Comparing GDP Indexed Bonds to Standard Government Bonds

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This paper discusses the construction of a new financial instrument whose payoffs are linked to the overall performance of the U.S. economy. The idea behind this financial instrument, known as a GDP bond, has been explored by financial economists for several years. Since there is no historical data for GDP bonds in the U.S., we construct a simulation process through which the payoff function for a GDP bond could be compared with other high quality bonds during the 1947-2010 period. It is observed that the GDP bond has a superior performance to other high quality bonds in a risk return framework.

INTRODUCTION

Today's macroeconomic climate is one where there is weak economic growth, burgeoning budget deficits and higher than average risk in financial instruments. At the time of writing, although the U.S. economy is showing some signs of recovery, the Federal Reserve has downgraded its growth forecasts for the United States through 2013, and the stock market continues to be volatile. The U.S. government budget deficit is at $15.25 trillion, which is more than 100% of the 2010 value of U.S. GDP. The federal funds rate is still at a range between 0% and 0.25%, and thus market interest rates in general are rather low. Many firms have had their credit rating downgraded, and debate continues in Congress regarding the debt ceiling for the United States government. In fact, the U.S. economy itself has had its credit rating downgraded slightly. Thus the investment climate is one where there are greater risks while at the same time returns are comparatively low. The financial climate is thus ripe for an instrument that could offer a multi-faceted solution to these problems. This paper discusses a financial instrument that could mitigate the rise in U.S. government debt, during down-turns in economic activity, provide a new variety of low default risk instrument for risk-averse investors, and mitigate inflation risk.

Rational individuals in the pursuit of wealth accumulation seek to mitigate risks faced when investing in different financial instruments. One primary risk associated with financial instruments, especially in economies that are on up-swings of the real business cycle, is inflation risk[1]. A rational investor would therefore contemplate earning the prevailing real rate of interest while being compensated for inflation. For a bond seeker, one way of doing this is purchasing a bond that is indexed to inflation. An existing example of such an instrument is TIPS (U.S. Treasury Inflation Protected Securities) whose par value and annual cash flows change with the Consumer Price Index (CPI).

Another option, not currently offered in the United States, would be a GDP indexed bond (GDP bond). A GDP bond is a financial instrument that provides investors with periodic realized real returns

together with observed inflation as measured by the GDP deflator. This paper shows one way of constructing these bonds using a comparatively more intuitive model as compared to the existing literature – the result is a bond that mitigates inflation risk, whose coupon payments maintain ex ante purchasing power expectation, and whose returns compare favorably with U.S. government intermediate and long term securities. The GDP bonds, as formulated in this paper, possess the aforementioned properties.

Argentina has achieved great success with its GDP indexed bond, which works by way of GDP warrants. The bonds are designed to pay investors when economic growth rates exceed government projections. Argentina has been experiencing a growth spurt since 2010 and holders of GDP warrants are expected to realize returns of about 24%[2]. These bonds became a very useful way for Argentina to restructure debt from the economic crisis she experienced earlier, and now that economic growth has been re-established, investors are realizing returns that keep at pace with this economic growth. Thus countries that are seeking to restructure debt and encourage investors (both domestic and international) may seek to follow Argentina's example and issue nominal GDP indexed bonds.

The remainder of the paper is divided into an overview of related literature, the bond pricing model, simulations, and supporting econometric analysis, and the conclusion.

REVIEW OF THE LITERATURE

Baker and Wurgler (2009) show that during the 1962-2005 period, U. S. government bonds and common stock of large, well established, dividend paying companies tend to move together over time. The reasons appear to be the business cycle, changes in investor sentiments and the required risk premium. In a business cycle contraction investors tend to concentrate in government bonds and larger company common stock due to their cash flow predictability. Furthermore, perceptions of increased risk appear to have a lesser impact on the required risk premiums for larger companies as compared to the smaller ones.

The potential benefits of GDP bonds are analyzed by scholars in the past. Li (2002) reviews data during 1958-2001 and finds that the correlation between common stock and bond returns is stronger during rising uncertainty regarding long term expected inflation. According to this observation, GDP bonds should perform better than either common stock or regular bonds during rising inflation due to their inflation hedging properties.

Schroeder, Heinemann, Kruse and Meitner (2004), show by way of simulations that GDP bonds tend to outperform regular bonds in the presence of unexpected rise in GDP, and under-perform in cases of unanticipated slowdown in the economy. Ruban, Poon and Vonatsos (2008) analyze GDP bonds using Monte Carlo simulation and conclude that indexation to the nominal growth in GDP appears to be the proper design. This conclusion is based on an evaluation of cash flows, default risk, investors risk aversion, and economic fluctuations.

Griffith-Jones and R. Sharma (2006) provide various benefits of GDP bonds for the issuing institutions and express that the idea goes back to 1980s citing Lessard and Williamson (1985) and Shiller (1993). The benefit of GDP bonds for the issuing countries is expected to be stabilization of government expenditures during the business cycles since the bond's cash flow expenses for the issuer would decline during recessions, as the government revenue also diminishes. Investors meanwhile may benefit from a GDP bond as they share in the growth of the economy. The authors further review experiences of countries including Bulgaria, Bosnia and Costa Rica in the 1990s as well as Argentina in 2006. The problems with those bonds appear to be their complexity and pricing issues. Griffith-Jones and Sharma further explain that GDP bonds appear to have the risk return characteristics of common stock.

Kamstra and Shiller (2009) express the idea for a bond to be issued by U.S. Treasury "with a coupon tied to the United States' current dollar GDP," with a coupon of one-trillionth of the GDP. Such a bond is expected to provide growth of income as well as a compensation for inflation. The authors continue to state that the GDP bond would provide a financial security that would reflect the growth in labor income

that constitutes about two-thirds of the national income. They further state that GDP bonds would be expected to provide a return close to common stock with half the risk.

An important benefit of any inflation protected security is highlighted by Kamstra and Shiller (2009) in the discussion on the composition of retirement funds. On average about one-third of retirement funds assets are made up of inflation protected assets and fixed income assets. This would seem to indicate that a significant factor in investment decision in such funds is low risk-load. GDP indexed bonds fit in perfectly in such a scenario, especially for the savvy pension fund managers. Such managers can hedge against risk in down-turns by moving money from risky sectors of the market into GDP indexed bonds (recessionary periods are also when governments would typically want to issue these instruments in order to raise funds for expansionary fiscal policies) and thus avoid credit risk and other forms of risk that arise with corporate bonds and the stock market.

GDP BOND PRICING MODEL

One way to initiate a GDP bond is to set the issue price at one trillionth of GDP with a total return tied to the growth of GDP. This structure for the GDP bond is expected to provide price transparency and competitive yield for it in the capital markets. As shown in this paper the price of such a bond is expected to closely track the reported GDP. In addition, random fluctuations over the short time horizon should provide opportunities for trading in the derivative markets. By providing simulations comparing accumulated wealth resulting from the GDP bond and other high quality bonds we show its superior performance in a risk return framework.

In a GDP bond an investor will receive periodic incomes that are based on the growth in the economy as measured by the real growth in GDP as well as the inflation embedded in the GDP deflator. TABLE 1 provides information regarding price and total return for the bond. As shown in TABLE 1, the GDP bond will have a book value in line with concurrent GDP while earning the prevailing real return.

As shown in TABLE 1, the principal value of the bond, as the investor's wealth, will rise (or fall) in line with changes in GDP and fair value of the bond meanwhile should be the same as GDP at the time of transactions. Discrepancies however may arise due to the uncertainty regarding the true value of GDP at the time of transactions. An investor in a GDP bond would thereby earn a real return on investment as well as being fully compensated for inflation as measured by the GDP deflator.

$$\text{Let } r_i = \bar{r} + e_i \qquad (1)$$

where $e_i \sim (\bar{o}$, constant variance); error terms possess zero mean and constant variance over time, and $\bar{r}$ being a persistent component of real return. Then the year-end principal value of GDP bond would be GDP_o (geometric average of real return)^t = GDP_t , for t= 1,2,3 years. In this manner, the year-end principal value of GDP bond in any given year would be in line with the observed value of GDP. Furthermore, as shown in TABLE 1, the periodic cash flows resulting from a GDP bond would be GPD_0 (geometric average of real return) $^{t-1}$ * r_t.

This implies a GDP bondholder would expect to earn observed real returns as well as inflation prevailing during the holding period time horizon. These features for the GDP bond are similar to cash flow patterns in common stock. In addition, the possibility of earning the real return, adjusted for inflation, for GDP bonds, tends to help in the convergence of interests of bondholders and common stockholders.

TABLE 1
GDP BOND PRICING MODEL

Yr	ROI	Year-End Principal Value	Income Earned or Received	Real Interest Earned
1	r_1	$GDP_o(1+r_1) = GDP_1$	$GDP_o * r_1$	r_1
2	r_2	$GDP_o(1+r_1)(1+r_2) = GDP_2$	$GDP_o(1+r_1)\, r_2$	r_2
3	r_3	$GDP_o(1+r_1)(1+r_2)(1+r_3) = GDP_3$	$GDP_o(1+r_1)(1+r_2)r_3$	r_3
T	r_t	$GDP_o\left(\begin{matrix}geometric\\ avg\text{ of real}\\ return\end{matrix}\right)^{t} = GDP_t$ for t= 1,2,3 years	$GDP_o\left(\begin{matrix}geometric\\ avg\text{ of real}\\ return\end{matrix}\right)^{t-1} * r_t$	r_t

GDP_o denotes nominal GDP at the initial issue price divided by $1 Trillion,
$r_{t=}$ real growth rate (%) in GDP during year = t. ROI denotes return on investment.

Hedging Against Inflation

The inflation hedging properties of a GDP bond would make it a desirable investment with other financial instruments. Past studies have shown that common stock can have inflation hedging properties (see for example, Bodie (1976), Ely and Robinson (1997)), especially in the long run, and regardless of whether the inflation has real or monetary causes. However, Ely and Robinson (1997) while showing that on average stocks hedge against inflation in the long run, have also highlighted the U.S. as an exception to this case. Common stockholders hoping for a real return in line with growth in the economy thus may or may not be compensated for expected inflation. This strengthens the case for the introduction of a GDP indexed bond market in the United States. The introduction of U.S. Treasury Inflation Protection Bonds (TIPS) in January 1997 appears to help in protecting bondholders against expected and unanticipated inflation while earning a real return. The real return on TIPS, however, is constant for its tenure. For example, a buyer of a 10-year TIPS in 2010 will earn the prevailing real return in 2010 during the next 10 years together with the later observed inflation in the years ahead.

One perceived problem with TIPS is that real return changes over time since the real return tends to rise during the recovery phase of the business cycle and falls towards the trough. Assuming an efficient capital market, an investor in TIPS would more likely buy TIPS toward the peak of the business cycle in order to lock into a higher real rate. While TIPS theoretically resolve the inflation issue, regular bondholders will have to forecast a reasonable real return commensurate with the later prevailing state of economy for as long as 30 years.

In spite of the fact that TIPS are supposed to perfectly protect an investor against inflation risk, evidence has emerged that suggests that 10 year expected inflation rates calculated from TIPS data averages about 50 basis points below those of professional inflation forecasters (Carlstrom and Fuerst, 2004). The illiquid nature of the TIPS market may be one reason why inflation forecasts from these markets tend to under-estimate actual expected inflation. All of these reasons combined make the case ever stronger for the introduction of a new instrument that better matches both inflation rates and movements in the real business cycle.

The biggest selling point for a GDP indexed bond is that the investor has a large essence of risk removed. Rational investors seek to maximize return at any time while controlling for their risk tolerance levels. A typical yield curve (term structure of interest rates) displays this behavior on the part of investors who seek higher returns for longer term securities. In fact, past research has shown that the term

structure (slope of the yield curve) is an important predictor of economic activity (see for example, Estrella and Hardouvelis, 1991). The advantage of GDP indexed bonds is that the problem of an inverted yield curve is largely mitigated. The return on the bond moves in tandem with the growth rate of real GDP and so has co-movement with the real business cycle. Therefore coupon rates are continually adjusting with the rate of economic growth. Fisher's hypothesis regarding the relationship between the nominal and real return is stated as shown in eq. (2).

$$NR = RR + I + I * RR \quad (2)$$

where NR denotes nominal return, RR denotes real return and I denotes inflation. Thereby, the nominal return desired by regular bondholders is the combination of forecasted real return, inflation and interaction between the two. At the time of purchasing a bond, a rational investor is expected to require the expected real return and inflation during the planning time horizon. Since the periodic cash flows of the bond are fixed, regular bond holders would suffer from unanticipated inflation. However, regular bondholders tend to benefit from a subsequent decline in inflation, real return or slowdown in economic activity since their return is fixed. Such a stable return is not, however, beneficial to an existing bondholder in the case of unpleasant surprises during rising inflation. Meanwhile, bond holders as well as common stockholders tend to suffer from unanticipated inflation.

A GDP bond, as formulated in this paper, resolves both issues of observed real return and inflation. Its property of providing year-by-year observed real return appears to make it superior to TIPS. Meanwhile, the combined properties of providing real return and inflation for GDP bonds would make its return profile dominant to regular bonds. Regular bondholders would have to assess both the real return and inflation in the upcoming years during the time remaining to maturity of the bond.

In a GDP bond both the real return and inflation can vary. If investors are likely to assume that business recoveries are accompanied by both higher real returns and inflation, they would more likely buy GDP bonds during the trough of the business cycles or during recessionary times, whereas TIPS would more likely be purchased at the peak. These securities would thereby provide reasonably good returns for active investors. Given that the time horizon for recoveries is longer than the downturns, the payoff for a buy and hold investment in GDP bonds should dominate those of TIPS.

Inflation Indices

The question arises as to whether nominal GDP adequately captures true inflation. If so, then nominal GDP must have some correlation with consumer prices. Inflation is usually gauged using either the Consumer Price Index (CPI) or the GDP Deflator. These indexes provide information regarding changes in prices for representative bundles of goods and services. Eq.(3) shows the regression of changes in the CPI onto changes in the GDP Deflator.

$$\%\Delta GDP\ deflator_t = a + \beta * \%\Delta\ CPI_{t-1} + \varepsilon_t \quad (3)$$

The results for eq.(3) are shown in TABLE 2 and indicate that the lagged inflation rate (measured using the CPI) is an important explanatory variable for the current inflation rate measured according to the GDP deflator. This result is logical given that the CPI tracks prices of goods and services consumed by consumers whereas the GDP deflator tracks prices of all final goods and services in the economy and is therefore based on a large bundle of goods and services.

TABLE 2
REGRESSION OF LAGGED CPI ONTO THE GDP DEFLATOR

	Intercept	Lagged CPI
Coefficient value	0.374698	0.475886
Std. Error	0.053423	0.040087
t-statistic	7.013816**	11.87124**
Prob.	0.0000	0.0000

Sample: 1947 to 2010
Adjusted R-squared: 0.50
**Significant regressors.

Services including wages and salaries have a large share of GDP. In addition, corporate profits and proprietors' income comprise a reasonably large portion of GDP. A sample component of GDP for 2007 is shown in TABLE 3.

TABLE 3
COMPONENTS OF US GROSS DOMESTOC PRODUCT

Sector	% of GDP
a. services, including wages & salaries	60%
b. corporate profits	12%
c. proprietors' income	8%
d. other?	20%
Total	100%

As shown in TABLE 3, services including wages and salaries account for 60 percent while corporate profits and proprietors' income for 20 percent of GDP in 2007. These observations appear to show that since CPI does not properly account for these components it may not provide adequate information regarding inflation. In particular, final value of financial wealth should be in line with the growth in the wages, salaries and profits of business enterprises.

That is, the GDP deflator appears to play an important role in testing for inflation hedging properties of financial assets. A GDP linked bondholder would benefit from the growth in the service sector and the associated rise in profit. Such variables may not be reflected in CPI and as such TIPS (inflation linked bonds) may not be as good as GDP bonds in compensating investors for inflation. In addition, an investor would like to benefit from the growth in the economy and the current structure of U.S. economy is heavily concentrated in the service sector.

The sociological evolution in the capital markets appears to help in explaining factors affecting accumulation of wealth as Piketty and Saez (2003) state that the share of wage income has outpaced the share of financial and real assets in such a way that the wealthy are now due to "the work income." Higher wages appear to follow the growth in the economy and thereby investors in GDP bonds will share in the prosperity of business enterprises. Thereby, lenders, in line with wage earners and owners of the business enterprises, will all share in the profitability of the corporation.

Selected Issues

The fair value of a GDP bond may differ from its current price. This is because GDP is estimated on a quarterly basis, subject to periodic revisions. Thereby, the true price of a GDP bond at any point in time will not be known until several months later. Such a mispricing, however, can be resolved in the

derivatives markets. For example, a swap may be purported for an exchange of a fixed price (or total return) at the end of each quarter with the later observed values (or total return).

Meanwhile, a GDP bond is subject to random price fluctuations during each quarter. This drawback is dealt with financial contracts such as futures, options and swaps. Through these instruments, a counter-party will agree to pay the reported price at the end of the quarter, earning a profit for assuming the risk involved. The pricing models developed by Kruse, Meitner and Schroder (2005) can mitigate these issues.

An investor in a GDP bond may be provided with a choice of receiving periodic total returns comprising of the observed real return as well as inflation, or a lump sum at a later time. At any rate, the total payoffs will be the same and in line with the growth of the economy. The income generated from a GDP bond, either in a lump sum or periodic, would account for as regular income and since GDP includes tax revenues, it would be automatically indexed to inflation in taxes.

GDP BOND SIMULATION RESULTS

Data

Total returns data are sourced from Ibbotson's Yearbook (Morningstar), for both long term and intermediate U.S. government bonds[3]. Nominal GDP data and inflation indexes are sourced from the Federal Reserve Bank of St. Louis Database (FRED)[4]. The period of focus for all simulations and estimations of real returns on actual instruments in this paper is 1947-2010.

Methodology

As Kamstra and Shiller (2009) propose, a GDP bond would generally be expected to be one of long maturity. If such a bond were issued in the United Kingdom, it would probably be a perpetuity. Since no perpetuities of the bond variety are offered in the United States, a perpetual term GDP indexed bond would widen the U.S. bond market.

A bond that attempts to follow the real business cycle of an economy would need to reflect the changes in the price of real variables in an economy. The question then arises as to whether an aggregate price index such as the GDP deflator or the CPI does indeed correlate with changes in the prices of real variables such as employment. If so, then an aggregate price index should be highly correlated with a cost index of real variables. The cost index of choice here is the Employment Cost Index (ECI), sourced from the Bureau of Labor Statistics. TABLE 4 shows the results of regressing the inflation rate (measured using the GDP deflator) on to the rate of change in the ECI as shown in eq. (4).

$$\%\Delta ECI_t = a + \beta * \%\Delta \text{ GDP Deflator}_t + \varepsilon_t \quad (4)$$

TABLE 4
REGRESSION OF GDP DEFLATION ONTO EMPLOYMENT COST INDEX (ECI)

	Intercept	GDP deflator
Coefficient value	0.380613	0.779100
Std. Error	0.044042	0.042676
t-statistic	8.642030**	18.25622**
Prob.	0.0000	0.0000

Sample: 1947 to 2010
Adjusted R-squared: 0.70
**Significant regressors.

RESULTS AND ANALYSIS

The principal of the bond is taken to be $1000. The simulation assumes annual returns on GDP bonds (these returns are annualized nominal GDP growth rates). The continuous compounding method is then

used to compare the bond returns with those of competing instruments. This section discusses the results of the simulation and comparison exercises. The simulated nominal GDP indexed bond is compared to the following instruments:

a. Treasury bill
b. Intermediate term government bond
c. Long term government bond
d. Large company bond
e. Large company common stock

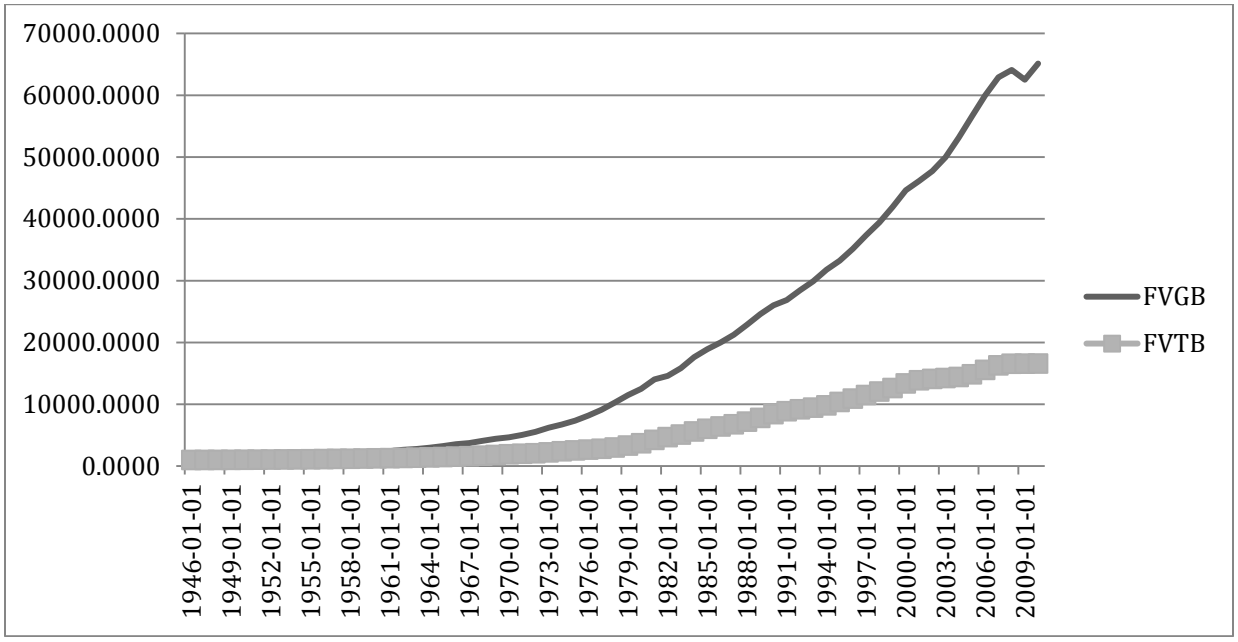
Thus the comparisons are done over instruments of varying risk and maturity. A priori it is not expected that the simulated bond will out-perform the corporate bonds or common stock, but these checks are carried out for robustness purposes.

The results indicate that the simulated GDP bond performs very well in comparison to typical competing instruments that are issued by the government. Since this is a long term bond and its returns are based on long run nominal GDP, it easily out-performs short term Treasury Bills. The gap between the GDP indexed bond and actual returns on instruments lessens as the term to maturity of the instrument increases. Thus the simulated bond still out-performs the intermediate term and long term government bonds, and thus would be a good option for a cautious investor who would like to hedge against inflation risk and enjoy a return that matches the growth rate of the real economy.

It is rather startling that the simulated bond out-performs long term corporate bonds. Typically even well rated corporations offer returns that beat government instruments since there is an inherent credit risk even with AAA rated corporations. However, the simulated GDP indexed bond allows the long term investor to enjoy higher returns with a lower risk level. This is a significant selling point for the simulated bond as this indicates that medium risk tolerant consumers who typically seek AAA rates corporate bonds or mutual funds that are primarily composed of such bonds would achieve higher returns with a government instrument.

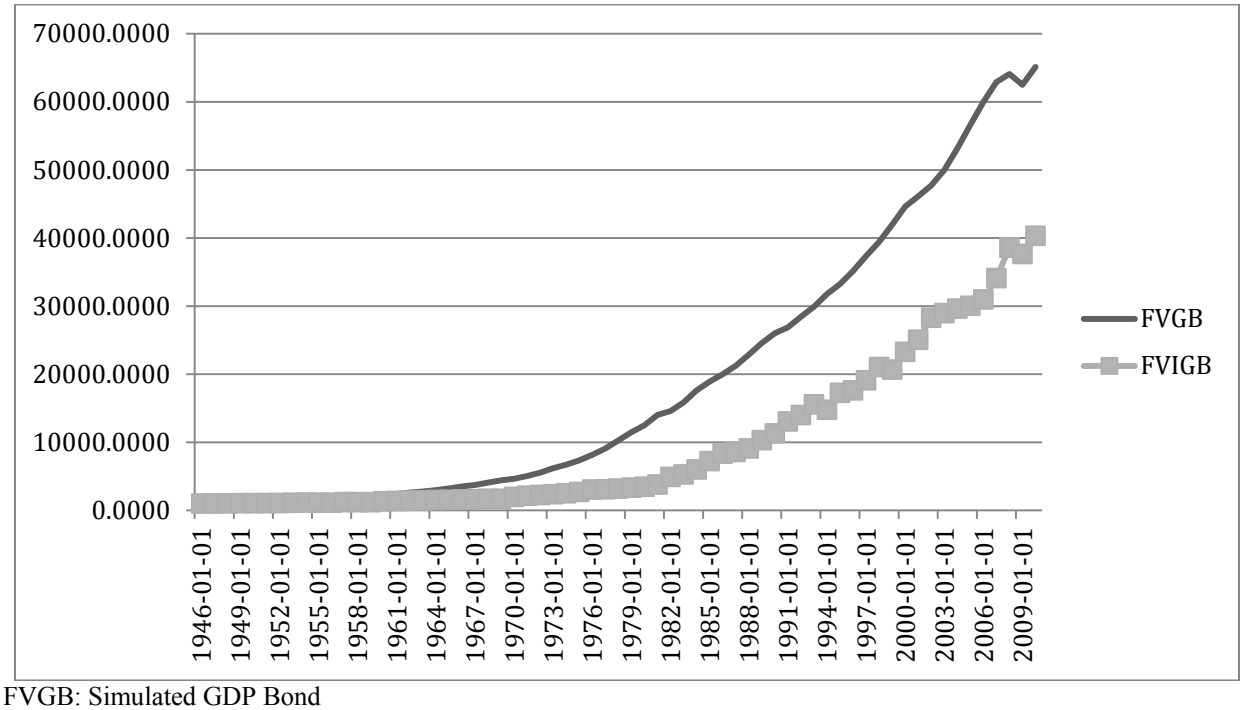
It is of course not surprising that the simulated bond cannot outperform long term common stock. An investor with a higher tolerance for risk would therefore earn much more with long term stocks than with the simulated bond. The simulated instrument would thus primarily appeal to investors with a lower risk tolerance.

CHART A
SIMULATED GDP BOND VS. TREASURY BILL



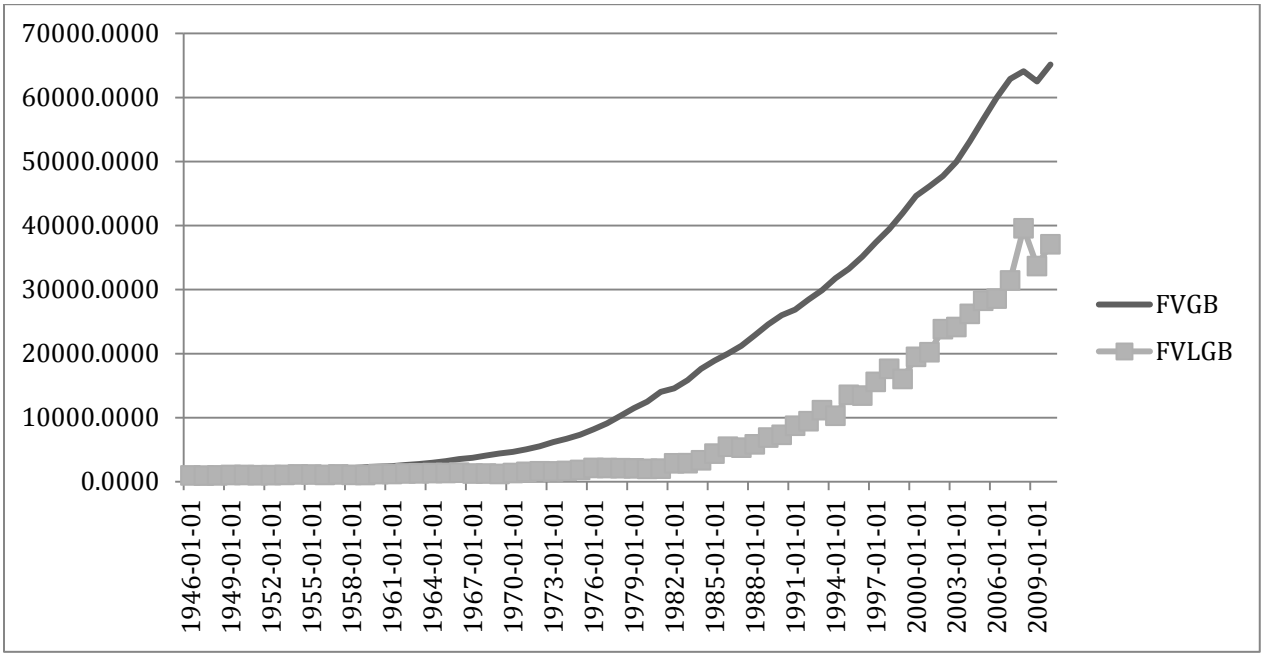
FVGB: Simulated GDP Bond
FVIGB: Actual returns based on Treasury Bills.

CHART B
SIMULATED GDP BOND VS. INTERMEDIATE TERM GOVERNMENT BONDS



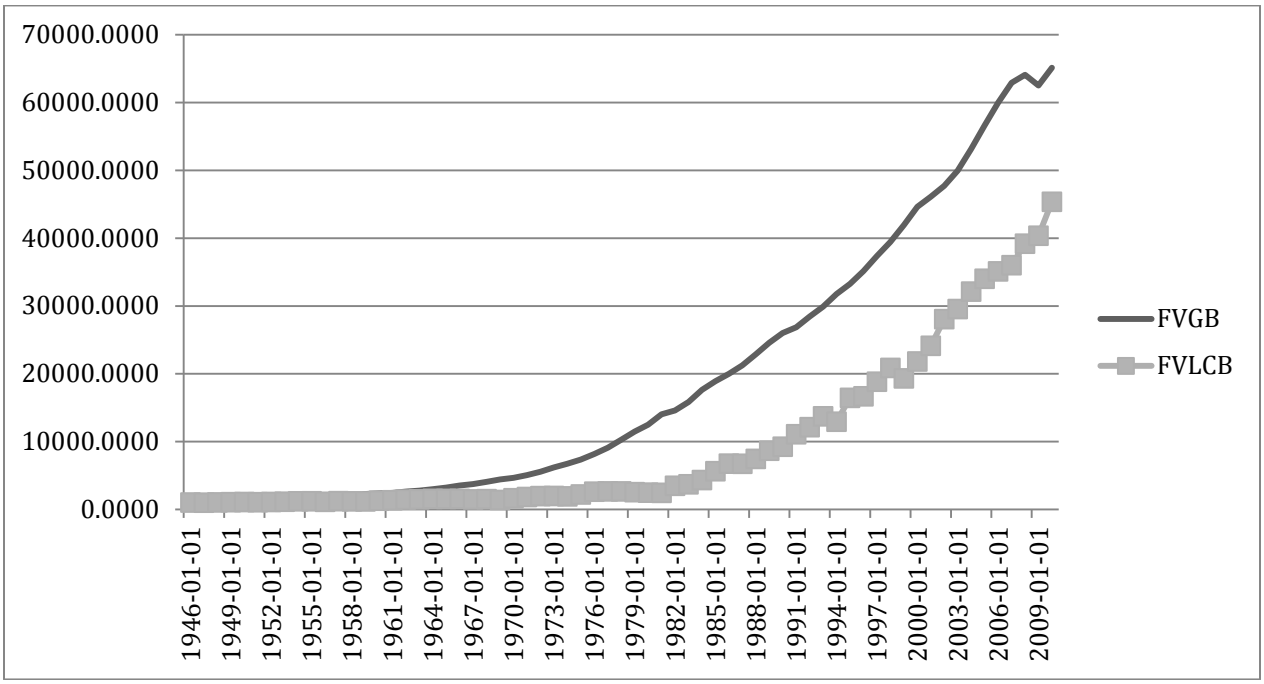
FVGB: Simulated GDP Bond
FVIGB: Actual returns based on intermediate term government bonds.

CHART C
SIMULATED GDP BOND VS. LONG TERM GOVERNMENT BONDS



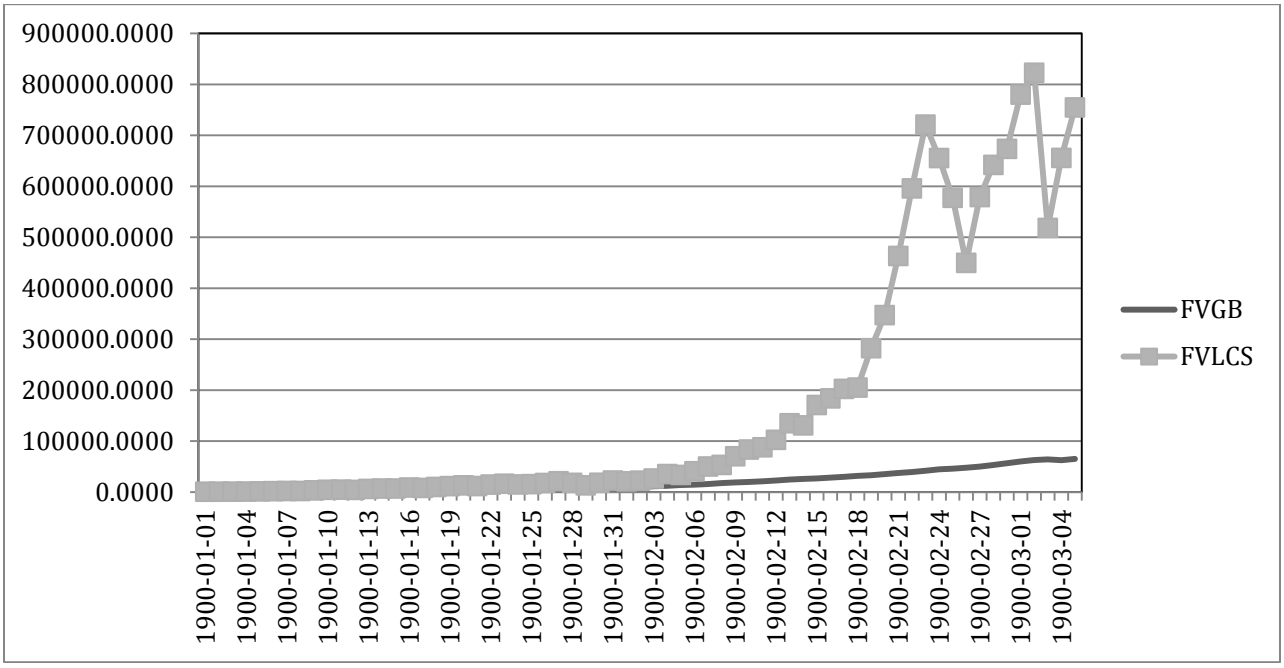
FVGB: Simulated GDP Bond
FVIGB: Actual returns based on long term government bonds.

CHART D
SIMULATED GDP BOND VS. LARGE CORPORATE BONDS



FVGB: Simulated GDP Bond
FVIGB: Actual returns based on the long term corporate bonds.

CHART E
SIMULATED GDP BOND VS. LARGE COMMON STOCK



FVGB: Simulated GDP Bond.
FVIGB: Actual returns based on long term corporate stocks.

CONCLUSION

A market exists for investors to enjoy returns based on real variables in the economy. A bond that has its returns based on nominal GDP growth rates mitigates inflation risk, but also allows the cautious investor to partake in returns associated with the upswing of the real business cycle. This bond would be very advantageous for government trying to raise money during recessionary periods as investors are typically wary of the stock market and seek to maintain their funds in lower risk instruments. In the case of a country like the United States that has budget deficit issues, the widening of the bond market using an instrument like this would be very useful for deficit control. Although governments that issue such bonds do have to pay greater returns during growth periods of the real business cycle, clauses can be inserted such that payment is issued only when growth rates exceed certain levels. This is the methodology used by Argentina with its GDP warrants.

Simulations show that the instrument compares very well against both short and medium term bonds, and even out-performs long term corporate bonds. Issues that need to be addressed are the issue price for such bonds, and the fact that speculative investors may choose to purchase them only towards the upswings of the business cycle and sell them towards the downswings in the business cycle. Thus while these bonds are cheaper for a government to institute during downswings, they are more expensive during upswings in the business cycle as returns rise with the business cycle. Thus a further issue to contend with is whether a payment clause needs to be inserted into the instruments such that interest coupons are only issued above certain GDP growth rates. Regardless of these issues, the simulations indicate that there is a very lucrative missing market that government can tap to mitigate budget issues during downturns in the business cycle.

END NOTES

1. Inflation risk is defined as the potential loss of purchasing power when price indexes rise in an economy.
2. Bloomberg News.
3. Table A-6 from Ibbotson's Yearbook provided total returns data for the Long-Term Government Bonds, and Table A-10 from Ibbotson's Yearbook provided total returns data for the Intermediate-Term Government Bonds.
4. http://research.stlouisfed.org/fred2/.

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