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On Obama's Carbon Tax and Tax Credit Idea: A Teaching Note

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On Obama's Carbon Tax and Tax Credit Idea: A Teaching Note

Introduction

The new president is proposing a new tax on carbon to be offset by an income tax credit of up to 80% of the incoming revenues from the government's sale of the carbon credits. This type of dual program results in a very convoluted analysis from the consumer's perspective and therefore distorts the policy implementation aspects of the program. In this short note we will address the proposed policy from a dual perspective: using basic supply and demand analysis and an indifference curve analysis.

In order to analyze the Obama proposal, the first step is to recall the issues of a production possibilities frontier and how the question of carbon emissions is a political one. The first treatment of this proposed policy is a very useful combination of the analysis for a Principles of Microeconomics course. A basic supply and demand model is used to reintroduce the concept of an excise tax based on the internalization of an externality. The question of the weights of the supply and demand elasticities indicates the proportion of the carbon tax borne by the consumers versus the producers. The income elasticity of gasoline becomes important when the subsequent tax credit goes into effect. Finally, the perfectly inelastic supply of gasoline, due the inelastic amount of carbon credits, leads to a rather surprising conclusion for the Obama suggestion.

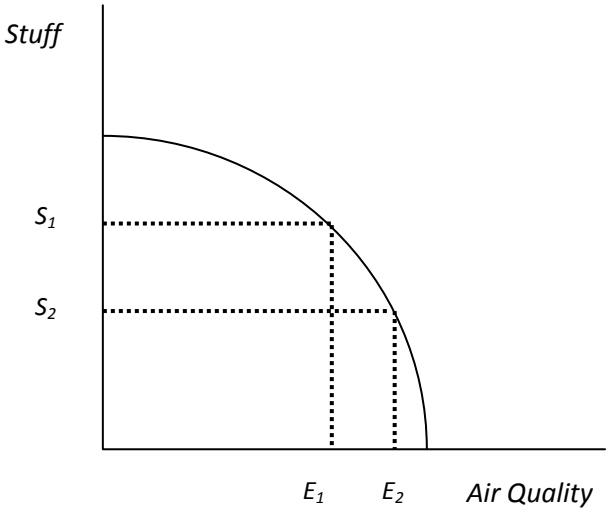
An approach is then developed for an application in a typical Intermediate Microeconomics Theory course. This results in an interesting interpretation of the Obama proposal using the concepts of Slutsky and Hicks compensation. The students need to critically think through each step in the process to the final solution.

The Social Choice Concerning Carbon Emissions

Climate change policy is being developed and there are many social experiments being conducted around the world. The new Obama administration has indicated that various policies will be created as efforts increase to create carbon emissions restrictions. Using a simple production possibilities frontier showing the amount of environmental quality on the X-axis and the composite good Stuff on the Y-axis the social decision to reduce carbon emissions can be easily discussed. (For reasons that will become clear as the conclusions are reached, the amount of gasoline is not the second variable and is subsumed into the composite good.)

In Figure One the social decision process is addressed. Let S_1 and E_1 represent the current situation before any such policy is introduced. Economic analysis can indicate the opportunity cost tradeoffs between improving environmental quality and Stuff. In a more complex environment, the costs and benefits of mitigating climate change can be addressed. Scientific assessment combined with economic analysis can estimate the impacts adaptation and mitigation regarding climate change. In the simple analysis the political process addresses the social desirability of moving from the initial point to another. Economic analysis *cannot* assess this aspect of the decision. Economic analysis can only determine the costs and benefits of any change and then the political process determines if society wants to accept the results.

Figure 1



The result of the political process is S_2 and E_2. The cost of reducing carbon emissions due to the reduced use of gasoline is the opportunity cost of $S_1 - S_2$. The translation of carbon emissions to gasoline reduction is a question of basic chemistry. Each carbon atom, atomic weight of 12, combines with two oxygen atoms, atomic weight of 16, to form a molecule of CO_2. Thus each weight of gasoline results in more than 3 times the amount of carbon dioxide. Although gasoline is not pure carbon, there is hydrogen and other components, each 6.3 pound gallon of gasoline results in roughly 20 pounds of CO_2.

The current analysis assumes that the gasoline policy is independent of carbon emission policy regarding other sources such as coal. For example, the tradable permits distributed for gasoline cannot be sold to a coal company for the production of electricity. Given the social decision to reduce carbon emissions attributable to gasoline, a predetermined number of tradable permits will be made available directly to the gasoline refinery companies. The number of allowable permits predetermines the amount of gasoline that can be produced. The value of this variable becomes vitally important as the analysis progresses.

Supply and Demand Analysis

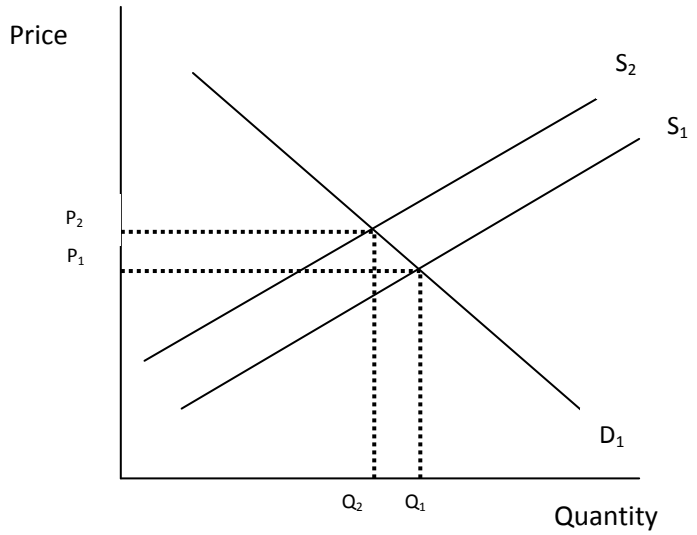
Figure 2 shows the first stage of the supply and demand analysis. The original equilibrium shows a private equilibrium of P_1 and Q_1. The producers of gasoline buy the permits from the government as a means to internalize the externality of carbon emissions. The vertical shift of the supply curve is the marginal cost of the permit attributable to a gallon of gasoline. This is very much akin to an excise tax on gasoline.

Presuming a perfect set of estimates concerning the demand and supply elasticities, based on the volatility of the gasoline markets in recent years, we will presume that the policy bureaucrats are perfectly able to estimate the number of carbon permits to reach the emissions goal for gasoline. The resulting equilibrium after the sale of the permits and the realization of the carbon reduction is P_2 and Q_2.

At this point the students should calculate the resulting revenues as the vertical difference between S_1 and S_2 multiplied by Q_2. The elasticities of supply and demand will determine the share of the revenues paid by the producers and consumers. This typical incidence of the taxation can be addressed with varying detail.[2]

[2] A further classroom discussion can address whether this is a “tax” or a “user fee” or some other type of government revenue.

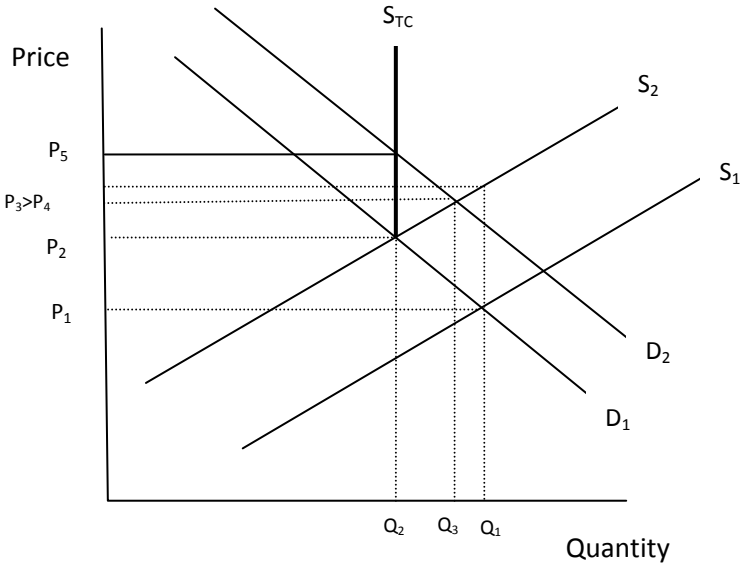
Figure 2



However, the Obama plan is to rebate much of the resulting government revenues to the consumers. Figure 3 shows the resulting new demand curve after the tax credit goes into effect. Presuming gasoline to be a normal good, this increase in income causes an increase in demand. Since only a portion of the cost of the permits is returned to the consumers D_2 must pass below P_3 and Q_1 where P_3 shows the full social cost of producing the gasoline combined with the permit costs. (Further details on drawing the new demand are addressed below.)

The post tax credit equilibrium *should* be P_4 and Q_3. But this is where the complexity of the program results in fascinating results. There are no permits to produce and sell any gasoline above the level of Q_2! Thus the actual supply curve turns vertical or perfectly inelastic at Q_2. The actual equilibrium is P_5 and Q_2. If the new demand is fairly steep or inelastic (be careful drawing this in without explaining) then the final price *can* actually be above P_3. If the new demand is relatively elastic, then it *might* be below P_3. (If the students are drawing their graphs freehand they will have a mixture of results.)

Figure 3



P_3 is the price at which the full cost of the carbon permit is added to the original price of gasoline. Presuming competitive forces exist in the market, the marginal production cost of gasoline equates to the market price. Alternatively, P_2 is the full social cost of the gasoline production. Presuming competitive forces, the marginal cost of the permits will equate to the marginal social cost of reducing the carbon emissions. Since it is essentially impossible to use gasoline without releasing the carbon dioxide, the permit policy should result in an internalization of the externality attributable to carbon emissions.

Policy Analysis

The efficiency of tradable permits to reach a social target regarding the internalization of externalities is well known, the proposed policy of the Obama administration adds a quirky tax credit. Presumably, the tax credit is opined to offset the increase in gasoline price by returning most of the overall costs back to the lower end of the income distribution. In order to gain political support for the reality of carbon emission reductions, the policy is designed, supposedly, to offset the cost to the lower end of the income distribution and still retain some government revenues to research and development of new transportation vehicles.

Goodwin, Dargay and Hanly (2004) conclude that gasoline is both price inelastic and income normal. Thus the imposition of the carbon permits results in increased expenditures on gasoline. The tax credit should result in even more expenditures. Since gasoline is now perfectly inelastic in supply, there is another price increase resulting in even more gasoline expenditures. All three policy outcomes increase gasoline revenues/expenditures and yet the overall amount of gasoline offered for sale decreases. The overall price increase to P_5 results in an unambiguous conclusion that the program *more* than shifts the cost of policy fully onto the consumers! Indeed, depending on the elasticity of the demand, consumers may end up paying a higher price than the original price plus the full cost of the permits, and yet have less gasoline to purchase. We will call this result the Obama Paradox. In the classroom, this is an excellent point to explain the beauty of economic analysis and the need for due diligence is analyzing complex issues!

Indifference Curve Analysis

A more advanced level of analysis can be conducted in an Intermediate Microeconomics course following the introduction of the Slutsky versus Hicks compensation. For simplicity in a rather complicated graph, we have minimized the necessary labeling.

Let B_1 and U_1 yield the original pre-policy equilibrium between gasoline and a composite commodity called Stuff for the representative consumer: g_1 and s_1. The sale of tax credits will result in a de facto price increase to the consumer resulting in a new budget line of B_2 and a new equilibrium indifference curve U_2 yielding a new equilibrium of g_2 and s_2. Let t equal the value of the permit costs. The amount of tax revenue stemming from this consumer is:

(1) $T = t*g_2$

Without any loss of generality, assume this consumer is representative of all consumers. The "rebate" to this consumer will be a share of the 80% overall tax collections. (In the proposed policy, the rebates will only go to the lower end of the income distribution.) Thus:

(2) $R=.8T$

We propose that g_2 is the share of the post-permit gasoline this consumer will purchase at the post-permit price. The policy decision is based on the political outcome of the permit analysis and is therefore beyond the scope of economic analysis. If the American society desires more or less emission control, then a different amount of gasoline will be targeted by the policy makers.

The total amount of permits will be based on a constant of (roughly) 20 lbs of CO_2 per gallon of gasoline multiplied by the allowed gallons of gasoline. (Other sources of CO_2 will be dealt with in

different policy measures.) Assuming there are N consumers, the share of gasoline allowed per consumer is g_2 and is determined by equations 3 and 4. C* is the total amount of CO_2 allowable from the consumption of gasoline and thus G_2 is the total amount of allowable gasoline for which permits will be sold by the government. The specific policy variable in this case is C*.

(3) $C^* = 20^*G_2$ or $G_2 = C^*/20$

Thus:

(4) $g_2 = G_2/N$

Thus, the de facto policy variable is g_2 and is *predetermined* based on the demand and supply elasticities. The amount of tax revenue and therefore the amount of the price increase will be a function of those elasticities.[3]

However, the President's proposed plan is to rebate up to 80% of the tax revenues (costs to consumers) back to the tax payers as a tax credit. For simplicity, assume all tax payers pay the same marginal rates so after the tax rebate the new budget line is B_3. B_3 is parallel to B_2 since the relative prices are unchanged after the carbon tax price increase, but below B_1 since only 80% of all taxes are rebated.

Given B_3, the consumer finds a new equilibrium of g_3 and s_3 on U_3. Presuming gasoline is a normal good as above, then the net result of the initial plan is an over consumption of gasoline and therefore an excess of carbon: $g_3 > g_2$. However, since the number of carbon permits is limited to the equilibrium value of g_2, there are too few permits and therefore a shortage of gasoline necessarily obtains. Thus the price of gasoline will be bid upward.

The next budget line will pass through (g_2, s_2) and have the same y-intercept as B_3. This is akin to a Slutsky income adjustment. As per Hicks' commentary on the Slutsky compensation, the consumer is no longer at equilibrium at (g_2, s_2) with the budget line B_4 since the price ratio has changed from B_2. And with a Hicksian compensation the consumer will actually purchase less than g_2 resulting in a surplus of available gasoline.

According to Friedman, the Slutsky type budget line represented by B_4 has one advantage, which is why g_2 became the policy target: it can be estimated.

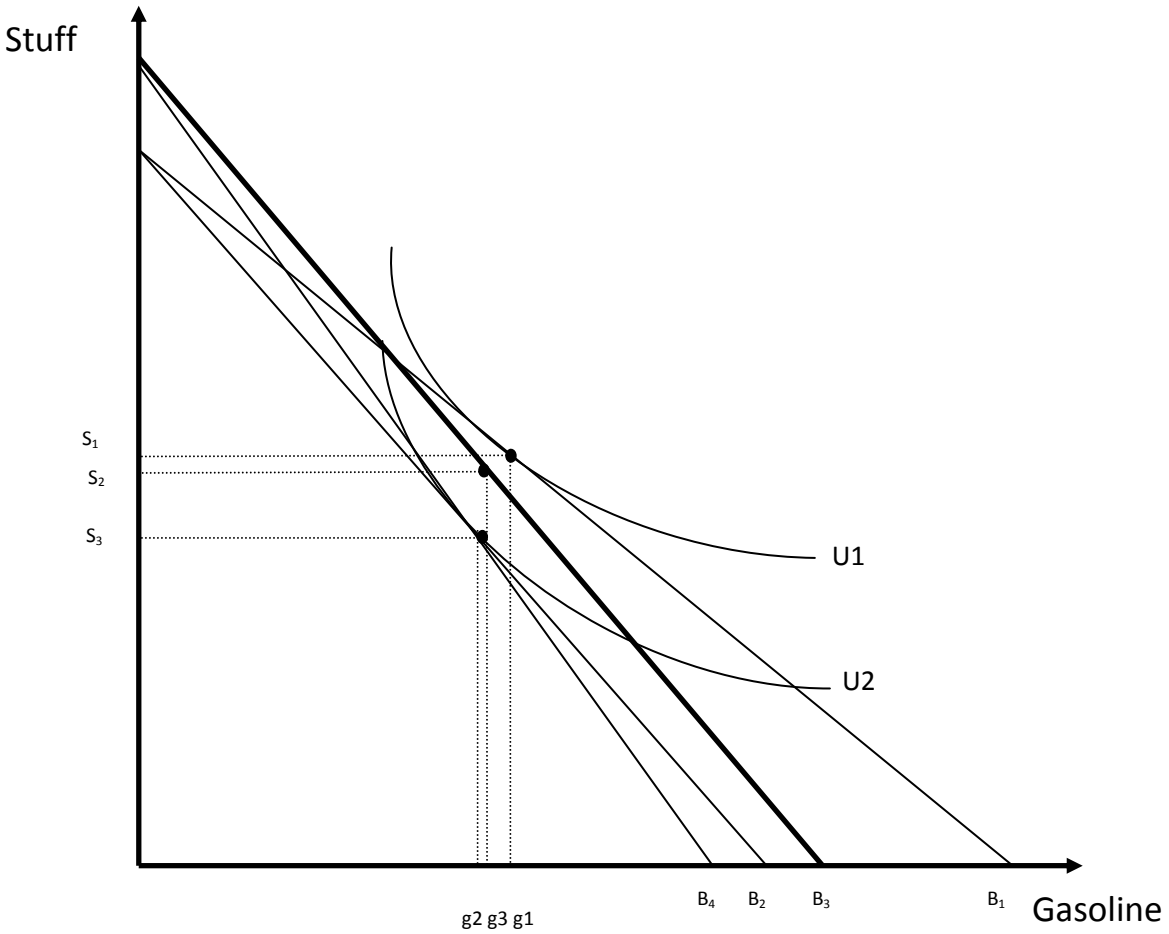
> The advantages of the Slutsky measure, even though in one sense it is an approximation while the Hicks measure is not, is that it can be computed directly from observable market phenomena and behavior, namely prices and quantities purchased. The Hicks measure cannot; it requires knowledge of indifference curves. (Friedman, 1976, page 50)

However, the Slutsky type of approach can *only* be an approximation of actual behavior and cannot be used to determine any equilibrium amount of gasoline purchased by the consumer. In order to do so, the policy bureaucrats would need knowledge of the consumers' indifference curves.

Furthermore, no definitive equilibrium exists in this scenario. There would have to be a combination of prices and rate of marginal substitution at some value s_x such that the combination (g_2, s_x) is on an indifference curve tangent to a budget line B_x, between B_3 and B_4 for any equilibrium to exist. Although the price consumption curve passing through g_3 and s_3 must pass through g_2, it need not do so between B_3 and B_4.

[3] For extra points, have the students determine the algebraic steps necessary to determine the price increase!

Figure 4



In our graph the combination g_3 and s_3 was randomly selected simply to have gasoline as a normal good. Depending on the income elasticities of the two goods and the cross-price elasticity of Stuff with gasoline, it is not necessary for the equilibrium (g_2, s_x) as described to exist. Unless the indifference map is known, the final outcome cannot be determined. So even if we endow the policy bureaucrats with perfect knowledge concerning the demand and supply elasticities, it is unlikely that any policy as proposed can reach an equilibrium.

Conclusions

President Obama is attempting to create a policy to address the external cost of carbon emissions from the consumption of gasoline. In order to appease the political issue of seemingly leveling a tax on gasoline during a deep recession, an otherwise simple externality internalization becomes more complex with the addition of a tax credit rebate of most of the resulting governmental revenues. The complicating factor of the tax credit combined with the inelastic demand for gasoline results in a policy outcome that counters the secondary intention of the policy: reducing the tax incidence on low income consumers.

The actual outcome of the policy is the opposite of the proposed political claim! We have called this result the Obama Paradox since it requires diligent economic analysis to show how the goal of the policy is actually counteracted. From both a simple supply and demand analysis and a more advanced indifference curve assessment, the amount of income paid by the consumers for gasoline actually increases as the price increases to now buy the more limited gasoline. The policy, due to the limited number of available permits, does achieve the policy goal of reducing carbon emissions attributable to

gasoline consumption. However, instead of protecting low income consumers, the gasoline producers are being provided with a wealth transfer!

The same policy goal can be achieved with more efficiency, and more equity to consumers. According to the Intergovernmental Panel on Climate Change (2007), mitigation of gasoline emissions will cost up to 3% of GDP, based on 2030 macroeconomic costs and emissions trajectories. However, this amount can be substantially lower, if the revenues from the carbon tax are used to promote low carbon technologies. If the Obama administration's intention is to curb carbon emissions and promote renewable forms of energy such as wind and solar power, then it would be far more efficient to use all of the revenues from the carbon tax to promote these cleaner technologies. Returning the revenues in the form of a tax credit, results in a policy that is convoluted from the consumers' perspective, and inadequately provides revenues that will encourage low carbon technologies.

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