BIOFUEL PROGRAMS AND FARM SUPPORT: NEW TOOLS FOR OLD POLICIES?

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Paper prepared for presentation at the 14th ICABR Conference
"Bioeconomy Governance: Policy, Environmental and Health Regulation, and Public Investments in Research"
Ravello, Italy, June 16-18, 2010

Paper to be considered for special issue of AgBioForum: No

Financial support received by the "New Issues in Agricultural, Food and Bio-energy Trade (AGFOODTRADE)" (Grant Agreement no. 212036) research project, funded by the European Commission, is gratefully acknowledged. The views expressed in this paper are the sole personal responsibility of the authors and do not reflect those of the Commission which has not viewed, let alone approved the content of the paper. The paper does not reflect the views of the institutions of affiliation of the authors either.

Abstract

In this paper, we focus on some indirect effects of biofuel policies that have not attracted a lot of attention, in particular the linkages with agricultural policy. In brief, biofuel policies re-introduce in the agricultural policy some of the mechanisms that characterized the farm support of the 1980s. In both the European Union (EU) and the United States (US) these policies relied on market price support achieved through a set of guaranteed prices, public purchases and export programs. By creating an "artificial" demand of agricultural products for non food use, biofuel policies play a rather similar role to the ones played by former EU intervention/export subsidies policy and to the US export enhancement/target price programs. We focus on the welfare effects of current biofuel policies compared to old farm support policies, and we explore the similarities and differences. Finally, we present some empirical illustrations of the overall differentiated effects using a large scale general equilibrium model.

Keywords: Agricultural Policies, Biofuels, Computable General Equilibrium.

Introduction

The United States (US) and the European Union (EU) have implemented ambitious biofuel policies. As a result, a third of US corn production and two thirds of EU rapeseed production are now channeled into energy markets (USDA, 2009). A number of studies have focused on the consequences for food markets, on the environmental effects and on budgetary costs. Most studies suggest that biofuels have contributed to inflate food costs for consumers – even though the magnitude of the effect is highly controversial – and that they have been costly for taxpayers (Steenblik, 2008; De Santi 2008, OECD 2008, GAO, 2009; de Gorter and Just 2010). Recent studies also conclude that the environmental impact of such policies is questionable, especially when one takes into account the global changes in land use that the production of energy crops require at the world level (Howarth and Bringezu 2009; Al-Riffai *et al*. 2010). Even if one accounts for the value of the greenhouse gases (GHG) emission reduction, e.g. using prices based on the emission trading markets, EU and US biofuel policies are unlikely to pass cost-benefit analysis criteria, at least before a major technical change takes place which would make the second generation of biofuels more competitive.

In this paper, we focus on some indirect effects of biofuels that have not attracted a lot of attention, in particular the linkages with agricultural policy. We consider the effect of the EU and US biofuel policies in a second-best framework, assuming that the primary objective is to support agricultural producers, and we compare them to alternative farm policies. The second-best framework adopted here is no justification of the distortions introduced by biofuel subsidies and tax credits, and farm support could be reached through more targeted and less distorting instruments, closer to the lump sum transfers advocated by standard economic theory (Gardner, 1995). Support to EU and US agricultural production has nevertheless been in place for decades, and recent agricultural legislations such as the US 2008 Farm Bill or the 2008 EU "Health Check" decision, suggest that it is unlikely to go away. We consider that biofuel enhancement programs are part of agricultural support policies. A relevant question is how this instrument compares with the support policies that the EU and the US were implementing, and still use in spite of recent reforms.

Comparative statics show that EU and US biofuel policies actually re-introduce in the agricultural policy some of the mechanisms that characterized the farm support of the 1980s. In the EU as well as in the US these policies relied on market price support achieved through a set of guaranteed prices, public purchases, export programs and deficiency payments. Many of these instruments were dismantled in the 1990s and 2000s and both the EU and the US moved towards systems of direct payments to farmers, which are supposed to be less distorting. By creating an "artificial" demand of agricultural products for non-food use, biofuel policies – and in particular the current quantitative mandates to use biofuels – play a rather similar role to the ones played by former EU intervention/export subsidies and US export enhancement/target price programs.

Most agricultural economists would agree that the global record of "old" price support policies is at best questionable, as far as welfare and transfer efficiency are concerned. However, the particular kind of farm support brought about by biofuel policies does not lead to all the same undesirable effects. In spite of similarities, there are significant differences with traditional farm support, in particular for domestic taxpayers and for third countries producers, even though the mechanisms at stake are different in the EU and the US, in particular as far as the terms of trade effects are concerned. If we consider that biofuels are part of a political economy balance and take for granted the fact that governments will support farmers, the comparison of biofuel policies with traditional farm policies (i.e. in a second-best framework) shows that the current EU and US biofuel mandates bring some significant differences compared to old instruments, notably by redistributing the burden on particular agents. In section 1 we describe the current EU and US agricultural and biofuel policies. In section 2 we focus on the welfare effects of current biofuel policies compared to old farm support policies, and we explore the similarities and differences using stylized situations. Because of the different instruments used in the EU and US farm policies and the net trade situation, conclusions that hold for the US do not necessarily hold for the EU and vice versa. In section 3, we present some empirical illustrations of the overall effects of EU and biofuel policies using a large scale general equilibrium model. In the simulations, we assume that biofuel policies are primarily a way to support farm incomes, and neglect other rationales such as reduced dependency from foreign energy supply, or GHG emissions reduction. In order to account for the potential second-best nature of the EU biofuel policies, we compared the effects of the EU and US current mandates to a situation where farmers would have been paid the same feedstock price through “old policies” schemes.

1. EU and US farm policies

1.1. "Old" and new farm policies

In the EU, a major characteristic of agricultural policy support in the 1980s was the organization of transfers from consumers to producers, through (high) guaranteed prices. The main agricultural markets were managed by a system of import duties, public intervention purchases to support prices above a pre-defined target price, and export subsidies (called export "refunds") to dispose the excess production that was not purchased by consumers. This system characterized the EU policy for wheat and coarse grains, in particular. In the case of oilseeds, the EU policy was somewhat different. After the 1974 "soybean crisis" and the embargo on US soybean exports that damaged the EU cattle sector, the EU implemented a policy that aimed at reducing dependency on foreign imports of oilseeds and proteins. The EU had bound very low tariffs during the Dillon Round of the General Agreement on Tariffs and Trade. An intervention system would have led to public purchase of foreign products (the corollary of a public intervention *à la* EU is to have some degree of border protection). In addition, the domestic livestock sector lobbied against policies that would lead to an increase in EU feedstuffs prices. As a result, the EU implemented a "deficiency payment" type of policy, i.e. an administrative target price to producers, achieved through a per ton direct payment, leaving consumers enjoy a lower market price. After the US embargo, the EU raised the guaranteed price, leading to a rapid expansion of the area sown and an increase in production from 3.1 million tons in 1979 to 12.2 million tons in 1987. Within a few years, the oilseeds sector became the largest source of budgetary expenditure in the CAP. Deficiency payments for rapeseed only increased from 179 million Ecus in 1979 to 1.6 billion in 1990, before the system was reformed in 1992.

Markets were also largely administered in the US, where public intervention on prices dated back to the 1930s. A system of "loan rates" acted as a floor price for producers (it still does for "program crops"). Unlike in most EU Common Market Organizations, the taxpayer (rather than the consumer) was asked to contribute to a larger share of the price support, since deficiency payments covered the difference between this loan rate and target prices (see Gardner, 1992). The US also "retaliated" to EU export refunds by also implementing a variety of schemes to subsidize exports, through the Bonus Incentive Export Program, then followed by the Export Enhancement Program (still in place but not activated for years), several systems of export credits and food assistance programs that were sometimes used as a way to provide subsidies to buyers of US products (see Bureau and Witzke 2009 for details).

The caveats of EU and US policies systems became apparent in the 1980s. Their domestic price support policies depressed world prices, making the support system increasingly expensive. The cost of the EU export refunds and the US export enhancement programs swelled. Intervention stocks piled up in the EU with supply boosted by high producer prices and technical changes, while demand, in particular for cereals, was depressed by the high domestic price. The US had to idle up to more than 20 percent of arable cropland, also at a very high cost for taxpayers.

Major reforms took place in the 1990s. A common feature of these reforms was a reduction of the role of market price support. In 1993, single per hectare payments for cereals, oilseeds and protein seeds – subject to a surface limitation and the obligation of set-aside – replaced price support, while the intervention price for wheat was halved between 1992 and 2005. These payments progressively lost their links with the quantities produced. Eventually, the EU got rid of most market management, basically leaving some public intervention only for wheat and dairy products. Furthermore, most EU payments were decoupled from production with the 2003 and 2008 reforms.

In the United States, reforms have not been as dramatic as in the EU. Farmers still enjoy a larger share of payments that are function of the quantities produced. The system of marketing loan programs still guarantees farmers a minimum price for all production and has the potential to influence acreage decisions more than any other program. The move away from price support in the 1997 farm legislation was somewhat reversed in 2002 with the move back towards payments based on market conditions. However, there has also been a move away from price support, and a move towards decoupled payments and index-based insurance payments, compared to the farm policy of the 1980s. The category of support called "direct payments" in the US farm policy includes transfers that are largely independent from price variations and to a large extent decoupled from production. "Countercyclical payments" are triggered whenever the market price ("season-average" price) is less than the effective target price but the amount of payment is based on a farm’s program yield, and a farm’s program acreage, so they are decoupled from current production, hence with limited impact on planting.

1.2. Economic consequences of farm policy reforms

The welfare effects of the "old" policies of price support through export subsidies/administrative price setting (both EU and US for grains in the 1980s) or through deficiency payments (US for grains and EU for oilseeds in the 1980s) are illustrated in many textbooks (for example in Helmberger 1991). The typical approach is to measure surplus variations for producers, taxpayers and consumers, and the deadweight losses usually represented as "Harberger triangles". When the importing or exporting country has market power, as it is the case here – the US being a large exporter of grains and soybeans, and the

EU a large exporter of grains and a large net importer of oilseeds – the quantities traded impact the world price.

The size of the Harberger triangles depends on the price elasticities. For some highly inelastic supply and demand, deadweight losses are limited. In a competitive market, with no externality and perfect information, there is a broad agreement that a system of targeted decoupled payments results in smaller deadweight losses than a system of price support. The opportunity cost of public funds nevertheless makes this conclusion less certain in a second-best framework given that direct payments impose a larger burden on taxpayers, involving some indirect costs of raising taxes and managing individual payments. In a large importing country, a higher domestic price associated with border protection can have a positive terms-of-trade effect that offsets some of the distortions costs borne by consumers. In real life, some other impacts should also be taken into consideration, especially those related to imperfect information on future prices and on risk. In particular, a more stable price *ceteris paribus*, has a positive impact on consumers, who are often risk-averse. It can also have a positive impact on producers, but if the market is competitive, a more stable price leads producers to pass the risk premium saved (i.e. the difference between the average fluctuating price and the certainty equivalent) to consumers through a lower average price. Altogether price stabilization can often lead to a social gain (Samuelson, 1972). As a result, the welfare effect of price-support policies for the countries that implement them is somewhat ambiguous and numerical estimates are often required in order to make a conclusive statement on the comparisons of policies. The impact on third countries is also ambiguous. By leading to larger domestic production, the consequences of both a deficiency payment and an export subsidy are lower world prices. This benefits foreign consumers (and net food-importing countries as a whole) but adversely affects foreign producers. The long-run consequences of deterring local production in third countries should also be taken into account (World Bank 2008).

In practice, numerical estimates suggest that the welfare costs of agricultural policies exceeded the benefits for producers. Indeed, the costs for the EU food industry and the final consumers caused by high institutional prices, as well as the costs of storage and surplus disposal for taxpayers were large compared to the gains for farmers in the EU. In the US, the deficiency payment policy was seen as generating less deadweight losses on the consumer side, but the successive export enhancement programs of the 1980s were also characterized by a low degree of transfer efficiency (Helmberger and Chavas, 1996). Typically, the traditional EU and US farm policies, that supported and stabilized domestic prices, imposed a considerable burden on third countries producers, by disposing EU and US surpluses in the world markets. The 1990s reforms, which led to less reliance on market price support and are greater use of direct payments, removed many of these distortions. They also generated some inefficiency.[1] However, for what is considered as reasonable levels of elasticities and opportunity costs of public funds, numerical estimates suggest that the shift toward direct payments reduced the overall welfare losses for the EU and the US and increased transfer efficiency of supporting farmers (OECD, 2009).

1.3. The EU and US biofuel policies

Both the EU and the US have set targets for biofuels. These policies include a mix of tax credits and subsidies. Because of the budgetary cost of tax credits and subsidies, there has been a shift towards mandatory incorporation of predefined quantities of biofuels in transport fuel in many OECD countries over the recent years. Quantitative targets are now the main driving force of biofuel production in both the EU and the US.

[1]For example, the management costs for direct payments are large. For high values of the opportunity cost of public funds, it is theoretically possible that export subsidies (which lead to subsidize only a share of production) be a less costly way of reaching a pre-determined level of producer support, even though the transfer efficiency of each unit of public subsidy is lower (Alston, Carter and Smith 1991).

The EU biofuel policy remains largely a Member State issue. Some EU governments have defined their own targets, designed their own policy instruments, and bear the cost of biofuel policies. However, what now appears as the major driver for EU biofuel production is the 2009 Renewable Energy Directive. The adoption of this directive has been controversial.[2] After much debates and objectives revised downwards, the final version of the Directive adopted in 2009 expanded the target to "renewable fuels" in road transport i.e., including potential "green" electricity and hydrogen, rather than a strictly biofuel target (in practice, biofuels, and in particular biodiesel remain by far the main renewable fuels).

The US bioenergy policy is based on the 2007 Energy Independence and Security Act, the 2008 Energy Improvement and Extension Act of 2008 and the 2008 Conservation and Energy Act (FCEA) as well as on many state-level programs. Several analysts estimate that through the energy act as well as other policies, the total public support to biofuels reaches $100 billion in the US for the 2006 - 2012 timeframe (Koplow, 2007; Steenblik, 2008). The US biofuel policy includes a combination of subsidies and mandates. The Energy Act includes a dramatic expansion of the renewable fuels mandate up to 36 billion gallons by 2022 (i.e. approximately 11 percent of demand for transport fuel), including 16 billion gallons for cellulosic ethanol and 15 billion gallons for corn starch and 1 billion gallon for biodiesel. The

[2] EU leaders initially set ambitious objectives for the blending of biofuel in road transportation. Criticisms regarding the environmental impact of biofuels have led to question the impact of such objectives, an issue heavily debated within the Commission and the European Parliament. Various EU internal analyses suggested that the carbon balance of biofuels might actually be negative, owing to a "carbon debt" incurred by biofuels when their production implies land use changes leading to a carbon release. The Directive eventually introduced sustainability criteria: minimal GHG savings have to be achieved (biofuels must provide at least 35% carbon emission savings compared to fossil fuel in 2010, and this level will rise to 45% by 2013 and 50% by 2017), some types of land are unfit to grow biofuels crops (primary forests, protected areas, grassland with a rich biodiversity, wetlands, and peatlands), and social standards have to be met. Subtargets for first- and second-generation biofuels were finally not taken into account and no legally binding reference to "indirect land use" aspects was kept in the final compromise. The Parliament and the Council will have to make a decision on indirect land use changes based on Commission's proposals before 2012.

FCEA includes extra provisions.[3] It was also used as a legal vector to set the subsidy at $0.46 per gallon, for all ethanol blended with gasoline. Payments go to petroleum blenders in the form of a tax rebate. Note that there is a great variability of measures at the state level and some state-level tax exemptions go up to doubling the amount resulting from federal subsidies and tax credits. There is also an additional federal support for small ethanol producers, a $0.54 per gallon import duty on ethanol, biodiesel tax credits, as well as other federal provisions for biofuels, topped by state and local programs for both ethanol and biodiesel which also contribute to large levels of support to biofuels (Yacobucci, 2008; GAO, 2009). Such a level of support has increased the attractiveness of ethanol and biodiesel production to levels well beyond those provided by market forces alone. With more than a third of the corn production used for ethanol production, the US biofuel policy is now having significant effects on crop demand, crop plantings, crop prices, food production costs and the availability of major US grain and oilseed crops for food use and exports.

The EU production of biofuel is mostly composed of biodiesel made from rapeseed. By contrast, in the United States, ethanol from corn is by far the main product, even though biodiesel production has increased dramatically since 2006. The linkage with other support policies that affect the feedstock is therefore different in the EU and the US.

The EU production of biodiesel reached 8.3 million cubic meters in 2008, up by a third from previous year. EU biodiesel production is highly concentrated, as three countries only (Germany, France, and Italy) account for more than 70% of quantities. Germany is by far the EU leading producer (36 percent of EU production, while France accounted for 24 percent in

[3] The FCEA includes an "energy" title, and several other titles also deal with bioenergy issues. The FCEA includes funding of loan guarantees for commercial-scale biofuel facilities; payments that support the production of advanced biofuels (e.g. biodiesel and cellulosic ethanol); the Biomass Research and Development program; the cellulosic ethanol producer credit. For the promotion of 2nd generation ethanol (cellulosic ethanol) a blenders' credit of $1.01 per gallon applies to ethanol produced from qualifying cellulose feedstock, and extends the tariff on ethanol imports.

2008). Biodiesel production uses today around 3 million hectares of arable land in the EU. Rapeseed accounts for 80 percent of the EU biodiesel production, while the share of soybean and palm oil (both imported) are both roughly 8 percent and sunflower is a minor source. The EU, which was a net importer of oilseeds but a net exporter of rapeseed oil, has now become a net importer of both seeds and oil, including rapeseed oil. Even though the area harvested in rapeseed has increased steadily because of the biofuel programs, total consumption of rapeseed exceeds domestic supply and the EU is expected to import 2.8 million tons of rapeseed in 2010. The EU ethanol production reached 2.8 million cubic meters in 2008. Preliminary figures indicate a strong growth in 2009, with 3.9 million cubic meters of ethanol. The most significant production increases were reported in France, Germany and Poland. Roughly 80 percent of EU ethanol production comes from grain and 16 percent from sugar beet. Wheat accounts for half of the grains used, but corn has grown rapidly over the recent period. The equivalent of some 2.1 million tons of wheat, 1.8 million tons of corn and close to 0.7 million tons of rye, barley and triticale were used for ethanol production in the EU in 2008. This remains marginal compared to more than 300 million tons harvested, including 160 million tons devoted to feeding animals. Ethanol is a relatively larger outlet for sugar beet (5% of EU production of beets).

Ethanol is by far the main biofuel used in the US, in the form of blends of 10 percent and 90 percent gasoline. In 2009, the United States consumed approximately 44 million cubic meters of US-produced ethanol (plus perhaps roughly 4 million cubic meters of imported ethanol). The US production of ethanol is therefore close to be ten times larger than the EU one. It is nevertheless to be compared to 600 million cubic meters of gasoline (which has a larger calorific power). Corn was grown on 35 billion hectares for a production of 338 million tons. The use of corn for ethanol was 109 million tons in 2009, to be compared to food and feed use of 137 million tons and exports of 53 million tons. In 2008, approximately 2.650 million tons were produced in the US (US National Biodiesel Board). The consumption of biodiesel is however limited, representing roughly 1 percent of the total consumption of petroleum-based diesel fuel. Soybean oil is the most common raw material, accounting for approximately 60 percent of US biodiesel production.

1.4. The "back to the future" effect of biofuels for farm policy

One issue that is often overlooked is that biofuel policy has *de facto* led to reverse the move away from price support and towards direct payments during the recent years, at least in the arable crops sector.[4] Indeed, support to biofuels has provided new outlets to grain and sugar farmers. The considerable use of corn for ethanol in the US and of oilseeds for biodiesel in the EU are now at levels that have a significant impact on the corresponding markets and they contribute significantly to higher prices. In both cases the public incentives have been determinant. To put it bluntly, by providing a new outlet to farmers, the biofuel policy *de facto* plays the role that export enhancement programs and other price support programs played in the 1980s.

One may argue that the biofuel policy is by no means comparable to the old agricultural policies, in the sense that its primary objectives are different from those of the farm policies. Indeed, EU authorities invoke several motives to legitimize public support to biofuels. Climate change is the first one. In a context where the transport sector accounts for around 30 percent of GHG emissions, biofuels are presented as a significant instrument of the EU strategy for lowering emissions in the transport sector. The second motivation is to reduce the dependence on foreign oil supply. Around 80 percent of EU oil consumption is covered by

[4] One may argue that the effect of public support to biofuels is not only overlooked by analysts, but also ignored by international arrangements dealing with distortions in farm policies, including those under the auspices of the World Trade Organization (WTO). Indeed, public incentives for diverting grains, beets and oilseeds into energy are not taken into account by the usual indicators used to measure farm support such as those constructed by the Organization for Economic Co-operation and Development (OECD, which developed the Producer Support Estimates) and the WTO which developed the Aggregate Measures of Support).

imports, and reducing dependence on foreign suppliers is a strong motivation given the recurrent threats of gas export restrictions by Russia and the fears of major crises that would limit oil supply by OPEC countries. In the US, alleviating the dependency on foreign sources of fossil energy is a posted target for biofuel policy. An initial driver of the development of fuel ethanol in the US was also the air quality legislation and the fact that there were fears that alternative additives such as Methyl Tertiary Butyl Ether (MTBE) could leak into groundwater.

However, these posted objectives are hardly convincing (OECD, 2008). The compelling evidence that ethanol made from corn or wheat actually leads to a reduction in GHG emission is weak, once the release of some gases from soil, and the warming power of some non-CO_2 (carbon dioxide) gases such as N_2O (nitrous oxide) are taken into account, especially if one considers the indirect land use changes through integrated markets. Most estimates conclude that the cost of GHG savings through the use of first-generation biofuels such as EU rapeseed-based biodiesel or EU wheat-based ethanol is much beyond what is recommended for public calculation. The cost per ton of reductions achieved through public support for biofuels made from corn, wheat or rapeseed exceeds the cost of alternative reductions through energy savings, and is much larger than the CO_2-equivalent offsets on the European Climate Exchange. The use of ethanol from grains, in particular through the conversion into Ethyl Tertiary Butyl Ether (ETBE, which is currently the main way to blend ethanol in gasoline in the EU) seems particularly inefficient in terms of cost per ton of CO_2 avoided (Doornbosch and Steenblik 2007; Zah et al 2008). Regarding energy dependency, the Commission and EU authorities acknowledge that, even under optimistic development scenarios, the production of biofuels would hardly dent the EU level of imported fossil fuel (the target of 10% of road transport fuel only corresponds to hardly more than 1% of total oil imports). The case of biofuel as a national security issue is perhaps slightly more convincing in the US, where large national reserves of coal make it possible to produce part of the fossil energy that is needed to produce biofuels. However, the energy efficiency of the US transportation and housing is so poor that considerable degrees of freedom exist for reducing imported oil consumption without biofuels, many of them at a lower cost (McKinsey, 2008). Neither in the EU nor in the US are other positive externalities (such as, e.g., increasing rural employment) believed to affect considerably the outcome of a cost benefit analysis (European Commission, 2007; House of Commons 2008).

In practice, in both the EU and the US, the objective of providing a larger outlet to the farm sector and by this way, increasing farm income, has certainly been a major determinant of the support to biofuels, as the OECD survey of Member States motivation shows (OECD, 2008). Political economy considerations support this point of view. Indeed, in the EU, the objective of providing a larger outlet to the farm sector has openly been a major objective of biofuel programs, in particular in some particular Member states such as France and Germany, at a time where the farm sector was hit by low prices and painful reforms, the need to comply to WTO panel on exports (sugar) and the prospect of further trade liberalization under the Doha round of multilateral negotiations. In the US, the role of the ethanol program as a farm policy instrument is well-documented (Runge and Senauer 2007; Collins 2008; Elam 2008). There have been many examples of mobilization of congressmen from corn-producing States in order to defend biofuel programs.[5]

[5] Recently, senators from ethanol producing States criticized the methodology of the EPA’s 2009 draft Regulatory Impact Analysis, claiming that it led to understate the potential benefits of ethanol (Harkin et al. 2009). Facing the risk that the inclusion of indirect land use changes in the estimates of net GHG emission assessments in EPA (2009) would jeopardize support for the mandated annual production of 36 billion gallons of ethanol by 2022 (under 2007 Energy Bill and 2008 Farm Bill provisions) some congressmen voiced their opposition to this inclusion.

2. Biofuel policies in a second-best setting for agricultural price support

The current biofuel programs, which provide indirect support to corn in the US, to rapeseed in the EU and to a more limited extent oilseeds in the US as well as sunflower, wheat and sugar beet in the EU, show some similarities with the former farm support policy in the sense that they contribute to support the price of feedstock. The impact of biofuel policies is nevertheless different from the one of former price support policies. For example, the cost is not borne the same way by EU consumers and by US taxpayers. The terms of trade effects are also different, and so are the consequences on other countries' producers and consumers. The various effects are complex, and one cannot claim that biofuel policies result in either more or less deadweight losses than the old price support policies. In order to be conclusive, both analytical and numerical analyses are called for.

This raises a series of questions: Have the biofuel policies replaced coupled farm support? How much support do they provide compared to old policies? From a domestic welfare point of view, is the support through biofuel costlier than the one granted through old policies? What is the impact for third countries? What is their impact on foreign producers and consumers? Are the overall effects so important that biofuel policies be subject to multilateral constraints, and be counted as production incentive subsidies? Shedding light on these questions would also help in the debate on the legitimacy of biofuel support policies, which has raised considerable controversies, and on its responsibility in the 2007-2008 "food crisis" another controversial issue (Keyzer et al, 2008).

2.1. The US case: corn based ethanol

Consider first the US situation, focusing on corn-based ethanol. Historically, the US has been a large exporter of corn, and in spite of the considerable quantities channeled into the energy market, it still is, exporting more corn than what goes into ethanol production. In the past, the

US supported corn producers through a combination of a minimum price to producers – the loan rate – and deficiency payments. Export subsidies were not widely used for corn production (most of the Export Enhancement Program budget went to wheat and the rest went to vegetable oils, and other feed grains like sorghum, in addition to a specific program for dairy). However, large quantities of corn were exported using export credit (the so-called GSM-102 export credit guarantee program) and food aid (under the PL 480 provisions).

Here, we compare a stylized representation of the US ethanol program to an equally stylized representation of the US past farm support policy, namely deficiency payments. In practice, the mix of mandates, tax credits, and the different agricultural programs interact in a rather complex way. The respective impact of the farm policy instruments and those of the biofuel policy are difficult to unravel.[6] In a simplified framework we assume that all US biofuels is directed to corn based ethanol and that the US policy is driven by a single instrument, the consumption mandate.

Consider the supply *(S)* and demand *(D)* of corn in the US, as depicted in Figure 1. Let (ES_1) be the excess supply from the USA, obtained by horizontally substracting the quantity demanded from the quantity supplied: $ES_1(p)=S(p)-D(p)$. Let also *(ED)* be the excess demand from the rest of the world. The equilibrium quantity on the world market is $(q_2 - q_1)$ at price p_{w1}, at price, i.e. the quantity supplied by US corn producers (q_2) exceeds the quantity demanded by US corn consumers (q_1). Assume now that a quantity Q_B of corn is diverted from the traditional food/feed outlet in order to be transformed into ethanol. This corresponds to the mandate of the 2007 energy bill. This introduces a kink in the demand curve, which shifts from *D* to *D'*. Hence, $D'(p)=D(p)+Q_B$ and the new excess supply on the world market is

[6] For example, De Gorter and Just (2008) show that the US biofuel tax credit provides an incentive for refiners to bid up the price of ethanol above that of gasoline by the amount of the tax credit. However, there are situations where the loan rate is the cause of ethanol production even with the tax credit, while in other cases, it is the tax credit that provides farmers with the benefits, and the loan rate is in such cases redundant.

ES_2 defined by $ES_2(p)=S(p)-D'(p)=S(p)-D(p)-Q_B$. The new equilibrium quantity on the world market is given by the intersection of ED with ES_2 i.e. q_4-q_3, which is traded at price pw_2 with $pw_2>pw_1$. On the domestic market, an aggregate quantity q_3, of corn is demanded, of which $q_f= q_3,-Q_B$ for food/feed uses, while a quantity q_4 is supplied by US corn producers. In the domestic market, corn producers gain area $a+b+c+d+e$, while corn consumers lose area $a+b$. In the world market, consumers lose area $i+j$ and producers gain i, or equivalently the aggregated rest of the world loses $f+g+h$.

[Insert Figure 1]

As a result of the US biofuel policy, corn producers experience a surplus. If we assume that this is the main objective of the US corn ethanol support, one may wonder how this policy compares to more direct forms of farm support. It is well-admitted that decoupled payments, i.e. the closest policy of the ideal "lump sum transfers" of economic theory, results in fewer market distortions. However, if we see ethanol support as a way to replace former policy instruments (which actually remain in place in the US, at least as far as target prices and marketing loans are concerned), a relevant comparison is between our stylized representation of corn ethanol in Figure 1 and deficiency payments. Under this latter policy, producer price were supported but consumer prices were not affected, given that taxpayers pay the difference between an administratively set price and market price. Such a policy is depicted in Figure 2, which represents the supply of corn S by farmers, the domestic demand D and the total demand TD. The government introduces a target price at level p_{w2} for farmers, which is coupled with a subsidy to enable farmers to sell quantity q_4 at price p_{w3}. For farmers to receive p_{w2} for the quantity q_4 the taxpayer has to pay a subsidy p_{w2} - p_{w3} on each unit of output. The target price policy at price p_{w2} has the following welfare consequences with respect to the free trade situation. Domestic (US) producers gain area $A+B+C$, while consumers gain area F and taxpayers lose area $A+B+C+D+E+F$. Overall, for the US, the welfare variation adds up to a loss *D*+*E* while the rest of the world gains *H*, which can be broken down as a gain of *G*+*H* for foreign consumers and a loss of *G* for foreign producers.

[Insert Figure 2]

Compared to the ethanol policy, the former situation with deficiency payments is unambiguously better for US consumers, due to the lower corn price.

It is realistic to assume that the ethanol production cost is (on an equivalent calorific power) higher than the price of gasoline. Because the extra demand generated by the mandate leads to produce corn in areas where the marginal cost is higher, and because the valorization of more abundant byproducts is lower, it is likely that the mandatory incorporation of ethanol in transport fuel results in a higher cost for users of the blended fuel.[7] Additionally, if we consider that corn for industrial use generates some byproducts in a fixed proportion of ethanol production, the fixed demand for ethanol drives an extra supply of byproducts, whose price goes down.

Compared to the deficiency payment policy, the losses for consumers of corn are partly (or potentially completely) offset by gains for taxpayers, by gains for consumers of byproducts (in particular the livestock sector) and by improved terms of trade. That is, part of the policy is now paid by foreign consumers. Clearly, the magnitude of these contrasting effects depends on the various supply and demand elasticities. The welfare comparisons between the deficiency payments and the ethanol mandate policies for the different economic agents are summarized in Table 1 below. The sign ambiguities will be lift in the next section thanks to the CGE modeling.

[Insert Table 1]

[7] Du and Hayes (2008) find that the US ethanol policy leads to a decrease in the price of the gasoline blend, but they model the tax credit instrument, while we focus on the blending mandate.

2.2. The EU case: wheat based ethanol

Consider now the EU policy that leads to support ethanol made of wheat. The EU was a major exporting country. Its share of the world market has declined steadily since the intervention price was lowered in 1992 and 1999 (note that in real terms it has also been declining steadily afterwards), but the EU can still be considered as a large country on the wheat market. For the sake of simplicity, we also consider that the EU support to wheat ethanol, whose production has increased steadily in particular in France over the last few years, is caused by a mandate (we consider that Member States incorporation targets for ethanol are the national translation of the EU mandate for renewable energy). That is, the analytical effects of the EU wheat based ethanol policy is similar to the one described for US corn in Figure 1. If we consider the EU biofuel mandate as a way to support farm income, a relevant comparison is with former EU policies. Historically the EU offered a guaranteed price to its farmers well above the world price, and got rid of the excess supply on the world market, which was only possible with export subsidies. This was the main instrument in the wheat sector in the "old" CAP.

Figure 3 below exposes the welfare consequences from such a policy, which relies on a high price for both producers and consumers, thanks to export subsidies. The EU wheat supply *S* and the corresponding demand *D* are represented on the right side. In the situation of free trade, p_{w1} is the domestic and world price, domestic consumption is q_1 while domestic production is q_2. With the introduction of an export subsidy, the domestic price is p_{w2}. Because the EU is a large exporter, the increase in exports triggers a fall in the world price to p_{w4}. Consequently, domestic consumers lose area *A'+B'*, domestic producers gain area *A'+B'+C'* and taxpayers lose area *B'+C'+D'+E'+F'+G'+H'* in financing the export subsidy. Hence, the net cost for the exporting country is a loss of area *B'+D'+E'+F'+G'+H'*: export subsidies appear as a very costly way of financing domestic producers. However, note that the rest of the world's producers and consumers gain area *J'* from the setting of an export subsidies policy (gain of *I'*+*J'* for rest of world (ROW) consumers and a loss of *I'* for ROW producers.)

[Insert Figure 3]

It is noteworthy that the stylized case illustrated here for the EU wheat, i.e. a large exporting country that used to support market prices through export subsidies and shifted to a biofuel mandate also corresponds to the US biodiesel case: in the late 1980s, up to 70 percent of the US exports of vegetable oil were covered by export subsidies programs, under the Export Enhancement Program, the Sunflower Oil Assistance Program or food aid programs.

The shift from a price support/export subsidy policy to a support through a biofuel mandate does not lead, like in the case of US corn, to higher prices for consumers of wheat. Rather, it shifts part of the burden that was experienced by food consumers to consumers of gasoline. In addition, taxpayers are also winners since they no longer have to pay for disposing excess supply (rather, gasoline users are requested to "buy" these quantities). For third countries, the gain is, like in the previous case, for foreign producers who do not have to compete with subsidized wheat or flour surpluses dumped on their market, while foreign consumers suffer from a higher world price. The welfare comparisons between the export subsidies and the ethanol mandate policies for the different economic agents are summarized in Table 2 below.

[Insert Table 2]

2.3. The EU case: rapeseed based biodiesel

Consider now the EU policy that leads to support biodiesel made from rapeseed and sunflower oil, by far the main biofuel production in the EU. The difference with the previous case is that the EU has long been a major importing country of oilseeds (it used to export rapeseed oil but was a net importer of seeds and for the sake of simplicity we consider that even in the 1980s, the net situation was that of an importer). For the sake of simplicity, we also consider that the EU support to biodiesel is caused by the consumption mandate. Due to the net trade situation in oilseeds and vegetable oil, the analytical effects of the EU biodiesel differs from Figure 1, and a stylized version is depicted in Figure 4. The welfare effects of the EU biodiesel policy are the following. EU rapeseed and sunflower producers gain while consumers (users) lose area *a'+b'+c'+d'* because of the EU mandate that leads to divert the quantity Q_B of oilseeds towards the energy market. The rest of the world gains *i'*, which can be further broken down in a gain of *i'+h'* for foreign producers and a loss of *h'* for foreign consumers.

If we consider the EU biofuel mandate as a way to support farm income, a relevant comparison is with former EU policies. In the old CAP, since the 1960s, the common organization of the market in oilseeds relied on an annual basis for rape and sunflower of a target price and an intervention price, the latter being, in fact, a minimum price guaranteed to producers. However, given that oilseeds entered the Community exempt from duties, the system that was implemented was close to the deficiency payments described in section 2.1. Indeed, animal-feeding stuff manufacturers were paid direct aid from the Community budget for each ton of Community grain purchased at a higher price than the world price, as a way to support indirectly producers. The welfare effects of this policy can be derived from Figure 2 in a rather straightforward way, considering an area where prices are such that the right handed panel corresponds to a net importing situation.

[Insert Figure 4]

The welfare comparisons between the deficiency payments and the biodiesel mandate policies for the different economic agents are summarized in Table 3 below.

[Insert Table 3]

Clearly, the comparison of the stylized case of the EU biodiesel program and the US ethanol program (i.e. Figure 1 and Figure 4) shows that the impact on welfare differ a lot due to the net trade situation. In the case of the US, the shift in demand resulting from the ethanol mandate results in an improvement in the terms of trade, while in the case of the EU the policy that boosts the use of biodiesel (and has turned the EU from a slight next exporter to a net importer) lead to a degradation of the terms of trade. While it is not represented here, it is noteworthy that this effect is mitigated by the fact that the price of the byproducts of biodiesel, namely the rapeseed and sunflower cakes, decreases. Their lower price also drives the price of substitutes down, in particular that of imported soybean (soybean cake, which can be replaced by rapeseed cake in several livestock productions, without being a perfect substitute).

The US ethanol program raises the price received by corn producers, in the same way as a mechanism of target prices and deficiency payments used to do. This also holds for the EU biodiesel program and the increase in rapeseed price. This has spillover effects on the price of possible substitutes for consumers, i.e. for most starch and oilseeds products, respectively. This also leads to a larger production, which competes for primary inputs with other products. As a result, the increase in the production of corn results in both an intensification in intermediate inputs (e.g. fertilizers) and a reduction of alternative crops, even though some might be complements rather than substitutes because of agronomical reasons.

3. An empirical investigation

In order to assess the pros and cons of the EU and US biofuel policies compared to traditional farm support instruments, we assume that both the EU and US governments want to maintain the price of feedstock received by agricultural producers at a certain level. This means that we consider biofuel policies in a second-best framework, assuming that their purpose is primarily to support agricultural prices by addressing a demand to the agricultural market, in a way similar to what traditional price support programs were doing. The question is how the EU and US biofuel policies compare to past policies from a welfare point of view both from the domestic point of view and for third countries.

To conduct our investigation, we rely on an applied general equilibrium model, MIRAGE (Bchir *et al.*, 2002; Decreux and Valin, 2007) developed at CEPII (Centre d'Etudes Prospectives et d'Information Internationales). The core model has recently been extended for agricultural and trade issues so as to single out specific biofuel sectors. This required considerable changes in the representation of the production functions, the demand system and the modeling of land markets as well as improvement of social accounting matrices (Laborde and Valin, 2010; Al Riffai *et al.*, 2010).

The biofuel version of the model contains 11 regions and 43 products, in a disaggregation allowing a precise representation of different feedstocks. The base year for data in the social accounting matrices and the various parameters is 2004, and the model can be run along a baseline going up to 2020 taking into account trends in exogenous variables (population, productivity, etc.) and recent changes in policies (trade agreements, agricultural policy reforms, etc.).

For the present comparisons, we use the static version of the model. Policy shocks are implemented in an initial situation corresponding to the 2008 level of biofuel incorporation. Additional policies directly come into effect to allow easier comparison, with an increase in the magnitude of biofuel demand or a subsidy to the production or the export of a crop. The reference situation considers an increasing in the oil price leading to a 15% increase in the volume of fuel consumed at the horizon 2020. The shock for biofuel policy is always implemented first and the level of support leading to the same level of price for the targeted commodity is then computed endogenously. Here we present simulations of alternative policies relatively to the markets analyzed in section 2.

3.1. The US ethanol program

Consider first the case of US corn-based ethanol as described in section 2.1. We start from a reference situation where 12.4 Mtoe of corn ethanol is produced (6.5 bn gallon). The current US policy aims at the incorporation of 36 bn gallon of biofuels in 2022, where 15 billion gallons come from corn ethanol. We therefore introduce a shock of 8.5 bn gallon of additional demand, which requires the transformation of an extra quantity of 65 million tons of corn. Accounting for the various substitutions and expansion effects, the resulting impact of the US ethanol policy on the price received by corn for producers is equivalent to an 8% increase compared to a situation without such a policy. Assume that instead of the ethanol program, the US had implemented a system of deficiency payments. In order to obtain a similar price for US corn producers, the deficiency payments to corn would have been $3.6 billion (Table 4) with a similar level of extra production.

For the US consumer, differences are tangible. With the deficiency payment, the price of crop products paid by consumers would be lower: -13% for corn when compared with the biofuel policy situation. The price of meat would be driven down by cheaper corn, even if the effect would be partly offset by the reduced availability of corn gluten feed and other biofuel byproducts. Overall consumers would nevertheless experience a 2% decrease in the price of beef. For the US car driver, ethanol production would be 70% lower than with the mandate, and US ethanol imports would also be 84% lower. The price of gasoline would therefore be 2% cheaper for consumers (assuming the absence of ethanol subsidies and tax credit in addition to the mandate).[8]

[8] In practice, the current US biofuel program includes a subsidy on biofuel, and the overall effect of the program is to subsidize indirectly the consumption of fossil fuel (see De Gorter and Just, 2010; Du and Hayes 2008). That is, this positive aspect of the biofuel mandate, i.e. shifting the burden of the farm support from taxpayers to the producers of a negative externality, does not materialize. However, it is

On international markets, in case of deficiency payments rather than a biofuel program, the US would export much more corn, with considerable impacts. Indeed, the world price for corn would be 8% lower. Table 4 shows the different welfare implications. First, the US biofuel program results in a significant improvement of the US terms of trade. Secondly, it involves significant benefits for foreign crop producers, given that the quantities of corn that would be produced but would not go to ethanol production would be competing with their production ($5.1 billion). The US biofuel programs therefore organizes a transfer from foreign consumers of grains and oilseeds to US producers, while, in comparison, a policy of deficiency payments would impose a burden on US taxpayers. However, if we compare the US biofuel mandate with traditional farm support, the US biofuel program appears like a much lesser evil option for foreign farmers, which departs from usual critics from non-governmental organizations on the negative impact of international price depressing agricultural support from the US and the EU. Foreign consumers are the more impacted by the move from US deficiency payment to biofuel policies with a loss of $5.9 billion.

However, welfare comparisons also suggest that the US ethanol program delivers farm support at a higher cost than deficiency payments. In spite of the terms of trade gains and the savings for the US taxpayer, the cost imposed on US food consumers and gasoline buyers is such that the biofuel mandate appears as a costlier way to support farm prices, because they affect prices of rather inelastic goods. Total US welfare is $6.3 billion worse off than in the deficiency payment policy. However, the increase in the price of gasoline (+2%) contributes to have the cost of the support to US farmers funded by car users. From a social point of view, imposing a policy that imposes a cost on car drivers, rather than consumers or taxpayers is perhaps a source of correcting existing distortions (as long as it is not subsidized). Indeed, road transportation generates considerable negative externalities (through congestion costs,

still a potential social benefit, if a biofuel mandate were associated with a more socially optimal tax system than the current US one.

air pollution, carbon emissions). In a second-best framework, a biofuel mandate could potentially help reducing distortions by making the providers of a negative externality pay for price support.[9]

[Insert Table 4]

3.2. The EU ethanol program

Consider now the case of the EU wheat-based ethanol described in section 2.2. While there is no mandate that explicitly targets wheat (or barley or triticale) ethanol, wheat-based ethanol production has increased significantly in the EU over the recent years. Wheat ethanol is seen as a potential outlet in order to help coping with low wheat prices, and contracting for ethanol is perceived as a way to ensure a stable price for a share of the future harvest by farmers, which increasingly plays the role of a safe asset in a diversified portfolio. In this respect the ethanol program partly plays the role that the former CAP, which relied on guaranteed and stable domestic prices, achieved through public storage and export refunds, used to play for supporting agricultural prices and farm incomes.

We start from a reference situation where incorporation of grain ethanol represents roughly 1.1% of gasoline used for EU transportation (0.8 Mtoe for wheat and 0.3 Mtoe for maize). The modeled EU biofuel mandate results in the production of 10 Mtoe of ethanol in which 6.2 Mtoe come from the transformation of 25 million tons of wheat. This shock is equivalent to a 7% increase in EU wheat production price compared to a situation without such a policy (Table 5). Assume that instead of the incentives for ethanol, the EU had kept a system of guaranteed prices obtained using export subsidies. In order to obtain a similar price for EU wheat producers, the corresponding export subsidy would have to reach €295 million.[10] As a result, the 27.1 million tons of wheat exports from the EU are doubled (57.5 million tons). As

[9] Obviously, this argument is hardly valid in a first best context, and one may argue that the negative externalities should be corrected by an appropriate tax structure in the first place.
[10] We consider for euros calculation an average conversion rate of $1.24 for €1 on the base of the 2004 base year used for social accounting matrixes.

a consequence, EU ethanol production and imports are 89% lower than with the current mandate. Moreover, the price of gasoline would be 4% cheaper for consumers, and the price of agricultural products paid by consumers would also be cheaper (-3.3% for wheat when compared with biofuel policy). The impact on world markets of this policy is significant, as the price of wheat would be 6.6% lower in the case of export subsidy than biofuel policies. However, unlike in the US corn-based ethanol program, the terms of trade of the EU are hardly affected.

The use of wheat in the production of ethanol in the EU involves some benefits for foreign crop producers, compared to the situation where the EU used to support its domestic price by dumping some excess production on the world market. Like in the US case, the EU ethanol program is a lesser evil for foreign farmers, as they can benefit from a gain of $4.3 billion in revenue. However, compared to the traditional instrument of farm support through intervention and export subsidies, the EU biofuel program also contributes to higher food prices for consumers in third countries, and the overall loss of welfare for the foreign consumer adds up to $6.2 billion. As a consequence, the overall effect on the world welfare is much worse in the case of ethanol mandate, with a relative loss of $9.3 billion.

[Insert Table 5]

3.3. The EU biodiesel program

If the EU production of grain ethanol is limited, the EU biodiesel production provides a larger outlet for oilseed producers and contributes to support both oilseed prices and the income of arable crop producers, as explained in section 2.3. We now start from a reference situation where EU biodiesel production is 5.9 Mtoe. This corresponds to an incorporation of 4.0% into gasoline. To reach a 10% mandate, the shock that we model results in the incorporation of 3.3 Mtoe of additional rapeseed oil and 0.8 Mtoe of sunflower oil. The remainder is provided from imported soybean oil and palm oil. The mandate contributes to boost rapeseed production by 12% and leads to devote more acreage to this non-food use. Once substitution effects have been taken into account on the production side, the EU biofuel mandate, through its biodiesel component is equivalent to a 27% increase in the EU rapeseed production price compared to the reference situation (Table 6). Assume that EU biodiesel production is driven only by the biofuel mandate. And compare this situation to the case where the EU had supported rapeseed prices with a system of coupled direct payments, like the one that characterized the EU oilseeds policy in the 1980s. In order to obtain a similar price for EU rapeseed producers, the corresponding payment would have to reach €775 million. Assuming that the current producer prices for rapeseed in the EU was supported by a coupled payment rather than through a mandate that corresponds to the current use of biodiesel, the EU price of diesel would be 8% cheaper for consumers (before tax), while the price of agricultural products paid by consumers would also be much cheaper (-24% for rapeseed). The EU would import much less rapeseed and rapeseed oil (72% less than under the biodiesel mandate). This would have a significant impact on world markets for oilseeds even though there are signs that these prices are increasingly driven by the price of fossil oil, which is rather exogenous. The price of feedstocks would be higher, given that the EU biodiesel mandate results in a production of rapeseed cake that would be supplied in a larger quantity. Unlike in the US corn based ethanol program, the terms of trade of the EU are negatively affected, given that the EU biofuel program results in a rarefaction of oilseeds in the world market, while the EU is itself a net importer.

The EU biodiesel production involves some benefits for foreign crop producers ($6.5 billion), compared to the situation where the EU used support its domestic price with deficiency payments. Because such a large share of EU rapeseed is channeled into the energy market, and the price of oilseeds on the world market is significantly higher. Like in the US case, the EU biofuel program is relatively better for foreign farmers but significantly decrease the foreign consumer welfare (-$5.3 billion). The consequence is a relative welfare loss of $7.8 billion at the world level.

[Insert Table 6]

4. Conclusion

The support granted to biofuels in the EU and the US has been heavily criticized. The environmental effects of biofuels have recently been shown to be less positive than what was originally expected when one counts all the indirect effects. Given the controversial GHG balance of the first generation of biofuels, the externalities resulting from an increased use of inputs such as fertilizers and pesticides, the environmental argument for supporting biofuels is now questioned (OECD, 2008). The cost of the carbon emission saved by using biofuels seems much higher than one could achieve through other policies. The posted objective of reducing the dependency on imported fossil oil is also hardly convincing given that biofuels and biofuel inputs are now increasingly imported, and that even the most optimistic scenarios regarding biofuel use suggest that only a very small percentage of the EU imports of crude oil would be replaced.

However, the well-deserved criticisms made to the EU and US biofuel programs hide the potential role of biofuel as an instrument of farm policy. If we consider that the primary objective of the biofuel policy is to support agricultural producers - a rather realistic point of view - current EU and US biofuel policies show some similarity with traditional farm support instruments. In particular, the current biofuel policies provide a form of support to EU and US crop producers that is rather similar to the market price support granted by the US target price and deficiency payments system, or by the EU public purchase and export subsidies system. Indeed, the channeling feedstocks into the energy market shows some similarities with the former policies of diverting them into third (foreign) markets. The high budgetary cost of subsidies and tax exemptions for biofuels has led most developed countries to replace subsidies by a mandatory incorporation rate, therefore shifting the cost of biofuel policy from taxpayers to consumers, which can be seen as reversing the shift from price support to direct payments observed over the last decades.

Once substitutions and feedback effects are taken into account through the closure of a general equilibrium model, we estimate that, starting from the 2008 level of biofuel consumption, the current US ethanol policy objectives (stylized as a simple blending mandate) leads to an increase in domestic producer surplus that represents a $3.6 billion deficiency payment to corn; that the current EU biofuel policy provides a support to grain producers equivalent to a €295 million export subsidies on wheat through support granted to grain-based ethanol; and that the use of rapeseed and sunflower in biodiesel triggered by the EU mandatory blending has similar effects to a €775 million coupled payments.

The EU and US biofuel policies nevertheless show major differences with the "old" instruments of the farm policy in at least three areas.

- Rather than using the world market as an outlet to maintain high prices, biofuels use a domestic outlet, i.e. the energy sector. This makes a considerable difference for a large exporting country like the US. Unlike former export enhancement programs, the diversion of some US corn exports towards a domestic (non-food) market results in a significant improvement of the US terms of trade. The US biofuel mandate even shows some similarities with some well-known form of optimal taxation where a monopolistic exporter taxes the production of its exporting commodity. It is noteworthy, though, that the situation is different for the EU. By shifting the excess demand curve, the biofuel policy leads the EU to import oilseeds and oil products for domestic biodiesel production, suggesting that it has detrimental terms of trade effects.

• The stakeholders experiencing the costs of the biofuel policy are not those that bore the burden of "old" farm policies. In the US, the diversion of agricultural crops towards the energy sector results in higher market prices, while the traditional US loan rate/deficiency payments policy supported producer prices while maintaining low consumer prices. In the EU, consumers used to bear the cost of the market price support policy in the grain sector (taxpayers subsidized the direct payments for oilseeds in the 1980s). The recent reforms largely shifted the burden to taxpayers, through an increased reliance on direct payments. Additionally, the impacts on the foreign markets also lead to significant redistribution effects between consumers, impacted by biofuel policies and producers, who take the benefits from increased food prices. To this respect, biofuel policies offset some of the gains for consumers obtained during two decades of reforms.

• In the case of particular biofuel policies, such as mandatory blending, the cost is borne by consumers of gasoline and diesel in the road transportation sector. Indeed, a biofuel mandate shifts some of the burden of farm price support (for rapeseed, sunflower, but also wheat and sugar beets) to gasoline and diesel users. Compared to the "old" farm policies, which made either consumers or taxpayers bear the cost, this is a major difference. Indeed, the demand for gasoline and diesel is inelastic and car users are known to pay for only a fraction of their social cost in terms of infrastructure and externalities. Biofuel policies might lead to farm support funded by a tax on a negative externality, generating a double-dividend effect *à la* Tullock (1967).

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Table 1: Welfare variations, US ethanol case. Both the US ethanol and deficiency payments policies lead to an increase in the domestic farmers' surplus. However, the situation is contrasted as far as domestic food consumers are concerned: with respect to the free trade situation, the ethanol policy is detrimental for them, while a deficiency payments policy unambiguously leads to a welfare increase. Taxpayers are unaffected by an ethanol mandate, while they experience a welfare loss from shifting to deficiency payments. The two policies have contrasting effects as far as the ROW is concerned. Overall, the US ethanol policy leads to welfare losses for the ROW, with farmers gaining and food consumers losing from the policy shift from free trade to a US ethanol mandate. On the contrary, the deficiency payments policy has a global positive effect on the ROW, with consumers gaining and farmers losing from the policy change with respect to free trade. Finally, the last line of the table shows the various welfare variations implied by a policy shift from an ethanol mandate to deficiency payments.

	Domestic Farmers	**Domestic Food consumers**	**Taxpayers**	**Gasoline consumers**	**Domestic country overall**	**Foreign Farmers**	**Foreign Food consumers**	**ROW overall**
US ethanol policy *vs* Free trade	+	-	=	-	***?***	+	-	-
Deficiency payments *vs* Free trade	+	+	-	=	-	-	+	+
Deficiency payments *vs US* ethanol policy	=	+	-	+	***?***	-	+	***?***

Table 2: Welfare variations, EU ethanol case. Both the EU ethanol and export subsidies policies lead to an increase in the domestic farmers' surplus, and a decrease in the domestic food consumers' surplus. Taxpayers are unaffected by an ethanol mandate, while they experience a welfare loss from shifting to export subsidies. The two policies have contrasting effects as far as the ROW is concerned. Overall, the EU ethanol policy leads to welfare losses for the ROW, with farmers gaining and food consumers losing from the policy shift from free trade to an EU ethanol mandate. On the contrary, the export subsidies policy has a global positive effect on the ROW, with consumers gaining and farmers losing from the policy change with respect to free trade. Finally, the last line of the table shows the various welfare variations implied by a policy shift from an ethanol mandate to export subsidies.

	Domestic Farmers	**Domestic Food consumers**	**Taxpayers**	**Gasoline consumers**	**Domestic country overall**	**Foreign Farmers**	**Foreign Food consumers**	**ROW overall**
EU ethanol policy *vs* Free trade	+	-	=	-	***?***	+	-	-
Export subsidies *vs* Free trade	+	-	-	=	-	-	+	+
Export subsidies *vs* ethanol policy	=	=	-	+	***?***	-	+	***?***

Table 3: Welfare variations, EU biodiesel case. Both the EU biodiesel and deficiency payments policies lead to an increase in the domestic farmers' surplus. However, the situation is contrasted as far as domestic food consumers are concerned: with respect to the free trade situation, the biodiesel policy is detrimental for domestic food consumers, while a deficiency payments policy unambiguously leads to a welfare increase. Taxpayers are unaffected by a biodiesel mandate, while they experience a welfare loss from shifting to deficiency payments. Both policies have a global positive effect as far as the ROW is concerned. However, the gainers and the losers from the policy shifts are different. Hence, the EU biodiesel policy leads to welfare gains for the ROW, with farmers gaining and food consumers losing from the policy shift from free trade to an EU biodiesel mandate. Similarly, the deficiency payments policy has a global positive effect on the ROW, but this time consumers gain while farmers lose from the policy change with respect to free trade. Finally, the last line of the table shows the various welfare variations implied by a policy shift from a biodiesel mandate to deficiency payments.

	Domestic Farmers	**Domestic Food consumers**	**Taxpayers**	**Diesel consumers**	**Domestic country overall**	**Foreign Farmers**	**Foreign Food consu-mers**	**ROW overall**
EU biodiesel policy *vs* Free trade	+	-	=	-	***?***	+	-	+
Deficiency payments *vs* Free trade	+	+	-	=	-	-	+	+
Deficiency payments *vs* *EU* biodiesel policy	=	+	-	+	***?***	-	+	***?***

Table 4. Comparison of US ethanol program with deficiency payments to corn producers (producer price of corn identical)

	Reference	US mandate (15 bn gallons)		Deficiency payment ($3.6 bn)		**Defiency payment - US mandate**	
	Abs	Abs	*Rel*	Abs	*Rel*	**Abs**	***Rel***
Corn price (normalised)							
US Producer	1.000	1.079	*7.9%*	1.079	*7.9%*	**0.000**	***0.0%***
US Consumer	1.000	1.078	*7.8%*	0.934	*-6.6%*	**-0.144**	***-13.4%***
World market	1.000	1.040	*4.0%*	0.957	*-4.3%*	**-0.082**	***-7.9%***
Corn market (million tons)							
US production	300.2	334.2	*11.3%*	336.1	*11.9%*	**1.8**	***0.5%***
US exports	48.7	37.6	*-23.0%*	61.0	*25.2%*	**23.5**	***62.5%***
Foreign production	422.4	430.8	*2.0%*	414.8	*-1.8%*	**-16.1**	***-3.7%***
Ethanol production (Mtoe)							
US production corn	12.39	29.12	*135.1%*	13.12	*5.9%*	**-16.01**	***-55.0%***
US imports	0.83	2.30	*176.0%*	0.76	*-8.6%*	**-1.54**	***-66.9%***
Foreign production	14.90	16.93	*13.6%*	14.81	*-0.6%*	**-2.12**	***-12.5%***
Welfare (bn USD)							
US Terms of trade (normalised)	1	1.002	*0.181%*	1.000	*-0.021%*	**-0.002**	***-0.202%***
US Producer surplus	117	122	*4.263%*	121	*3.920%*	**-0.4**	***-0.329%***
US Total welfare	10058	10050	*-0.075%*	10056	*-0.012%*	**6.3**	***0.062%***
Foreign producer surplus	1012	1016	*0.358%*	1011	*-0.142%*	**-5.1**	***-0.498%***
Foreign welfare	22359	22354	*-0.023%*	22360	*0.004%*	**5.9**	***0.027%***
World welfare	32417	32404	*-0.039%*	32417	*-0.001%*	**12.2**	***0.038%***

Table 5. Comparison of UE ethanol program with export subsidies (producer price of wheat identical)

	Reference	EU mandate (10% in gasoline)		Export subsidy (€295 mln)		**Export subsidy - EU mandate**	
	Abs	Abs	*Rel*	Abs	*Rel*	**Abs**	***Rel***
Wheat price (normalised)							
EU Producer	1.000	1.069	*6.9%*	1.069	*6.9%*	**0.000**	***0.0%***
EU Consumer	1.000	1.064	*6.4%*	1.029	*2.9%*	**-0.035**	***-3.3%***
World market	1.000	1.023	*2.3%*	0.955	*-4.5%*	**-0.068**	***-6.6%***
Wheat market (million tons)							
EU production	149.6	156.2	*4.4%*	156.7	*4.7%*	**0.4**	***0.3%***
EU exports	27.1	17.5	*-35.3%*	57.5	*111.9%*	**39.9**	***227.6%***
Foreign production	477.6	483.4	*1.2%*	470.6	*-1.5%*	**-12.8**	***-2.7%***
Ethanol production (Mtoe)							
EU production total	1.16	11.08	*856.6%*	1.13	*-2.2%*	**-9.95**	***-89.8%***
EU production wheat	0.77	6.95	*807.4%*	0.72	*-5.5%*	**-6.23**	***-89.6%***
EU imports	0.43	4.47	*951.2%*	0.44	*2.8%*	**-4.04**	***-90.2%***
Foreign production	26.13	30.11	*15.2%*	26.15	*0.1%*	**-3.95**	***-13.1%***
Welfare (bn USD)							
EU Terms of trade (normalised)	1.000	1.000	*0.034%*	1.000	*-0.001%*	**0.000**	***-0.036%***
EU Producer surplus	198	201	*1.311%*	200	*0.843%*	**-0.9**	***-0.462%***
EU Total welfare	10373	10369	*-0.034%*	10373	*-0.005%*	**3.0**	***0.029%***
Foreign producer surplus	930	933	*0.334%*	929	*-0.123%*	**-4.3**	***-0.455%***
Foreign welfare	22044	22038	*-0.026%*	22045	*0.002%*	**6.2**	***0.028%***
World welfare	32417	32408	*-0.029%*	32417	*0.000%*	**9.3**	***0.029%***

Table 6. Comparison of UE biodiesel program with coupled payments to rapeseed (producer price of rapeseed identical)

	Reference	EU mandate (10% in diesel)		Deficiency payment (€775 mln)		Deficiency payment - EU mandate	
	Abs	Abs	*Rel*	Abs	*Rel*	**Abs**	***Rel***
Rapeseed price (normalised)							
EU Producer	1.000	1.272	*27.2%*	1.272	*27.2%*	**0.000**	***0.0%***
EU Consumer	1.000	1.265	*26.5%*	0.954	*-4.6%*	**-0.310**	***-24.5%***
World market	1.000	1.044	*4.4%*	0.995	*-0.5%*	**-0.049**	***-4.7%***
Rapeseed market (million tons)							
EU production	19.9	22.2	*11.8%*	22.3	*12.1%*	**0.1**	***0.2%***
EU imports	3.2	9.3	*190.8%*	2.9	*-9.8%*	**-6.4**	***-69.0%***
Foreign production	32.5	34.2	*5.1%*	32.4	*-0.5%*	**-1.8**	***-5.4%***
Biodiesel production (Mtoe)							
EU production total	5.87	14.86	*153.2%*	6.09	*3.8%*	**-8.77**	***-59.0%***
EU production rapeseed	4.80	8.07	*68.0%*	5.23	*8.8%*	**-2.84**	***-35.2%***
EU imports	1.08	4.05	*276.7%*	1.01	*-6.4%*	**-3.04**	***-75.1%***
Foreign production	1.97	4.91	*149.4%*	1.90	*-3.4%*	**-3.01**	***-61.3%***
Welfare (bn USD)							
EU Terms of trade variation (normalised)	1.000	1.000	*0.014%*	1.000	*0.003%*	**0.000**	***-0.011%***
EU Producer surplus	198	201	*1.374%*	201	*1.205%*	**-0.3**	***-0.167%***
EU Total welfare	10373	10370	*-0.026%*	10373	*-0.002%*	**2.5**	***0.024%***
Foreign producer surplus	930	937	*0.669%*	930	*-0.034%*	**-6.5**	***-0.698%***
Foreign welfare	22044	22039	*-0.024%*	22044	*0.000%*	**5.3**	***0.024%***
World welfare	32417	32409	*-0.025%*	32417	*-0.001%*	**7.8**	***0.024%***

Figure 1: US ethanol policy

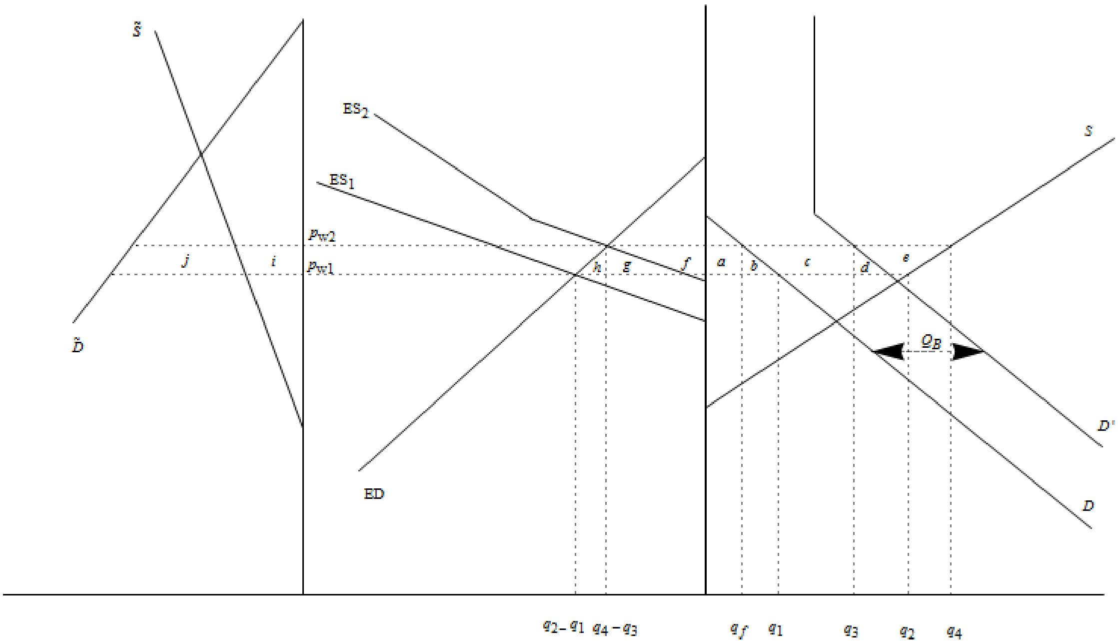

Figure 2: Price support through deficiency payments

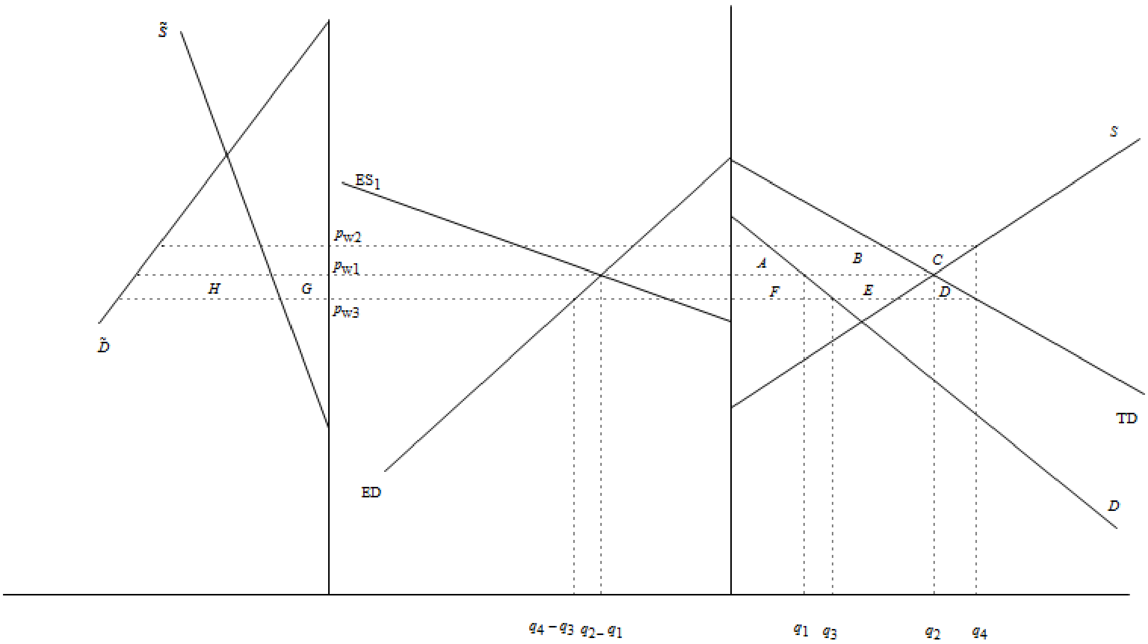

Figure 3: Price support through export subsidies

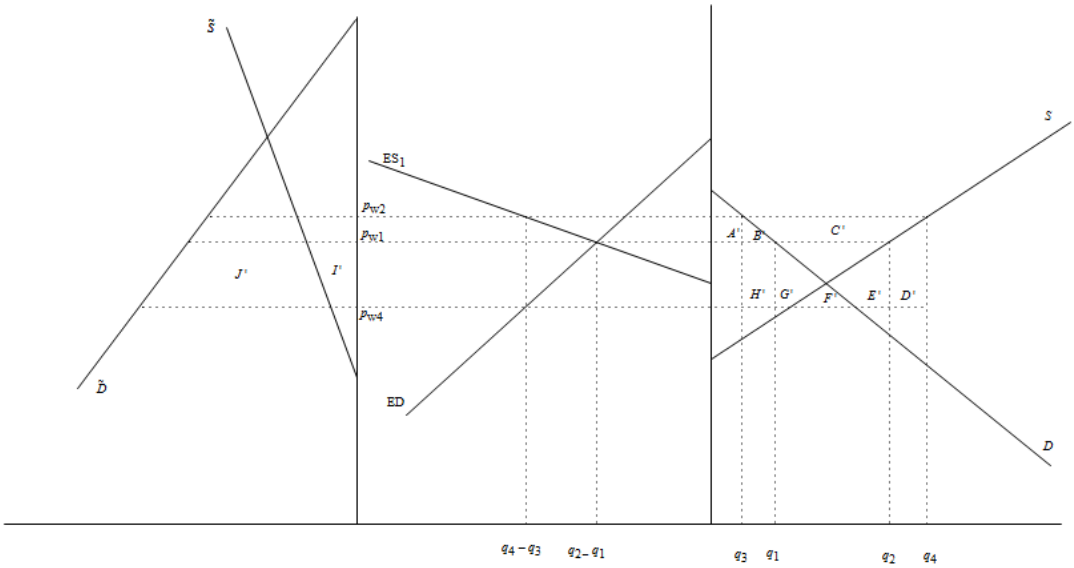

Figure 4. EU biodiesel policy