Problem A

Executive Summary

Our goal was to create a model of future United States real national debt and its relationship with Gross Domestic Product (GDP) and population growth based on federal deficits, inflation, and interest rates.

Before calculating our model, we reasoned that government revenue less government spending would result in the deficit or surplus for any given year. Further, the debt would increase exponentially on a *continuous* basis. In addition, we concluded that the deficit varies from year to year.

Our economic model is flexible enough to reflect the continuously expanding national debt and the inconstancy of the federal deficit without being unwieldy or overcomplicated. The model allows us to predict future debt given current debt, budget deficit as a function of time, inflation rate, interest rate, and time. We dealt with the inconsistency of annual deficit by using calculus to calculate the *average* deficit over a time period. Our model for debt is as follows.

$$\text{debt} = \frac{\int_0^t (\text{current debt} + \int_0^t (\text{deficit}\,dt))\,dt}{t} e^{rt}$$

In addition to the model of debt, we also determined models of per capita debt and debt as a percentage of the GDP. All of these models reflect trends based on historical data.

After having developed models based solely on current trends, we used mathematical and economic principles to adapt our models to incorporate the influence of specified changes in spending and taxation.

Using these adapted models, we explored three different realistic spending and taxation scenarios for the next 8 years. The results of these scenarios are expressed in the table below.

Year 2017	Scenario I	Scenario II	Scenario III
Real National Debt	16,690,000,000,000	$12,892,770,000,000	$14,798,400,000,000
Gross Domestic Product	23,333,200,000,000	$17,655,669,280,000	$20,595,000,000,000
RND/GDP	.715288	.730234	.718543

Especially while amidst this current recession, myriad factors contribute to economic performance. No model can truly foretell the unpredictable factors that go into government spending (and, by extension, national debt): war, natural disaster, economic depression, etc. Our model is fair insofar as it captures normal behavior of the debt over a short time period and can be adapted to model changes in controlled scenarios.

Interpretation of the Question

In essence, this question has two parts. The first part asks us to determine how the real national debt is likely to change over time. Also, this debt must be put into context by comparing it to GDP and population. The second part asks us to alter our spending and taxation policies in order to control future real national debt. Various methods of controlling the real national debt must be devised and compared.

Assumptions

- GDP can be described with an exponential function obtained through regression of historical data. This assumption is reasonable since GDP has indeed increased at an increasing rate. Though regression rarely ever models data perfectly, GPD must be expressed by an equation in order to forecast the future.
- Population can be described with a polynomial function obtained through regression of historical data. Though the end behavior of such a function is not realistic, a polynomial function accurately models the interval in which we are interested. This assumption must be made because population must be expressed by an equation in order to forecast the future.
- Interest rates on the nation debt can be averaged. Since interest rates will neither be negative nor increase infinitely, it is realistic to assume that there is an average interest rate. This assumption is necessary because an average interest rate is needed in order to model the growth of the national debt.
- Deficits can be described with a linear function obtained through regression of historical data. Though the actual data oscillates above and below the trend line, resulting in a low r^2, deficits do generally increase linearly over time. The oscillation is likely due to boom and bust cycles. This assumption must be made because deficits must be expressed by an equation in order to forecast the future.
- Marginal Propensity to Consume and Marginal Propensity to Save can be averaged. This assumption is realistic because MPC and MPS are bounded in between 0 and 1; if they changed over time, these bounds would be broken. This assumption is necessary because an average MPC and MPS are needed in order to model the growth of GDP.
- The various components of the economy will not diverge from their current trends due to wars, natural disasters, or other unforeseen events.
- The basic principles of economics hold true. Though they over-simplify the economy, they generally hold true.
- Implemented changes will go into effect immediately despite the fact that President Obama has not yet assumed his role as President. We make this assumption for the sake of simplicity. Nevertheless, this assumption is reasonable since very little time remains before President Obama does assume office.
- Changes in spending and taxation directly affect deficits and GDP without ripple effects. This assumption is reasonable since the direct effects or comparably far more influence. This assumption must be made because we do not have enough information to determine the exact nature of ripple effects.

Model

The first task was to derive an equation modeling real debt over time. Debt increases exponentially due to the accumulation of interest. However, the real value of debt decreases exponentially due to inflation. In sum, the value of r in the equation $debt=Pe^{rt}$ equals the interest rate minus the rate of inflation. The following table shows the cost of servicing the real national debt.

Year	Amount needed to service the debt	Debt
2008	4.51154E+11	1.00247E+13
2007	4.29978E+11	9.00765E+12
2006	4.05872E+11	8.50697E+12
2005	3.5235E+11	7.93271E+12
2004	3.21566E+11	7.37905E+12
2003	3.18149E+11	6.78323E+12
2002	3.32537E+11	6.22824E+12
2001	3.59508E+11	5.80746E+12
2000	3.620E+11	5.67418E+12
1999	3.53511E+11	5.64627E+12
1998	3.63824E+11	5.52619E+12
1997	3.55796E+11	5.41315E+12
1996	3.43955E+11	5.22481E+12
1995	3.32414E+11	4.97398E+12
1994	2.96278E+11	4.69275E+12
1993	2.92502E+11	4.41149E+12
1992	2.92361E+11	4.06462E+12
1991	2.86022E+11	3.6653E+12
1990	2.64853E+11	3.23331E+12
1989	2.40863E+11	2.85743E+12
1988	2.14145E+11	2.60234E+12

By dividing each year's debt by the amount needed to pay the interest, the interest rate can be calculated. The interest rates for each year are shown in the following table.

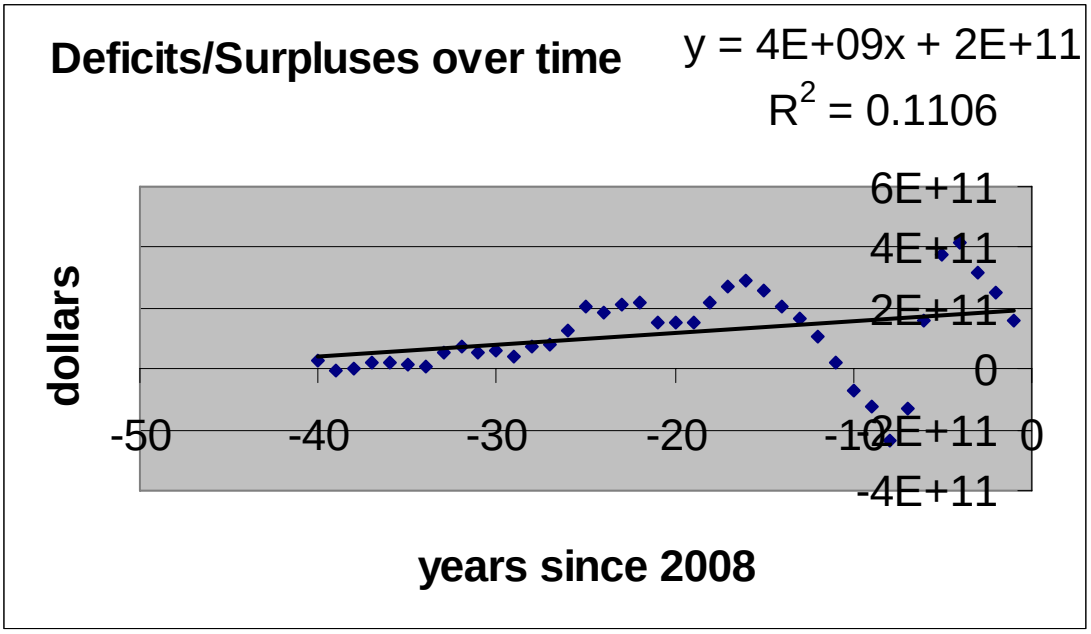
Year	Interest Rate on Debt
2008	0.045004133
2007	0.047734741
2006	0.047710515
2005	0.044417389
2004	0.043578266
2003	0.04690221
2002	0.053391837
2001	0.061904417
2000	0.063797385
1999	0.062609726
1998	0.065836232
1997	0.065728106
1996	0.065831105
1995	0.066830458
1994	0.063135213
1993	0.066304648
1992	0.071928256
1991	0.078034993
1990	0.081913662
1989	0.084293631
1988	0.082289485

The average of these values is 0.063938963. As for inflation, the inflation adjuster (with 2000 as the base year) in 1977 was 0.39, but by 2007 it was 1.21. Since $\frac{1.21-0.39}{2007-1977} = 0.02733333$ the average rate of inflation has been 0.02733333.

Now that we have the average interest rate and the average rate of inflation, we know that r = 0.063938963 – 0.02733333. However, debt also increases due to budget deficits run by Congress. The following table shows the budget deficits over the past 40 years.

Year	Years since 2008	Deficit
1968	-40	25200000000
1969	-39	-3200000000
1970	-38	2800000000
1971	-37	23000000000
1972	-36	23400000000
1973	-35	14900000000
1974	-34	6100000000
1975	-33	53200000000
1976	-32	73700000000
1977	-31	53700000000
1978	-30	59200000000
1979	-29	40700000000
1980	-28	73800000000
1981	-27	79000000000
1982	-26	1.28E+11
1983	-25	2.08E+11
1984	-24	1.85E+11
1985	-23	2.12E+11
1986	-22	2.21E+11
1987	-21	1.50E+11
1988	-20	1.55E+11
1989	-19	1.53E+11
1990	-18	2.21E+11
1991	-17	2.69E+11
1992	-16	2.90E+11
1993	-15	2.55E+11
1994	-14	2.03E+11
1995	-13	1.64E+11
1996	-12	1.07E+11
1997	-11	21900000000
1998	-10	-69300000000
1999	-9	-1.26E+11
2000	-8	-2.36E+11
2001	-7	-1.28E+11
2002	-6	1.58E+11
2003	-5	3.78E+11
2004	-4	4.13E+11
2005	-3	3.18E+11
2006	-2	2.48E+11
2007	-1	1.61E+11

We then did a linear regression on these values and determined that deficit = 3,897,598,499(t)+194,545,769,230 . A graph is shown below.



Due to deficits, the principle of the exponential equation modeling debt is not constant. To rectify this problem, we used integration to find the average principle over a given time interval.

$$\frac{\int_0^t (\text{current debt} + \int_0^t (\text{deficit}\,dt))\,dt}{t}$$

We then plugged this expression into the exponential equation.

$$\text{debt} = \frac{\int_0^t (\text{current debt} + \int_0^t (\text{deficit}\,dt))\,dt}{t} e^{rt}$$

We then plugged in values and simplified. $10,655,457,229,922.34 was used as the current debt.[1]

$$\text{debt} = \frac{\int_0^t (10655457229922.34 + \int_0^t (3897598499t + 194545769230)dt))dt}{t} e^{0.0366056297t}$$

$$\text{debt} = \frac{\int_0^t (10655457229922.34 + \frac{3897598499}{2}t^2 + 194545769230t)dt}{t} e^{0.0366056297t}$$

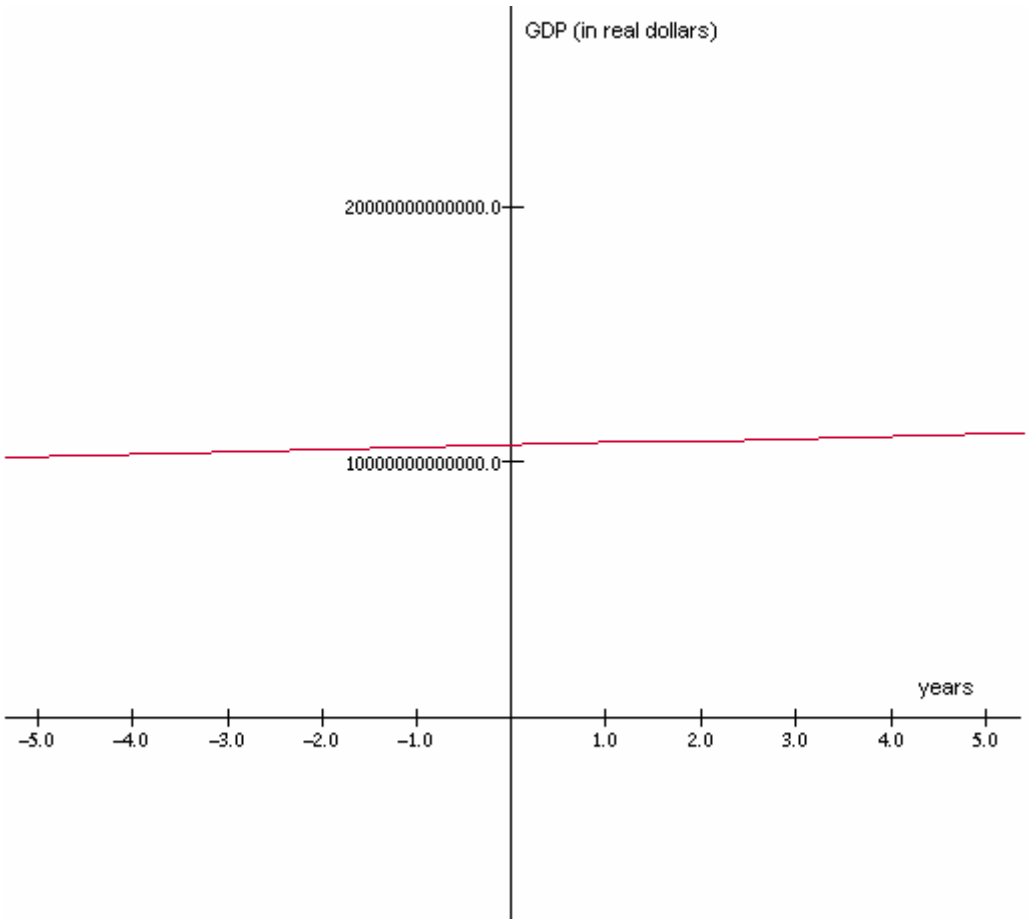
$$\text{debt} = \frac{10655457229922.34t + \frac{3897598499}{6}t^3 + \frac{194545769230t^2}{2}}{t} e^{0.0366056297t}$$

$$\text{debt} = (10655457229922.34 + \frac{3897598499}{6}t^2 + \frac{194545769230t}{2}) e^{0.0366056297t}$$

A graph of this equation is shown below.

[1] Department of the Treasury, "Total Public Debt Outstanding," 23 November 2008, <http://www.treasurydirect.gov/NP/BPDLogin?application=np> (accessed 23 November 2008).

GDP Over Time Given Current Trends

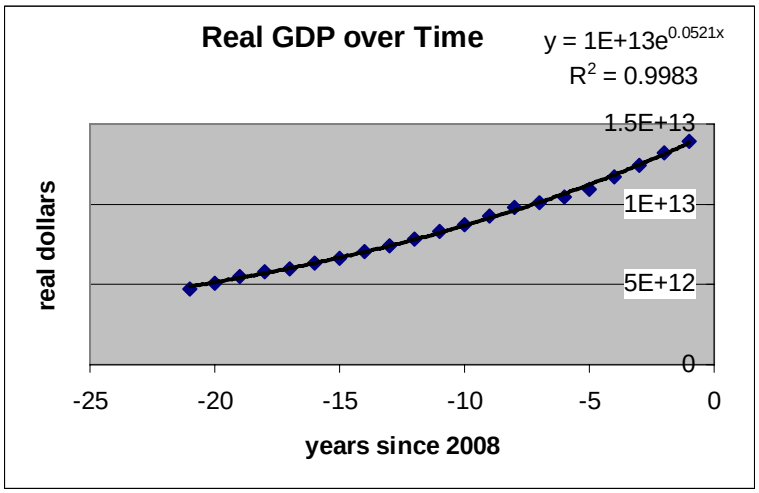


In order to give meaning to these numbers, we must also know how GDP increases over time so as to express the ratio of debt to GDP. The following table gives real GDP over the past 21 years.

year	years since 2008	real GDP
1987	-21	4.7395E+12
1988	-20	5.1038E+12
1989	-19	5.4844E+12
1990	-18	5.8031E+12
1991	-17	5.9959E+12
1992	-16	6.3377E+12
1993	-15	6.6574E+12
1994	-14	7.0722E+12
1995	-13	7.3977E+12
1996	-12	7.8169E+12
1997	-11	8.3043E+12
1998	-10	8.747E+12
1999	-9	9.2684E+12
2000	-8	9.817E+12
2001	-7	1.0128E+13
2002	-6	1.047E+13
2003	-5	1.0961E+13
2004	-4	1.1686E+13
2005	-3	1.2422E+13
2006	-2	1.3178E+13
2007	-1	1.3908E+13

We then did an exponential regression on these values. The resulting graph and equation are shown below.

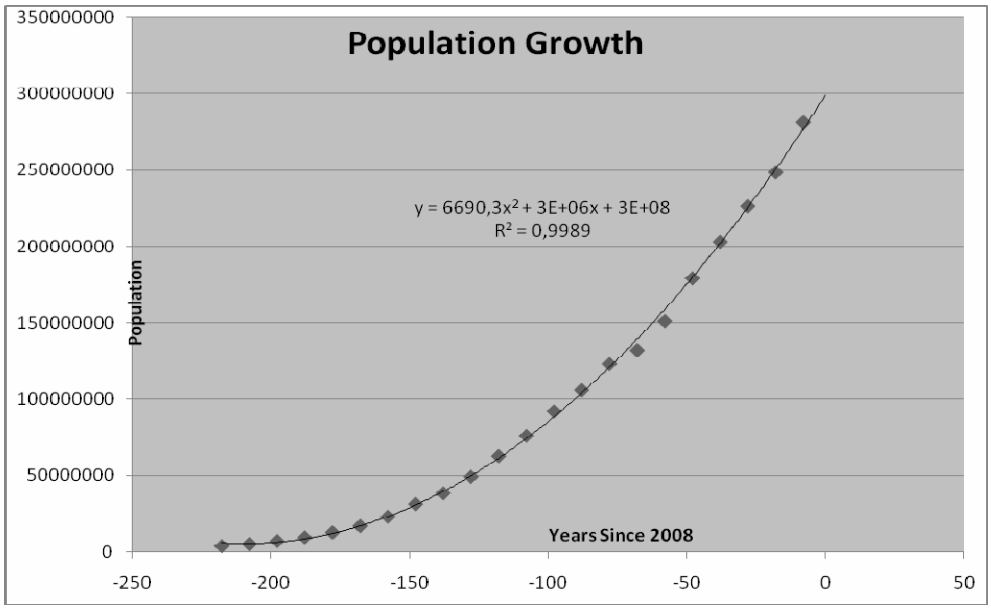
$$GDP = 14{,}591{,}835{,}000{,}000e^{0.0521574637t}$$



It would also be interesting to see how per capita debt changes over time. The following table shows the population of the United States throughout its entire history.

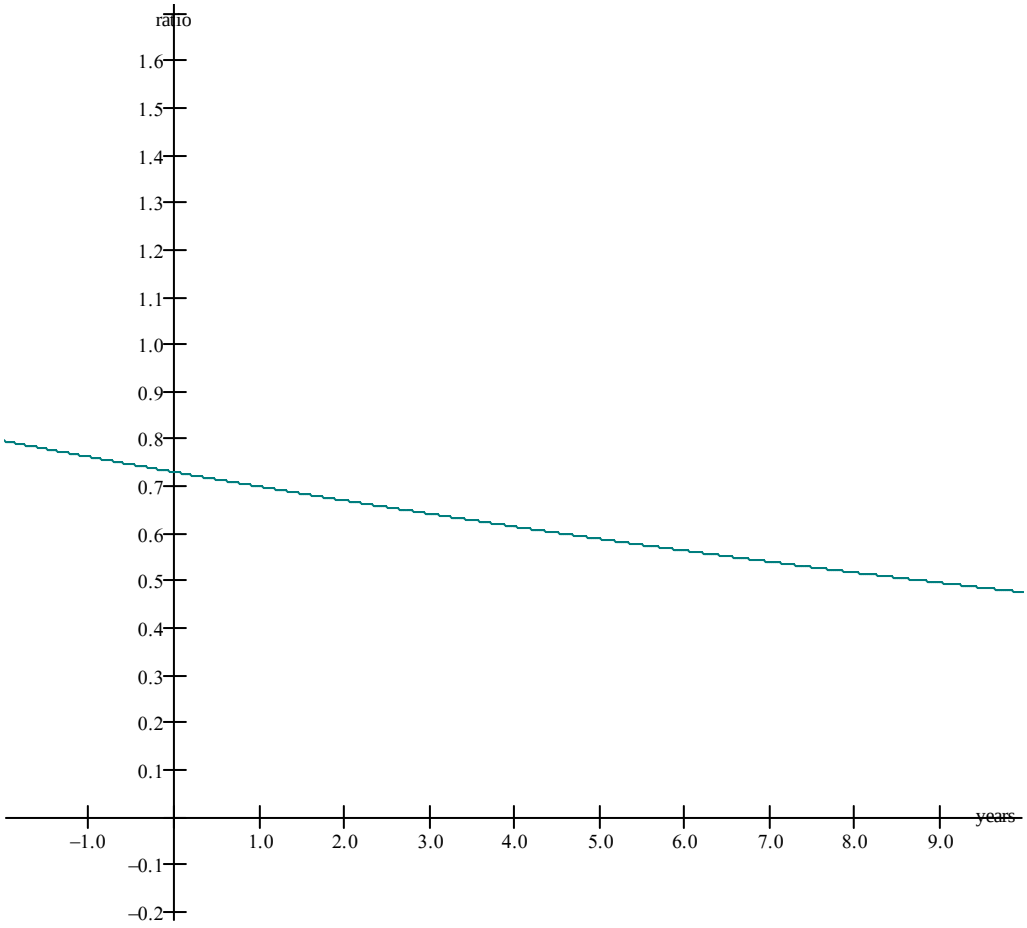
year	years since 2008	population
1790	-218	3929214
1800	-208	5236631
1810	-198	7239881
1820	-188	9638453
1830	-178	12866020
1840	-168	17069453
1850	-158	23191876
1860	-148	31443321
1870	-138	38558371
1880	-128	49371340
1890	-118	62979766
1900	-108	76212168
1910	-98	92228496
1920	-88	1.06E+08
1930	-78	1.23E+08
1940	-68	1.32E+08
1950	-58	1.51E+08
1960	-48	1.79E+08
1970	-38	2.03E+08
1980	-28	2.27E+08
1990	-18	2.49E+08
2000	-8	2.81E+08

We then did a power regression on these values. The resulting graph is shown below.

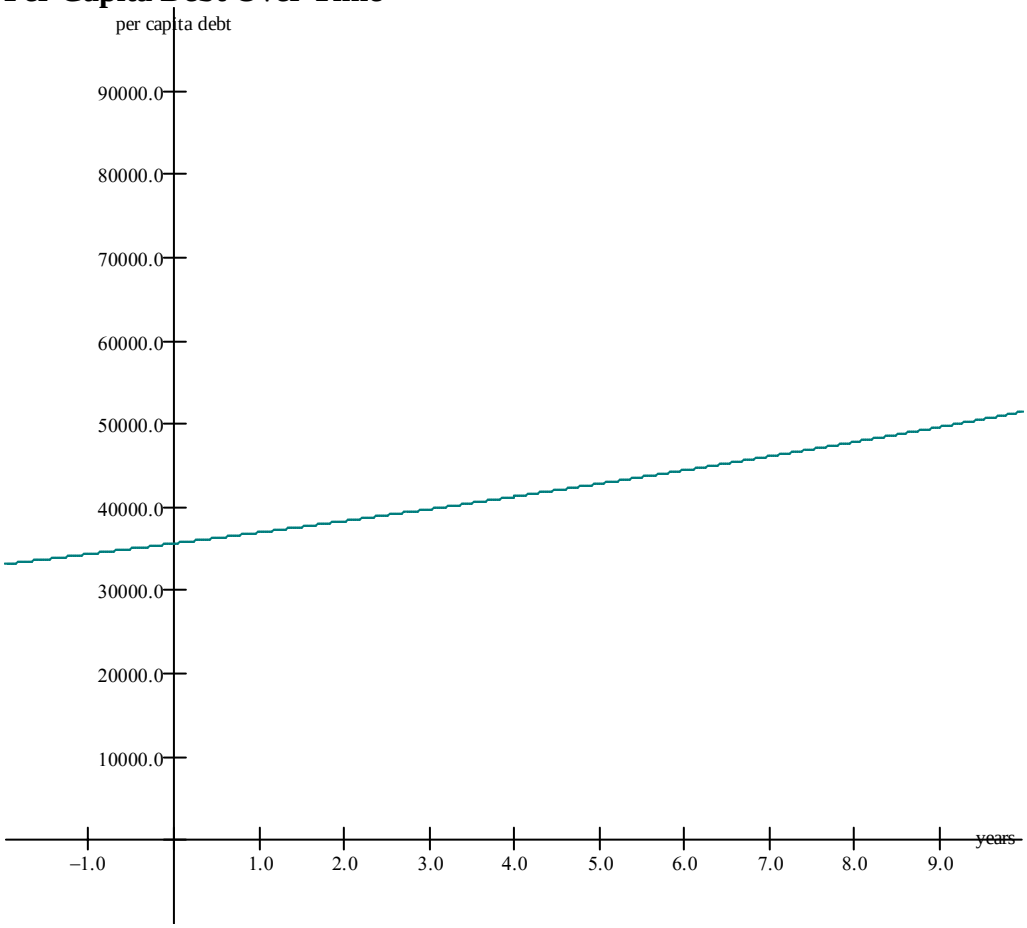


Now that we have the functions of GDP over time and population over time, we can express the ratio of debt to GDP and debt to population.

Debt/GDP



Per Capita Debt Over Time



These graphs forecast the future debt to GDP ratio and per capita debt based on current trends. However, we would also like determine what would happen if we changed spending and taxing practices. Therefore the debt and GDP equations must be modified. If we are to change spending, we must add the variable *spending* to the deficit function. The new debt function would be as follows.

$$\text{debt} = \frac{\int_0^t (\text{current debt} + \int_0^t ((\text{deficit}+\text{spending})dt))dt}{t} e^{rt}$$

$$\text{debt} = \frac{\int_0^t (10655457229922.34 + \int_0^t (3897598499t+194545769230+\text{spending})dt))dt}{t} e^{0.0366056297t}$$

$$\text{debt} = \frac{\int_0^t (10655457229922.34 + \frac{3897598499}{2}t^2 +194545769230t+\text{spending}(t))dt}{t} e^{0.0366056297t}$$

$$\text{debt} = \frac{10655457229922.34t+\frac{3897598499}{6}t^3+\frac{194545769230t^2}{2}+\frac{\text{spending}(t)^2}{2}}{t} e^{0.0366056297t}$$

$$\text{debt} =(10655457229922.34+\frac{3897598499}{6}t^2+\frac{194545769230t}{2}+\frac{\text{spending}(t)}{2})e^{0.0366056297t}$$

However, GDP is also affected also by changes in spending. The laws of economics state that (increase in spending/marginal propensity to save) = increase in GDP. The following table gives the marginal propensities to save and consume over the period of 1970 to 2001.

Year	Marginal Propensity to Save	Marginal Propensity to Consume
1970	0.094	0.906
1971	0.1	0.9
1972	0.089	0.911
1973	0.105	0.895
1974	0.107	0.893
1975	0.106	0.894
1976	0.094	0.906
1977	0.087	0.913
1978	0.09	0.91
1979	0.092	0.908
1980	0.102	0.898
1981	0.108	0.892
1982	0.109	0.891
1983	0.088	0.912
1984	0.106	0.894
1985	0.092	0.908
1986	0.082	0.918
1987	0.073	0.927
1988	0.078	0.922
1989	0.075	0.925
1990	0.078	0.922
1991	0.083	0.917
1992	0.087	0.913
1993	0.071	0.929
1994	0.061	0.939
1995	0.056	0.944
1996	0.048	0.952
1997	0.042	0.958
1998	0.047	0.953
1999	0.024	0.976
2000	0.01	0.99
2001	0.02	0.98

The average MPS is 0.07825, and the average MPC is 0.92175. Now that we know these values, we can add the increase in GDP to the GDP equation.

$$\text{GDP} = 14{,}591{,}835{,}000{,}000e^{0.0521574637t} + \frac{\text{spending}}{0.07825}$$

If we were to increase taxes, we would subtract the increase from the deficit function. The new debt function would be as follows.

$$\text{debt} = \frac{\int_0^t (\text{current debt} + \int_0^t ((\text{deficit} - \text{taxes})dt))dt}{t} e^{rt}$$

$$\text{debt} = \frac{\int_0^t (10655457229922.34 + \int_0^t (3897598499t + 194545769230 - \text{taxes})dt))dt}{t} e^{0.0366056297t}$$

$$\text{debt} = \frac{\int_0^t (10655457229922.34 + \frac{3897598499}{2}t^2 + 194545769230t - \text{taxes}(t))dt}{t} e^{0.0366056297t}$$

$$\text{debt} = \frac{10655457229922.34t + \frac{3897598499}{6}t^3 + \frac{194545769230t^2}{2} - \frac{\text{taxes}(t)^2}{2}}{t} e^{0.0366056297t}$$

$$\text{debt} = (10655457229922.34 + \frac{3897598499}{6}t^2 + \frac{194545769230t}{2} - \frac{\text{taxes}(t)}{2}) e^{0.0366056297t}$$

Changes in taxes, just like changes in spending, also affect GDP. The laws of economics state that ((increase in taxes)(marginal propensity to consume)/marginal propensity to save) = decrease in GDP. Therefore, we can subtract this term from the GDP equation.

$$\text{GDP} = 14{,}591{,}835{,}000{,}000 e^{0.0521574637t} - \frac{\text{taxes}(0.92175)}{0.07825}$$

Now that our model of debt and GDP can take into account changes in spending and taxation, we can evaluate several different fiscal policies.

Scenario 1: Debt Incurred Under President Obama's Proposed Taxing & Spending Policy

Under Obama's plan, the deficit each year is estimated to be $300 billion. Using our model, we can reasonably forecast the real national debt under President Obama assuming that his proposals are enacted over the next eight years. To make this forecast, the deficit component of the debt equation must be $300 billion rather than the historical average deficit.

We calculated the value of $300 billion as follows. The Congressional Budget Office forecasted "Baseline Budget Projections"[2] for years 2008 to 2017 (Table 1.1). We averaged their yearly estimates. The value according to the CBO was $**258.7** billion.

Table 1.1: Budget Deficit: 2007-2017

Congressional Budget Office Baseline Budget Predictions

	Actual	Projected -->									
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Tax revenue (Billions of dollars)	2,568	2,548	2,720	2,881	3,178	3,451	3,619	3,770	3,958	4,145	4,341
Total expenditures	2,729	2,955	3,158	3,312	3,502	3,577	3,766	3,939	4,120	4,352	4,514
Total deficit (-) or Surplus	-161	-407	-438	-431	-325	-126	-147	-170	-162	-207	-174

Source: CBO's Baseline Budget Projections

We then compared $258.7 billion with the estimate attained by the Committee for a Responsible Federal Budget, a think-tank. Their forecast predicted that in 2013 (given Obama's proposed spending policies), the federal government will run a deficit of $**281** billion (Table 1.2).[3]

Table 1.2: Deficit Impact in 2013

Tax policy	**-$147 billion**
Health Care Policy	-$65 billion
Energy Policy	$0
Other Spending/Savings	+$144 billion
Total	**-$281 billion**

Source: US Budget Watch

[2] Congressional Budget Office, "CBO's Baseline Budget Predictions," September 2008, page 1, <http://www.cbo.gov/ftpdocs/97xx/doc9706/Selected_Tables.pdf> (accessed 23 November 2008).
[3] Committee For a Responsible Federal Budget, "US Budget Watch," 7 October 2008, page 8, <http://www.usbudgetwatch.org/files/crfb/USBW%20Voter%20Guide%20October%205%202008.pdf > (accessed 23 November 2008).

With the two predicted deficits in mind ($281 billion and $258.7 billion), we reasonably ascertained that on average the annual federal deficit will run around $300 billion. This figure more accurately reflects government spending (which tends to be increase, rather than decrease, over time) and unpredictable discretionary spending in reaction to economic downturns, wars, natural disasters, etc. In addition, the figure represents Obama's proposed tax cuts which would reduce tax revenue and his increased spending on income transfers (Social Security, Medicaid, etc.).

To understand our mathematical model in this scenario, observe that the only difference from the original equation is the piece of the model expressed below:

$$\int_0^t \text{deficit}\,dt = 300*10^9\text{t}$$

This part of the expression represents the average deficit over a time interval times the total time of the interval. In lieu of utilizing the equation to represent deficit over time from our original model (derived from historical data), we used information on Barack's economic goals for his upcoming term (see above).

Therefore, our adapted model describes real national debt as

$$\frac{\int_0^t (\text{current debt}+300*10^9\text{t})\,dt}{\text{t}}\,e^{rt}$$

Where current debt = $10655457229922.34 and r = .0366056297 as before. This equation is graphed below and the debt each year is shown in a table thereafter.

Graph 1.1: National Debt from Year 2009 to Year 2017 under Barack Obama

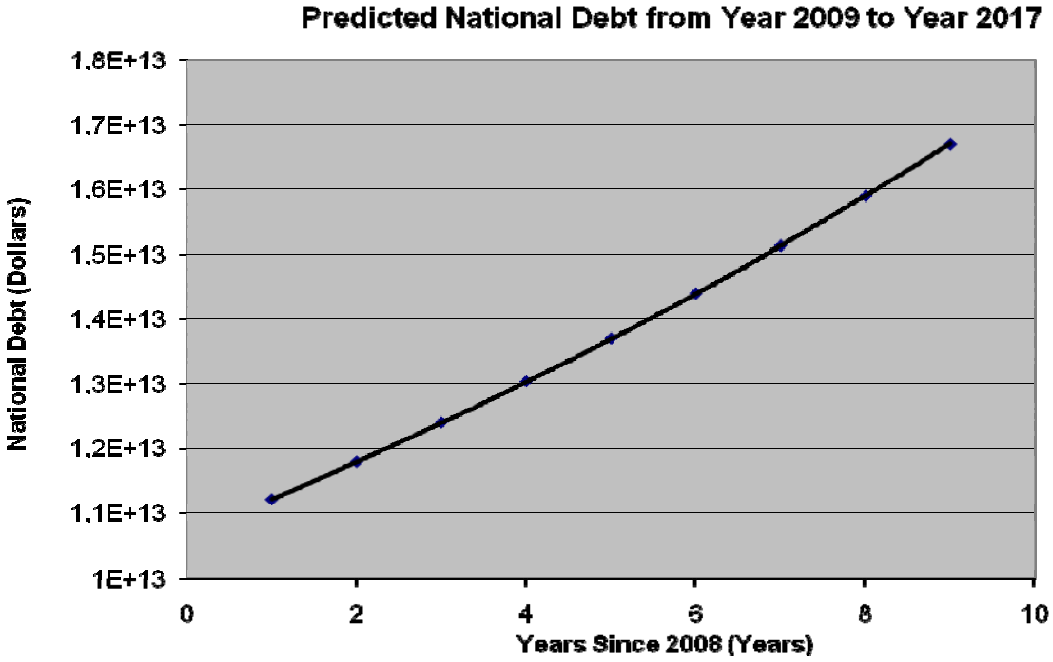


Table 1.1: National Debt from Year 2009 to Year 2017

Years Since 2008	National Debt (Dollars)
1	1.12083E+13
2	1.17876E+13
3	1.23945E+13
4	1.30303E+13
5	1.36962E+13
6	1.43937E+13
7	1.51242E+13
8	1.58891E+13
9	1.66900E+13

Using this new debt equation and our population equation, we expressed debt per capita in a graph below. The debt per capita is also shown in a table thereafter.

Graph 1.6: Debt Per Capita

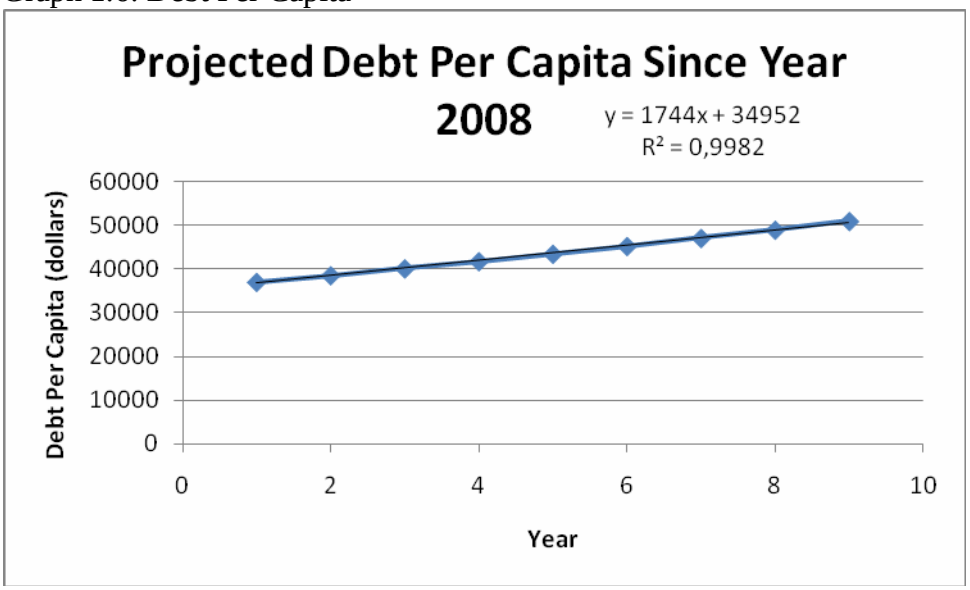


Table 1.6: Debt Per Capita

Year	Debt Per Capita (Dollars)
1	36,990
2	38,518
3	40,104
4	41,749
5	43,457
6	45,229
7	47,068
8	48,976
9	50,955

We also expressed the ratio of debt and GDP under Obama in the graph and table below.

Graph 1.7: Debt-GDP Ratio Since 2008

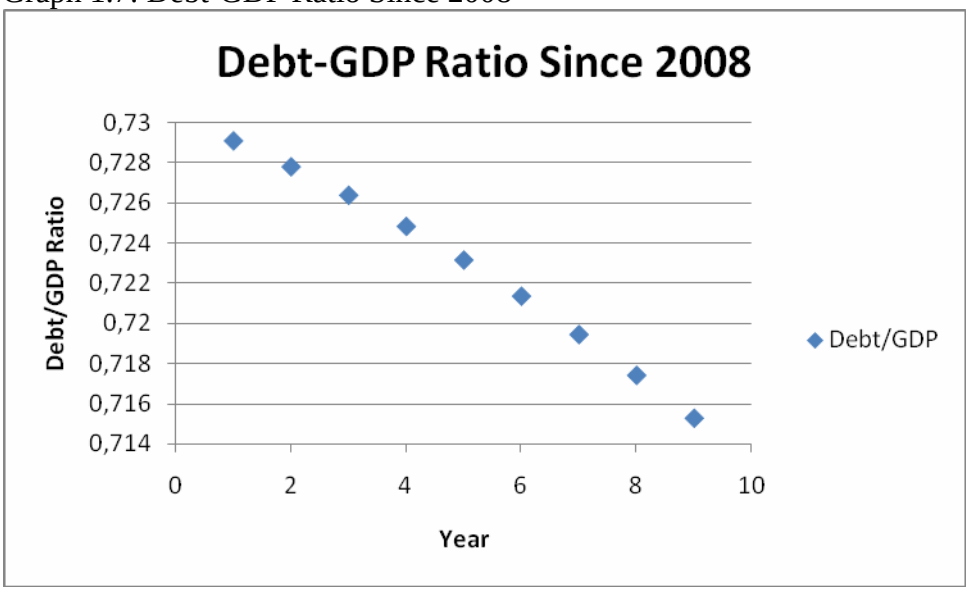


Table: 1.6: Debt-GDP Ratio Since 2008

Year	Debt/GDP
1	0.729084959
2	0.727800052
3	0.726380213
4	0.724832588
5	0.723155486
6	0.721360479
7	0.719449991
8	0.71742383
9	0.715288327

Scenario II:

In Scenario II, we strove to have the current debt to GDP ratio equal to the debt to GDP ratio in 2017. To achieve this goal, we first calculated the current ratio.

Current Debt / Current GDP = constant
= 10655457229922.34 / 14591835000000
= 0.730234

We then calculated what increased spending would produce the same ratio in 2017.

Debt = [(10655457229922.34 + (3897598499)*(81/6) + (194545769230)*(9/2) + (SPENDING)*(9/2)]*$e^{(0.0366056297)*(9)}$

GDP = 14591835000000 + (SPENDING/0.07825)

Debt / GDP = 0.730234 = [((10655457229922.34 + (3897598499)*(81/6) + (194545769230)*(9/2) + (SPENDING)*(9/2))*$e^{(0.0366056297)*(9)}$] / [14591835000000 + (SPENDING/0.07825)]
SPENDING = \$-3.04*10^{11} per year

We then plugged -3.04*10^{11} back into the Debt equation.

Debt = [(10655457229922.34 + (3897598499)*(81/6) + (194545769230)*(9/2) + (-3.04*10^{11})*(9/2)]*$e^{(0.0366056297)*(9)}$ = \$1.289277*10^{13}

Using the debt to GDP ratio, we calculated the GDP for year 2017.

GDP = Debt / 0.730234
= 1.289277*10^{13}/ 0.730234
= \$2.33332*10^{13}

Scenario III

In Scenario III, we strove to achieve a balanced budget every year via tax hikes. By calculating the deficit in the nine years after 2008, then multiplying it by the marginal propensity to consume, and finally dividing it by the marginal propensity to save, we figured out the GDP without deficit by subtracting this value from the expected GDP value nine years from 2008. For calculating the debt, the principle debt stayed constant at $10,655,457,229,922.34 since there were no annual deficits.

In order to achieve this final zero deficit, the country would need to adopt greater taxing policies to balance government spending. This final balance could be reached by slowly decreasing the deficit yearly. Given the current financial crisis, it would be most appropriate to greatly raise taxes for the upper class rather than for the lower-middle class. Although the amount of government spending is not changed in this policy, it is of the utmost importance that expenditures focus on saving the economy.

Deficit = 3897598499t +194545769230 t = number of years after 2008

= $2.29624E+11

GDP without Deficit = (14591835000000*$e^{0.0521574637t}$) - (Deficit*MPC/MPS)

MPC/MPS = ((1 – 0.07825) / 0.07825)

= $2.0595E+13

Debt without Deficit = Current Debt*(e^{rt}) Current Debt = 10655457229922.3

r = 0.0366056297

= $1.47984E+13

Debt without Deficit / GDP without Deficit = 0.718543321

In the end, we found that the debt in 2017 under this policy would be $14,798,400,000,000. The GDP would be $20,595,000,000,000, and the RND/GDP ratio would be 0.718543.

Cultural Impact

Year 2017:

	Scenario I	Scenario II	Scenario III
Real National Debt	16,690,000,000,000	$12,892,770,000,000	$14,798,400,000,000
Gross Domestic Product	23,333,200,000,000	$17,655,669,280,000	$20,595,000,000,000
RND/GDP	.715288	.730234	.718543

Under Scenario I—President Obama's proposed spending policies—the debt to GDP ratio decreased over time. Scenario I also boasts the highest GDP. Scenario I also has the lowest debt to GDP ratio and is the most practical to implement. It does not require an abnormal reduction in spending or a sharp increase in taxation.

An advantage of Scenario II is the decrease in government spending which would result in a real national debt lower than that of Scenario I. A disadvantage of Scenario II is a lower GDP than that of Scenario I.

Since Scenario II reduces spending rather than raises taxes to generate revenue, one possible concern is a reduced economic stimulus package for the economy. It is important to effectively redistribute money to businesses and individuals during periods of economic recession. Therefore, gratuitous government spending in the form of earmarks would have to be greatly reduced. In addition, war appropriations would likely have to be eliminated or greatly reduced.

In order to achieve a continuous deficit of zero per Scenario III, raised federal tax revenue would need to balance government spending. Given the current financial crisis, it is most appropriate to increase taxes for the highest brackets. Although the amount of government spending is not changed under this policy, the government must spend its money more wisely to balance the budget.

This method provides a debt to GDP ratio similar to Scenario I while also producing a significantly lower real national debt. The downside—as with Scenario II—is that the GDP thus is lower than that of Scenario II.

Scenarios I and II have varying implications for the United States. In Scenario II, the large decrease in government spending brings up the issue of how to best use the government's budget. This fiscal dilemma would lead to a discussion of appropriations for Healthcare, Social Security, etc. However, Scenario II's lower taxes would lead to more disposable income and thus a greater propensity to consume. Consumer spending is a central component of GDP.

Scenario III's economic impact would be quite the opposite. The increased taxes, even if created mainly for the upper tax brackets, would take money away from the public that could be potentially spent. The government would have a larger budget, but fiscal responsibility would be essential. The combination of Scenario III's relatively low real national debt and low RND/GDP ratio makes it seem like the best scenario of the three, but it also may be the most impractical. Historically, America has rarely balanced its federal budget.

Weaknesses

- In Scenario I, GDP is not adjusted to Obama's proposed changes in taxation and spending. Since we do not know the exact changes in taxation and spending, we have no values to plug in to the spending/MPS and taxes*MPC/MPS formulas.
- For Scenario II deficits are zero each year. Rarely is Congress able to balance the budget. Therefore, this scenario would be unlikely.
- Different time intervals are used for the regression of various quantities. Due to the limited information available to us, we could not always use the same interval.
- Neither scenarios involved changes in both spending and taxation. For simplicity, we chose not to deal with two variables.

Strengths

- Our model uses formulas that can make exact predictions for debt and GDP for any point in time.
- Scenario I is based on Barack Obama's economic plans. Seeing as he is president and plans to enact these policies, our model is extremely relevant.
- Our formulas for debt and GDP can be adopted to incorporate changes in spending and taxations.
- The continuous exponential rate of change of debt incorporates both the influence of interest and inflation.
- Many of the quantities in our formulas are not constant. By using calculus to manage the changing values, we were able to be accurate and did not need to use approximations.

Letter to the President

November 22, 2008

President Barack Obama
The White House
1600 Pennsylvania Avenue NW
Washington, DC 20500

Dear President Obama:

Among the most pressing issues facing our nation is the growing national real debt compounded with the skyrocketing annual deficit. Since 1961, the real national debt has never decreased for any extended length of time. As it continues to grow, the amount required to service the debt increases as well. If unsolved, it will become an increasingly greater burden to United States government.

Employing mathematical models based on historical precedent, we have forecasted the real national debt for fiscal years 2009-2017. We have included three scenarios for you and your staff to consider.

The first scenario incorporates your planned budgetary reforms and then determines an approximate annual deficit. The resulting deficit is then plugged into a larger equation that models future debt expansion.

The second scenario consists of a projected reduction in spending of $304 billion annually. We tailored this scenario to our goal of having the same ratio the real national debt to GDP in 2017 as it is now.

The third scenario presumes a continuously balanced budget for the next nine years by raising taxes. Though optimistic, success would cause a substantial decrease of the ratio of real national debt to GDP.

We hope that you consider these debt forecasts as you enter your first term, and that our findings will serve as a reliable guide.

Sincerely,

Math Modelers

Resources

- http://www.cbo.gov/budget/data/historical.pdf
- http://www.treasurydirect.gov/govt/reports/pd/histdebt/histdebt_histo4.htm
- http://www.treasurydirect.gov/govt/reports/ir/ir_expense.htm
- http://en.wikipedia.org/wiki/National_debt_by_U.S._presidential_terms
- http://www.treasurydirect.gov/NP/BPDLogin?application=np
- http://economics.about.com/library/moffattdata/mudry-appendix-3.xls
- http://en.wikipedia.org/wiki/Demographics_of_the_United_States
- http://www.bea.gov/national/nipaweb/TableView.asp?SelectedTable=6&ViewSeries=NO&Java=no&Request3Place=N&3Place=N&FromView=YES&Freq=Year&FirstYear=1929&LastYear=1999&3Place=N&Update=Update&JavaBox=no
- http://www.cbo.gov/ftpdocs/97xx/doc9706/Selected_Tables.pdf
- http://www.usbudgetwatch.org/files/crfb/USBW%20Voter%20Guide%20October%205%202008.pdf