ELSEVIER

Energy Policy 33 (2005) 171–182

ENERGY POLICY

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Micro-economic modelling of biofuel system in France to determine tax exemption policy under uncertainty

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Abstract

Liquid biofuel support program launched in 1993 in France is implemented through tax exemptions to biofuels produced by agro-industrial chains. Activity levels are fixed by decree and allocated by the government to the different chains. Based on earmarked budget increase voted in the parliament, total quantity of biofuels will be increased by 50% in the horizon 2002–2003. A micro-economic biofuel activity model containing a detailed agricultural sector component, that is represented by 700 farms, is used to estimate costs and surpluses generated by the activity at the national level as well as tax exemption levels. Furthermore, Monte Carlo simulation has been used to search for efficient tax exemptions policies in an uncertain environment, where biofuel profitability is significantly affected by petroleum price and soja cake prices. Results suggest that, for the most efficient units both at the industry level (large size biomass conversion units) and at the agricultural sector level (most productive farms), unitary tax exemptions could be decreased by 10–20% for both biofuels, ethyl ether and methyl ester, with no risk for the viability of any existing chain.

Keywords: Liquid biofuels; Monte Carlo simulation; LP modelling; Tax exemption policy

1. Introduction

Biofuel Production (ethanol-to-ETBE and methyl esters)[1] has reached a significant level in France, where about half of total European production of ethanol and methyl esters is produced. This development is triggered by the EU revised Common Agricultural Policy of 1992, that obliged large farms to set aside a part of their land previously cultivated by cereals in order to control overproduction related expenses. In France, the government attempted to alleviate farmers' revenue decrease due to the obligatory set-aside that meant to them an unacceptable idleness rate of machinery, through the implementation of an ambitious support program to incite liquid fuel production from biomass. A tax exemption of $0.35\,€\,l^{-1}$ for methyl ester from vegetable oil and $0.50\,€\,l^{-1}$ for bioethanol as well as a budget of 1.2 billion francs have been allocated to biofuels. As a result, farmers have cultivated energy crops in set-aside land (according to the revised CAP land set-aside could be cultivated by crops not destinated to food markets) since the 1993–1994 period.

The development of both biofuel chains depends actually on two interrelated elements: the European Union regulations and their transposition to the national law system through industrial capacity approvals by regulation authorities and second on tax exemptions. The European Commission decree (9 April 1997) that approved the tax exemption regime applied to predefined volumes of biofuels was based on the notion of pilot projects supporting the development of non-polluting activities (directive 92/81-Article 8-section 2). After BP Chemicals Ltd. lodged a complaint against France, the European court verdicted that given the level of development of the activity it could no longer be considered as a pilot project. In response to that France has demanded that dispensations may be granted according to section 4 of the directive 92/81-Article 8 focusing on specific policies of member states. At the time being two proposals are examined by the Commission services: The first concerns a modification of the directive 92/81 to give the possibility to apply less tax rates to fuels containing biomass-origin components. Secondly, it is seriously considered an obligation of incorporation of biofuels to fuels of fossil origin.

By the year 2000, the cultivated surface reached 400 000 ha and the total amount of biofuels production

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[1] ETBE: ethyl tertio-butyl ether, RME: rapeseed methyl ester.

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doi:10.1016/S0301-4215(03)00208-8

in France has crossed the line of 400 000 t, marking an increase of 19% comparing with the year 1999 (Table 10 in the appendix). Biofuel volume currently represents approximately 536 000 t (considering that 92 000 t of ethanol are equivalent to 196 000 t of ETBE), or 1.5% of the national liquid fuel consumption. The conversion of biomass to biofuels is concentrated in a few plants (Table 11 in the appendix), whereas the agricultural raw material is produced by thousands of farms located in different parts of the country at varying costs. Total production will increase according to new agreements allocated to the industry by the French government (three more conversion units), to reach in 2002–2003 the quantities shown in Table 1.

The increased importance of the biofuel development program in France stimulated our interest to improve modelling tools used in the past to evaluate public policy (Sourie et al., 1997; Bard et al., 2000) and to attempt to build a biofuel system encompassing model in order to complete recent studies that focus on a mono-chain biofuel analysis (concerning ME production, Costa and Requillart, 2000). A micro-economic supply chain model has been developed for this purpose, based on the detailed description of the agricultural sector that has been used to evaluate Berlin EU summit decision impacts to arable cultures in France. An industry model of French biofuel chains (ETBE from wheat and sugarbeet, rapeseed biodiesel), as well as demand functions of products and by-products are integrated in such a way that a partial equilibrium model to be formulated.

A micro-economic analysis of the French biofuel system is undertaken using this model in order to estimate biomass-to-energy opportunity costs as well as agents' surpluses. Welfare increases or losses due to the biofuel activity can thus be calculated as well as minimum tax exemptions for the three chains operating in France to break even. First results of this model have been published indicating that tax exemptions allow the industry to realise non-negligeable profits and farmers to benefit as well, although in a lessen extent (Rozakis and Sourie, 2002); a multi-criteria analysis have been carried out considering greenhouse gases emission reduction due to the biofuel substitution for fossil fuels (Rozakis et al., 2001). It is important though to assess systematically the project risk, as biofuel chains operate in an uncertain environment (highly volatile petroleum price—see Fig. 1, by-product price fluctuations directly influenced by the soja cake world market). As a matter of fact tax exemptions compensated for low oil prices whereas by the end of the 1990s a boom of oil prices resulted in high market prices for biofuels so that most of the tax exemption was transformed in net benefit for the industry. Even analysts[2] close to stakeholders point

[2] Les Cahiers de l'ONIOL, October 2001, "La jachère industrielle", p. 11.

Table 1
Biofuel production in France

	Sugarbeet	Wheat	Rapeseed	Total
Production ETBE (t)	249 333	124 667		374 000
Production RME (t)			387 507	387 507

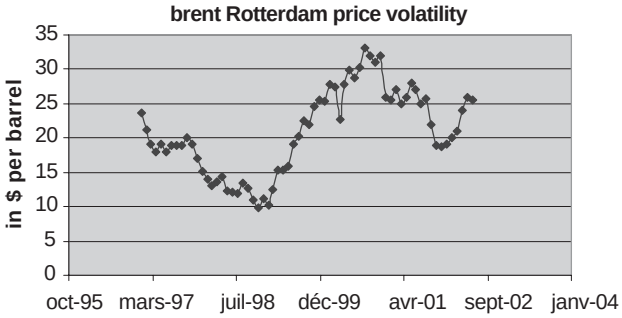

Fig. 1. Oil price evolution in the late 90s.

out "the modulation of tax exemption levels, as a function of oil and oil-seed grain world prices regarding ME and oil price regarding ETBE, is on the agenda" in order to adjust tax exemption levels taking into account oil price evolution since 1989. Efficiency and equity issues are of prime importance in the eyes of the taxpayer and the perpetuation of the support program will depend on reasonable adjustments of tax exemptions to biofuels.

We assume that model parameters such as product and by-product prices are related to oil and soja cake world prices through simple functions estimated using regression analysis. Then Monte Carlo simulation method that is extensively used to analyse conjuctural impacts on project rates of return (Houdayer, 1999) is implemented to estimate the impact of the oil and soja price fluctuation to biofuel chain benefits and to explore feasible tax exemption adjustments as a compromise between the objectives of budget concerns and the operation viability.

This paper is organised as follows. The partial-equilibrium model is briefly presented in the next section. Model results on biofuel cost of chains operating currently in France under different policy scenarios are presented and analysed. Next, the contribution of micro-economic modelling for the exploration of possibilities of biofuel cost reduction in the short- and medium-term is pointed out. Finally, Monte Carlo simulation is implemented to cope with the uncertainty question and results are presented along with estimations of minimal tax exemption levels for the viability of the activity; remarks on policy implications conclude the paper.