REVENUE-NEUTRAL TAXATION IN WASHINGTON, OREGON, AND IDAHO GIVEN THE RENEWABLE FUEL STANDARD

By

Tristan D. Skolrud, Assistant Professor, Department of Agricultural and Resource Economics, University of Saskatchewan. Gregmar I. Galinato, Associate Professor, School of Economic Sciences, Washington State University
Revenue-Neutral Taxation in Washington, Oregon, and Idaho Given the Renewable Fuel Standard

Preface

We assess the welfare implications of imposing a revenue-neutral carbon tax, where the use of crude oil emitting carbon is taxed and the revenues are used to supplement the reductions in revenues from a lower income tax rate or sales tax rate, in the presence of the Renewable Fuel Standard (RFS) in Washington, Oregon, and Idaho. Simulations conducted using data from Washington, Oregon, and Idaho indicate that the imposition of a revenue-neutral tax raises state welfare, an estimate of the combined well-being of producers and consumers, by 19% to 20% and increases the cellulosic biofuel sector marginally at a rate of 1% to 2%. Also, raising the input ratio requirement for cellulosic biofuel from the RFS will have little impact on state welfare and the revenue-neutral tax rate chosen by the regulator to control pollution. However, changes to the cellulosic biofuel waiver price, which can be used to circumvent the input ratio requirement, reduces the revenue-neutral tax because less pollution is emitted.


Introduction

A carbon tax is touted by economists and environmental scientists as an effective and efficient means of reducing greenhouse gas (GHG) emissions (Tol 2005), but considerable opposition exists in the U.S. at the national level to adopting such a program. However, when the tax revenue from a carbon tax is used to offset an existing distortionary tax policy, public support across political groups increases drastically (Amdur et al. 2014). Representative John Delaney recently announced that he would introduce federal legislation taxing GHG emissions and using the revenues to reduce the corporate tax rate (Congress John Delaney 2015). California, New York, Massachusetts, Oregon, and Washington have proposed initiatives for a revenue-neutral carbon tax that reduces an existing distortionary tax leading to zero net increase in tax revenue. In Washington, the group CarbonWA was successful in collecting enough signatures for their revenue-neutral carbon tax initiative to appear on the November 2016 ballot (CarbonWA 2016). Thus, there appears to be growing support to impose a revenue-neutral tax system to control GHG emissions at both the national and state level in the U.S.

Congress passed the Energy Independence and Security Act (EISA) of 2007 which imposes increasing consumption mandates designated as RFS policies for several types of renewable fuel through 2022. The law reduces GHG emissions by substituting energy feedstock that emits less carbon dioxide than fossil-based sources. The law mandates an increasingly important role for advanced biofuels derived from cellulosic feedstocks, such as woody biomass or crop residue. By 2022, the mandate calls for the consumption of approximately 16 billion gallons of cellulosic biofuel; a significant increase from 33 million gallons produced in 2014 (RFSP 2015). There are two important RFS policies relating to the cellulosic biofuel requirement: the input ratio requirement, which imposes a lower bound on the amount of cellulosic biofuel used in the production of blended fuel, and the price of EPA-issued cellulosic biofuel waivers, which can be purchased by fuel producers and importers to circumvent the input requirement (GPO 2011). It remains to be seen whether these federal regulations will be sufficient to reduce GHG emissions.

Our research question analyzes how a revenue-neutral carbon tax can be imposed to induce the optimal level of carbon dioxide pollution in the presence of the RFS policies. We analyze the effect with two different tax types: a revenue-unconstrained tax, and a more politically palatable revenue-neutral tax, where the revenue collected from the environmental tax is used to offset an existing tax in such a way that guarantees that overall government revenue remains at the same level. By comparing results across the two tax types, we have a benchmark with which to compare the revenue-neutral tax, both in terms of pollution reduction and overall welfare enhancement.

We build a model where a tax is placed on fossil fuel use in the fuel production sector and the tax revenue is used to offset an existing distortionary tax on a currently taxed item. We provide a numerical simulation to show the effect of such a policy in Washington, Oregon, and Idaho—states that could be significant providers of cellulosic feedstocks for biofuels due to their abundance of agricultural land and woody biomass (Yoder et al. 2010). We compare and contrast the effects of a revenue-neutral tax in states with different existing taxes. In Washington, which has no state income tax, sales taxes are offset. In Oregon and Idaho, state income tax is offset.

Three effects are identified in the literature when a revenue-neutral tax is imposed (Parry 1995). First, there is what is called a Pigouvian effect that improves welfare because the pollution tax makes the good more expensive, leading to lower
consumption and, consequently, lower pollution. The second effect is called a revenue-recycling effect that improves welfare because the existing tax rate in a market is reduced, leading to more goods produced and consumed in that market. The final effect is called a tax-interaction effect that reduces welfare because increasing the tax rate of a good that creates pollution may reduce goods consumed in related markets. For example, if the consumption of a polluting good like gasoline complements consumption of other goods such as food and clothing, then a tax imposed on the polluting good will reduce the consumption of these goods, leading to lower sales tax revenue. For the policy to be revenue-neutral, these lost tax-revenue dollars have to be made up, either by lessening the reduction in the distortionary tax rate or lessening the increase in the pollution tax.

In our model, we identify a fourth effect that we call the residual Pigouvian effect which is the reduction in welfare that occurs when the tax increase in the polluting market decreases output and non-polluting input use. The effect is not new in the environmental taxation literature but, to our knowledge, this is the first time its welfare effects have been quantified.

The efficiency cost, defined as the economic cost of increasing revenue from an inefficient taxing mechanism, of raising an additional dollar of revenue is higher when increasing the income tax as opposed to the sales tax. This leads to larger revenue-recycling and tax-interaction effects in Oregon and Idaho than in Washington State. We also show that more stringent input ratio requirements for cellulosic biofuels and higher waiver prices lead to lower revenue-neutral taxes because of a reduction in pollution. We use numerical simulations to calculate the revenue-neutral tax that yields the largest state welfare magnitude.

The RFS and Cellulosic Biofuel

The EISA designates fuel consumption mandates by fuel type. After 2014, the corn ethanol mandate is held constant at 15 billion gallons annually, while the cellulosic mandate is gradually increased, rising to 16 billion gallons by 2022. All U.S. fuel producers and importers must comply with this Environmental Protection Agency (EPA)-enforced mandate, ensuring that the correct ratio of fuel inputs derive from renewable sources.

In addition to the quantity mandate, expressed as in input ratio requirement, the EPA has a unique policy tool to employ with respect to cellulosic biofuels. Because the technology used to refine cellulosic feedstocks is still in its infancy, it is often the case that cellulosic production falls short of the annual RFS mandate level. When this occurs, fuel producers and importers have the option to purchase waiver credits which can be used to partially satisfy the RFS mandate requirement. The waiver credit price is set as the greater of $0.25 or $3 minus the wholesale price of gasoline, where each credit replaces an obligated gallon of cellulosic biofuel. Throughout the entire policy, the latter calculation has been binding, resulting in cellulosic waiver credit prices ranging from $0.42/gallon to $0.78/gallon from 2012 through 2015 (RFSP 2015). Skolrud et al. (2014) demonstrates that this low waiver price actually inhibits cellulosic biofuel production.

In this report, we construct simulations wherein we allow these two policy mechanisms to vary, analyzing the subsequent impact on the optimal revenue-neutral tax rates. In the next section, we describe the methodology underlying the simulation.

Methodology

We modify the model developed by Goulder et al. (1997) to derive expressions for the welfare effects from a revenue-neutral tax in the presence of the RFS policy. We build on their model in four ways. First, we allow for an oligopoly (few firms) market structure instead of a competitive (many firms) market structure. Second, we add an input ratio requirement and the waiver price to account for the RFS policies. Third, we allow for intermediate sectors that supply feedstocks to a blended fuel sector as we describe below. Finally, we allow the possibility of recycling tax revenue to reduce consumer sales tax instead of a labor income tax which is usually done in the literature.

Our baseline model includes a consumption sector where a representative consumer purchases goods produced in two final goods sectors: a composite goods sector and a blended fuel sector that is directly affected by the RFS mandates. A government chooses the optimal tax instrument given the welfare of all agents in the economy. To model both Washington State and the Oregon/Idaho cases, we construct two models. The first recycles pollution tax revenues to offset the reduction of a sales tax in Washington State, and the second recycles revenues to offset the reduction of an existing income tax in Oregon/Idaho.

A schematic of the model demonstrating the linkages between sectors is shown in Figure 1. In our model, we disaggregate the production of cellulosic feedstock into two sources: agriculture and forestry. Without information specifying production from each sector, we assume that half the feedstock is produced by the agricultural sector (in the form of switchgrass) and half from the forestry sector (in the form of mill residues). The remainder of the output from the agriculture and forestry sectors flows into the composite good, indicated by the dashed lines in Figure 1. After the feedstock is produced, it is used as input in the cellulosic refining sector, which produces cellulosic ethanol for use by the fuel blending sector. The
blended fuel sector utilizes (taxed) crude oil and cellulosic ethanol to produce blended fuel which is then sold to the consumer sector. The consumer chooses amounts of blended fuel, composite goods, and leisure to consume.

In the blended fuel production process, pollution is emitted as a byproduct, which negatively impacts the consumer. The emission of pollution is considered a negative externality of production—a process through which one sector harms another and the negative value associated with the damage is not included in the market price. In our model, the government is responsible for setting an optimal tax to mitigate the externality, which integrates the pollution damage affecting the consumer into the market price.

To set the value of the optimal revenue-unconstrained tax in an efficient manner, the government chooses the optimal tax rate on crude oil to maximize aggregate social welfare, defined as the sum of consumer surplus (a measure of consumer well-being), fuel blending profits, tax revenues, and waiver credit expenditures, minus the monetary value of pollution damages. To determine the optimal revenue-constrained tax, the government chooses the tax rate to maximize social welfare, but in this case, the value of the tax is limited by a constraint enforcing government revenue neutrality. All of the tax revenue in the revenue-constrained version is used to offset an existing tax whose imposition distorts the economy from its free market equilibrium. This process results in the previously discussed welfare effects: the revenue-recycling effect, the Pigouvian effect, the tax-interaction effect, and the residual Pigouvian effect.

Our theoretical model admits a set of mathematical equations governing the optimal behavior of each sector, as well as the conditions required for prices to be set and all produced quantities to be consumed. We set parameter values in each of these equations to be consistent with the observed data through a process referred to as calibration. The data used in the calibration and simulations are derived from different sources, which are explained in detail in Skolrud (2015). We obtain quantity and price data for Washington, Oregon, and Idaho for each sector of the model. Differences in state-level quantities demonstrate Washington State’s emphasis on agriculture over forestry, whereas Oregon is the opposite. Both Idaho’s forestry and agricultural sectors are smaller than Washington or Oregon. Washington State employs more labor and capital in agriculture and less labor and capital in forestry than Oregon. Washington State has a higher wage rate and land rental rate than Oregon or Idaho. The remainder of the prices in the model do not vary by state.

In 2014, the EPA reported national production of cellulosic ethanol equal to 33 million gallons (RFSP 2015). As state-level production is not provided, we assume that Washington State, Oregon, and Idaho accounted for a share of national cellulosic ethanol production equal to their respective shares of national petroleum consumption. In 2012, Washington’s share of national petroleum consumption was 2% (EIA 2013a), Oregon’s share was 0.9% (EIA 2013b), and Idaho’s share was 0.4% (EIA 2013c), accounting for cellulosic ethanol production of 660,000 gallons, 297,000 gallons, and 132,000 gallons respectively.

To assess the impacts of changes to the waiver price and RFS percentage standard for cellulosic ethanol, we hold the calibrated parameters fixed, and then we vary the policy parameters over pre-specified ranges (from $0.78 to $2.23 for the waiver price, in $0.05 increments, and from the 2014 level of 2% to the proposed 2022 level of 9% for the input ratio requirement in 0.05% increments). We simulate cellulosic fuel and blended fuel production at three levels of the crude oil tax: zero, the optimal revenue-unconstrained level, and the revenue-neutral tax level. Finally, we measure changes to aggregate welfare under revenue-unconstrained and revenue-neutral taxation.

**Results**

Table 1 summarizes our state welfare results, where the welfare effects are expressed in terms of dollars per gallon of crude oil. Notice that the welfare effects are split into two panes: in the top pane, welfare effects associated with the revenue-recycling process are enumerated, and in the bottom pane, aggregate social welfare effects (the measure of producer and consumer well-being) are presented. We find that the revenue-recycling and Pigouvian effects are positive, while the residual Pigouvian and tax-interaction effects are negative, as expected from our theory. The revenue-recycling effects in Oregon and Idaho are larger than in Washington State. Therefore, simulation results suggest that the gain in efficiency from revenue-neutral taxation is higher in the economy with an income tax as opposed to a sales tax. Similarly, the absolute value of the tax-interaction effect is larger with an income tax from Oregon and Idaho than a sales tax from Washington. These magnitudes are consistent with the fact that the
Table 1. Welfare Effects

<table>
<thead>
<tr>
<th>Welfare effects</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>($/gal of crude oil)</td>
<td>WA</td>
</tr>
<tr>
<td>Revenue recycling</td>
<td>$0.16</td>
</tr>
<tr>
<td>Pigouvian</td>
<td>$0.13</td>
</tr>
<tr>
<td>Residual Pigouvian</td>
<td>−$0.04</td>
</tr>
<tr>
<td>Tax interaction</td>
<td>−$0.15</td>
</tr>
<tr>
<td>Sum of effects</td>
<td>$0.10</td>
</tr>
<tr>
<td>Aggregate social welfare effects (percentage increase in social welfare from no-tax baseline)</td>
<td>WA</td>
</tr>
<tr>
<td>Revenue-unconstrained taxation</td>
<td>11%</td>
</tr>
<tr>
<td>Revenue-neutral taxation</td>
<td>19%</td>
</tr>
</tbody>
</table>

efficiency cost is larger for an income tax than for a sales tax (Ballard et al. 1985).

Approximately 2.6 billion gallons of fuel in Washington, 1.17 billion gallons in Oregon, and 520 million gallons in Idaho are consumed annually. Our results imply that imposing a revenue-neutral tax yields $261 million, $164 million, and $62 million in annual welfare gains for Washington, Oregon, and Idaho, respectively. We calculate the percentage change from the no-tax baseline to the revenue-unconstrained and revenue-neutral tax cases. We find welfare improvements in Washington State on the order of 11% from revenue-unconstrained taxation and 19% from revenue-neutral taxation. Oregon welfare improvements are 13% and 20% for revenue-unconstrained and revenue-neutral taxation, respectively. Idaho welfare improvements are similar to Oregon’s at 12% and 20%, respectively. These results demonstrate a positive welfare effect from revenue-neutral taxation similar to Goulder et al. (1997) whose study of revenue-neutral sulfur dioxide taxation finds net welfare gains valued at between $153.7 million and $952.1 million dollars depending on the monetary value of pollution damages. In his review of the environmental economics literature focusing on pollution reduction through revenue-neutral taxation, Goulder (1995) finds mixed welfare results, which he attributes to differences in efficiency cost across different types of taxation.

Next we examine optimal values of the two taxes for each state as shown in Table 2. Our results indicate that the optimal revenue-neutral tax is approximately 66% to 75% of the revenue-unconstrained tax due to the tax-interaction effect and the residual Pigouvian effect. The results are consistent with evidence from Parry (1995) and Galinato and Yoder (2010). We also note that the revenue-unconstrained tax is slightly higher than the marginal environmental damage ($0.25/gal of crude oil) which would be the optimal level in a partial equilibrium framework. The tax accounts for how our model incorporates an oligopoly market structure as well as interactions across sectors, which explains the deviation from a level equal to the marginal environmental damage.

Table 2. Optimal Taxes at Baseline Parameter Values ($/gal of crude oil)

<table>
<thead>
<tr>
<th>State</th>
<th>WA</th>
<th>OR</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue unconstrained</td>
<td>$0.26</td>
<td>$0.31</td>
<td>$0.35</td>
</tr>
<tr>
<td>Revenue neutral</td>
<td>$0.19</td>
<td>$0.21</td>
<td>$0.25</td>
</tr>
</tbody>
</table>

Imposition of either revenue-neutral or unconstrained tax regimes result in a notable change in blended fuel production as shown in Table 3. Both taxes lead to a decrease in blended fuel production and an increase in cellulosic fuel production. With the revenue-neutral tax, the absolute value of the change for each fuel type is lower. The results demonstrate the firm substituting away from the now expensive crude oil towards blended fuel, but the substitution effect is not large enough to overcome the drop in total output of blended fuel from the output effect.

Table 3. Change in Fuel Production (millions of gallons)

<table>
<thead>
<tr>
<th></th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WA</td>
</tr>
<tr>
<td>2012 Baseline values</td>
<td></td>
</tr>
<tr>
<td>Blended fuel</td>
<td>2,604.11</td>
</tr>
<tr>
<td>Cellulosic fuel</td>
<td>0.66</td>
</tr>
<tr>
<td>With revenue-unconstrained tax (% change from baseline)</td>
<td></td>
</tr>
<tr>
<td>Blended fuel</td>
<td>−6.89%</td>
</tr>
<tr>
<td>Cellulosic fuel</td>
<td>3.01%</td>
</tr>
<tr>
<td>With revenue-neutral tax (% change from baseline)</td>
<td></td>
</tr>
<tr>
<td>Blended fuel</td>
<td>−5.14%</td>
</tr>
<tr>
<td>Cellulosic fuel</td>
<td>1.53%</td>
</tr>
</tbody>
</table>

We simulate the tax response to an increase in the cellulosic waiver price (from $0.78/gallon to $2.23/gallon) and an increase in the input ratio requirement. Figures 2 and 3 illustrate the results for the revenue-unconstrained tax and Figures 4 and 5 show the results for the revenue-neutral tax. The simulations indicate that each tax is more sensitive to changes in the waiver price than to changes in the input ratio requirement, especially for waiver prices between $0.78/gallon and $1.18/gallon.

We note further that the trend seen in Figures 2–5 is consistent across states. While the intercepts differ in accordance with the variation in optimal baseline taxes across states, the slope of each curve varies only slightly. Interestingly, a consistent
pattern for Washington State emerges even with its use of a retail sales tax in lieu of income taxes. This implies that the change in the optimal tax rate due to the change in the federal biofuel policy variables is relatively unaffected by the difference in tax structure.

Figure 6 demonstrates that cellulosic ethanol production responds to changes in the waiver price much more compared to changes in the input ratio requirement, shown in Figure 7. When the waiver price increases, producers use more cellulosic fuel and decrease crude oil use. This results in smaller environmental damage which leads to a lower pollution tax rate. When the input ratio requirement increases, producers can mitigate its effect by purchasing cheap waiver credits, which results in insignificant changes to input levels. The level of environmental damage is maintained along with the pollution tax.
Figure 7. Simulated Response of Cellulosic Ethanol Production to Changes in the Input Ratio Requirement

**Conclusion**

This report analyzes the welfare implications of imposing a revenue-neutral tax in the context of the RFS. We formulate a model that includes a fuel production sector that is subject to both RFS requirements and a revenue-neutral tax on fossil fuel (crude oil) usage and a consumer sector that values consumption of blended fuel and environmental quality. We find simulated values for the revenue-neutral tax consistent with other estimates in the literature. We present evidence that the RFS waiver credit price can impact the optimal tax rate, while the RFS input ratio requirement for cellulosic biofuel has only a limited effect. The variability of the optimal tax rate as a function of RFS policy variables, especially the waiver credit price, suggests that the optimal tax rate would only perform as intended if it is allowed to vary with changes in the federal RFS policy.

With a suitable increase in the price of cellulosic waiver credits, cellulosic ethanol production has the potential to increase substantially. However, large changes to the RFS percentage standard will have a limited effect on production if the waiver price is low. This result echoes previous research highlighting the danger to the burgeoning cellulosic ethanol industry from incorrectly priced waiver credits. Our results imply that by imposing a revenue-neutral tax on fossil fuel usage in fuel production, social welfare increases in the form of lower pollution. They also imply that with an appropriately high waiver credit price, the optimal tax rate could be reduced substantially while still yielding the same societal benefits.

In a related study, Galinato and Skolrud (2016) consider an alternative revenue-neutral carbon tax scheme wherein carbon tax revenues are used to directly subsidize the price of cellulosic ethanol for the fuel sector, rather than to decrease the amount of an existing tax. In that study, social welfare increases by just a fraction of a percent, but cellulosic ethanol production increases dramatically: from 28% in Washington to 238% in Idaho. In comparing these studies the message is clear: if the policy is to target social welfare, using the carbon tax revenue to offset an existing tax is far more effective. However, if the policy target is to expand a biofuel industry, using the revenues to subsidize cellulosic ethanol production is important.

The revenue-neutral policy analyzed in this report shares some important similarities with the policy proposed by CarbonWA in early 2016. Both policies seek to incentivize the usage of low polluting, renewable fuel sources, and both use the pollution tax revenue to offset a preexisting distortionary tax. However, the CarbonWA policy is much more far-reaching, imposing the carbon/pollution tax on every sector in the state economy. In Washington State’s fuel production sector, we would expect producers to substitute away from crude oil towards less carbon-intensive options like cellulosic biofuel if subjected to the CarbonWA policy. Importantly, our results suggest that the optimal tax rate varies as a function of federal RFS policies. If the CarbonWA rate is to be optimal, in the sense of state welfare maximization, it may be necessary for their proposed rates to be allowed to fluctuate with federal RFS policy, especially with regard to changes in the cellulosic waiver credit price and the input ratio requirement.

**References**


