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How policies affect international biofuel price linkages

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HIGHLIGHTS

- We estimate the role of biofuel policies in determining biofuel prices.
- We use a cointegration analysis and the Vector Error Correction (VEC) model.
- The biofuel policies in US and Brazil determine the world ethanol prices.
- EU biofuel policies tend to form the world biodiesel price.

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ABSTRACT

We estimate the role of biofuel policies in determining which country is the price leader in world biofuel markets using a cointegration analysis and a Vector Error Correction (VEC) model. Weekly prices are analyzed for the EU, US, and Brazilian ethanol and biodiesel markets in the 2002–2010 and 2005–2010 time periods, respectively. The US blender's tax credit and Brazil's consumer tax exemption are found to play a role in determining the ethanol prices in other countries. For biodiesel, our results demonstrate that EU policies – the consumer tax exemption and blending target – tend to determine the world biodiesel price.

1. Introduction

Noticeable changes in world markets for biofuels and biofuel feedstocks have occurred since the introduction of ambitious biofuel consumption targets in the United States, the European Union, and elsewhere over the last decade. In order to meet these targets, various policies have been introduced to incentivize biofuel production and/or consumption including blend or consumption mandates, consumption subsidies, and biofuel feedstock production subsidies. As biofuels' shares of their feedstocks have increased, the link between biofuel and feedstock prices has become stronger. During this same period, international trade in biofuels has increased significantly. Since biofuel and feedstock prices are closely linked, it is important to understand how international biofuel policies affect local prices of biofuels.

The link between biofuel and feedstock prices has been analyzed by previous research, including de Gorter and Just (2008), Lapan and Moschini (2012), and Mallory et al. (2012).[1] These authors derive analytical formulae that theoretically explain the (long-term) link between ethanol and corn prices. On the other hand, recent studies such as Balcombe and Rapsomanikis (2008), Busse et al. (2010), Ciaian and Kancs (2011), Serra et al. (2009), and Zhang et al. (2010) use econometric techniques to empirically study the nexus between fuel, biofuel, and feedstock (food) prices. A third strand of literature, which includes Abbott et al. (2009), Wright (2011), Yano et al. (2010), Hertel and Beckman (2011), and Janda et al. (2012), has attempted to explain the links between biofuel policies, oil prices, and the levels and volatility of food prices.

The growing volume of trade in biofuels has been driven by differences in biofuel blend requirements between countries as well as differences in environmental legislation (Meyer et al., 2012). For example, high sugarcane prices have recently caused Brazil to switch from being an ethanol exporter to being a major ethanol importer, and the US switched from being an importer of ethanol to supplying ethanol to Brazil's former export markets. US ethanol exports exceeded Brazil's exports for the first time in 2011 (Reuters, 2011). Another example of biofuel policies' international interactions is seen in the "splash and dash" exports of US (and non-US)

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[1] Kristoufek et al. (2012) use a taxonomy approach to analyze the link.

biodiesel to the European Union before mid-2009; see de Gorter et al. (2011) for further discussion of this phenomenon.

A key question pertaining to any analysis of biofuel policies is how the biofuel price is determined. In a closed economy framework, when a binding (i.e., determining the biofuel market price) mandate is combined with a blender's tax credit, the mandate price premium and the tax credit are not additive (de Gorter and Just, 2009). This implies that only one biofuel policy determines the biofuel price at a given point in time. But what biofuel policy and which country determines the world biofuel price when international trade is considered? Although the answer to this question has important implications for the analysis of biofuel policies, we are only aware of two studies which address it: Kliauga et al. (2011) and de Gorter et al. (2011). The former finds that the US blender's tax credit for ethanol determined ethanol market prices in the United States and Brazil; the latter concludes that the European Union was the price leader for biodiesel in 2005–2010, with the market prices initially determined by an EU tax exemption and later by EU biofuel targets. A drawback of the foregoing studies is that they base their empirical conclusions on simple differences between the observed and theoretically predicted market prices, where the theoretical price is calculated under the assumption that the tax credit/tax exemption was the binding policy.

In this paper, we use time series econometric techniques (variance decomposition and cointegration analysis)[2] to answer two questions: which country is the price leader in world biofuel (ethanol, biodiesel) markets, and which biofuel policy (blender's tax credit, tax exemption, or mandate) determines the biofuel price in the world market. Unlike Kliauga et al. (2011), who include only two countries in the world ethanol market, we consider the United States, Brazil, and the European Union. Owing to data availability, our analysis of the biodiesel market is limited to the European Union (as proxied by Germany) and the United States. For both biofuels, we investigate a longer time period than Kliauga et al. (2011), and we use higher-frequency data than previous studies (weekly vs. monthly). Since our approach to identifying the price leader and the price-determining biofuel policy differs from the previous studies, we can assess the robustness of previous studies' results.

We find that the ethanol price was co-determined by the United States and Brazil over the period analyzed in our study (2002–2010), mostly via the US tax credit and the Brazilian tax exemption. This result differs from Kliauga et al. (2011), who conclude that the United States solely determined the world ethanol price with their blender's tax credit. For biodiesel, in the period 2005–2010 we find that the European Union established the world biodiesel price, which is consistent with de Gorter et al. (2011). Our results suggest that the EU biofuel target is the policy which determined the biodiesel price, although it is more difficult for biodiesel than for ethanol to convincingly determine which policy dictates the biofuel price.

The remainder of the paper is organized as follows. In the next section, we briefly describe the biofuel policies which are used in the countries we study. In Section 3, we discuss an existing theory of biofuel price formation and formulate three hypotheses to empirically test this theory. Section 4 describes the data, and Section 5 presents the econometric techniques used. Empirical results are presented in Section 6. Section 7 provides some concluding remarks.

[2] Cointegration analysis and the vector error correction model used in this paper are well-established techniques in the literature on energy markets. For example, price interdependencies at the global level as well as among different types of energy markets – such as oil, gasoline, or natural gas – have been analyzed by Serletis and Herbert (1999), Asche et al. (2001), Paul et al. (2001), Asche et al. (2003), Siliverstovs et al. (2005), and Cuddington and Wang (2006).

2. Biofuel policies

A variety of policies exist which can directly or indirectly affect biofuel production or consumption. The policies which directly impact the biofuel market include blender's tax credits, tax exemptions, mandates, and biofuel production subsidies; policies which indirectly affect the biofuel market include import tariffs, biofuel feedstocks production subsidies, and research and development subsidies. In our study, we focus on three direct policies: blender's tax credits as used in the United States, tax exemptions as used in the European Union and Brazil, and mandates, which are used by all three countries studied. The remainder of this section describes these policies in more detail.[3]

In the United States, a blender's tax credit is received by fuel blenders for each gallon of biofuel they blend into the final fuel (which is a blend of a biofuel and a fossil fuel). Since the tax credit is a subsidy to biofuel consumption, it benefits fuel consumers. Blenders are able to reduce the price of the final fuel by the amount of the tax credit, adjusted for the share of the biofuel in the fuel blend. The federal corn ethanol blender's tax credit was equal to 45 cents per gallon before it expired on December 31, 2011; fuel blenders receive an additional state-level subsidy, which averages 7 cents per gallon and takes the form of a tax credit in most states. Biodiesel blenders enjoy a tax credit of $1 per gallon of biodiesel blended with regular diesel.[4]

A tax exemption in the European Union and Brazil represents a reduction in the fuel excise tax collected at the pump level. The economic impacts of a blender's tax credit and tax exemption are identical in a closed economy—both constitute a biofuel consumption subsidy, but their effects differ substantially in an open economy framework.[5] The level of the tax exemption varies across EU countries and between biofuels, but it declines over the period of our study as governments tried to recoup fuel tax revenue. For example, a tax exemption for biodiesel in Germany declined from €0.47 per liter to €0.29 per liter between 2005 and 2009. For Brazil, Kliauga et al. (2011) report a consumption-weighted average tax exemption for ethanol of $0.67 per liter, which is approximately 2.7 times the US tax credit.

Finally, biofuel mandates are often used in combination with either a blender's tax credit, as used to be the case in the United States, or a tax exemption, as is currently the case in the European Union and Brazil. Although the US biofuel mandate is set as a consumption mandate, that is, as a quantitative requirement, in practice the US Environmental Protection Agency implements it as a blend mandate by annually specifying a minimum volumetric percentage of a biofuel in the final fuel mix (Tyner, 2010). The European Union uses a blend mandate, requiring that the biofuel makes up a pre-specified minimum share of energy content of the fuel. For instance, the blend equivalent of the US ethanol consumption mandate was set to 7.95 percent in 2011 (Reuters, 2010). In the EU, a mandatory 10 percent minimum target is set for the share of biofuels in transport fuel consumption by 2020 (Directive

[3] According to the data from the US Energy Information Administration, in 2009, the United States, Brazil, and the European Union combined represented 92 and 93 percent of world ethanol production and consumption, respectively. In the same year, the EU and US shares of world biodiesel production and consumption amounted to 67 and 75 percent, respectively (http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=79&pid=80&aid=1&cid=regions,&syid=2005&eyid=2009&unit=TBPD).

[4] Since its implementation in 2005, the biodiesel tax credit was allowed to expire twice: first in 2010 (later reenacted) and then in 2012. The tax credit was retroactively reenacted again in 2013.

[5] The reason is that once the world market price of a biofuel is established by one country, a tax credit or a tax exemption in the other country cannot affect it, but would instead act as a production subsidy in the case of a tax credit or a fuel consumption subsidy in the case of a tax exemption (Kliauga et al., 2011; de Gorter et al., 2011).