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FEASIBILITY OF GDP-LINKED BONDS

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ABSTRACT

GDP-Linked Bonds are a relatively new product in financial markets that can be utilized by sovereign nations and investors in order to diversify their fiscal debt structure and investment portfolios, respectively. This new investment instrument has a variety of advantages and disadvantages that will be discussed throughout this thesis. This work explores GDP-Linked bonds, their history in the financial markets, and current and previous research surrounding the topic. This research leads us to insight on the appropriate risk premium for a 10-year US GDP-Linked Bond, the logistics and design of a GDP-Linked Bond, and how this instrument would price in certain market conditions. This work is intended to support previous works surrounding GDP-Linked Bonds in an effort to raise awareness to the advantages of using such a debt instrument in financial markets in the global landscape today.

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Chapter 1

An Analysis of GDP Linked-Bonds

GDP-Linked Bonds (GLB's) are fixed-income investment vehicles that could be the future of sovereign debt issuances implemented over the next century. GLB's provide advantages for both governments and investors that will be explained throughout this study. This study will begin by explaining what GLB's are and determining the feasibility of these instruments in the current market landscape. It will then address the advantages and disadvantages of these instruments to stakeholder groups such as governments, citizens, investors, etc. The study will then hypothesize the design and logistics of such a bond and what risk premium investors would require for a US GLB. Due to the complexity of this type of investment instrument I have constructed a simple, back of the envelope model to understand the bond's price in certain conditions. Before we proceed in this study, let's examine what GLB's are and the history surrounding the topic.

What are GLB's?

In short, GLB's are fixed-income investment instruments issued by sovereign nations and rather than fixed coupon payments to investors, governments pledge to pay coupons in proportion to the resources they have, measured by their respective GDP's. It is important to address why a government would value GLB's over typical treasury bonds before we dive deeper.

The rationale behind GLB's is that in times of economic decline, when economic activity is low and tax revenues are weak, coupons payments on outstanding debt would fall. As a result, government liabilities are reduced which helps diminish the chance of a debt crisis. While it is easy to understand how GLB's can assist governments in economic downturn, this investment vehicle has an opposite effect in times of economic expansion. Hence, coupon payments on GLB's would increase during economic expansion and take money out of the economy and pay it to investors around the world.

Challenges Facing GLB's

As discussed above, there are clear advantages of issuing such bonds to prevent economic collapse, so why are governments hesitant to issue these investment vehicles? Countries issuing GLB's face many challenges with respect to fiscal discipline. As a result, GLB's can be assessed in terms of both their practicality as well as the frugality that GLB's impose on the sovereign governments that elect to issue GLB'S.

Due to the relative "new-ness" of these bonds and the relative lack of experience sovereign nations have with issuing GLB's, governments are hesitant to be the first to explore these instruments. While studies can depict the hypothetical advantages and disadvantages of issuing GLB's, there is risk associated with being the first one to issue such a bond. Furthermore, it is hard to determine how these instruments would work. How much risk premium will

investors demand? How is GDP measured? How much GDP-linked debt should a country issue? What volatility would such an instrument have? What liquidity would this market face?

Current Landscape

It is evident that there are concerns for a government to issue such instruments; however, in today's landscape the advantages in using GLB's are more plentiful than ever before. Increased levels of debt can be seen across the world following the 2008 financial crisis. Due to the increased levels of debt in today's environment, central governments have little room to raise more debt in times of economic downturn. However, using GLB's governments can essentially expand fiscal space. As economic downturn arises, coupon payments would fall, lessening debt payments and allowing sovereign nations to raise more debt. As mentioned earlier, this would reduce the need for bailout packages and help to eliminate sovereign defaults.

Chapter 2

General Bond Theory

Before we dive deeper into GLB's it is important to understand general bond theory. General bond theory explains the purpose of bonds and what drives or changes their price.

Bonds can be issued by either a form of government (national, state, or local) or a specific company in order to raise capital by taking on debt. Governments and companies use bonds when they need to borrow large sums of money that banks cannot provide on their own. In this case the government or company would be considered the borrower and the investors that buy the bond are considered the lenders. In exchange for buying the bond, the borrower typically agrees to pay back the lender the face value of the loan, the original price of the bond when issued, and periodic interest or coupon payments (typically once or twice a year). For example, a 30-year annual bond with a 5% coupon and $1,000 face value would pay $50 a year for 30 years and in year 30 they would also return the $1,000 they borrowed to begin with.

The above example shows what an average coupon bond would look like however there are other variations of bonds. Another common example is a discount bond, or a zero-coupon bond, which is typically bought below face value or at a discount and is repaid full face value at maturity. However, a discount bond pays no coupon payments throughout the life of the bond which is why it sells at a discount.

The main difference between a stock and a bond is that when you purchase a stock you are buying ownership in a firm while a bond has no ownership rights. You are simply agreeing to lend to a certain amount of money for more money in the future. The reason borrowers will agree to pay more money in the future is because of the time value of money; $50 in your wallet today is more valuable than $50 in your wallet in one year.

US government debt is issued and named treasury bills around the world and this debt is considered to be risk-free. Treasury bills are thought to be risk-free because the US economy is so large that investors believe it would be impossible for the US government to default on their debt obligations. The US government is such a large part of the global economy that if other nations allowed the US to default on their debt then the world economy would be propelled into a global recession (Mishkin, 2013). Due to this phenomenon, bonds are priced relative to US treasury bills by systematic risk and idiosyncratic risk factors. Corporate bonds, unique to their characteristics or risk factors, sell at a credit spread to US treasury bonds. Later in the thesis we will determine an appropriate credit spread or risk premium for a GLB.

What Drives Bond Prices?

The price of a bond is driven by two main factors: interest rates and credit rating or worthiness, however before we dive into these factors it is important to understand what a yield to maturity (YTM) on a bond is and why it is significant.

The YTM of a bond is the interest rate that equates the present value of the cash flow payments received in today's value. The price of a bond is just the present value of the incoming cash flows (determined using the coupon rate and par value) discounted at the YTM. The price can be shown through this simple equation (Let P denote bond price and F denote the face value):

$$P = \frac{C}{1+YTM} + \frac{C}{(1+YTM)^2} + \frac{C}{(1+YTM)^3} + \ldots + \frac{F}{(1+YTM)^n}$$

When a bond is first issued at face value the YTM equals the coupon rate. Throughout the life of the bond the coupon rate remains fixed, yet the YTM will shift as interest rates in the real economy move. When YTM becomes greater than the coupon rate then the bond sells below face value or at a discount. Therefore, when YTM is less than the coupon rate, the bond sells above face value or at a premium. Let's take a moment to show an example of this using a 10-year bond issued at face value ($1,000) with a 10% coupon rate:

$$P = \frac{100}{1+YTM} + \frac{100}{(1+YTM)^2} + \frac{100}{(1+YTM)^3} + \ldots + \frac{1000}{(1+YTM)^{10}}$$

In this example, we know the bond sells at face value so we can plug in $1,000 for P leaving us to solve for the YTM. As mentioned above when a bond sells at face value, the coupon rate equals the YTM leaving us with YTM = 10%.

While this is easy to understand in theory, the real world works quite differently. When a US corporation wants to issue new debt, they agree to pay a coupon rate that is positively correlated with the US interest rate on the day of issuance. As the bond begins to mature, US interest rates will move throughout the maturity of a bond. If interest rates fall (rise), corporations will now be able to issue new debt at a lower (higher) coupon rate for the same initial price of $1,000. Therefore, bonds already issued with a higher coupon rate are worth more (sell at a premium) than bonds that are now issued at the lower rate. In short, bond price is negatively correlated with interest rate movements. Bond price has a similar affect when looking at creditworthiness. As a firm's credit rating falls, the price of current debt should also fall due to the increased chance of default. If the firm was to issue new debt they would have to issue at a higher rate meaning that the current bond issued at a lower coupon rate should be sold at a discount to investors. In this sense, corporate risk is similar to sovereign risk in that both corporations and nations face similar problems when issuing debt (Mishkin, 2013).

Chapter 3

History of GLB's

While GLB's are a relatively new concept, tradeable sovereign debt was first introduced in Venice in the 13th century. Since then new forms and ideas have formed surrounding sovereign debt. Due to the fiscally conservative biases of how markets assess the debt positions of nations, progress has developed slowly (Benford, 2018). Before we begin to focus on GLB's it is important to discuss when GDP became a measurement for a nation's wealth in order to show how new this debt structure concept is. Due to the lack of congruent reporting of overall economic output between nations, the fundamentals of GDP were established by Simon Kuznets and Richard Stone in 1934, however not adopted until the 1940's (Benford, 2018).

GDP-Linked bonds were not even a consideration of nations until the 1990's during the Brady restructuring agreements. In the late 1980's many emerging countries defaulted on their debt, which led to Brady bonds. Due to the small and illiquid market surrounding Latin America and South America debt, Nicholas Brady, the current US Treasury Secretary, called for these emerging sovereign nations to issue to debt instruments that could be exchanged by commercial banks for current fiscal debt. These instruments were tradeable in the marketplace successfully engineering liquidity in a typical illiquid market. These bonds led the way for creating tradeable debt for small and illiquid sovereign nations with below investment grade sovereign debt (Brady, 2012).

Robert Shiller, a professor at Yale University, first wrote about GLB's in his 1993 book Macro Markets describing the basics of the instrument and how it would work to essentially create fiscal space for countries, however the book lacked explanation of how such a bond could be implemented in the real world (Shiller, 2007). Robert Shiller's Macro Markets introduced the idea of how risk sharing across boarders could help diminish economic fluctuations in the world economy.

In the early 1990's Mexico, Nigeria, Uruguay, and Argentina issued bonds that paid higher returns if the prices of commodities were high because in these times, the issuing countries would have more wealth. Following these issuances, Costa Rica, Bulgaria, and Bosnia issued bonds that would pay a higher coupon rate when GDP exceed a certain threshold, yet not a pure GDP-linked bonds where investors take on both the upside and the downside (Benford, 2018). Argentina and Greece issued similar debt in 2005 and 2012 respectively as well as Uruguay issuing one billion dollars of debt indexed to nominal wages in 2014. While these issuances show that nations are starting to move in the direction of pegged issuances, let's examine how a GLB's could have been useful in the Greece debt crisis.

Following the financial crisis of 2008, Greece published that their estimated budget deficit was running between 3-4%. However later that same year Greece published that its budget deficit was nearly 11% larger than originally estimated, causing panic in the financial markets. Investors quickly fled selling their bonds on large discounts allowing yields to reach 30-40%. This large deficit illustrated that Greece would be likely incapable of paying their debt off and in doing so caused Greece's credit rating to earn a Junk rating (Higgins, 2011). Greece was

incapable of issuing new debt because of their Junk rating and was forced into a state of default. How would this situation be different with GLB's?

If Greece's debt was fixed to their GDP then their outstanding liabilities would have decreased as their GDP data weakened. This would have lowered the coupon payments they needed to pay investors making their debt more manageable. Real GDP growth in Greece from 2008 to 2014 was negative for all except one quarter, widely below expectations for the region. Assuming Greece's debt was GDP-Linked, depending on the logistics of the bond, it would not be surprising for their interest expense to decrease dramatically over this span of time. This may have lessened the blow to the Eurozone economy, the euro, and Greece through a smaller bailout package and a more manageable path to recovery.

Another similar debt instrument is Treasury Inflation Protected Securities (TIPS) which allow governments to increase coupon payments indexed to the inflation rate so investors are willing to invest in high inflation environments and protect investments against inflation. TIPS differentiate from ordinary government debt because the principal amount also adjusts up and down as inflation data increases or decreases, respectively. These instruments are considered to be risk-free due to the inflation protection feature however the interest rate offered is lower than a similar fixed-income bond with the same characteristics. In a rare case, during times of deflation, TIPS could work against the investor. Similarly, in times of economic contraction, the lender of a GLB would be hurt by the economic environment. TIPS provide insight into the benefits and drawbacks of investing in GLB's.

Chapter 4

Stakeholders

Advantages and drawbacks of GLB's can be seen through two main lenses: sovereign nations and investors. Nations help share growth and default risk with investors while allowing investors to benefit in times of economic expansion and hurt during economic contraction.

Sovereign Nations

A study by the IMF can be used to illustrate the effects of the benefits of GLB's. IMF's approach allows coupon and principal payments to be linked to nominal GDP and assumes 20% of debt stock would be GDP indexed. This approach theoretically allows advanced economies and emerging economies to raise their debt limit by 15 and 8 percentage points, respectively (State-Contingent, 2017). Another yet parallel study showed that if we allow all the debt stock to be indexed to GDP the debt limit could increase by 15-70 percentage points for advanced economies (State-Contingent, 2017). A similar conclusion was reached by Jonathan Ostry and Jun Kim in *Sovereign GDP Linked Bonds: Rationale and Design.* This approach illustrates that by using GLB's there is less uncertainty in debt growth due to lower coupon payments in times of economic downturns as does the prior. If all debt is indexed to GDP sovereigns could increase their debt limit by 10-60% for advanced economies (Benford, 2018).

It is important to also consider the shortcomings of raising debt using GLB's. In times of economic prosperity, sovereign interest payments will increase essentially causing the nation to export its capital to investors. In order for a sovereign nation to emerge and become an advanced

economy it is vital to reinvest within the country. Respective citizens would suffer at the fault of GLB's while investors would benefit. Many critics of GLB's cite this as an essential flaw of the investment device.

Investors

With increased risks of investing in GLB's, investors should still demand such bonds, considering they are priced within reason according to Markowitz efficient frontier model. The rational investors should not concern himself with the risk of a certain asset, but the whole portfolio or the Sharpe Ratio. Increasing the diversification of a given portfolio should help decrease risk per unit of return as illustrated by the Capital Asset Pricing Model (CAPM). Specifically, GLB's should be demanded by consumers due to the similar effects TIPS provide investors. GLB's would also provide a variation in coupon payments relative to GDP of the sovereign nation which provides a natural hedge for those living in retirement (Kamstra, 2009). As investors age, their investment portfolio switches from equities to fixed-income, demonstrating the importance of low-risk investments. GLB's should be demanded by this older age group due their risk tolerance with little to no counterparty risk. A typical pension fund plan focuses on steady income; however, it lacks the ability for investors to make more in times of economic expansion (Kamstra, 2009).

Chapter 5

Risk Premia

Risk premiums or credit spread, as discussed above, is the amount of excess return an investor requires in order to buy a bond relative to a treasury bill. When new bonds are issued in the market today it is easy to relatively determine a range in which the credit spread of the bond may fall. This can be done by comparing the new bond with a bond already on market with similar credit worthiness, coupon payments, and length. However, because GLB's have never been issued on the open market this is one of the most debated topics regarding the practicality of issuing such an instrument.

For our purposes, it is essential to split the risk premium into four parts: a model uncertainty premium, a liquidity premium, a default premium, and a volatility risk premium (Benford, 2018).

Model uncertainty simply refers to investors requiring more return on new and complex investment instruments. If these instruments were first issued the premium would likely be high however as GLB's become more of a common practice the model uncertainty premium should fall. A similar effect on the model uncertainty premium occurs as data integrity changes (i.e. how to calculate GDP). As the data becomes more consistent and pricing is more standard the model uncertainty premium should fall, but not disappear (State-Contingent, 2017).

Liquidity refers to the ability to trade or exchange an asset into cash. For example, T-bills are extremely liquid because the market is so large and there are plenty of buyers and sellers constantly trading. An illiquid asset could be seen as investing in a startup because you cannot sell your shares on an open market exchange. When markets are liquid investors are more willing to buy and sell within the market because they have the availability to trade as they please. In an illiquid market investors are less willing to buy because they may not be able to find a buyer in the future when they choose to sell. This causes investors to require a higher risk premium in order to buy to begin with. As discussed above with model uncertainty, as the market becomes larger and more standardized liquidity premium should fall due to the increase of market size (State-Contingent, 2017).

Default premium in this context is similar to default risk that sovereigns have on conventional bonds. Raising additional debt using GLB's will increase the default risk initially because of increased debt, but in the long run it should allow advanced economies to increase their debt limit.

Volatility describes how extreme an asset's value changes due to changes in market conditions. Assets with low volatility are preferred by investors because there is less risk, while assets with high volatility prove to be riskier and cause investors to require more return. The volatility of a GLB is unknown and would cause investors to require more or less risk premium.

Joel Bowman and Kevin Lane use the CAPM to estimate what risk premium an investor would require. While they acknowledge that CAPM is not the only way to measure risk

premiums, the model is widely used by analysts to predict stock price so it is fitting in their research. Under the assumptions of CAPM, a rationale investor required return for a given asset depends on the level of risk it contributes to the overall portfolio rather than just the asset itself.

Bowman and Lane used four different benchmarks (world equities, US equities, World GDP, and US GDP) for their market portfolio in order to measure what risk premiums investors would demand. They used a baseline CAPM model, a D-CAPM model, which accounts for risk aversion preferences that investors typically show, and a 15-year rolling CAPM model to account for possible changes in risk premiums over time (Benford, 2018). The givens and data they used to reach this conclusion can be found below the chart.

Table 1: Estimates of Volatility Risk Premiums (basis points)

Median across G20 countries[(a)]

	World Equities	US Equities	World GDP	US GDP
Baseline	30	32	330	79
+ Downside CAPM	10	21	165	66
+ Rolling CAPM (max)	18	19	140	81

(a) The estimates use annual data from 1989 to 2016, except Russia, which begins in 1993 due to data availability. We assume a real risk-free rate of zero, expected market rate of return on equities of 6.5%, US GDP growth of 1.6% and World GDP growth of 3.8%. The real risk-free rate is broadly consistent with US 10-year Treasury inflation-index bond yields, the equity returns is equal to the long-run average return on US equities (Siegal 2014) and US and World GDP equal to the long run projections in the IMF October 2017 World Economic Outlook.

Sources: Bloomberg; IMF; RBA

Their research highlights that what the market portfolio is for an investor has significant effect on what some investors required return would be. As GLB's have a higher beta relative to

world GDP and US GDP, a higher return would be required by investors. While their research is inconclusive on what a potential investor would require, it begins to highlight what the rationale investor should require in the situations given and identifies gray area in regards to market portfolio, investor 'risk aversion' preferences, and risk premium changes over time.

The Bank of England (BOE) is currently undergoing research to further understand risk premium required by investors. The study focuses on gaining a more specific number for the required risk investors would demand as it is not clear that returns on hypothetical GLB's would have likewise returns to the market portfolio (Eguren-Martin, 2020). Similarly, the study wants to determine as return may vary through the maturity of the bond. The BOE determines the risk premium relative to the risk premium of equity investments accounting for changes in investor demands through the economic cycle. The study concludes that the premia for US GLB's is approximately 1% for a 10-year maturity bond (Eguren-Martin, 2020). It is important to note that this estimate is in line with an earlier study of US risk premia by Kamstra and Shiller using the CAPM model.

Mark Kamstra and Robert Shiller performed a similar study to Bowman and Lane in 2009 using CAPM to determine the risk premium investors would require to purchase GLB's. Kamstra and Shiller explore what the required yield on a GLB would be relative to the S&P500 index from 1950-2007 using an extension to the Gordon Growth Model (GGM) developed by Donaldson and Kamstra (DK) in 1996 for complex analysis that would not be feasible by the GGM. This study leads us to believe that their conclusion is comparable to an upper bound estimate of the risk required by an investor in a US GLB.

The results of their study using the DK analysis show that investors would require between 125-275BP of premium to invest in such an instrument while noting that their estimations are likely overly conservative of an upper bound (Benford, 2018). They found a similar conclusion using a simple CAPM equation. This study showed that a GLB would have a beta of 0.25, indicating low risk, and a risk premium of 150BP (Kamstra, 2009).

Chapter 6

Methodology and Valuation

Due to the lack of real data that can be used to estimate the price and yield of GLB's trading at in the real world, I propose exploring measuring GLB's through different yet similar instruments. I am merely suggesting that measuring the dominant feature of a GLB to understand it better is similar to the way Current yield estimates Yield to maturity. For example, current yield is the annual interest divided by the current price which tells investors what you will earn if you buy a bond and hold it for one year. Yield to maturity rather estimates the anticipated return if you buy a bond and hold it until maturity. Yield to maturity is a much more complicated measure because you must take into account market price, par value, coupon interest rate, and time to maturity. Current yield can be easily calculated and is typically a good indication of the YTM. Using the same methodology, the dominant feature of a GLB can be used to better understand the instrument.

I begin by comparing GLB's to TIPS due to the inflation protection feature of TIPS being a comparable feature to GLB's in that coupon payments are dependent on GDP data. TIPS, as earlier mentioned, are US government issued debt instruments that provide the lender a higher coupon payment as CPI increases throughout the maturity of the bond. For example, let's consider a bond with a 1% coupon payment and $1,000 face value. If CPI is 2% for a given year, the face value of the bond would increase by 2%, giving us a new face value of $1,020. The coupon payment is then 1% of the new face value ($1,020) or $10.20 rather than $10. TIPS trade at a difference in yield from normal treasury bonds by inflation estimates. This can be shown by

looking at historical data. In September 2019, 10-year treasury bonds would yield 1.7% while 10-year tips had a yield of 0.11%. The difference between these two bonds was 1.59% or the 10-year inflation estimation (St louis fed). I originally estimated that GLB's could work similarly in respect to the inflation protection feature being comparable to a GDP protection figure, however, this method has shortfalls. A GLB needs to have the ability to lower coupon payments in times of economic slowdown not solely in times of pure economic contraction or negative real GDP growth. A GLB needs to pay a higher coupon payment when GDP is greater than expected and pay a smaller coupon when GDP is lower than expectations. That is what has led me to the following model. This model captures both the advantages and disadvantages of a GLB for the lender and issuer.

My model will allow the GLB to be a floating rate or variable bond that's coupon payment is as follows,

$$Coupon\ Payment = Coupon\ rate * [1 + (Real\ GDP - GDP\ Estimates) * 5],$$

where GDP estimates are pre-determined when the bond is issued. In this study, it is suggested that we assume that a 10-year GLB has a risk premia of 100bps to a 10-year treasury note due to the research in Chapter 5. If we allow the coupon rate to be the 10-year treasury coupon + 100BP and use Real GDP as our variable we can explore how profitable this investment would be to the US government and investors of such a bond. The 10-year treasury yield on January 4th of 2010 was 1.47% causing our base coupon premium for this GLB to be 2.47%. We use a multiple of 5 here as a constant standard multiple to amplify the floating aspect of the bonds coupon payments. For simplicity, we use historical data to understand how this instrument would trade. In 2008, the FOMC in the beginning of the financial crisis, estimated that the change in real GDP for 2008,

2009, and 2010 would be 1.6% 2.8% and 3.0% respectively. This is in line with the average annual GDP growth of the US over the last 70 years of 3.19%. We can assume the average real GDP growth is overstated because US growth has dropped overtime as the nation has become more developed. This can be seen by the average growth in the 50's and 60's was above 4% and in the 70's and 80's it dropped to around 3%. The average real growth rate for the 10 years prior to 2008 was also around 3%. In line with the FOMC estimations and historical growth data we will assume that the GDP estimate for our GLB will be 3%.

Exercising this data, we came to the conclusion that the average coupon payment of such a bond with the given parameters and yield equation would result in an average yield of 2.38% roughly 90 BP above a 10-year treasury bond over the same period. This was calculated using real GDP data for each year in order to find the difference between actual GDP and GDP estimates. This number was then multiplied by 5 in order to amplify the difference into a significant enough value where it would have an effect on the coupon payment. This number was then used in order to achieve what percentage of the coupon premium lenders would receive per period. The model can be seen below:

Table 2: Model Data

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Real GDP Growth	2.60%	1.60%	2.20%	1.80%	2.50%	2.90%	1.60%	2.40%	2.90%	2.30%
GDP Estimation	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
Real GDP - Estimated GDP	-0.40%	-1.40%	-0.80%	-1.20%	-0.50%	-0.10%	-1.40%	-0.60%	-0.10%	-0.70%
GDP Amplifier Feature	-2.00%	-7.00%	-4.00%	-6.00%	-2.50%	-0.50%	-7.00%	-3.00%	-0.50%	-3.50%
Percentage Ledners Will Receive	98.00%	93.00%	96.00%	94.00%	97.50%	99.50%	93.00%	97.00%	99.50%	96.50%
Coupon Rate	2.47%	2.47%	2.47%	2.47%	2.47%	2.47%	2.47%	2.47%	2.47%	2.47%
Variable Coupon Rate	2.42%	2.30%	2.37%	2.32%	2.41%	2.46%	2.30%	2.40%	2.46%	2.38%
Coupon Payment	$ 24.21	$ 22.97	$ 23.71	$ 23.22	$ 24.08	$ 24.58	$ 22.97	$ 23.96	$ 24.58	$ 1,023.84

Chapter 7

Results, Implications, and Future Research

While the model has shortfalls that will be expressed below there are clear takeaways from this research that can be used going forward. In short, the model showed that an investor that bought a 10-year GLB would have received an extra 90 BP in return over a regular 10-year treasury for carrying the extra risk. In order for an investor to receive less money than the yield on the 10-year the average coupon payment would have had to be 1.47% or lower. The model would have actually rendered that actual real GDP would have had to have been -5.1% or lower in order to receive a smaller yield than holding the 10-year treasury.

This leads us to believe that our amplifier effect in our study was much lower than it should have been in order to achieve a fair coupon payment that would allow the government to lessen interest payments in times of economic contraction. Holding all else constant and increasing the amplifier effect to a constant of 50, our GLB still would have yielding approximately 10bps above the 10-year treasury in time the US real GDP was lower than expectations. Another point to inspect is that as the US has become more advanced and developed. Therefore, it is likely that our GDP estimation of 3% per year is overstated and US GDP should be closer to 2.3% going forward based on the last 10 years of historically data. If we lower our GDP estimation to 2.3% from 3.0%, holding all us constant, our amplifier would have to be increased again in order to replicate lower interest payments in periods of economic contraction as discussed above. Furthermore, the model assumes an annual coupon payment for

simplicity, however, it would most likely be semiannual coupon payments; this should have a minimal effect on the accuracy of our data due to similar GDP output on a semiannual basis.

While increasing the amplifier constant in our model while lowering our GDP estimation could prove to be effective in illustrating the effects of an economic contraction that we are looking to achieve, our model is still assuming 100bps of risk premium for investors holding such an investment vehicle. Let us revisit the four fundamental factors that contribute to overall risk premium: model uncertainty, liquidity, default, and volatility premium. The 100BP premium a modest average of the studies above may be overstated and the true risk premia an investor should achieve may be much lower. Due to the uncertainty of a new investment instrument and the illiquid market of such, the true risk premia of a GLB may be significantly lower. It is difficult to determine just how much risk premium an investor should demand without knowing the other features of the bond such as GDP estimates, current economic landscape, and the amplifier constant. Future research should begin to try to understand how much of the risk premium investors demand is correlated to the model uncertainty and liquidity effect. As GLB's become more of a common instrument these factors of risk premium should begin to diminish as the market becomes larger and more liquid. Investors will not demand excess premium when GLB's can be sold easily at investor discretion. Similarly, as these products become household names and an accessible investment vehicle to the average household investor these facets of risk premium should exponentially decrease to zero. Future research can also use different levels of assumed risk premium while independently measuring effects of changes to the amplifier variable and vice versa so we may better understand at what levels of risk premium a sovereign nation would benefit rather than the investor. More research could be done in a similar fashion

by measuring the dominant feature of the bond. There is argument to make that a GLB would have a similar feature to both a warrant and redeemable preferred stock. It would be interesting to measure a GLB through a similar valuation to either investment instrument.

Chapter 8

Conclusion

The IMF is working with central banks to conduct research to better understand GLB's. Through financial analysis we can understand how during times of economic contraction these instruments would provide the issuing nation debt stabilizing effects by decreasing the interest payments on existing debt. Contrarily, these instruments would provide investors increased coupon payments in times of economic expansion, essentially allowing the nation to wealth share in times of economic expansion. The possible advantages for both central governments and investors should be clear at this point, yet there is still so much left that is unknown about how these instruments would work and how perceptive investors and nations would be to adopting a new debt class. While the US government opted for introducing TIPS in order to gain the benefits of having a real term structure, most sovereign nations do not have CPI data. In this sense, GLB's could prove to be more of a promising debt instrument.

Financial instruments must be trusted and understood in order to be adopted and widespread. We can see how successful the introduction of TIPS in the US market was and how the percent of US inflation-indexed debt has increased in the last 15 years. Someday, not too far in the future, advanced nations will be able to introduce these bonds in a similar fashion to TIPS providing investors a GDP protection feature. While much more research must be completed before we will see GLB's widespread in the marketplace, we have come a long way from when Robert Shiller was first discussing the subject in the 1990s.

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