Team #119

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SUMMARY

In response to a recession bred by a perfect storm of financial crises, housing market implosions, deflation, and enormous increases in unemployment, President Obama and the Democratic-controlled Congress introduced sweeping legislation aimed at strengthening the job market. Warning that inaction would lead to an economic downturn comparable to the Great Depression, the White House pushed the American Recovery and Reinvestment Act of 2009 through Congress. Despite promising to "create or save" 3,000,000 jobs, numerous questions remain as to the efficacy and timeliness of this enormous expenditure. 20% of the funds allocated in the law will be spent this year. A further 44% will be spent in 2010. Will the act reduce unemployment? Was the money directed to the most effective programs, sectors and agencies? Will further stimulation of the economy be required? If so, how much money should be allocated in the future, and which programs will be priorities? This paper attempts an *ex post facto* dissection of the so-called stimulus package, investigating its potential impact on today's key economic indicator, the unemployment rate.

The Federal Reserve recently estimated that recovery will begin in early 2010. Therefore, this paper examines the effects of the stimulus package over the next two years. It is generally agreed that deficit spending is most effective while the economy is declining. Even in pessimistic scenarios, only 64% of the $787 billion will be spent during the recession. Therefore, only planned expenditures for the 2009 and 2010 fiscal years were considered for this analysis. The four largest areas by expenditure were analyzed to predict changes in employment over the next two years. Federal disbursements and revenue reductions with respect to (1) energy, (2) taxes, (3) housing and urban development, and (4) health and education were used to estimate changes in unemployment. Empirically, historical employment values were coupled with various economic indicators to ease the estimation of future changes.

Computer models determined that outlays in the renewable energy sector had large impacts on employment. This analysis predicted that employment will rise 63.5%, strengthening this tenuous and small industry. However, it is notable that the amount of money allocated is far greater than the size of the industry, and that this prediction is an overestimation.

The reduction in taxes mandated by the bill is a promising way to increase employment across the workforce. Optimistic predictions show that there will be an 8% increase in employment.

The model estimated 7.8% growth in the housing sector, which will be a welcome relief for this devastated industry. However, it will not do nearly enough to bring the housing sector back to baseline within the year. Housing requires a one-year lag to observe visible employment increases. The industry will not recover before 2011 at the earliest.

Despite allocating over 30% of the spending to the health and education sectors, there is a lack of evidence for significant job growth there. Employment in these industries was found to be largely independent of the business cycle; i.e., employment is unaffected by the recession and growth of the rest of the economy. Therefore, it seems unlikely that the stimulus package will stimulate major growth.

Despite the huge package authorized by Congress, it is apparent that recovery will be minimal or completely absent in 2009. Therefore, this paper proposes a second stimulus package focusing on corporate income taxes. By their very nature, corporate taxes reduce the amount of money available for salaries, depressing employment. They also create additional costs for the company, which are passed along to the consumer, creating a financial burden in a difficult economic period. Assuming the corporate income tax was completely eliminated, the economy would see growth approaching 5% for 2009, exceeding growth over the past decade. This would offer a speedy and strong recovery.

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II. Introduction

In order to analyze the overall efficacy of the American Recovery and Reinvestment Act, various assumptions and simplifications had to be made. Because of the sheer number of uncontrollable variables in the economy, it is impossible to ensure that all variables would be given full consideration as merited.

One popular solution to this problem of the difficulty of isolating indicators and variables of interest is to introduce extensive econometric models. These are comprised of sophisticated formulas that hold certain variables constant and through complex statistical methodology isolate and extrapolate economic data of interest. This approach, despite its promise with the advent of the rapid increase in the availability of computers, the growth of the Internet, and a general abundance of technology, yielded much disappointment within academia. Nobel laureate and famed American economist Paul Samuelson said regarding econometric models,

> Let me make a confession. Back when I was 20, I could perceive the great progress that was being made in econometric methods. Even without foreseeing the onset of the computer age, with its cheapening of calculations, I expected that the new econometrics would enable us to narrow down the uncertainties of our economic theories…My expectation is that this has not worked out.

The failure of econometric models simply proves that computers are incapable of predicting the behaviors of living, flesh-and-blood participants in the economy.

Thus, despite the probable aptness of an econometric model to answer the question of how effective the American Recovery and Reinvestment Act will be in resuscitating employment in the US economy, we felt that using an empirical approach to data analysis would prove to be superior to a dependence on econometric models for two reasons. One, instead of making broad and nebulous assumptions regarding the economy, that any econometric model calls for, an empirical approach rooted in graphical analysis allowed us to utilize actual economic conditions. Furthermore, since our results as well as our assumptions were taken right from reputable government and private statistical agencies such as the Labor Bureau of Statistics, Bureau of Economic Analysis, and Energy Information Agency, we felt our results were far more reputable themselves as well than any result of any complex econometric model.

Nonetheless, some assumptions were made, as they inevitably must be in any analysis of the economy. In tackling the problem of evaluating the efficacy of the American Recovery and Reinvestment Act, we made the following assumptions:

- The impact of the stimulus package on each individual sector of the economy, such as energy and health, was assumed to be directly reflected in a representative indicator of that sector. For example, in analyzing the renewable energy sector, private consumption of solar/photovoltaic energy was assumed to reflect the impact of the stimulus spending and investment on that industry with sufficient sensitivity to discern the impact of the stimulus on that sector.

- The stimulus bill would be completely effective in stimulating the economy. Though in essence, a Keynesian multiplier of 1.5 was assumed, this number was used sparingly due to the lack of consensus on an exact figure within the economic literature as well as the demanding current circumstances of a global economic meltdown that deviate significantly from any historical precedents.

- Any major economic crises that are not foreseeable in the immediate future, excluding eventualities such as major GDP contractions or mass failure of the banks precipitated by debt deflation and a complete absence of credit demand, were assumed not to take place.

- Only that portion of the stimulus package to be spent by the year 2010 was considered in our analysis due to the lagging effect of stimulus due to impeding factors such as implementation and a defunct banking system as well as the fact that the bulk, 69%, of the stimulus package $526 billion is to be spent by 2010.

With these assumptions, we tracked data series of a representative indicator of key industries affected by the stimulus package, based on the portion of the $526 billion spent by 2010 committed to spending and investment in that industry. The sectors analyzed were energy, labor and health, transportation, housing, and urban development. The impact of tax cuts, though not an industry, was also analyzed due to the large portion of the bailout that plan tax cuts occupied.

These indicators were tracked, over time, with employment figures in each sector retrieved from the Bureau of Labor Statistics. The correlations between these indicators were measured using an algorithm to optimize coefficient of determination between the two data series by varying the time lag between the two series (i.e., shifting the data series horizontally to maximize the correlation).

Finally, the model was used to predict an increase in employment due to the impact of fiscal spending in that industry.

III. Design

In order to fully understand how the money from the stimulus bill might affect employment rates in different work sectors, we needed to predict the correlation between the number of people employed in a sector and the magnitude of direct impact of the stimulus on the sector. To make this connection, we assumed that, one, the stimulus would be completely successful in directly impacting the sector in question as prescribed in the content of the stimulus bill, and two, the magnitude of this impact could be directly measured through a representative indicator of that sector. Therefore, we were able to make a model for the effectiveness of the stimulus to generate job growth in each of six public sectors by comparing past employment data with past sector strength indicators. For example, for renewable energies, we assumed that the consumption of solar/photovoltaic energy was a direct indicator of money invested in the renewable energy industry and compared these data to employment figures in the same industry over time.
    Public data on employment figures and strength indicators in each of the sectors was gathered from the Internet. The information gave annual figures, and from this we calculated the percent change between years for all of the data. If the indicators and employment figures of a sector are closely correlated, then significant percent changes in the indicator should, either immediately or after a certain interval of time, consistently induce a similar percent change in the number of people employed in the sector. Otherwise, it can be said that there may be little or no correlation between the two variables.
    The two sets of percent change data for a sector were calculated in Microsoft Excel, and input simultaneously into a smooth-line scatter plot. In this plot, the *x*-axis represented the year that each data point came from, and the *y*-axis represented the magnitude of percent change of the data during that year from the previous year. These graphs were first analyzed visually to determine if

employment changes closely followed indicator changes. However, this is a very qualitative way of extracting data from a graph, and thus we turned to statistics to find a measure of correlation between the data.

The coefficient of determination, or r^2, is a standard statistical indicator of the amount of correlation between two sets of data. The term can range from 0.0 to 1.0; a value of exactly 1.0 means that one set of data can be exactly mapped to the other via a linear function – one in the form of $y = mx + b$, where x values are taken from one set of data and y values from the other. In the case of our economic model, a high r^2 value for a job sector means that employment rates can be closely modeled as a linear function of the sector's indicator, whereas a lower r^2 value indicates job growth that is largely independent of stimulus factors.

Calculating one r^2 value for each sector is not enough, however, because employment growth may lag behind indicator growth by one or more years. This type of relationship is very important to our analysis, yet would not be seen as a correlation by the standard r^2 calculation. Therefore, it was necessary to manually offset the graph of job growth by a variable amount of years to account and check for a possible lag in market effects. This was done by writing a Java program to calculate an r^2 value for every possible shift.

The program took the two sets of percent change data as input, and, starting with the normal mapping of indicator data to job growth data, iterated through calculating each possible r^2 value. Upon each successive iteration, each piece of indicator data (considered to be the independent variable of the mapping) was chosen to map to the next successive piece of employment data (considered the dependent variable, though it was sometimes the case that employment was independent of the indicator). For example, in the original mapping, indicator data for the year 2000 was mapped to employment data for the year 2000; in the next iteration that indicator data was mapped to 2001's employment data, and in the iteration after that the indicator data was mapped to 2002's employment data; this was done for every single piece of data (within the bounds of the collected data) upon each iteration, and each iteration yielded a unique r^2 value using the formula

$$r = \frac{1}{n-1} \sum \left(\frac{x_i - \overline{x}}{s_x} \right) \left(\frac{y_i - \overline{y}}{s_y} \right),$$

where $\overline{x}$, $\overline{y}$ are the averages of the two sets of data in the domain, range of the mapping, and $s_x = \sqrt{\frac{1}{n-1} \sum (x_i - \overline{x})^2}$ is the standard deviation of the indicator values in the domain. (s_y, defined similarly, is the standard deviation of the employment figures in the range.)

In each job sector, the local maximum r^2 values were found by the Java program, and output to a text file, along with the horizontal displacements that yielded them. Due to the small amount of data available, we assumed that large lags were impossible to support, and therefore only focused on the maximum r^2 values that occurred after a minimal displacement. The end result was an accurate factor of correlation between market indicators and employment, and a proposed lag between indicator changes and employment changes.

Knowing how we could then link employment to indicators, we could then find the Least-Squares Regression Line (also known as LSRL or line of best fit). With these lines we could then apply the conditions that the stimulus package would produce upon the market and get a rough estimate of how employment in each sector of the market should end up.

VIII. Unemployment and Stimulus Package
### A. Energy

a. *Introduction*

Energy, in particular renewable energy sources such as solar, wind, and nuclear energy, has enjoyed immense media coverage due to a host of economic, environmental, and geopolitical concerns. In devoting $18.5 billion by congressional authority to "Energy and Water," Congress had made clear that energy is a key component of the US economy, particularly with regards to consumer confidence and industrial production. Energy spending occupied 3.5% of the $526 billion allocated to be spent prior to 2010.

b.*Assumptions*

As per our methodology, we had to assume one particular representative indicator in the energy sector as being a sensitive indicator of stimulus spending on that industry, once the money had been spent. The energy sector was divided into two subsectors in our analysis: the oil and other petroleum products industry and the renewable energy sources industry. We felt this division was necessary due to the geopolitical implications, long-term surge in global demand, and popularity among speculators commonly associated with the oil industry as well as the political and environmental concerns often associated with renewable energies.

For the oil and petroleum products industry, US oil and petroleum products produced was assumed to be the representative indicator of the industry, as it was the EIA's (Energy Information Administration's) primary approximate indicator of overall consumption in the industry. For the renewable energies industry, the primary indicator was assumed to be the private consumption of solar and photovoltaic energy in the United States, due to the relatively nascent and minute nature of the industry characteristic of renewable energy industries. The *annual percent change* of these data series were tracked over time, juxtaposed with annual percent change in employment in that sector.

c.*The Model*
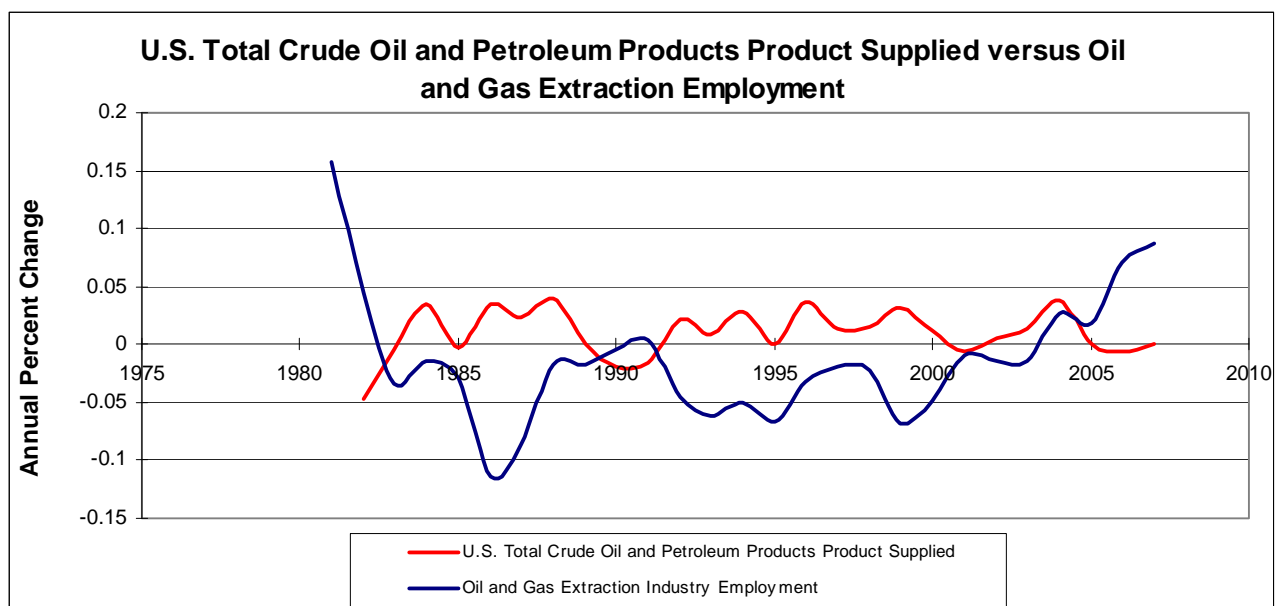
As seen in the graphs above, the peaks and troughs of each data series, for the most part, coincide. With the exception of 1990, when the relationship became inverted, the two graphs generally display a recognizable trend. The optimized coefficient of determination, obtained by making variable the lag between the two curves, was found to be .222. This is due to the anomalies seen between 1990 and 2000 to 2005. It is also important to note that very small variations in the supply of crude oil had a greatly amplified impact on employment figures in the industry.
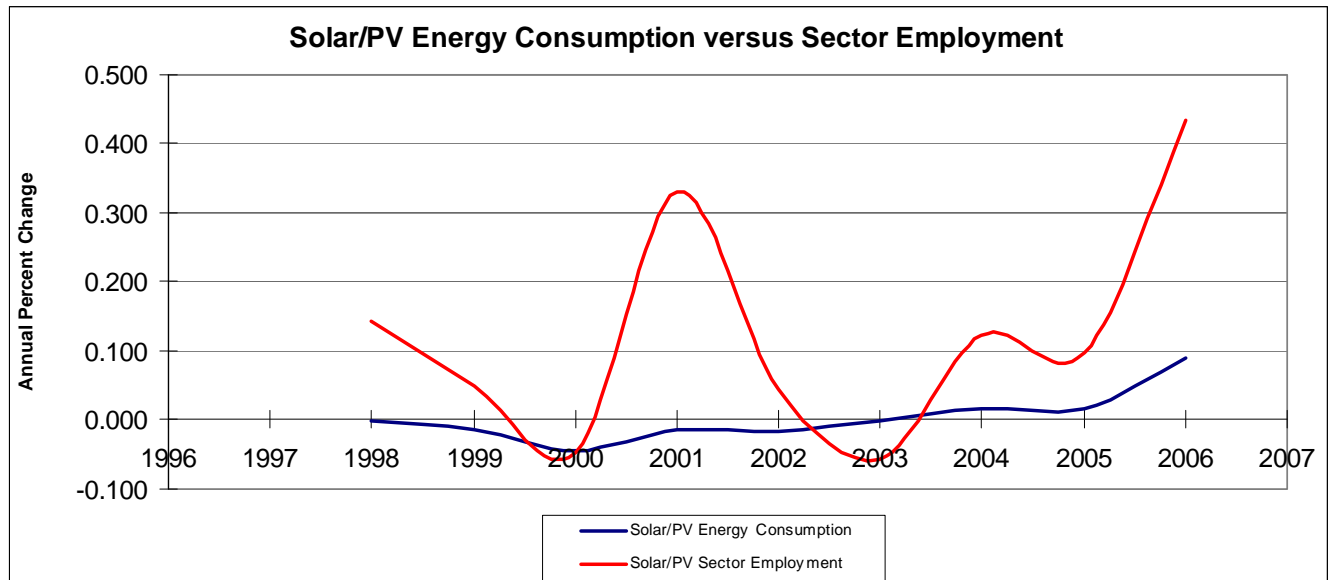
Despite an apparent lack of correlation to the naked eye, tracking consumption and employment in the solar and photovoltaic energy sector yielded an extremely coefficient of determination, and thus indicated a very high correlation. The coefficient of determination between these two data series was .956. This high correlation appears misleading because of the large difference in amplitude of the two data series. Like the previous graph displaying consumption of petroleum products and employment in the petroleum industry, this graph shows that small fluctuations in energy consumption lead to very large fluctuations in the sector's employment.

d.*Conclusion*

Oil Industry Employment
The coefficient of determination for employment in the oil sector was too low (.222) to have a reliable enough correlation to make predictions from.

Renewable Energy Employment
The renewable energy sector had a coefficient of determination of .955, our tightest fit, after removing the outliers for 2001 (affected by a terrorist attack) and 2003 (affected by a hurricane much more catastrophic than usual).

Based on the previous years of the construction sector, we predict that its change in employment, *y*, can be predicted by the change in amount of money, *x*, in the sector by the relation:
$y = 3.513x + .096$
This gave a predicted increase in employment of 63.5%.

B. Taxes

a. *Introduction*

Perhaps exacerbated by political debate in mainstream US politics, tax policy is an extremely contentious topic in US economic policy. However, because of historical precedents and intuitive economic theory supporting government tax cuts in times of economic hardship, Congress was successful in allocating 33% of the $526 billion of the American Recovery and Reinvestment Act to be spent by 2010 on tax reductions.

We believe tax cuts to be the most effective measure of economic stimulus due to its reliance on the free market to allocate the actual money spent, as well as the absence of a minimum one year lag typically attributed to fiscal spending. This position will be elaborated upon in greater detail in section VIII.

b.*Assumptions*

Once again, as per our methodology, we had to assume a particular representative indicator of the impact of government tax policy on the economy once the money had been spent. This impact was measured via the impact of government tax policy on *private consumption*, which being 70% of GDP, we felt was an appropriate representative of the overall economy. In particular, the impact of tax policy on private consumption was measured by tracking *net national disposable income per capita*. This was calculated from the national disposable income by the BEA (Bureau of Economic Analysis) and measured the portion of national income that is not allocated to taxes, savings, or investments. Disposable income is a accurate measure of the impact of government tax policy on private spending, as the quantity of disposable income per capita directly rises or declines in response to a tax cut or tax raise, respectively.

c.*The Model*

Not surprisingly, tracking net national disposable income with overall national employment figures painted a very visually convincing relationship between the two indicators. This is a good example of clear leading and lagging indicators that, when tested for correlation via statistical analysis, betrays the key relationships embedded in a visual examination. Every trough and peak seen in net national disposable income can be linked to a corresponding trough and peak in national employment, yet because of constantly varying periods and amplitudes, a statistical analysis yielded an optimum coefficient of determination of .698.

Net National Disposable Income versus Employment
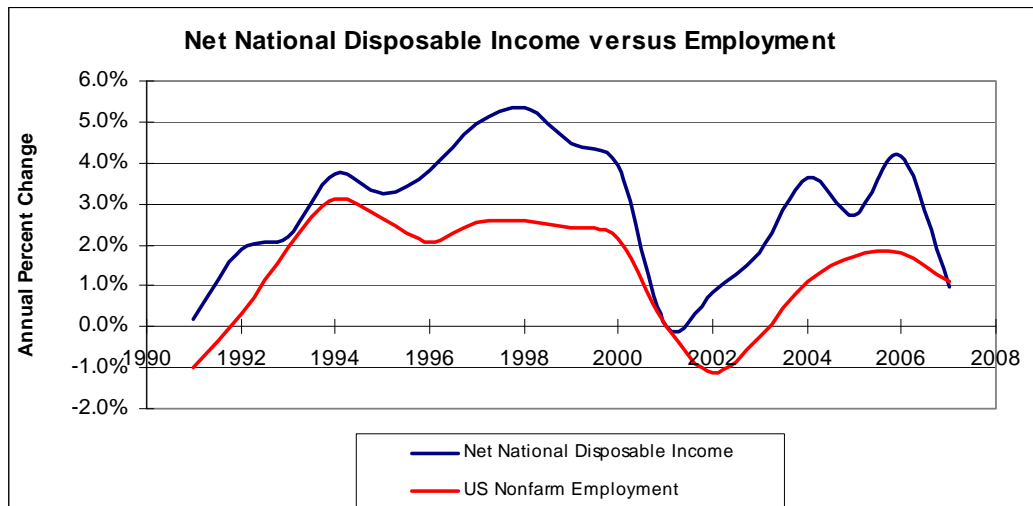
d. *Conclusion*

Our modeling simulation shows that only an 8.4 % increase in employment should result from the tax cuts offered by this stimulus package. The .72 coefficient of determination for this model gives us strong confidence that this will be a very accurate prediction of the aid of this plan. This is based on a total tax rebate of $173.6 billion dollars, distributed across a workforce 138 million people, receiving $1257 each.

C. Housing and Construction

a. *Introduction*

Housing
To evaluate the impact of the stimulus package on the housing market, we investigated the relationship between housing starts and the housing sector unemployment rate. Housing starts record the number of new homes being built each month, as calculated by the Census Bureau and the Department of Commerce. Housing (as a sector) is very accurate in predicting the future direction of an economy considering the various components that go into building a home. Among others, contractors, builders, designers, engineers, lawyers, and bankers are affected by home sales. We hypothesized that more housing starts would correlate with increased employment in the "housing industry." To measure the historical levels of employment in the housing industry, we utilized "residential building employment" as defined and published by the BLS (Bureau of Labor Statistics).

Construction
Construction spending, published monthly by the Census Bureau, tallies up all spending on public and private construction on both residential and nonresidential projects. The stimulus package makes provisions for local and state governments to commence public works projects such as the building of schools, roads, and highways. We compared the Census Bureau figures with the "construction employment" figures published by the BLS in search of a relationship.

Overall
The stimulus package provided roughly $59.5 billion in 2009 and 2010, or 11.3% of all stimulus funds spent in this period, for housing and construction in the public and private sectors.

b. *Assumptions*

Our major, well-founded, assumption is that increased stimulus provisions for housing will increase housing starts figures, just as increased funds in the construction sector will encourage construction spending.

c. *The Model*
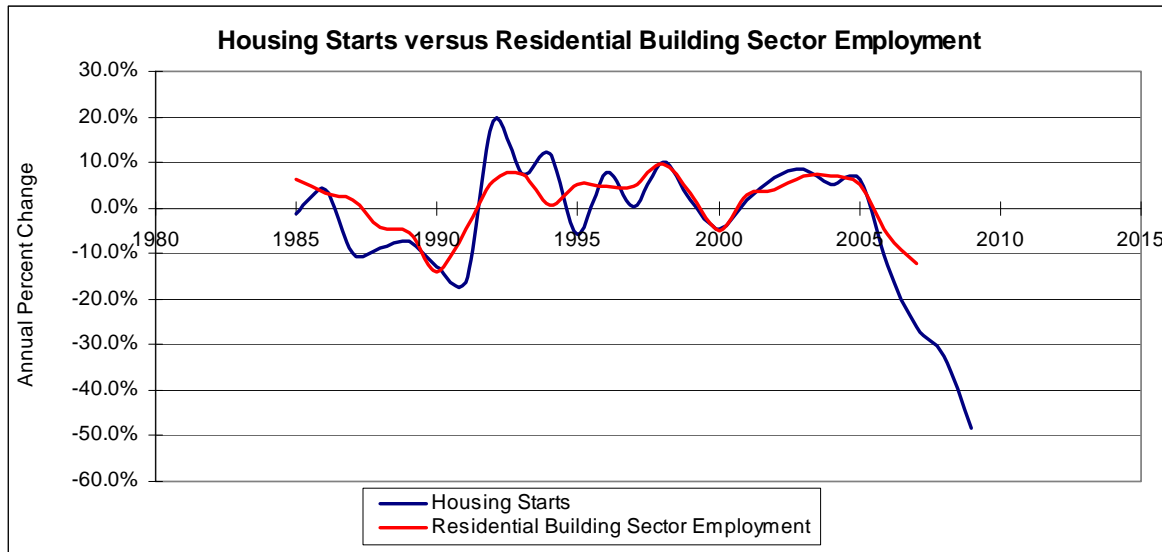
As shown in the graph above, variations in housing starts tended to precede similar changes in industry employment. With the exception of 2000, this trend held up since 1980. The optimized coefficient of determination, obtained by making variable the lag between the two curves, was found to be .662.
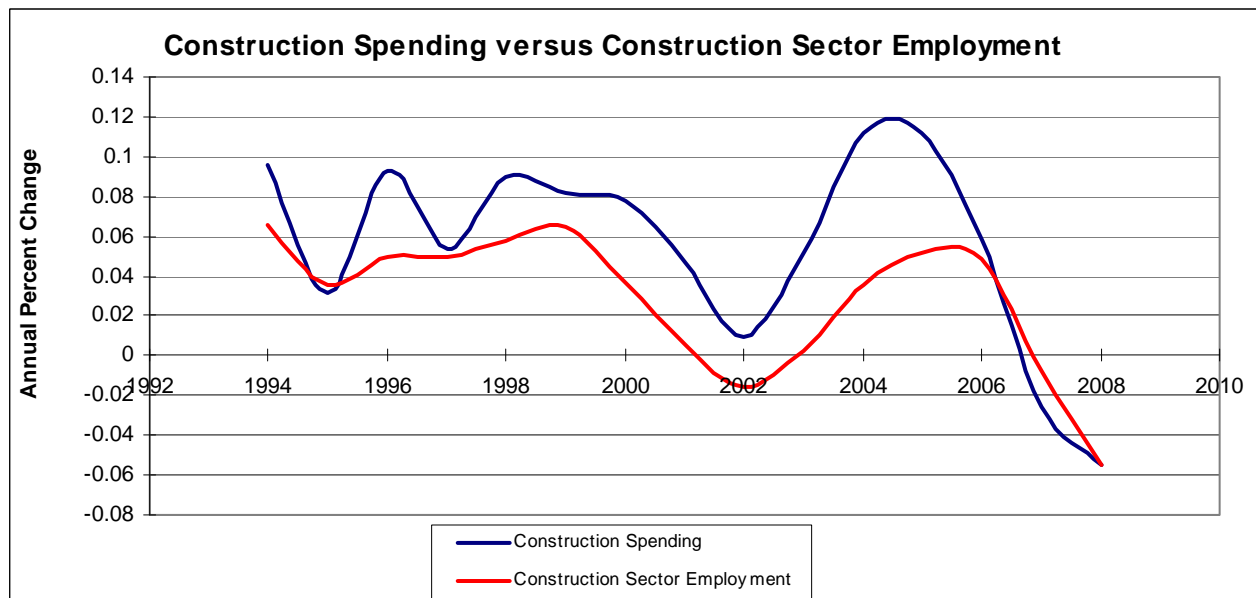
As shown in the graph above, the peaks and trophs of the two data series overlap, with the exception of the period between 1994 and 1996 where the curves became inverted. 2002 is a

excellent reference point for this clearly distinguishable trend where decreases in construction spending mimics decreases in construction sector employment. At some points, such as in 1997, large decreases in construction spending resulted in very minimal reductions in employment. The optimized coefficient of determination, obtained by making variable the lag between the two curves, was found to be .748.

d. *Conclusion*

Construction Employment
The construction sector exhibited a coefficient of determination of .748.
Based on the previous years of the construction sector, we predict that its change in employment, y, can be predicted by the change in amount of money, x, in the sector by the relation:

$$y = .613x - .005; \text{ with } x \text{ and } y \text{ in percent.}$$

This gives a predicted increase in employment of 33.93%.

Housing Employment
The housing sector had a coefficient of determination of .638.

Based on the previous years of the housing sector, we predict that its change in employment, y, can be predicted by the change in amount of money, x, in the sector by the relation:

$$y = .486x + .014$$

This gives a predicted increase in employment of 7.82%.

As a special note, this sector exhibits a 1-year lag, so the effects predicted by this model are not likely to be seen until 2011.

**D. Labor, Health, and Education**

a. *Introduction*

The stimulus package devotes approximately 30.1% ($161.8 billion) of all spending in 2009 and 2010 to education and health services. In order to forecast the effect these funds will have on employment in this sector, we utilized the Healthcare SPDR which is a stock measuring an amalgam of firms in the biotechnology, healthcare, and pharmaceuticals industries. Due to the political pressure for healthcare reform, it comes as no surprise that a large portion of the stimulus is devoted to this field. We investigated the historical relationship between increases in the value of the SPDR and increases in employment in the healthcare industry.

b.*Assumptions*

We based our analysis on the assumption that increases in the Healthcare SPDR will continue to mimic increases in healthcare employment in the future.

c.*The Model*

Health Care SPDR Closing Value versus Health Services Sector Employment
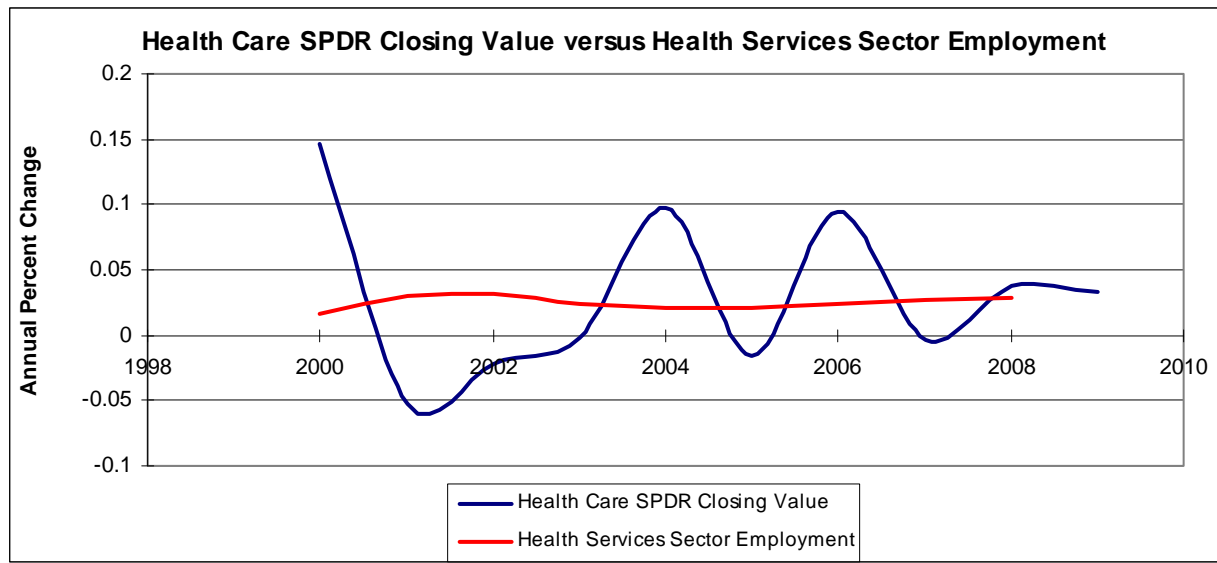
Analysis on the healthcare sector was the most disappointing, especially given that 7.27% of the $526 billion to be spent by 2010 of the American Recovery and Reinvestment Act was allocated to the healthcare section. Again, as with the analysis on disposable income and national employment, the lesson to be learned here is that a statistical correlation analysis will often belie the significant relationship that is evident from an even cursory glance. Clearly, from this graph, there is absolutely no relationship between the health care SPDR closing value and employment in the same sector. However, the optimized coefficient of determination was .622, remarkably high given the clear lack of correlation between the indicators evident from a visual examination.

d.*Conclusion*

Health care has been seen to be invariant with changes in GDP and consumption in the health sector.

The only trend to be seen is a steady acyclic rise over time.

The graph of GDP and health services illustrates these facts.

IX. Further Stimulus

Without further stimulus, the Survey of Professional Forecasters 2009Q1 estimates that the US economy will experience a 2.0% contraction over the coming year. The economy would continue to be flat until late 2009. This represents an unacceptable decline in real wealth. Christina Romer, the Chair of the Council of Economic Advisers, suggested in a recent paper that for every $1 of exogenous tax changes, the GDP will experience a change of $3 in the same direction. This tax multiplier is distinct from the Keynesian spending multiplier we rejected earlier. The paper estimates that the effects of the new tax code will be long lasting and that the change will be most fully realized after 10 months. We elected to eliminate the corporate income tax to stimulate the economy. This represents a sector-blind method of stimulating the economy. It avoids sponsoring or supporting the special priorities of either political party. Putting extra money in corporate coffers

will ease the strain on their balance sheets and hopefully stem the job loss hemorrhage. Healthier corporate finances translate into greater hiring power. The IRS collected $312.1 billion in corporate income tax returns in 2005. Eliminating this tax would not make the federal budget much more unbalanced than it already is.

For this model, we will work in 2000 chained dollars to account for inflation. Thus, income tax returns in 2005 amounted to $253.3 billion dollars. Assuming that one-fourth of that amount is conserved by corporations each year because of the tax repeal, three-fourths of the amount should be added to GDP every quarter. Assuming the stimulus would be passed almost immediately, the second quarter would be the first to be affected. Thus,

$$GDP_n = GDP_{n-1} * (1 + r) + 253.3/4$$

where GDP$_n$ is the GDP in the nth quarter, n goes from 2009Q2 to 2010Q1, and r is the predicted percent change. The resulting improvement in the real GDP over the nonstimulated baseline is substantial. Without the stimulus, the economy is predicted to shrink 2.0%. With the stimulus, it is predicted to grow 4.8%.
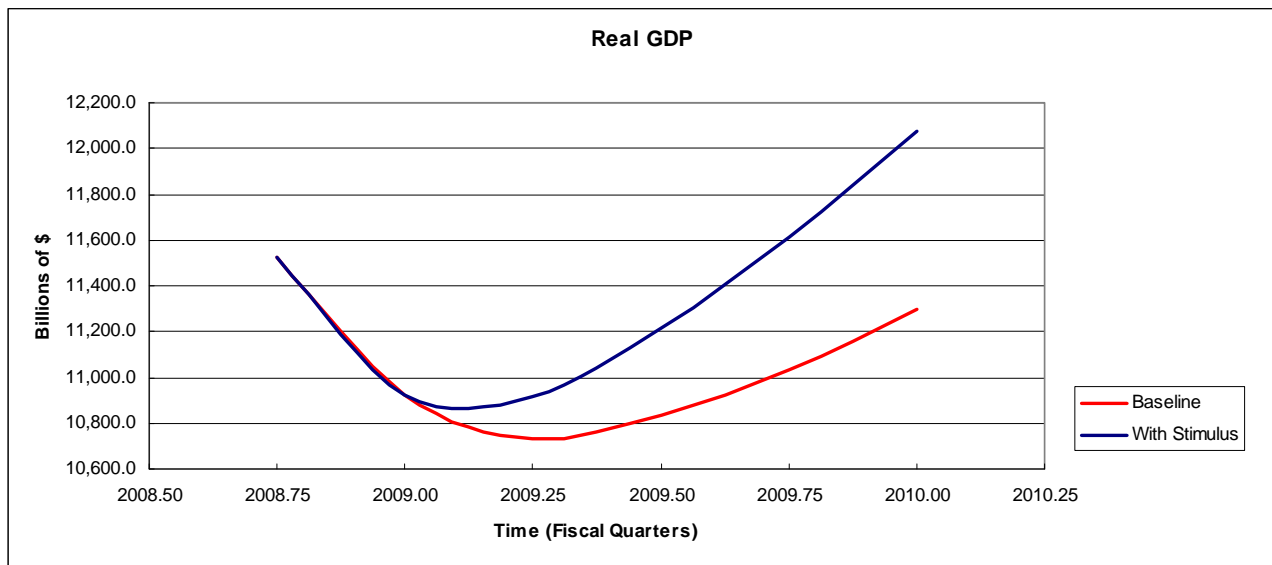
Quarter	Real Baseline GDP (billions)	% Quarterly Change	Real Stimulated GDP (billions)	% Quarterly Change
2008Q4	11,525.00		11525.00	
2009Q1	10925.70	-5.2	10925.70	-5.2
2009Q2	10729.04	-1.8	10919.01	-0.06
2009Q3	10836.33	1.0	11218.18	2.7
2009Q4	11031.38	1.8	11610.08	3.5
2010Q1	11296.13	2.4	12078.70	4.0

It is generally accepted that increases in real GDP are reflected by a decrease in unemployment. Historically, this is apparent from simple graphical analysis.

Unemployment Lagging Real GDP
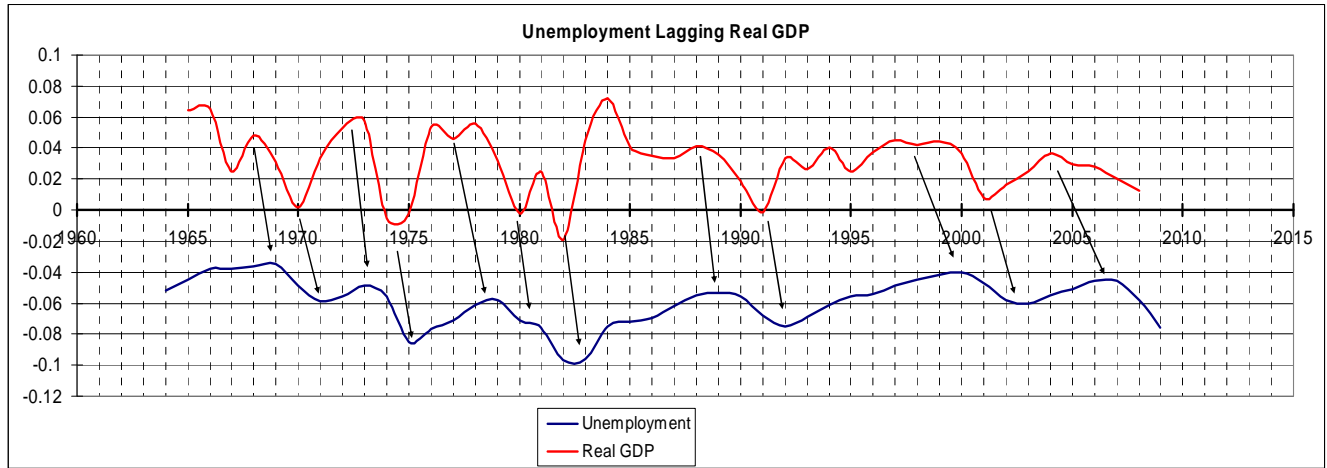
Thus, eliminating the corporate income tax propels the economy towards robust growth in the coming year.

X. Conclusion

To recapitulate, the sectors impacted by the stimulus package were energy, health and education, construction (including transportation), as well as an analysis on tax cuts. Furthermore, the energy sector was subdivided into petroleum and renewable energy sectors. Thus six different sets of data were ultimately analyzed. The coefficients of determination are displayed in the following table and chart:

Optimized R^2 Values	Best Correlation / R^2 Value
Construction Employment Versus Construction Spending	0.748
Gas Extraction Employment Versus Petroleum Supplied	0.222
House Building Employment Versus Housing Starts	0.662
National Employment Versus Disposable Income	0.698
Health Employment Versus Health Care Value	0.622
Employment Versus Energy Consumption	0.956

Optimized R^2 Values Between Sector Indicator and Employment
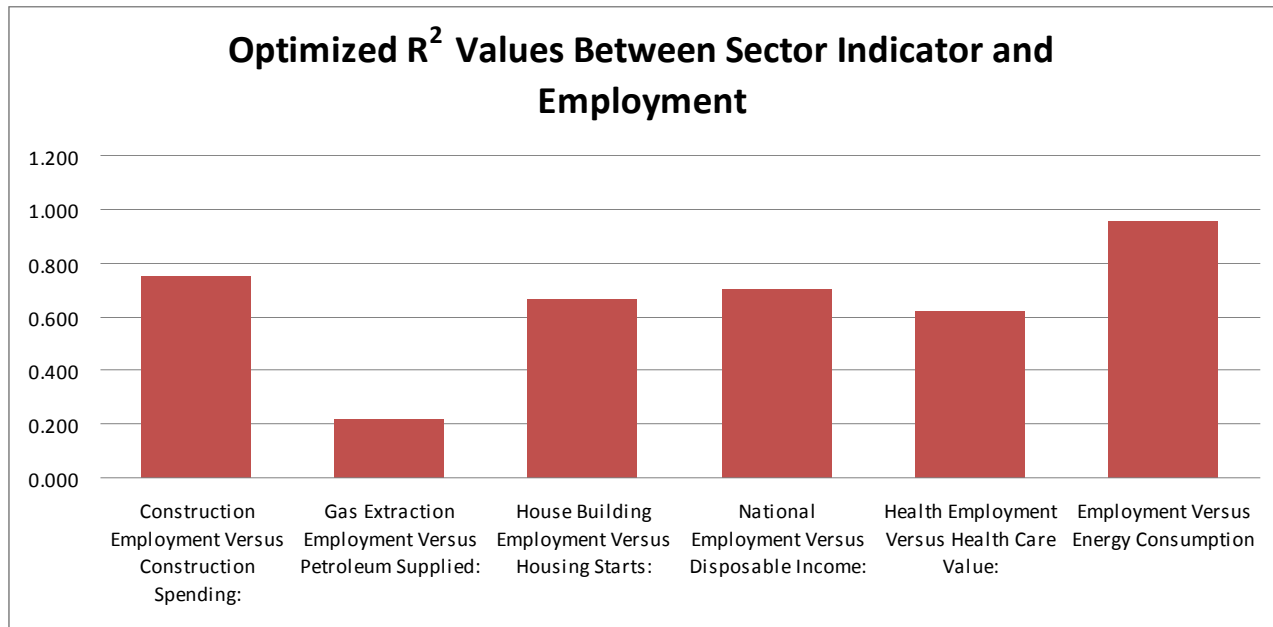
Furthermore, the relationships between the representative indicators and employment figures in each sector were extrapolated to calculate an expected percent increase in employment in each sector for the year 2010 and included in the conclusion section for each sector. The following table summarizes these statistics:

Industry Name	Expected % Increase in Employment in 2010
Housing	7.82%
Renewable Energy	63.5%
Construction (excluding Housing)	33.93%

By our analysis, spending and investment in renewable energy proved to be the efficient allocation of the stimulus bill, followed by housing. These results are not surprising as renewable energy is a very nascent industry with a high potential for growth, and the housing market has been severely depressed with the crashing of the housing bubble. The petroleum and health care industries were deemed to be of no statistical significance in terms of correlation; the petroleum industry because of a low coefficient of determination and the health care industry because the employment trends in the sector are clearly acyclical.

Testing

This model has tremendous potential as an application for economists, academics, individuals, corporate executives, and politicians with a vested interested in the outcome of the economy and the impact of the stimulus bill. Because of our heavy dependence on empirical methods and our independence of hotly disputed Keynesian multipliers, we are strongly confident that our model will be highly effective in predicting the future impact of government spending and tax cuts on the economy, especially sector by sector. The emphasis on individual sectors in the economy is what we believe to be our model's strongest point, as the economy is simply too large to be analyzed as a whole, and our model allows the broadness of the economy to be analyzed in a practical and facilitative manner.

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