Team Control #: 2086

Understanding the National Debt and its Impact

November 23, 2008

Abstract

In this paper we studied the historical trend and current policies and promises made by the current president elect, Barack Obama, and constructed four models based on different assumptions. Model one, the most basic model, takes into consideration only the impact of national revenue and national expenditure on the national debt for the last 20 years, and produces a single-variable linear regression line. Model two is based on model one, but takes into consideration the GDP, the inflation rate, and the party in power. Model two generates a four-variable linear regression model. The third model studies with more detail the upward trend of gross national revenue and gross national expenditure. Based on three different financial goals, we created three sub-models, each with two parameters for user input: expanding, compact, and neutrality. The fourth model incorporated models one, two and three and looks into government policies on revenue and expenditure with more detail.

Team Control #: 2086

Table of Contents

1. Introduction

The term national debt refers to direct liabilities of the United States Government. There are several different concepts of debt that are at various times used to refer to the national debt: Public debt is defined as public debt securities issued by the U.S. Treasury. U. S. Treasury securities primarily consist of marketable Treasury securities (i.e., bills, notes and bonds), savings bonds and special securities issued to state and local governments (State and Local Government Series securities, or SLGS). A portion is debt held by the public and a portion is debt held by government accounts. Debt held by the public excludes the portion of the debt that is held by government accounts. Gross federal debt is made up of public debt securities and a small amount of securities issued by government agencies. Debt held by the public is the most meaningful of these concepts and measures the cumulative amount outstanding that the government has borrowed to finance deficits.

2. Data

2.1 Revenue and Expenditure

Revenue – The Federal revenue is the total amount of money made by the government each year. We recorded the revenue of the United States government from the past fifty-three years in order to discover a trend. That trend has allowed us to predict the revenue for the next eight years, or even sixteen, which can prove to be very valuable. Estimation of the revenue of the United States for the next eight years is crucial to approximate the amount of money the government will be able to spend, which allows for the government to budget their expenditure. By doing so, the government can determine the amount of money they have available to spend before resorting to borrowing money and further increasing the national debt. Each year's revenue is comprised of the income tax (individual and corporate), the social insurance taxes, the excise and sales tax, fees and charges, and business and other revenue, from which the three major contributors are the income (38.8%), the social (20.8%), and the excise and sales (20.4%). Throughout the past fifty-three years, the revenue has gradually increased to form a parabolic type graph. The total revenue of the government each year in combination with the expenditures is how each year's gain or loss is calculated, which contributes to the national debt. Therefore, increasing revenue and decreasing spending is key in eliminating the national debt.

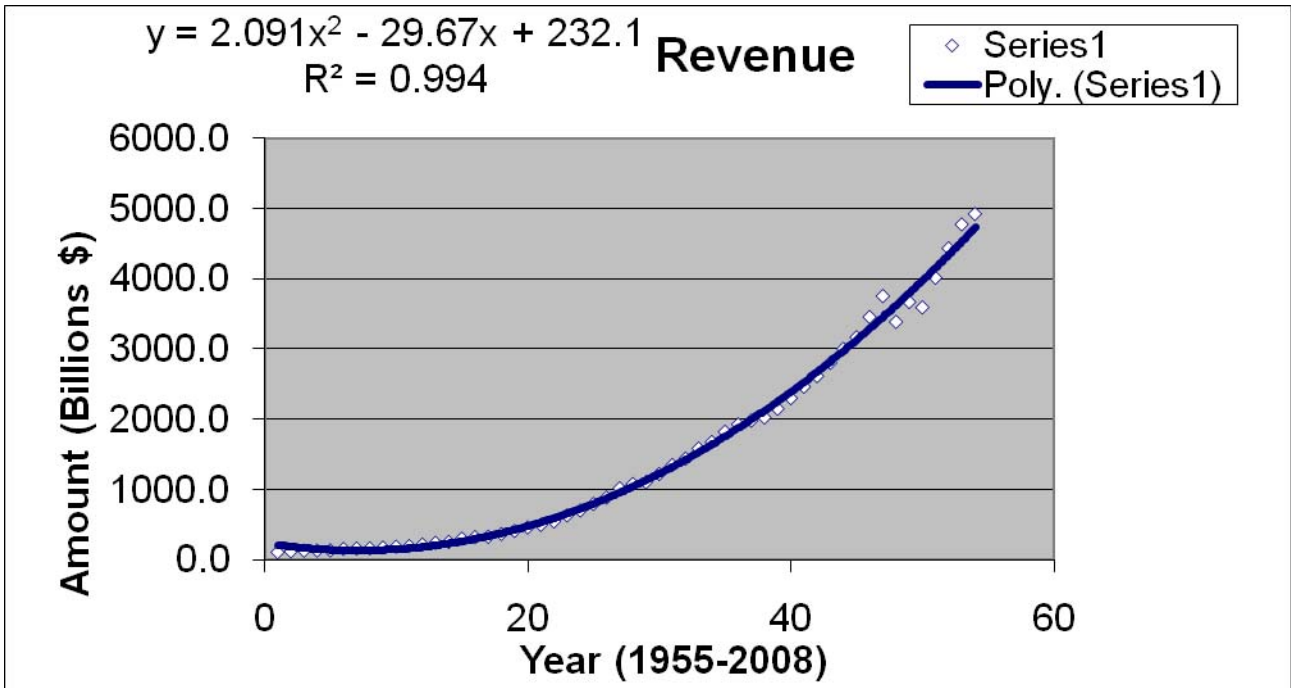
Expenditure – Expenditure is the amount of money, in dollars, that the federal government spends each year. Expenditures fall under a variety of categories: pensions, healthcare, education, defense, welfare, protection, transportation, general government, interest of public debt transactions, and other spending. The government spending is fairly divided with pensions around 16%, health 17%,

education 17%, defense 13%, welfare 9%, and other 29%. Expenditures include such programs as welfare, healthcare, public education, civil defenses, foreign military aid, public safety services, courts, government research, and waste management. These expenditures are just a small portion of the various areas which the federal government must support. Since the government tends to spend more than it makes in revenue, expenditures are the main cause for the escalation of the national debt. In the past the government has spent more than its revenue and the gap between expenditures and revenue has gradually increased. The value of each small annual gap adds to the larger value of the national debt. We can use this trend of expenditures to see the effect has on the national debt and use this to budget our money and ultimately decrease the national debt.

Table 2.1 – Predicted Change in National Deficit

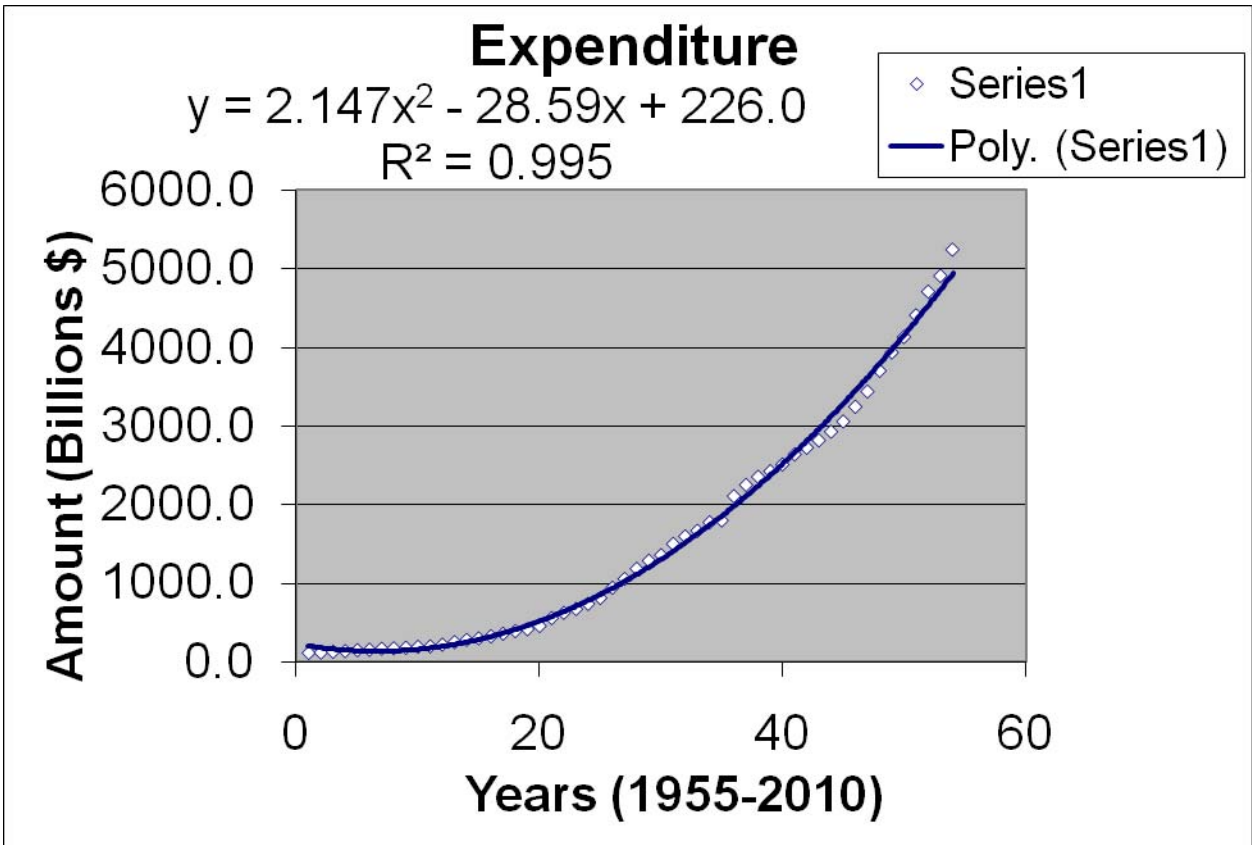
Year	Revenue	Expenditure	Balance
2009	4928.0425	5149.775	221.7
2010	5160.2434	5359.5636	199.3
2011	5396.6281	5573.6474	177.0
2012	5637.1966	5792.0264	154.8
2013	5881.9489	6014.7006	132.8
2014	6130.885	6241.67	110.8
2015	6384.0049	6472.9346	88.9
2016	6641.3086	6708.4944	67.2
2017	6902.7961	6948.3494	45.6

Figure 2.1 – National Revenue



2.1.1 Predictions Based on Past Years

Figure 2.2 – National Expenditures



2.1.2 Revenue and Expenditures Based on Government Estimation (2009 – 2017)

Table 2.2 – Predicted Change in National Deficit

	Revenue in Year *t* (millions of dollars)	Expenditure in Year *t* (millions of dollars)	Change in National Deficit in Year *t* (millions of dollars)
Year	R(t)	E(t)	R(t) - E(t)
2009	2699947	3107355	-407408
2010	2931348	3091340	-159992
2011	3076423	3171233	-94810
2012	3269878	3221828	48050
2013	3428235	3398886	29349

2.2 – Inflation Rate

Inflation – To better estimate the productivity of previous plans, we must account for the value of the U.S. dollar within each time period. Thus we considered inflation in order to predict the efficiency and the reality of future plans. Inflation is the constant rise of general prices due to the economic axiom: Supply + Demand = Value. Inflation causes consumer products to rise in price, diminishing the power of a dollar. As well, printing and putting more dollars into the economy will cause a decrease in the worldwide value of the dollar. The global value of the dollar has become a vital component to the world economy due to the growing interaction and accountability between countries through bonds, exports, imports, etc. Therefore, inflation has transformed from a national concern into an international concern. Especially relevant to the national debt, inflation significantly contributes to the reasons that the U.S. Federal Government must sell more bonds each year to foreign countries. With the inflation percentage increasing, the authority and dominance of the United States over foreign countries decreases. We see the effects of inflation when a currency such as the Euro, once worth half a dollar, has the value of two dollars. This result shows the value and importance of incorporating inflation into our mathematical model.

Figure 2.3

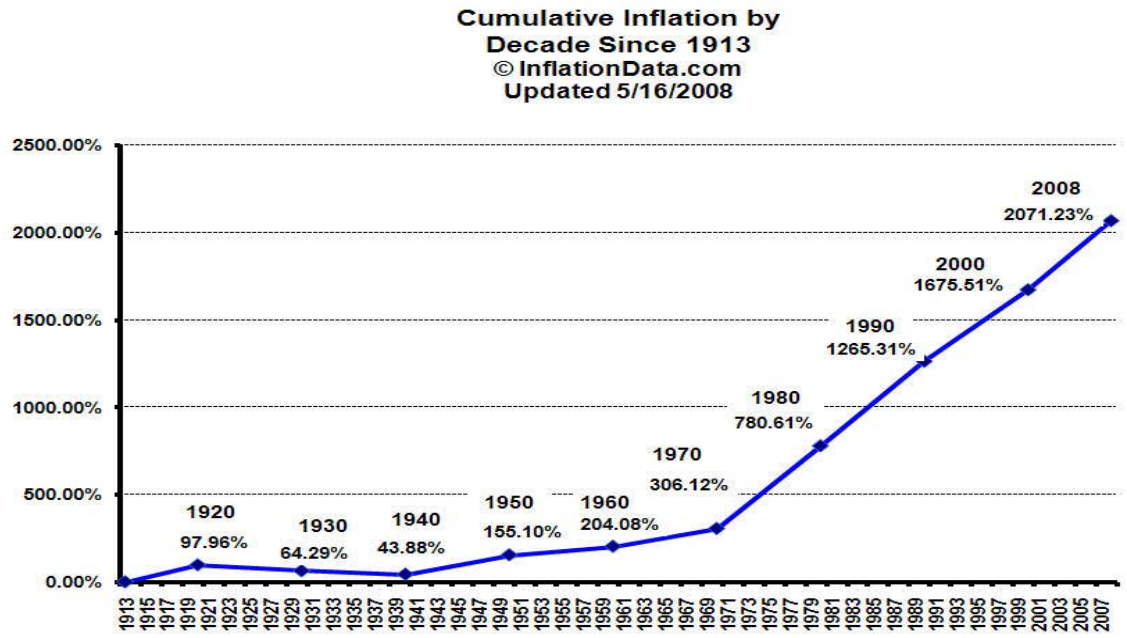
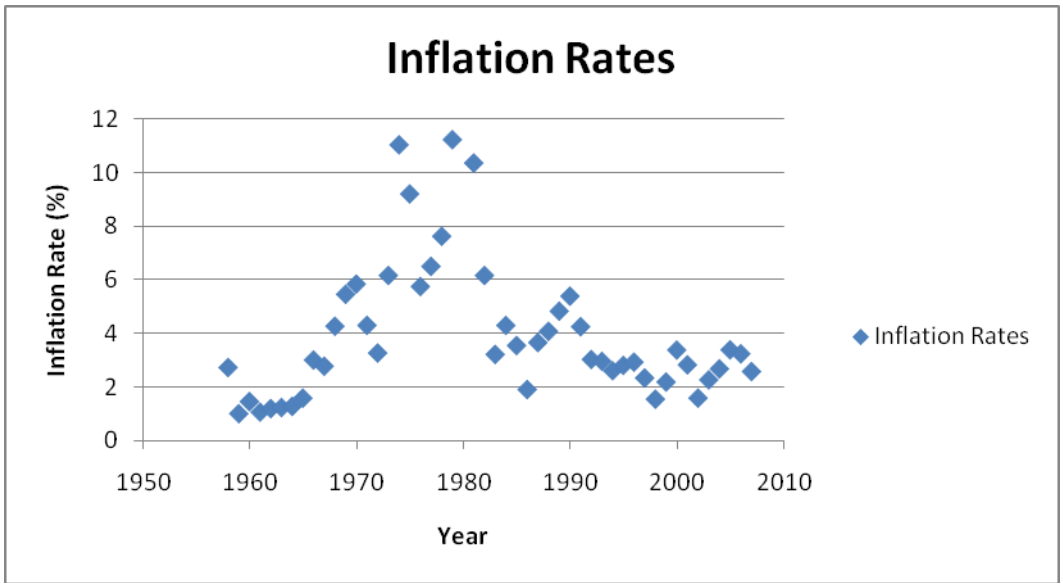


Figure 2.4



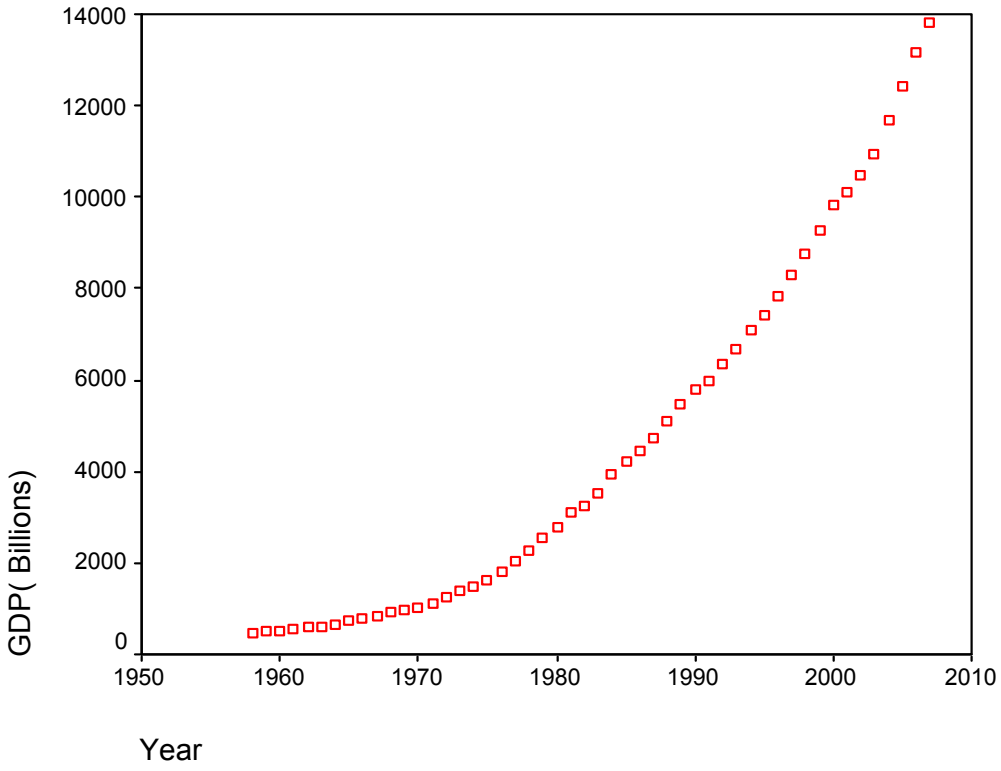
2.3 – GDP

GDP – GDP stands for Gross Domestic Product and is a measure of the national income or output, or a measure the total market value for all goods and services within a country within a certain time. The most common method for determining the GDP of a country is:

GDP = consumption + gross investment + government spending + (exports − imports)

Because an increase in government spending and consumption has the potential to increase the national debt, GDP must be taken into account when dealing with the national debt.

Figure 2.5



The regression line for GDP graph is:

$y = 6.0476x^2 - 47.44x + 644.05$

Using this formula, we are able to predict the GDP for the next 8 years:

Table 2.3 – Predicted GDP (2009-2017)

Year	Predicted Gross Domestic Production (GDP)
2009	14,529.88
2010	15,117.44
2011	15,717.09
2012	16,328.84
2013	16,952.68
2014	17,588.62
2015	18,236.66
2016	18,896.79
2017	19,569.01

2.4 – Parties in Power (1977 – 2007)

Because the party in office controls which programs receive priority spending, which party is in power during year *t* is a necessary variable, as historical trends point to greater spending by Republicans and decreased spending by Democrats. As well, Republicans tend to lower taxes across the board, while Democrats tend to raise taxes, especially on the wealthy. A change in taxes causes a change in revenue, which influences GDP and the overall budget.

3. Assumptions

3.1 Both models conform to linear regression

Linear Regression – Linear Regression, as defined by Wikipedia, is *"a form of regression analysis in which the relationship between one or more independent variables and another variable, called dependent variable, is modeled by a least squares function, called linear regression equation. This function is a linear combination of one or more model parameters, called regression coefficients. A linear regression equation with one independent variable represents a straight line. The results are subject to statistical analysis.*

A linear regression model assumes, given a random sample $(Y_i, X_{i1}, \ldots, X_{ip}),\ i = 1, \ldots, n$, a possibly imperfect relationship between Y_i, the regressand, and regressors $X_{i1}, \ldots, X_{ip}$. A disturbance term ε_i, which is a random variable too, is added to this assumed relationship to capture the influence of everything else on Y_i other than $X_{i1}, \ldots, X_{ip}$. Hence, the multiple linear regression model takes the following form:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_p X_{ip} + \varepsilon_i, \qquad i = 1, \ldots, n$$

Note that the regressors are also called independent variables, exogenous variables, covariates, input variables or predictor variables.

4. Models

4.1 – Basic Model

4.1.1 – Assumptions:

1. Do not consider inflation, the GDP, or the rate of exchange between the U.S. dollar and other currencies.
2. There is a linear relationship between [*R(t) – E(t)*] and each year's new federal deficit.

4.1.2 – Construction of the Basic Model

In our first model, we first establish from our sources the national revenue, *R*, during year *t*. Next we establish national spending, *E*, during year *t*. From there we determine that the national deficit *T* in year *t* is defined by:

$$T(t) = T(t-1) + \Delta T(t)$$

Where $T(t-1)$ is the national debt from the previous year and $\Delta T(t)$ is the new debt made in year *t* and is calculated by:

$$\Delta T(t) = F(x) = F(R(t) - E(t))$$

Using linear regression based on the federal deficit and the national revenue between years 1978 and 2007, we determine the two variables α_1 and α_0. With these variables we can predict *R(t)* and *E(t)* in the next 8 years using the formula:

$$\Delta T(t) = F(x) = \alpha_0 + \alpha_1(R(t) - E(t)) + \varepsilon_0$$

Figure 4.1

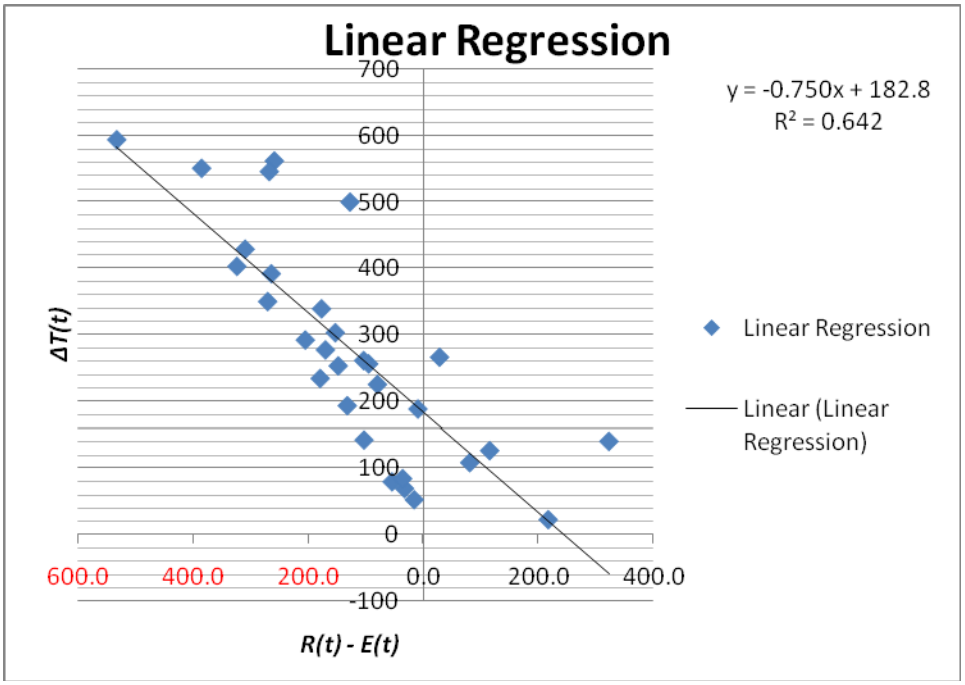


Table 4.1 – Changes in the National Debt

Year(t)	R(t)-E(t)	ΔT(t)
1978	32.9	70

1979	16.1	53
1980	54.6	80
1981	36.1	85
1982	103.3	143
1983	179.6	234
1984	132.4	193
1985	148.3	253
1986	153.3	303
1987	80.0	225
1988	95.2	256
1989	27.9	266
1990	177.1	339
1991	264.4	392
1992	324.1	403
1993	270.7	350
1994	205.3	292
1995	170.3	277
1996	104.0	261
1997	9.6	188
1998	80.4	109
1999	115.0	127
2000	216.8	23
2001	322.3	141
2002	309.8	429
2003	259.2	562
2004	533.0	594
2005	385.5	551
2006	268.0	546
2007	127.7	500

From the linear regression we conclude that:

$$\Delta T(t) = 182.84 + (-.7503)(R(t) - E(t)) + \varepsilon_t$$

Therefore:

$$T(t) = T(t-1) + 182.84 + (-.7503)(R(t) - E(t)) + \varepsilon_t$$

4.2 – Generalized Model

4.2.1 – Assumptions:

1. Besides revenue and expenditures, we take into consideration the values of the Dollar compared to other currencies, the GDP, and the inflation rate. The inflation rate affects the value of the Dollar, and we only need to take the GDP and the inflation rate into consideration because of how inflation affects the strength of the Dollar.
2. All the variables conform to linear regression regard to ΔT(t).
3. ε_0 is an independent variable which functions as extra input for unpredictable and therefore incalculable events.

4.2.2 – Construction of the Generalized Model

Because the policies of the political party in power have historically affected how the national debt is handled, we introduce the dummy variable *D(t)*, where:

$$D(t)\begin{cases} 1, & democrat\ party \\ 0, & republican\ party \end{cases}$$

Because factors such as political party, the GDP, and inflation affect how the national debt is handled, we arrive at a generalized formula for $\Delta T(t)$:

$$\Delta T(t) = F(x) = \alpha_0 + \alpha_1(R(t) - E(t)) + \alpha_2 GDP(t) + \alpha_3 I(t) + \alpha_4 D(t) + \varepsilon_0$$

where *I(t)* is the inflation rate for year *t* and *GDP(t)* is the GDP for year *t*. From this revised formula, and historical *GDP(t), I(t)* and D(t) data, we can calculate $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$.

Therefore, using linear regression with 4 variables, we calculate that using SPSS:

$\alpha_0 = 76.537$

$\alpha_1 = -0.586$

$\alpha_2 = 0.024$

$\alpha_3 = -3.963$

$\alpha_4 = -56.465$

$\varepsilon_0 = 0$

D(t) will equal 1 until 2013 because of the recent election, and two cases shall be laid out for 2013 for both 0 and 1.

which results in the formula:

$$\Delta T(t) = F(x) = 76.537 - .586(R(t) - E(t)) + .024(GDP(t)) - 3.963(I(t)) - 56.465D(t) + \varepsilon_0$$

Regression

Figure 4.2

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	PARTY, INFLATIO, RTET, GDP[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Y

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.956[a]	.914	.900	51.82761

a. Predictors: (Constant), PARTY, INFLATIO, RTET, GDP

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	715179.6	4	178794.912	66.563	.000[a]
	Residual	67152.518	25	2686.101		
	Total	782332.2	29			

a. Predictors: (Constant), PARTY, INFLATIO, RTET, GDP

b. Dependent Variable: Y

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	76.537	40.645		1.883	.071
	GDP	.024	.004	.494	6.495	.000
	INFLATIO	-3.963	4.222	-.070	-.939	.357
	RTET	-.586	.062	-.626	-9.473	.000
	PARTY	-56.465	21.192	-.174	-2.664	.013

a. Dependent Variable: Y

5. Application and Predictions Based on the Basic Model

5.1 – Predictions Based on Extrapolation of Past Years

Table 5.1 – Predictions Based on Past Years		
Year	Change T(t) (Billions)	Total T(t) (Billions)
2009	349.2058948	10,676.79
2010	332.3899461	11,026.00
2011	315.6575808	11,358.39
2012	299.0087989	11,674.04
2013	282.4436005	11,973.05
2014	265.9619855	12,255.50
2015	249.5639539	12,521.46
2016	233.2495057	12,771.02
2017	217.018641	13,004.27

5.2 – Predictions Based on Government Estimation

Table 5.2 – Predictions Based on Government Estimation		
Year	Change T(t)	Total T(t)
2009	488.5182224	11165.28612
2010	302.8819976	11468.16812
2011	253.975943	11722.14406
2012	146.788085	11868.93215
2013	160.8194457	12029.7516

6. Application and Prediction Based on the Generalized Model

6.1 – Predictions Based on the Extrapolations of Past Years

Table 6.1 – Predictions Based on Past Years (Democrat in office)				
Year	Change T(t) (Billions)	Total T(t) (Billions)		
2009	483.2380446	11,160.03		
2010	484.2058288	11,644.23		
2011	485.5291782	12,129.76		
2012	487.2080928	12,616.97		
			Change T(t) (Billions)	Total T(t) (Billions)
	REPUBLICANS IN OFFICE		DEMOCRATS IN OFFICE	
2013	545.6985726	13,162.67	489.2425726	11,166.03
2014	548.0886176	13,710.76	491.6326176	11,657.67
2015	550.8342278	14,261.59	494.3782278	12,152.04
2016	553.9354032	14,815.53	497.4794032	12,649.52
2017	557.3921438	15,372.92	500.9361438	13,150.46

6.2 – Predictions Based on Government Estimation

Table 6.2 – Predictions Based on Government Estimation (Democrat)				
	Change T(t)	Total T(t)		
2009	592.034878	11268.80278		
2010	461.150542	11729095332		
2011	437.34549	12167.29881		
2012	368.31153	12535.61034		
	Change T(t)	Total T(t)	Change T(t)	Total T(t)
	Republican		Democrat	
2013	450.707476	12986.31782	394.242476	12929.85282
2014				
2015				
2016				
2017				

7. Discussion of Policy and Prediction Based on Detailed Policy

7.1 – Introduction

When a party takes power, the party must examine the health of the economy and decide which economic policy to follow. Generally speaking, the macroeconomic regulation and control has four big goals: the promotion of economic growth, an increase in employment, stable prices, and a balance in international trade. In order to achieve these goals, or create a balance between these goals, the predicted policy can be divided into three models:

(1) The expanding financial policy (a positive policy), which refers to the increase of the society's total demand by increasing the national debt with more expenditures than revenue.
(2) The compact financial policy, which consists of reduction of the total demand by decreasing both expenditure and the national debt.
(3) The neutral financial policy, which equalizes both revenue and expenditure to prevent creation of new debt.

Therefore the party in power has three options: To increase expenditures, reduce taxes (and therefore revenue), and increase the national debt; to cut expenditures, increase the taxes (and therefore revenue), and reduce the national debt; or to maintain relative stability and keep expenditures equal to revenue.

Because the national debt is changed primarily by income versus expenditure choices, our model only considers income and expenditure. Looking at the historical data, expenditures tend to surpass revenues and may be understood like this: If expenditures become higher than originally budgeted and revenues are lower than originally predicted, one would surmise that this plan utilizes to the expansion financial policy. Correspondingly, if expenditures are lower than originally budgeted and revenues higher than predicted, one would believe that this plan belongs to the compact financial policy; if expenditure and revenue are equal, then that plan uses the neutral financial policy. Thus we arrive at a model which supposes the rate of expenditure, k, in the year t, is positive. With k being the number of years to take averages, we took the levels which recent years t should be. Supposing a belongs is a sector constant, (0 - 1), we may use the following relations to explain the nature of a chosen policy as either expanding, compact, or neutral. Therefore, we model the financial policy and if we need to predict an expanding policy, then we can make RE(t) large while Rr(t) remains small. Then parameters k and a are used in the model, where $k = 3$, $a = 0.1$. Next, using the current US data with the Austria Pama policy viewpoint model, the chance of the current US loan crisis leading into an economic recession becomes very large, and the model must predict a suitably expanding economic policy. But how such expansion should be carried out depends on an analysis of the income versus expenditure data. This model unifies the Austria Pama's policy viewpoint, and emphasizes tax revenue, insurance, and military expenditure.

7.2- Variables

k=number of years
a= parameter of input by user based on the desired model, (0,1)

Rr(t) = the rate of annual revenue change in year *t*
Re(t) = the rate of annual expenditure in year *t*
Rr(k) = the average rate of revenue change in the last *k* years

$$\overline{Rr}(k) = \frac{1}{k}\sum_{t=t-k}^{t} Rr(t)$$

Re(k) = the average rate of expenditure change in the last *k* years

$$\overline{RE}(k) = \frac{1}{k}\sum_{t=t-k}^{t} RE(t)$$

Expanding model must conform to:

$$\frac{RE(t)}{\overline{RE}(k)} \geq 1 + a, \frac{Rr(t)}{\overline{Rr}(k)} \leq 1 - a$$

Compact model must conform to:

$$\frac{RE(t)}{\overline{RE}(k)} \leq 1 - a, \frac{Rr(t)}{\overline{Rr}(k)} \geq 1 + a$$

Neutral model must conform to:

$$1 - a \leq \frac{RE(t)}{\overline{RE}(k)} \leq 1 + a$$

$$1 - a \leq \frac{Rr(t)}{\overline{Rr}(k)} \leq 1 + a$$

7.3 –Predictions Based on Past Years' Data

Expanding Model:

$$R(t-1)\left(1+(1-a)\left(\overline{Rr}(k)\right)-E(t-1)\left(1+(1+a)\left(\overline{RE}(k)\right)\right)\right]+.024(GDP(t))-(3.963*3.91)-56.465(D(t))+a$$

$$R(t-1)\left(1+(1-a)\left(\overline{Rr}(k)\right)-E(t-1)\left(1+(1+a)\left(\overline{RE}(k)\right)\right)\right]+.024(GDP(t))-(3.963*3.91)-56.465(D(t$$

Table 7.1 – Predictions Based on Calculated Marginal Values when k=3, a=0.1

Year	Rr(t)	R(t)	Re(t)	E(t)	R(t)-E(t)	ΔT(t)	T(t)
2009	0.063677	5239.141	0.065605	5580.68	-341.539	553.4359	-11229.43588
2010	0.055798	5531.475	0.067566	5941.005	-409.53	607.3799	-11836.81575
2011	0.053154	5825.495	0.072627	6372.982	-547.487	702.6143	-12539.43
2012	0.063279	6194.126	0.074359	6846.336	-652.21	778.6637	-13318.09367
2013	0.063133	6585.18	0.077569	7377.401	-792.222	875.6828	-14193.7765
2014	0.065841	7018.755	0.082337	7984.836	-966.081	992.8269	-15186.6034
2015	0.070493	7513.528	0.085897	8670.713	-1157.19	1120.367	-16306.97034
2016	0.073138	8063.053	0.090128	9453.515	-1390.46	1272.91	-17579.88082
2017	0.076806	8682.35	0.094733	10349.07	-1666.72	1450.933	-19030.8143

8. Generalization of Expanding, Compacting, and Neutral Models According to the Democratic Plan

As well as gross income and the gross expenditure of each year, to be more accurate when constructing this model, we must consider the major components of Revenue and Spending and analyze their

properties by incorporating the possible policies of the next 10 years. While certain areas predict the expanding model, some show contracting trends, such as the policies for Defense and Medicare.

8.1 – The Economic Crisis We Face Today and the Policy Using the Expansion Model

We are currently in an economic crisis where many people throughout the country are suffering and lack the financial capability to support themselves and/or their families. Thus the Expansion Model is the optimum choice for our country's current situation. The expansion model suggests that the government spend more, which increases expenditures, through beneficiary programs and pensions to the American people. These programs and pensions will start the circulation of more money into the drowning economy in order to keep it from floundering.

8.2 – Democratic Party Platform and Major Revenue and Expenditures

8.2.1 – Expenditures

Table 8.2.1 – Expenditures for the Democratic Party Platform (2007-2008)

Year	Pensions	Health Care	Defense	Welfare	Interest
2007	636.1	641.8	653.9	254.2	237.1
2008	667.8	680.8	728.7	271.4	243.9
	$\overline{Re}(3)$	$\overline{Re}(3)$	$\overline{Re}(3)$	$\overline{Re}(3)$	$\overline{Re}(3)$
2007	0.05457587	0.073951332	0.05993051	0.0219623	0.1205431
2008	0.05428421	0.068894563	0.06220757	0.0326325	0.0867206

From our data we conclude that the major contributing programs to federal expenditures are Pensions, Health Care, Defense, Welfare and Interest, with Pensions, Health Care and Interest contributing to the compacting model and Defense and Welfare contributing to the expanding model.

Table 8.2.2 – Predicted National Expenditures Based On Major Programs (2009-2017)

Year	$R_p(t)$	$E_{Pension}$	$R_{hs}(t)$	$E_{health\ care}$	$R_d(t)$	$E_{defense}$	$R_w(t)$	$E_{welfare}$	$R_i(t)$	$E_{interest}$	E(t)
2009	0.048856	700.426	0.062005	723.013	0.068428	778.5635	0.035896	281.1422	0.078049	262.9362	2746.081
2010	0.050356	735.697	0.060635	766.8526	0.081064	841.6772	0.043034	293.241	0.045064	274.7852	2912.253
2011	0.044004	768.0709	0.054825	808.8953	0.092452	919.4918	0.052179	308.5419	0.045298	287.2324	3092.232
2012	0.042965	801.0711	0.053239	851.9604	0.088713	1001.063	0.048073	323.3745	0.050523	301.7443	3279.213
2013	0.041198	834.0734	0.05061	895.0779	0.096151	1097.315	0.052538	340.3641	0.042266	314.4977	3481.328
2014	0.03845	866.1437	0.047602	937.6856	0.101682	1208.893	0.056023	359.4323	0.041426	327.526	3699.681
2015	0.036784	898.0038	0.045435	980.2897	0.105067	1335.908	0.057433	380.0755	0.040264	340.7137	3934.99
2016	0.03493	929.3707	0.043094	1022.535	0.111063	1484.278	0.060864	403.2086	0.037187	353.3837	4192.775
2017	0.033049	960.0855	0.04084	1064.294	0.116531	1657.243	0.063917	428.9806	0.035663	365.9865	4476.59

8.2.2 – Revenues

Table 8.2.3 – Major Sources of Revenue

Year	Individual (billions of dollars)	Social and Retirement (billions of dollars)
2006	1043.91	836.82
2007	1163.47	869.61
	$R_i(3)$	$R_s(3)$
2006	0.086	0.279
2007	0.114	0.192

Year	Ri(t)	Individual Income Taxes	Rs(t)	Social and Retirements	R(t)
2008	0.122821	1306.368549	0.1731	434.328544	1740.697093
2009	0.120922	1464.337489	0.1293	490.5002546	1954.837743
2010	0.124194	1646.198911	0.1039	541.4774556	2187.676366
2011	0.13491	1868.287959	0.1219	607.4877268	2475.775686
2012	0.139343	2128.620596	0.1066	672.2155501	2800.836146
2013	0.146097	2439.605983	0.0997	739.2462047	3178.852188
2014	0.154128	2815.618606	0.0985	812.0265584	3627.645164
2015	0.161175	3269.426214	0.0914	886.2583251	4155.684539
2016	0.16918	3822.548538	0.0869	963.2520806	4785.800618
2017	0.177644	4501.601672	0.083	1043.223955	5544.825627

From our data we conclude that the greatest contributors to the federal income are individual taxes and social and retirement taxes.

Individual taxes conform to expanding model, social and retirement taxes conform to compacting model.

8.3 – Calculation of the model

8.3.1 – variable

$R_{st}(t)$ = The rate of change of social and retirement taxes of year t.

$R_i(t)$ = The rate of individual income taxes change of year t.

$R_p(t)$ = The rate of pension spending change of year t.

$R_{hs}(t)$ = The rate of health care spending change of year t.

$R_d(t)$ = The rate of defense spending change of year t.

$R_w(t)$ = The rate of welfare spending change of year t.

$R_I(t)$ = The rate of interest spending change of year t.

8.3.2 – calculation

$R(t)=R_{\text{Social and retirements taxes}} + R_{\text{Individual come taxes}}$

$=R_{sr(t-1)}\,[1+(1-\alpha)(R_{sr}(t)] + R_{i(t-1)}[1(1+\alpha)R_i(t)]$

$E(t) = E_{pension} + E_{healthcare} + E_{defense} + E_{welfare} + E_{interest}$

$= E_{pension(t-1)}[1+(1+\alpha)R_p(t)] + E_{healthcare(t-1)}[1+(1-\alpha)R_{hs}(t)] + E_{defense(t-1)}[1+(1-\alpha)R_d(t)] + E_{welfare(t-1)}[1+(1+\alpha)R_w(t)] + E_{interest(t-1)}[1+(1-\alpha)R_i(t)]$

Expanding and compacting models are explained in Model 3

$$\Delta T(t) = 76.537 - .586(R(t) - E(t)) + .024(GDP(t)) - 3.963(I(t)) - 56.465D(t) + \varepsilon_n$$

Table 8.3.2-predictions for year 2009 to 2017

Year	Change T(t) (Billions)	Total T(t) (Billions)		
2009	816.967188	11429.6719		
2010	792.002352	12284.96954		
2011	476.405632	12761.37517		
2012	676.802752	13438.17792		
			Change T(t) (Billions)	Total T(t) (Billions)
	REPUBLICANS IN OFFICE		DEMOCRATS IN OFFICE	
2013	646.8509061	14085.02883	590.3909061	14028.56883
2014	525.3812944	14610.41012	468.9212944	14497.49012
2015	369.3946502	14979.80477	312.9346502	14810.42477
2016	167.0518042	15146.85658	110.5918042	14921.01658

2017	95.288386	15051.56819	151.748386	14769.26819

9. Strength and weakness of the model:

Strengths:

1. Our four models are theoretically mature and have a broad aim that applies to a variety of different users. Each can explain and predict real world problems, are very stable, and can be easily analyzed and explained. The combination of clear comprehension and realistic value fortifies the reliability of the models.
2. The first model was a simple, clear, concise model based on the fact that national debt did not equal to the national revenue minus national expenditures; the second model takes more into consideration, such as GDP, the inflation rate, the party in power, etc.; the third model is
3. We classified and constructed our last two models based on the final goals, and studied and analyzed in depth of the math modeling with extensive policy of different parties involved.

Weaknesses:

1. Because of the time limitation, the variables in the math models were not comprehensively studied and looked at from all aspects; we can use statistical tests to choose the variables.

10. Conclusion:

The four models we generated produced very close and desirable results: The first, basic model predicted that the national debt will be between 10,676.79 billion dollars in 2009 and 13,004.27 billion in 2017. The second model, the model incorporating the inflation rate, GDP and the party in power, predicted a national debt between 11,160.03 billion dollars in 2009 and 15,372.92 billion dollars in 2017. This model also shows the national debt trends difference between Republican in power and Democrat in power: When the Republican party is in power, it tends to accumulate more national debt, as predicted by 15,372.92 billion dollar projection for the Republican versus 13,150.46 billion dollar projection for Democrat in year 2017. The third and forth models incorporate more factors into consideration, such as the current economic crisis, policies of president-elect Barack Obama as well as detailed analyses and of the major components of national revenue and national expenditures. With all factors taken into consideration, our model produced a national debt of 11,299 billion dollars in year 2009 with an upward trend of 19,030.81 billion dollars in 2017. This figure is greater than those of the first two models because our nation is facing an economic crisis and the government must contribute a portion of its revenue to help relieve the economy. The forth model, practically considering every single factor, predicts the most accurate national debt: starting with 11,429.67 billion dollars in year 2009, the debt will be increased to 15,051.57 billion dollars in 2017 if Republican is in power, or increased to 14,769.27 billion dollars in 2017 if Democrat is in power.

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All Saints' Episcopal School

Barack Obama

1600 Pennsylvania Avenue NW

Washington, DC 20500

November 23, 2008

All Saints' Episcopal School

9700 Saints' Circle

Fort Worth, TX 76107

Dear President Barack Obama:

This letter has been written to you from four students from All Saints' Episcopal School, in Fort Worth, Texas. We present to you a present a number of mathematical models which estimate the national debt for the next ten years. We participated in the High School Mathematical Contest in Modeling, creating mathematical models, and in connection with such a contest we have incorporated different tax and spending policies to determine their effects on the national debt.

First we made a base model for calculating the national debt. We predicted the expenditures and revenues for the next ten years using our mathematical model. Within our first model we did not consider inflation, GDP, or the rate of exchange between the U.S. dollar and other currencies based on the best fit line

In our second model, we took into consideration federal revenue, expenditure, the dollar compared to other currencies, the inflation rate, the GDP, and the party in power. Then we could calculate new predictions for the national debt for the next ten years. We assume the four variables: GDP, $R(t) - E(t)$, inflation, and the party in power have a linear regression with $\Delta T(t)$.

Our third model incorporates the different party policies and how parties can enforce an expanding, compacting, or a neutral economic model for the national debt. We found the trend that most presidents tend to enforce an expanding economic plan and have more expenditures than revenue.

Our last model predicts how your promised economic policies should affect the economy and national debt over the next 4 years, using your own provided statistics for funding and revenue for specified programs, summarizing the cost and surplus from each program funded by the

government. We recommend you take our statistics under advisement and adjust your funding, and your promises, accordingly.

Sincerely,

Meng Ge, Ben Childs, Caitlyn Grudzinski, Gaines Myer