Team #57

M3 Challenge Fifth Place: Exemplary Team Prize of $5,000
West Windsor-Plainsboro High School North
Plainsboro, New Jersey

Coach: John Cornell
Students: Shir Aharon, Chris Bergman, Moya Chin, Tracie Kong, YunHui Lin

Increasing the 2009 Stimulus Plan

I. Summary

To begin with, we looked at what elements of the $787 billion package would bring the greatest improvements in employment. In order to find this, we looked at the correlation between unemployment and economic growth, or GDP. By comparing expected GDP change based on unemployment statistics with actual GDP change every year, and then averaging to remove outliers, we were able to find a ratio of 2.899: for every 1% increase in unemployment, there should be a 2.899% decrease in GDP. This let us focus on what parts of the stimulus package increased GDP the most. We found different theoretical multipliers from Mark Zandi, the chief economist at Moody's, and used those to estimate the effect of the stimulus spending on the growth in the economy. This let us find what parts of the stimulus bill would have the greatest impact on employment.

We then took that data, and found when all of it was implemented. The stimulus bill, we found, would be implemented over the course of several years, with the majority spent in the first three years. We assumed a lag time of 6 months, and that let us estimate when the stimulus bill should take effect. We then found that, using leading indicators in the economy, one can figure out when the economy is getting out of a recession, and that should tell us when the stimulus package is taking effect. We have fairly high confidence in our estimates because they agree with professional economists.

We finally found that it will be necessary to have a second stimulus package in order to reduce unemployment to acceptable levels. This package would need to be larger than the first, and there are no better ways to increase employment than this.

II. Elements that will produce the greatest improvements in employment

Assumptions:

The multipliers that we used to calculate the increase or decrease in GDP are accurate and remain constant. This is reasonable since they come from Mark Zandi, a respected economist at Moody's, who published these numbers (1 and 2). We used a factor of 0.9 per $100 billion spent in each multiplier category, as there has been a dearth of research on the subject of diminishing marginal return on individual fiscal multipliers. However, the diminishing marginal return is an extremely important aspect of the stimulus: if the first $100 billion of infrastructure spending has a multiplier of 1.59, the next $100 billion is unlikely to have as much of an effect as the most necessary infrastructure spending. Our assumption is therefore justified.

We also assume that there are no other programs that will have a major effect on employment over the years included in our projection. This is reasonable since, until the economy is expanding, companies will not initiate major hiring, and no source other than the government will spend enough to have such an effect. Substantial losses in unemployment are already included in our projections, based on the Survey of Professional Forecasters and the Federal Reserve central tendency projections.

We are reasonably accurate with our distribution of the allocations of money in the stimulus plan. We assumed that the elements we designated are representative of the plan.

Analysis:

The projection of employment against gross domestic product (GDP) shows a statistically significant relationship. (See part IV.) Therefore, the elements that will produce the greatest improvements in employment are the ones that will produce the greatest increases in GDP. The increase in GDP contributed by each element is calculated by multiplying the amount allocated to that element by the multiplier value unique for each element.

For example, if $100 million is allocated to Program A, which has a multiplier value of 1.5, and $300 million is allocated to Program B, which has a multiplier value of 0.5, each program will produce a $150 increase in GDP. However, Program B was allocated more money than Program A. Program A had more "bang for the buck."

Therefore, we want to maximize the increase in GDP per dollar allocated; we want the highest multiplier value.

Table 1: Fiscal Bang for the Buck
Data for the multiplier values was taken from the publications of Mark Zandi from Moody's at Economy.com and from Essentials of Economics by Paul Krugman.

One-year $ change in real GDP per $ reduction in federal tax revenue or increase in spending

Policy	Multiplier Value
Business Investment Write-off	0.24
Accelerated Depreciation	0.27
Cut Corporate Tax Rate	0.30
Extend AMT Patch	0.48
Personal Margin Tax Reductions	0.59
Nonrefundable Lump-Sum Tax Rebate	1.02
Child Tax Credit Rebate	1.04
Issue General Aid to State Governments	1.36
Increase Infrastructure Spending	1.59
Extend Unemployment Insurance Benefits	1.64
Temporarily Increase Food Stamps	1.73

According to Mark Zandi's predictions of multiplier values, temporary increase in food stamps, unemployment insurance and benefits, and relief to state governments would produce the greatest improvements in employment.

Calculations:

To calculate the decrease in percent unemployment effected by each stimulus policy, we followed the following steps:

1) The concept of diminishing marginal return dampens the multiplier value (V). For each $100 billion spent, the multiplier value decreases by 0.1.302. So each adjusted multiplier (V') value is affected by the amount spent in billions (I):

$$V' = V*0.9^{(I/100)}$$

2) The increase in GDP in billions of dollars (ΔG) is calculated by multiplying the amount spent for each policy by the adjusted multiplier value for that policy:

$$\Delta G = I*V'$$

3) The percent of GDP (Δg) increase is calculated by dividing the GDP increase (in $ billion) by the current GDP, which is $14264.6 billion:

$$\Delta g = \Delta G / 142.646$$

4) We calculated the relationship between the change in GDP and the change in unemployment. Each 2.899% increase in GDP results in a 1% decrease in unemployment.
5) The percent change in unemployment (ΔE) is calculated by dividing the percent change in GDP by 2.899:

$$\Delta E = \Delta g / 2.899$$

The final model is:

$$\Delta E = I*V*0.9\text{^}(I/100) / 47.74$$

The calculations yield the following results.

Table 2: Effect on Employment

Policy	Amount Spent (billions of dollars)	Multiplier Value	Adjusted multiplier value	GDP increase with original multiplier value (billions of dollars)	GDP increase with adjusted multiplier value (billions of dollars)	GDP increase (%)	Decrease in Unemployment (%)	Decrease in Unemployment ($1/1000^{th}$ %)
Business Investment Write-off	15.000	0.24	0.236	3.600	3.544	0.025	0.009	0.571
Accelerated Depreciation	5.000	0.27	0.269	1.350	1.343	0.009	0.003	0.649
Cut Corporate Tax Rate	18.000	0.30	0.294	5.400	5.299	0.037	0.013	0.712
Extend AMT Patch	70.000	0.48	0.446	33.600	31.211	0.219	0.075	1.078
Personal Margin Tax Reductions	13.000	0.59	0.582	7.670	7.566	0.053	0.018	1.407
Nonrefundable Lump-Sum Tax Rebate	133.300	1.02	0.886	135.966	118.151	0.828	0.286	2.143
Child Tax Credit Rebate	44.600	1.04	0.992	46.384	44.255	0.310	0.107	2.399
Issue General Aid to State Governments	169.120	1.36	1.138	230.003	192.464	1.349	0.465	2.752
Increase Infrastructure Spending	224.929	1.59	1.255	357.637	282.176	1.978	0.682	3.034
Extend Unemployment Insurance Benefits	86.950	1.64	1.496	142.598	130.115	0.912	0.315	3.619
Temporarily Increase Food Stamps	19.900	1.73	1.694	34.427	33.713	0.236	0.082	4.097
Total	799.799			998.635	849.835	5.958	2.055	2.569

Conclusions:
We can conclude from our extrapolations that:

- The elements which will effect the greatest decrease in unemployment are to Increase Infrastructure Spending (0.682% decrease) and to Issue General Aid to State Governments (0.465% decrease).
- The elements which will effect the greatest decrease in unemployment per billion dollars are to Temporarily Increase Food Stamps (down 0.004097%), to Extend Unemployment Insurance Benefits (down 0.003619%), and to Increase Infrastructure Spending (down 0.003034%).

After applying the multipliers to the stimulus bill, we had our predicted net effect on GDP due to the stimulus bill, $849.835 billion. From this, we found that the stimulus bill's effect on nominal GDP (501) would be 5.96% of GDP. We then sought to find a correlation between changes in unemployment and GDP. In order to find this correlation, we set up a function to find the effect on GDP of an increase in unemployment.

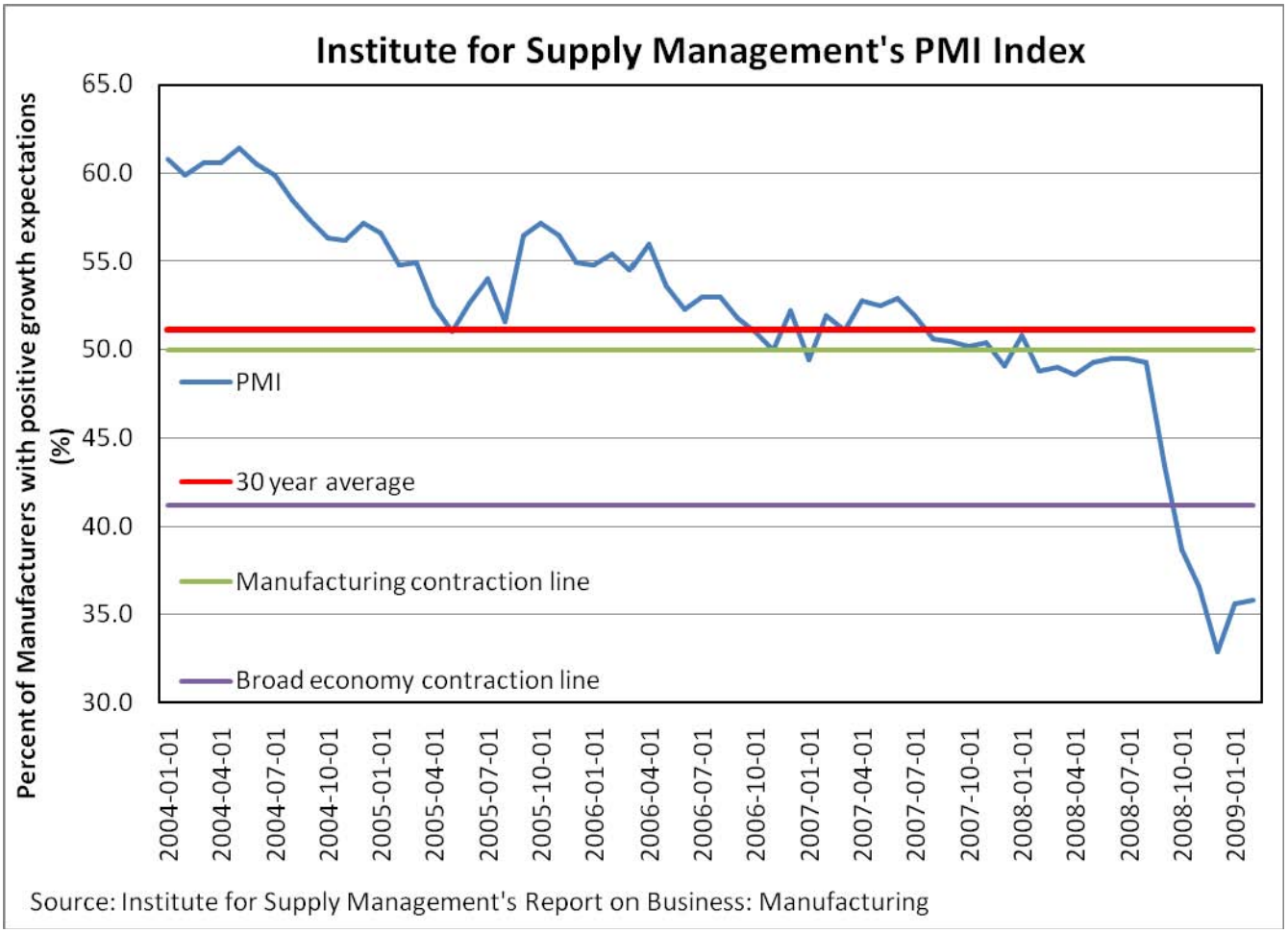
Our final value of 2.899 as the relationship between a 1% decrease in unemployment and a 1% increase in GDP agrees with Okun's law (505), that a 1% increase in unemployment should lead to a somewhere between 2 and 3% decrease in GDP. Going back to the effect of the stimulus plan, we had found that it would have an effect on GDP equal to an increase of 5.96% on nominal GDP. Applying our value of 2.899, we find that the stimulus plan should decrease unemployment by 2.055%. Our prediction for the peak unemployment is 9.1%, based on extrapolations of data from the Survey of Professional Forecasters (507) and the Federal Reserve Central Tendency Projections (507). In order to decrease unemployment to our estimate of NAIRU (505), we need to increase GDP in total by 11.9%. As the first stimulus bill has already had a 5.96% increase, we need only a 5.94% increase further. However, given the diminishing marginal return on multipliers, we must maximize the return on investment for a second stimulus bill, which is necessary in order to reduce unemployment to NAIRU levels.

III. Results of the Stimulus Package

Assumptions:
The multipliers we used to calculate the increase or decrease in GDP are accurate and remain constant. This is reasonable since they come from Mark Zandi, a respected economist, who published these numbers. We used a factor of 0.9 per $100 billion spent in each multiplier category.

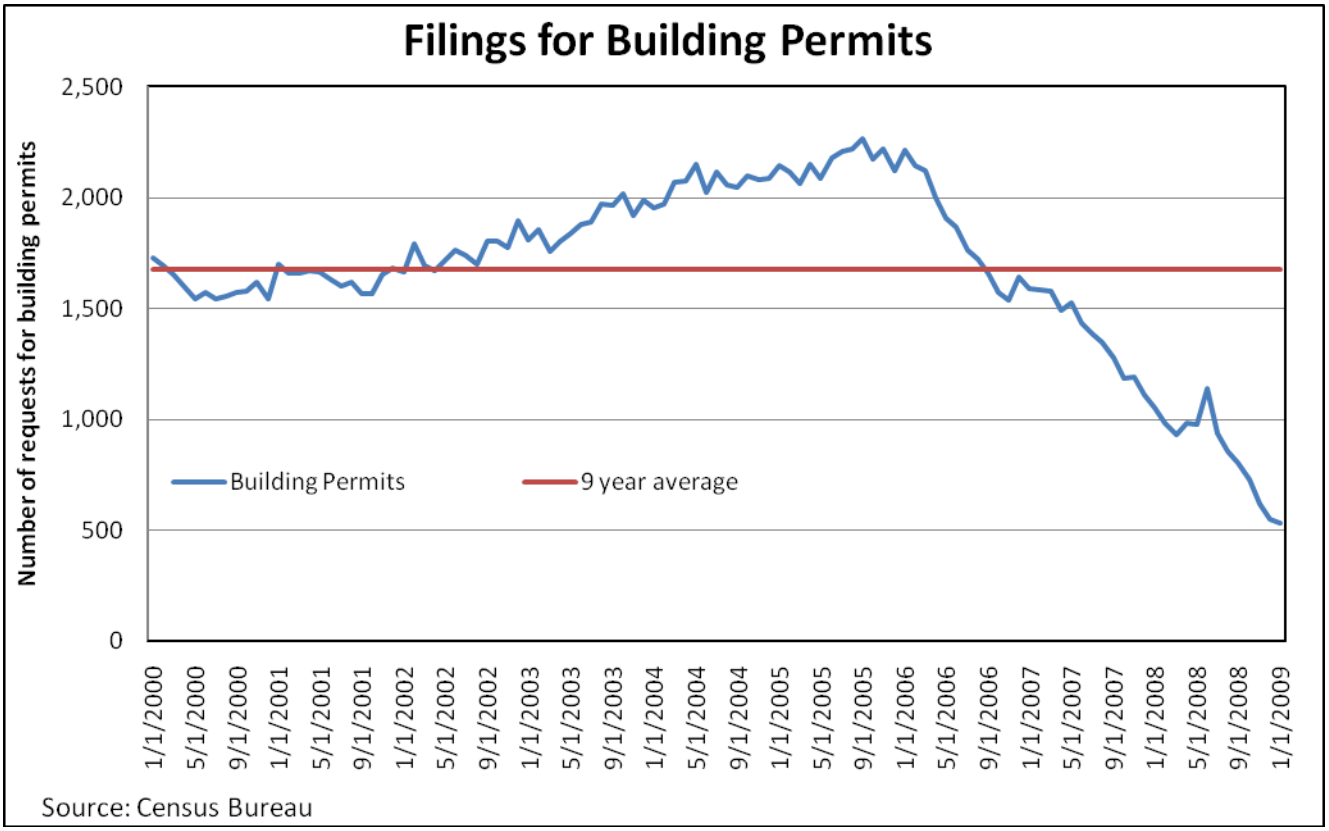
We assume a lag time with a maximum of 6 months between the time the budget is spent and the time it will cause an effect.

We assume that the effect caused by a Title is proportional to the amount spent in that title.

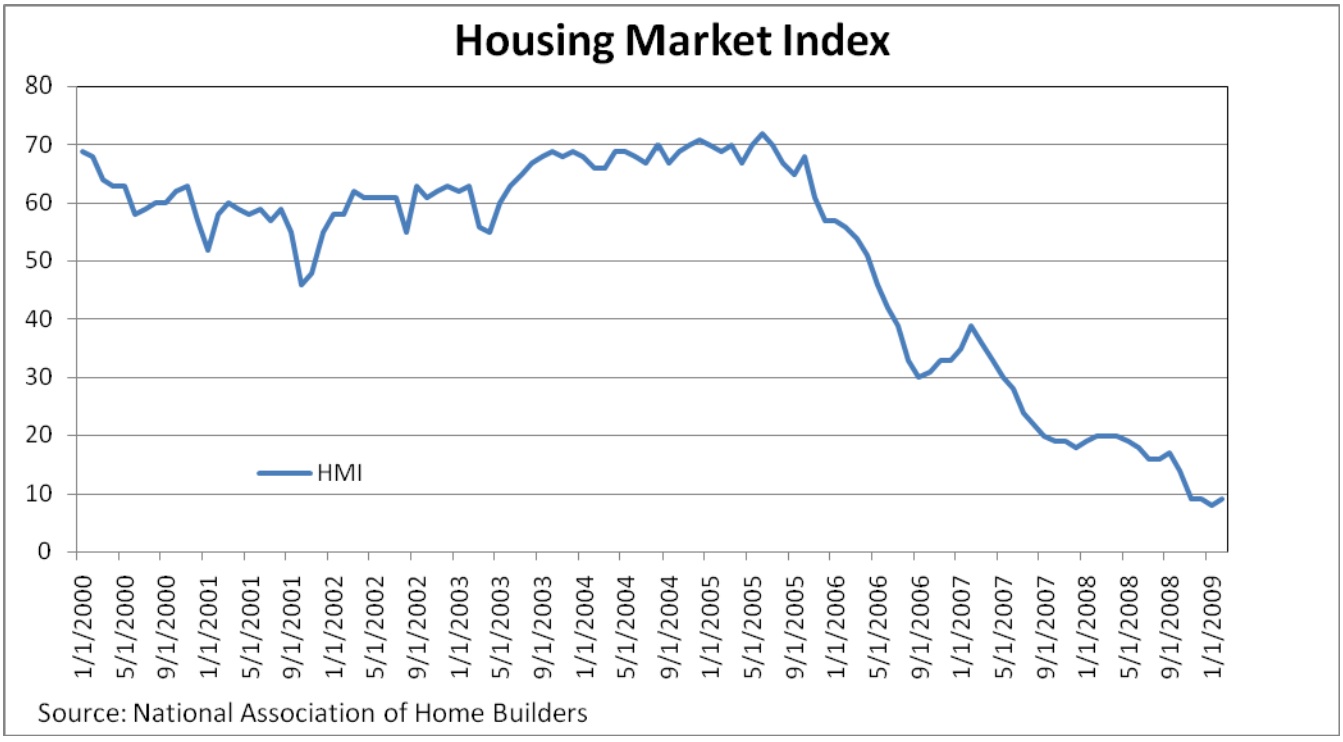


Graph 1: PMI, from the Institute for Supply Management

Another good indicator is how well the housing sector will do. Housing and construction make up a significant aspect of GDP, and many other industries get a significant amount of their business from the housing and construction sectors; when the housing sector is doing well, so, too, is the broader economy, usually. The Housing Market Index and applications for building permits are perhaps the best way to measure future construction growth, showing respectively expectations for and future construction of housing. When the building permits (Graph 2) begin to return to moderate levels, and the HMI rises from record lows (see Graph 3), the infrastructure aspect of the stimulus plan can be said to have had an effect on the housing sector.

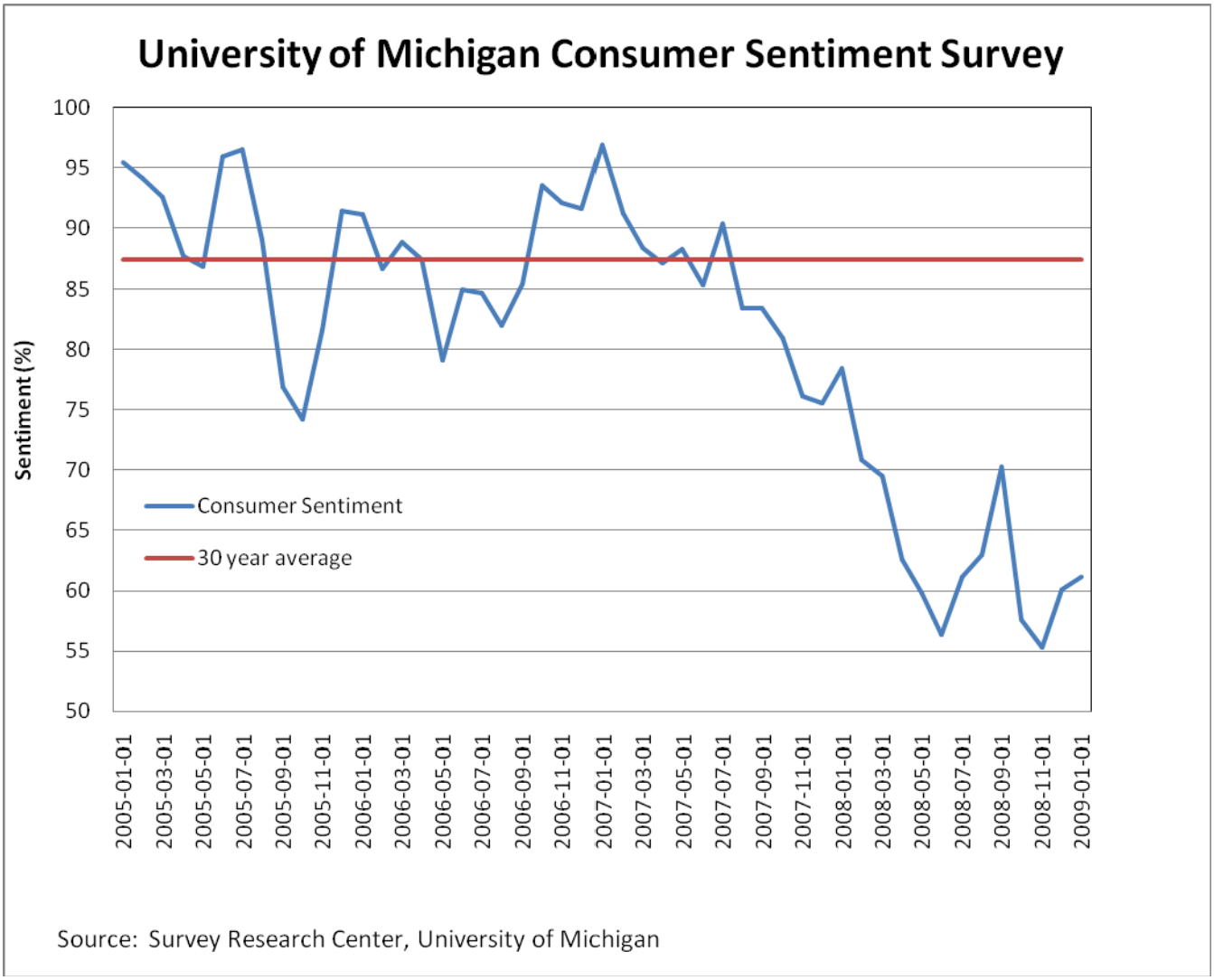


Graph 2: Filings for Building Permits, Census Bureau



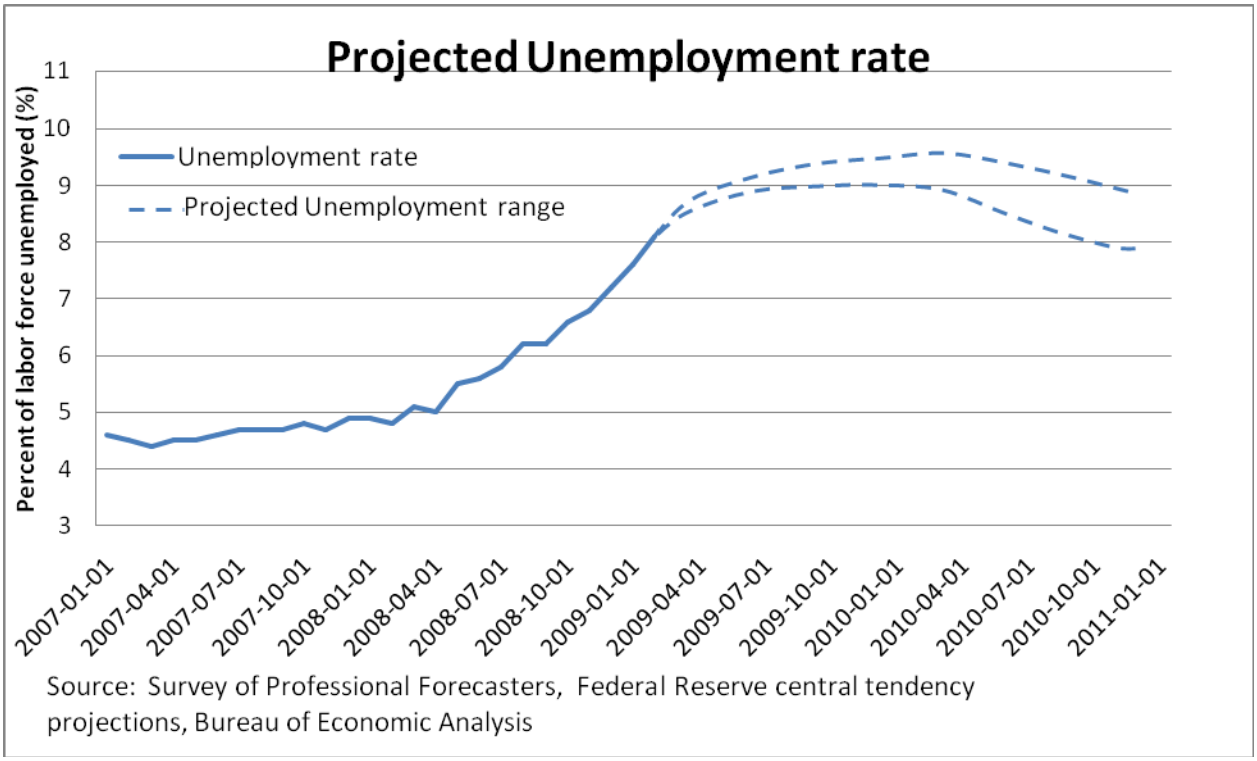
Graph 3: HMI, National Association of Home Builders

When the stimulus bill begins to take effect, consumer confidence should begin to rise, as consumers see their personal situation improve in spite of the past recessionary tendencies of the economy. This will have the effect of increasing personal consumption, which makes up 70% of GDP. This would be a significant reason for stating that the stimulus plan is working. Now, however, the Michigan Consumer Sentiment survey is at record lows (see Graph 4).

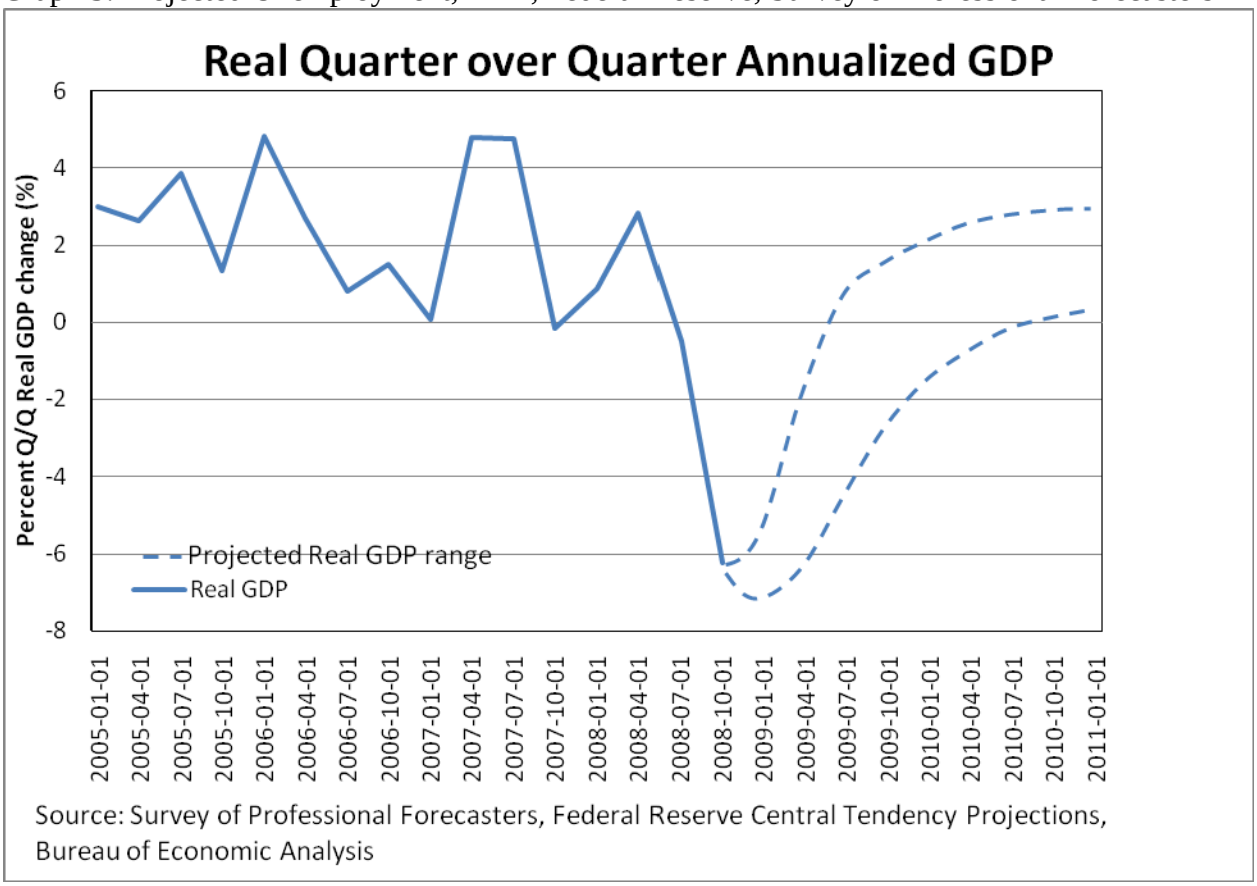


Graph 4: Michigan Consumer Sentiment Survey, University of Michigan

Finally, as we see the stimulus take effect, we should see first GDP rise, then unemployment decrease, as companies begin to hire in order to increase productivity and take advantage of a rising economy. This is a lagging indicator rather than a leading indicator, and so is less an indication that the stimulus has begun to work than that the stimulus has already worked. Our projections for unemployment and GDP are on Graphs 5 and 6, based on the projections of the Survey of Professional Forecasters and the Federal Reserve Central Tendency Projections.



Graph 5: Projected Unemployment, BEA, Federal Reserve, Survey of Professional Forecasters



Graph 6: Projected GDP, BEA, Federal Reserve, Survey of Professional Forecasters

We are fairly confident in our predictions. First, the Federal Reserve and Survey of Professional Forecasters have taken the stimulus bill into account in their projections, and our projections agree with theirs. Second, as the credit markets begin to stabilize due to the TARP program and the

Federal Reserve's unconventional lending facilities, we should see credit return to the broader economy. This should help to stabilize the housing sector, as people can get financing for purchases of houses; it should help reduce layoffs and the rate of increase in unemployment, as companies can get short-term financing; and it should benefit the consumer, as they can get credit for durable goods. Therefore, given that TARP and the Federal Reserve have injected several trillion dollars into the banking system, we should see a recovery first there and then in the broader economy.

Modeling the Relationship Between Real GDP and the Unemployment Rate

Determining a relationship between real GDP and the unemployment rate is necessary to any sort of analysis of the effects of the stimulus plan on employment in the U.S. Okun's Law is a commonly used rule of thumb; it states that for every percent increase in unemployment, there is a corresponding 2 to 3 percent decrease in GDP. However, this is more of a qualitative than a quantitative measure; a guideline rather than a definitive mathematical relationship. The values 2-3% are only approximate and largely arbitrary. In determining the efficiency of the new stimulus plan, we deemed it necessary to calculate a more correct multiplier that would allow us to correlate GDP with unemployment rate. We formulated the following equation to calculate GDP loss due to unemployment, which was then used to calculate a multiplier that would allow us to better model the relationship between GDP and unemployment rates:

GDP = V * (I + C)

Where: **V** is the velocity of money
I is the total income after federal and state tax
C is unemployment compensation

I represents the amount of income lost or gained from the economy due to changes in employment. **C** represents the money that the government pays out to the private sector in the form of unemployment compensation; when changes in unemployment are positive, **C** will be negative. The sum of these two, **(I + C)** represents the change in the total amount of money in the private sector, due to unemployment. This sum is multiplied by **V**, the velocity of money, to represent the factor by which the value of the money is multiplied as it is transformed from income into GDP. The velocity of money corresponds to the number of times that the money is used in transactions in the U.S. economy.

In modeling the relationship between GDP and unemployment within the U.S., we made the following assumptions:

1. On a large time scale, the employment rate is the only significant factor affecting GDP.
2. Any other factors that do affect GDP will also affect employment in a similar manner, and the effects from such factors will thus be cancelled out in the long run.
3. The unemployment compensation in the district of St. Louis, MO, is representative of the unemployment compensation throughout the entire country.
4. California, Texas, Florida, and New York represent the populated states in the West Coast, Southwest, Southeast, and Northeast; Idaho represents the more sparsely populated states in the Midwest, West, and South.
5. Workers were assumed to be single or part of a married couple filing separate tax returns.

In this report we have incorporated samples of the calculations we performed, because the full data table was too extensive to include. Any example calculations we have included involve data for the construction sector of the industry during the period between January and February of the year 2000.
In actuality, we calculated values for all three sectors (construction, manufacturing, and financial activity) of the industry, from the years 2000 to 2008.

A. Calculating I, the Income Remaining after Federal and State Tax

1. We divided American industry into three major sectors that experience significant job loss: construction, manufacturing, and financial activities. Any example calculations from here on will involve data from the construction sector.
2. We obtained data on the number of unemployed individuals per month within the U.S. in each of the three sectors [701].
   January 2000: 745 thousand
   February 2000: 812 thousand
   67 thousand
   The difference between the numbers unemployed in consecutive months represents the number of newly unemployed workers each month.

3. We obtained data on the average weekly earnings within each of the sectors and multiplied by 4 to adjust for monthly earnings [701].

   $ 685.78 x 4 = $2743.12
   This is the amount earned by construction workers per month in February 2000.
   The monthly earnings were multiplied by the number of newly unemployed each month to represent the amount of potential income that was lost per month due to unemployment.
   $2743.12 x 67 thousand = - $183,789.04
   A negative sign is included since $183,789.04 is *lost* due to unemployment.

4. We needed to know the average annual income in order to calculate the amount of money that the unemployed would have contributed as federal taxes. The monthly earnings as calculated above were multiplied by 12 to reflect yearly earnings.
   $2743.12 x 12 = $32, 917.44
   From the federal income tax brackets on Internal Revenue Service, we calculated the tax revenue that was gained or lost from what the workers would have earned had they been employed [702].
   $4386.25 + 0.25 ($32917.44 – 31850) = $4653.11
   This value was multiplied by the change in the number of unemployed individuals per month in order to obtain the amount of tax revenue gained or lost due to total unemployment.
   $4653.11 x 67 thousand = - $311,758.37 thousand
   Again, a negative sign is included to represent tax revenue lost due to increased unemployment rates.

5. Different states have different tax policies, which complicates our simple model. We chose five states, as listed before, to represent various regions of the United States. We averaged the tax rates in each of the five states and then applied this average tax rate to all further calculations [703]. We applied this tax rate to the amount of income remaining after the workers had filed the federal income tax return.
   [(Yearly Earnings) – (Federal Taxes)] x (change in number of unemployed)
   ($32, 917.44 - $4653.11) x (67 thousand) = - $1,893,710.11 thousand
   A negative sign is included as before. This value represents the change in the amount of income available for state taxing after federal income tax returns have been filed.

   We determined the state income tax rate by averaging the values from five representative states. The rate we obtained was 6%. We calculated the total income tax workers would pay towards their state government had they been employed.
   - $1,893,710.11 thousand x 0.06 = - $113,622.6066 thousand
   This is the total amount of state tax revenue lost due to unemployment.

6. Using the values calculated in previous steps, we subtracted the amounts of money unemployed individuals would have paid towards state and federal taxes from their imaginary income.
   (Income) – (Federal Income Tax) – (State Income Tax)
   - $183,789.04 – (- $311,758.37) – (- $113,622.6066) = $241, 591.937 thousand
   This value represents the amount of money that would have been available to the economy if the workers had been employed.
   We added up the values of income lost due to unemployment in each of the three sectors of the industry.
   ($ Lost in Construction) + ($ Lost in Manufacturing) + ($ Lost in Financial Activity) = I

B. Calculating C, the Unemployment Compensation

1. Total unemployment compensation in the Federal Reserve district of St. Louis was obtained from the Bureau of Economic Analysis [704].

2. **Total C in St. Louis / Population in St. Louis x Total Population in U.S. = Total C in the U.S.**

   The values used in these calculations were obtained from the U.S. Census Data [704].
   Total C in U.S. / Total Unemployment in U.S. = Compensation per Unemployed Worker

3. We obtained data on monthly change in nonfarm payroll employment from the St. Louis Federal Reserve Economic Data (FRED). The monthly change in employment was then multiplied by the unemployment compensation per unemployed worker to obtain the total monthly change in unemployment compensation.

(Change in Nonfarm Payroll Employment) x (Compensation per Worker) = Monthly Change in Unemployment Compensation

C. Calculating V, the Velocity of Money

To calculate the velocity of the money supply, we used the following equation:
V = (PQ) / M

Where **P** is the price level [704]
Q is GDP [704]
M is the M1 money supply

Note: a 2001 chain-typed index was used for GDP, M1 money supply, and price level.

D. Calculating GDP Loss

We returned to the equation we had originally formulated: **GDP = V * (I + C)**
The values of **I, C,** and **V** which we had obtained in Parts A, B, and C were used in the calculation for GDP lost due to unemployment.

We then found real annual change in GDP, and we divided annual change in GDP by the effective GDP from unemployment [704].

Doing this for years 2000 to 2009, we found ratios between 1.5 and 5.8. In order to reduce outliers and effects upon GDP not based on unemployment, we averaged the data.

This gave us 2.899 as the ratio between a 1% increase in unemployment and the % decrease in GDP.

This is the value of the multiplier we will use in further calculations as we analyze the effects of the new stimulus plan on American employment and GDP. As Okun had predicted, the value of the multiplier lies between 2 and 3.

To estimate when the stimulus plan has an effect on the economy, one should look at leading indicators of the broader economy. The health of the manufacturing sector has historically foretold the health of the broader economy, and manufacturing has been one of the hardest hit in this economy. Moreover, the stimulus plan has several provisions specifically aimed at manufacturers, but not so many as to distort the predictive power of the Institute for Supply Management's PMI index (507). This index, which has just risen from a historical low (see Graph 1), is still significantly below the contraction lines of the broad economy, the manufacturing sector, and the 30-year historical average. When the PMI rises above the economy contraction line, 41.2, this is likely to be a signal that the economic crisis is easing. If such an easing happens within the next two years, there is every reason to believe that this is due to the stimulus package; current economic data and expectations are so low as to show that the U.S. economy requires an external force (i.e., some sort of fiscal stimulus) to rise out of the recession.

Analysis:

While some of the allocations included in the Stimulus Package are given all at once, others are given over a period of eleven years. The former will induce immediate results, while the latter will continue to affect the U.S. economy for years to come.

To show the breakdown of the amounts spent per year for each program, data was used from the letter regarding the 2009 Stimulus Package published by the Congressional Budget Office:

Table 3: Estimated Cost of American Recovery and Reinvestment Act of 2009

Title	Estimated Outlays (Millions of Dollars)											
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
A Title I	5691	8031	5685	4111	2286	468	159	0	0	0	0	26431
A Title II	2538	5000	2861	2535	2222	492	162	0	0	0	0	15810
A Title III	1679	2122	551	129	36	11	3	0	0	0	0	4531
A Title IV	3159	9389	11063	9988	6945	5090	2234	1317	1150	470	-30	50775
A Title V	620	1562	1339	1167	1019	500	300	150	50	0	0	6707
A Title VI	506	591	857	457	230	93	10	0	0	0	0	2744
A Title VII	1168	3498	2697	1771	783	329	129	77	45	48	0	10545
A Title VIII	6831	37719	20508	4984	1009	187	31	2	0	0	0	71271
A Title IX	8	15	2	0	0	0	0	0	0	0	0	25
A Title X	448	1564	1229	638	241	93	33	0	0	0	0	4246
A Title XI	96	180	162	114	50	0	0	0	0	0	0	602
A Title XII	5509	12657	13309	9820	7815	5540	3991	1619	418	338	178	61194
A Title XIV	6540	28377	16070	2363	250	0	0	0	0	0	0	53600
B Title I	69570	212616	38852	-8979	-1738	-4539	-6004	-4667	-3928	-3873	1018	288328
B Title II	31962	22851	1369	745	414	288	225	112	85	50	45	58146
B Title III	14302	9154	1407	-26	-75	-46	-29	-10	-1	0	0	24676
B Title IV	417	178	4621	6219	6103	13821	3413	-5970	-5405	-3195	-2643	17559
B Title V	33881	43923	11847	88	-6	35	44	56	57	59	59	90043
Total	184925	399427	134429	36124	27584	22362	4701	-7314	-7529	-6103	-1373	787233

IV. Second Stimulus Package

Using the relation between the change in GDP and the change in unemployment rate, we can calculate how much GDP change is needed to bring unemployment to appropriate levels.

We know that the unemployment rate is 9.1% at its peak and can safely assume that the first stimulus plan has not yet had time to affect this significantly. Ideally unemployment should be reduced to 5%, and by multiplying by 2.899, we get that the necessary change in GDP is 11.9% or $1.8 trillion. The first stimulus plan accounts for $800 billion spent and an expected change of $850 billion, which is well short of what is required.

This means that another stimulus package will be needed to make up the difference and bring unemployment to acceptable levels. The net expected change should be at least $1.8 trillion, and of course, we would like to achieve this with the smallest actual expenditure.

If we were to ignore the fact that multipliers decrease as more is spent in a category, then obviously the ideal solution would be to spend the entire remaining amount in the highest valued categories.

However, we do need to account for this devaluation, and thus need to optimize the amount spent in each category.

If we use x0 to represent what the first plan contributes and x to represent the second plan's contribution, then

value(x) = (x+x0) * mult * [.9^((x0+x)/100)]

and where sum of value over all categories should equal $1.8 trillion.

The method we use is to fix the amount spent on each category for the second stimulus plan and calculate the effect it would cause on the overall value. If it meets the minimum required value, we record it as the best solution if the amount spent is less than the last best solution. (The first set tried is trivially a best solution.)

This algorithm is simple although costly with computer resources due to the repetitions. To reduce the run time to a reasonable limit, we satisfy ourselves with working in $5 billion increments, so the final solution will be the best to $5 billion. For this reason, we can expect the GDP effect to overshoot a bit as well as the spending, but not by more than a few billion. In addition, we only used the 6 categories with the highest initial multiplier rate. Although it is possible that some spending in the less valued categories would have been more optimal, it is not likely to have been much, especially since we found that the only $40 billion was spent on the lowest valued categories which had an initial multiplier of 1.02 vs. a multiplier of 0.59 for the 7th lowest category, which makes it unreasonable to spend as a good choice.

The last constraint that we gave the program was the upper limit to test for each category. By running test runs and adding variable by variable to the optimization, we could get a sense for the upper limits of each category before spending more became counterproductive. We see in the final output shown in Figure 1 that none of the categories are at the imposed spending point, so there was no issue of needing a higher bound.

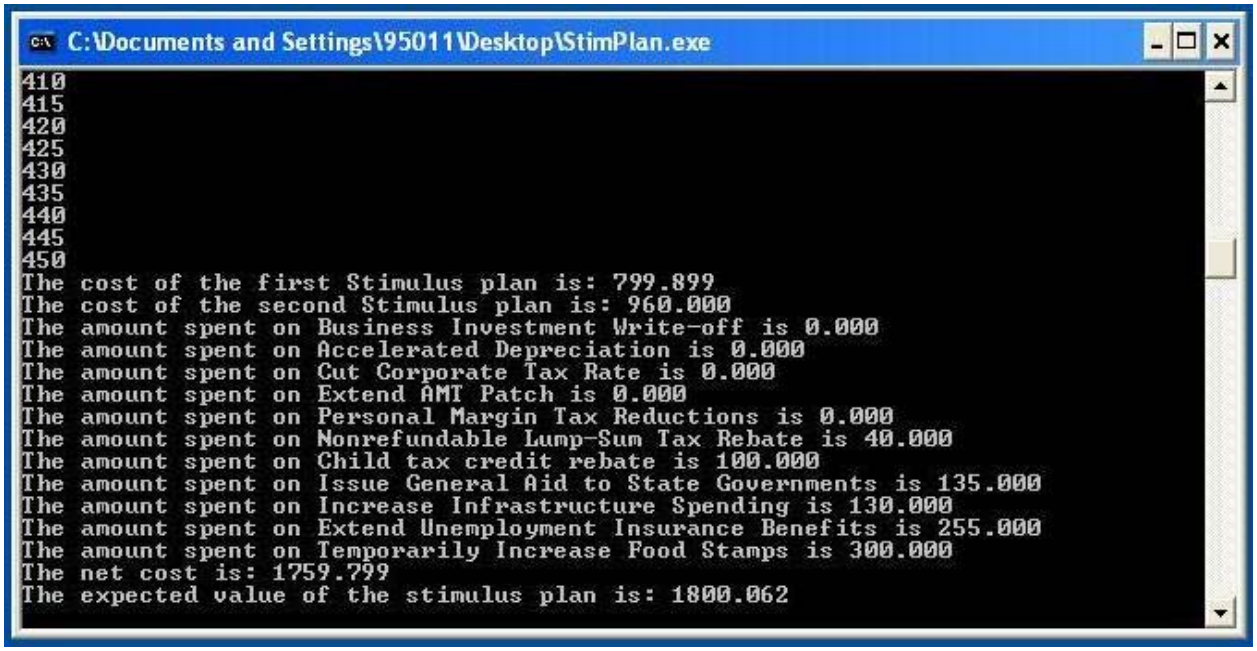


Figure 1 Program output with stimulus plan 2 optimized values

Figure 1 gives that we need to spend an additional amount as shown in Table 2 below. The table summarizes the distributions for the first and our proposed second stimulus plan. The second plan will be valued at approximately $960 billion dollars and will give just about exactly the needed $1.8 trillion of actual GDP change. It is interesting to note that without the devaluation of the multipliers the plan could have had an effect of almost $2.5 trillion.

Table 4: Stimulus Plan

Category	Plan 1	Plan 2	Net	Multiplier	Adjusted	Regular	Effect
Business Investment Write-off	15.000	0.000	15.000	0.24	0.236	3.600	3.544
Accelerated Depreciation	5.000	0.000	5.000	0.27	0.269	1.350	1.343
Cut Corporate Tax Rate	18.000	0.000	18.000	0.30	0.294	5.400	5.299
Extend AMT Patch	70.000	0.000	70.000	0.48	0.446	33.600	31.211
Personal Margin Tax Reductions	13.000	0.000	13.000	0.59	0.582	7.670	7.566
Nonrefundable Lump-Sum Tax Rebate	133.300	40.000	173.300	1.02	0.850	176.766	147.265
Child tax credit rebate	44.600	100.000	144.600	1.04	0.893	150.384	129.133
Issue General Aid to State Governments	169.120	135.000	304.120	1.36	0.987	413.603	300.211
Increase Infrastructure Spending	224.929	130.000	354.929	1.59	1.094	564.337	388.268
Extend Unemployment Insurance Benefits	86.950	255.000	341.950	1.64	1.144	560.798	391.146
Temporarily Increase Food Stamps	19.900	300.000	319.900	1.73	1.235	553.427	395.077
Totals	**799.799**	**960.000**	**1759.799**			2470.935	**1800.062**

The money that is to be spent on food stamps will go towards raising the allowances for the poorest families and raising the ceiling of how poor one needs to be to receive these benefits. This will give many of those in poverty and in the lower classes the chance to spend money that they would otherwise use for food on other things and help stimulate the economy beyond the basic necessities.

The portion for unemployment insurance benefits will go to increase the subsidies for COBRA plans, both how much the government pays and their duration, from the current 65% and 9 months [306]. This will help protect the unemployed from medical problems and give them a chance to return to the workforce as productive members of society. Also, since there wasn't a separate category for unemployment wage subsidies, some can go to increase the duration of these benefits to help people maintain their status of living while searching for a job in the more difficult times of today.

The spending on infrastructure and aid to the states will go partially to set up the offices needed to carry out the above proposals, and the rest will be allocated to various projects, supplementing the spending in the original stimulus plan.

The tax rebates for children and the general tax rebate will be used to increase the amounts in the original stimulus plan; there is not particularly a wide range of methods to distribute them. They will be allocated to primarily return money to those in the lowest tax brackets, as this will have the greatest effect on the economy.

Conclusion:

We found that, first, the elements of the $787 billion package that are composed of food stamps, uninsurance benefits, and infrastructure spending were most likely to increase employment, as we found a correlation between unemployment and GDP. We then found that there was a 2.6-year time period between when the stimulus package is enacted and when maximum results should be expected. Moreover, one can tell whether the stimulus package is working based on leading indicators in the economy, though coincident indicators are considered the most important to consumers. We are fairly confident in our predictions. We found that a second package will be needed, as approximately $1.8 trillion are needed to bring the unemployment to a reasonable 5%, and that it should be around $1 trillion in order to achieve maximum effectiveness, after we maximized the GDP multipliers given a diminishing marginal rate on the multiplier. We also found that there were no better ways to stimulate the economy, as the economy is in a deep recession that does not have any simple ways out except trying to revive it through increased spending targeted at helping those of lower classes have more money.

Appendix A:

```
#include <stdio.h>
#include <math.h>

main()
{
//* 00 Business Investment Write-pff
// 01 Accelerated Depreciation
// 02 Cut Corporate Tax Rate
// 03 Extend AMT Patch
// 04 Personal Margin Tax Reductions
// 05 Nonrefundable Lump-Sum Tax Rebate
// 06 Child tax credit rebate
// 07 Issue General Aid to State Governments
// 08 Increase Infrastructure Spending
// 09 Extend Unemployment Insurance Benefits
// 10 Temporarily Increase Food Stamps
*/

//Initialize Variables
double plan1[]={15,5,18,70,13,133.3,44.6,169.12,224.929,86.95,19.9};
double net_plan1=0;
double plan2[]={0,0,0,0,0,0,0,0,0,0,0};
double plan2_best[]={0,0,0,0,0,0,0,0,0,0,0};
double net_plan2=0;
double net_plan2_best=1000000000;
double net_spending[]={0,0,0,0,0,0,0,0,0,0,0};
double net_cost=0;
double mult0[]={.24,.27,.30,.48,.59,1.02,1.04,1.36,1.59,1.64,1.73};
double mult_adj[]={0,0,0,0,0,0,0,0,0,0,0};
double value[]={0,0,0,0,0,0,0,0,0,0,0};
double net_value=0;

int i;
int a,b,c,d,e,f;

for (i=0; i<10; i++) {net_plan1 += plan1[i];}

//START MAIN LOOP//
for(a=0;a<451;a+=5)
{     plan2[10]=a;
```

```
        printf("%d\n", a);
    for(b=0;b<401;b+=5)
    {   plan2[9]=b;
    for(c=0;c<251;c+=5)
    {   plan2[8]=c;
    for(d=0;d<151;d+=5)
    {   plan2[7]=d;
    for(e=0;e<101;e+=5)
    {   plan2[6]=e;
    for(f=0;f<051;f+=5)
    {   plan2[5]=f;

      //Calculate values of vars
      net_plan2 = net_cost = net_value = 0;
      for (i=0; i<11; i++){net_plan2 += plan2[i];}
      for (i=0; i<11; i++){net_spending[i] = plan1[i] + plan2[i];}
      for (i=0; i<11; i++){net_cost += net_spending[i];}
      for (i=0; i<11; i++){mult_adj[i]=mult0[i]*pow(.9,net_spending[i]/100);}
      for (i=0; i<11; i++){value[i] = mult_adj[i]*net_spending[i];}
      for (i=0; i<11; i++){net_value += value[i];}

      //Update Best vars
      if(net_plan2_best > net_plan2 && net_value > 1800)
      {
      for (i=0; i<11; i++){plan2_best[i] = plan2[i];}
      net_plan2_best = net_plan2;
      }
    }}}}}}

    //Calculate Final Values
    net_plan2 = net_cost = net_value = 0;
    for (i=0; i<11; i++){plan2[i] = plan2_best[i];}
    for (i=0; i<11; i++){net_plan2 += plan2[i];}
    for (i=0; i<11; i++){net_spending[i] = plan1[i] + plan2[i];}
    for (i=0; i<11; i++){net_cost += net_spending[i];}
    for (i=0; i<11; i++){mult_adj[i] = mult0[i]*pow(.9,net_spending[i]/100);}
    for (i=0; i<11; i++){value[i] = mult_adj[i]*net_spending[i];}
    for (i=0; i<11; i++){net_value += value[i];}

    // Print out final values
    printf("The cost of the first Stimulus plan is: %1.3f\n",net_plan1);
    printf("The cost of the second Stimulus plan is: %1.3f\n",net_plan2);
    printf("The amount spent on Business Investment Write-off is %1.3f\n",plan2[0]);
    printf("The amount spent on Accelerated Depreciation is %1.3f\n",plan2[1]);
    printf("The amount spent on Cut Corporate Tax Rate is %1.3f\n",plan2[2]);
    printf("The amount spent on Extend AMT Patch is %1.3f\n",plan2[3]);
    printf("The amount spent on Personal Margin Tax Reductions is %1.3f\n",plan2[4]);
    printf("The amount spent on Nonrefundable Lump-Sum Tax Rebate is %1.3f\n",plan2[5]);
    printf("The amount spent on Child tax credit rebate is %1.3f\n",plan2[6]);
    printf("The amount spent on Issue General Aid to State Governments is %1.3f\n",plan2[7]);
    printf("The amount spent on Increase Infrastructure Spending is %1.3f\n",plan2[8]);
    printf("The amount spent on Extend Unemployment Insurance Benefits is %1.3f\n",plan2[9]);
    printf("The amount spent on Temporarily Increase Food Stamps is %1.3f\n",plan2[10]);
    printf("The net cost is: %1.3f\n",net_cost);
    printf("The expected value of the stimulus plan is: %1.3f\n",net_value);
    getchar();    //Used to make program wait
}
```

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