OPEC and the Environmental Impact of Biofuels

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Much attention has been given to the introduction of biofuels assuming competitive oil markets. This paper argues that OPEC behaves as a cartel of nations and that this suggests different outcomes than those derived under the competitive or the standard cartel models. In particular, the paper shows that the competitive model overestimates the price effect of the introduction of biofuels but underestimates the quantity effect and, thus, the impact of the introduction of biofuels on the environment.

Concerns about the high price of oil, energy security, and balance of trade, combined with the desire to reduce greenhouse-gas (GHG) emissions and enhance rural development, led to a wide array of policies supporting biofuel production in the United States and the European Union (EU). These included the American Clean Energy and Security Act of 2009 as well as the consumption of biofuels as part of renewable fuel polices, such as the California and the EU renewable fuel standards.

A large body of literature analyzed the impacts of these policies on fuel and food markets and their optimality. However, some of the studies analyzing the impacts of biofuel on the fuel markets assume that they are competitive without special attention to the behavior of the Organization for Petroleum Exporting Countries (OPEC) and their impacts. In this paper we present the results of research that aim to model OPEC's behavior and how OPEC's behavior will affect the price impact of biofuel on fuel prices and GHG emissions.

Oil Revenue and Fuel Prices

In the 1960s, OPEC was founded to unify and coordinate members' petroleum policies. Currently, it has 12 members, including major oil producers, such as Saudi Arabia, Iran, Iraq, Venezuela, and Nigeria, which control more than 50% of the known oil reserve and produce 42% of the crude-oil production. The organization uses its market power to control production and pricing of oil with varying degrees of effectiveness.

Figure 1 depicts OPEC's revenues through 2008 and suggests that OPEC members' revenues peaked in the late 1970s and in the new millennium. The increase in oil revenues in the new millennium was a result of an increase in global demand for crude oil from 2000 to 2008, associated with a slow increase in supplies, which led to a rapid increase in the price of crude oil during the same period.

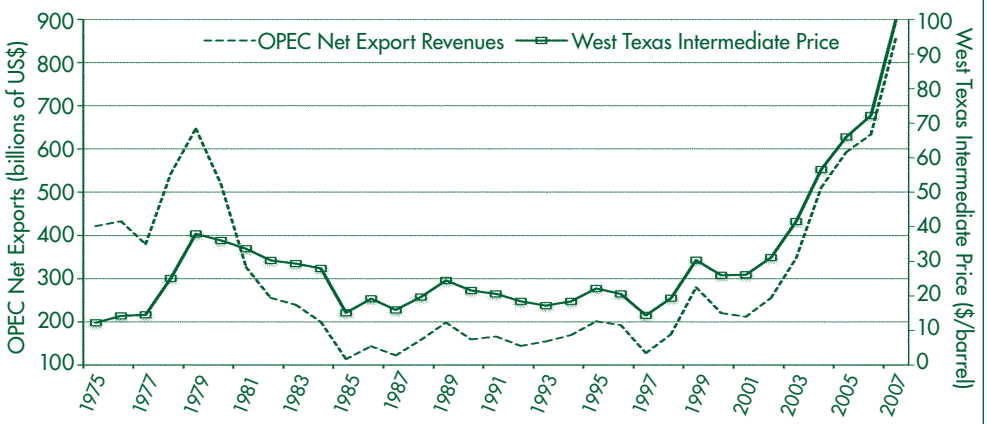
Although prices more than quadrupled, OPEC production during 1998–2010 increased by an average of only 0.6% a year and the exports grew by only 0.2% a year. The slow growth in production may reflect either slow expansion of supply or more discipline exercised by the cartel members.

Some of the revenue of OPEC countries has been allocated to subsidize fuel prices domestically, as consumers of gasoline and diesel in OPEC countries pay significantly lower prices at the pump compared to the rest of the world. In 2006 average super gasoline prices in non-OPEC countries were 1.04 USD per liter, including an average base retail price of 0.63 USD per liter and extra domestic fees of 0.41 USD per liter, whereas in OPEC countries they averaged only 0.28 USD, which reflects a subsidy of 0.35 USD per liter.

We computed the subsidy or tax equivalent levied on gasoline at the fuel pump compared to a benchmark export gasoline price, and the results are depicted in Figure 2. The figure illustrates the widening of the gap between gasoline prices in the oil-importing countries and OPEC countries in the new millennium. During this period, nominal gasoline subsidies in OPEC countries increased while crude-oil prices grew by more than 500% and gasoline prices in the rest of the world surged.

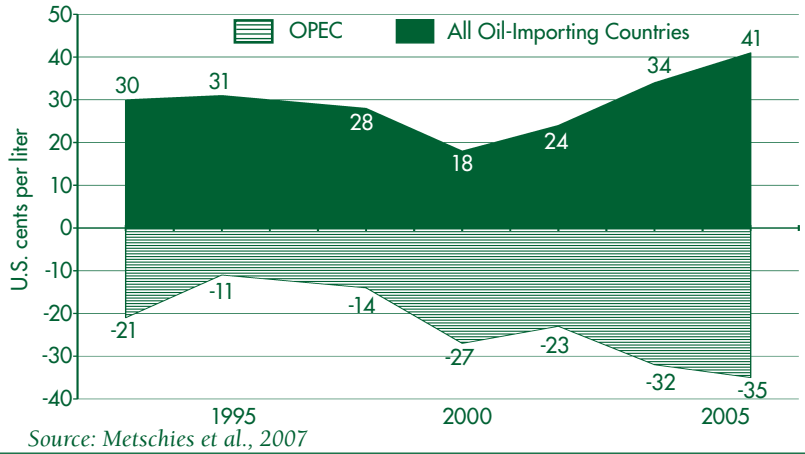
Another perspective of fuel pricing is presented in Figure 3. It depicts average gasoline and diesel prices in both OPEC countries and in the rest of the world. From 1993 to 2000, the gap between prices in OPEC countries and the rest of the world was stable but, after 2000, the gap began to grow at an increasing rate as OPEC intensified the utilization of its monopoly power.

Figure 1. OPEC Oil-Export Revenues and West Texas Intermediate Price, 1975–2007



Source: EIA, 2010

Figure 2. Subsidies or Taxes Levied on Gasoline Consumption



Source: Metschies et al., 2007

Explaining the Pricing of Crude Oil and Transportation Fuels

The pricing patterns presented above suggest that OPEC countries exercise their market power so that the outcomes of crude-oil and transport-fuel markets deviate from the competitive outcome. Under this equilibrium, output is determined by equating supply and demand and the price is equal to the marginal cost of production—the cost of producing the marginal (most expansive) unit sold.

Several studies model OPEC as if it were a cartel of firms and suggest that it sets prices to maximize profits for its members so that the quantity sold is below the competitive level and the price is above the competitive price and the marginal cost of production. However, a monopolistic firm will not subsidize a group of consumers as OPEC does. So we model OPEC as a cartel of nations.

Such cartels are run by politicians who consider the gains of producers (technically, producers' surplus) from profits (both in the domestic and international market), and the gains of consumers (consumers' surplus) from the gap between the benefits of fuel and the price paid for it. Therefore, a cartel of nations will charge consumers in an importing nation a profit-maximizing monopoly price while subsidizing the domestic consumers. The subsidy depends on the relative weight given to producers' versus the consumers' surplus. Our empirical analysis suggests that, on average, equal weight is given to the welfare of the two groups but there are differences in the subsidizations among countries (see Table 1).

The fuel subsidies are "cheap fuel" policies used by the government to buy political support. They are akin to the widely used "cheap food" policies but, unlike cheap food policies that aim to placate the poor, the cheap fuel policies are targeted to buy the good will of the middle class. Countries may provide more subsidies if the political accommodations that they buy are especially valuable. Indeed, Table 1 suggests that subsidies are more likely to occur in countries with a major reserve or in authoritarian countries, such as Iran or Venezuela.

OPEC and Biofuels

This research aims to explain the impact of the introduction of biofuels on fuel markets while introducing OPEC into the analysis. This work evaluates the impact of biofuels on fuel markets while incorporating OPEC into the analysis and assessing the effect of the introduction of biofuels on the international price of oil, the price of gasoline inside as well as outside of OPEC countries, and the global GHG emissions.

This is done while making three alternative assumptions on the international oil markets: Markets are competitive, OPEC is a cartel of firms that maximizes profit, and OPEC is a cartel of nations that maximizes economic surplus from oil production and domestic consumption.

Using data from 2007 while considering quantities of both ethanol and biodiesel consumed that year (approximately 16 billion gallons), we developed a model that is used to synchronize outcomes among gasoline, diesel, and crude-oil markets—a challenge given that we only have partial data for each of the markets.

A key parameter that affects the outcome of the analysis is how responsive the demand of oil from OPEC in the oil-importing countries is to changes in fuel prices. Less responsive (less elastic) demand means that, when price increases, there is less reduction in consumption or, inversely, that prices go up further for a given decline in fuel demanded. We use four parameters from -1.25 (least elastic) to -2.0 (most elastic).

The introduction of biofuels is estimated to have increased fuel subsidies

Table 1. The Gap Between Domestic and International Prices Varies Among OPEC Countries

Country	Domestic Price cents/liter	Gap
Venezuela	2	62
Iran	3	61
Saudi Arabia	7	57
Libya	13	50
Algeria	19	44
Qatar	19	44
Kuwait	21	42
Angola	36	27
Indonesia	44	19
UAE	53	10
Nigeria	66	-3
Iraq	NA	NA

Note:The gap equals the international price minus the domestic price of fuel in an OPEC country using 2006 data. The international price of 0.63 USD per liter equals the retail price of gasoline in the United States minus 0.10 USD for two road funds (federal and state). Because there are no other specific fuel taxes, this price can be considered as the international price of fuel.

in OPEC countries in 2007 by 2%–3% and reduced world fuel prices by 2%. The introduction of biofuels caused the import demand of oil from OPEC countries to decline, leading to a decline in fuel prices. Then, OPEC responded by reducing exports so that the supply of oil available to oil importers would decline, which would contribute to increased fuel prices in the oil-importing countries.

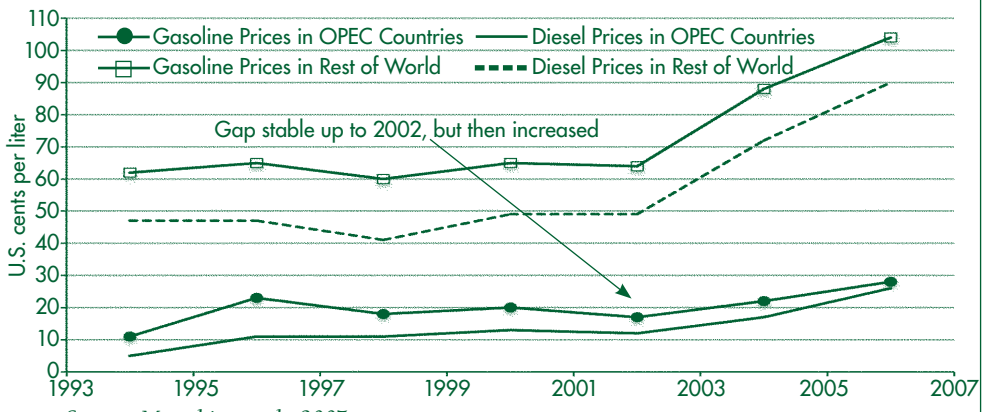
Some of the oil that was withdrawn from the oil-importing countries went directly to OPEC's domestic consumers. Thus, OPEC mitigated the loss in profits due to the introduction of biofuels by redistributing benefits from the introduction of biofuels to its domestic constituencies.

The introduction of biofuels caused consumption of gasoline and diesel in 2007 to decline by about three billion gallons a year, which is about 2.5% of total consumption. However, the decline in fuel prices resulted in an increase in total fuel consumed (including biofuels). This increase in overall fuel consumption because of a lower price is called the "rebound effect." For the range of elasticities investigated, we show a rebound effect of about nine billion gallons a year. The rebound effect may lead to an increase in overall GHG emissions with biofuels.

While biofuels may emit less GHGs per unit of energy, the larger volume of fuel consumption may lead to a larger volume of GHG emissions. Using the cartel of nations model, we show that there is potential for GHG emission savings with the introduction of advanced biofuels, such as cellulosic biofuels.

The model used to characterize the energy market affects estimates of the biofuel effects on consumption and production as well as on fuel prices and GHG emissions. Competition overestimates the price effect but underestimates both quantity and environmental effects associated with the introduction of biofuels (e.g., the environmental effect is underestimated by about 40%). Our analysis also shows that modeling the oil market as either competitive or with a cartel of nations overestimates the monetary benefits of the introduction of biofuels to oil-importing countries but underestimates the costs to oil-exporting countries.

Figure 3. Gasoline and Diesel Prices Inside and Outside of OPEC Countries



Source: Metschies et al., 2007

Discussion and Concluding Remarks

The analysis suggests that the introduction of alternatives to crude oil (e.g., shale gas and biofuels) will reduce fuel prices and crude-oil production but increase overall fuel consumption. The GHG emissions will decline if the alternatives to conventional fossil fuels are relatively clean but, for most commercially used biofuels, total GHG emissions will increase.

The introduction of biofuels affects OPEC pricing behavior: OPEC mitigates the reduction in oil revenues due to the introduction of biofuels by increasing domestic fuel consumption but reducing exports more than implied by the introduction of biofuels under the competitive model. Thus, when assessing the impact of biofuels, the outcomes under a cartel of nations model are different than those under competition.

Although the introduction of biofuels leads to a reduction of fuel prices in oil-importing countries, this reduction is smaller than the reduction computed under competition, suggesting that the estimated gain from biofuels to the consumers in the oil-importing countries under a cartel of nations is smaller than under competition (the decline in prices is smaller under a cartel of nations). However, when compared to the competitive model, the cartel of nations predicts a larger reduction in exports and, thus, a larger reduction in foreign exchange. That is, the impact of biofuels on GHGs under the cartel of nations is relatively more positive than predicted by the competitive behavior.

Theory and empirical analyses suggest that assessment of the impact of alternatives to crude oil require better quantitative modeling of the oil markets, including OPEC. They suggest that further empirical work, especially econometric analysis of OPEC pricing behavior, is needed to further support and expand this line of research and to improve our understanding of the international oil markets.

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