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The effect of biodiesel policies on world biodiesel and oilseed prices

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ABSTRACT

A theoretical and empirical model is developed to analyze the effect of a biodiesel mandate, a tax exemption (tax credit) and an exogenous diesel price shock on world soybean and canola markets. The jointness in crushing oil and meal from the oilseed reduces the size of the link between biodiesel and oilseed prices. A diesel price shock with a mandate results in a smaller change in oilseed prices compared with a tax exemption. Higher diesel prices increase biodiesel prices under a tax exemption but lower them with a blend mandate. When both canola and soybeans are used to produce biodiesel, an increase in the diesel price leads to higher canola prices, but the effect on soybean prices is ambiguous and depends on relative elasticities of meal demand and canola supply because canola produces more oil than soybeans.

1. Introduction

Biodiesel averaged 17.9% of total world biofuel production in the period of 2010–2012[3]; however, its share in vehicle miles traveled (VMT) equivalent is higher as a gallon of biodiesel produces 91% of the VMT compared to the same volume of diesel while ethanol produces only 70% of the VMT compared to gasoline. In the United States, biodiesel prices have been on average 1.91 times higher (or 1.49 times higher on energy equivalent basis) than ethanol prices in the period of April 2007 to December 2012, reaching a peak in December 2011 with a multiple of 2.24 or 1.74 on energy equivalent basis (Fig. 1).[4] A similar pattern is found in the European Union and Brazil.[5] There are several reasons for this significant price differential. For example, the United States and Brazil[6] have a specific biodiesel mandate where soybean oil is the primary feedstock, and the European Union employs significantly higher import barriers on biodiesel than on ethanol (with canola oil being the principal feedstock).[7]

The implications of OECD biodiesel policies for developing countries are not only higher oilseed prices but also a substantial increase in the relative value of oil *versus* oil meal in an oilseed which affects food prices and consumer welfare because vegetable oil consumption rises significantly as a country develops (OECD/FAO, 2011). Moreover, world prices of corn and other feedstock for ethanol also increase as a result of biodiesel policies in large developed countries – because of competition for land – thus, altering income distribution in developing countries: net producers of staple commodities are better-off, while net consumers lose. Needless to say, changes in world commodity prices can change the trade position of a developing country.

The objective of this paper is to provide some insights into the functioning of the oilseed–biodiesel–diesel market complex in a large country that determines the biodiesel price and to determine how the market equilibrium changes in response to diesel price shocks. Since (small) developing countries act as price takers in the commodity

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[3] http://stats.oecd.org/Index.aspx?DataSetCode=HIGH_AGLINK_2011.
[4] For comparison, we also depict the (volumetric) ratio of diesel and gasoline prices.
[5] The European Union, the United States and Brazil are world's most important biodiesel producers and consumers.
[6] Brazil's market is isolated from world markets through a government price setting program.

[7] In the United States, biodiesel is regarded as an advanced biofuel and its consumption is thus important for meeting the overall Renewable Fuel Standard. Some EU countries also set biodiesel specific blending targets. The future levels of EU blending targets have been intensively discussed recently. The EU Commission proposed in 2012 to cap the share of food-based biofuels to 5% by 2020. In September 2013, the EU Parliament voted to loosen the cap to 6% and set a separate 2.5% target to incentivize production of 'second-generation' biofuels, made from waste products. But on October 17, 2013 the proposal to cap EU's use of food-based biofuels was stalled by a vote in the European Parliament's environment committee.

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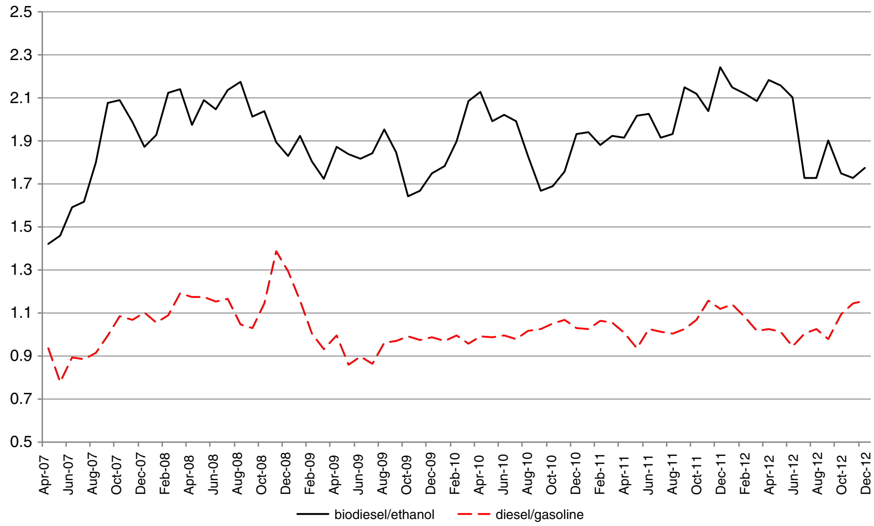

Fig. 1. Relative prices of transportation fuels.

markets analyzed in this paper (*i.e.*, soybean, canola and oils/meat thereof, as well as biodiesel), the predictions of our model can be used, for example, for shaping biofuel policies in developing countries. We assume that biodiesel producers in the large country face stable and sufficient supply of feedstock, an assumption that might not be appropriate for a small developing country (Msangi and Evans, 2013).

The analytical model captures the most important features of the oilseed–biodiesel–diesel market complex by incorporating the value of joint products, processing costs, fuel taxes and biodiesel policies. We also study how shocks in diesel prices affect the biodiesel feedstock prices. Our model assumes a large country in world biodiesel and oilseed (soybean, canola) markets that either implements a biodiesel consumption subsidy (*e.g.*, the U.S. tax credit or tax exemption at the pump level as in the European Union; see de Gorter et al. (2011) for details) or imposes a blending mandate on the share of biodiesel in the final diesel fuel blend (as in most countries with a biofuel policy).[8] In addition to the major biodiesel feedstocks – soybean and canola – the model is applicable to a variety of other oilseeds that are crushed into oil and meal; the model can also be used, after small adjustments, for analyses of biodiesel from jatropha or oil palm.

We emphasize how the different production process of ethanol and biodiesel affects the link between a biofuel and its feedstock. While corn-ethanol is directly produced from yellow corn, creating the direct relationship between ethanol and corn prices (Cui et al., 2011; de Gorter and Just, 2009; Drabik, 2011; Lapan and Moschini, 2012; Mallory et al., 2012), soybean (canola) has to be crushed first into soybean (canola) oil and meal, and biodiesel is then produced from the extracted soybean (canola) oil. It is the *jointness* in soybean crushing (*i.e.*, soybean oil and soybean meal) that breaks the direct link, observed for ethanol,[9] between the biofuel and its feedstock prices.[10]

We find that higher diesel prices (due to higher crude oil prices) increase the biodiesel price under the binding tax exemption (tax credit), but reduce it under the binding mandate.[11] This occurs because under the tax exemption consumers are free to choose which fuel they buy, depending on fuel's price per mile traveled; hence diesel and biodiesel are substitutes under a binding tax exemption (tax credit).[12] However, a binding blend mandate dictates a fixed proportion of biodiesel to diesel, thus implying complementarity between the two fuels. However, the impact of a diesel price surge on the feedstock prices is generally ambiguous and depends on the number of biodiesel feedstocks modeled — the results are equivocal when both soybean and canola are used to produce biodiesel (because canola yields more oil per hectare than soybean). We also find that for the same biodiesel production, a shock in the diesel price under a binding blend mandate results in a change in canola (soybean) price of a lower magnitude than under a binding tax exemption.

The remainder of the paper is structured as follows. The next section outlines the basic model with only one biodiesel feedstock, soybean. In Section 3, we extend the basic model to include a second feedstock (canola) that yields more oil per hectare and is thus preferred by farmers. We show how the inclusion of the second feedstock alters the model's responses to a higher diesel price. In Section 4, we empirically illustrate our theoretical results using the United States as an example of a large country in oilseeds and biodiesel markets. The final section concludes and draws some implications of the model for small developing countries.

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8 Janda et al. (2012) provide a review of frequently used biofuel policies in the world biggest biofuel producing and consuming countries.

9 The ethanol production process yields Dried Distillers Grains with Solubles (DDGS) which serve a similar role in animal feed as soybean meal. For more information, see footnote 17.

10 Despite a weaker link between biodiesel and soybean prices as compared to ethanol and corn prices, Kristoufek et al. (2012) find that the connections between biofuels and their feedstocks are much stronger after the 2007/08 food crisis than prior to it.

11 This implies that higher crude oil prices also impact soybean prices differently, depending on which biofuel policy (a tax exemption or a mandate) is binding. Therefore, it is important to incorporate biofuel policies in a model that is meant to quantify the effects of higher crude oil prices on agricultural commodities that are used as a biofuel feedstock. Ciaian and Kancs (2011) develop a multi-commodity model to investigate the responsiveness of prices of selected agricultural commodities to a positive crude oil price shock. They find that an increase in the crude oil price of $1/barrel increases soybean prices by $0.99/tonne. However, because they do not model any biofuel policy, the estimated price transmission coefficient should be interpreted cautiously as its bias grows larger the longer a biofuel policy was binding.

12 Although vehicle engines could, in theory, run on pure biodiesel (B100), in practice the upper limit for blending approved by vehicle manufacturers is 5 (B5) or 20 (B20) %, meaning that the fuel blend contains 5 (20) % of biodiesel and 95 (80) % of conventional diesel. The EPA recommends that biodiesel blends containing more than 20% of biodiesel should be evaluated on a case-by-case basis (Environmental Protection Agency, EPA, 2007).