billions)	5th Percentile	\$773	\$819	\$803	\$829	\$873	\$1,097
	25th Percentile	\$1,032	\$1,085	\$1,079	\$1,101	\$1,115	\$1,482
	Median	\$1,228	\$1,304	\$1,308	\$1,321	\$1,316	\$1,758
	75th Percentile	\$1,458	\$1,573	\$1,591	\$1,599	\$1,574	\$2,075
	95th Percentile	\$1,893	\$2,039	\$2,080	\$2,054	\$1,965	\$2,626
Earliest Asset Depletion		--	--	--	--	--	--
Median Asset Depletion		--	--	--	--	--	--
Correlation with Copper Revenue		-0.01	-0.02	-0.03	-0.03	-0.03	-0.01

Figure 6.12 – Stochastic Analysis Scenario 2

Scenario 2		Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
12/31/2030 Projected Market Value (CLP, billions)	5th Percentile	(\$3,421)	(\$3,448)	(\$3,491)	(\$3,461)	(\$3,416)	(\$3,500)
	25th Percentile	(\$3,078)	(\$3,104)	(\$3,124)	(\$3,103)	(\$3,084)	(\$3,116)
	Median	(\$2,850)	(\$2,855)	(\$2,853)	(\$2,856)	(\$2,860)	(\$2,858)
	75th Percentile	(\$2,645)	(\$2,626)	(\$2,608)	(\$2,627)	(\$2,644)	(\$2,591)
	95th Percentile	(\$2,341)	(\$2,298)	(\$2,268)	(\$2,289)	(\$2,342)	(\$2,233)
Earliest Asset Depletion		2023	2023	2023	2023	2023	2023
Median Asset Depletion		2025	2025	2025	2025	2025	2025
Correlation with Copper Revenue		-0.02	-0.01	-0.01	-0.01	-0.01	0.03

Figure 6.13 – Stochastic Analysis Scenario 3

Scenario 3		Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
12/31/2030 Projected Market Value (CLP, billions)	5th Percentile	(\$1,160)	(\$1,152)	(\$1,176)	(\$1,154)	(\$1,124)	(\$1,054)
	25th Percentile	(\$967)	(\$948)	(\$962)	(\$948)	(\$931)	(\$765)
	Median	(\$817)	(\$789)	(\$791)	(\$786)	(\$784)	(\$551)
	75th Percentile	(\$657)	(\$589)	(\$577)	(\$579)	(\$596)	(\$319)
	95th Percentile	(\$352)	(\$259)	(\$218)	(\$233)	(\$275)	\$58
Earliest Asset Depletion		2025	2025	2024	2025	2025	2025
Median Asset Depletion		2027	2027	2027	2027	2027	2027
Correlation with Copper Revenue		-0.02	-0.02	-0.03	-0.03	-0.03	0.01

Figure 6.14 – Stochastic Analysis Scenario 4

Scenario 4		Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
12/31/2030 Projected Market Value (CLP, billions)	5th Percentile	(\$3,635)	(\$3,765)	(\$3,765)	(\$3,755)	(\$3,726)	(\$3,948)
	25th Percentile	(\$3,092)	(\$3,124)	(\$3,132)	(\$3,124)	(\$3,106)	(\$3,168)
	Median	(\$2,746)	(\$2,758)	(\$2,763)	(\$2,770)	(\$2,770)	(\$2,759)
	75th Percentile	(\$2,409)	(\$2,384)	(\$2,375)	(\$2,385)	(\$2,404)	(\$2,372)
	95th Percentile	(\$1,884)	(\$1,857)	(\$1,851)	(\$1,862)	(\$1,880)	(\$1,824)
Earliest Asset Depletion		2021	2021	2021	2021	2021	2021
Median Asset Depletion		2024	2024	2024	2024	2024	2024
Correlation with Copper Revenue		-0.11	-0.08	-0.08	-0.08	-0.08	-0.03

7.0 Portfolio Back-testing

In this section we back-test the portfolios using historical index returns. The analysis is done in real CLP terms. All calculations are based on a monthly periodicity, and we analyze the period January 2010 to December 2020. While back-testing can be helpful to understand how various portfolios would have performed, it is important to factor in the market environment going forward may be materially different than that of the past. As discussed in Section 4, RVK believes we are entering a period of significantly lower returns than we have seen over the past 10 years. We believe the analysis in this section provides further support for Portfolio D.

Figure 7.1 shows the trailing and calendar year returns for each portfolio. Focusing the analysis on Portfolio A (existing policy structure) and Portfolio D (RVK’s recommended portfolio) we see that over the last 10 years Portfolio A has outperformed on an annualized basis by 20 basis points. This is largely driven by the higher duration of the sovereign bonds portfolio in Portfolio A, which benefited from an extended period of falling rates. Looking at more recent periods - 1, 3, and 5 years - we see that Portfolio D outperforms. While rates fell for part of this period, they increased in 2020 making Portfolio D more attractive.

Figure 7.1 – Trailing and Calendar Returns

	1 Year	3 Years	5 Years	7 Years	10 Years	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011
Portfolio A	-2.30%	5.70%	0.70%	3.70%	3.60%	-2.30%	10.10%	9.70%	-6.00%	-6.60%	11.50%	11.40%	5.10%	-7.60%	14.30%
Portfolio B	-0.60%	5.90%	1.30%	3.10%	2.80%	-0.60%	10.00%	8.70%	-3.30%	-7.30%	9.10%	6.20%	5.10%	-8.30%	11.10%
Portfolio C	0.20%	6.30%	1.60%	3.40%	3.30%	0.20%	10.70%	8.30%	-2.90%	-7.00%	8.90%	7.20%	5.10%	-7.40%	12.10%
Portfolio D	0.10%	6.40%	1.70%	3.50%	3.40%	0.10%	10.90%	8.40%	-3.00%	-6.90%	9.10%	7.40%	5.30%	-7.20%	11.90%
Portfolio E	-0.30%	6.10%	1.50%	3.30%	3.20%	-0.30%	10.60%	8.50%	-3.10%	-6.90%	9.10%	7.00%	5.30%	-7.60%	11.40%
Portfolio F	2.80%	9.20%	5.20%	6.80%	6.90%	2.80%	20.90%	4.90%	2.30%	-3.10%	10.20%	11.70%	16.30%	-1.20%	6.70%

Figure 7.2 examines the standard deviation of each portfolio. Comparing Portfolio A to Portfolio D, we see Portfolio D has exhibited lower volatility during the periods analyzed. The introduction of credit and its diversifying aspects helps reduce volatility; the same is true for the reduction in sovereign bonds duration.

Figure 7.2 – Volatility (1/2010 – 12/2020)

	5 Years	7 Years	10 Years
Portfolio A	11.60%	11.10%	11.22%
Portfolio B	10.66%	10.25%	10.13%
Portfolio C	10.67%	10.27%	10.10%
Portfolio D	10.66%	10.26%	10.09%
Portfolio E	10.66%	10.24%	10.09%
Portfolio F	10.70%	10.08%	9.46%

Figure 7.3 shows the Sharpe Ratio, or risk-adjusted return, for each portfolio. Portfolio A experienced a higher return over the 10 year period, but Portfolio D exhibited lower volatility, leading to similar risk-adjusted characteristics.

Figure 7.3 – Sharpe Ratio (1/2010 – 12/2020)

	5 Years	7 Years	10 Years
Portfolio A	0.02	0.30	0.32
Portfolio B	0.06	0.26	0.26
Portfolio C	0.09	0.30	0.31
Portfolio D	0.10	0.30	0.31
Portfolio E	0.08	0.29	0.30
Portfolio F	0.42	0.62	0.69

Figure 7.4 shows the max drawdown for each portfolio. Portfolio D shows a significant improvement over Portfolio A in this context.

Figure 7.4 – Max Drawdown (1/2010 – 12/2020)

	Max Drawdown
Portfolio A	-16.7%
Portfolio B	-13.4%
Portfolio C	-12.8%
Portfolio D	-12.7%
Portfolio E	-12.7%
Portfolio F	-7.7%

Figure 7.5 shows the returns for each portfolio during various historical market events based on a factor exposure model. This model generates factor exposures for each portfolio. It then applies the experienced factor return during each event to those weights to generate the returns each portfolio would have earned during the event. This analysis is helpful for understanding when various portfolios may be expected to perform well and when they may be expected to suffer through periods of poor performance. We caution that factors may not always react to similar conditions in the future the way they did in the past. For example, while rates may have fallen during the

2008 Lehman event, with where rates sit today, they may not have as much room to fall during a similar event today. This may limit the strong gains in many government bond portfolios.

Figure 7.5 – Historical Stress Tests

	Portfolio A	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
1987 Black Monday	-8.4%	-13.5%	-13.8%	-13.6%	-13.3%	-9.4%
2008 January Crisis	1.6%	1.7%	1.7%	1.7%	1.6%	-7.0%
2001 Nasdaq	3.2%	1.7%	1.6%	1.6%	1.7%	-1.8%
1997 - 1998 Asian Crisis	2.8%	2.3%	2.2%	2.2%	2.2%	0.5%
2001 WTC Attack	5.0%	4.8%	4.7%	4.7%	4.7%	-3.7%
2007 August Crisis	5.1%	5.0%	5.0%	5.0%	4.9%	-0.4%
2002 Market Downturn	13.1%	14.6%	15.0%	14.8%	14.4%	-7.9%
2008 Lehman Blow-Up	31.7%	30.7%	30.4%	30.3%	30.4%	2.0%

A.1 Asset Allocation in Real vs. Nominal Terms; Chilean Pesos vs. US Dollars

Upon the Financial Committee's request, all modeling in the study was conducted in real Chilean Pesos. The rationale for this decision was that modeling in these terms would better fit an investor needing returns in Pesos and therefore the covariance matrix is better estimated in those terms. RVK, while ultimately agreeing to conduct the modeling to the specifications of the FC, believes best practice would be to optimize in the terms that the assets will be invested – nominally, with securities priced in US dollars – with resulting outputs converted to real Chilean Pesos for the evaluation of projected spending outcomes. As a result of the difference in opinion on how to best optimize the portfolios, the Financial Committee requested a formal evaluation of each methodology.

RVK believes that when conducting asset allocation optimization modeling, the most important factor is the relative accuracy of the model inputs. This necessitates establishing assumptions for return, risk, and correlation that accurately correspond with the relative risk/return tradeoff of each asset class and how the asset returns behave relative to each other in practice. While RVK is in agreement with the FC that the ESSF should be constructed to optimize the value of the Fund in real Chilean Pesos, we believe that adding inflation and currency inputs to the optimization adds noise to the model through additional estimation error without producing more optimal portfolio allocations. Instead, RVK would recommend optimizing in terms that minimize estimation error, and capture the tradeoffs experienced in the market, converting the resulting outputs to real Pesos to analyze the projected Fund value available for spending needs.

Further detail regarding each discussion point is detailed in the sections below.

Inflation: Real vs. Nominal Modeling

As is the case with any practical modeling exercise, the ultimate goal of a model is to build a best-fit replication of the real-world environment in question, and to appropriately capture the relationships between the variable inputs. Since investments are made in nominal terms, practical investment tradeoffs are conducted in these terms. Similarly, assets move in relationship (correlation) to each other based on nominal returns. While valid arguments can, and have been made for conducting the analysis in real terms, RVK believes that modeling in nominal terms best reflects the market environment, and the practical tradeoffs that investors are faced with.

When adjusting the inputs in the model from nominal to real the assumptions are primarily changed in terms of the absolute value of the returns, while risk and correlation assumptions are not meaningfully impacted as detailed in the two tables below. In Figure A1.1 we compare the expected return and risk for each asset class modeled in the study, detailing the resulting change in the return/risk ratios. When accounting for inflation the expected returns for each asset class decrease by the assumed 2.00% inflation assumption, while the adjusted returns do not impact risk beyond a rounding

threshold – moving no more than a few basis points each. As is the case with risk, when evaluating the change in correlation between the two assumption sets, as detailed in Figure A1.2 table below, we see minimal changes.

Figure A1.1 – Nominal vs. Real Assumptions (USD)

	Nominal USD		Real USD		Difference (Nominal - Real)	
	Expected Return (Arithmetic)	Expected Standard Deviation	Expected Return (Arithmetic)	Expected Standard Deviation	Expected Return (Arithmetic)	Expected Standard Deviation
Bank Deposits	0.77%	4.75%	-1.23%	4.50%	2.00%	0.25%
Treasury Bills	0.78%	4.50%	-1.23%	4.25%	2.00%	0.25%
Sovereign Bonds	1.37%	7.00%	-0.63%	7.00%	2.00%	0.00%
Inflation Linked	0.58%	7.25%	-1.42%	6.75%	2.00%	0.50%
Credit	2.30%	5.50%	0.30%	5.00%	2.00%	0.50%
Equities	7.05%	16.60%	5.05%	16.25%	2.00%	0.35%

Figure A1.2 – Nominal vs. Real Assumptions Correlations (USD)

	Correlations (Nominal USD - Real USD)					
	Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities
Bank Deposits	0.00					
Treasury Bills	0.00	0.00				
Sovereign Bonds	-0.01	-0.01	0.00			
Inflation Linked	0.00	0.01	0.00	0.00		
Credit	-0.03	-0.03	-0.02	0.01	0.00	
Equities	0.00	0.01	-0.01	0.00	0.02	0.00

The downward change in expected returns without meaningful differences in risk or correlation results in a meaningful change in the relative attractiveness of assets. The resulting changes create an outsized benefit for riskier assets like equities, as the change in return due to inflation is much smaller relative to the level of risk. This change results in efficient portfolios favoring riskier assets, with the potential of producing portfolios that expose the Fund to undue market risk, inconsistent with the stated objectives.

While nominal returns should be used for establishing efficient portfolio allocations, RVK is in agreement that real returns should be used when projecting market values, distributions/spending, and other money based variables as relative wealth and spending grows in real terms.

Currency: CLP vs. USD Modeling

Consistent with the goal of the model reflecting the investment choices made in practice, RVK is in favor of conducting the study in USD terms, adjusting outputs to Chilean Pesos. With the recommended asset class structure changes, particularly due to the recommendation for the sovereign bond portfolio to track the Bloomberg Global Aggregate Treasury 5-7 Year Index, all recommended portfolios have more than 80% allocated to track indices that are weighted with a base currency of the USD. Given the restriction for the ESSF portfolio to not hold any Chilean securities and the use of the USD as the primary base currency, managers in the portfolio are not explicitly factoring

in the CLP in their investment processes. While an objective of the Fund is to maximize the spending power of the Fund in CLP, incorporating the currency exchange in the model optimization is a deviation from the practical tradeoffs each manager is facing.

In addition to the differences in methodologies, it is also important to consider the impact the change would have on the assumptions, as was shown in the case of inflation. In Figure A1.3 and Figure A1.4 below the impact the change in base currency from USD to CLP has on the model inputs is shown for return, risk, and correlations.

Figure A1.3 – Real USD vs. Real CLP Assumptions

	Real USD		Real CLP		Difference (USD - CLP)	
	Expected Return (Arithmetic)	Expected Standard Deviation	Expected Return (Arithmetic)	Expected Standard Deviation	Expected Return (Arithmetic)	Expected Standard Deviation
Bank Deposits	-1.23%	4.50%	-3.08%	11.08%	1.85%	-6.58%
Treasury Bills	-1.23%	4.25%	-3.08%	11.50%	1.85%	-7.25%
Sovereign Bonds	-0.63%	7.00%	-2.39%	12.00%	1.76%	-5.00%
Inflation Linked	-1.42%	6.75%	-3.13%	9.75%	1.71%	-3.00%
Credit	0.30%	5.00%	-1.50%	8.50%	1.79%	-3.50%
Equities	5.05%	16.25%	3.24%	15.00%	1.81%	1.25%

Figure A1.4 – Real USD vs. Real CLP Assumptions Correlations

	Correlations (Real USD - Real CLP)					
	Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities
Bank Deposits	0.00					
Treasury Bills	-0.01	0.00				
Sovereign Bonds	-0.03	-0.04	0.00			
Inflation Linked	-0.25	-0.21	-0.15	0.00		
Credit	-0.37	-0.38	-0.24	-0.07	0.00	
Equities	-0.03	-0.03	-0.03	0.06	0.21	0.00

As reflected in the above tables, when assumptions are converted between currencies the primary driver of standard deviation and correlation becomes currency movements, as opposed to the risks and relationships between the asset classes themselves. Additionally, currency movements tend to be volatile, particularly relative to low yielding fixed income asset classes, while return does not meaningfully change; this shift in risk/return tradeoffs results in riskier assets looking more attractive in CLP terms relative to USD.

Consistent with inflation, RVK believes that when analyzing liabilities, including potential cash flows and market values, the study outputs should be converted to CLP – matching the liabilities of the fund – to understand the outcomes of the potential investment options. This methodology optimizes portfolios in the base currency, in the same terms managers optimize their investment strategies, and then analyzes the outcomes in relation to the Fund values in CLP.

A.2 Asset Class Structure Analysis and Recommendations

The Financial Committee (FC) asked RVK to analyze asset class structure as part of this project. The below details our recommended structure for each asset class utilized in the recommended policy target asset allocation. The structures recommended below are used to develop the capital markets assumptions in Section 4. Changes to asset class structure may alter assumptions.

RVK believes the purpose of an asset allocation study is to set a strategic policy target asset allocation (or exposures) to allowable asset classes. For example, an asset allocation study sets how much equity should be in portfolio versus how much fixed income versus the level of alternative assets that should be targeted. These allocations are designed to be long-term in nature with only periodic shifts and reevaluations as they set the desired risk profile for the portfolio which typically does not change over short time periods.

Asset allocation studies are not the appropriate tool to determine tactical positioning, or to evaluate specific elements of the structure of each asset class that frequently reprice in relationship to each other. For example, individual security selection falls outside of the asset allocation process; RVK believes the same is true for currency exposure. These are best set on an ongoing basis by an investment manager. Currency relationships tend to move quickly and should not be set in a long-term strategic manner, but rather continuously as market conditions evolve. By allowing an investment manager to make currency decisions, they can position the portfolio on an ongoing basis based on the current market conditions far more frequently and efficiently than through adjustments to the strategic asset allocation which may be only updated once every several years. Additionally, strategically optimizing currency exposure implies currency changes - and not local currency returns - are the primary driver of returns and risk. This can be true for short periods, but over longer periods we believe return will be driven by the underlying securities.

For these reasons we recommend utilizing broad benchmark based exposures as the baseline allocations where such investable indexes exist. The below discussion contains specific recommendations for each asset class.

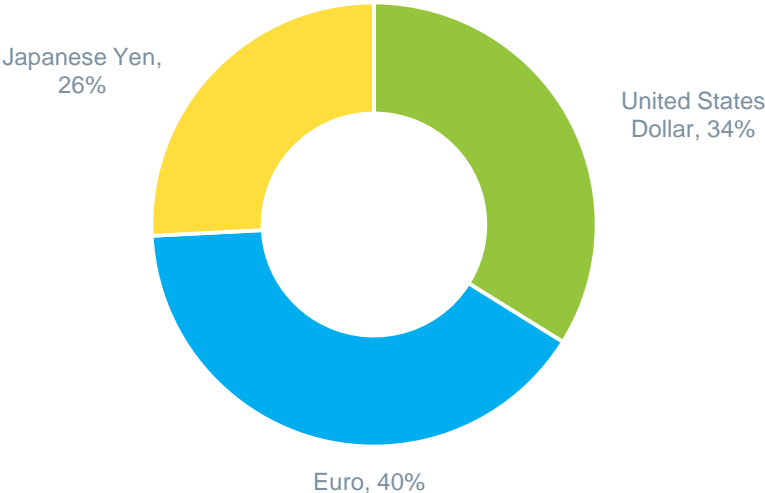
Bank Deposits

There is not a broadly utilized global cash or bank deposit benchmark to rely on for this asset class. Additionally, bank deposits are not like other asset classes in that actual securities are not purchased; instead an asset owner invests in cash and cash equivalents. The purpose of this asset class within the ESSF is to provide stable cash reserves in major global currencies. Therefore, the selection of currencies should be limited to a select group for potential holdings. The existing structure of the asset class is shown in Figure A2.1 below. We believe the utilization of the US Dollar, Euro, and Japanese Yen are appropriate selection for currency holdings in the context of the ESSF. All three are subject to market pricing, trade in large markets, and are easily convertible to other currencies. According to the April 2019 Bank for International

Settlements Triennial Central Bank Survey of Foreign Exchange Turnover report, these three currencies make up more than 68% of daily trade volume.

Other currencies that could potentially be considered include the Australian Dollar, Canadian Dollar, Chinese Yuan, Swiss Franc, and British Pound. The Australian and Canadian Dollars are likely highly correlated with commodity prices, similar to the Chilean Peso. The Pound and Franc make up less than 10% of overall trade combined, making them less relevant on a global scale. Finally, while the Chinese Yuan has seen significant use in global markets, it is still subject to strict capital controls in China and market manipulations, making it less than ideal for a store of value. Based on these considerations, we limited our analysis to the three existing currencies in the ESSF bank deposit portfolio.

Figure A2.1 – Existing ESSF Bank Deposit Policy Allocations



As discussed previously in Section 4, our return assumption for each country is shown again in Figure A2.2. Figure A2.3 shows historical volatility using three different methodologies as discussed in more detail in Section 4 of this report. The final row of the table shows the assumption used by RVK in the analysis after we consider each of the different methodologies. We have used actual correlations since 2009 when the current monetary regime began; this corresponds with a period of sustained central bank intervention and is representative of RVK’s views on the interrelationships of these cash rates going forward. We use this data to conduct an MVO analysis on the asset class and have constrained the minimum and maximum allocation for each currency. A minimum of 20% was chosen to maintain material allocations to each currency. At the same time we do not want any one currency to dominate the portfolio and therefore have constrained the model to not allow any one currency to represent more than 50% or half of the allocation. Using the same constraints for each currency removes potential qualitative bias from influencing how currencies are allocated.

Figure A2.2 – Bank Deposits Return Assumptions (Real CLP)

Sub-Asset Class	Inflation	Yield	Spread	Rate	Currency	Total
US Dollar-Denominated Deposits	-3.00%	0.10%	0.00%	1.25%	-0.82%	-2.47%
Euro-Denominated Deposits	-3.00%	-0.65%	0.00%	1.00%	-0.96%	-3.61%
Yen-Denominated Deposits	-3.00%	-0.23%	0.00%	0.25%	-0.80%	-3.78%

Figure A2.3 – Bank Deposits Volatility Assumptions (Real CLP)

	US Dollar-Denominated Deposits	Euro-Denominated Deposits	Yen-Denominated Deposits
Implied	10.76%	9.89%	12.61%
Monthly	11.61%	11.54%	15.13%
Annual	12.92%	12.77%	17.54%
Average	11.76%	11.40%	15.09%
RVK Assumption	12.00%	11.50%	15.25%

Figure A2.4 – Bank Deposits Copper Correlations (Real CLP)

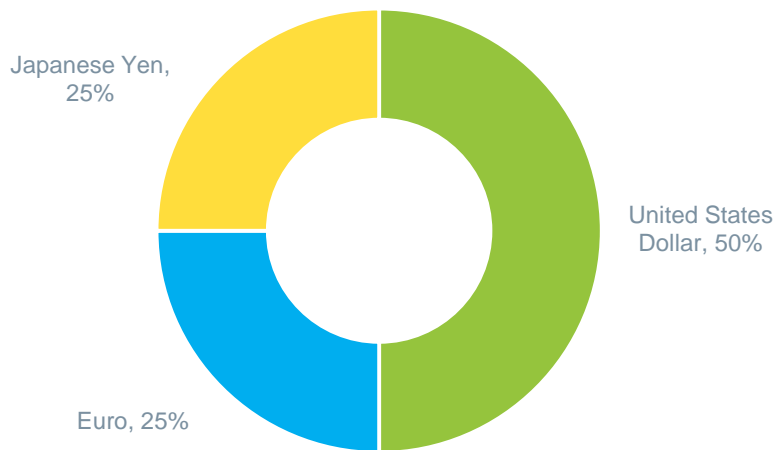
	US Dollar-Denominated Deposits	Euro-Denominated Deposits	Yen-Denominated Deposits
Correlation to Copper	-0.12	0.04	-0.24

Based on this analysis, and as shown in Figure A2.5, RVK recommends adopting a policy target of 50% US Dollar, 25% Euro, and 25% Yen denominated bank deposits. This increases deposits in the US which we believe is appropriate given higher rates. This is offset with a reduction in Euro deposits and leaves Euro and Yen deposits equal. While the US has higher rates, in real Pesos terms the Euro has exhibited lower volatility than the US Dollar and the Yen offers the lowest correlation offering diversification benefits. While an allocation with 25% to the Yen is not precisely on the efficient frontier we believe qualitative factors make it worth maintaining a 25% allocation. The efficient frontier is used as a guide and in this case we believe the lower correlation of the Yen to the other currencies is sufficient to slightly overweight it relative to the model output.

Figure A2.5 – Bank Deposits Analysis (%)

	Min	Max	1	2	3	4	5	6	7	8	9	10	Current Policy	Recommended
US Dollar	20	50	29	31	34	36	38	41	43	45	48	50	34	50
Euro	20	50	50	49	46	44	42	39	37	35	32	30	40	25
Yen	20	50	21	20	20	20	20	20	20	20	20	20	26	25
Total			100	100	100	100	100	100	100	100	100	100	100	100
Expected Arithmetic Return			-3.32	-3.29	-3.26	-3.24	-3.21	-3.18	-3.15	-3.13	-3.10	-3.07	-3.27	-3.08
Expected Risk (Standard Deviation)			10.62	10.63	10.65	10.68	10.71	10.75	10.79	10.84	10.88	10.94	10.76	11.08

Figure A2.6 – Recommended Bank Deposits Policy Allocations



Treasury Bills

We utilized a similar approach for treasury bills. The exception is that there are no Euro issued treasury bills, instead they are issued by each member country. The existing ESSF policy target utilizes securities issued by Germany to represent the Euro exposure. We believe this is reasonable and simplifies portfolio construction and implementation by not introducing several small allocations to many Euro member countries. Figure A2.8 shows the return assumptions used in the MVO modeling for treasury bills while Figure A2.7 shows the existing ESSF treasury bills policy allocations. Similar to Bank Deposits, we have constrained the MVO model. We have used the same constraints as in the Bank Deposits sections given similar considerations for building asset class exposures.

Figure A2.7 – Existing ESSF Treasury Bills Policy Allocations

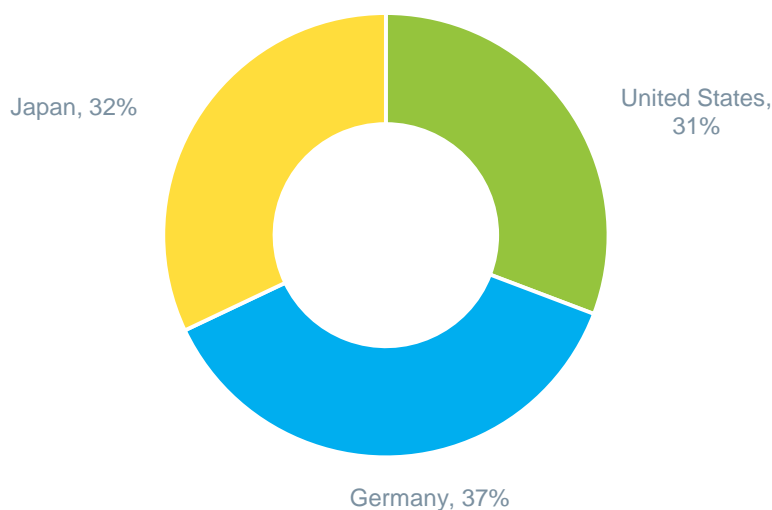


Figure A2.8 – Treasury Bills Return Assumptions (Real CLP)

Sub-Asset Class	Inflation	Yield	Spread	Rate	Currency	Total
US Treasury Bills	-3.00%	0.07%	0.00%	1.25%	-0.82%	-2.50%
German Treasury Bills	-3.00%	-0.68%	0.00%	1.00%	-0.96%	-3.64%
Japan Treasury Bills	-3.00%	-0.11%	0.00%	0.25%	-0.80%	-3.66%

Figure A2.9 – Treasury Bills Volatility Assumptions (Real CLP)

	US	Germany	Japan
Implied	10.87%	9.95%	12.61%
Monthly	11.61%	11.73%	15.00%
Annual	12.93%	13.06%	18.46%
Average	11.80%	11.58%	15.36%
RVK Assumption	12.50%	12.00%	15.50%

Figure A2.10 – Treasury Bills Copper Correlations (Real CLP)

	US Treasury Bills	German Treasury Bills	Japan Treasury Bills
Correlation to Copper	-0.12	0.04	-0.24

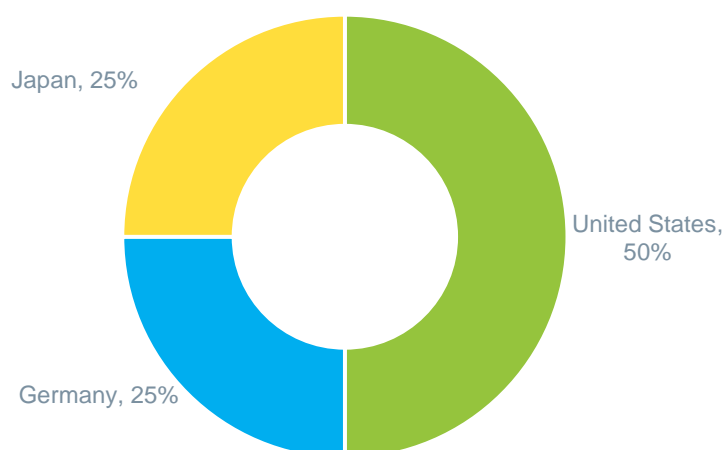
Based on this analysis, and as shown in Figures A2.11 and A2.12, RVK recommends adopting a policy target of 50% US Treasuries, 25% German Treasuries, and 25% Japanese Treasuries. This increases exposure to the US which we believe is appropriate given higher rates. This is offset with a reduction in German exposure and

leaves German and Japanese allocations equal. While the US has higher rates, in real Pesos terms the Euro has exhibited lower volatility than the US Dollar and the Yen offers the lowest correlation to copper, leading to additional diversification benefits.

Figure A2.11 – Treasury Bills Analysis (%)

	Min	Max	1	2	3	4	5	6	7	8	9	10	Current Policy	Recommended
US Treasury Bills	20	50	26	29	32	34	37	39	42	45	47	50	31	50
Germany Treasury Bills	20	50	50	50	48	46	43	41	38	35	33	30	37	25
Japan Treasury Bills	20	50	24	21	20	20	20	20	20	20	20	20	32	25
Total			100	100	100	100	100	100	100	100	100	100	100	100
Expected Arithmetic Return			-3.34	-3.31	-3.28	-3.25	-3.22	-3.19	-3.16	-3.13	-3.10	-3.07	-3.30	-3.08
Expected Risk (Standard Deviation)			11.03	11.04	11.06	11.08	11.12	11.16	11.20	11.25	11.30	11.36	11.27	11.50

Figure A2.12 – Recommended Treasury Bills Policy Allocations



Sovereign Bonds

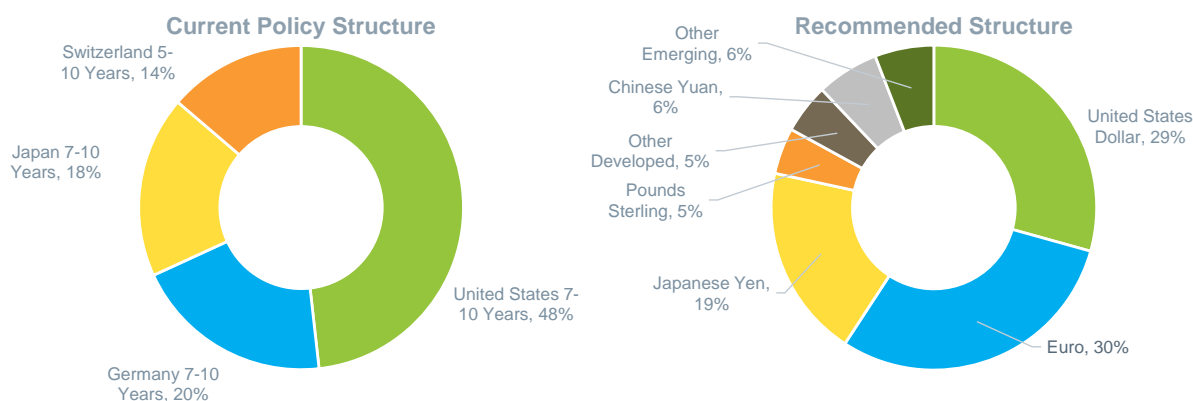
RVK recommends utilizing a market weighted approach to building out this asset class. We do not believe optimizing the allocation to each country or currency is advisable as part of an asset allocation study. Taking a broad approach allows for greater diversification within the asset class through the inclusion of exposure to additional countries and currencies. RVK recommends the adoption of the Bloomberg Global Aggregate - Treasury 5-7 Years Index for this asset class. The 5-7 year index has a duration 5.8 years; while duration could be reduced further, this is the range of the yield curve where we see yields begin to increase as the maturity moves away from the shorter end of the curve that tends to be more connected to central bank policy. Should the FC wish to optimize this allocation we recommend doing so through the utilization of an active investment manager.

One potential downside to such an approach is the inclusion of securities with less liquidity in times of market stress. As shown in Figure A2.13, the recommended allocation to non-reserve currencies is just under 17%. Furthermore, of that 17%, approximately 37% is to the Chinese Yuan which is on its way to reserve status.

Therefore, we believe this is a very minimal risk. In the event assets need to be utilized quickly, treasury bills would be first to be liquidated further reducing our concern.

The composition of the existing ESSF sovereign bonds policy portfolio as well as the resulting allocations of the proposed structure are shown in Figure A2.13.

Figure A2.13 – Existing and Proposed Sovereign Bonds Policy Allocations

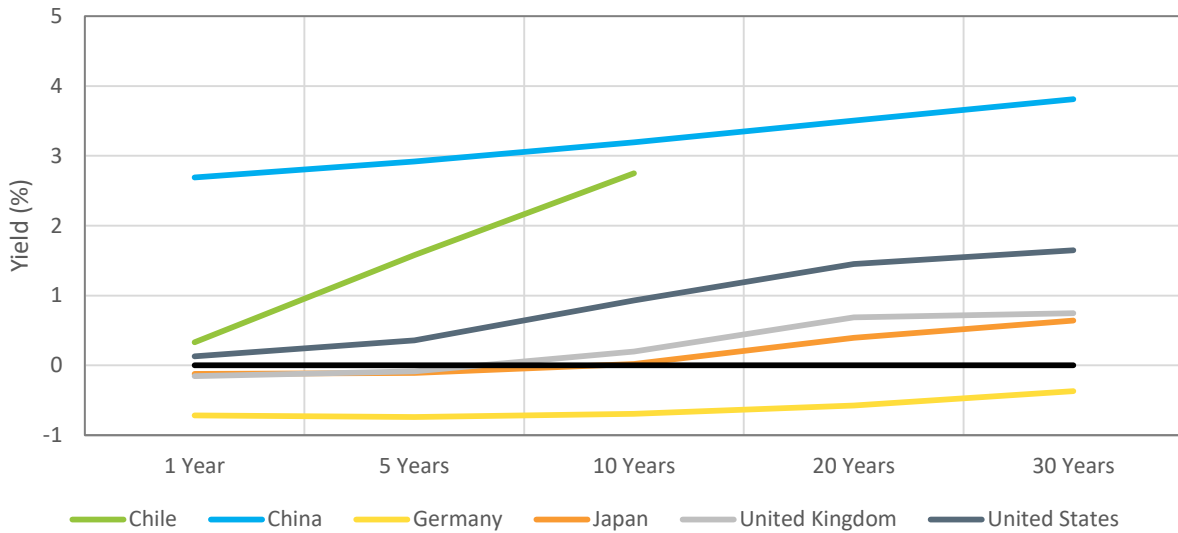


Additionally, RVK recommends reducing the duration of the sovereign bonds policy portfolio. The existing ESSF sovereign bonds policy portfolio has a duration of 7.8 years while the proposed benchmark has a duration of 5.8 years. Shortening portfolio duration reduces interest rate risk while only giving up marginal yield. This is due to the relatively flat yield curves observed around the world as a result of significant central bank intervention and lower long-term global growth expectations. Figure A2.14 shows the yield curves for select major economies. When rates normalize, having a portfolio with shorter duration will reduce volatility. Additionally, with rates at or below the zero bound in many countries, the prospect for future price appreciation is low indicating that taking undue duration risk is unnecessary.

The risk to this strategy is a potential for long-term rates falling past near record lows. This is likely most apparent in the US where long-term rates remain significantly above 0, with the 10-year US Treasury trading at 0.93% as of December 31, 2020. Rates have risen to some degree in the US since then and were at 1.67% at the time of this writing, May 13, 2021. However, we continue to believe that over the long-term the risk to rates is future increases, and not lower rates.

The change to a single index-based approach allows for additional country and currency diversification. It also simplifies portfolio management if implemented through either a passive or active manager.

Figure A2.14 – Select Yield Curves



Source: FactSet. (2021)

Figure A2.15 –Existing and Proposed Sovereign Bonds Portfolio Characteristics

	Existing Policy Portfolio	Recommended Structure
Modified Duration (years)	7.8	5.8
Avg. Maturity (years)	8.3	6.0
Avg. Quality	Aa1	Aa2/Aa3
Yield to Worst	0.19%	0.37%
Coupon Rate	1.63%	1.77%

The FC has raised questions around the necessity of adding multiple additional currency exposures in sovereign bond portfolio. RVK believes the implementation of such an approach is not different than the existing structure of the public equity mandate where exposure is maintained to the index. The equity index contains exposure to more than 20 currencies, far more than we are proposing for the sovereign bond portfolio. However, we have analyzed two alternate potential scenarios for the sovereign bond allocation to address this concern should the FC not wish to increase the currency count in this part of the portfolio. We examine the possibility of limiting to the top three currencies (US Dollar, Euro, and Yen). Together these three currencies compose 78.3% of the broad index. This would serve to simplify the mandate and focus on the primary reserve currencies. We analyzed two potential portfolios, one based on market weighting of the broad based index and the second based on an optimization of the three currencies. The resulting portfolios and characteristics are shown in Figure A2.16. The effects of utilizing these two asset class structures are examined in Appendix 3.

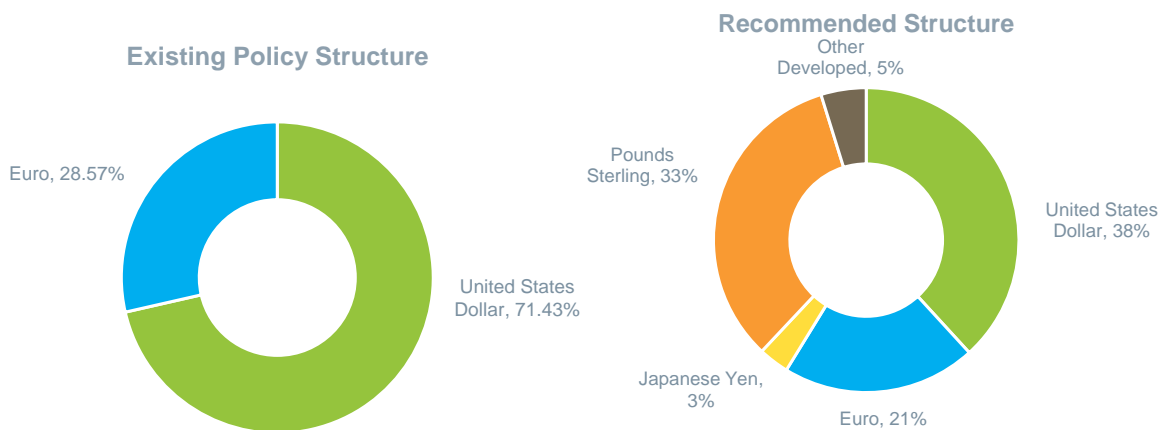
Figure A2.16 – Alternate Sovereign Bonds Portfolios

	Existing Policy Portfolio	Recommended Structure	Alt SB 1	Alt SB2
			Top 3 Currencies - Optimized	Top 3 Currencies - Market Weighted
European Euro (Germany)	19.9%	29.8%	20.0%	38.1%
United States Dollar	48.2%	29.3%	40.0%	37.4%
Japanese Yen	18.1%	19.2%	40.0%	24.5%
Chinese Yuan	-	6.2%	-	-
Pounds Sterling	-	4.6%	-	-
Australian Dollar	-	2.3%	-	-
Korean Won	-	1.3%	-	-
Canadian Dollar	-	1.0%	-	-
Swiss Franc	13.7%	0.2%	-	-
Other Developed	-	1.4%	-	-
Other Emerging	-	4.6%	-	-
Expected Return - Real	-3.36%	-2.39%	-3.33%	-3.49%
Expected Standard Deviation	11.25%	12.00%	10.92%	11.27%
Correlation to Copper	-0.17	-0.14	-0.18	-0.19

Inflation Linked Bonds

Similar to sovereign bonds, we recommend utilizing a broad global based benchmark for inflation linked bonds. RVK recommends adopting the Bloomberg Global Inflation-Linked Index for this asset class. Currently the policy portfolio only contains exposure to US and Germany issued securities in this asset class as shown in Figure A2.17. Adopting the proposed index would expand exposure to 8 currencies as shown in Figure A2.17.

Figure A2.17 – Existing and Proposed Inflation Linked Bonds Policy Allocations



Credit

Similar to bank deposits and treasuries, RVK has conducted an optimization to build out the recommended credit structure. Figure A2.18 shows the return assumptions used in the MVO modeling for credit while Figure A2.19 shows the volatility assumptions. Figure A2.20 shows correlations to copper prices. The constraints for the Credit optimization were designed to focus the exposure on global investment grade and MBS securities,

while limiting exposure to high yield, banks loans, and EMD corporate to maintain a reasonable level of absolute risk and credit risk exposure.

Figure A2.18 – Credit Return Assumptions

Sub-Asset Class	Inflation	Yield	Spread	Rate	Currency	Default	Total
Global Investment Grade Corporate Credit	-3.00%	1.34%	-0.13%	0.75%	-0.81%	0.00%	-1.85%
US Corporate High Yield	-3.00%	4.18%	-0.32%	0.75%	-0.82%	-1.00%	-0.21%
Bank Loans	-3.00%	4.24%	0.00%	0.00%	-0.82%	-1.00%	-0.58%
MBS	-3.00%	1.25%	-0.04%	1.00%	-0.82%	0.00%	-1.61%
EMD Corporate	-3.00%	3.42%	-0.10%	0.75%	-0.42%	0.00%	0.64%

Figure A2.19 – Credit Volatility Assumptions

	Corporate	High Yield	Bank Loans	MBS	EMD Corporate
Implied	7.11%	10.02%	10.74%	9.43%	3.67%
Monthly	10.87%	10.73%	11.02%	11.69%	11.07%
Annual	10.33%	9.07%	9.36%	13.64%	7.42%
Average	9.44%	9.94%	10.37%	11.59%	7.39%
RVK Assumption	9.50%	10.00%	10.50%	12.00%	7.50%

Figure A2.20 – Credit Copper Correlations (Real CLP)

	Global Investment Grade Corporate Credit	US Corporate High Yield	Bank Loans	MBS	EMD Corporate
Correlation to Copper	0.01	0.21	0.20	-0.15	0.16

Based on this analysis, and as shown in Figures A2.21 and A2.22, RVK recommends adopting a policy target of 50% corporates, 5% high yield, 5% bank loans, 35% MBS, and 5% EMD corporate. Given the efficient frontier maximizes the allowed exposure to high yield, bank loans, and EMD-C, the tradeoff then becomes between corporate and MBS exposure. We recommend the portfolio as described above and shown below given the better risk-adjusted return for corporate versus MBS, all while trying to limit a single exposure's absolute level. The impact of allocating more to corporate or MBS is minimal in absolute terms.

Figure A2.21 – Credit Analysis (%)

	Min	Max	1	2	3	4	5	6	7	8	9	10	Recommended
Corporate	0	75	75	68	61	53	46	39	32	24	17	10	50
High Yield	0	5	5	5	5	5	5	5	5	5	5	5	5
Bank Loans	0	5	5	5	5	5	5	5	5	5	5	5	5
MBS	0	75	10	17	24	32	39	46	53	61	68	75	35
EMD-C	0	5	5	5	5	5	5	5	5	5	5	5	5
Total			100	100	100	100	100	100	100	100	100	100	100
Expected Arithmetic Return			-1.56	-1.54	-1.52	-1.50	-1.49	-1.47	-1.45	-1.43	-1.42	-1.40	-1.50
Expected Risk (Standard Deviation)			9.04	9.15	9.27	9.42	9.57	9.74	9.92	10.12	10.33	10.55	9.49

Figure A2.22 – Recommended Credit Policy Allocations

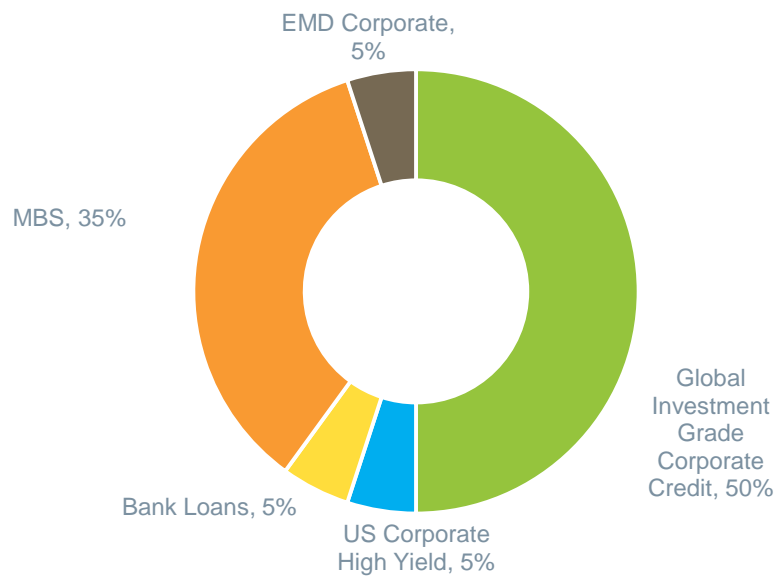
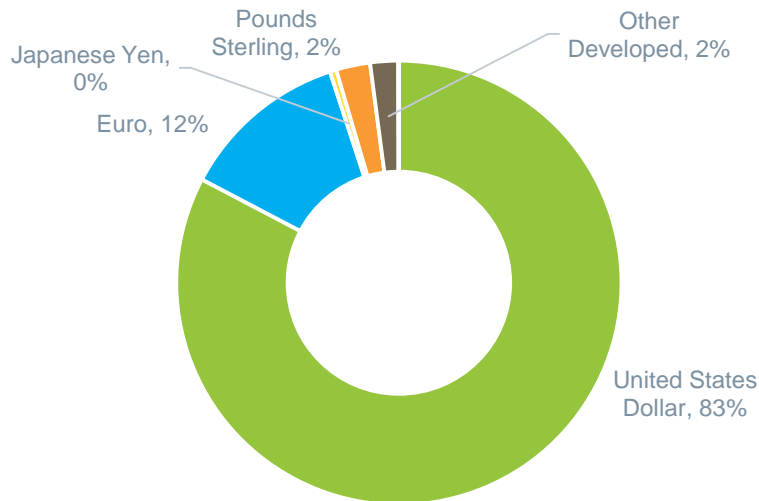


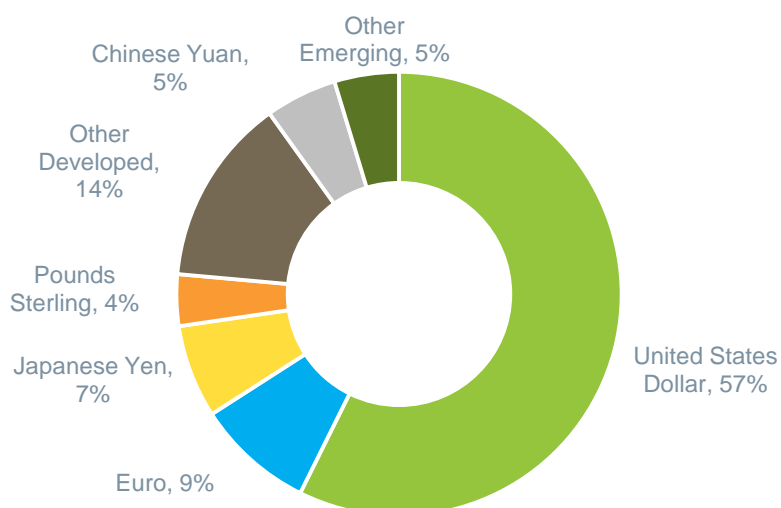
Figure A2.23 – Recommended Credit Policy Currency Allocations



Equity

The existing equity policy portfolio index is the MSCI All Country World Index ex Chile. We believe this remains an appropriate structure as it represents the global public equity opportunity set. This results in broad country, currency, and capitalization diversification. Figure A2.24 shows the currency exposure of this index.

Figure A2.24 – MSCI All Country World Index ex Chile Currency Exposure



Implementation

Each asset class discussed above can be implemented through various approaches. Figure A2.25 highlights RVK's recommendations for each asset class. We recommend, the Central Bank of Chile continue to implement the bank deposits, treasury bills, sovereign bond, and inflation linked portfolios.

Figure A2.25 – Asset Class Implementation

	Active/Passive	# of Managers	Time Required to Fully Implement	ESG
Bank Deposits	Passive	Central Bank	1 Month	N/A
Treasury Bills	Passive	Central Bank	1 Month	N/A
Sovereign Bonds	Passive	Central Bank	3 Months	N/A
Inflation Linked	Passive	Central Bank	1 Month	N/A
Credit	Active	1	3 Months	No
Global Equity	Passive	1-2	No Changes	Yes

Active Credit

RVK recommends a single active manager to implement the credit portfolio. While a multiple manager portfolio could be used to implement the credit portfolio, the smaller mandates would likely result in less fee efficiency, which we would not expect to be offset by benefits of performance or risk through manager diversification. RVK generally believes in passive mandates in highly efficient asset classes to control costs, however, we do not believe this is optimal for credit, particularly for the high yield and bank loans component of our recommended structure. These asset classes are highly inefficient making them a rewarding space for active management. The indexes weight securities

regardless of the possibility of a company defaulting. Active management allows for credit research into each security prior to purchase. Additionally, the indexes essentially prescribe a higher weight to companies with more outstanding debt. We believe this is a pitfall active managers can avoid. Finally active managers can tilt the portfolio among the various sub asset classes through time as market dynamics change to exploit the current opportunity set, something a passive mandate is incapable of doing.

Within the credit mandate the one sector that could potentially be implemented through a passive approach is the MBS sleeve. While passive MBS products exist and are largely efficient, they miss an important segment of the markets in the US. The US MBS market is segregated into agency and non-agency markets. The agency market is what is captured in passive MBS products. While the non-agency market is shrinking, and will continue to do so over time, it is an important source of increased yield and additional diversification allowing active managers to add non-benchmark exposure to achieve superior long-term risk-adjusted performance.

We also examine performance of a peer universe of active managers in the global credit space to evaluate the merits of utilizing active management for this mandate. We do so by analyzing the performance of managers in the eVestment Global Multi-Sector Fixed Income peer universe. The proposed credit mandate has been designed to fit the needs of the ESSF and therefore when selecting the peer group, we had to find the best match among imperfect options. The below description is provided by the eVestment, the data provider, for the Global Multi-Sector Fixed Income peer universe. Of the available universes, it best matches the custom credit mandate as proposed. While the peer group may not be a 100% match, we believe it is representative of the ability of active managers to outperform the custom credit mandate as proposed.

“Global Fixed Income products that tactically invest across the full spectrum of long-only fixed income. These strategies focus on yield and total return, are typically well-diversified and have the flexibility to invest across both high yield and investment grade debt. Multi-Sector products differ from Core Plus approaches due to a larger scope of investable instruments and credit quality exposure. They differ from Unconstrained Fixed Income by not utilizing shorting instruments or leverage. Common benchmarks include the Bloomberg Barclays Global Aggregate and Bloomberg Barclays Multiverse, but large deviations from benchmark exposure is typical.”

There are also no perfect or universally accepted benchmarks for similar mandates. For this reason we compare the peer universe to two benchmarks. The first benchmark (“Custom Credit Index”) uses the weighted proposed allocation to each underlying benchmark in the proposed credit allocation. This has the advantage of aligning precisely with the proposed mandate. However, given it is a custom mandate, existing strategies do not manage to this benchmark. The second benchmark we examine is the Barclays Global Credit Index. It contains both investment grade and high yield fixed income securities. For the analysis we examine trailing period performance as of June 30, 2021 as well as rolling 36 month periods to eliminate end point sensitivity.

Investment managers report returns on a gross of fees basis to eVestment. In order to analyze the effectiveness of active managers we have reduced peer universe returns by the median fee of the peer group. In order to calculate a median fee we must assume a mandate size. To be conservative we have assumed a mandate size of \$150 million (USD), representing a 5% allocation at a \$3 billion (USD) portfolio size. If assets were to increase the median fee would decrease on a percentage basis. Based on this assumption, the median fee for the eVestment Global Multi-Sector Fixed Income peer universe is 40 basis points. The median fee is based on separate account structures and excludes funds and pooled products.

Figure A2.26 shows the analysis for the eVestment Global Multi-Sector Fixed Income peer universe against the Custom Index, while Figure A2.27 is against the Barclays Global Credit Index. Returns are shown in USD. Net of fees, the median manager has outperformed the Custom Credit Index in each time period shown by between 0.45% and 1.09% over the 3-, 5-, 7-, and 10-year trailing periods. Additionally, at least 68% of managers outperformed in each of these trailing time periods. The data compared to the Barclays Global Credit Index is also strong for active management. However, for the 3-year period the median manager did underperform by 13 basis points with 49% of managers outperforming. All other long-term trailing periods show outperformance and a majority of managers beating the benchmark. The Barclays Global Credit Index has a significantly higher weight to high yield fixed income compared to the Custom Credit Index. For this reason we would expect higher performance for this index over time.

Figure A2.26 – eVestment Global Multi-Sector Fixed Income Peer Universe Custom Credit Index

	1 Year	3 Years	5 Years	7 Years	10 Years
Median Manager (Net)	8.37%	6.02%	4.97%	4.05%	4.83%
Custom Credit Index	4.43%	5.57%	3.97%	3.32%	3.74%
Difference	3.94%	0.45%	1.00%	0.73%	1.09%
% of Manager Outperforming	83%	70%	72%	68%	70%
Population	41	37	36	34	20

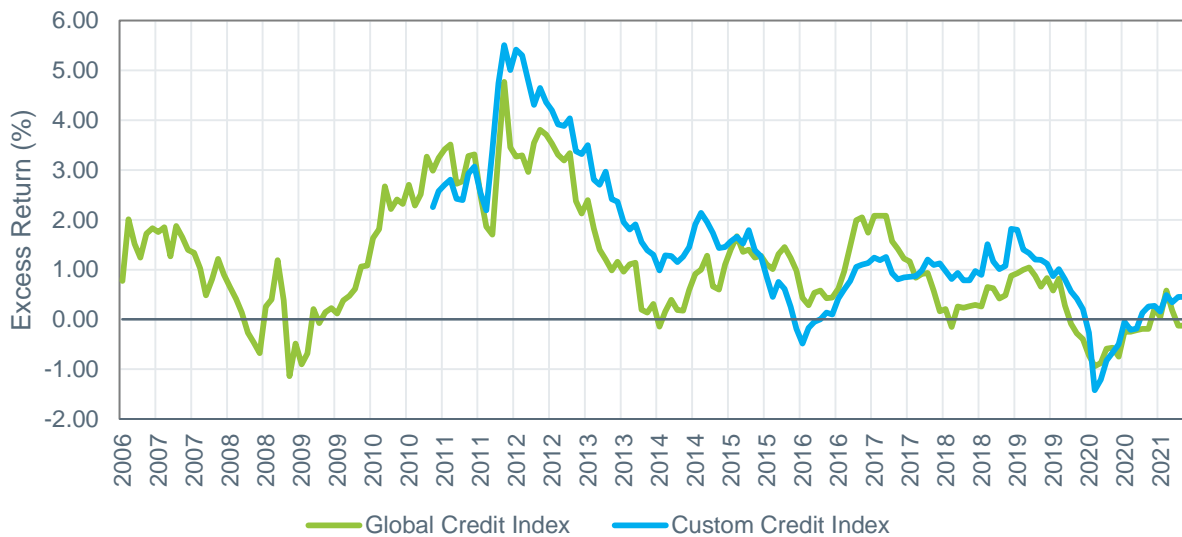
**Figure A2.27 – eVestment Global Multi-Sector Fixed Income Peer Universe
Barclays Global Credit Index**

	1 Year	3 Years	5 Years	7 Years	10 Years
Median Manager (Net)	8.37%	6.02%	4.97%	4.05%	4.83%
Barclays Global Credit Index	6.54%	6.15%	4.58%	3.30%	4.05%
Difference	1.83%	-0.13%	0.39%	0.75%	0.78%
% of Manager Outperforming	63%	49%	64%	68%	60%
Population	41	37	36	34	20

Figure A2.28 shows rolling 36 month periods of the median manager versus each index. We started the analysis once a rolling 36 month period had at least 10 members. This was on September 30, 2003 however, the Custom Credit Index only has history back to 2008 so analysis was started at this time for this index. Over this time period, and compared to the Barclays Global Credit Index, the median manager average 36 month rolling outperformance has been 1.12%. Furthermore, the median manager outperforms in 85% of trailing 36 month time periods. The same figures are 1.51% and 90% when compared against the Custom Credit Index.

We believe the above analysis supports RVK’s recommendation to utilize active management when the credit mandate is implemented.

**Figure A2.28 – eVestment Global Multi-Sector Fixed Income Peer Universe
Rolling 36 Month Excess Return**



Other Asset Classes

When we examine the active versus passive implementation decision for the other asset classes in the portfolio, we conclude that passive management is most appropriate. Bank deposits do not lend themselves to active management through security selection. Treasury bills, sovereign bonds, and inflation linked could be implemented actively. This could consist of both duration and currency selection away from the benchmark. The duration of each asset class was designed to meet the objectives of the ESSF and therefore we do not believe should be modified via active management. The same is true of currency exposure. Currency exposure could be tilted in an attempt to increase return or reduce risk, the additional cost and complexity do not seem justified in our opinion.

Other than credit, equity is the next most logical asset class to consider active management. According to RVK's 2021 Active vs. Passive Study, the median global equity manager adds, on average, 0.24% of excess return per year. At a 5% allocation size, this equates to a 0.01% of additional return at the total fund level. While all return is valuable, this level of additional return is not worth the additional administrative considerations of moving from passive to active management in equity. Additionally, while there is a probability of return greater than the median outcome, there is also a probability of lower excess returns than median. Finally, when we examine the drivers of median excess return, we find much of it can be attributed to over allocation of certain factors rather than true manager skill. The factors biases may work over many time periods but are also likely to produce below benchmark returns during other market environments.

ESG

ESG Investing is defined as the consideration of environmental, social, and governance factors in the investment decision-making process. Although there are nuances for each, ESG is often synonymous with socially responsible investing, sustainable investing, impact investing, and positive / negative screening. ESG factors range across many topics such as climate change, renewable energy, gender diversity, gender equality, data security, and executive pay. It has become increasingly common for asset owners (pension plans, endowments, foundations, and sovereign wealth funds) to implement ESG into their investment programs. Beyond more asset owners focusing on ESG, there is little industry standard or consensus for how to implement ESG or even how to measure ESG success.

ESG implementation also varies substantially by asset class. For example, it would be very difficult to implement an ESG approach in treasury bills and sovereign bonds. These securities are government issued debt and the only real option would be to exclude specific countries based on their policies that may not align with domestic policy. It is unlikely that other asset classes recommended should be altered for ESG considerations given the nature of the underlying securities and the underdeveloped market for fixed income ESG strategies. The recommended credit allocation within the long-term strategic target (portfolio above \$5 billion USD) could be implemented with certain ESG requirements/restraints, but it is likely that the additional cost and

complexity would constrain the available universe of providers, and potentially significantly alter the risk and return characteristics of the modeled credit portfolio. Equities are the primary asset class where we see asset owners engaging in ESG and the most applicable for the ESSF.

While ESG implementation may not be available, or practical, for every mandate in the ESSF portfolio currently, the investment opportunity set is continuously growing and should be reevaluated on a recurring basis. Furthermore, there has been a growing industry trend to include a review of the ESG policy and practices of current and prospective managers in a fund's investment policy. If implemented this could serve as a formal consideration in the process of hiring as well as the ongoing monitoring of ESSF managers. In cases where ESG investment strategies may not be available, or practical, managers can still be evaluated on their commitment to promoting ESG, both internally at the firm level, and in the integration of ESG in their investment philosophy. In the case of passively managed strategies this could be evaluated through a firm's policy of engagement and proxy voting. While managers could also be evaluated based on how they integrate ESG considerations of risk and return into their active strategies.

RVK recommends exploring adding an ESG-specific equity mandate in the future. As the recommended portfolio when assets are between \$3 and \$5 billion USD begins to be implemented, we believe there can be a complementary ESG-centric equity strategy alongside the passive MSCI ACW ex. Chile already in place. This ESG strategy could remain passive but would be customized to better align with the views of the FC and ultimately the State. Depending on the market at the time of the initiated search, it may be prudent to wait until the portfolio is closer to the \$5 billion USD level, but the legwork can be completed in advance.

A.3 CMA Stress Testing

In addition to the base set of CMAs used in this study, the FC instructed RVK to stress test the model outcomes under various alternate sets of CMAs. The follow list of stress test were completed:

- Alternate sovereign bond structures (Alt SB 1 and Alts SB 2)
- USD based CMAs (USD Real)
- Nominal CLP CMAs (CLP Nominal)
- CLP Remains Constant (currencies do not mean-revert but stay at current levels) (Constant Currency)

This section summarizes the results of these alternate CMA sets and compares the outcomes to the baseline outcomes as presented in the main body of this report.

A.3.1 Alternate Sovereign Bond Structures (Alt SB1 and Alt SB 2)

The baseline CMAs used in the report utilized both the existing policy structure, as well as RVK’s recommended structure for the sovereign bond portfolio. RVK’s recommended structure is based on the market weights to various currencies held in the Bloomberg Global Aggregate - Treasury 5-7 Year Index. We have examined two additional sovereign bond portfolio structures as shown in Figure A3.1 below. Alt SB 1 was developed through a process similar to what was described in Section A.2 for the bank deposits and treasury bills portfolios. RVK conducted an optimization of the Euro, USD, and Yen to construct a sovereign bond portfolio. In addition to the optimized portfolio we also test a portfolio of the top 3 currencies by market weight, this is represented in the below table as Alt SB 2. In addition to the allocations, Figure A3.1 also shows the expected return and risk of each portfolio. The values shown are in CLP on real basis. Figure A3.2 shows the complete set of assumptions used in this analysis.

Figure A3.1 – Alternate Sovereign Bond Structures

	Existing Policy Portfolio	Recommended Structure	Alt SB 1	Alt SB2
			Top 3 Currencies - Optimized	Top 3 Currencies - Market Weighted
European Euro (Germany)	19.9%	29.8%	20.0%	38.1%
United States Dollar	48.2%	29.3%	40.0%	37.4%
Japanese Yen	18.1%	19.2%	40.0%	24.5%
Chinese Yuan	-	6.2%	-	-
Pounds Sterling	-	4.6%	-	-
Australian Dollar	-	2.3%	-	-
Korean Won	-	1.3%	-	-
Canadian Dollar	-	1.0%	-	-
Swiss Franc	13.7%	0.2%	-	-
Other Developed	-	1.4%	-	-
Other Emerging	-	4.6%	-	-
Expected Return - Real	-3.36%	-2.39%	-3.33%	-3.49%
Expected Standard Deviation	11.25%	12.00%	10.92%	11.27%
Correlation to Copper	-0.17	-0.14	-0.18	-0.19

Figure A3.2 – Alt SB 1 CMAs

	Expected Return (Arithmetic)	Expected Standard Deviation	Correlations						
			Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities	
Bank Deposits	-3.08%	11.08%	1.00						
Treasury Bills	-3.08%	11.50%	1.00	1.00					
Sovereign Bonds	-3.33%	10.92%	0.93	0.94	1.00				
Inflation Linked	-3.13%	9.75%	0.86	0.87	0.85	1.00			
Credit	-1.50%	8.50%	0.93	0.93	0.92	0.93	1.00		
Equities	3.24%	15.00%	0.25	0.25	0.13	0.36	0.46	1.00	

Analyzing the alternate sovereign bond portfolios on expected return and risk alone we see the recommended structure has a significantly better return than the other options. However, risk is slightly higher as well. Figure A3.3 highlights the efficient frontier using the Alt SB 1 structure. Figure A3.4 shows the original outcomes (previously in Figure 5.5 in Section 5) using the recommended sovereign bond structure. When we compare the differences, shown in Figure A3.5, we see an increase in allocation to sovereign bonds among the efficient portfolios on the left side of the efficient frontier but a decrease in the more aggressive portfolios on the right. We also see reduced expected returns across the board. All efficient portfolios in the revised frontier have lower sovereign bond allocations than Portfolio D. If the Alt SB 1 sovereign bond structure were to be implemented, RVK would suggest a lower allocation to the asset class. This would be offset with higher allocations to bank deposits and treasury bills.

Figure A3.3 – Efficient Frontier with Alt SB 1

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	14%	17%	20%	23%	25%	25%	25%	25%	25%	25%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	10%	10%	10%	10%	11%	14%	16%	19%	22%	25%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds Alt 1	30%	70%	56%	53%	50%	47%	44%	42%	39%	36%	33%	30%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation			80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	92%	85%	82%	82%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	4%	10%	8%	8%
Expected Arithmetic Return			-2.83%	-2.82%	-2.82%	-2.81%	-2.80%	-2.79%	-2.79%	-2.78%	-2.77%	-2.77%	-2.91%	-2.93%	-2.84%	-2.82%
Expected Risk (Standard Deviation)			10.13%	10.13%	10.13%	10.14%	10.15%	10.17%	10.19%	10.21%	10.23%	10.26%	10.44%	10.26%	10.17%	10.17%
Expected Compound Return			-3.35%	-3.34%	-3.34%	-3.33%	-3.32%	-3.32%	-3.31%	-3.30%	-3.31%	-3.31%	-3.47%	-3.47%	-3.37%	-3.35%
Expected Return (Arithmetic)/Risk Ratio			-0.28	-0.28	-0.28	-0.28	-0.28	-0.27	-0.27	-0.27	-0.27	-0.27	-0.28	-0.29	-0.28	-0.28
Expected Global Equity Beta			0.18	0.18	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.21	0.17	0.17	0.18	0.18
RVK Liquidity Metric (T-Bills = 100)			95	95	95	95	95	95	96	96	96	96	96	95	95	95

Figure A3.4 – Efficient Frontier with Recommended Sovereign Bond Structure

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	23%	19%	15%	11%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	21%	17%	13%	10%	10%	10%	10%	10%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds Rec	30%	70%	30%	34%	38%	43%	47%	51%	55%	59%	63%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation			80%	80%	80%	80%	80%	80%	80%	80%	83%	87%	92%	85%	82%	82%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	4%	10%	8%	8%
Expected Arithmetic Return			-2.48%	-2.45%	-2.43%	-2.40%	-2.37%	-2.34%	-2.31%	-2.28%	-2.25%	-2.22%	-2.38%	-2.33%	-2.28%	-2.33%
Expected Risk (Standard Deviation)			10.64%	10.66%	10.68%	10.70%	10.73%	10.77%	10.82%	10.86%	10.96%	11.08%	11.13%	11.04%	10.91%	10.82%
Expected Compound Return			-3.06%	-3.03%	-3.01%	-2.98%	-2.95%	-2.93%	-2.90%	-2.88%	-2.86%	-2.84%	-3.01%	-2.95%	-2.88%	-2.92%
Expected Return (Arithmetic)/Risk Ratio			-0.23	-0.23	-0.23	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.20	-0.21	-0.21	-0.21	-0.22
Expected Global Equity Beta			0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22
RVK Liquidity Metric (T-Bills = 100)			96	96	96	95	95	95	95	95	95	95	96	95	95	95

Figure A3.5 – Differences between Figure A3.3 and Figure A3.4

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	--	--	-11%	-8%	-5%	-2%	2%	6%	10%	14%	15%	15%	0%	0%	0%	0%
Treasury Bills	--	--	-15%	-11%	-7%	-3%	1%	4%	6%	9%	12%	15%	0%	0%	0%	0%
Sovereign Bonds	--	--	26%	19%	12%	5%	-2%	-9%	-16%	-23%	-30%	-37%	0%	0%	0%	0%
Inflation Linked	--	--	0%	0%	0%	0%	0%	0%	0%	0%	3%	7%	0%	0%	0%	0%
Credit	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Global Equity	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Capital Appreciation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Capital Preservation			0%	0%	0%	0%	0%	0%	0%	0%	-3%	-7%	0%	0%	0%	0%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			0%	0%	0%	0%	0%	0%	0%	0%	3%	7%	0%	0%	0%	0%
Expected Arithmetic Return			-0.35%	-0.37%	-0.39%	-0.41%	-0.43%	-0.45%	-0.48%	-0.50%	-0.52%	-0.55%	-0.53%	-0.60%	-0.56%	-0.49%
Expected Risk (Standard Deviation)			-0.51%	-0.53%	-0.55%	-0.56%	-0.58%	-0.60%	-0.63%	-0.65%	-0.73%	-0.82%	-0.69%	-0.78%	-0.74%	-0.65%
Expected Compound Return			-0.29%	-0.31%	-0.33%	-0.35%	-0.38%	-0.39%	-0.42%	-0.43%	-0.44%	-0.47%	-0.46%	-0.52%	-0.49%	-0.43%
Expected Return (Arithmetic)/Risk Ratio			-0.05	-0.05	-0.05	-0.06	-0.06	-0.05	-0.06	-0.06	-0.06	-0.07	-0.07	-0.08	-0.07	-0.06
Expected Global Equity Beta			-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	-0.01	-0.05	-0.05	-0.04	-0.04
RVK Liquidity Metric (T-Bills = 100)			-1	-1	-1	0	0	0	1	1	1	1	0	0	0	0

Figure A3.6 displays various risk statistics for the portfolios when utilizing Alt SB 1. This can be compared to Figure 5.9 in Section 5.

Figure A3.6 – Portfolio Characteristics with Alt SB 1

	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Expected Arithmetic Return	-2.91%	-2.93%	-2.84%	-2.82%
Expected Compound Return	-3.47%	-3.37%	-3.35%	0.00%
Expected Risk (Standard Deviation)	10.44%	10.26%	10.17%	10.17%
Expected Global Equity Beta	0.17	0.17	0.18	0.18
99% VaR	8.11%	7.92%	7.82%	7.83%
99% C-VaR	8.49%	8.17%	8.06%	8.07%
Expected 1 Year 95th Percentile Drawdown	-13.5%	-14.0%	-13.4%	-12.6%
Expected 1 Year 99th Percentile Drawdown	-17.2%	-18.1%	-17.0%	-16.0%
Fixed Income Duration (Years)	5.4	6.7	6.5	5.8
Portfolio Yield	0.18%	0.31%	0.36%	0.34%

Figure A3.7 compares the correlations of the portfolios using the Alt SB1 sovereign bond structure to copper. When compared to Figure 5.16 in Section 5, the correlation to copper for the portfolios is slightly lower (0.01 - 0.04 lower) using the Alt SB 1 bond structure. While this is a positive, the larger change in expected return outweighs any benefits to slightly reduced copper correlations. Overall the analysis suggests this is less optimal structure for the sovereign bonds portfolio.

Figure A3.7 – Correlation to Copper Alt SB 1

	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Using Alt SB 1					
Historical Correlation to Price of Copper	-0.13	-0.12	-0.12	-0.11	0.19
Historical Beta to Price of Copper	-0.07	-0.07	-0.07	-0.06	0.10
Recommended SB Structure					
Historical Correlation to Price of Copper	-0.09	-0.09	-0.08	-0.08	0.20
Historical Beta to Price of Copper	-0.05	-0.05	-0.04	-0.04	0.10
Change					
Historical Correlation to Price of Copper	-0.03	-0.04	-0.03	-0.03	-0.01
Historical Beta to Price of Copper	-0.02	-0.02	-0.02	-0.02	0.00

We then analyze the Alt SB 2 sovereign bond portfolio structure. The results are similar to the above analysis and again do not alter our recommendations. Figure A3.8 shows the complete set of assumptions used in this analysis.

Figure A3.8 – Alt SB 2 CMAs

	Expected Return (Arithmetic)	Expected Standard Deviation	Correlations					
			Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities
Bank Deposits	-3.08%	11.08%	1.00					
Treasury Bills	-3.08%	11.50%	1.00	1.00				
Sovereign Bonds	-3.49%	11.27%	0.92	0.93	1.00			
Inflation Linked	-3.13%	9.75%	0.86	0.87	0.84	1.00		
Credit	-1.50%	8.50%	0.93	0.93	0.92	0.93	1.00	
Equities	3.24%	15.00%	0.25	0.25	0.12	0.36	0.46	1.00

Figure A3.9 highlights the efficient frontier using the Alt SB 2 structure. Again, comparing this to the original outcomes as shown previously (originally shown in Figure 5.5 in Section 5), we see an increase in allocation to sovereign bonds among the efficient portfolios on the left side of the efficient frontier but a decrease in the more aggressive portfolios on the right. Differences are shown in Figure A3.11. We also see reduced expected returns across the board. All efficient portfolio have lower sovereign bond allocations than Portfolio D. If this sovereign bond structure were to be implemented we would suggest a lower allocation to the asset class. This would be offset with higher allocations to bank deposits and treasury bills. Figure A3.12 shows the portfolio risk statistics. As shown in Figure A3.13 the correlations to copper do fall using the Alt SB 2 structure.

Figure A3.9 – Efficient Frontier with Alt SB 2

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	10%	12%	13%	15%	17%	18%	20%	22%	23%	25%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds Alt 2	30%	70%	45%	43%	42%	40%	38%	37%	35%	33%	32%	30%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100.0%	100.0%	100.0%	100.0%
Capital Appreciation	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	92%	85%	82%	82%
Alpha	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	4%	10%	8%	8%
Expected Arithmetic Return			-2.87%	-2.87%	-2.86%	-2.85%	-2.85%	-2.84%	-2.83%	-2.83%	-2.82%	-2.81%	-3.00%	-3.03%	-2.94%	-2.90%
Expected Risk (Standard Deviation)			10.27%	10.27%	10.28%	10.29%	10.29%	10.30%	10.31%	10.32%	10.32%	10.33%	10.60%	10.45%	10.35%	10.32%
Expected Compound Return			-3.41%	-3.41%	-3.40%	-3.39%	-3.39%	-3.38%	-3.37%	-3.37%	-3.36%	-3.35%	-3.57%	-3.59%	-3.49%	-3.44%
Expected Return (Arithmetic)/Risk Ratio			-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.27	-0.27	-0.27	-0.27	-0.28	-0.29	-0.28	-0.28
Expected Global Equity Beta			0.19	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.20	0.20	0.17	0.16	0.17	0.18
RVK Liquidity Metric (T-Bills = 100)			95	95	95	96	96	96	96	96	96	96	96	95	95	95

Figure A3.10 – Efficient Frontier with Recommended Sovereign Bond Structure

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	23%	19%	15%	11%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	21%	17%	13%	10%	10%	10%	10%	10%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds Rec	30%	70%	30%	34%	38%	43%	47%	51%	55%	59%	63%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	83%	87%	92%	85%	82%	82%
Alpha	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	4%	10%	8%	8%
Expected Arithmetic Return			-2.48%	-2.45%	-2.43%	-2.40%	-2.37%	-2.34%	-2.31%	-2.28%	-2.25%	-2.22%	-2.38%	-2.33%	-2.28%	-2.33%
Expected Risk (Standard Deviation)			10.64%	10.66%	10.68%	10.70%	10.73%	10.77%	10.82%	10.86%	10.96%	11.08%	11.13%	11.04%	10.91%	10.82%
Expected Compound Return			-3.06%	-3.03%	-3.01%	-2.98%	-2.95%	-2.93%	-2.90%	-2.88%	-2.86%	-2.84%	-3.01%	-2.95%	-2.88%	-2.92%
Expected Return (Arithmetic)/Risk Ratio			-0.23	-0.23	-0.23	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.20	-0.21	-0.21	-0.21	-0.22
Expected Global Equity Beta			0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22
RVK Liquidity Metric (T-Bills = 100)			96	96	96	95	95	95	95	95	95	95	96	95	95	95

Figure A3.11 – Differences between Figure A3.9 and Figure A3.10

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	--	--	0%	0%	0%	0%	2%	6%	10%	14%	15%	15%	0.0%	0.0%	0.0%	0.0%
Treasury Bills	--	--	-15%	-9%	-3%	3%	7%	8%	10%	12%	13%	15%	0.0%	0.0%	0.0%	0.0%
Sovereign Bonds	--	--	15%	9%	3%	-3%	-8%	-14%	-20%	-26%	-31%	-37%	0.0%	0.0%	0.0%	0.0%
Inflation Linked	--	--	0%	0%	0%	0%	0%	0%	0%	0%	3%	7%	0.0%	0.0%	0.0%	0.0%
Credit	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Global Equity	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Total			--	--	--	--	--	--	--	--	--	--	--	--	--	--
Capital Appreciation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Capital Preservation			0%	0%	0%	0%	0%	0%	0%	0%	-3%	-7%	0%	0%	0%	0%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			0%	0%	0%	0%	0%	0%	0%	0%	3%	7%	0%	0%	0%	0%
Expected Arithmetic Return			-0.39%	-0.42%	-0.43%	-0.45%	-0.48%	-0.50%	-0.52%	-0.55%	-0.57%	-0.59%	-0.62%	-0.70%	-0.66%	-0.57%
Expected Risk (Standard Deviation)			-0.37%	-0.39%	-0.40%	-0.41%	-0.44%	-0.47%	-0.51%	-0.54%	-0.64%	-0.75%	-0.53%	-0.59%	-0.56%	-0.50%
Expected Compound Return			-0.35%	-0.38%	-0.39%	-0.41%	-0.44%	-0.45%	-0.47%	-0.49%	-0.50%	-0.51%	-0.56%	-0.64%	-0.61%	-0.52%
Expected Return (Arithmetic)/Risk Ratio			-0.05	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.07	-0.07	-0.08	-0.07	-0.06
Expected Global Equity Beta			-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.02	-0.02	-0.05	-0.06	-0.05	-0.04
RVK Liquidity Metric (T-Bills = 100)			-1	-1	-1	1	1	1	1	1	1	1	0	0	0	0

Figure A3.12 – Portfolio Characteristics with Alt SB 2

	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Expected Arithmetic Return	-3.00%	-3.03%	-2.94%	-2.90%
Expected Compound Return	-3.57%	-3.59%	-3.49%	-3.44%
Expected Risk (Standard Deviation)	10.60%	10.45%	10.35%	10.32%
Expected Global Equity Beta	0.17	0.16	0.17	0.18
99% VaR	8.26%	8.09%	7.99%	7.97%
99% C-VaR	8.57%	8.36%	8.24%	8.22%
Expected 1 Year 95th Percentile Drawdown	-13.9%	-14.4%	-13.8%	-13.0%
Expected 1 Year 99th Percentile Drawdown	-17.5%	-18.7%	-17.5%	-16.3%
Fixed Income Duration (Years)	5.3	6.7	6.4	5.8
Portfolio Yield	0.11%	0.23%	0.28%	0.27%

Figure A3.13 – Correlation to Copper Alt SB 2

	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Using Alt SB 2					
Historical Correlation to Price of Copper	-0.13	-0.13	-0.13	-0.12	0.19
Historical Beta to Price of Copper	-0.08	-0.07	-0.07	-0.07	0.09
Recommended SB Structure					
Historical Correlation to Price of Copper	-0.09	-0.09	-0.08	-0.08	0.20
Historical Beta to Price of Copper	-0.05	-0.05	-0.04	-0.04	0.10
Change					
Historical Correlation to Price of Copper	-0.04	-0.04	-0.04	-0.04	-0.01
Historical Beta to Price of Copper	-0.03	-0.03	-0.03	-0.02	0.00

A.3.2 USD Based CMAs (Real)

In this section we compare the results of the optimization using USD based assumptions. Figure A3.14 shows the complete set of assumptions used in this analysis. Figure A3.15 shows the efficient frontier using these assumptions. Figure A3.16 shows the original result using CLP based assumptions. Finally Figure A3.17 shows the differences between the two optimizations. We note two primary observations when comparing the efficient portfolios from each frontier. First, the USD based assumption set prefers treasury bills over bank deposits when compared to the frontier based in CLP. Second, the USD based frontier selects lower levels of inflation-linked bonds across most of the frontier. This is a result of the volatility assumption falling less for inflation linked relative to the other assets classes in this set of assumptions. Risk is significantly lower in the USD frontier while return is significantly higher across all portfolios. The lower levels of risk are driven by the lack of conversion

from global currencies to the CLP, which introduces additional volatility compared to the USD. Examining Figure A3.19 we see correlations to copper are much higher using the USD assumptions.

Figure A3.14 – Real USD CMAs

	Expected Return (Arithmetic)	Expected Standard Deviation	Correlations					
			Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities
Bank Deposits	-1.23%	4.50%	1.00					
Treasury Bills	-1.23%	4.25%	0.99	1.00				
Sovereign Bonds	-0.63%	7.00%	0.92	0.92	1.00			
Inflation Linked	-1.42%	6.75%	0.61	0.65	0.75	1.00		
Credit	0.30%	5.00%	0.57	0.56	0.69	0.86	1.00	
Equities	5.05%	16.25%	0.22	0.22	0.18	0.41	0.67	1.00

Figure A3.15 – Efficient Frontier USD Real

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	21%	17%	12%	10%	10%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	25%	25%	25%	25%	25%	23%	19%	14%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds	30%	70%	30%	33%	37%	41%	45%	50%	54%	58%	63%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	7%	3%	3%	3%	3%	3%	3%	3%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation	80%	83%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	92%	85%	82%	82%
Alpha	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation	10%	7%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	4%	10%	8%	8%
Expected Arithmetic Return	-0.68%	-0.65%	-0.63%	-0.60%	-0.57%	-0.55%	-0.52%	-0.50%	-0.47%	-0.44%	-0.42%	-0.40%	-0.58%	-0.56%	-0.49%	-0.54%
Expected Risk (Standard Deviation)	5.15%	5.19%	5.24%	5.34%	5.46%	5.57%	5.68%	5.81%	5.94%	6.06%	6.19%	6.32%	6.06%	5.79%	6.06%	5.72%
Expected Compound Return	-0.81%	-0.79%	-0.77%	-0.74%	-0.72%	-0.71%	-0.68%	-0.67%	-0.65%	-0.62%	-0.61%	-0.59%	-0.75%	-0.74%	-0.67%	-0.70%
Expected Return (Arithmetic)/Risk Ratio	-0.13	-0.13	-0.12	-0.11	-0.10	-0.10	-0.09	-0.09	-0.08	-0.07	-0.07	-0.07	-0.09	-0.09	-0.08	-0.09
Expected Global Equity Beta	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.13	0.14	0.13
RVK Liquidity Metric (T-Bills = 100)	96	96	96	96	96	96	96	96	96	95	95	95	96	95	95	95

Figure A3.16 – Efficient Frontier CLP Real

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	23%	19%	15%	11%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	21%	17%	13%	10%	10%	10%	10%	10%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds	30%	70%	30%	34%	38%	43%	47%	51%	55%	59%	63%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	83%	87%	92%	85%	82%	82%
Alpha	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	4%	10%	8%	8%
Expected Arithmetic Return	-2.48%	-2.45%	-2.43%	-2.40%	-2.37%	-2.34%	-2.31%	-2.28%	-2.25%	-2.22%	-2.22%	-2.22%	-2.38%	-2.33%	-2.28%	-2.33%
Expected Risk (Standard Deviation)	10.64%	10.66%	10.68%	10.70%	10.73%	10.77%	10.82%	10.86%	10.96%	11.08%	11.13%	11.13%	11.13%	11.04%	10.91%	10.82%
Expected Compound Return	-3.06%	-3.03%	-3.01%	-2.98%	-2.95%	-2.93%	-2.90%	-2.88%	-2.86%	-2.84%	-2.84%	-2.84%	-3.01%	-2.95%	-2.88%	-2.92%
Expected Return (Arithmetic)/Risk Ratio	-0.23	-0.23	-0.23	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.21	-0.22
Expected Global Equity Beta	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22
RVK Liquidity Metric (T-Bills = 100)	96	96	96	95	95	95	95	95	95	95	95	95	96	95	95	95

Figure A3.17 – Differences between Figure A3.15 and Figure A3.16

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	--	--	0%	0%	0%	-4%	-7%	-7%	-5%	-1%	0%	0%	0.0%	0.0%	0.0%	0.0%
Treasury Bills	--	--	0%	4%	8%	13%	15%	15%	13%	9%	4%	0%	0.0%	0.0%	0.0%	0.0%
Sovereign Bonds	--	--	0%	-1%	-2%	-2%	-2%	-1%	-1%	-1%	-1%	0%	0.0%	0.0%	0.0%	0.0%
Inflation Linked	--	--	0%	-3%	-7%	-7%	-7%	-7%	-7%	-7%	-4%	0%	0.0%	0.0%	0.0%	0.0%
Credit	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Global Equity	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Capital Appreciation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Capital Preservation			0%	3%	7%	7%	7%	7%	7%	7%	4%	0%	0%	0%	0%	0%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			0%	-3%	-7%	-7%	-7%	-7%	-7%	-7%	-4%	0%	0%	0%	0%	0%
Expected Arithmetic Return			1.80%	1.80%	1.80%	1.80%	1.80%	1.79%	1.79%	1.78%	1.78%	1.78%	1.80%	1.77%	1.79%	1.79%
Expected Risk (Standard Deviation)			-5.49%	-5.47%	-5.44%	-5.36%	-5.27%	-5.20%	-5.14%	-5.05%	-5.02%	-5.02%	-5.34%	-4.98%	-4.97%	-5.10%
Expected Compound Return			2.25%	2.24%	2.24%	2.24%	2.23%	2.22%	2.22%	2.21%	2.21%	2.21%	2.26%	2.21%	2.21%	2.22%
Expected Return (Arithmetic)/Risk Ratio			0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.11	0.12	0.13	0.13
Expected Global Equity Beta			-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.09	-0.09	-0.10	-0.09	-0.08	-0.09
RVK Liquidity Metric (T-Bills = 100)			0	0	0	1	1	1	1	0	0	0	0	0	0	0

Figure A3.18 – Portfolio Characteristics using USD Real CMAs

	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Expected Arithmetic Return	-0.58%	-0.56%	-0.49%	-0.54%
Expected Compound Return	-0.75%	-0.74%	-0.67%	-0.70%
Expected Risk (Standard Deviation)	5.79%	6.06%	5.94%	5.72%
Expected Global Equity Beta	0.12	0.13	0.14	0.13
99% VaR	4.26%	4.43%	4.32%	4.16%
99% C-VaR	4.49%	4.68%	4.52%	4.33%
Expected 1 Year 95th Percentile Drawdown	-7.3%	-8.0%	-7.6%	-6.9%
Expected 1 Year 99th Percentile Drawdown	-10.0%	-11.0%	-10.3%	-9.3%
Fixed Income Duration (Years)	3.9	5.1	5.0	4.5
Portfolio Yield	0.30%	0.45%	0.49%	0.44%

Figure A3.19 – Correlation to Copper USD Real

	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
USD Real					
Historical Correlation to Price of Copper	0.19	0.21	0.22	0.22	0.53
Historical Beta to Price of Copper	0.04	0.05	0.05	0.05	0.18
CLP Real					
Historical Correlation to Price of Copper	-0.09	-0.09	-0.08	-0.08	0.20
Historical Beta to Price of Copper	-0.05	-0.05	-0.04	-0.04	0.10
Change					
Historical Correlation to Price of Copper	0.28	0.30	0.30	0.30	0.33
Historical Beta to Price of Copper	0.09	0.09	0.09	0.09	0.08

A.3.3 Nominal CMAs (CLP)

In this section we compare the outcomes of using nominal assumptions compared to the baseline real assumptions used in the body of the report. Both assumption sets are based in CLP. Figure A3.20 shows the complete set of assumptions used in this analysis. Figure A3.21 shows the efficient frontier based on the nominal assumptions. Figure A3.22 shows the efficient frontier based on real assumptions and Figure A3.23 shows the differences between the two efficient frontiers. As we would expect, there are no differences in the efficient portfolios produced under the two sets of assumptions. This is due to the fact that adding (or subtracting) a constant (such as inflation) to the expected return of each asset class does not shift the expected risk-return tradeoff and therefore does not result in different efficient allocations. The return for each portfolios is offset by the inflation assumption of 3.00.

Figure A3.20 – Nominal CLP CMAs

	Expected Return (Arithmetic)	Expected Standard Deviation	Correlations						
			Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities	
Bank Deposits	-0.08%	11.75%	1.00						
Treasury Bills	-0.08%	12.50%	1.00	1.00					
Sovereign Bonds	0.61%	12.75%	0.95	0.96	1.00				
Inflation Linked	-0.13%	10.50%	0.87	0.87	0.90	1.00			
Credit	1.50%	9.50%	0.94	0.93	0.92	0.93	1.00		
Equities	6.24%	14.00%	0.25	0.25	0.21	0.35	0.46	1.00	

Figure A3.21 – Efficient Frontier CLP Nominal

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	23%	19%	15%	11%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	21%	17%	13%	10%	10%	10%	10%	10%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds Alt 1	30%	70%	30%	34%	38%	43%	47%	51%	55%	59%	63%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation			80%	80%	80%	80%	80%	80%	80%	80%	83%	87%	92%	85%	82%	82%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	4%	10%	8%	8%
Expected Arithmetic Return			0.52%	0.55%	0.57%	0.60%	0.63%	0.66%	0.69%	0.72%	0.75%	0.78%	0.62%	0.67%	0.73%	0.67%
Expected Risk (Standard Deviation)			11.38%	11.39%	11.39%	11.40%	11.43%	11.48%	11.52%	11.58%	11.68%	11.80%	11.86%	11.74%	11.62%	11.52%
Expected Compound Return			-0.12%	-0.09%	-0.07%	-0.04%	-0.01%	0.01%	0.04%	0.06%	0.08%	0.10%	-0.07%	-0.01%	0.07%	0.02%
Expected Return (Arithmetic)/Risk Ratio			0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.07	0.05	0.06	0.06	0.06
Expected Global Equity Beta			0.26	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.25	0.25
RVK Liquidity Metric (T-Bills = 100)			96	96	96	95	95	95	95	95	95	95	96	95	95	95

Figure A3.22 – Efficient Frontier CLP Real

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	23%	19%	15%	11%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	21%	17%	13%	10%	10%	10%	10%	10%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds Rec	30%	70%	30%	34%	38%	43%	47%	51%	55%	59%	63%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation			80%	80%	80%	80%	80%	80%	80%	80%	83%	87%	92%	85%	82%	82%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	4%	10%	8%	8%
Expected Arithmetic Return			-2.48%	-2.45%	-2.43%	-2.40%	-2.37%	-2.34%	-2.31%	-2.28%	-2.25%	-2.22%	-2.38%	-2.33%	-2.28%	-2.33%
Expected Risk (Standard Deviation)			10.64%	10.66%	10.68%	10.70%	10.73%	10.77%	10.82%	10.86%	10.96%	11.08%	11.13%	11.04%	10.91%	10.82%
Expected Compound Return			-3.06%	-3.03%	-3.01%	-2.98%	-2.95%	-2.93%	-2.90%	-2.88%	-2.86%	-2.84%	-3.01%	-2.95%	-2.88%	-2.92%
Expected Return (Arithmetic)/Risk Ratio			-0.23	-0.23	-0.23	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.20	-0.21	-0.21	-0.21	-0.22
Expected Global Equity Beta			0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22
RVK Liquidity Metric (T-Bills = 100)			96	96	96	95	95	95	95	95	95	95	96	95	95	95

Figure A3.23 – Differences between Figure A3.21 and Figure A3.22

Credit	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Treasury Bills	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Sovereign Bonds	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Inflation Linked	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Credit	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Global Equity	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%	0.0%	0.0%	0.0%
Total	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Capital Appreciation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Capital Preservation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Expected Arithmetic Return			3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.01%	3.00%
Expected Risk (Standard Deviation)			0.74%	0.73%	0.71%	0.70%	0.70%	0.71%	0.70%	0.72%	0.72%	0.72%	0.73%	0.70%	0.71%	0.70%
Expected Compound Return			2.94%	2.94%	2.94%	2.94%	2.94%	2.94%	2.94%	2.94%	2.94%	2.94%	2.94%	2.94%	2.95%	2.94%
Expected Return (Arithmetic)/Risk Ratio			0.28	0.28	0.28	0.27	0.28	0.28	0.27	0.27	0.27	0.27	0.26	0.27	0.27	0.28
Expected Global Equity Beta			0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.03
RVK Liquidity Metric (T-Bills = 100)			0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure A3.24 – Portfolio Characteristics with CLP Nominal

	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Expected Arithmetic Return	0.62%	0.67%	0.73%	0.67%
Expected Compound Return	-0.07%	-0.01%	0.07%	0.02%
Expected Risk (Standard Deviation)	11.86%	11.74%	11.62%	11.52%
Expected Global Equity Beta	0.24	0.24	0.25	0.25
99% VaR	8.71%	8.55%	8.44%	8.39%
99% C-VaR	9.03%	8.93%	8.77%	8.65%
Expected 1 Year 95th Percentile Drawdown	-11.7%	-12.5%	-11.9%	-10.8%
Expected 1 Year 99th Percentile Drawdown	-15.9%	-17.4%	-16.3%	-15.2%
Fixed Income Duration (Years)	3.9	5.1	5.0	4.5
Portfolio Yield	0.30%	0.45%	0.49%	0.44%

Figure A3.25 – Correlation to Copper CLP Nominal

	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Nominal CLP					
Historical Correlation to Price of Copper	-0.12	-0.11	-0.11	-0.11	0.17
Historical Beta to Price of Copper	-0.06	-0.06	-0.06	-0.06	0.08
Real CLP					
Historical Correlation to Price of Copper	-0.09	-0.09	-0.08	-0.08	0.20
Historical Beta to Price of Copper	-0.05	-0.05	-0.04	-0.04	0.10
Change					
Historical Correlation to Price of Copper	-0.02	-0.02	-0.02	-0.02	-0.03
Historical Beta to Price of Copper	-0.01	-0.01	-0.01	-0.01	-0.01

A.3.4 Constant Currency CMA's (Real CLP)

In this section we examine a set of assumptions that assumes currency levels do not change on average going forward and therefore there is no effect of currency on returns. Currency still effects volatility and correlations. Figure A3.26 shows the complete set of assumptions used in this analysis. Figure A3.27 shows the efficient frontier under this set of assumptions. Figure A3.28 shows the efficient frontier under the original set of assumptions. Finally, Figure A3.29 shows the differences between the two efficient frontiers. The outcomes in terms of efficient portfolios produced by the optimization are effectively unchanged. This is in large part because the effect from eliminating currency movements in return is largely similar for all asset classes. This leaves the risk/return tradeoff for each asset class largely unchanged. Just as in Section A.3.3, when we add a constant to the expected return of each asset class, the optimization does not produce difference results.

Figure A3.26 – Constant Currency (Real CLP) CMA's

	Expected Return (Arithmetic)	Expected Standard Deviation	Correlations						
			Bank Deposits	Treasury Bills	Sovereign Bonds	Inflation Linked	Credit	Equities	
Bank Deposits	-2.23%	11.08%	1.00						
Treasury Bills	-2.23%	11.50%	1.00	1.00					
Sovereign Bonds	-1.63%	11.27%	0.95	0.96	1.00				
Inflation Linked	-2.42%	9.75%	0.86	0.87	0.90	1.00			
Credit	-0.70%	8.50%	0.93	0.93	0.92	0.93	1.00		
Equities	4.05%	15.00%	0.25	0.25	0.21	0.36	0.46	1.00	

Figure A3.27 – Efficient Frontier Constant Currency (Real CLP)

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	23%	18%	14%	10%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	21%	16%	12%	10%	10%	10%	10%	10%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds	30%	70%	30%	34%	39%	43%	47%	52%	56%	60%	64%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	6%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation			80%	80%	80%	80%	80%	80%	80%	80%	84%	87%	92%	85%	82%	82%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			10%	10%	10%	10%	10%	10%	10%	10%	6%	3%	4%	10%	8%	8%
Expected Arithmetic Return			-1.68%	-1.65%	-1.63%	-1.60%	-1.57%	-1.55%	-1.52%	-1.50%	-1.47%	-1.44%	-1.58%	-1.56%	-1.49%	-1.54%
Expected Risk (Standard Deviation)			10.64%	10.66%	10.68%	10.70%	10.74%	10.78%	10.83%	10.89%	10.98%	11.08%	11.13%	11.04%	10.91%	10.82%
Expected Compound Return			-2.25%	-2.22%	-2.20%	-2.18%	-2.15%	-2.13%	-2.11%	-2.10%	-2.08%	-2.06%	-2.20%	-2.17%	-2.09%	-2.13%
Expected Return (Arithmetic)/Risk Ratio			-0.16	-0.15	-0.15	-0.15	-0.15	-0.14	-0.14	-0.14	-0.13	-0.13	-0.14	-0.14	-0.14	-0.14
Expected Global Equity Beta			0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22	0.22
RVK Liquidity Metric (T-Bills = 100)			96	96	96	95	95	95	95	95	95	95	96	95	95	95

Figure A3.28 – Efficient Frontier CLP Real

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	10%	25%	25%	25%	25%	25%	23%	19%	15%	11%	10%	10%	15.5%	12.0%	12.0%	20.0%
Treasury Bills	10%	25%	25%	21%	17%	13%	10%	10%	10%	10%	10%	10%	19.5%	10.0%	10.0%	10.0%
Sovereign Bonds	30%	70%	30%	34%	38%	43%	47%	51%	55%	59%	63%	67%	56.5%	63.0%	60.0%	52.0%
Inflation Linked	3%	10%	10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	3.5%	10.0%	8.0%	8.0%
Credit	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	0.0%	0.0%	5.0%	5.0%
Global Equity	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5.0%	5.0%	5.0%	5.0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Capital Appreciation			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	5%	5%	10%	10%
Capital Preservation			80%	80%	80%	80%	80%	80%	80%	80%	83%	87%	92%	85%	82%	82%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			10%	10%	10%	10%	10%	10%	10%	10%	7%	3%	4%	10%	8%	8%
Expected Arithmetic Return			-2.48%	-2.45%	-2.43%	-2.40%	-2.37%	-2.34%	-2.31%	-2.28%	-2.25%	-2.22%	-2.38%	-2.33%	-2.28%	-2.33%
Expected Risk (Standard Deviation)			10.64%	10.66%	10.68%	10.70%	10.73%	10.77%	10.82%	10.86%	10.96%	11.08%	11.13%	11.04%	10.91%	10.82%
Expected Compound Return			-3.06%	-3.03%	-3.01%	-2.98%	-2.95%	-2.93%	-2.90%	-2.88%	-2.86%	-2.84%	-3.01%	-2.95%	-2.88%	-2.92%
Expected Return (Arithmetic)/Risk Ratio			-0.23	-0.23	-0.23	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.20	-0.21	-0.21	-0.21	-0.22
Expected Global Equity Beta			0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22
RVK Liquidity Metric (T-Bills = 100)			96	96	96	95	95	95	95	95	95	95	96	95	95	95

Figure A3.29 – Differences between Figure A3.27 and Figure A3.28

	Min	Max	1	2	3	4	5	6	7	8	9	10	Portfolio B	Portfolio C	Portfolio D	Portfolio E
Bank Deposits	--	--	0%	0%	0%	0%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%
Treasury Bills	--	--	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sovereign Bonds	--	--	0%	0%	0%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%
Inflation Linked	--	--	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%
Credit	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Global Equity	--	--	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total			--	--	--	--	--	--	--	--	--	--	--	--	--	--
Capital Appreciation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Capital Preservation			0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
Alpha			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Inflation			0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%
Expected Arithmetic Return			0.80%	0.80%	0.80%	0.80%	0.80%	0.79%	0.79%	0.78%	0.78%	0.78%	0.80%	0.77%	0.79%	0.79%
Expected Risk (Standard Deviation)			0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.03%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
Expected Compound Return			0.81%	0.81%	0.81%	0.80%	0.80%	0.80%	0.79%	0.78%	0.78%	0.78%	0.81%	0.78%	0.79%	0.79%
Expected Return (Arithmetic)/Risk Ratio			0.07	0.08	0.08	0.07	0.07	0.08	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.08
Expected Global Equity Beta			0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
RVK Liquidity Metric (T-Bills = 100)			0	0	0	0	0	0	0	0	0	0	0	0	0	0

A.3.5 Reduced Correlation to the Price of Copper

As a last objective we attempted to reduce the correlation of the portfolios to the price of copper. In the current construct, we were unable to materially reduce this correlation. The only 3 asset classes with negative correlations to the price of copper are bank deposits, treasury bills, and sovereign bonds. In order to reduce the correlation we modeled bank deposits and treasury bills as 100% Yen and sovereign bonds as 100% USD. In each case this represented the currency for each asset class that had the lowest correlation to the price of copper (in real CLP). Figure A3.30 shows the resulting reduction in correlation to coppers prices for each of the portfolios analyzed in this report. For Portfolio D, the correlation dropped from -0.08 to -0.16. We do not believe these are prudent or desirable asset class structures, particularly for the small change in correlation to copper prices.

Figure A3.30 – Correlation to Copper Prices (Real CLP)

	Portfolio B	Portfolio C	Portfolio D	Portfolio E	Portfolio F
Baseline Asset Class Structure	-0.09	-0.09	-0.08	-0.08	0.20
Minimum Copper Correlation Structure	-0.18	-0.17	-0.16	-0.17	0.16
Change	-0.09	-0.08	-0.08	-0.08	-0.04

A.4 Recommendations by Asset Level

Late in the writing of this report, RVK was asked to create multiple portfolios, each reflecting reasonable asset allocation mixes based on portfolio breakpoints by asset levels. These breakpoints were determined in conjunction with the MoF, as well as RVK's view of the reasonable asset size required for various asset classes. Factors we considered in determining the appropriate break points included:

- Sizing of past and expected withdrawals
- Liquidity of asset classes
- Asset class implementation parameters
- Portfolio duration

Without certainty about future withdrawals, RVK is forced to be conservative with our recommendations and prioritize liquidity over other factors (including expected return and risk) at low asset levels. Should asset levels stabilize and become more certain, liquidity can become less of a concern. This is discussed in more detail later.

The breakpoints considered the size of past and expected withdrawals from the portfolio (liquidity needs). Looking at Figure 6.7, the minimum stimulus withdrawal in a given calendar year has been \$2 billion USD. Even if we assumed stimulus at half of this level, a \$3 billion USD portfolio could see withdrawals of 33%+, which necessitates an extremely liquid portfolio. With a \$5 billion USD portfolio size the same withdrawal would be 20% of assets. While still significant, this is at a level that is more manageable in the short-term. Even at a \$5 billion USD portfolio size RVK is recommending a 48% allocation to treasury bills. At \$3 billion this would allow for a quick withdrawal of \$1.44 billion USD and at \$5 billion USD a \$2.4 billion payout without forced selling of assets beyond treasury bills. As the portfolio size grows in the future, certain risks – duration, equity, credit, etc. – can be introduced as the near term liquidity demands would have less impact on total portfolio size.

Asset class liquidity is an important factor in determining appropriate allocation levels when liquidity demands may be high. This precludes the investment of several asset classes at lower asset levels. For example, while equity and credit are highly liquid, during times of market stress liquidity tends to be reduced. The asset may be able to be sold, but at prices far below acceptable levels. Forced selling of assets at depressed prices reduces long-term returns for the portfolio. This makes equity and credit less appropriate at lower asset levels. Bank deposits are not traded on the market and must wait until maturity in order to use them to meet withdrawal needs. Therefore, they are also not appropriate at significantly depressed asset levels.

Asset class implementation is also a consideration for allocation at given asset levels. For example, the recommended credit allocation of 5% in the long-term portfolio would not be easily implemented at lower asset levels; this allocation will require custom separate accounts with (likely) multiple investment managers and would not be prudent

nor cost effective below a certain size. In a separate account vehicle, a certain minimum investment is required to ensure proper security diversification.

Finally, duration was also a factor in determining the asset allocation by portfolio asset size. While sovereign bonds and inflation linked will likely meet the hurdles discussed above for inclusion in a smaller portfolio, they have a significant duration that does not align with the potential duration of withdrawals. This leaves the portfolio susceptible to interest rate movements. For this reason, we have excluded these asset classes from the smallest portfolio size.

The recommended allocations are shown in Figure A4.1.

Implicit in the assumption for liquidity needs is that continued withdrawals will be made and/or additional assets will not be added to the ESSF. These assumptions imply a short time horizon for the portfolio.

The first portfolio is designed to maximize liquidity and is therefore 100% treasury bills. This reduces the overall expected return of the portfolio when we compare it to the long-term portfolio for when assets are increased above \$5 billion USD. This return reduction is necessary to be able to quickly generate cash should additional withdrawals be needed.

The portfolio for assets between \$3 billion USD and \$5 billion USD begins to transition towards the long-term recommendation. Bank deposits, inflation linked, and equities are introduced. However, the portfolio still maintains a higher level of liquidity with 48% allocated to treasury bills. The return of this portfolio is improved compared to the portfolio discussed above.

Finally, when assets are again over \$5 billion USD, RVK recommends implementing the recommended portfolio discussed in this bulk of this report. In addition to increasing the sovereign bonds allocation it also introduces a credit allocation.

Figure A4.1 – Recommended Asset Allocations by Asset Level

	Less than \$3 Billion USD	Between \$3 and \$5 Billion USD	Greater than \$5 Billion USD
Bank Deposits	-	12.0	12.0
Treasury Bills	100.0	48.0	10.0
Sovereign Bonds	-	30.0	60.0
Inflation Linked	-	5.0	8.0
Credit	-	-	5.0
Global Equity	-	5.0	5.0
Total	100	100	100
Expected Arithmetic Return	-3.08	-2.56	-2.28
Expected Risk (Standard Deviation)	11.08	10.99	10.91

The recommendation for a 100% treasury bills portfolio at assets less than \$3 billion USD is based on the assumption that the horizon of the ESSF has materially shortened. As discussed elsewhere, this is a result of the uncertainty surrounding future withdrawals and their likely size relative to remaining assets. However, should the MoF and FC feel confident that the size of the ESSF has stabilized and future withdrawals are unlikely, there may be an opportunity to rethink the correct asset mix at a \$3 billion USD portfolio size. Essentially, if we assume the horizon is mid- to long-term at current asset levels, a more diversified asset allocation may make sense. The primary attribute of the 100% treasury bill allocation that makes it desirable at current asset levels is its liquidity profile. With a long horizon, liquidity does not need to be the only driver of asset allocation. Under this scenario, the ESSF could begin shifting towards the \$3 - \$5 billion USD portfolio. This would improve the long-term return expectation of the ESSF and actually slightly reduce expected risk as shown in Figure A4.1.

RVK would still recommend holding off on a credit mandate until asset levels increased. As previously discussed, even if the illiquidity was not an issue, the mandate size could pose a challenge. At \$3 billion USD, the credit mandate would be \$150 million. While it is certainly possible to find a manager to run a separate account at this size, it is on the lower end of the spectrum and may become an unsustainable option should assets move lower again.

We believe the FC should understand to the best their ability the likely sizing of the ESSF going forward before implementing any of these asset allocations. There are consequences to future return and costs should the decision be made to move to the 100% treasury bill allocation and then quickly reversed to a more diversified allocation. For example, if equities are sold, they would need to be repurchased to reestablish an allocation. This would result in unnecessary transition costs.

Should the 100% treasury bill allocation be implemented followed by a stabilization in asset levels, RVK would recommend adding a sovereign bond allocation first, followed by bank deposits and inflation linked. Equity should be next and credit would be the last asset class added. The addition of sovereign bonds would help increase the portfolio's yield and provide a better duration match of potential cash flows and investments. As an example, if sovereign bonds were added back to the ESSF, we would add a 30% allocation per the recommended target and leave the remaining assets (70%) in treasury bills.

A.5 Recommended Benchmarks and Asset Allocation

The table below includes RVK’s proposed asset allocation and benchmarks for the ESSF portfolio when assets are greater than \$5 billion. While RVK has proposed two additional portfolio allocations for portfolio balances less than \$3 billion, and between \$3 and \$5 billion, the proposed implementation and associated benchmarks for each asset class remains unchanged.

Asset Class	Sub-Asset Class	Benchmark	Proposed Policy Weight	
Bank Deposits	US Dollar-Denominated Deposits	ICE BofA US Dollar 3 Month Deposit Bid Rate Average Index	12.00%	6.00%
	Euro-Denominated Deposits	ICE BofA Euro Currency 3 Month Deposit Bid Rate Average Index		3.00%
	Yen-Denominated Deposits	ICE BofA Japanese Yen 3 Month Deposit Bid Rate Average Index		3.00%
Treasury Bills	US Treasury Bills	ICE BofA US Treasury Bills Index	10.00%	5.00%
	German Treasury Bills	ICE BofA German Treasury Bills Index		2.50%
	Japan Treasury Bills	ICE BofA Japan Treasury Bills Index		2.50%
Sovereign Bonds	Global Sovereign Bonds	Bloomberg Barclays Global Aggregate - Treasury 5-7 Yr Index	60.00%	60.00%
Inflation Linked	Global Inflation-Indexed Sovereign Bonds	Bloomberg Barclays Global Inflation-Linked Index	8.00%	8.00%
Credit	Global Investment Grade Corporate Credit	Bloomberg Barclays Global Aggregate Corporates UH USD	5.00%	2.50%
	Global High Yield	Bloomberg Barclays US Corporate High Yield		0.25%
	Bank Loans	Credit Suisse Leveraged Loan Index		0.25%
	MBS	Bloomberg Barclays US Mortgage Backed Securities (MBS) Index		1.75%
	EMD Corporate	JPM CEMBI Broad Diversified Index		0.25%
Equities	Equities	MSCI All Country World Index ex Chile GR UH USD	5.00%	5.00%

About RVK

RVK was founded in 1985 to focus exclusively on investment consulting and today employs over 100 professionals. The firm is headquartered in Portland, Oregon, with regional offices in Boise, Chicago, and New York City. RVK is one of the five largest consulting firms in the world, as reported by Pensions & Investments' 2020 Special Report – Consultants. Additionally, RVK received a notable award in April 2021 when it was named a Coalition Greenwich Quality Leader among large US investment consultants, based upon Greenwich's 2020 study. Coalition Greenwich is an industry-recognized third-party firm which asks plan sponsors to rank their consultants on a series of key metrics. Notably, RVK is the only firm among large US consultants to receive an award for a fourth consecutive year.² RVK's diversified client base of over 190 clients covers more than 30 states, and covers endowments, foundations, corporate and public defined benefit and contribution plans, Taft-Hartley plans, and high-net-worth individuals and families. The firm is independent, employee owned, and derives 100% of its revenues from investment consulting services.


² Between July and October 2020, Coalition Greenwich (formerly known as Greenwich Associates) conducted in-person and phone interviews and online surveys with 856 individuals at 704 of the largest tax-exempt funds in the US—including corporate and union funds, public funds, endowments and foundations, insurance general accounts, and healthcare organizations, with either pension or investment pool assets greater than \$150 million. Study participants were asked to provide quantitative and qualitative evaluations of their asset managers and investment consultants, including qualitative assessments of those firms soliciting their business and detailed information on important market trends. RVK is one of three firms recognized in the large investment consultant category. The ratings may not be representative of any one client's experience with RVK; rather they are representative of those clients that chose to participate in the survey. The results are not indicative of RVK's future performance. To read the Greenwich press release, please refer to the following URL: <https://www.greenwich.com/press-release/covid-19-crisis-put-investment-consultant-advisory-capabilities-test>
For more information about RVK, please refer to the following URL: <https://www.rvkinc.com/about/about.php>

PORTLAND

BOISE

CHICAGO

NEW YORK

A landscape photograph of rolling green hills under a clear sky. A dirt road winds through the hills, and a single tree stands on a ridge in the distance. The image is partially obscured by a large green curved shape on the right side of the page.

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