Dynamics of a Democracy Deeply in Debt: Simulation Studies of Federal Revenue and the Capacity of the U.S. to Service its Debt

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ABSTRACT

The issue of the growing federal debt and whether it will be serviceable in the years to come is addressed. Can the U.S. federal government continue to expect its tax revenues to rise to the occasion? Will the retirement of seventy-seven million baby boomers result in diminished federal revenue after the year 2010? Will the changing tax structure reduce federal revenues? Will these circumstances lead in-turn to an incapacity of our federal government to service its burgeoning national debt, now nearly nine trillion dollars? Are there probable disaster scenarios that policymakers must navigate through using judicious policy choices? Is it time to start drastically cutting the federal budget? These are the questions that get addressed by the simulation models we will present.

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1. INTRODUCTION

Few economic issues have such far-reaching implications as excessive government budget deficits and debt. It is almost universally agreed that fiscal imbalances retard economic growth, impose heavy burdens on future generations, and heighten the risk of financial market disruption and meltdown. It is also agreed, however, that correcting such imbalances is a difficult task. This issue is at the core of many political and economic debates and is the subject of this study.

In this paper we shall endeavor to use simulation to address a rather important question: will the U.S. be able to service its burgeoning national debt after the year 2010? Currently, our national debt stands at nearly nine trillion dollars. Congress, in February 2006, recently passed a bill raising the debt ceiling. Our national debt increases at an average rate of $2.21 billion per day and has done so since September 30, 2005 (The National Debt Clock). This amounts to an annual budget deficit of 806 billion dollars. Meanwhile, the Bush tax code calls for tax changes that would reduce revenue by $1.7 trillion over the next several years. Furthermore, because of inflationary declines in the dollar, one could expect interest rates to go up, making debt service even more expensive and painful. After the year 2010, we expect the beginnings of 77 million baby-boomers to retire, leaving behind good paying jobs that were a substantial source of tax revenue. It is expected that baby boomers will be completely retired over the ten-year period that begins in the year 2010. Finally, the off-shoring of high-value jobs may take additional tax revenues away from the U.S. Federal Government. Add to this mix the tendency of our economy to enter into a recession every ten years at the beginning of a new decade (does anybody remember the recession of 2000-2003?) and you have the makings of a real disaster.

Here is how the doomsday scenario might play out. As debt service becomes more and more arduous, the federal government cuts its services to patrons like the elderly through cuts in social security and Medicare. At the same time, it continues to sell its bonds to accommodate continuing deficits, but with increasing difficulty. Interest rates are higher now and there is growing recognition that “full faith and credit” is less secure than it once was. U.S. bond ratings start to go down and that means interest rates on these bonds must go up in order to sell the bonds. Eventually, it becomes clear—the U.S. Federal Government must raise taxes. But the mandate to raise taxes comes at a time when the U.S. economy is flat and only leads to further slowing of the economy, indeed a recession. But with the increases in tax rates comes the decision on the part of some senior citizens to leave, take their assets and move to another country—where they can enjoy a tropical paradise at low costs of living and low tax rates. Thus raising taxes actually erodes the tax base while it diminishes the economy. The result is a structural tailspin, a vicious downward spiral from which the U.S. government is unable to emerge. How can we be sure this is not the future we are creating for ourselves, our children and grandchildren? Why is it that we think we have the right to impose upon our children, grandchildren and great-grandchildren the excesses of this onerous generation?

Federal Reserve Chairman Ben Bernanke may already be faced with only two choices—an inflationary scenario in which devaluation of the U.S. dollar leads to inflation, or a deflationary scenario in which the substantial and pervasive raising of interest rates holds inflation in check, but leads to a decline in the economy. According

to Kirchhoff (2003), “When deficits started taking off 20 years ago, the retirement of the baby boomer generation was just a distant worry. Now, as the nation faces years of red ink, including at least a $400 billion shortfall in 2003 alone, the graying population is fast-approaching the reality that will put unprecedented strains on Medicare, Social Security and the economy starting around 2010.”

Bonner and Wiggin (2006) assert that, although the U.S. federal debt was about $7 trillion at the time of their writing their book, that number did not include “the gap between the government’s Social Security and Medicare commitments and the money put aside to pay for them.” That takes the total real federal debt to nearly $30 trillion or $100,000 for every man, woman and child in the country. This is roughly 2 times the annual GDP (nearly $14 trillion) of the United States—the largest economy in the world! It also exceeds half the net worth ($60 trillion) of the entire U.S. (Kirchoff, 2003).

2. A SYSTEM DYNAMICS MODEL TO STUDY THIS PROBLEM

To address the questions raised in previous section, we have taken the numbers and used them as parameters in a rather simple System Dynamics model that captures the basic structure of the underlying problem. The intent here is to capture the dynamic complexity of the problem with as parsimonious a structure as possible. Rather than focusing in on the detail complexity of the problem, this study endeavors to take a much aggregated look that is intent on capturing the dynamic complexity.

The basic structure is exhibited in Figure 1 below. This figure exhibits the basic structure of the growth in federal debt taken in relation to growth in GDP.

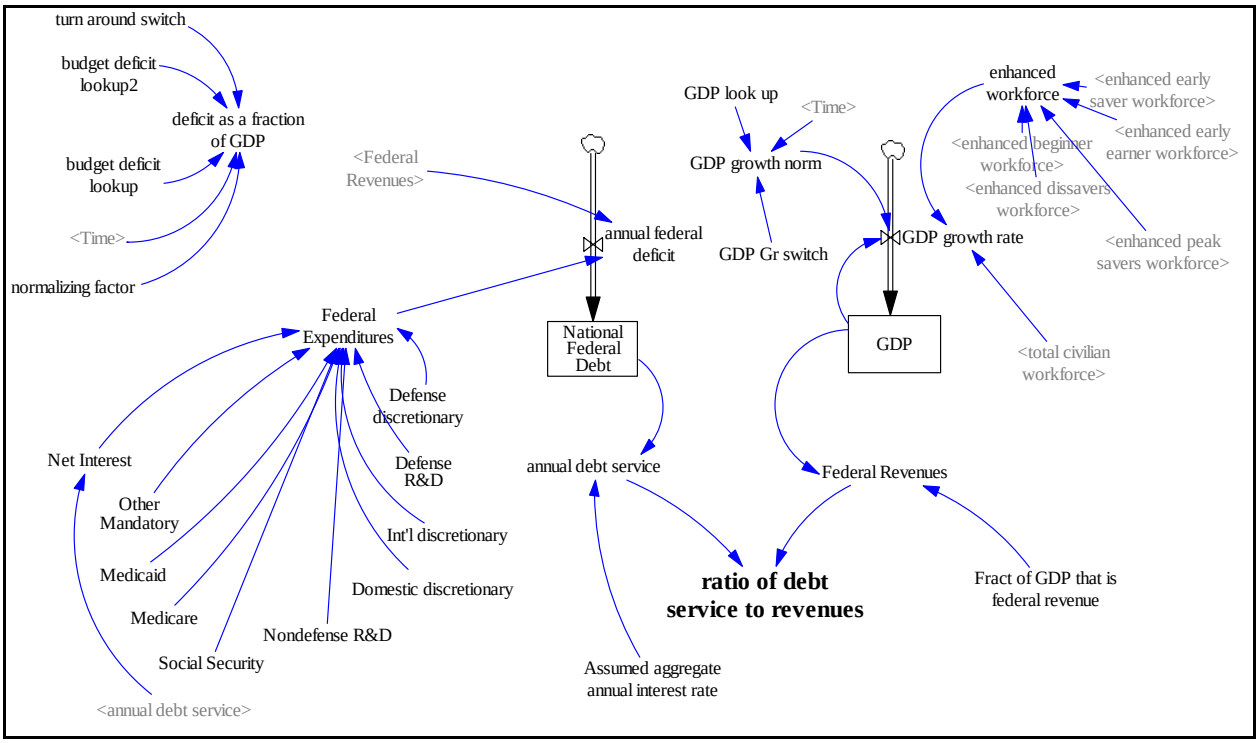

Figure 1: Basic Simplified Structure of the Growth in Federal Debt taken in relation to Growth in GDP

As can be seen from the above structure, GDP experiences an increase or decrease depending upon the attendant factors. However, based on the past history and more particularly, the growth rate experienced in the period 1994 to 2003 (IMF, 2004), a steady growth rate of 3% p.a. is incorporated as a 'base case' setting (i.e. GDP growth norm =0.03). As per Jones (2003), Federal revenues have averaged 18% to 19% of GDP since 1950. Further, assuming that the current policies continue, Jones (2003) predicts that the Federal revenues will stabilize at 19% of the GDP in the future. Accordingly, the 'Fraction of GDP that is Federal revenue' is set at 0.19 in the model as the base case setting. Jones (2003) also made an assertion that the Federal deficit would rise over the next few years to reach a level of 20% of the GDP by the year 2075. Accordingly, the variable 'budget deficit lookup' is incorporated to provide the necessary logic for the gradual rise in the deficit from the current level of 3% to 20% in the year 2075 (as base case setting).

Obviously, persistent Federal budget deficits are accumulated within the National debt and this logic is captured by modeling the annual federal deficits as an inflow into the National Federal Debt stock. National Federal Debt as on January 1, 2005 was $7.596 Trillions (Bureau of Public Debt, 2006) and accordingly, the initial value of the National Federal Debt in the model is set to this number. It is a well known fact, that the National debt needs to be serviced by payment of annual interest and the current average interest rate on the national Debt is at 4.8% p.a. (Bureau of Public Debt, 2006). Based on the debt and the applicable interest rate, one can calculate the annual interest burden of the National Debt, and compute what percentage of the federal revenues this interest burden constitutes.

The following figure, Figure 2, shows the ratio of debt service to federal revenues, based on the structure above. The line indexed by 1s assumes an aggregate interest rate of 4.8%, roughly the current rate while the line indexed by 2s assumes an aggregate interest rate of 6%. What Figure 2 shows is that debt service will consume an ever greater proportion of federal revenues at least if the current levels of GDP and budget deficits persist, all the way through the year 2050.

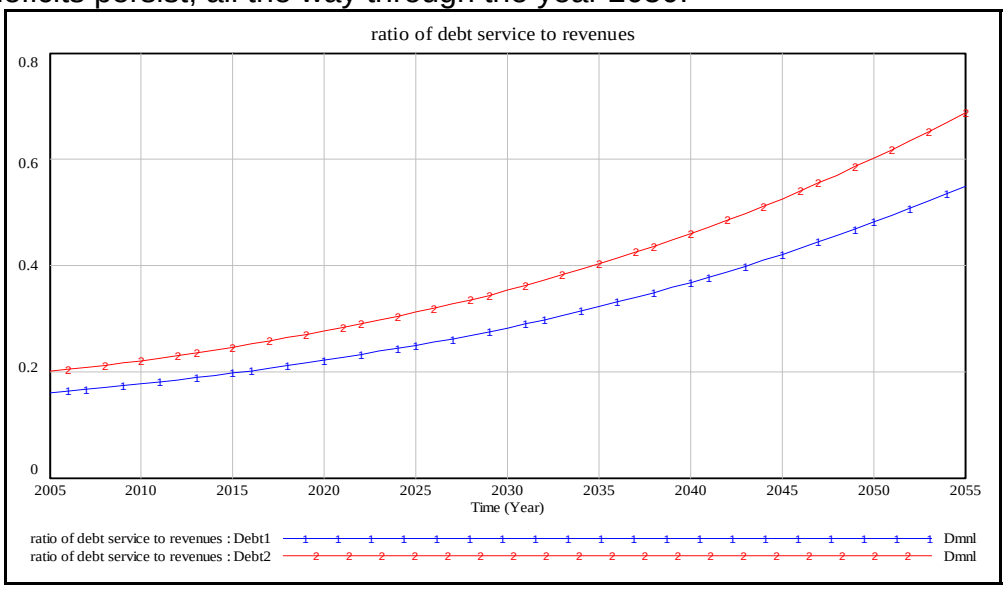

Figure 2. Ratio of Debt Service to Revenues: Curve 1 Corresponds to a 4.8% Average Interest Rate, while Curve 2 Corresponds to a 6% Average Aggregate Interest Rate

The following figure is the basic demographics sector, from which the overall age-structure of the workforce can be determined. This structure depicts age-cohorts that evolve over time, providing some indication of what percentage of the population is working taken in relation to the number of retirees.

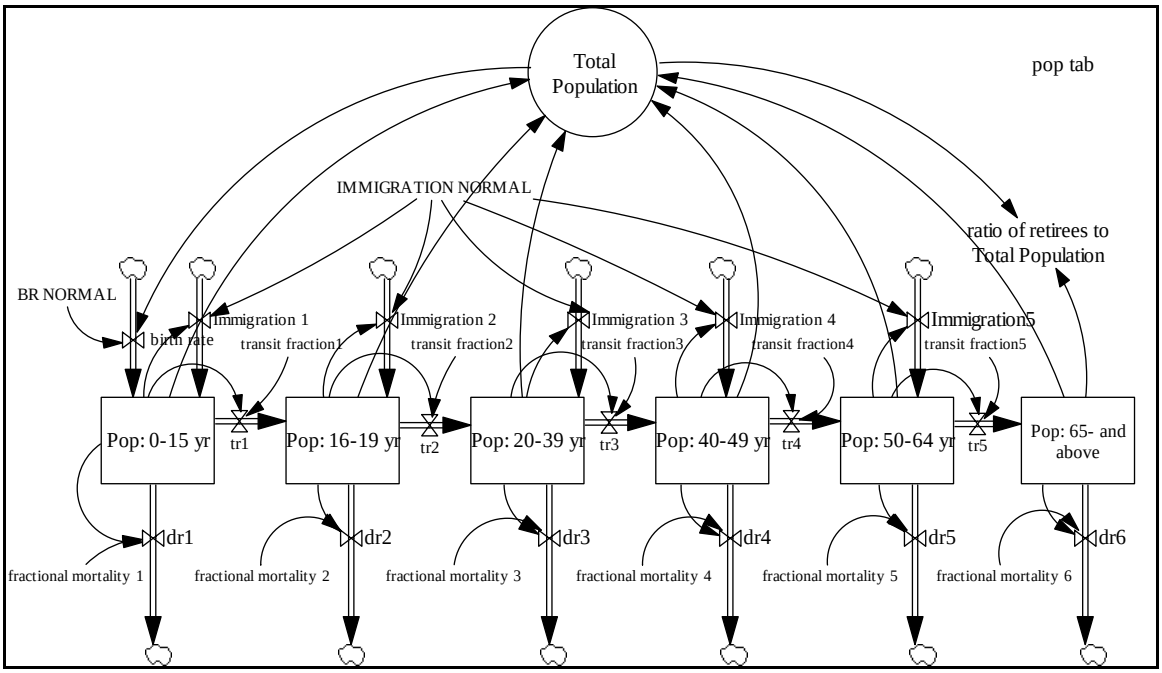

Figure 3. Basic Structure of the U.S. Population Demographics

The above figure, Figure 3, represents the disaggregated U.S. population, created to watch how the population will age over time. It is used in connection with the structure in the following figure to determine actual workforce behavior.

In the following figure, Figure 4, we exhibit the growth over fifty years, starting in 2005, of the various population cohorts exhibited in Figure 3. There are six cohorts in Figure 3. They are the boxed quantities in Figure 3. Specifically, they are the following:

1) Pop: 0-15 yr, a.k.a., Youthful Dependent;
2) Pop: 16-19 yr, a.k.a., Beginner Earners;
3) Pop: 20-39 yr, a.k.a., Early earners;
4) Pop: 40-49 yr, a.k.a., Early Savers;
5) Pop: 50-64 yr, a.k.a., Peak Savers;
6) Pop: 65- and above, a.k.a., Dissavers.

As can be observed, all the additions by way of births take place in the first age cohort of Pop: 0-15 yr. and a birth rate normal has been adopted based on birth rates reported by the US Census bureau (Martin et al, 2000). Further, the BR NORMAL in the model is fine tuned by calibrating the Total Population growth against mid series projections given by the population projections taken from the Population Projection Branch of the US Census Bureau (2000). The transition of population stock from cohorts to the successive cohorts is determined based on the cohort span. For example, the transition from 40-49 cohort will be $1/10^{th}$ of the stock per year that moves into the next cohort, because the span of 40-49 cohort is 10 years and a uniform

distribution of the population over this span is assumed. Thus, 1/10th of the population transitions to the next cohort each year. Fractional mortalities from each age cohort are modeled based on the death rates reported in the National Vital Statistic Reports (2004) suitably adjusted for the modeled cohort spans. The immigration rate into the US population is modeled based on the net migration projections forecast by the Population Projection Branch of US Census Bureau (2000) mid series projections. The in-migration rate represented by the IMMIGRATION NORMAL has also been fine-tuned under the calibration process as reported above.

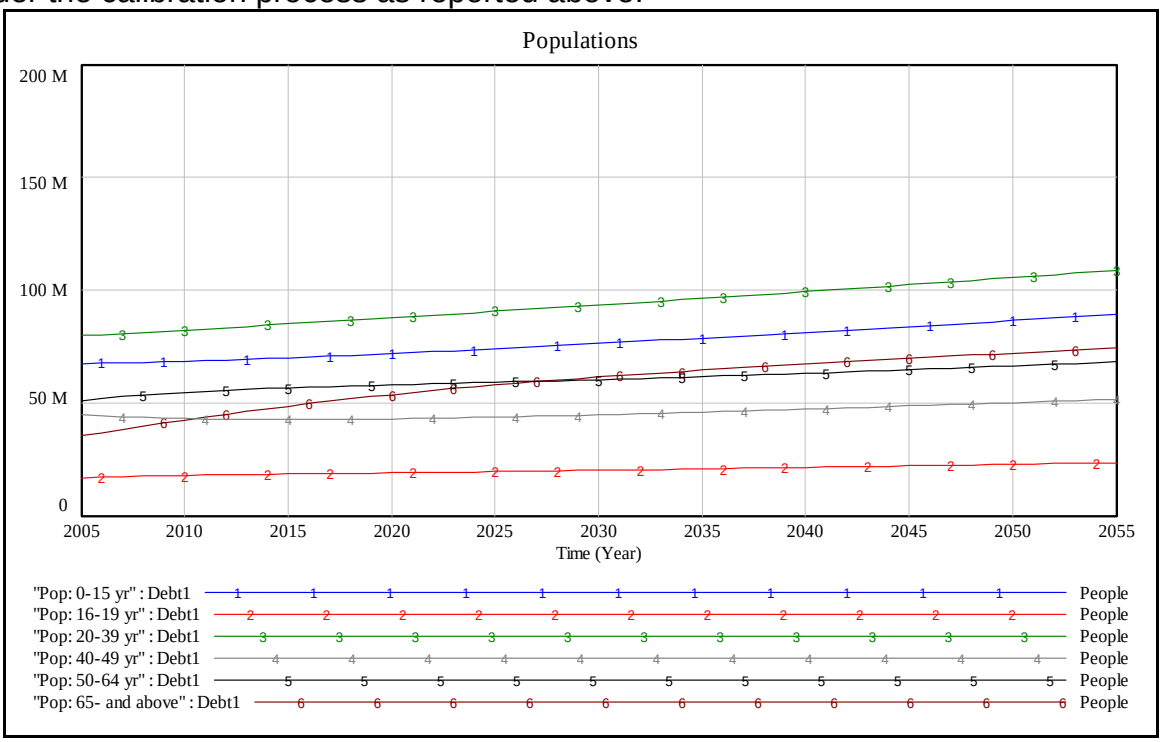

Figure 4. The evolution in size of each of the six population cohorts from 2005 until 2055

What Figure 4 reveals is very good news. There is good growth in the youngest cohort, Pop: Youthful Dependent 0-15 yr, and these individuals will become taxpayers in the next decade. Further, the demographics are very balanced, each roughly 50+ million in size and growing. Moreover, the growth in the demographics of the curve labeled 6—the retired and aging population cohort—does not appear to be outstripping the growth observed in some of the other cohorts. Pop: 16-19 yrs—Youthful Dependent—is somewhat smaller in size than the other cohorts because it covers a spread of only four years. The other cohorts cover a spread that is nine to fifteen years in duration. The reason for this uneven categorization is because of the known saving and buying habits of the various age groups and the ages at which these various age groups enter and exit the workforce. For example, the third through fifth age cohorts are considered to make up the workforce. The demographics that we observe above are generally positive for the U.S. Other countries, notably Japan and Europe, do not exhibit as many people (as a percentage of total population) in the youthful cohorts as does the U.S. While the age 65+ cohort does exhibit growth that is faster than the other cohorts, the good news is that its growth is only slightly faster than the growth of the

other cohorts. Harry Dent (1998, 2003) was among the first to point out the importance of demographics as a contributor to economic growth and development.

Next, we consider the ratio of retirees to total population, as depicted below in Figure 5. This ratio simply divides the cohort Pop: 65- and above, a.k.a. Dissavers, by the Total Population which is the sum of the contributions of all of the population cohorts.

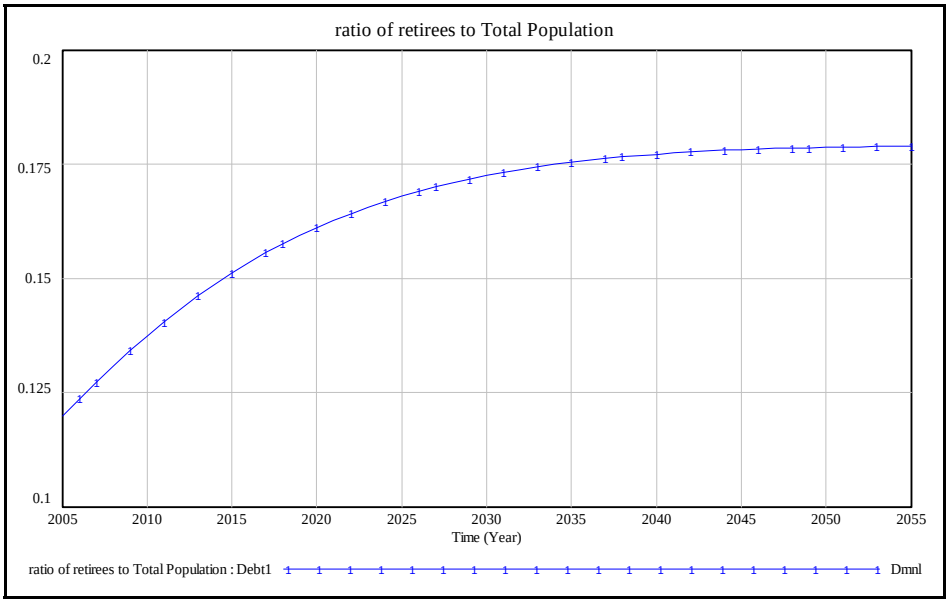

Figure 5. Ratio of Retirees to TOTAL POPULATION

Figure 5 reveals that the ratio of retirees to total population is not getting out of hand and is actually stabilizing after the year 2035. The stabilization occurs around the number .175, suggesting that there will be 1 retiree for every 6 persons in the rest of the population. We will consider this issue again when we deliberate the U.S. workforce.

One Focal Point: Gross Domestic Product (GDP)

Why the Interest in GDP? Simply stated, "Gross Domestic Product is the market value of all final goods and services produced within a country in a given period of time" (Mankiw, 1998; Ch 22, p 480). Typically, GDP is estimated in three different ways. They are: a) income approach, b) expenditure approach, and c) production approach. All the three methods are expected to result in approximately the same value, though often differences in results are very common due to a multitude of factors. These factors include among others, differences in the tools used for estimation, errors in estimation, differences in exchange rates in respect of imports, exports etc.

In the current research, components used under 'income approach' of estimating GDP and the behavior thereof are considered, to assess the impact of alternative policies on GDP. Typically, under the income approach, GDP is estimated by summing up wages, interest, profits, and taxes.

The single most significant contribution of GDP is that, it provides a good estimate of a national economy's financial well being. GDP measures two things at

once: the total income of everyone in the economy and the total expenditure on the economy's output of goods and services (Mankiw, 1998; Ch 22, pp 478). This assertion appears to be the basis for the first two approaches of estimating the GDP, namely the income approach and expenditure approach.

There are several criticisms of the use of GDP that include, a) GDP does not effectively measure customer satisfaction or the quality of life in a nation, and b) GDP doesn't measure the sustainability of growth. Without going into the debate on the usefulness and limitations of the use of GDP, we shall assert instead that GDP is widely accepted in economic literature as a useful metric. Therefore, we shall try to assess the possible effect of various policies on the GDP of the US, under the current model. No attempt is made to estimate the GDP; rather, the effect of changes in GDP, on other dependent variables, is studied. Obviously, this is too simple a model to attempt estimating the actual GDP, because estimation of GDP by itself is an enormous task. Our effort under this section is limited to studying the effect of the various scenarios, in so far as they affect the GDP and the behavior of other variables that are dependent on GDP.

The primary reason for the interest in the U.S. GDP is because it is a good measure of the overall health of the U.S. economy. A persistent secular decline in the GDP over a period of several quarters would be disastrous for the U.S. economy. The ability of the U.S. government to service its accumulating federal budget deficit is largely contingent upon continued growth of the U.S. GDP.

The Workforce View

The workforce view in the model is depicted in Figure 6. Fig. 6 shows what proportion of each cohort is actively participating in the 'Civilian Workforce.' For obvious reasons, a healthy and growing level of workforce ensures steady growth in the GDP (assuming steady productivity rates). The participation fractions for each age cohort have been calculated based on the civilian workforce data provided by the Department of Labor, Bureau of Labor Statistics website resources. These fractions are compared with the workforce participation fractions reported by the RAND Corporation (2004). The current participation fractions are adopted as a base case setting. The following participation fractions were used for each age cohort:

AGE COHORT	AGE GROUP (YEARS)	WORK PARTICIPATION FRACTION
Beginner participation rate	16-19	.402543
Early earner participation rate	20-39	.802898
Early savers participation rate	40-49	.8347
Peak savers participation rate	50-64	.697525
Dis-savers participation rate	65 and up	.151038

Table 1. Work Participation Fractions for the five identified age cohort groups

After thorough testing and comparisons with real data, the above participation fractions were judged to best fit the cohort categories shown in Table 1 above.

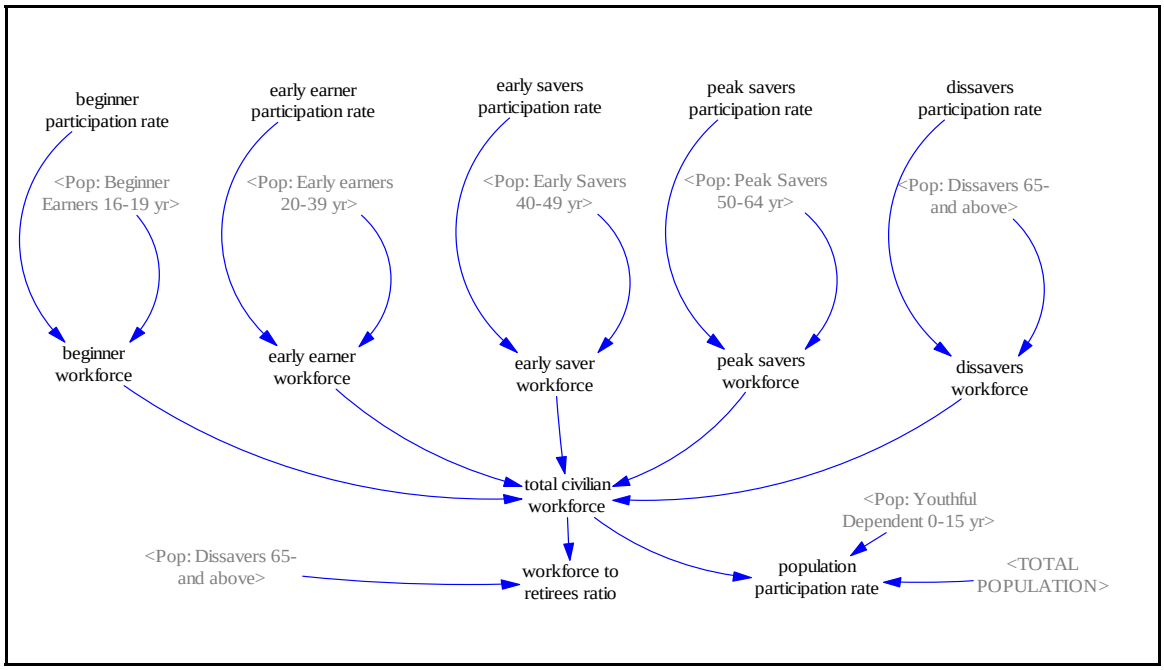

Figure 6. A Mapping of population demographics into the workforce

The following behavior-over-time chart shows how the workforce-to-retirements ratio is likely to decline over the next fifty years. This chart suggests that the number of workers to retirees will number approximately three in the year 2030 and decrease slowly after that. This puts the U.S. in a better position than most of Europe and Japan, whose workers-to-retiree ratios are going to approach 2. This chart also is in agreement with the RAND (2004) report which asserts that the U.S. will be in a better position than many other developed countries in terms of workers to retirees. Clearly, a healthier workforce can make a significant difference here because higher workforce participation fractions are possible. Similar statements hold true for a workforce that is drug and crime-free, making higher participation fractions possible. Our country must do all it can to get as much workforce participation as possible.

There are two scenarios shown in Figure 7. Curve 1 assumes the average age of retirements for dis-savers to be age 65. Curve 2 assumes the average age of retirements for dis-savers to be age 70. Obviously, the second curve exhibits much better performance and significantly better performance than curve 1. The obvious implication is to encourage the dis-savers to stay in the workforce longer. There are actually two benefits here—first these dis-savers continue to make contributions to medicare and social security and second, these dis-savers are not yet drawing funds out of medicare and social security. Clearly, substantial benefits accrue doing everything possible to allow the aging workforce to continue working until it no longer chooses to do so. Firms should be encouraged to accommodate its senior workforce in every way possible from telecommuting to work accommodations of every conceivable kind so that workers can continue to enjoy the personal fulfillment that comes from making real contributions to work up into their 70's.

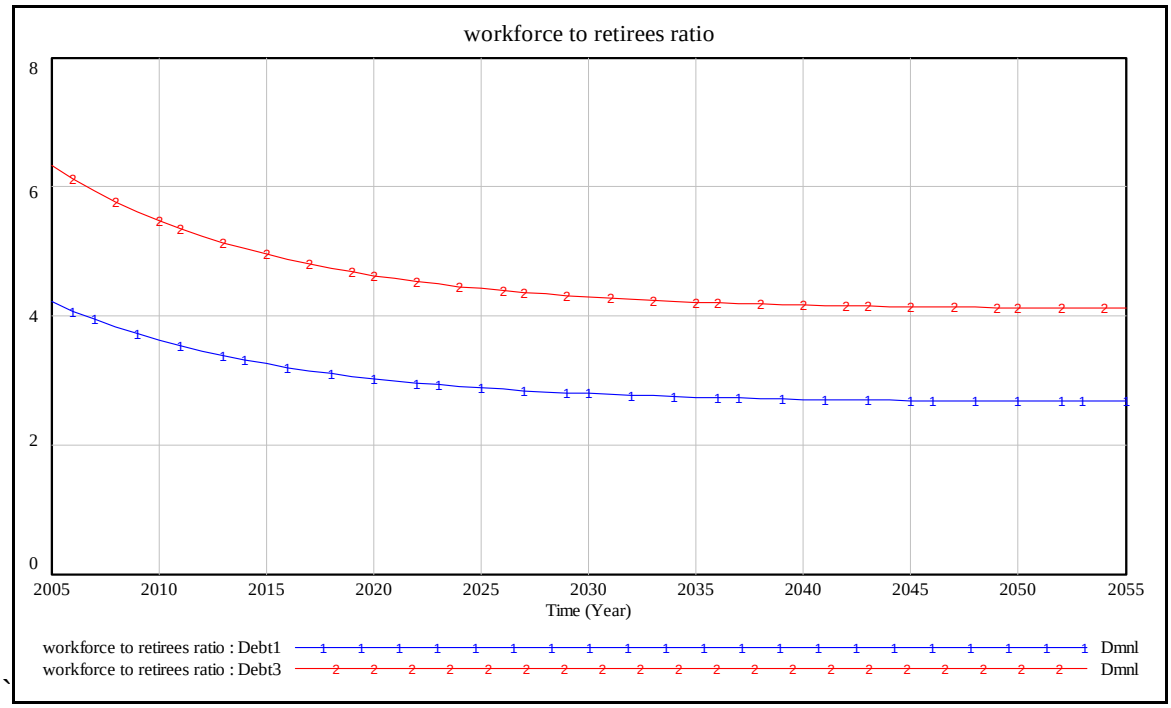

Figure 7. How the U.S. workforce is likely to decline taken in relation to retirees: Curve 1 assumes retirements at age 65, while curve 2 assumes retirements at avg. age 70.

Metrics for Policy Assessment

Three metrics for judging the effectiveness of any policy were defined as follows: **Debt per capita, avg**. **Debt Service to revenue ratio** and **avg**. **Workforce to retirees ratio**. These metrics are calculated in the following view.

The point of each of these metrics is the following. Perhaps the most credit worthy ratio that mortgage companies use to ascertain credit worthiness of individuals is to calculate annual debt service requirements as a fraction of annual income. Anything greater than .5 raises a red flag and signals that the individual should not be given any more credit. The U.S. could find itself into a situation very quickly where suddenly the debt ratio, taken in relation to federal revenue is going to .5 and above. All it would take is for the scenario described in the introduction to occur. The worst case scenario shown here is the curve labeled '2' in Figure 9 below. In this scenario the average interest rate on government bonds is assumed to be constant at 8%, while the economy (GDP) continues to grow at 3.1%. This is far from 'worst case.' A worst case is one in which the average interest rate on U.S. bonds goes up at the rate of half a percent a year until it reaches something like 15%, while the economy (GDP) erodes at a rate of 5% a year AND government revenues are falling at a rate of 10% a year. While it appears that currently, we are far away from such a disastrous future, we want to stay that way, and to do so means our government must exercise frugality, while making carefully considered, judicious choices about how to grow the economy and federal revenues.

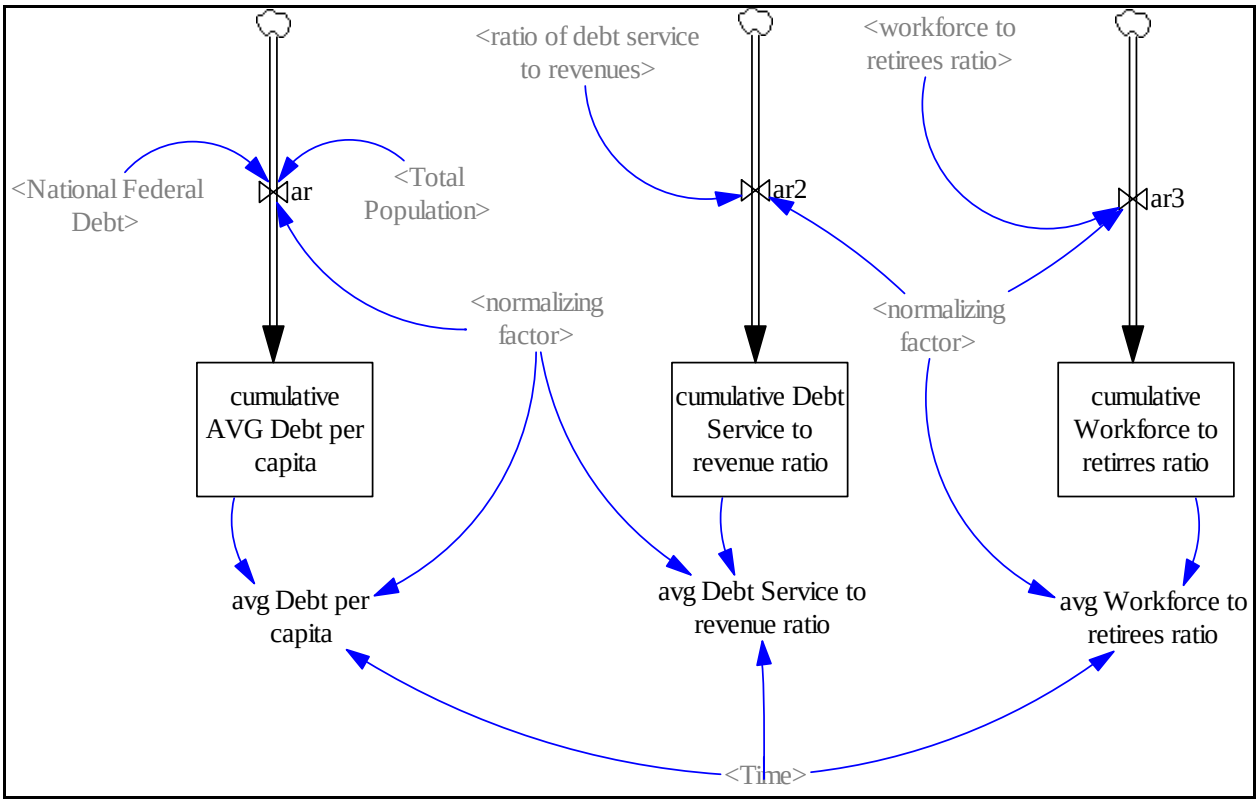

Figure 8. View Showing How the Metrics Selected Were Captured

From Figure 8 above, the following behavior chart for **avg**. **Debt Service to revenue ratio** was determined for various scenarios.

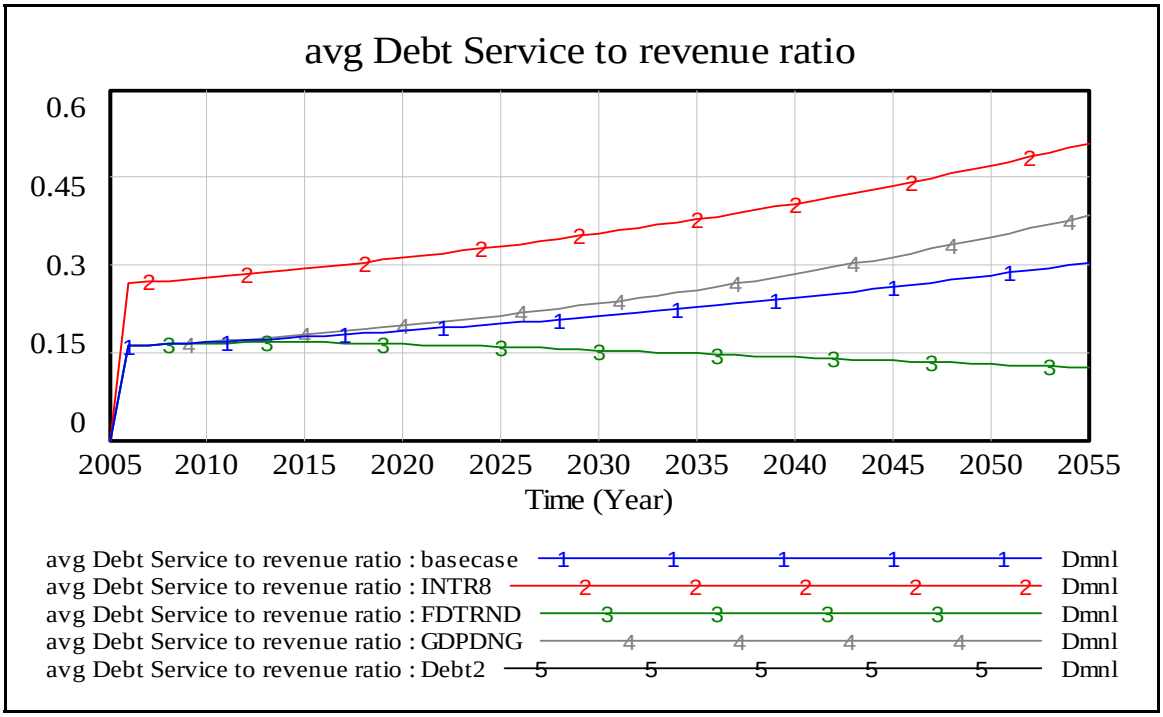

Figure 9. How Debt Service varies as a Function of Interest Rate and other factors.

Figure 9 shows how debt service would vary as a function of interest rate and other factors (see Table 2 below for a definition of what these other factors were for the exhibited scenario runs). The least desirable scenario shown above is the one in which the assumed aggregate annual interest rate is constant at 8% (giving the curved labeled with a '2' above). This scenario suggests that the debt service to revenue ratio could approach .5 by the year 2055.

3. WHAT IF ANALYSIS

Table 2 shows the results for four scenarios.—the basecase and four alternative scenarios.

	Settings					Key metrics		
Dataset	***Interest rate (%)***	***GDP Growth rate***	***Federal Deficit % assumed***	***retirement age***	***Avg workforce participation rate***	***debt service to revenues ratio in 2055***	***National debt per capita***	***workforce to retirees ratio***
Basecase	4.80	at 3.1%	increasing	65	0.7	0.3045	$94,320.00	2.993
GDPDNG	4.80	3.1% declines to 1% by 2025	increasing	65	0.7	0.3841	$73,139.00	2.993
FDTRND	4.80	at 3.1%	turned around	65	0.7	0.1239	$31,053.00	2.993
INTR8	8.00	at 3.1%	increasing	65	.7	0.5076		2.993
GDPDNG= GDP does not continue to grow								
FDTRND=Fed deficit turned around								

As can be seen from the above, steady growth in the GDP at the current rate coupled with steady increases in the Federal Deficit lead to undesirable levels of National Debt, causing a less than acceptable level of debt service to revenues ratio. On the other hand, a best case scenario (not shown) would be one in which interest rates hold steady at around 4.8%, GDP growth continues at 3.1%, the retirement age moves to age 70 and the aggregate workforce participation rate moves up to .75 or higher.

4. CONCLUSION

The U.S. workforce is steadily growing; however, retirements are on the rise. Revenues are flat; debt is soaring; something has to give. The purpose of this model is to raise awareness of the problem, to ascertain to what extent this problem is pervasive, and to suggest possible ways to ameliorate it, while the growing deficits are a cause. In particular, it does not appear that this is the 'beginning of the end.' One promising picture is the demographics of the U.S., which show that there are plenty of young people in the pipeline who can take on jobs and help sustain tax revenue. However,

there are 'things' we should do now to help alleviate the growing budget deficit. Specifically, we should find ways to reduce federal expenditures and ways to increase federal revenues.

On the expenditures side, several possibilities exist. First, baby boomers should be allowed to work for as long as they wish, extending the average retirement age to 70 or 75. One way to do this is to provide seniors with flexible work hours, allowing them to telecommute, etc. Clearly, some programs like Medicare will have to be modified in order to reign in costs.

On the revenues side, many possibilities exist as well. First, there must be continued growth in the U.S. Gross Domestic Product. To sustain GDP growth, job growth must remain strong. Perhaps the Federal Reserve should be encouraged to allow the economy to grow at a rate faster than 3.5% annually. We must allow many more people to enter the U.S. workforce. The fraction of the population in the workforce must be taken from .7 to .75 and higher, taken as an average. For early earner, early saver and peak saver cohorts, the workforce fraction should be allowed to approach .9. Higher salaries, along with higher material standard of living costs will compel more people to enter the workforce, resulting in higher participation rates. Increases in immigration will also do wonders to grow the workforce. Especially, we should allow for more professional and technical people to immigrate to our country. Engineers, scientists, doctors, computer engineers, programmers and information technologists should be allowed to immigrate with expediency. We should encourage more young Americans to pursue technical careers in engineering, computer science, mathematics, and information technology. And our Federal Government should aggressively develop its energy and mineral resources in places like the Alaskan National Wildlife Refuge and the outer Continental shelf. The Federal Government has access to vast uranium deposits as well. We should endeavor to become energy-self-sufficient as a country. As citizens of this great country, we must begin now to encourage our federal government to reign in its spending, increase its revenues and do everything it can to balance the federal budget. We cannot pass this debt on to our children and grandchildren. As MacDonald (2003) points out, a free nation deeply in debt cannot truly be free.

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