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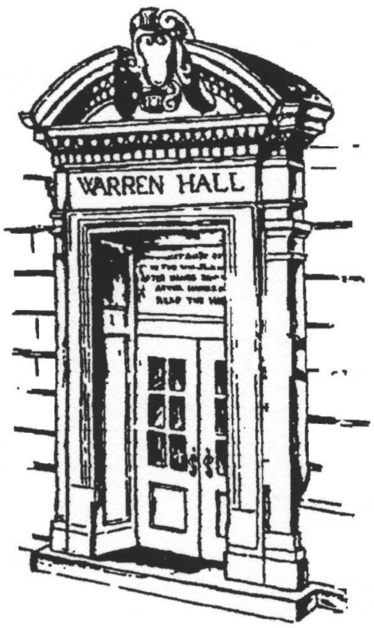

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Department of Applied Economics and Management
Cornell University, Ithaca, New York 14853-7801 USA

The Welfare Economics of an Excise-Tax Exemption for Biofuels and the Interaction Effects with Farm Subsidies

Harry de Gorter and David R. Just

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Harry de Gorter

and

David R. Just*

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Abstract

A general theory is developed to analyze the efficiency and income distribution effects of a biofuel consumer tax exemption and the interaction effects with a price contingent farm subsidy. Using U.S. policy as an example, ethanol prices rise above the gasoline price by the amount of the tax credit. Corn farmers therefore gain directly while gasoline consumers only gain from any reduction in world oil prices due to the extra ethanol production. Domestic oil producers lose. Because increased ethanol production improves the terms of trade in both the export of corn and the import of oil, we determine the optimal tax credit and the conditions affecting it.

Historically, the intercept of the ethanol supply curve is above the gasoline price. Hence, part of the tax credit is redundant and represents 'rectangular' deadweight costs that dwarf standard triangular deadweight cost measures of traditional farm subsidies. We show under what conditions corn subsidies can eliminate, create, have no effect or have an ambiguous effect on rectangular deadweight costs. There are situations where corn subsidies have been the sole cause of ethanol production (and therefore of rectangular deadweight costs), even with the tax credit. Corn producers do not benefit from a tax credit when the subsidy program is in effect.

Proponents of ethanol argue that the tax credit reduces tax costs of farm subsidies. But this ignores rectangular deadweight costs. To assess this, we calibrate a stylized empirical model of the U.S. corn market and determine that total rectangular deadweight costs averaged $1,520 mil. from 2001-2006. Over 25 percent of this is due to the farm subsidy program which also increased the tax costs of the tax credit by 50 percent. Furthermore, the tax credit itself doubles the deadweight costs of the corn production subsidies. Ethanol policies can therefore not be justified on the grounds of mitigating the effects of farm subsidy programs.

Key words: biofuels, tax exemption, rectangular deadweight costs, price subsidies, welfare economics

JEL: F13, Q17, Q18, Q42

* Associate and Assistant Professor, respectively, Department of Applied Economics and Management, Cornell University. There is no senior authorship assigned as authors are listed strictly in alphabetical order. This is a revised version of a paper presented at the International Workshop on *Economics, Policies and Science of Bioenergy*, Ravello Italy, 26 July 2007.

The Welfare Economics of an Excise-Tax Exemption for Biofuels and the Interaction Effects with Farm Subsidies

1. Introduction

Biofuels have generated a great deal of interest worldwide as a solution to a host of problems, ranging from reducing dependency on oil and tax costs of farm programs to improving farm incomes and environmental quality (Miranowski 2007; Zilberman 2007). Ambitious goals on the use of biofuels are being set in many countries, including developing countries (Jank et al. 2007; Kojima and Johnson 2006, Rajagopal and Zilberman 2007). In addition to grants, guaranteed loans and tax incentives for the production of biofuels, many governments exempt biofuels from consumer excise taxes to help achieve targets on biofuel use.[1] Along with high oil prices, the tax exemption for ethanol facilitated the increase in demand for agricultural commodities in U.S. biofuel production (Tyner 2007).[2] Although ethanol accounted for only 4 percent of transportation fuel consumption and 20 percent of total corn use in 2006, the rapidly expanding production of ethanol has resulted in sharp increases in the price of corn. As well, the increase in resources devoted to corn production has pushed up prices of other commodities that compete with corn for land, are substitutes in demand for corn or use corn as an input (Elobeid et al. 2007). This has a direct adverse effect on the users of these crops, including livestock industries and consumers in developing countries (Runge and Senauer 2007). Meanwhile, increased market prices reduced the tax costs of price contingent farm subsidies.

This paper develops a prototype welfare theoretic framework to analyze the efficiency and income distribution effects of a biofuel consumption tax credit and the interaction effects with price contingent production subsidies. We analyze the U.S. ethanol tax credit and loan deficiency payments as a stylized example to empirically illustrate the implications of the model. As shown in de Gorter and Just (2008), the tax credit provides an incentive for refiners and blenders to bid up the price of ethanol above that gasoline by the amount of the tax. We show in this paper that gasoline consumers only gain from the reduction in world oil prices due to the extra ethanol production while domestic oil producers lose. Because increased ethanol production improves the terms of trade in both the export of corn and the import of oil, we determine the optimal tax credit and the conditions affecting it.[3]

Although one bushel of corn produces 2.8 gallons of ethanol, de Gorter and Just (2008) show that if the value of by-products is taken into account, a tax credit of 51¢/gal translates into approximately a $2.04/bu increase in the corn price. Except in times of very high oil prices, the intercept of the ethanol supply curve is above the market price of ethanol that would occur without the tax credit. This means a significant part of the tax credit can be redundant. This 'water' in the tax credit generates 'rectangular' deadweight costs, defined as that part of the cost of the tax credit that is not a transfer to corn producers. Therefore, any terms of trade improvements in the export of corn and import of oil can easily be eliminated.

Using a stylized empirical model of the U.S. corn market to illustrate the potential welfare effects of a tax credit, we find that rectangular deadweight costs averaged $1,520 mil. from 2001 to 2006.[4] The tax costs of the tax credit averaged $1,914 mil. This means that over 75 percent of the tax costs due to the tax credit were rectangular deadweight costs. Although the tax credit reduces taxpayer costs of price contingent farm subsidies, tax savings in farm subsidies are replaced by increases in costs to corn consumers and by increases in the tax costs of the tax credit due to the loan rate. Meanwhile, the tax credit increases the deadweight costs of the loan rate program.

In theory, the effect of the loan rate on rectangular deadweight costs are to both increase and decrease it (net effect is ambiguous), to eliminate it, to create it, or to have no impact at all.

The outcome depends on whether the market price of corn is above or below the price that would prevail without ethanol production, and on whether there is water in the tax credit with the loan rate. Empirically, we find that one-third of rectangular deadweight costs of the tax credit is due to the loan rate. But there are situations where ethanol production occurs only because of price supports.

This paper is organized as follows. The next section develops the general theoretical model while Section 3 analyzes the interaction effects between the tax credit and price supports. Section 4 presents an algebraic formulation of the general theory while Section 5 presents the empirical results. The last section provides some concluding remarks.

2. Theoretical Model

We assume constant returns to scale in ethanol production.[5] The price premium for ethanol over gasoline sometimes exceeds the tax credit due to the additive value of ethanol as an oxygenate and octane enhancer Tyner (2007). This additive value is assumed to be fixed in our model and is normalized to zero.[6] We also assume ethanol imports to be exogenous as international trade in biofuels has been small (Howse et al. 2006).[7] Except for episodes of very high U.S. ethanol prices, most imports into the United States normally come through a preferential trading arrangement with Caribbean countries and are limited by an import quota.

Denote the U.S. corn supply curve by S_C and total non-ethanol demand for corn by D_{NE} (Figure 1).[8] Their intersection determines the price of corn P_{NE} that occurs with no ethanol production. The excess supply of corn for ethanol production S_E is given in panel (b) of Figure 1. Denote S_d as the domestic supply curve for gasoline. This along with the import supply curve generates a total gasoline supply curve S_F. Since the intercept of the ethanol supply curve is assumed to be above the price of gasoline P_G, the supply curve S_F is of gasoline only. The intersection with the domestic demand for fuel D_F solves for P_G, the market price of gasoline.[9] In this situation, the corn price P_C equals P_{NE} and is not related to oil prices.

Define t_c as the 51¢ gal tax credit to refiners for using ethanol with gasoline.[10] As described in de Gorter and Just (2008), competition among refiners will ensure that the market price of ethanol will rise and equal $P_G + t_c$. One can depict this as a downward shift in the supply curve for ethanol by t_c to S'_E. The new fuel supply curve becomes S'_F such that domestic oil production and imports fall to OG and GH, respectively. The new level of fuel (ethanol and gasoline) consumption is OJ, resulting in gasoline and corn prices of P'_G and P_C, respectively. The corn price is now equal to the gasoline price plus the tax credit. As derived in de Gorter and Just (2008), to transform a variable from ¢/gal into \$/bu, one multiplies a variable expressed in ¢/gal by $\beta/(1\text{-}\delta)$ where β is the gallons of ethanol produced from one bushel of corn and δ is the proportion of the value of corn returned to the market in the form of by-products. This means the tax credit is approximately \$2.04 per bushel.[11]

Gasoline consumers only gain from the consumption tax credit through the reduction in world oil prices due to the extra ethanol production. The tax credit raises the price to corn producers and non-ethanol corn consumers (an equal production subsidy and consumption tax) by $P_C - P_{NE}$, which is less than the tax credit t_{cb} (expressed in \$/bu) because of possible water in the tax credit equal to the initial level of water P_{NE} - P_{Gb} (the difference between the intercept of the ethanol supply curve and initial price of gasoline expressed in \$/bu) plus the reduction in fuel prices due to ethanol production (P_{Gb} - P'_{Gb}). The tax credit therefore reduces gasoline use by the distance HI in Figure 1 and increases fuel consumption by IJ.

Non-ethanol consumers of corn transfer area a to corn producers while taxpayers transfer area $b + c + d$ plus the hatched and cross-hatched areas.[12] The hatched area represents net rectangular deadweight costs of the tax credit while the cross-hatched area represents that part of rectangular deadweight costs that are the transferred from taxpayers to fuel consumers due to the decline in fuel prices resulting from increased ethanol production. Corn producer surplus increases by area $a + b + c$ and the deadweight costs of overproduction is given by area d.

Water in the tax credit varies year to year as it depends critically on both P_{NE} (market conditions in the corn market) and the price of gasoline (market conditions in the oil market). For example, a large increase in the price of oil will reduce water in the tax credit and may even eliminate it. If so, the rectangular deadweight costs disappear and become part of the transfer to corn farmers. Denote w as the water in the tax credit: $w = P_{NE} - P'_{Gb}$. If oil prices are low enough, water can equal the entire tax credit. Note also that $w = t_{cb} - (P_C - P_{NE}) - (P_{Gb} - P'_{Gb})$. Oil prices have to increase by more than the water, w, before all water in the tax credit t_{cb} is squeezed out.

Figure 2 presents a more detailed explanation of the various costs and benefits of the tax credit. Panel (a) shows domestic oil production to be OG, oil imports to be GH and ethanol consumption to be HJ (letters corresponding to that in Figure 1). Domestic oil producers lose producer surplus of area $e + f$ while the international terms of trade improvement in oil imports is area $f + g + h$.[13] The terms of trade improvement from increased ethanol production in oil prices is captured by domestic consumers and is given by area $i + j + k$ (corresponding to the cross hatched area in panel (a) of Figure 1). The gain by domestic gasoline consumers from taxpayers is due to the international terms of trade effect for oil. The gain in consumer surplus is the sum of all areas denoted in panel (a) of Figure 2 less area k (the deadweight costs of over-consumption) while the international gains from trade in the oil market is offset by area f (the deadweight costs of underproduction of domestic oil).

The detailed breakdown of welfare effects in the corn market is depicted in panel (b) of Figure 2. Denote the domestic demand for non-ethanol corn by D_d. The transfer to corn producers from domestic non-ethanol corn consumers is area *l* while transfers from importers of U.S. corn is area $n + q$.[14] Deadweight costs of under-consumption is given by area *n*. The cross hatched area is identical to that in the first panel of Figure 1 and represents the transfer of taxpayer funds to consumers of gasoline because of increased ethanol production induced by the tax credit that displaces gasoline consumption. Corn producers only get the full benefit of the tax credit t_c if the price of oil is fixed and there is no water in the tax credit. There are four deadweight cost triangles (areas *f* and *k* in Figure 2a; area *n* in Figure 2b and area *d* in Figure 1a). Net U.S. social welfare can be positive with a tax credit because of these two international terms of trade improvements. The U.S. import tariff on ethanol may also improve their terms of trade in world ethanol markets. Adding a foreign excess supply curve of ethanol to the model would allow one to analyze this. Finally, there may be more net social gains if we include the effects of the tax credit subsidy in reducing price contingent subsidies for corn. We take this issue up in the next section.

3. Interaction Effects between a Tax Credit and Price Contingent Farm Subsidies

There are two particularly important issues to analyze: the impact of the tax credit on both the tax costs and deadweight costs of the loan rate program, and vice-versa, particularly how the loan rate impacts rectangular deadweight costs due to the tax credit. The analysis assumes oil prices are exogenous so the market price for corn P_C is determined by the price of gasoline plus the tax credit.[15]

Consider first the case in Figure 3 where the observed market price for corn P_C is above P_{NE}, the corn price with no ethanol production. If the tax credit is the only policy in effect, then the taxpayer costs are $t_{cb}\cdot(Q_C - C_{NE})$ where Q_C is production with the tax credit only and C_{NE} is non-ethanol corn consumption. If the loan rate is the only policy in place, then the tax costs are $(L - P_L)\cdot Q_L$ where L is the loan rate (guaranteed price to producers), Q_L is corn production with the loan rate and P_L is the market price of corn without the tax credit. Tax costs with both the tax credit t_{cb} and loan rate are L,

(1) $(L - P_C)\cdot Q_L + t_{cb}\cdot(Q_L - C_{NE})$

The loan rate in this case (Figure 3) has no impact on non-ethanol corn consumption. The first term of equation (1) denotes the tax costs of the deficiency payments independent of the tax credit. We therefore focus on the second term. We know that t_{cb} can be expressed as,

(2) $t_{cb} = P_C - P_{Gb} = (P_C - P_L) + (P_L - P_{Gb})$

Therefore, the gross tax savings of deficiency payments due to the tax credit is given by,

(3) $(P_C - \text{MAX}[P_L, P_{Gb}])\cdot Q_L$

Let us consider the case of Figure 3 where $P_L > P_{Gb}$. The components of Q_L in equation (3) are given by,

(4) $Q_L = C_{NE} + (Q_C - C_{NE}) + (Q_L - Q_C)$

Using each of the right hand terms of (4) with (3), we can breakdown the different components of the tax savings in deficiency payments due to the tax credit. To begin, part of the tax savings represents increased costs to consumers of corn (both domestic and foreign),

(5) $(P_C - P_L)\cdot C_{NE}$

Another part of the tax costs of the tax credit that otherwise would have been part of the tax costs of the loan rate but is independent of the deficiency payment program is given by,

(6) $(P_C - P_L)\cdot(Q_C - C_{NE})$

The tax costs in equation (6) cancels with what otherwise would have been deficiency payments (area $a + c$ in Figure 3).

On the other hand, part of the tax costs of the tax credit are due to the deficiency program, given by $(P_C - P_{Gb})\cdot(Q_L - Q_C)$. For now, let us focus only on that part of the loan rate's contribution to the tax costs of the tax credit which cancels with the reduction in tax costs of the loan rate due to the tax credit, namely area $b + d$ in Figure 3:

(7) $(P_C - P_L)\cdot(Q_L - Q_C)$

The increased costs in equations (5) – (7) exactly cancel the reductions in the tax costs of the deficiency payment program due to the tax credit given by equation (3). However, there are tax costs of the tax credit yet unaccounted for that are above and beyond the tax savings in deficiency payments. These are the tax costs that represent rectangular deadweight costs and are given by area $e + f$ in Figure 3:

(8) $(P_L - P_{Gb})\cdot(Q_L - C_{NE})$

Define water in the presence of the loan rate as $w_L = P_L - P_{Gb}$ which is always less than the water without a loan rate $w = P_{NE} - P_{Gb}$. Because of the water, the area $e + f$ in Figure 3 represents that part of the tax costs of the tax credit that are deadweight costs. The second term in parentheses of equation (8) can be re-written as,

(9) $Q_L - C_{NE} = (Q_C - C_{NE}) + (Q_L - Q_C)$

Using each term in (9) and combining with (8), we can therefore identify two components of the extra tax costs due to the tax credit that are beyond the savings in tax costs of deficiency payments due to the tax credit. The first of these is the rectangular deadweight cost of the tax credit regardless of deficiency payments (area e),

(10) $w_L\cdot(Q_C - C_{NE})$

followed by the rectangular deadweight costs of the tax credit due to the deficiency payment program (area *f*),

(11) $w_L \cdot (Q_L - Q_C)$

To summarize, the tax savings of the deficiency payment program in equation (3) are offset by increased consumer costs and tax costs of the tax credit policy given in equations (5) – (7) that exclude the additional rectangular deadweight costs described in equations (10) – (11). This is only relevant for the case in Figure 3. Nevertheless, part of the increased consumer costs in equation (5) is to foreign importers of U.S. corn exports, thereby increasing the U.S. international terms of trade in corn export markets. These terms of trade gains can more than offset the additional rectangular deadweight costs, depending on market parameters. We discuss this further in the empirical section later.

The net savings in total taxpayer costs due to the tax credit is ambiguous in theory and depends on the relative size of $(P_C - P_L) \cdot C_{NE}$ versus $w_L \cdot (Q_L - C_{NE})$. Given that the share of corn used in ethanol production is historically much lower than all other uses of corn, it is likely that the tax credit results in a net savings in tax costs. This may change in the future however as ethanol production increases along with market prices of corn. Nevertheless, we will show later in the empirical section that the benefits of the reduced tax costs are more than offset by higher prices to consumers and rectangular deadweight costs.

So far we have shown that part of the existing rectangular deadweight costs is due to deficiency payments. Let us now examine the effect of the deficiency payments on rectangular deadweight costs in general. The loan rate expands output by $Q_L - Q_C$. The rectangular deadweight costs with the tax credit t_{cb} only are area $c + e$ in Figure 3:

$w \cdot (Q_C - C_{NE})$

The rectangular deadweight costs with both the tax credit t_{cb} and loan rate L is area $e + f$:

$$w_L \cdot (Q_L - C_{NE})$$

Hence, the effect of the loan rate on rectangular deadweight costs is to increase it by area f $[w_L \cdot (Q_L - Q_C)]$ and decrease it by area c $[(P_{NE} - P_L)(Q_C - C_{NE})]$. The net effect of the loan rate on rectangular deadweight costs is therefore ambiguous.

An exogenous increase in the price of oil will reduce water and increase market price for corn, with the reduced non-ethanol corn consumption diverted to ethanol use. A decrease in the tax credit has exactly the opposite effect. Note that the effects of these exogenous changes in the oil price and tax credit are the same for each of the cases examined in Figures 3-4.

However, the analysis so far assumes water with the loan rate is positive *ex ante* and *ex post*. There is a possible case where the initial water, $w = P_{NE} - P_{Gb}$, is eliminated with the introduction of the loan rate so the loan rate unambiguously reduces rectangular deadweight costs in this situation. Otherwise, the analysis above in equations (1)–(7) still holds for this case where the initial water is eliminated with the loan rate.

The analysis so far in Figure 3 assumes positive ethanol production with no loan rate. However, this may not be the case as it is possible that the market price of corn P_C is less than P_{NE} as shown in Figure 4.[16] Rectangular deadweight costs before the introduction of the loan rate is zero because water in the tax credit is 100 percent and so there is no ethanol production. After the introduction of the loan rate, the rectangular deadweight costs are $w_L \cdot (Q_L - C_{NE})$. Hence, the loan rate creates rectangular deadweight costs in this case. When the price of corn is below P_{NE}, then ethanol production is due to the loan rate. Without a loan rate, there would be no ethanol production even with a tax credit. The loan rate not only increases rectangular deadweight costs, it can be the sole cause of it. Not only is water greater than the tax credit, de Gorter and Just (2008) show that it is often greater than the price of corn.

Although not shown in Figure 4, there is a possible case where P_{GB} is greater than P_L. In this case, there are no rectangular deadweight costs so the loan rate has no impact on rectangular deadweight costs.

In summary, the tax credit decreases tax costs of the loan rate but the latter increases the tax costs of the tax credit. The net effect on tax costs is ambiguous *a priori*. Nevertheless, the tax credit increases consumer costs and incurs rectangular deadweight costs. In theory, the effect of the loan rate on rectangular deadweight costs are to both increase and decrease it (net effect is ambiguous), to eliminate it, to create it, or to have no impact at all. The outcome strictly depends on which of the four possible initial equilibriums discussed in Figures 3 and 4. Thus it is vital to understand the prevailing equilibrium if one is to assess the welfare effects of the tax credit.

4. An Algebraic Formulation of the Welfare Effects of the Tax Credit

Because the tax credit for ethanol can have such disparate effects on welfare and trade, we derive the optimal tax credit for a large country exporter of corn and importer of oil for each of the situations described in Figures 1-4. This serves as an important benchmark to understand how different market parameters determine the social welfare effects of the tax credit policy.

Consider a demand sector represented by the indirect utility function $V\left(P,Y\right)$, where P is the vector of prices and Y the level of income. This indirect utility function generates the demand curve for corn, $q^D = -V_{P_1} / V_Y$, and for fuel $q_F^D = -V_{P_2} / V_Y$. The supply sector can be represented by $\pi\left(P\right)$ generating the supply curve for corn, $q^S = -\pi_1$, where the subscript 1 denotes the derivative of the first element of P. Likewise, the supply curve for gasoline is given by

$q_G^S = -\pi_2$. Additionally, let the foreign demand for corn be given by $q^X = q^X(P)$ and the import supply of gasoline given by q_G^X. Denote the tax credit given to ethanol producers as t_{cb}, thus $P_c' = P_c + t_{cb}$. The optimal t_{cb} solves

(12) $$\max_{t_{cb}} V\left(\left[\tilde{P} \quad P_g\right], Y\right)$$

subject to

$$Y = Y_0 - t_{cb}\left(q^S\left(\hat{P}\right) - q^D\left(\tilde{P}\right) - q^X\left(\tilde{P}\right)\right) - \theta q^S + \pi\left(\hat{P}, P_c\right),$$

$$q_G^S\left(P_c\right) + q_G^X\left(P_c\right) + \left(q^S\left(\hat{P}\right) - q^D\left(\tilde{P}\right) - q^X\left(\tilde{P}\right)\right) = q_F^D\left(P_c\right),$$

where $\hat{P} = \max\left\{P_c + t_{cb}, P_{NE}, L\right\}$ is the producer price for corn, $\tilde{P} = \max\left\{P_c + t_{cb}, q^{-1D}\left(-\pi_1\left(\hat{P}\right)\right)\right\}$ is the consumer price for corn, $\theta = \max\left\{L - \tilde{P}, 0\right\}$ is the deficiency payment. The variable P_{NE} is defined implicitly as $q^S\left(P_{NE}\right) = q^D\left(P_{NE}\right) + q^X\left(P_{NE}\right)$, L is the loan rate, and $q^{-1D}(.)$ is the inverse of the demand function for corn consumption.

Let η^i be the price elasticity of curve *i*. Define the elasticity of excess supply of ethanol by $\kappa_1 = \eta^S \frac{q^S}{q^X} - \eta^D \frac{q^D}{q^X} - \eta^X$, the elasticity of excess demand for ethanol as $\kappa_2 = \eta_F^D - \eta_G^S \frac{q_G^S}{q_F^D} - \eta_G^X \frac{q_G^X}{q_F^D}$ and define $\kappa_3 = \kappa_1 - \eta^S \frac{q^S}{q^X}$. The corn devoted to ethanol is defined by $E = q^S - q^D - q^X$ and the excess demand for imported gasoline and domestic ethanol fuel is given by $M = q_F^D - q_G^S$. Solving the optimization conditions for (12) (see the appendix for a complete proof), we find:

(i) if $P_L > P_{NE} > L$, then

$$t_{cb} = \begin{cases} \dfrac{P_c}{(\kappa_1 - 1)}\left[(E-M)\dfrac{\kappa_1}{q_F^D \kappa_2} + 1\right] & \text{if} \quad \left(\dfrac{\kappa_1}{\kappa_1 - 1}\right)\left[\dfrac{E-M}{q_F^D \kappa_2} + 1\right] > \dfrac{P_{NE}}{P_c} \quad \text{(CASE A)} \\ 0 & \text{otherwise} \quad \text{(CASE B)} \end{cases}$$

(ii) if $L > P_{NE} > P_L$, then

(iii)

$$t_{cb} = \begin{cases} \dfrac{P_c}{(\kappa_1 - 1)}\left[(E-M)\dfrac{\kappa_1}{q_F^D \kappa_2} + 1\right] & \text{if} \quad \left(\dfrac{\kappa_1}{\kappa_1 - 1}\right)\left[\dfrac{E-M}{q_F^D \kappa_2} + 1\right] > \dfrac{L}{P_c} \quad \text{(CASE A)} \\ \dfrac{P_c}{(\kappa_3 + 1)}\left[(E-M)\dfrac{\kappa_3}{q_F^D \kappa_2} + 1\right] & \text{if} \quad \dfrac{L}{P_c} > \dfrac{1}{(\kappa_3 + 1)}\left[(E-M)\dfrac{\kappa_3}{q_F^D \kappa_2} + \kappa_3 + 2\right] > \dfrac{P_L}{P_c} \quad \text{(CASE C1)} \\ 0 & \text{otherwise} \quad \text{(CASE C2)} \end{cases}$$

The formula defines the parameters that will minimize areas *a* and *d* in Figure 1a and area *n* in Figure 2b while at the same time maximize the area *q*. If the oil price is exogenous, then κ_2 is infinite, leaving only the last term in each case. When the loan rate is not operational (as in CASE A above) the optimal tax credit is then given by $P_C/(\kappa_1 - 1)$. The more inelastic the domestic supply and non-ethanol demand (domestic and foreign) curves are, the higher the optimal tax credit or equivalently, the lower the social costs of the tax credit. In this case, the tax credit has a relatively smaller impact on the amount of corn used for non-ethanol consumption, thus reducing the incidence of the tax. In addition, the higher the share of corn exports relative to supply (weighted by the supply elasticity) and relative to domestic demand (weighted by the domestic non-ethanol demand elasticity), the lower the social cost of the tax credit. In this case corn importers carry the brunt of the corn price increase, the added revenue to domestic producers outweighing the loss to domestic consumers.

Because we assume the oil market absorbs all ethanol at a fixed world oil price, the elasticity of demand for ethanol is not a factor. If the loan rate is operational (CASE C1), then the social cost of the tax credit will no longer depend on the supply of corn as this is fixed at the loan rate. The optimal tax will now only depend on the properties of the domestic and foreign demand for corn, κ_3.

When oil prices are endogenous, then the results are conditioned by $-\left(E-M\right)$, or the amount of fuel from foreign oil producers, and κ_1/κ_2, the ratio of the elasticities of excess supply and demand of ethanol. The higher the imports of oil, the lower the social cost of the tax credit. In this case, the tax credit allows fuel consumption to substitute ethanol for imported oil, potentially improving the terms of trade (both lowering the imported oil price and raising the corn price for exports). Additionally, the more negative the ratio of elasticities of excess supply and demand for ethanol, the lower the social cost of a tax credit. While the tax credit raises the corn price, the higher elasticity of supply suggests that corn producers can increase production to take advantage of the better terms of trade. Alternatively, the lower (less negative) elasticity of demand for ethanol suggests that domestic consumers of fuel do not adjust their ethanol consumption very much, given the price decrease in fuel. Thus the tax credit will more directly improve the international terms of trade. Table 1 summarizes these results for each of the possible price contingencies described in Figures 1-4 that could affect the social welfare effects of the tax credit.

5. An Empirical Illustration

The basic market parameters calibrated and derived for the U.S. corn market are summarized in Table 2. Annual data are presented for the crop years 2001/02 to 2006/07 for which the simulations were undertaken. Data were obtained from the United States Department of Agriculture (USDA). The supply and demand curves were calibrated assuming a constant elasticity of 0.4, -0.2 and -1.0 for corn supply, domestic demand and export demand, respectively. An estimate of the corn price without ethanol production P_{NE} is first required to determine water in the tax credit (with and without the loan rate). Water is found to be positive in each year. Note that the average water in the tax credit was \$1.87/bu and \$1.67/bu when including the effects of the loan rate. Because of water in the tax credit, the average increase in the market price of corn was \$0.21/bu due to the tax credit, far less than the implied subsidy of \$2.04/bu. In other words, the average difference between P_C and P_{NE} was 21¢/bu.

The first three columns in Table 3 show the various sources of deadweight costs with the deadweight cost triangle averaging \$186 mil. and \$18 mil. due to overproduction and underconsumption of corn, respectively. However, rectangular deadweight costs averaged \$1,520 mil. (column [3]), significantly higher than if there was no loan rate (\$1,103 mil. in column [4]).[17] The values of column [3] represent are $e + f$ in Figure 3 while column [4] represents area e (the difference being area f). Recall in the theory section earlier that the loan rate has an ambiguous impact on rectangular deadweight costs, depending on the value of area f versus area c in Figure 3. In 2003/04, area c was greater than area f, implying rectangular deadweight costs were lower with the loan rate in that year but the opposite was the case for all other years. The loan rate increased annual rectangular deadweight costs on average by \$417 mil. (column [3] minus column [4]).

Average total tax costs were \$3,331 mil. while average transfers from domestic and foreign consumers to corn producers were \$1,484 and \$433 mil., respectively. Net social welfare was negative in every year, averaging -\$1,291 mil. (column [11]). Therefore, the improvement in the international terms of trade for corn exports (averaging \$433 mil. per year) was more than offset by rectangular deadweight costs in each year (averaging $1,520 mil. per year). Additionally, the net social costs varied significantly, as it depends on the level of oil prices and the level of P_{NE} (which depends on supply and demand shifts in the non-ethanol corn market).

If there were no loan rate program, then the social costs of the tax credit average $913 mil. (column [12]), significantly lower than before of $1,291 mil. This represents the increase in total deadweight costs because of the loan rate.

The final column of Table 3 shows that the net social costs of the loan rate program without the tax credit is $613 mil., more than if both polices were in place ($1,291 mil). This means the tax credit increases the deadweight costs of the loan rate program, even though the tax credit improves the international terms of trade improvement by $921 mil. per year (column [8] minus column [9]).[18] There are other costs of the ethanol tax credit not accounted for like the general equilibrium effects of a spike in food prices increasing the inefficiency of taxes on labor (Goulder and Williams 2003). The empirical simulation presented here is only meant to illustrate the properties of the theoretical model for a single sector and its interaction effect with a price contingent farm subsidy.

If only the tax credit was in place, then total taxpayer costs would have averaged $1,914 mil. (second to last column in Table 2), implying the loan rate increased the annual tax costs of the tax credit by an average of $526 mil.[19] Meanwhile, the tax credit reduced the average annual tax costs of deficiency payments, resulting in a net savings of $2,092 mil. in tax costs. But rectangular deadweight costs of the tax credit average about $1,520 mil. and increased costs to domestic consumers are $1,484 mil. Furthermore, average total tax costs are $3,331 (column [5] in table 3) but would average $3,508 is there was no tax credit. Therefore, the total reduction in annual tax costs with the tax credit is only $177 mil.

Another caveat of the analysis is the assumption that the loan rate set by politicians would not be affected by the tax credit. However, much higher oil and corn prices (and prices for related crops) give politicians an incentive to increase loan rates compared to a situation of no tax credit and lower crop prices with burgeoning taxpayer costs. As shown in Swinnen and de Gorter (1998), estimates of the welfare effects of one policy assuming the level of the other policy is unaffected can be seriously biased. For example, the recent House Farm Bill proposes an increase in loan rates and target prices for several crops. If the tax credit did not exist, ethanol and hence corn prices would be lower and tax costs of price contingent subsidies higher. As a result, Congress may otherwise have been proposing lower price supports. Hence, the counterfactual may be very different so caution should be exercised in attributing the social benefits of the tax credit in reducing tax costs of price supports.

6. Concluding Remarks

Many countries are implementing a variety of policies to increase biofuel use with consumption tax credits being a prominent method amongst them. Hence, it is very important to understand the welfare effects of such a policy on the markets for agricultural products, biofuels and oil. To this end, this paper develops a unique general theory to analyze the efficiency and income distribution effects of a tax credit for biofuels. It is a particularly important issue for other countries in the world where gasoline taxes are often far higher than the U.S. case analyzed here. Therefore, rectangular deadweight costs can be even higher in these countries.

Calibrating a stylized model of the U.S. corn-ethanol market, we estimate that rectangular deadweight costs averaged $1,520 mil. over the past six years, substantially higher than standard Harberger triangles estimated for traditional farm subsidies. We show that a price contingent production subsidy for corn like a deficiency payment program can eliminate, create, have no effect or have an ambiguous effect on rectangular deadweight costs. Rectangular deadweight costs increase because of the loan rate (as ethanol production expands with a given level of water) but at the same time decreases the rectangular deadweight costs as it lowers the water in the tax credit for a given level of ethanol production. The outcome depends on whether there is *ex ante* or *ex post* water in the tax credit. There are situations where corn subsidies have been the sole cause of ethanol production (and therefore of rectangular deadweight costs), even with the tax credit. Corn producers do not benefit from a tax credit when the subsidy program is in effect.

Many commentators emphasize the taxpayer savings in farm subsidies with the tax credit. This not only ignores the existence of rectangular deadweight costs due to the tax credit but also that deficiency payments increase the taxpayer costs of the tax credit. Furthermore, our empirical results determine that deficiency payments contribute to the deadweight costs of the tax credit and vice-versa, the tax credit increases the deadweight costs of the deficiency payment program. Ethanol policies can therefore not be justified on the grounds of mitigating the effects of farm subsidy programs.

Furthermore, we show how the welfare effects of a tax credit depends critically on whether the country is a large country importer or exporter in either the agricultural good used in biofuel production or oil. For large countries (or for the combined effect of all small countries), terms of trade effects in either the oil or the agricultural markets can be positive or negative, depending on the trade status in each market. Algebraic expressions for the effects of these and other market parameters on the impact of the tax credit on efficiency and transfers are formally derived.

The model presented in this paper allows one to analyze the implications of several other policy issues. For example, it is important to understand the impacts of a tax credit on international trade because of the recent controversy over how the U.S. ethanol “subsidy” of 51 cents per gallon should be treated by the WTO. The model developed in this paper shows the tax credit increases the price of both ethanol and corn, thereby conferring no specific subsidy to nor harming either producers of ethanol or corn in the rest of the world.[20] Only the oil industry can be potentially harmed by the subsidy attributed to a consumption tax credit for biofuels.

The model is also well suited to form a basis for evaluating both the social benefits of the tax credit in reducing local pollution, greenhouse gas linked warming and oil dependency and the social costs in adding to traffic congestion, accidents and other negative externalities arising from more fuel consumption (Parry et al. 2007). Hence, this paper provides a springboard to assess the efficacy of alternative policies like a gasoline tax in achieving multiple policy goals like reducing oil dependency and tax costs of farm programs, or improving farm incomes and environmental quality.

In future research, the model can be adapted to analyze other interesting issues, like the effects of subsidies for either ethanol production or R&D of new technologies, and of policies that shift the non-ethanol corn demand curve to the right (import quotas on sugar increases the demand for corn syrup) or that shift the corn supply curve left (subsidies for other crops). In addition to including more agricultural sectors, future research should also relax some assumptions by allowing for decreasing returns to scale in ethanol production, and for endogenous biofuel imports and variation in the additive value of ethanol.

Figure 1: Market Equilibrium with a Tax Credit

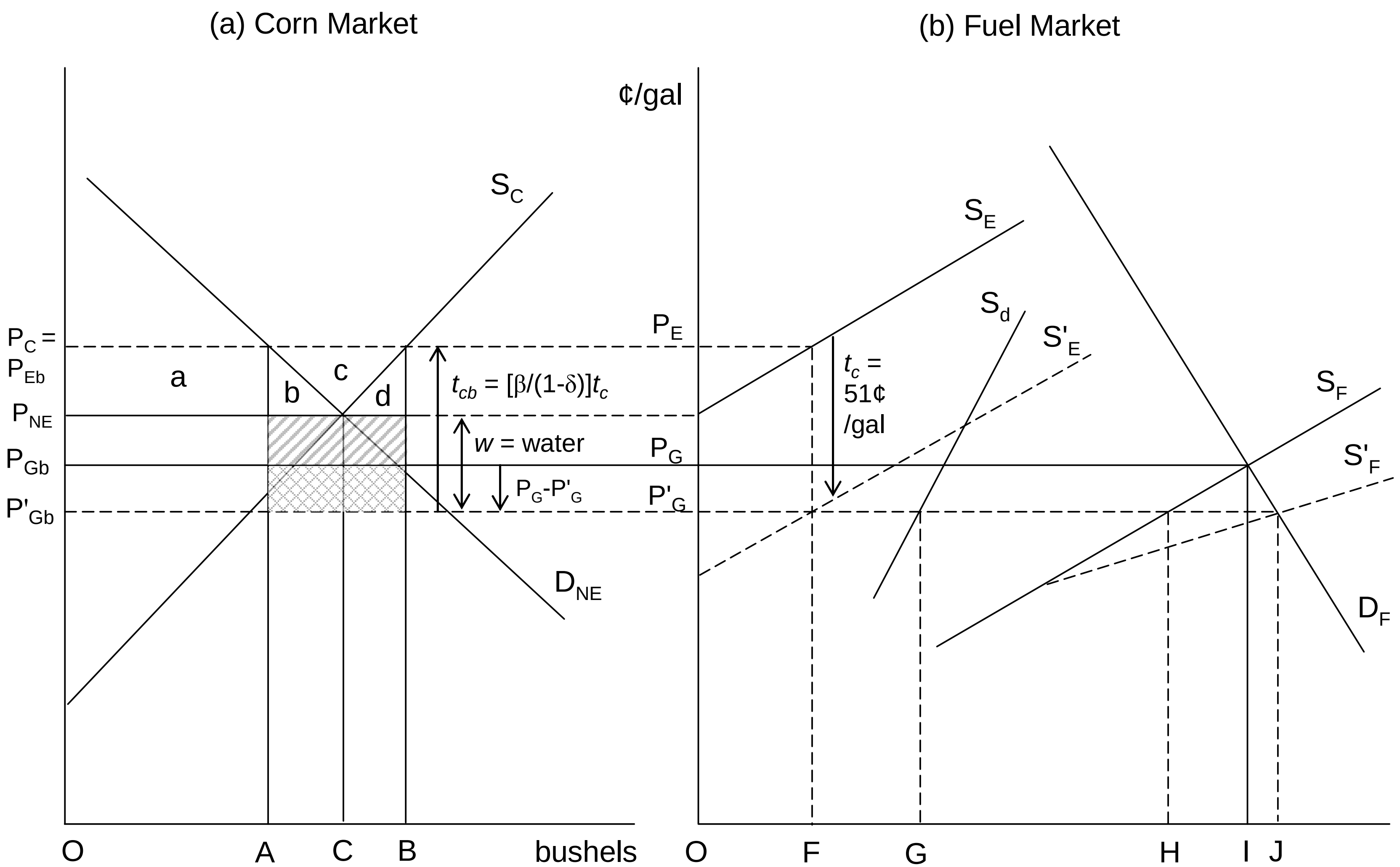
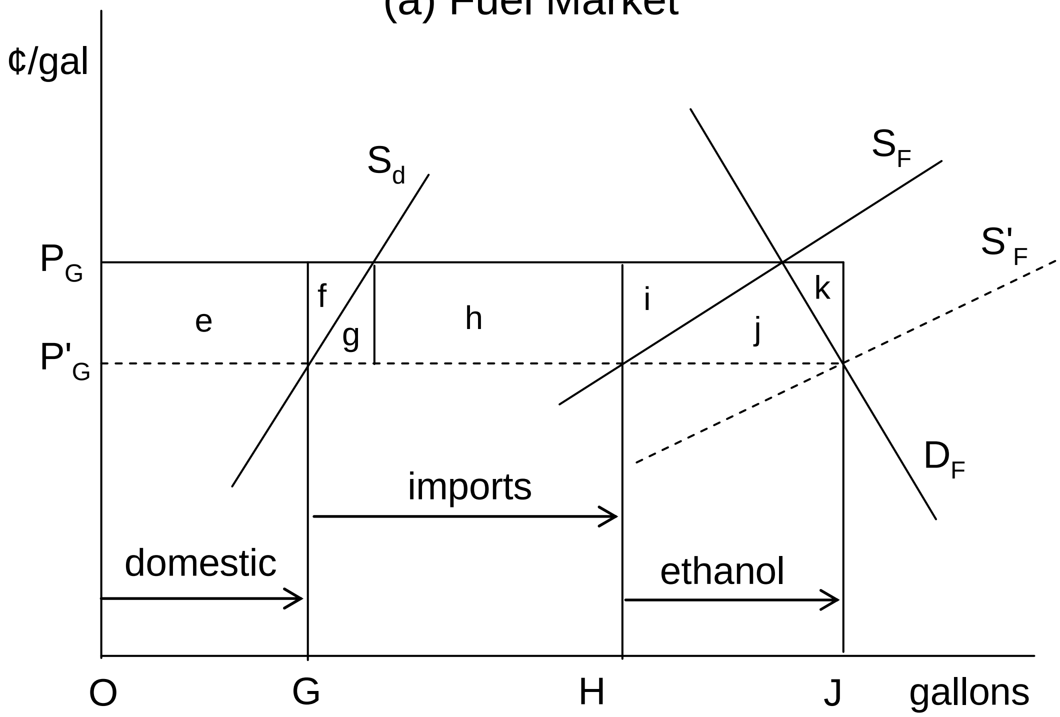


Figure 2: Welfare Economics of a Tax Credit

(a) Fuel Market



(b) Corn Market

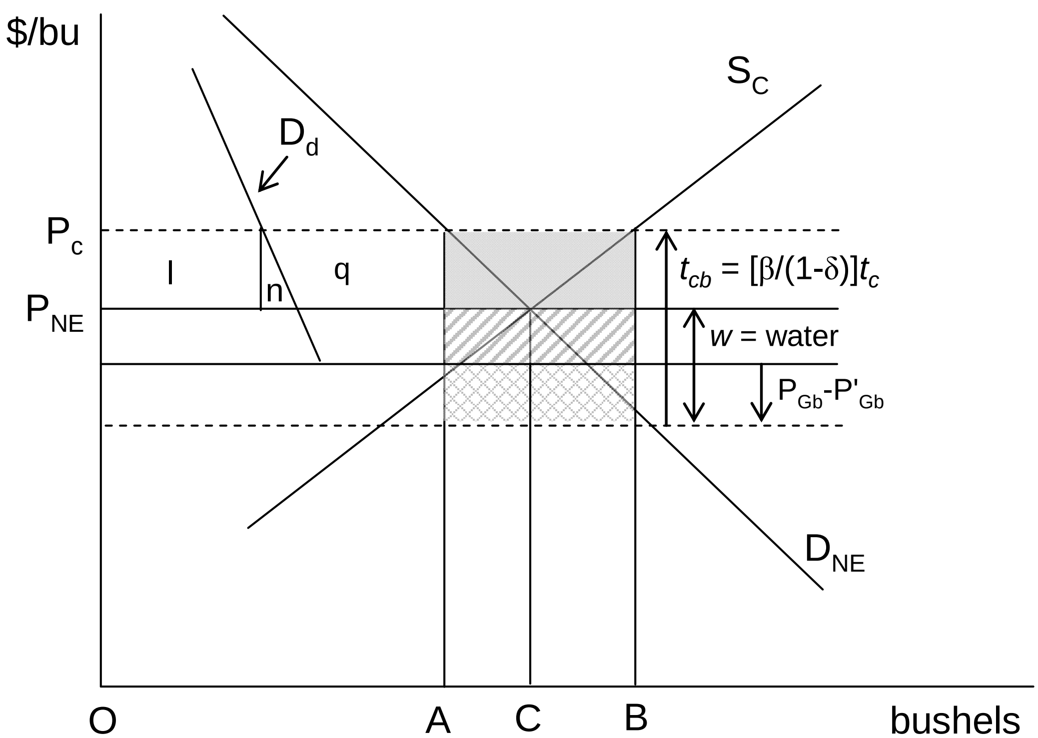


Figure 3: Tax Credit and Deficiency payments: $P_C > P_{NE}$

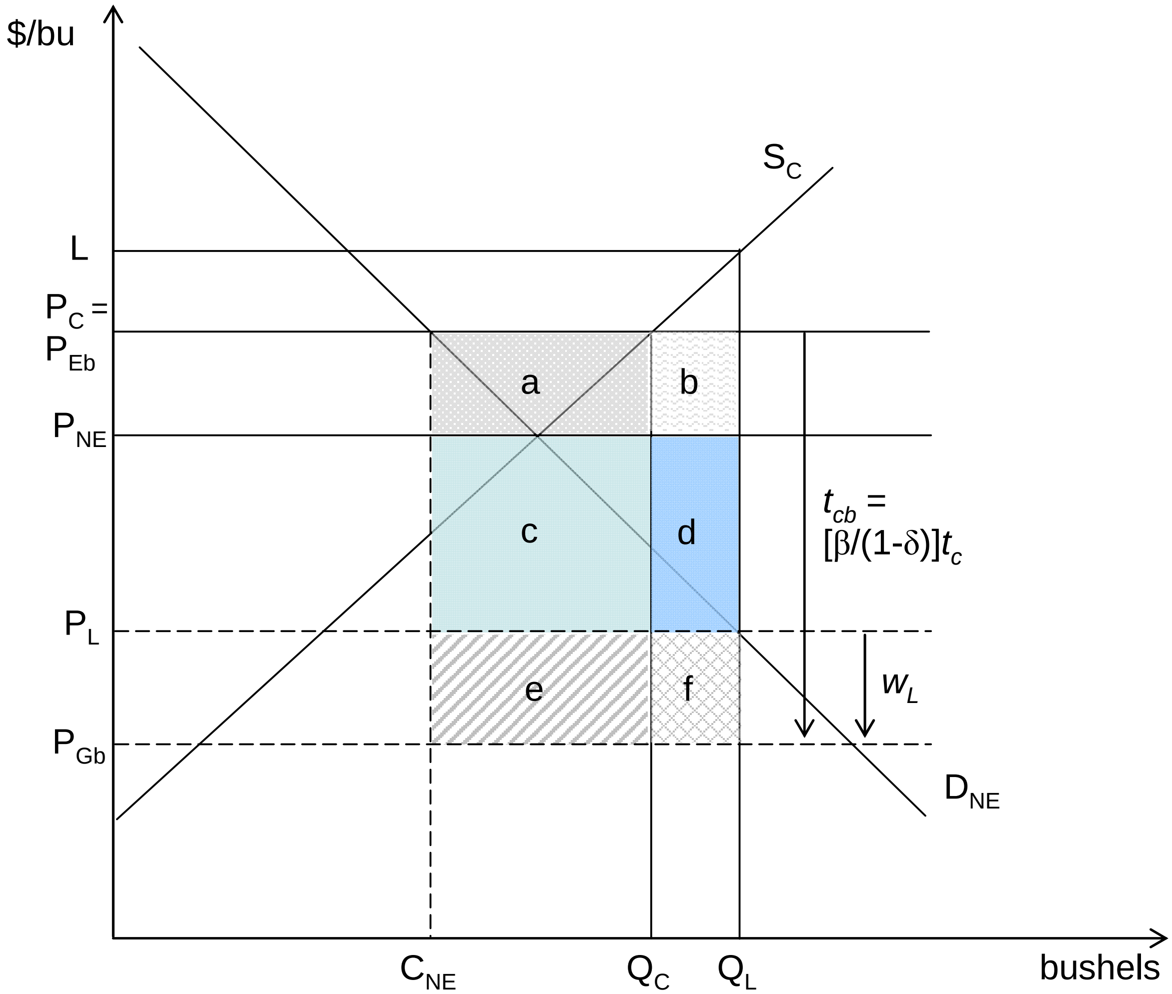


Figure 4: Tax Credit and Deficiency Payments: $P_C < P_{NE}$

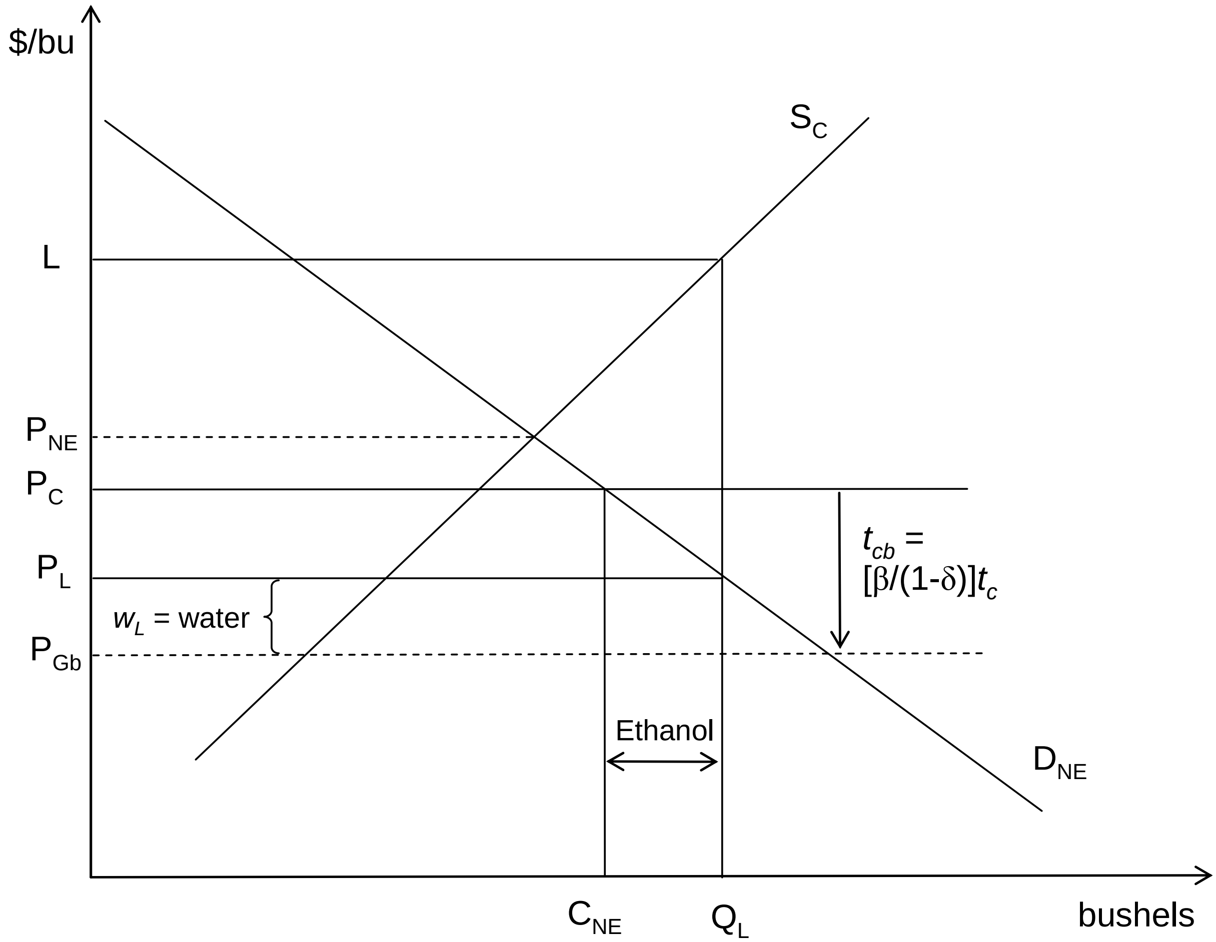


Table 1: Price Contingencies for the Social Welfare Effects of the Tax Credit

	CASE A [Figures 1,2]	**CASE B**[a]	**CASE C1** [Figures 3,4]	**CASE C2**
Effective Producer Price	$P_c + t_{cb} > P_{NE}, L$	$P_{NE} > P_c + t_{cb}, L$	$L > P_c + t_{cb}, P_{NE}$	
	Gasoline market drives producer corn price	Gasoline price has no effect on corn producers	Loan rate determines supply price for corn	
Effective Consumer Price	$P_c + t_{cb} >$ $q^{-1D}\left(\pi_1\left(P_c + t_{cb}\right)\right)$	$P_c + t_{cb} <$ $q^{-1D}\left(\pi_1\left(P_{NE}\right)\right)$	$P_c + t_{cb} >$ $q^{-1D}\left(\pi_1\left(L\right)\right)$	$P_c + t_{cb} <$ $q^{-1D}\left(\pi_1\left(L\right)\right)$
	Gasoline price transmits to corn consumers	Gasoline price has no effect on corn consumers	Gasoline price transmits to corn consumers	Gasoline price has no effect on corn consumers

[a] Because there is no ethanol production, there is no link between corn and gasoline prices.

Table 2: Corn Market Outcomes

	Consumption			Production at		Prices		'water' in tax credit		Taxpayer costs	
	Domestic Non-ethanol	Exports	Ethanol	Market price	Loan rate	Corn	If no ethanol	No loan rate	With loan rate	Tax credit	Deficiency payments
	D_d	X	E	Q_C	Q_L	P_C	P_{NE}	w	w_L		
	- - - - -- - - - - - - mil. bushels - - - - - - - - - - -					- - - - - - - - - - - - - $ per bushel - - - - - - - - - - -				- - - - mil. $ - - - -	
2001/02	6,877	1,904	721	-	9,502	1.97	1.90	2.03	1.85	1,048	1,195
2002/03	6,402	1,587	977	8,966	-	2.32	2.09	1.85	-	1,398	0
2003/04	6,997	1,899	1,193	-	10,089	2.42	2.18	1.84	1.60	1,715	134
2004/05	8,633	1,818	1,356	-	11,807	2.06	1.96	1.95	1.62	1,920	2,868
2005/06	7,316	2,147	1,649	-	11,112	2.00	1.91	1.97	1.59	2,344	4,300
2006/07	6,401	2,200	2,144	10,745	-	3.04	2.54	1.57	-	3,061	0
average	7,104	1,926	1,340	9,856	10,628	2.30	2.09	1.87	1.67	1,914	1,416

Source: USDA; calculated

Table 3: Transfers and Deadweight Costs of Ethanol Tax Credit and Loan Deficiency Payments ($ mil.)

	Deadweight Costs				Transfers to producers						Change in net social welfare		
	Triangular		Rectangular			Consumers						If no LDPs	If no tax credit
						Domestic		Foreign					
	Prod.	Cons.	Total	If tax credit only	Taxpayers	Total	No tax credit	Total	No tax credit	Net gain	Total	(effect of tax credit)	(effect of LDPs)
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
2001/02	49	1.9	919	490	2,243	510	-1,354	141	-420	1,833	-829	-427	-483
2002/03	81	15.1	1,247	1,247	1,398	1,498	0	371	0	1,940	-971	-971	0
2003/04	106	18.9	1,319	1,283	1,849	1,786	-1,804	485	-585	2,500	-959	-1,111	-711
2004/05	161	4.7	1,516	681	4,788	922	-3,101	194	-788	3,918	-1,488	-706	-1,006
2005/06	272	3.4	1,804	599	6,644	713	-3,119	209	-1,137	5,056	-1,870	-635	-1,478
2006/07	445	61.9	2,316	2,316	3,061	3,477	0	1,195	0	4,972	-1,628	-1,628	0
average	186	18	1,520	1,103	3,331	1,484	-1,563	433	-488	3,370	-1,291	-913	-613

Source: calculated

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Appendix

The resulting first order conditions can be written

$$\text{(A1)}\quad \begin{aligned} &q^D\left(1-\frac{\partial \tilde{P}}{\partial t_{cb}}\right)-q^S\left(1-\frac{\partial \hat{P}}{\partial t_{cb}}+\frac{\partial s}{\partial t_{cb}}\right)+q^X-t_{cb}\left(\frac{\partial q^S}{\partial P}\frac{\partial \hat{P}}{\partial t_{cb}}-\frac{\partial q^D}{\partial P}\frac{\partial \tilde{P}}{\partial t_{cb}}-\frac{\partial q^X}{\partial P}\frac{\partial \tilde{P}}{\partial t_{cb}}\right)-\theta\frac{\partial q^S}{\partial P}\frac{\partial \hat{P}}{\partial t_{cb}} \\ &+\lambda\left(\frac{\partial q^S}{\partial P}\frac{\partial \hat{P}}{\partial t_{cb}}-\frac{\partial q^D}{\partial P}\frac{\partial \tilde{P}}{\partial t_{cb}}-\frac{\partial q^X}{\partial P}\frac{\partial \tilde{P}}{\partial t_{cb}}\right)=0 \end{aligned},$$

$$\text{(A2)}\quad \begin{aligned} &-q^D\frac{\partial \tilde{P}}{\partial P_c}-q_F^D-t_{cb}\left(\frac{\partial q^S}{\partial P}\frac{\partial \hat{P}}{\partial P_c}-\frac{\partial q^D}{\partial P}\frac{\partial \tilde{P}}{\partial P_c}-\frac{\partial q^X}{\partial P}\frac{\partial \tilde{P}}{\partial P_c}\right)+\left(\frac{\partial \hat{P}}{\partial P_c}-\frac{\partial \delta}{\partial P_c}\right)q^S-\theta\frac{\partial q^S}{\partial P}\frac{\partial \hat{P}}{\partial P_c}+q_G^S \\ &+\lambda\left[\frac{\partial q_G^S}{\partial P}+\frac{\partial q_G^X}{\partial P}+k\left(\frac{\partial q^S}{\partial P}\frac{\partial \hat{P}}{\partial P_c}-\frac{\partial q^D}{\partial P}\frac{\partial \tilde{P}}{\partial P_c}-\frac{\partial q^X}{\partial P}\frac{\partial \tilde{P}}{\partial P_c}\right)-\frac{\partial q_F^D}{\partial P}\right]=0 \end{aligned},$$

If either $\frac{\partial \hat{P}}{\partial t_{cb}}$ or $\frac{\partial \tilde{P}}{\partial t_{cb}}$ are non-zero then we can solve (A1) for λ

$$\lambda=\frac{-q^D\left(1-\frac{\partial \tilde{P}}{\partial t_{cb}}\right)+q^S\left(1-\frac{\partial \hat{P}}{\partial t_{cb}}+\frac{\partial \delta}{\partial t_{cb}}\right)-q^X+\theta\frac{\partial q^S}{\partial P}\frac{\partial \hat{P}}{\partial t_{cb}}}{\left(\frac{\partial q^S}{\partial P}\frac{\partial \hat{P}}{\partial t_{cb}}-\frac{\partial q^D}{\partial P}\frac{\partial \tilde{P}}{\partial t_{cb}}-\frac{\partial q^X}{\partial P}\frac{\partial \tilde{P}}{\partial t_{cb}}\right)}+t_{cb}\,.$$

The definitions $\hat{P}=\max\left\{P_c+t_{cb},P_{NE},L\right\}$ and $\tilde{P}=\max\left\{P_c+t_{cb},q^{-1D}\left(\hat{P}\right)\right\}$, and $\theta=\max\left\{L-\tilde{P},0\right\}$ imply the following contingencies:

(i) If $P_c+t_{cb}>P_{NE},L$ then $\hat{P}=P_c+t_{cb}$, $\tilde{P}=P_c+t_{cb}$, $\theta=0$, and substituting into (A2) obtains

$$t_{cb}=\frac{\left(q^D+q_F^D-q^S-q_G^S+q^X\right)\left(\eta^S\frac{q^S}{q^X}-\eta^D\frac{q^D}{q^X}-\eta^X\right)}{\left(\eta_G^S\frac{q_G^S}{P_c}+\eta_G^X\frac{q_G^X}{P_c}-\eta_F^D\frac{q_F^D}{P_c}\right)\left(\eta^S\frac{q^S}{q^X}-\eta^D\frac{q^D}{q^X}-\eta^X-1\right)}+\frac{P_c}{\left(\eta^S\frac{q^S}{q^X}-\eta^D\frac{q^D}{q^X}-\eta^X-1\right)}$$

(ii) If $L > P_c + t_{cb} > P_{NE}$ or $L > P_{NE} > P_c + t_{cb} > P_L$ then $\hat{P} = L$, $\tilde{P} = P_c + t_{cb}$, $\theta = L - P_c - t_{cb}$, and substituting into (A2) obtains

$$t_{cb} = \frac{\left(-q^D - q_F^D + q^S + q_G^S - q^X\right)\left(-\eta^D \dfrac{q^D}{q^X} - \eta^X\right)}{-\left(\eta_G^S \dfrac{q_G^S}{P_c} + \eta_G^X \dfrac{q_G^X}{P_c} - \eta_F^D \dfrac{q_F^D}{P_c}\right)\left(-\eta^D \dfrac{q^D}{q^X} - \eta^X + 1\right)} + \frac{P_c}{\left(-\eta^D \dfrac{q^D}{q^X} - \eta^X + 1\right)}$$

(iii) If $L > P_{NE} > P_L > P_c + t_{cb}$ then $\hat{P} = L$, $\tilde{P} = P_L$, $\theta = L - P_L$. The tax credit does not appear in (A1), hence an optimum obtains when $t_{cb} = 0$.

(iv) If $P_{NE} > P_c + t_{cb}, L$ then $\hat{P} = P_{NE}$, $\tilde{P} = P_{NE}$, $\theta = 0$. The tax credit does not appear in (A1), hence an optimum obtains when $t_{cb} = 0$. $\blacksquare$

Endnotes

[1] Exempted or reduced biofuel excise taxes cover 65 percent of total world fuel consumption and are known to be in effect in Argentina, Australia, Brazil, Canada, China, Colombia, EU, Ghana, Honduras, India, Indonesia, Paraguay, Philippines, South Africa, Switzerland, Thailand, Uruguay and the United States (Redondo 2007; Kojima et al. 2007; UNCTAD 2006; Steenblik and Simón 2007; Rothkopf 2007). To help achieve EU wide biofuel consumption targets, 19 Member States have implemented excise tax exemptions and another 5 are planning to do so (EC 2007).

[2] The U.S. biofuel tax exemption was changed to a tax credit in 2004 but this was a change in implementation only and does not affect the economics of the program. The term "tax credit" is used hereafter in this paper.

[3] The import tariff on ethanol is another potential gain in the U.S. terms of trade but we assume ethanol imports are exogenous in the model. The tariff was implemented to offset the benefit exporters would otherwise obtain from the higher price of ethanol induced by the tax credit.

[4] Although we refer to the U.S. ethanol market as we develop our theory in this paper, it is only an example as the model can be applied to any biofuel market with a tax credit. For small countries, the oil price is fixed and there may be no terms of trade effect in the agricultural product market. Indeed, the effect of U.S. ethanol policy on the world price of oil is empirically small for historical levels of ethanol production, even though the United States is a large country importer of oil.

[5] A key aspect of analyzing the corn-oil market interface is the equilibrium breakeven price of corn. Studies find a linear relationship between the corn and oil price (e.g., Tyner 2007; Elobeid et al. 2006). These estimates of the breakeven curve differ, but the slopes are nearly identical. Linearity suggests that there are constant returns to scale in ethanol production.

[6] For an analysis of mandates and their interaction effects with tax exemptions, see de Gorter and Just (2007a).

[7] For an analysis on the economic effects import tariffs for ethanol, see de Gorter and Just (2007b).

[8] The non-ethanol demand curve for corn includes the by-products. For a methodological explanation, see de Gorter and Just (2008).

[9] Ethanol is a substitute for gasoline derived from petroleum. The term "fuel" in this paper refers to the ethanol/gasoline mixture. Ethanol can be up to 10 percent of the fuel mixture in traditional combustion engines with virtually no modifications required.

[10] As noted in de Gorter and Just (2008), the tax credit including those by individual states average 56.9¢/gal but we ignore this.

[11] The tax credit is not adjusted for its energy content and contribution to mileage because consumers are either unaware or unable to substitute between E85 and gasoline. However, with the advent of E85 stations and flex cars, this will likely change in the future for the United States (as is the case today in Brazil).

[12] In cases where water in the tax credit does not exist, taxpayers would also forego revenues on ethanol that would have been produced without the tax credit (in addition to the tax costs of increased ethanol production induced by the tax credit that displaces gasoline consumption).

[13] World prices of oil decline and as an importer, the United States benefits as a result. Normally, an optimal import tariff is a subsidy on domestic oil production and an equal tax on domestic oil consumption. Here, the opposite occurs with domestic oil production taxed and domestic oil consumption subsidized. The outcome is unique because of the way in which the tax credit affects the ethanol and hence oil markets.

[14] Normally an export tax improves a country's international terms of trade which is a tax on domestic production and an equal subsidy on domestic consumption. In the case evaluated here, the opposite occurs: corn producers are

subsidized and domestic non-ethanol corn consumers are taxed because the ethanol tax credit increases the world market price for corn.

[15] Because U.S. ethanol production in 2006 is estimated to be 0.211 percent of world petroleum consumption, a fixed oil price in the empirical analysis is a plausible assumption.

[16] The mathematical expression for the effect of the tax credit t_c on net tax costs of the loan rate L in Figure 4 is the same as for that in Figure 3 but the effect of the loan rate on the net tax costs of the tax credit differs slightly and is now given by $w_L \cdot (Q_L - C_{NE})$.

[17] The estimates for deadweight loss triangles are in line with those obtained by Gardner (2003) and Martinez-Gonzalez et al. (2007) but these studies omit rectangular deadweight costs.

[18] The United States could easily obtain the terms of trade improvements by restricting exports instead and not having the tax credit, saving both rectangular deadweight costs and increased costs to domestic consumers.

[19] Annual average costs of the tax credit were $1,914 mil while that of the loan rate was $1,416 mil. (Table 2).

[20] Nevertheless, the United States notifies the Agreement on Subsidies and Countervailing Measures in the WTO of the revenues foregone with the biofuel tax credit as a subsidy but categorizes it as an industrial product (IPC 2006). In regards to the recent case filed with the WTO on U.S. farm subsidies, Brazil argues the biofuel subsidy should be included in the domestic support disciplines of the WTO's Agreement on Agriculture but the U.S. response was "the case is about agriculture, not ethanol" (GMF 2007). Either way, our model shows that the tax credit would not constitute a specific subsidy nor have adverse effects on ethanol, corn or sugar producers in the rest of the world. Brazil should instead focus on the U.S.'s 54¢/gal import tariff on ethanol that prevents Brazil from taking advantage of this increase in ethanol price. The elimination of the so-called "subsidy" due to the tax credit while maintaining the import tariff would make things even worse for Brazil.

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