

# National Debt and National Crisis

2008 11<sup>th</sup> annual HiMCM

Problem A

Team #1966

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# 1 Introduction

## 1.1 Background Information

U.S. is now facing a severe financial crisis which is the worst of its kind ever since the Great Depression. This crisis can date back to July, 2007, when the credit crisis in U.S. that resulted from the subprime mortgage crisis occurred. It become significantly visible to people in September, 2008 with failures of large financial institutions in the United States, and rapidly evolved into a global crisis, in which the European countries and the stock market are affected most.

The crisis triggers on a series of results, beginning with failures of large financial institutions in the United States. It has led to a liquidity problem and the de-leveraging of financial institutions especially in the United States and Europe. Recently, the financial crisis has further triggered on a currency crisis, because investors and governments invest large amount of capital into the market, which leads to a severe inflation rate and the U.S. dollar devaluation. And this causes the increasing in price of almost everything, which makes many emergent economies to seek aid from the IMF (International Monetary Fund), for example, the Iceland.

U.S. is considered to experience a recession during the financial crisis. There are mainly four indicators of a recession: GDP per capita, inflation, the rise in unemployment and CPI. The situation of the U.S. is serious, but U.S. is coping with this crisis actively, and is taking measures like the bailout of the U.S. financial system.

## 1.2 National Debt

### 1.2.1 Definition

National debt, also known as United States total public debt or U.S. government debt. It can be defined as the amount of money owed by the United States federal government to holders of U.S. debt instruments. It is considered as the safest way of investment because of the high credit.

### 1.2.2 Components

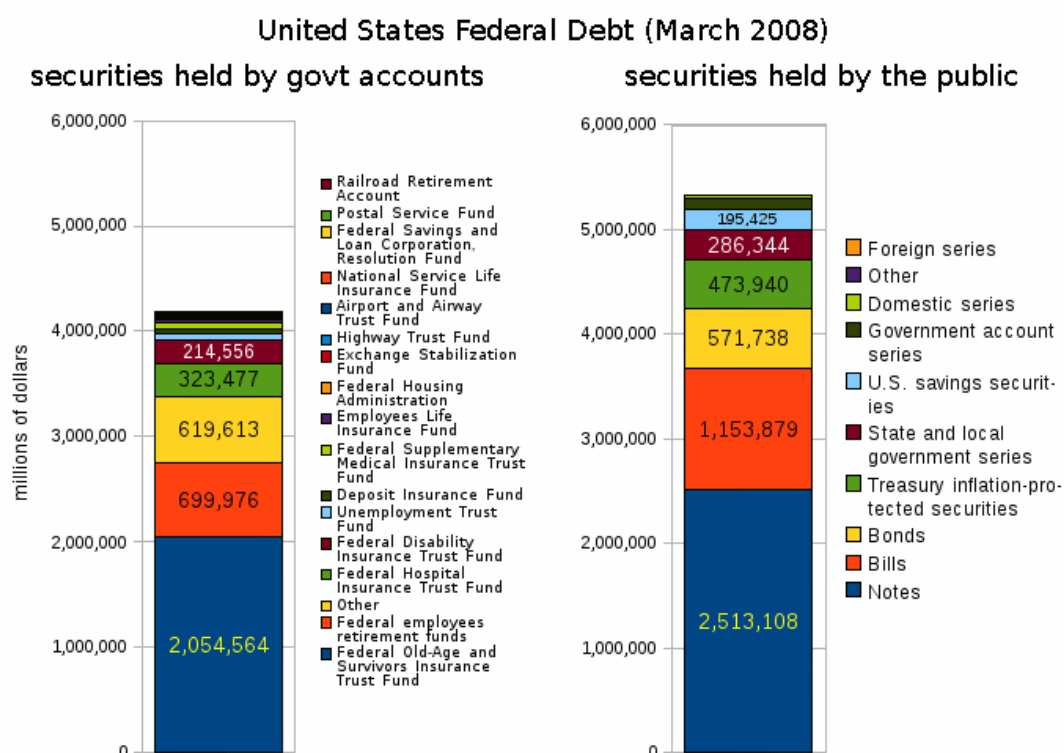
The national debt is mainly divided into 2 categories:

1. Debts held by the public
  - Marketable debts
  - Non-marketable debts
2. debts held by government accounts

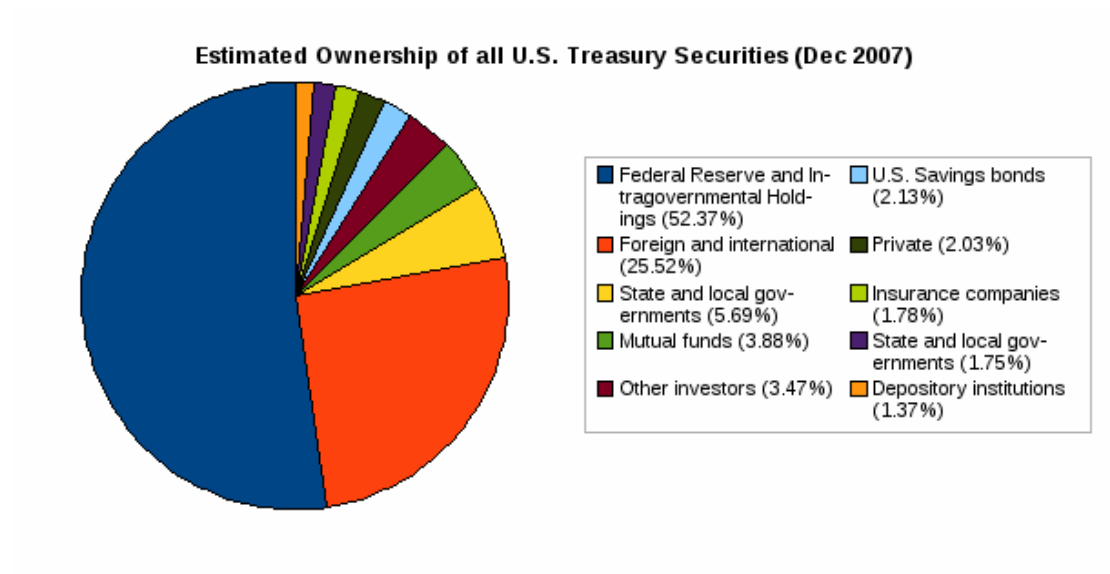
Here is the data for fiscal years 1999 to 2008 (Back Issues: Treasury Bulletin: Publications & Guidance: Financial Management Service the website of financial management service – a bureau of the United States Department of the Treasury)

United States national debt		
Fiscal year	Debts held by government accounts	Debt held by the public
1999	2.020 trillion	3.636 trillion
2000	2.269 trillion	3.405 trillion
2001	2.468 trillion	3.339 trillion
2002	2.675 trillion	3.553 trillion
2003	2.859 trillion	3.924 trillion
2004	3.072 trillion	4.307 trillion
2005	3.331 trillion	4.601 trillion
2006	3.664 trillion	4.843 trillion
2007	3.958 trillion	5.049 trillion
2008	4.216 trillion	5.809 trillion

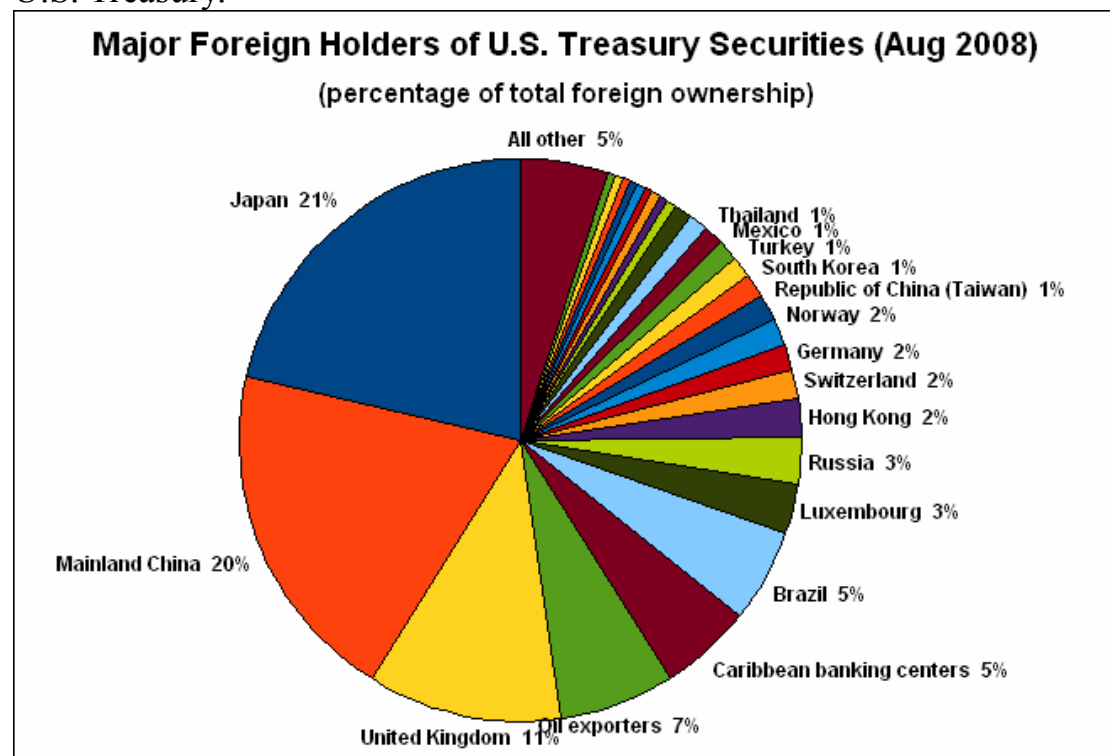
And below is a chart (using data published by the U.S. Treasury) showing the total of government and public portions of the debt as well as the components of each as of March, 2008.



Following is a chart for the data of estimated ownership of all U.S. Treasury Securities.



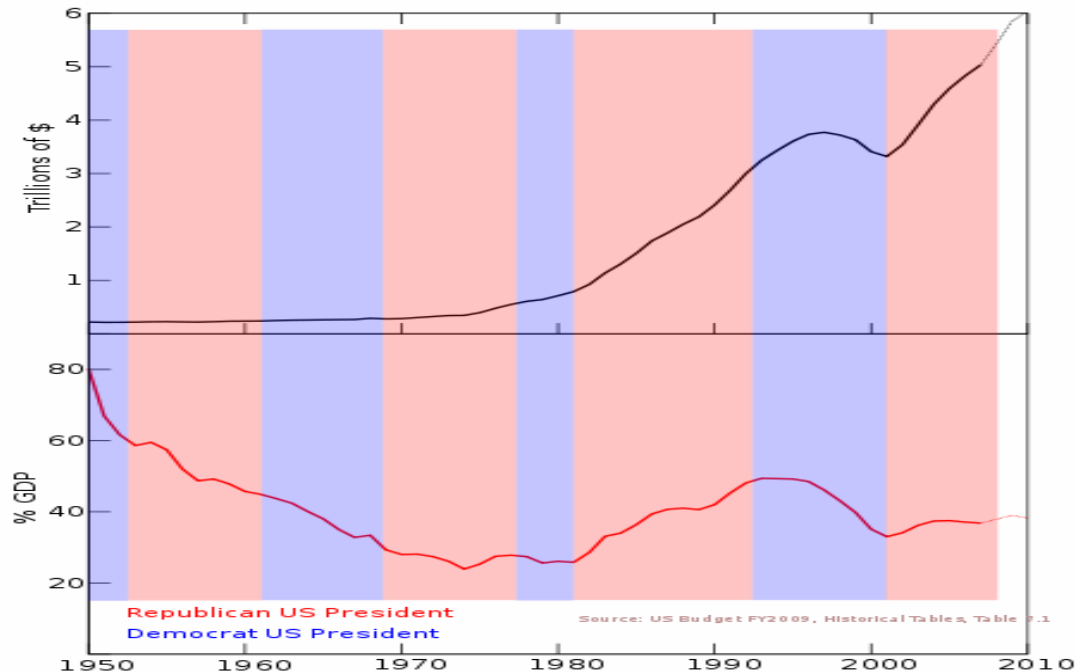
As we can see, debts held by foreign governments account for a large proportion (25% of the total). The U.S. Treasury statistics indicate that, at the end of 2006, foreigners held 44% of federal debt held by the public. And about 66% of that 44% was held by the central banks of other countries, in particular the central banks of Japan and China. In total, lenders from Japan and China held 47% of the foreign-owned debt. Here is a chart of the foreign owners of U.S. national debts listed by the U.S. Treasury.



### 1.2.3 Scale

The national debt is a very important part of federal policy. And the scale of national debt indicates a country's policy (deflation policy or expansion policy) and statement.

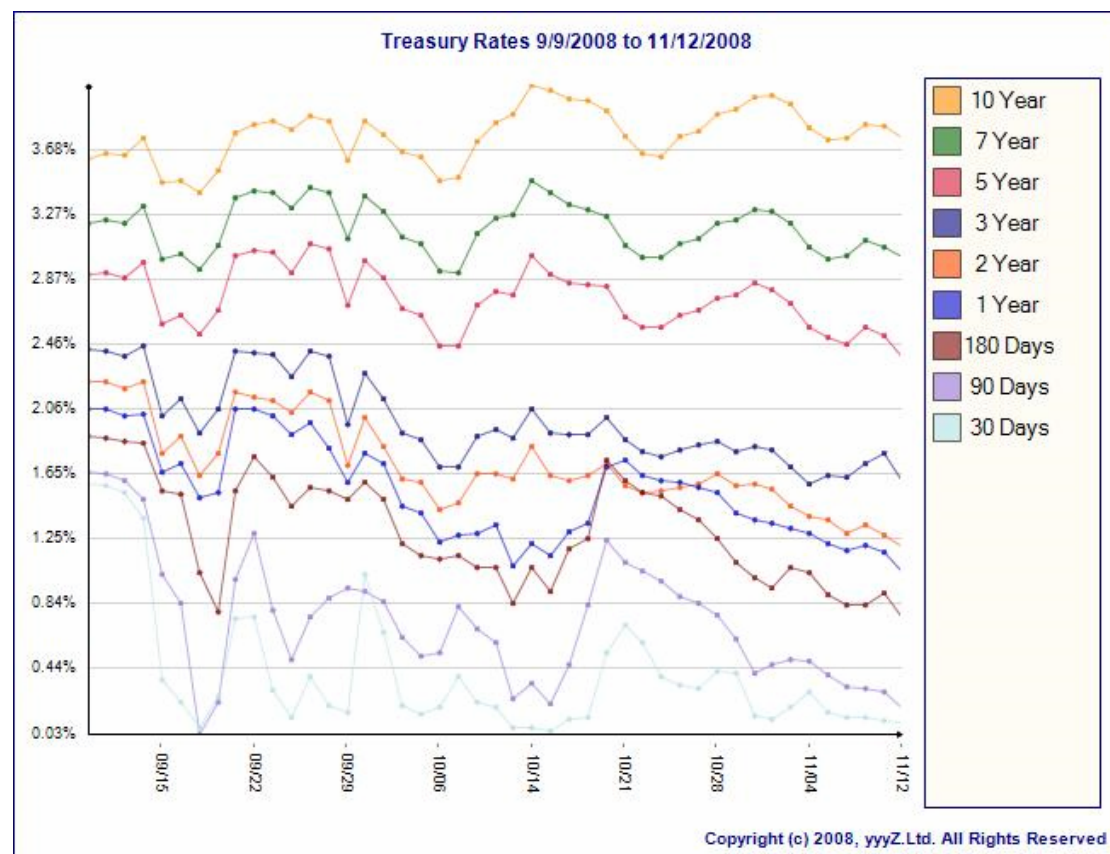
Here is a chart of the scale of national debt and its proportion in GDP.



### 1.2.4 Treasury Interest Rate

Treasury interest rates are used for a variety of purposes. The 3 year, 5 year, 7 year and 10 year rates are used to determine the rate used for IRC Section 72(t) and IRC Section 72(q) Substantially Equal Periodic [SEPP] Plans. The 10 year rate is watched as an indicator of fixed mortgage rates. The spread between the 30 day rate and the 20 year rate is frequently watched as the Treasury Yield Curve.

Here is a chart of recent treasury interest rate trend



### 1.2.5 National debt issue

The issuance of U.S. national debt can be divided into 3 main categories: competitive bid, noncompetitive bid (whose purchase unit is less than 1 million U.S. dollars) and nonpublic purchase (for example the intragovernmental accounts). They only auction the competitive bid. The auction is based on the yield. Bidders mark the yield and procurement they expert. The bonds are allocated by the sequence of yield from high to low.

## 2 Assumptions

1 The economic situation will be under control mainly through government's efforts.

1) The U.S. economic recession will last from the year of 2009 to the year of 2012, during which the GDP begin to decrease from the year of 2009 and will reach the lowest point by the year of 2012.

2) The U.S. economy will then recover from the year of 2012 to the year of 2017, during which the GDP increase relatively lower than that of healthy one.

3) The economic development will be healthy after the year of 2017.

4) The government will reduce a reasonable amount of tax to stimulate the economy in several fiscal years.

2 There is no dramatic changes in parameters.

3 The difference between the forecasted statistics and the actual ones exists, but in this model the affects can be neglected.

4 The U.S. government will pay off all the debts in order to remain its credit.

5 All the debt services are calculated through the method of simple interest.

6 The Callable bonds are not taken into consideration.

7 The affect of the inflation will not strike the U.S.'s economic hegemony position. For example, euro will not take the place of U.S. dollar in spite of the devaluation of U.S. dollar.



**3 Variables and Parameters**

R	Federal Receipt
X <sub>t</sub>	National Debt at the year of t
E	Federal Expenditure (net interest exluded)
X <sub>s</sub>	Debt Service
E <sub>a</sub>	Emergency Action

## 4 Analysis

We find that the main aim of this problem is about the modeling of the scale of national debt. After searching for relative information, we find out the main factors that effect the scale of U.S. national debt: GDP, the federal receipt, the federal expenditure and the debt service and inflation. And then we infer the relationship between them and the outcome is the equation below:

$$\text{Federal Income} = \text{Federal Spending}$$

$$\text{Federal Income} = \text{Federal Receipt (R)} + \text{Current National Debt (Xt)}$$

$$\text{Federal Spending} = \text{Federal Expenditure (E)} + \text{Debt Service (Xs)} + \text{Emergency Action (Ea)}$$

Then we analyze each factor and find out their future trend to predict the national debt.

### GDP

$$G = G^{\sim} + \Delta G$$

$G$  : GDP of the year being

$G^{\sim}$  : GDP estimated by the historical trend

$\Delta G$  : the change in GDP according to the economic policy and financial crisis

$$\Delta G = \sum \Delta R + \sum \Delta E + \sum Ea$$

$\Delta R$  : the change in federal receipt according to the economic policy

$\Delta E$  : the change in federal expenditure according to the economic policy

$$\sum \Delta R = \Delta R_{ct} * k_{ct} + \Delta R_{it} * k_{it}$$

$\Delta R_{ct}$  : the change in federal receipt according to the corporation income taxes policy

$\Delta R_{it}$  : the change in federal receipt according to the indeividual income taxes policy

$k_{ct}$  : the contribution to R made by  $\Delta R_{ct}$

$k_{it}$  : the contribution to R made by  $\Delta R_{it}$

$$\sum \Delta E = \Delta E_{pt} * k_{pt}$$

$\Delta E_{pt}$  : the change in federal expenditure according to the economic policy

$K_{pt}$  : the contribution to E made by  $\Delta E_{pt}$

$$\sum Ea \text{ Unidentified (according to the policy)}$$

Federal Receipt

$$R = R^{\sim} + \Delta R$$

$R^{\sim}$  : federal receipt estimated by the historical trend

$$R^{\sim} = G^{\sim} * Pr$$

$Pr$  : the proportion of  $R^{\sim}$  to  $G^{\sim}$

Federal Expenditure

$$E = E^{\sim} + \Delta E$$

$E^{\sim}$  : federal expenditure estimated by the historical trend

$$E^{\sim} = G^{\sim} * Pe$$

$Pe$  : the proportion of  $E^{\sim}$  to  $G^{\sim}$

Debt Service

$$X_s = \sum X_{stn} = \sum [X_{pt-n} * (I_{rn} + 1)]$$

$X_{stn}$  : the debt service generated by debts at the time limit of  $n$  years at the year of  $t$

$X_{pt-n}$  : 1)  $n \geq 1$  the debt principle of debts at the time limit of  $n$  years  $n$  years ago at the year of  $t$

2)  $n < 1$  the total amount of debt principle of debts at the time limit of  $n$  years in the year of  $t$

$I_{rn}$  : the simple interest rate of debts at the time limit of  $n$  years  $n$  years ago at the year of  $t$

National Debt

$$X_t = E + E_a + X_s - R$$

## 5 Task one

### 5.1 modeling

#### 5.1.1 GDP model

The federal receipt and expenditure are mainly affected by the GDP developing trend. So the first step of modeling is to predict the GDP development trend in the future. The Gross domestic product consists of contributions of a variety of industries, such as agriculture and auto industry. Because of the difficulties in collecting data from all industries and estimating them, we use another more feasible but realistic model.

$$G = G^{\sim} + \Delta G$$

$G$  : the actual GDP at the year of  $t$

$G^{\sim}$  : the estimated GDP at the year of  $t$

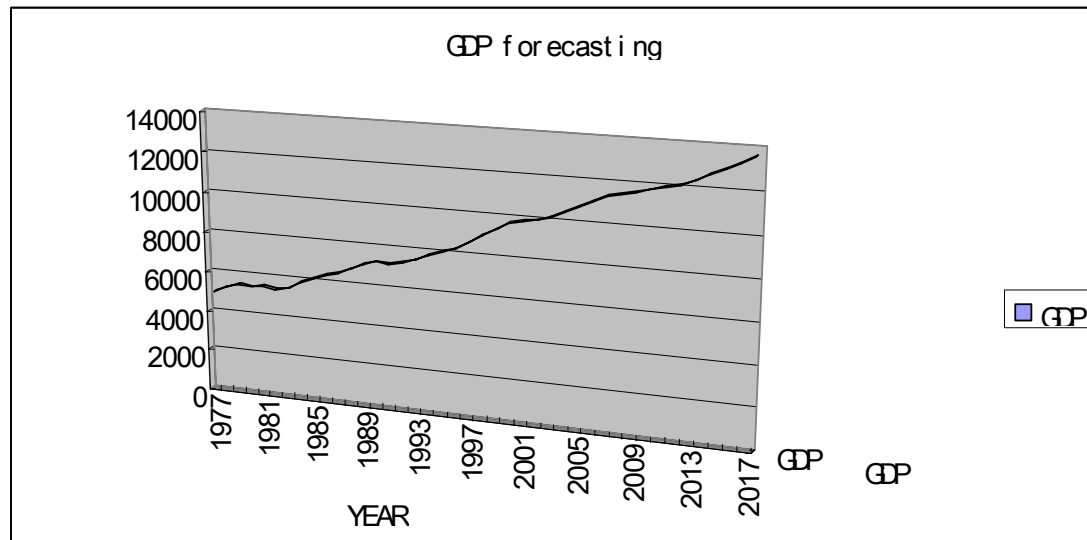
$\Delta G$  : the contribution of economic policies and economic crisis

In order to estimate the basic trend of GDP ( $G_t^{\sim}$ ), we made a regression according to the historical records found in the *BUDGET OF THE UNITED STATES GOVERNMENT Fiscal Year 2009*.

Here is the data table and chart of the historical records.

YEAR	GDP (billion)				
1977	\$5,019	1989	\$7,077	2001	\$9,829
1978	\$5,285	1990	\$7,277	2002	\$9,954
1979	\$5,494	1991	\$7,215	2003	\$10,099
1980	\$5,422	1992	\$7,334	2004	\$10,441
1981	\$5,492	1993	\$7,536	2005	\$10,717
1982	\$5,417	1994	\$7,820	2006	\$11,024
1983	\$5,510	1995	\$8,033	2007	\$11,329
1984	\$5,858	1996	\$8,248		

1985	\$6,108	1997	\$8,606
1986	\$6,352	1998	\$8,985
1987	\$6,506	1999	\$9,361
1988	\$6,806	2000	\$9,710



The following are estimations of GDP in the near future.

YEAR	GDP (billion)				
2008	11467	2009	11608	2010	11764
2011	11922	2012	12075	2013	12329
2014	12636	2015	12929	2016	13230
2017	13588				

$$\Delta G = \sum \Delta R + \sum \Delta E + \sum E_a$$

$\Delta R$  : the change in federal receipt according to the economic policy

$\Delta E$  : the change in federal expenditure according to the economic policy

The further analysis and calculation of  $\Delta R$  and  $\Delta E$  can be found in the following models.

### 5.1.2 Federal Receipt model

Federal receipts

$$R = R^{\sim} + \Delta R$$

1)  $R^{\sim}$

Usually the proportion of the federal receipts to the GDP ( $P_f$ ) is relatively

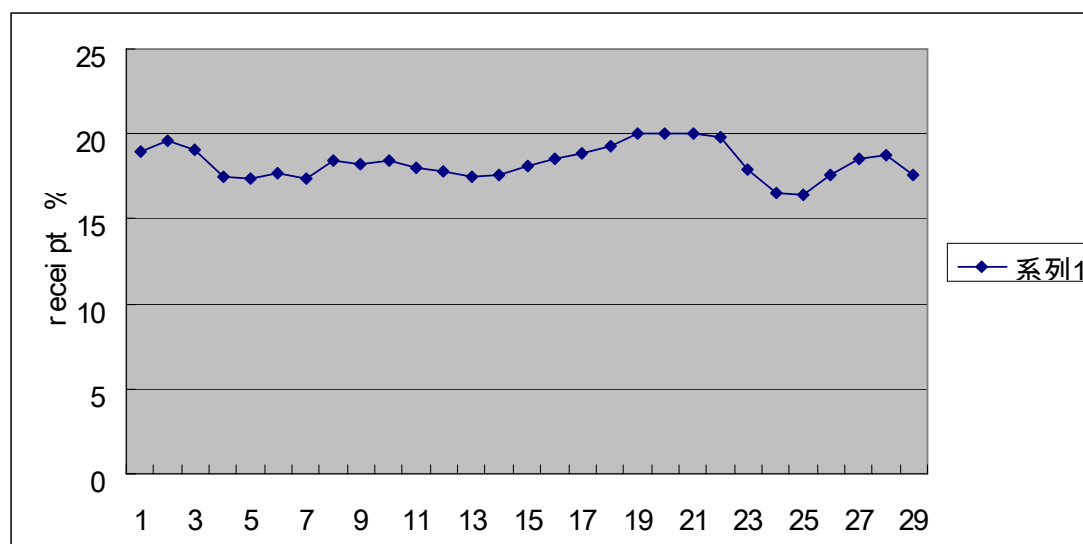
steady with the lowest point of 16.4 % in the year of 2003 and 2004 when the economic development is disturbed by the sudden increase in national defense ( the Iraqi War ) and the highest point of 20% in the year of 1998 to 2000 when the economic situation is relatively good .

$$\text{Pr} = \text{Federal receipt} / \text{GDP} * 100\%$$

Year	GDP' ( billion )	Pr(%)	year	GDP' ( billion )	Pr(%)
1980	2726.7	19	1995	7325.8	18.5
1981	3054.7	19.6	1996	7694.1	18.9
1982	3227.6	19.1	1997	8182.4	19.3
1983	3440.7	17.5	1998	8627.9	20
1984	3840.2	17.4	1999	9125.3	20
1985	4141.5	17.7	2000	9709.8	20
1986	4412.4	17.4	2001	10057.9	19.8
1987	4647.1	18.4	2002	10377.4	17.9
1988	5008.6	18.2	2003	10808.6	16.5
1989	5400.5	18.4	2004	11499.9	16.4
1990	5735.4	18	2005	12237.9	17.6
1991	5935.1	17.8	2006	13015.5	18.5
1992	6239.9	17.5	2007	14311.5	18.8
1993	6575.5	17.6	2008	15027	17.6

Compare the four year presidential term with the national debt .The proportion in the same presidential term resemble.

Calculate the average of the proportion .Pr average is 18.32759% , which is about the official estimated (economic recession considered)18.6 % (average) .



Therefore, the approximate federal receipts is

$$R \sim (G \sim + \Delta G) * P r \text{ average}$$

Year	$G \sim$	$R \sim - \Delta G * P r \text{ average}$
2009	11608	2127.467
2010	11764	2156.058
2011	11922	2185.015
2012	12075	2213.056
2013	12329	2259.609
2014	12636	2315.874
2015	12929	2369.574
2016	13230	2424.74
2017	13588	2490.353

2) From the chart above , it is clear that when the economic development slowed down ,the federal receipts decrease in adjust to the economic situation . Although no relationship between federal receipts decreasing rate and decreasing rate in GDP was discovered in our analysis , probably since different policy makers solve the problem in different methods ,yet the aim of decrease is obvious :to stimulate the nation's current economic situation or of the future. Presumably the government will decrease reasonable amount of federal receipt (individual tax and company tax etc) during recession and recovery.

$\Delta R$ : the amount of receipts decreased in policy making process to stimulate the economy of the future or current.

Moreover,  $\Delta R$  should be reasonable to maintain the basic function of federal expenditure. Assumed the proportion of  $\Delta R$  to  $R$  ( $P\Delta R$ ) ranges from -2.5% to 2.5%. From the historical statistics the range is within  $\pm(\max PR - \min PR)/2 = \pm(20\% - 16.5\%)/2 = \pm 2.25\%$ , but since the available statistics of the national economic crisis is limited; the economic recession may require unprecedented decrease in federal receipt to stimulate the economy etc, we expand the range to  $\pm 2.5\%$ . In this case,  $\Delta R$  ranged from  $(-2.5\%, 0\%)$ . Therefore,  $\Delta R \in (-2.5\% * R, +2.5\% * R) = (-2.5\% * (G \sim + \Delta G) * PR \text{ average}, +2.5\% * (G \sim + \Delta G) * PR \text{ average})$ .  $\Delta R$  from the year of 2009 to 2017 range as follows:

year	$G \sim$	$R \sim - \Delta G * PR$ average	$\Delta R - \Delta G * PR \text{ average} * P\Delta R$ $= \Delta R - \Delta G * 0.45818975\%$
2009	11608	2134.119	(-53.18667, 0)
2010	11764	2162.80	(-53.90144, 0)
2011	11922	2191.848	(-54.62538, 0)
2012	12075	2219.977	(-55.32641, 0)
2013	12329	2266.674	(-56.49021, 0)
2014	12636	2323.116	(-57.89686, 0)
2015	12929	2376.984	(-59.23935, 0)
2016	13230	2432.322	(-60.6185, 0)
2017	13588	2498.14	(-62.25882, 0)

Therefore,  $R = R \sim + \Delta R = (G + \Delta G) * PR \text{ average} + \Delta R$

### 3) $\sum \Delta R$ : $\Delta R$ contributed to $\Delta G$

Restrict the discussion of the  $\Delta R$  contributed to  $\Delta G$  to  $\Delta R$  in the area of individual income taxes  $\Delta R_{it}$  and corporation income taxes  $\Delta R_{ct}$ .

Compare the historical growth of  $R_{it}$ , the  $R_{ct}$  and the historic growth in different industry of GDP of contemporary years and years later, we find that the relationships are relatively distinct than others and base assumptions on the relationships as followings:

the profits produced by  $\Delta R_{it}$  ( $\sum \Delta R_{it}$ ) mainly contributed to the service and consuming industry of GDP that year;



the average proportion of delta ( $\sum \Delta RCT$ ) to the delta ( $\Delta R_{it}$ ), both of which are between this year and the year before, is  $K_{rit}$ ;

the profits produced by  $\Delta R_{ct}$  ( $\sum \Delta RCT$ ) mainly contributed to the industrial and investment of GDP next year.

The average proportion of the delta ( $\sum \Delta RCT$ ) to the delta ( $\Delta R_{ct}$ ), noticing that the former of which delta ( $\sum \Delta RCT$ ) is between one years before and that year yet the latter of which delta ( $\sum \Delta RCT$ ) is between two years before and one year before, is  $K_{ric}$ ;

$K_{rit} = \text{average } \{[GDP(\text{service and consuming industry})_t - GDP(\text{service and consuming industry})_{t-1}] / (\Delta R_{it}(t) - \Delta R_{it}(t-1))\} = -0.0514$

$K_{ric} = \text{average } \{[GDP_{ct}\%(\text{industrial and investment})_t - GDP_{ct}\%(\text{industrial and investment})_{t-1}] / (\Delta R_{ct}(t-1) - \Delta R_{ct}(t-2))\} = -0.166$

Year	$\Delta R_{ct}$	GDP <sub>ct</sub> %	$\Delta R_{it}$	GDP <sub>it</sub>
1980	6.46	20.774	46.79572	3,128.43
1981	6.1137	21.713	38.10207	3,255.03
1982	4.9207	19.341	40.26783	3,536.68
1983	3.7022	19.43	43.25253	3,933.18
1984	5.6893	22.246	44.40817	4,220.25
1985	6.1331	21.207	45.12699	4,462.83
1986	6.3143	20.609	44.87163	4,739.48
1987	8.3926	20.45	47.96099	5,103.75
1988	9.4508	19.745	54.14905	5,484.35
1989	10.3291	19.558	54.17972	5,803.08
1990	9.3507	18.554	51.78072	5,995.93
1991	9.8086	17.065	48.83737	6,337.75
1992	10.027	17.165	48.83185	6,657.40
1993	11.752	17.61	48.37764	7,072.23
1994	14.0385	18.642	45.72592	7,397.65
1995	15.7004	18.61	44.73602	7,816.83
1996	17.1824	19	44.10357	8,304.33
1997	18.2293	19.772	43.35129	8,746.98
1998	18.8677	20.252	48.15064	9,268.43
1999	18.468	20.634	51.41281	9,816.98
2000	20.7289	20.78	50.49532	10,173.37
2001	15.1075	19.138	49.78327	10,342.39

2002	14.8044	18.4	47.89375	10,049.42
2003	13.1778	18.43	46.39529	10,204.85
2004	18.9371	19.351	49.58492	10,893.34
2005	27.8282	19.996	52.03842	11,467.81

Therefore , the  $\sum \Delta R$  in the  $\Delta G$  is as follows

$$\sum \Delta R = \sum \Delta RCT + \sum \Delta RIT = \Delta RCT * K_{RCT} + \sum \Delta RIT * K_{RIT}$$

### 5.1.3 Federal Expenditure model

Federal expenditure (net interest excluded) E

1) E~

The proportion of the federal expenditure to the GDP ( $P_e$ )% is around (16.1 , 20.9)

$$P_e = E/G * 100\% = \text{outlay} / \text{GDP} * (1 - \text{net interest}) * 100\%$$

Calculate the average of  $P_e$  . The average proportion is 18.38497%

year	Outlay/ G %	Net interest/outlay%	E/G%
1980	21.7	8.9	19.7687

1981	22.2	10.1	19.9578
1982	23.1	11.4	20.4666
1983	23.5	11	20.915
1984	22.2	13	19.314
1985	22.9	13.7	19.7627
1986	22.4	13.7	19.3312
1987	21.6	13.8	18.6192
1988	21.3	14.3	18.2541
1989	21.2	14.8	18.0624
1990	21.8	14.7	18.5954
1991	22.3	14.7	19.0219
1992	22.1	14.4	18.9176
1993	21.4	14.1	18.3826
1994	21	13.9	18.081
1995	20.7	15.3	17.5329
1996	20.3	15.4	17.1738
1997	19.6	15.2	16.6208
1998	19.2	14.6	16.3968
1999	18.7	13.5	16.1755
2000	18.4	12.5	16.1
2001	18.5	11.1	16.4465
2002	19.4	8.5	17.751
2003	20	7.1	18.58
2004	19.9	7	18.507
2005	20.2	7.4	18.7052
2006	20.4	8.5	18.666
2007	20	8.7	18.26
2008	20.5	8.3	18.7985

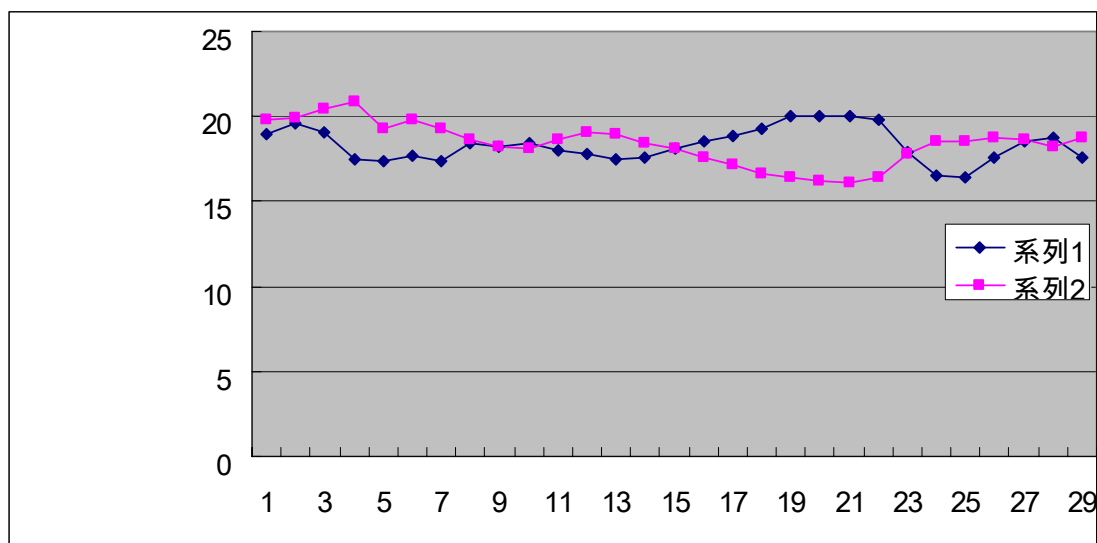
Therefore, Compare Pe and Pr.

It is obvious that the decrease and increase in federal expenditure is opposite to that of federal receipts.

Presumably the government will increase the expenditure to stimulate the economic situation.

Year	G~	E~-ΔG *P e average
2009	11608	2134.127
2010	11764	2162.808
2011	11922	2191.856
2012	12075	2219.985
2013	12329	2266.683
2014	12636	2323.125
2015	12929	2376.993

2016	13230	2432.332
2017	13588	2498.15



2)  $\Delta E$

Like  $\Delta R$  above

Since  $P_e \in (16.1, 20.9)$ , wave range  $\pm 2.25\%$

Expanded as  $\pm 2.5\%$

In this case  $+2.5\%$

Therefore

Year	$G \sim$	$E \sim -\Delta G * P_e \text{ average } (+2.5\%)$
2009	11608	(0,53.35318)
2010	11764	(0,54.0702)
2011	11922	(0,54.7964)
2012	12075	(0,55.49963)
2013	12329	(0,56.66708)
2014	12636	(0,58.07813)
2015	12929	(0,59.42483)
2016	13230	(0,60.8083)
2017	13588	(0,62.45375)

Similarly

$\Sigma \Delta E$  in  $\Delta G$  is mainly contributed by the  $\Delta E_{pr}$  of previous year and the two years before (the increase in physical resources).

$$\sum \Delta E(t) = \Delta E_{pr(t-1)} * K_{EPR}$$

### 5.1.4 Debt Service model

#### 5.1.4.1 Definition

The amount of money necessary to pay interest on outstanding bonds, the principal of maturing bonds and the required contributions to a sinking fund for term bonds. This amount is also known as the “debt service requirement”. “Annual debt service” refers to the total principal and interest paid in a calendar year, fiscal year, or bond fiscal year. “Total debt service” refers to the total principal and interest paid throughout the life of a bond issue. “Average annual debt service” refers to the average debt service payable each year on an issue.

2009	11608	2134.119	(53.353,0)
2010	11764	2162.80	(54.07,0)
2011	11922	2191.848	(54.7962,0)
2012	12075	2219.977	(55.4994,0)
2013	12329	2266.674	(56.6669,0)
2014	12636	2323.116	(58.0779,0)
2015	12929	2376.984	(59.4246,0)
2016	13230	2432.322	(60.8081,0)
2017	13588	2498.14	(62.4535,0)

#### 5.1.4.2 Calculation

The amount of national debt service is closely related to its treasury interest rate and time limit. We can easily infer the relationship between national debt principle and debt service.

$$X_{S_{tn}} = X_{p_{t-n}} * (I_{r_n} + 1)$$

$X_{S_{tn}}$  : the debt service generated by debts at the time limit of n years at the year of t

$X_{p_{t-n}}$  : 1)  $n \geq 1$  the debt principle of debts at the time limit of n years n years ago at the year of t

2)  $n < 1$  the total amount of debt principle of debts at the time limit of n years in the year of t

$I_{r_n}$  : the simple interest rate of debts at the time limit of n years n years ago at the year of t

(Assume that all the debt services are calculated through the method of simple interest.)

The total amount of national debt service can be considered as the sum of debt service of all time limits. That is to say:

$$X_{S_t} = X_{S_{t1/12}} + X_{S_{t1/6}} + X_{S_{t1/4}} + X_{S_{t1/2}} + X_{S_{t1}} + X_{S_{t2}} + X_{S_{t3}} + X_{S_{t5}} + X_{S_{t7}} + X_{S_{t10}} + X_{S_{t30}}$$

$X_{S_t}$  : The national debt service at the year of t

Therefore

$$X_{S_t} = X_{p_{t-1/12}} * (I_{r_{1/12}} + 1) + X_{p_{t-1/6}} * (I_{r_{1/6}} + 1) + X_{p_{t-1/4}} * (I_{r_{1/4}} + 1) + X_{p_{t-1/2}} * (I_{r_{1/2}} + 1) + X_{p_{t-1}} * (I_{r_1} + 1) + X_{p_{t-2}} * (I_{r_2} + 1) + X_{p_{t-3}} * (I_{r_3} + 1) + X_{p_{t-5}} * (I_{r_5} + 1) + X_{p_{t-7}} * (I_{r_7} + 1) + X_{p_{t-10}} * (I_{r_{10}} + 1) + X_{p_{t-30}} * (I_{r_{30}} + 1)$$

Since the treasury interest rate is based on a relatively casual basis, we can't make an accurate prediction. It can be figured out when accurate values are given.

### 5.1.5 National Debt model

$$X_t = E + E_a + X_s - R$$

$$E = E_{\sim} + \Delta E$$

$$\sum \Delta E = \Delta E_{pt} * k_{pt}$$

$$E_{\sim} = G_{\sim} * P_e$$

$$P_e = E/G * 100\% = \text{outlay} / \text{GDP} * (1 - \text{net interest}) * 100\% (18.38497\%)$$

$$R = R_{\sim} + \Delta R$$

$$\sum \Delta R = \Delta R_{ct} * k_{ct} + \Delta R_{it} * k_{it}$$

$$R_{\sim} = G_{\sim} * P_r$$

$$P_r = \text{Federal receipt} / \text{GDP} * 100\% (18.32759\%)$$

$$X_s = \sum X_{stn} = \sum [X_{pt-n} * (I_{rn} + 1)]$$

$E_a$  : Uncertain variable

### 5.2 Testing

Any slight change in economic policy can trigger on the altering of  $\Delta E$  or  $\Delta R$ , which will certainly cause the change of the four main factors: the federal receipt, the federal expenditure, the debt service and the emergency action, and the GDP trend. The four factors will surely affect

the scale of national debt of the year being, which can indicate the sensitivity of our model. Further more, the altering of  $\Delta E$  or  $\Delta R$  can influence of next year's GDP, which will affect the next year's four factors. The circulation will go on thus to change the whole trend of future GDP, national debt and economic development. This can prove the excellent sensitivity of our model.

## 6 Task Two

### 6.1 the Two Policies

#### 6.1.1 Economic Policy

Economic policy can be defined as the guiding principle and measures made by the government in order to solve certain economic problems or to stimulate the development of economy. So economic policies are for some certain purposes, and most of which are to raise the employment rate, stabilize the commodity prices, ensure the steady increase in economic development, obtain the balance between income and spending and so on.

Federal economic policies can be divided into mainly 2 categories: fiscal policy and currency policy. In order to reach the ideal effect, the fiscal policy and the currency policy should work together coherently. Because of the uncertainty and hazard in economy, the decision maker should reasonably vary the policies to optimize the structure and minimize the risks.

#### 6.1.2 Plans

##### 6.1.2.1 Taxation

##### 6.1.2.1.1 Individual income taxes

##### Plan 1

- ◆ Reduce the number of income tax brackets to three at 15%, 25%, 30% from 2009 to 2012

e.g. Single individuals:

If taxable income is over--	But not over--	The tax is:
\$0	\$8,025	10% of the amount over \$0
\$8,025	\$32,550	\$802.50 plus 15% of the amount

If taxable income is over--	But not over--	The tax is:
		over 8,025
\$32,550	\$164,550	\$4,481.25 plus 25% of the amount over 32,550
\$164,550	no limit	\$37481.25 plus 30% of the amount over 164,550

- ◆ Increase the tax rate 2% higher than tax rate in 2008 in the whole from 2013 to 2017.

e.g. Single individuals:

If taxable income is over--	But not over--	The tax is:
\$0	\$8,025	12% of the amount over \$0
\$8,025	\$32,550	\$963 plus 17% of the amount over 8,025
\$32,550	\$78,850	\$5132.25 plus 27% of the amount over 32,550
\$78,850	\$164,550	\$17633.25 plus 30% of the amount over 78,850
\$164,550	\$357,700	\$75578.25 plus 35% of the amount over 164,550
\$357,700	no limit	\$143180.75 plus 37% of the amount over 357,700

Plan 2

- ◆ Decrease the tax rate 2% lower than tax rate in 2008 in the whole from 2009 to 2012.
- ◆ Increase the tax rate 2% high than tax rate in 2008 in the whole from 2013 to 2017

#### 6.1.2.1.2 Corporations income taxes

Plan 1

- ◆ Reduce \$3000 from the taxes of an enterprise if it provide an extra post from 2009 to 2012.
- ◆ Increase the tax rate 2% higher than tax rate in 2008 in the whole from 2013 to 2017.

Income	Tax rate
US\$0–50,000	17%



US\$50,001–75,000	US\$8,500 + 27% of the excess amount
US\$75,001–100,000	US\$15,250 + 36% of the excess amount
US\$100,001–335,000	US\$24,250 + 39% of the excess amount
US\$335,001–10,000,000	US\$115,900 + 36% of the excess amount
US\$10,000,001–15,000,000	US\$3,595,300 + 37% of the excess amount
US\$15,000,001–18,330,000	US\$5,445,300 + 40% of the excess amount
US\$18,330,001 and above	37%

## Plan 2

- ◆ Decrease the tax rate 2% lower than tax rate in 2008 in the whole from 2009 to 2012.

Income	Tax rate
US\$0–50,000	13%
US\$50,001–75,000	US\$6,500 + 23% of the excess amount
US\$75,001–100,000	US\$12,250 + 32% of the excess amount
US\$100,001–335,000	US\$20,250 + 35% of the excess amount
US\$335,001–10,000,000	US\$102,500 + 32% of the excess amount
US\$10,000,001–15,000,000	US\$3,195,300 + 33% of the excess amount
US\$15,000,001–18,330,000	US\$4,845,300 + 36% of the excess amount
US\$18,330,001 and above	33%

- ◆ Increase the tax rate 2% higher than tax rate in 2008 in the whole from 2013 to 2017.

## 6.1.2.1.3 Welfares

### ◆ Plan 1 & 2

Allow citizens to withdraw up to \$10,000 of pension from 2009 to 2012.

## 6.1.2.2 Federal Expenditure

### 6.1.2.2.1 Military Spending

#### ◆ Plan 1

Stop the Iraq War, and withdraw all the troops from the battlefield.  
This can save about \$144 billion a year according to official prediction.

#### ◆ Plan 2

Stop the Iraq War, and withdraw 4/5 of the troops from the battlefield.  
This can save about \$115.2 billion a year according to official prediction.

### 6.1.2.2.2 Bailout plan

### ◆ Plan 1 & 2

There will be a \$850 billion bailout fund from 2009 to 2012.

#### 6.1.2.3

In the bailout measures, industries like banking, real estate and auto industry should be considered first, because we found that there is a coefficient that effect the efficiency of investment funds invested in an industry. And the coefficient will change when it come to different industries.

$$O_y = k_y * I_n_y$$

$O_y$  : the output of industry y when  $I_n_y$  is invested into it

$k_y$  : the coefficient that effect the efficiency of investment funds invested in industry y

$I_n_y$  : the funds invested in industry y

Therefore

$$k_y = O_y / I_n_y$$

So  $k_y$  can be considered as an indicator of the efficiency of an investment. Investments in industries whose  $k_y$  is higher should be considered first. For example, the banking, because it can fuel economic growth dominantly and recessively. The recover of banking industry can provide loan found for minor enterprises and also auto industry, so as to stimulate the economy and the transportation industry (which is vital to the economy of a country) a lot.

## 6.2 Comparison

### 6.2.1 On national debt

#### ◆ Plan 1

#### ◆ Plan 2

### 6.2.2 On the nation's future

## **7 Task Three**

### **Letter to the new president**

Honorable President of the United States:

We are high-school students who sincerely hope to contribute to the benefit of everyone around us (especially for the celestial president Obama) and we have always been regarding solving the U.S. debt crisis as our responsibility. We all have a particular interest in this subject since we are the people who will pay off or at least manage the national debt in the future. Based on our knowledge and experience, we have constructed a mathematical model in order to make a feasible, effective and economical way for the U.S to stimulate its economy in a short period of time. Thus, we believe we could finally create a kind of way to solve the national crisis and in most cases to calm down the public through our assessment. Personally, I think that our model will be the examiner to make a judgment about whether the policy made by the government is good or not.

To begin with, Our model boosts the consideration of the crisis triggers on a series of results, beginning with failures of large financial institutions in the United States. The factors contained in our model will lead to a liquidity problem and the de-leveraging of financial institutions especially in the United States and Europe. The economic relationship between the U.S. and Europe is a marked indicators. Specifically, we have considered a lot of situations which will probably happen in the future. Recently, the financial crisis has further triggered on a currency crisis, because investors and governments invest large amount of capital into the market, which leads to a severe inflation rate and the U.S. dollar devaluation. And this causes the increasing in price of almost everything, which makes many emergent economies to seek aid from the IMF (International Monetary Fund), for example, the Iceland. In fact, the affect of the Iceland economy crisis had already taken into the

consideration, and will demonstrated from the model made by us.

A good mathematics model must include different project. The fact that the U.S. is considered to experience a recession during the financial crisis is also put in this model. In one word, there are mainly four indicators of a recession: GDP per capita, inflation, the rise in unemployment and CPI. The situation of the U.S. is serious, but U.S. is coping with this crisis actively, and is taking measures like the bailout of the U.S. financial system. From the perspective above all, we put all the related parameters in many situation, thus sensitivity will demonstrate the data in its own independent period.

The fact is that U.S. is now facing a severe financial crisis which is the worst of its kind ever since the Great Depression. This crisis can date back to July, 2007, when the credit crisis in U.S. that resulted from the subprime mortgage crisis occurred. It become significantly visible to people in September, 2008 with failures of large financial institutions in the United States, and rapidly evolved into a global crisis, in which the European countries and the stock market are affected most.

Furthermore, time is taken into account as a determinative factor since a lot of profit could only been seen in the long run. Practically, we hold our far-sight perspective in the long term profitable debt (10 years, 30 years). Each method is attested whether it could preserve endurable effectiveness. According to our evaluation, we have confidence in the best policy could be helpfui to the national crisis by different methods. And when it ultimately meets the requirements in the evaluation, we could precisely achieve the best reasonable performance. Nevertheless, we are considering opposite factors and drawbacks that may encumber our approach.

Therefore, bringing out the adequate and moderate national debt is a proposed approach to maintain and stimulate the national economy.

To sum up, we believe our model will effectively help the kind of people who devoted themselves in this kind of fields understand the national debt and make the right decisions based on the different circumstances. We respectfully appreciate the great effort made by the government to maintain a better place for everyone to live and we really hope you can consider our proposal.

Sincerely,  
Team No. 1966

## 8 Conference

All the statistic data and charts are resourced from  
[http://en.wikipedia.org/wiki/National\\_debt\\_by\\_U.S.\\_presidential\\_terms](http://en.wikipedia.org/wiki/National_debt_by_U.S._presidential_terms);  
[www.bea.gov](http://www.bea.gov)

*BUDGET OF THE UNITED STATES GOVERNMENT Fiscal Year 2009*