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# Can biofuels policy work for food security?

## An analytical paper for discussion

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# Preamble

In April 2012, the UK published its Bioenergy Strategy, setting out the Government's commitment to bioenergy alongside the need to ensure it is produced sustainably:

> "Bioenergy is expected to play a key role in our ability to meet the 2020 renewables target as well as longer term carbon reduction targets to 2030 and 2050. But we recognise that bioenergy is not automatically low carbon, renewable or sustainable: alongside its many positives, bioenergy carries risks.
>
> "The UK bioenergy strategy, published jointly by DECC, Defra, DfT sets a framework of principles to guide UK bioenergy policy in a way that secures its benefits, while managing these risks.
>
> "The strategy's overarching principle is that bioenergy must be produced sustainably and that there is a role for UK Government to steer sustainable development of bioenergy in the UK and as far as possible internationally."
>
> http://www.decc.gov.uk/en/content/cms/meeting_energy/bioenergy/strategy/strategy.aspx

The Bioenergy Strategy commits the UK Government to further work to investigate the merits of temporarily flexing or otherwise relaxing biofuels mandates at times of agricultural price pressures (page 72). The current paper presents work by Defra analysts to explore some of the potential implications of this idea. It does not represent a change in Government policy.

The authors are all staff at the UK Department for Environment, Food and Rural Affairs (Defra). Chris Durham is an Economic Advisor on Commodities Markets and Global Food Security. Tanya Bhattacharyya is an Assistant Economist. Grant Davies is an Economic Advisor on Partial Equilibrium Modelling.

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# Executive Summary

Grains and oilseeds produced for use in biofuels could be allowed to flow into animal feed or human food markets during temporary spikes in the price of agricultural commodities. Currently this is strongly discouraged from happening by legal requirements to blend biofuels with conventional transport fuel (often called biofuels mandates or blending obligations), but temporarily relaxing these requirements could allow agricultural markets to work more efficiently and reduce the size of a price spike.

A system of flexible mandates would in effect create a 'virtual grain store'. Biofuels mandates have led to increased agricultural production relative to a state of the world where there are no biofuels mandates - this extra supply could follow market forces onto food or animal feed markets during a price spike, if the mandates allowed it.

Research carried out by the UK Department for Environment, Food and Rural Affairs (Defra) shows that up to 15% of a hypothetical spike in the price of "coarse grains" could be avoided if the European Union removed its biofuels mandate at the same time as prices started to spike (coarse grains include maize, barley, oats etc.). The work also finds that similar action in the US could avoid over 40% of a hypothetical spike in coarse grain prices.

Introducing flexibility into biofuels mandates is only one potential way to reduce price spikes in grain markets. Better information on supply and demand and encouraging undistorted international trade, as well as a number of other initiatives are also currently being pursued by the G20 and others in order to reduce volatility in agricultural commodities markets. This proposal should be seen as part of a broader effort to consider all policy options; it is important to investigate further so this option can be considered alongside its alternatives.

In the European Union (EU), biofuels production is encouraged in a number of ways. The Renewable Energy Directive obliges a 10% share of renewable energy in the transport fuel mix by 2020, subject to the "sustainability" of production and commercial viability of second-generation biofuels. It is left to individual EU Member States to decide how best to achieve this target, and across the trading bloc reduced taxes, production subsidies and capital grants may be used. The EU also imposes various tariffs and quotas on imports of biofuels. These targets are for renewable energy in any form, but current technology and infrastructure mean that biofuels produced from grain and other foodstuffs are the most cost-effective way to meet them.

US biofuel policy consists of quantitative mandates for biofuel consumption (the Renewable Fuel Standard) requiring that by 2022, 36bn gallons of renewable fuel be consumed annually and of this 15bn gallons come from maize-ethanol (this translates into a need for about 143 million tonnes of maize in 2022 – equivalent to 45% of the 2010/11 maize harvest in the USA). Since the US is the only major maize-ethanol producer, this acts as an effective US production mandate. Until January 2012, there was also a subsidy to ethanol blenders (the ethanol blenders' tax credit) and import duties payable on biofuels.

Removing the EU blending obligation (but retaining import tariffs and tax support) in the same year as a hypothetical spike in the global price of wheat, could reduce the magnitude of the spike by anything from 10% to 35%. Similarly, a hypothetical spike in the price of coarse grains could be mitigated by up to 15% by removing the blending obligation. These two price spikes are simulated by introducing a 25% reduction in the area of wheat or coarse grain harvested in the EU in either 2011 or 2018, which leads to price rises of up to €200 per tonne for wheat and €100 per tonne for coarse grain.

Reducing the US blending obligation to one half of its current value in the same year as a spike in the global price of coarse grain, could reduce the magnitude of the spike by around 40%. The model we used to calculate these figures would not allow for both US and EU mandates to be completely removed at the same time: the adjustment required in international commodities markets proved too large for the model to solve. This hints at the significant benefits of coordinated policy, but the important impacts of unilateral action by either the EU or US also demonstrate that it may not be necessary to wait for coordination.

These results are based on the AGLINK-COSIMO partial equilibrium model of the next 10 years of the global agricultural economy, developed and maintained jointly by the OECD and FAO. Results are generated from highly stylised scenarios in which agricultural prices spike, but oil markets are unaffected. In this model, the benefits of flexing biofuels mandates are therefore achieved at zero cost to oil or bioenergy markets. It will be useful to develop this initial analysis to explore alternative scenarios including feedback effects in the oil market, and to investigate what impacts there could be on bioenergy markets.

As with any modelling exercise, this approach has its limitations and there are reasons to believe the results presented here could over- or under-estimate the true potential of the idea. The model ignores the impact of panic buying and export restrictions, which often come in response to a price spike – if this policy avoided panic behaviour or export restrictions, its benefits would be significantly greater than suggested here. However, it also ignores how biofuels refiners might respond differently to a temporary rather than permanent change in the blending mandate. Further analysis of this idea should therefore not rely exclusively on high-level modelling.

Both the trigger and the mechanism used to introduce flexibility into mandates are crucial, and deserve more attention because these will dictate the impacts of the proposal on bioenergy and other markets. The trigger must be independent of political control to ensure this does not become a tool for market management and increase uncertainty in agricultural and bioenergy markets. The mechanism by which flexibility is introduced could potentially be designed to avoid a reduction in the overall ambition of bioenergy targets. Specific proposals for triggers and mechanisms need to be investigated and their costs and benefits assessed.

This work reveals the very significant potential associated with a mechanism that allows market forces to direct grain between biofuels, animal feed and food markets during a temporary supply shortage and price spike. It has not examined the implications of this idea for bioenergy markets and stops short of examining a particular mechanism, instead calling for commitments to more work to develop specific proposals and to appraise their individual merits.

The urgency of considering this proposal now arises from a review by the European Commission of EU renewable energy targets due in 2014, when a decision whether to introduce such flexibility into biofuels mandates could, in principle, be taken.

# Introduction

Throughout 2011, volatility in agricultural markets was hotly discussed in international policy circles: The UK published its Foresight Project on *The Future of Food and Farming*, the G20 committed to a 5-point Action Plan including action on volatility in agricultural markets and the UN's Committee on Food Security used its annual meeting in October to discuss volatility. For the second time in 5 years, agricultural commodities prices experienced a significant spike.

Many scientific papers point to the potential for volatility to increase in the future. Increased climate variability that impacts on agricultural yields is expected to result from climate change, and higher average incomes are likely to make demand for grains less responsive to prices, causing prices to rise further in response to shocks with important consequences for those on lower incomes.

Previous research conducted by UK Government Officials (HMG 2010) has argued that to date, biofuels are unlikely to have been a major driver of price spikes. The 2007/08 agricultural price spike was the result of a number of factors, including low international stock levels (itself a function of poor harvests in certain key countries and growing consumption), initial concerns about the 2008 harvest, rapid increases in energy costs, a significant weakening of the US Dollar and export restrictions imposed by some 30 countries. However, this paper contends that more flexible biofuels policies which allow grain to follow market forces during an agricultural price spike, could augment availability for food and animal feed and help to reduce the magnitude of similar grain price spikes in the future.

There are a number of potential ways to address volatility in agricultural markets, including:

- improving provision of information, as proposed by the G20 and institutionalised in the Agricultural Markets Information System (AMIS)
- improving the efficiency of the agricultural sector
- trade liberalisation
- stocks policies
- more flexible biofuel mandates

This paper is designed to open up an important debate: should biofuels policies in the EU or the US be adjusted to help reduce price volatility in global food and animal feed markets? It explores reasons why we might want to use biofuels policy to reduce volatility in global agricultural markets, and presents new research by Defra analysts that demonstrates the potential of this idea.

The paper has been prepared by Defra officials to inform and promote discussion. It does not represent a change in UK Government policy towards biofuels.

This paper demonstrates that removing support for biofuels during a grain price spike could reduce the magnitude of the spike. If implemented in the EU, this proposal could reduce the magnitude of a spike in the price of wheat by anything from 10% to 35%. Similarly, a spike in the price of coarse grain could be mitigated by up to 15%.

If a similar approach was followed in the US, modelling (presented in Annex A) shows that the magnitude of a spike in the price of coarse grain could be reduced by 40% if half the mandate was made flexible (the figure grows to over 55% reduction in the size of the spike if 75% of the mandate is temporarily waived).

The role that biofuels play in causing price spikes and general volatility in agricultural markets is the subject of much debate in academic and policy circles, and is not revisited here. However our findings suggest that, whether or not biofuels contribute to price spikes and volatility, introducing flexibility into biofuels mandates could potentially contribute to a solution.

Although there are challenges associated with implementing this proposal, the magnitude of its effects suggests it is worth further consideration. A first step would be to design more specific implementation options and assess each of these on their own merits.

The paper has eight sections. Section 2 provides background on biofuels policy and how it may increase volatility in agricultural markets; section 3 develops this into a reason for government action and section 4 runs through existing policy initiatives to address volatility. Section 5 presents the results of Defra's new research and section 6 discusses the practicalities of implementing flexibility in biofuels mandates. Section 7 concludes the paper and section 8 proposes a series of "next steps" for the UK Government if it chooses to develop the idea further. Annex A presents the results of modelling flexibility in US biofuels markets, and Annex B describes the parameters we changed in the model to carry out our research.

# What do biofuels policies do to agricultural markets?

This section explores what biofuels policies in the EU and US do to markets, in order to frame the subsequent discussion.

Governments may have a range of objectives when encouraging the use of biofuels. But changes in oil, grain and other prices mean that the optimal amount of biofuel production for the purposes of these objectives is constantly changing. An "economically efficient" biofuels policy would allow grains and other resources to be switched between biofuel production and other uses as dictated by the relevant market prices. With fixed blending obligations and mandates, this adjustment is prohibited so such policies could in theory represent a significant market distortion – in the face of any price spikes, fixed biofuel mandates effectively force all of the adjustment in demand onto the food and animal feed sectors.

Al Riffai et al. (2010) provide a good overview of the major biofuels policies affecting EU markets, including EU, US and Brazilian policies. In the EU itself there are several initiatives to promote use of biofuels: the Renewable Energy Directive and the Fuel Quality Directive set obligations for blending biofuels with conventional transport fuels; the Energy Tax Directive allows Member states to use tax incentives[1]; production subsidies and capital grants are also used as alternative incentives, in particular by the UK. Together these policies lead to significantly more biofuels production than a free market would given the current constraints around information, certainty of investment and climate change impacts. In 2014 the European Commission will be reviewing its targets for renewable energy.

US biofuel policy consists of quantitative mandates for biofuel consumption (the Renewable Fuel Standard) requiring that by 2022, 36bn gallons of renewable fuel be consumed annually and of this 15bn gallons come from maize-ethanol. Since the US is the only major maize-ethanol producer, this acts as an effective US production mandate. Until January 2012, there was also a subsidy to ethanol blenders (the ethanol blenders' tax credit) and import duties payable on biofuels (Yacobucci 2012).

Collectively these policies will raise the price of agricultural commodities and will contribute to making prices more volatile, although at current levels of biofuel production the size of these effects is hotly debated and perhaps small (for examples of this debate see OECD 2006, 2008; HMG 2010; Babcock 2011; Laborde 2011; Wright 2011).

In theory: as increasing demand incentivises agriculture to produce more, the marginal (and average) cost of production rises relative to the counter-factual and so does price because either poorer quality land has to be used or more intensive (and expensive) farming methods must be employed. These price increases will incentivise efficiency gains in the long run, bringing prices down again somewhat, but not below the price level we would have seen without demand from biofuels. Stimulating demand for specific crops (biofuels feedstocks) also encourages land away from alternative crops/uses. Equally, by imposing an obligation on blending biofuels with petrol or diesel, this "extra demand" for grains and oilseeds is largely constant[2], irrespective of availability and price of

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[1] The UK chooses not to use this particular lever.

[2] To be precise, the overall demand for biofuels is constant, and if sufficient and cheaper alternatives to grain were available, blenders today could switch to biofuels produced using alternatives to grains and oilseeds.

feedstocks[3]. Consequently, when grains are scarce the consequences of reduced supply (i.e. reduced consumption) falls on other markets, and in particular the food and animal feed markets, rather than being shared between these and the biofuels market.

However, there is also a significant body of literature on the need to reduce the use of fossil fuels in transport and to find alternatives that do not contribute to climate change. The challenge for Governments is to find policy levers that contribute to their carbon reduction objectives without imposing avoidable costs elsewhere.

In *Price Volatility in Food and Agricultural Markets: Policy Responses*, 10 international organisations suggest introducing flexibility as "a second-best alternative" to removing mandates altogether (FAO et al. 2011).

The United Nations Conference on Trade and Development (UNCTAD, undated web page) has called "For the United States and the European Union and for other countries relying on mandated blending volumes or percentages to introduce flexibility in those targets so as to restore the natural balance played by markets."

# Why does this matter?

It is not simply enough to assert that biofuels policies could be redesigned to reduce the magnitude of price spikes: there remains the important question of why this matters.

The terms "price volatility" and "price spikes" are often used interchangeably because they share many of the same impacts, but the difference can be important. "Price volatility" tends to be used to describe multiple variations in price over a period of time, so a single spike that is preceded and followed by stable prices does not indicate a volatile market. This has led commentators like Gilbert and Morgan (2011) to conclude it is too early to say whether, post-2007, we have entered a new phase of higher price volatility. Price spikes, on the other hand, involve rapidly rising and then falling prices, so have a specific direction. Evidence collected by the UK's Government Office for Science suggests that factors such as climate change could lead to more price spikes in future as the frequency and severity of extreme events increase (Foresight, 2010).

Price volatility and price spikes matter when they affect incomes, either of producers or consumers. Volatility can also affect investment decisions, reducing "risk-adjusted" returns on investment and potentially leading to less investment in agriculture. "Net consumers" (those who produce food, but consume more) in developing countries may be more affected than others by price spikes because they spend a larger share of income on food and may have fewer alternatives to switch between as prices rise. For these net-consumer

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However, the modelling we undertake here accounts for this degree of substitution and still finds a significant benefit to the proposal.

[3] Some EU member states have a mechanism whereby blenders can buy-out of their obligation to use biofuels if the costs are high relative to the oil price, but in practice the threshold for taking advantage of this buy-out option has never been reached.

households, diverting resources from staples into producing higher value cash crops is more difficult/unattractive where food markets are volatile.

It is plausible that the global market responds in an "economically efficient" manner to higher volatility by increasing privately held stocks of grain. Gilbert (2011) writes, "there is no generally valid theoretical argument that, at the world level, private storage will be inadequate". In effect, players in the global market can be expected to efficiently correct for higher volatility by making use of futures markets and/or increasing privately held stocks.

Indeed, the "optimum" amount of volatility in agricultural markets will not involve perfectly stable prices, because such a situation could only be achieved at extremely high cost and would lead to a miss-allocation of resources between these artificially stable agricultural markets, and other more volatile markets. But this does not imply that we should ignore the potential impact of biofuels mandates on volatility. Biofuel mandates are an instrument of public policy. The question is whether they should be designed in ways that reduce or increase agricultural market volatility.

This has led some commentators to share UNCTAD's view that "the relationship between biofuels and food price spikes should be interpreted more as a policy failure than as an intrinsic and unavoidable consequence of the production of biofuels." (UNCTAD, undated webpage).

# A menu of solutions for addressing volatility

Regardless of whether biofuels are responsible for price spikes or volatility, there is a general need to reduce volatility for the benefit of those at risk of food insecurity, to promote investment and "pro-poor" growth. There is at least a case for the costs of this action being borne by states with stretching biofuels mandates, since these states commonly have significant international development objectives.

But of course biofuels mandate flexibility is not the only potential solution to volatility in agricultural markets. There is a history of unsuccessful attempts to reduce volatility in commodities markets. In the past, the following have been tried:

- International Commodities Agreements (ICAs) were used in the past to try to manage price volatility, but proved much more effective at raising prices than stabilising them (Gilbert 2011, Gilbert and Morgan 2010).
- Publicly held global stocks might reduce volatility, although there is evidence that these simply crowd-out private stocks and prove very expensive (Miranda and Helmberger 1988; Gilbert and Morgan 2010; Gilbert 2011).

In more recent years, the following have been suggested:

- Better market information may reduce volatility. In May 2011 the G20 highlighted that some volatility in agricultural markets could be avoided simply by providing better information, and this led to the creation of the Agricultural Markets Information System (AMIS) (G20 2011).

- Nationally or regionally held stocks may be an alternative for areas without private stocks or access to global markets (Gilbert 2011).
- To mitigate the effects of volatility at a national level, Governments could buy "call options" in futures markets (Morgan 2001, Gilbert and Morgan 2010). These tools are also available to businesses and individuals.
- Wright (2011) has proposed a mechanism for diverting grain from "non-essential" to "essential" uses in times of crisis. The UK Department for International Development (DfID) have commissioned a study to explore this idea further.

A more complete list of policy options would also include improving the productivity and responsiveness of the agricultural sector, and removing trade distortions in agricultural markets.

Finally, to this suite of policy options it is important to add the relatively new possibility of flexible biofuels mandates. Similar to improving free trade and productivity, but unlike the proposals relating to public and private stocks, flexing existing biofuels mandates need not further increase agricultural commodities prices at the same time as reducing volatility. To date, evidence on the costs and benefits of introducing flexibility into biofuels mandates is much less developed than for some other options. But the modelling reported in the rest of this paper suggests that the possible magnitude of the impact of biofuel mandate flexibility on international price volatility is very significant and should be taken seriously by the international community.

# Estimating the potential impact of flexible mandates

This section outlines the method, results and conclusions of a modelling exercise undertaken by Defra analysts.

At a minimum, a flexible biofuels mandate needs two characteristics:

- Bring grain onto the food market if and only if there is an emerging price spike.
- Re-introduce the mandate only when food/feed grain is once again in sufficiently large supply.

Without making further assumptions about the delivery mechanism, Defra analysts have taken a first look at the impact of relaxing EU biofuels support during a few different grain price spikes. Defra has also examined the impacts of flexibility in the US mandate in a separate exercise, reported in the annex to this paper.

Due to modelling limitations, our work only examines the impact of removing support during an agricultural price spike – we continue to explore how best to reintroduce support in our model at the end of the spike.

## Introduction to the modelling exercise

Four price spikes were investigated one at a time using the AGLINK-COSIMO 2010 model (OECD/FAO 2010). For each spike we ran the model twice – first to see what happens if EU biofuels support is maintained, then if support is removed entirely in the same year as the spike. Nothing else in the model was changed from the OECD/FAO assumptions (Annex B reports more precisely which parameters were changed). The four spikes we examined are:

1. **Wheat shock 2011**: 25% reduction in the area of wheat harvested in the EU in 2011
2. **Wheat shock 2018**: 25% reduction in the area of wheat harvested in the EU in 2018
3. **Coarse grain shock 2011**: 25% reduction in the area of coarse grains harvested in the EU in 2011[4]
4. **Coarse grain shock 2018**: 25% reduction in the area of coarse grain harvested in the EU in 2018

These different price spikes can be thought of as the result of unusually poor weather in Europe, leading to a reduction in global availability of grain. The shocks should not be interpreted as the result of biofuels policy.

This approach does not allow us to test whether biofuels mandate flexibility could help to avoid panic behaviour, either by consumers in the form of panic buying or producing states in the form of export restrictions. Currently there are no agricultural models that claim to be able to simulate such behaviour.

## Detailed method for modelling exercise

This section outlines the method in more detail and discusses its main strengths and weaknesses. Readers interested in how we changed the structure of the AGLINK-COSIMO model can refer to Annex B.

AGLINK-COSIMO is a "partial equilibrium model" of the global agricultural economy, which is designed to answer questions about how changes in policy might affect agricultural markets over the next 10 years. It is therefore forward-looking, and can provide results broken down by region, by agricultural product and by usage.

To do this, AGLINK-COSIMO examines the complex interactions between different products grown in different regions and used for various purposes all over the world. For instance, our shocks to the wheat area in the EU translate into a price spike for coarse grain as well as wheat, because higher wheat prices make coarse grain-derived animal feed and bioethanol more attractive, so demand for coarse grain increases and price

[4] Maize is used as shorthand to mean all coarse grains, which actually includes barley etc. Maize makes up a large proportion of coarse grains at the global level so this is a reasonable simplification.

follows. Changes in EU production lead to global changes in price because production in the EU affects how much is available elsewhere in the world through imports and exports. Demand for wheat for use as human food, for animal feed and for biofuels changes by different amounts even though they all face the same price spike[5], depending on the alternatives that are available for each use. By-products from biofuels production re-enter the market as animal feed.

Twenty-four different combinations of shocks and flexible biofuels support were examined as part of this investigation, but the most significant results were seen when all support for biofuels was removed so this is what we report. Results from other model runs are discussed briefly in section 6.4 below, and show that removing the blending obligation alone is roughly equivalent to removing all support.

We focussed attention on shocks occurring in the wheat and coarse grain markets because these are by far the largest grain markets, so our shocks have impacts on the largest number of consumers. It would equally have been valid and possible to examine shocks in oilseed markets, which are likely to respond even more to relaxing EU support for biofuels because biofuels are a more significant source of demand in these markets[6].

The four shocks lead to between 70% and 150% rise in the annual price of wheat or coarse grain. For comparison, between March 2007 and March 2008, wheat prices rose almost 125%; between June 2007 and June 2008, maize prices rose 75%. This shows that whilst a weather shock that knocks out 25% of EU production is not very realistic, the resulting price spikes are of a similar magnitude to observed spikes in the recent past.

To remove all support for biofuels in the model:

- Taxes were set at the same level as diesel for biodiesel or petrol for bioethanol;
- Blending obligations were removed, leaving blending to the market;
- Import tariffs on biofuels were eliminated for imports from all nations.

Following the end of each price spike, the model did not re-introduce EU support for biofuels. This was simply to help the model solve, and we discuss its implications for the results in section 6.5.

[5] AGLINK-COSIMO effectively models a single global price for wheat (although durum wheat is modelled separately for the EU market). This implies the same wheat could be used for human food, animal feed or biofuels production. Whilst that may not always be the case (perhaps because of quality standards for human consumption), the tight link between the prices of different types of wheat indicates that there is enough substitutability at the margin. For a graphical example of how prices of hard (bread) wheat and soft (animal feed) wheat move together, see Section 3 of Defra's monthly Farming and Food Brief http://www.defra.gov.uk/statistics/category/food-farm/monthly-brief

[6] In 2010, EU production of biofuels accounted for 39% of EU demand for oilseeds, compared to 3% of demand for each of coarse grains and wheat. Data from AGLINK-COSIMO database.

All other assumptions in AGLINK-COSIMO were left unchanged from the OECD-FAO *Agricultural Outlook 2010*, including assumptions about the oil price, population growth, incomes, total transport fuel growth and third country support for biofuels.

We discussed this approach to modelling biofuels mandate flexibility with colleagues from OECD who designed the biofuels module of AGLINK-COSIMO, and agreed this was the correct way to proceed.

The prices of wheat, coarse grain, oilseeds, bioethanol and biodiesel were recorded for each of the model runs.

# Results of modelling exercise

This section presents results of the modelling exercise, showing how removing biofuels support in the EU can mitigate the 4 different price spikes. Results for each spike are presented in turn.

## Results for a Wheat price spike in 2011, and in 2018

The shocks to wheat production result in the price of both wheat and coarse grain rising; other grain prices were left broadly unaffected[7]. Wheat and coarse grain prices are therefore both reported in Table 1.

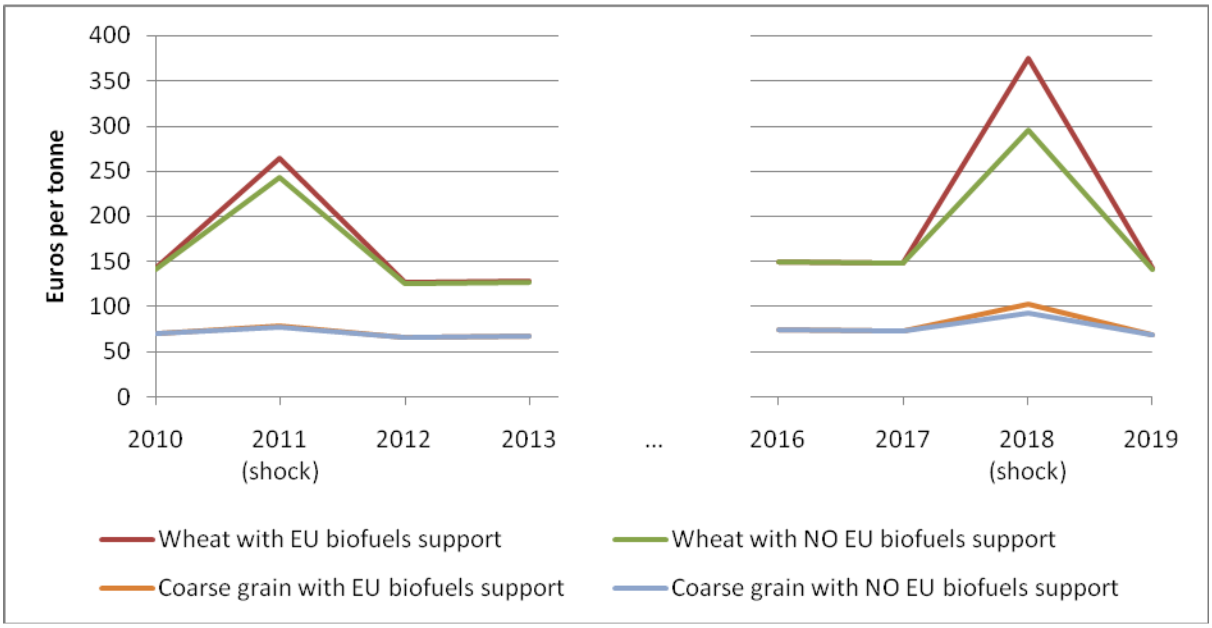
**Table 1: Results for wheat shocks in 2011 and 2018[8] - units are all Euros per tonne**

| Grain | EU biofuels support? | 2010 | 2011 (shock) | 2012 | 2017 | 2018 (shock) | 2019 |
|---|---|---|---|---|---|---|---|
| **Wheat** | Yes | €141 | €264 | €126 | €147 | €374 | €141 |
| | No | €141 | €242 | €125 | €147 | €295 | €141 |
| **Coarse Grain** | Yes | €70 | €79 | €66 | €73 | €103 | €69 |
| | No | €70 | €78 | €66 | €73 | €93 | €69 |

[7] Oil seed prices did rise, but only by around 4%. This is discussed in section 6.3.3

[8] Note that these shocks occur in separate model runs, i.e. the shock in 2018 is run on a model where there is no shock in 2011. The results are presented in one table purely for convenience.

**Figure 1: Chart showing effect on world price of removing EU biofuels support during two wheat price spikes**




The results show that the price spikes are partially mitigated by the removal of biofuels support. When there is a shock in the wheat market and both wheat and coarse grain prices rise, removing biofuels support can avoid 10-35% of this prices rise (10% for coarse grain in 2018 and 35% for wheat in 2018). These percentage changes are calculated relative to prices in the baseline version of AGLINK-COSIMO 2010, before we introduced production shocks or changes to EU biofuels support.

A few further observations:

- The mitigating impact of flexible biofuels support is greater in 2018 than 2011 because of the higher proportions of grains and oilseeds used for biofuels rather than for food or feed.[9]
- The price level following the end of the spike is lower than it was before the spike
- A temporary shock to wheat production has a fairly small impact on the price of coarse grain, in comparison to the effect on wheat price.

## Results for a coarse grain price spike in 2011, and in 2018

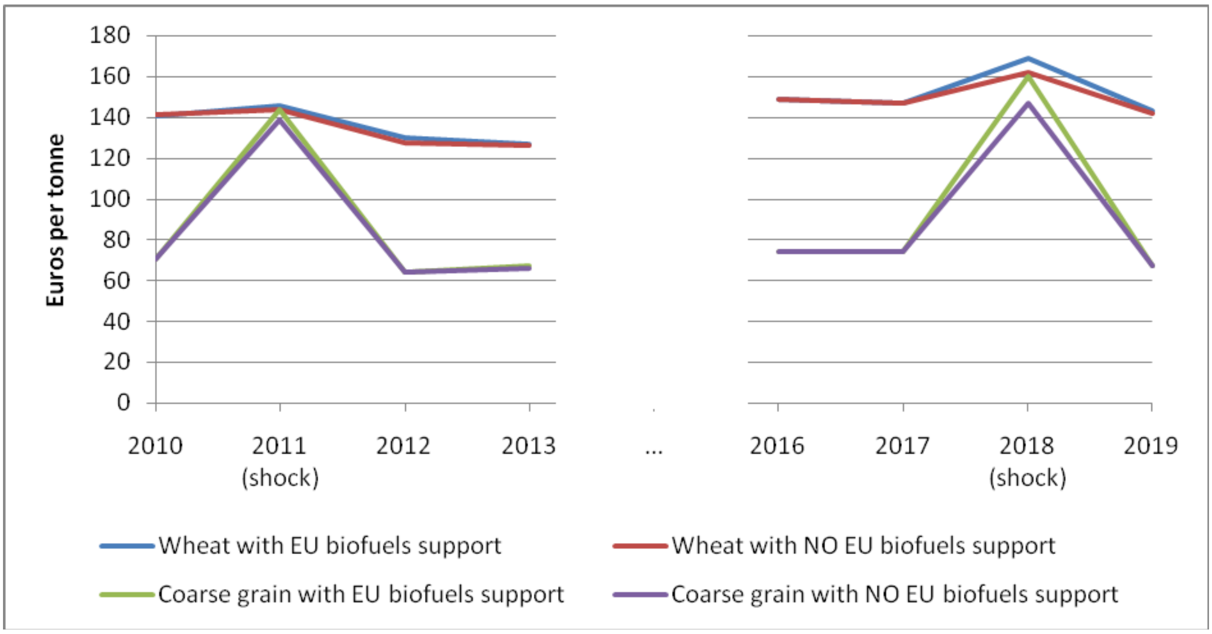
When coarse grain production was shocked in 2011 and 2018, again we found that both coarse grain and wheat prices rose so these are reported in Table 2.

[9] The proportion of global production used in biofuels production is projected to increase by 14% for vegetable oil and 92% for wheat between 2011 and 2018. Maize is expected to see only a 3% increase.

**Table 2: Results for maize shocks in 2011 and 2018 – units are all Euros per tonne**

| Grain | EU biofuels support? | 2010 | 2011 (shock) | 2012 | 2017 | 2018 (shock) | 2019 |
|---|---|---|---|---|---|---|---|
| **Wheat** | Yes | €141 | €146 | €130 | €147 | €169 | €143 |
| | No | €141 | €144 | €127 | €147 | €162 | €142 |
| **Coarse Grain** | Yes | €70 | €144 | €64 | €74 | €160 | €67 |
| | No | €70 | €139 | €64 | €74 | €147 | €67 |

**Figure 2: Chart showing effect on world price of removing EU biofuels support during two coarse grain price spikes**




When there is a shock in the coarse grain market and both coarse grain and wheat prices rise, removing biofuels support in the EU can once again avoid 7-35% of this price rise (7% for coarse grain in 2011 and 35% for wheat in 2018).

Additionally:

- The mitigating impact of biofuels flexibility is again stronger in 2018 than in 2011
- The price level after the end of the spike is lower than it was before the spike
- A shock to coarse grain production has a fairly small impact on the price of wheat, in comparison to the effect on coarse grain price.

### Impact of flexible mandates on other markets in the modelling exercise

AGLINK-COSIMO is designed to examine agricultural markets across the globe, and may be less suited to looking at precise quantities and prices for refined products like biodiesel and bioethanol in great detail[10], but for completeness these results are presented here.

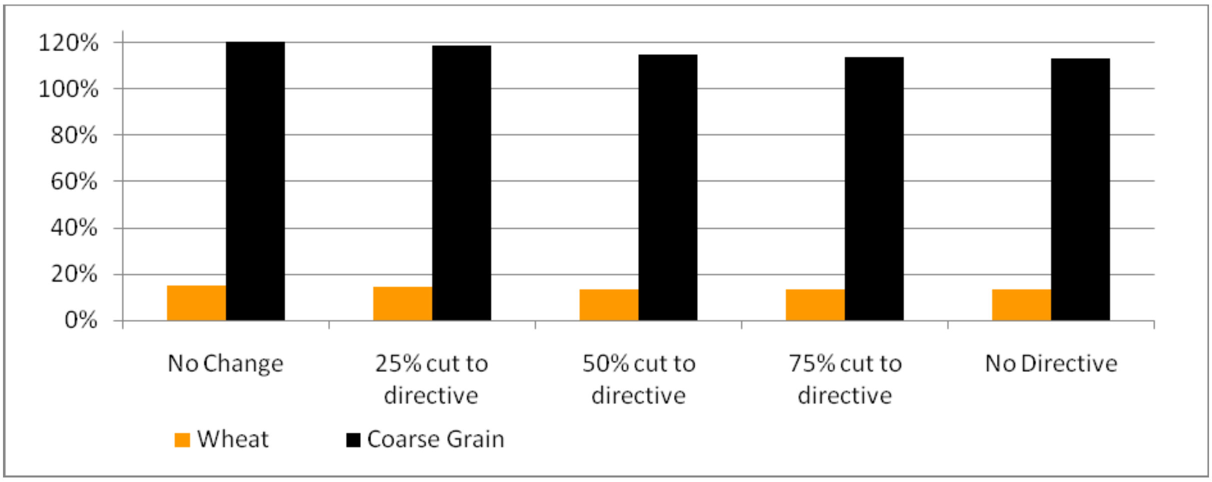
The four shocks we introduced to the model affected only feedstocks used to refine bioethanol, but there were also indirect impacts of these shocks on the price of oilseeds, which are used to make biodiesel.

- With EU biofuels support removed during a spike and (unlike the policy proposal) never reintroduced in our model, ethanol production in the EU falls by 30% 2 years after the 2011 price spikes, or by 60% 2 years after the 2018 price spikes. If support were reintroduced following the end of the spike it is unclear how ethanol production would respond, although it is likely to be lower during the period when mandates are relaxed.
- The price of oilseeds rises by 4% in response to each coarse grain shock, but by only 2-3% if EU biofuels support is removed.
- In spite of the modest rises in oilseed prices, there is no impact on vegetable oil prices and biodiesel production is unaffected.

## Alternative forms of flexibility in the modelling exercise

In addition to exploring the complete removal of EU biofuels support, we also investigated partial reductions in support. For both the wheat and coarse grain shocks in 2011, we examined the impact of reducing all support by 25%, 50% and 75% as well as the impact of retaining the preferential tax rate but reducing the import tariffs and blending obligation by 25%, 50% and 75%. Finally, we investigated the effect of removing the obligation alone, and then import tariffs alone.

**Figure 3: Price rises that result from a 25% reduction in the area of coarse grain harvested in the EU in 2011, for various changes to EU support for biofuels production**




[10] Whilst the biofuels module of AGLINK-COSIMO may be less developed than other parts of the model, it still represents the best available description of the links between global agricultural and bioenergy markets, and is more than adequate for this purpose.

Results of these alternative forms of flexibility were unsurprising: The more support that was removed, the greater the mitigating impact on grain prices. Removing the blending obligation alone was equivalent to removing all support. We also modelled removing import tariffs alone during a coarse grain shock in 2011, and found it lowered grain prices by around 3%[11].

## Discussion of modelling exercise

The modelling exercise clearly demonstrates that there is potential for flexible biofuels mandates to mitigate a price spike, but given the limitations of the model it does not provide a complete picture of all the costs and benefits of such a proposal. The model fails to capture the potential for a robust system of flexible mandates to avoid panic behaviour, nor does it fully consider the costs to biofuels producers. Such considerations would require a fuller cost-benefit analysis of the sort described in the final section of this paper on page 20.

Focussing on the results, these can be explained fairly simply and appear to support the theoretical justification for exploring flexible mandates:

- Removing EU support for biofuels makes the entire demand side of the grain market responsive to price (as opposed to just the food and feed components of demand), so demand from biofuels producers contracts a little along with demand in the rest of the food/feed market. This “burden-sharing” avoids the need for such high prices in the food/feed markets.
- As biofuels production in the EU is set to more than double over the next 10 years (OECD 2010), it is unsurprising that reducing support in 2018 has a bigger impact than in 2011. However, this does not necessarily mean that the biofuels market will remain as reliant on (and responsive to) EU support as it is today.
- Following the end of the price spike, EU biofuels support is not reinstated in order to help the model solve, so grain prices appear lower than before the spike and bioethanol production declines after a few years. It seems unlikely that either of these effects would occur if EU biofuels support were reinstated, although there could be a long-term impact on ethanol production if EU support were flexed frequently. This is clearly an area that requires further investigation.

The fact that biofuels support is not reinstated following the end of the spike has been identified as a weakness in our approach, but we can state with confidence that it has not affected the headline results on the potential of this policy idea. AGLINK-COSIMO models biofuels supply as a function of prices in the current year and historic refining capacity – it does not include expectations of future demand (see Annex B for the detail). This means that it would provide the same results on the mitigating potential of removing biofuels support during a price spike, whether or not support were reinstated at a later date.

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[11] This suggests that removing the blending obligation and import tariffs together results in some overlap, since the sum of the two isolated effects is larger than the effect of removing them simultaneously.

However, there are other reasons to believe these results are an over-estimate of the impact that mandate flexibility might have in reality, as well as reasons to believe they are an under-estimate.

The model we have used is designed to look at the medium-run implications of changes to global agriculture, and may exaggerate the ability of the economy to respond over the course of a single year. By exaggerating the response of farmers to a price spike, it will tend to underestimate the size of this spike and therefore the potential of short-run policies to mitigate such a spike. In technical terms, the model uses medium-run elasticities that tend to be larger than short-run elasticities.

This modelling exercise ignores "panic behaviour" and may therefore be an underestimate of the effectiveness of flexible mandates/flexible support in general. If, for instance, it is known that a certain price will trigger the release of large amounts of grain onto the food/feed markets, this could be enough on its own to avoid panic buying or even to avoid the imposition of export bans. In such a situation, the mechanism prevents further "unnecessary" price rises altogether.

We have attempted to explore what would happen if both EU and US biofuels support were removed at the same time during a global price spike, but the policy changes proved too large for our model to solve. On the one hand this underscores how fragile modelling of this sort can be, but it hints at the very substantial impact that coordinated policy might have. To provide a more global perspective on the potential of this idea, we modelled flexibility in US mandates separately, and report results in Annex A.

Our modelling also ignores how biofuels refineries and blenders might respond to a temporary rather than permanent change in EU support (this criticism would be valid whether or not we reinstated support in the model following the price spike, as explained above). A handful of EU Member States are currently failing to meet their blending obligation (Al-Riffai et al. 2010), so biofuels blenders might use a temporary relaxation to build inventories in order to meet the obligation when it is reinstated in the future. Such "smoothing" behaviour could reduce the effectiveness of this policy.

The model assumes that grain used for biofuels is of the same quality as grain used for animal feed, and so can be brought onto the animal feed market if required. If a very large proportion of biofuels feedstocks were unsuitable for animal feed (perhaps because the grain was cultivated on contaminated land) then the effects of flexing mandates could be smaller than modelled. There is no evidence that this is currently the case on a sufficient scale to be of concern.

Furthermore, if biofuels become increasingly commercially viable, production may grow to exceed the blending obligation and start responding to price signals. In such a situation, relaxing the blending obligation will have little or no short-term impact on demand for grains from biofuels and this policy will cease to be an effective way to mitigate grain price spikes (Laborde 2011). However, in such a situation, the biofuels market naturally becomes responsive to changes in feedstock prices so the need for flexible policy is also removed.

Brazil provides a good illustration of this point: in Brazil there is a blending obligation but it is currently exceeded by ethanol production from sugar cane, so at the current ratio of oil price to sugar price[12] removing the Brazilian obligation would not affect today's prices of sugar and maize[13]. It is therefore possible that the effectiveness of flexible biofuels mandates as a tool to mitigate volatility in agricultural markets (whether the result of biofuels or not) has a natural time limit of a few decades at most.

To the authors' knowledge, there have not been similar attempts by others to model the impact of flexible biofuels mandates in the EU. However, the results in Annex A, which explores the same policy idea for the US, can be compared to recent work by Bruce Babcock (2011). Babcock found that removing subsidies for ethanol production in 2011 would have led to a 17% reduction in maize prices. He also confirmed that "the model results show that if market conditions are tight because of poor maize yields, then the mandate will have a larger-than-average impact on market prices because it forces all the adjustment to tight supplies onto the livestock sector."

# Practicalities of implementation

There are challenges that this proposal will need to overcome if it is to be pursued, and most arise from considering how it would work in practice. The report for the G20 *Price Volatility in Food and Agricultural Markets* (FAO et al. 2011) contains an annex which explores some of these challenges, and is largely paraphrased here:

- The rule that triggers flexibility requires careful design, although it could be relatively simple to operate. One simple option is for a rule based on market prices: at a pre-defined (real) price of grains, mandates could be relaxed by some amount, and if the price reaches a second threshold they could be relaxed more. Alternatively, Laborde (2011) suggests the decision rule might need to take account of existing stocks, for which data is notoriously unreliable. Babcock (2011) suggests that feedstock supplies are the key metric, including both stocks and production. To provide the predictability needed to avoid panic behaviour, a publicly known rule would be required (FAO et al 2011).
- The precise nature of the flexibility is also important. This paper has discussed temporary reductions in the ambition of mandates, but Babcock (2011) suggests an alternative: in relation to the US he describes introducing flexibility by "increasing the limits by which fuel blenders can bank or borrow blending credits when meeting their blending obligation". This refers to the idea that over-production in one year can count towards meeting the obligation in another, and may be attractive because

[12] Commercial viability of biofuels depends critically on the costs of inputs like sugar, grain and oilseeds and on the price biofuels can be sold for. Recently, whilst sugar prices have been rising, the oil price has been so high that refining sugar cane for bioethanol makes commercial sense.

[13] However, the mandate could still affect investment and production in the longer term if there is a risk that biofuels will not always remain commercially viable.

it retains the overall level of ambition of the mandates whilst providing biofuels blenders with more discretion over their cost base.

- The trigger needs to be independent of political pressure to ensure it is used when necessary and not at other times. If this is not the case, policy uncertainty could translate into increased rather than decreased market volatility.
- International policy coordination is likely to be required for the proposal to be at its most effective. The intention to bring more grain onto the food markets could be undermined if other countries respond to the removal of EU mandates by increasing their consumption of biofuels. FAO et al. (2011) suggests the Committee on Global Food Security might be a good forum to facilitate such coordination.
- This is a highly politicised area of the economy, not least because for the most part both the biofuels and agricultural industries benefit from a significant amount of Government support. FAO et al. (2011) discusses this further.

The scale of each of these challenges needs further assessment.

# Conclusion

There are a number of challenges that can be foreseen in implementing the idea of flexible mandates, but our modelling work demonstrates the very significant benefits that could be gained if these challenges can be overcome.

The paper demonstrates that removing support for biofuels during a price spike could reduce the magnitude of the spike. If implemented in the EU, this proposal could reduce the magnitude of a spike in the price of wheat by anything from 10% to 35%. Similarly, a spike in the price of coarse grain could be mitigated by up to 15%.

Perhaps the most notable challenges relate to international policy coordination: introducing flexibility into biofuels mandates cannot be done alone by the UK.

We have assumed that mandates will continue to drive production of biofuels in the EU, but it is possible this will not be the case – consistently high oil prices could lead production to exceed its mandate. If and when biofuels become widely and consistently commercially viable the need for mandates, flexible or otherwise, will not arise.

Based on the evidence and discussion in this paper we suggest that the proposal is worth exploring further. In particular, two early tasks will be to explore specific triggers and implementation mechanisms, and to assess how quickly it could be implemented in either the EU or the US. A key date for the EU will be the European Commission's review of bioenergy targets in 2014.

# What's next?

This paper has been written to inform and stimulate debate, but it also makes a case for work to develop a more detailed policy proposal. Here we suggest what some of that work might involve.

## Significant refinement of policy, including wide engagement

As indicated in the conclusion, it will be important to understand if and when biofuels production is likely to become generally commercially viable. This needs to be set against the likely policy effort and time required to draft, adopt and implement revisions to the EU Renewable Energy Directive in order to allow flexible mandates to become a reality. If it looks like there are only a few years between implementing the changes and mandates becoming irrelevant, it may be worth going no further.

Section 7 identified a number of other challenges associated with introducing flexibility into biofuels mandates and these require attention to assess which are avoidable, and which if any are insurmountable. Section 6.5 also identified a number of reasons to be wary of the modelling results, so more detailed economic analysis would be helpful.

Early and constructive engagement with the UK biofuels industry, the European Commission, other EU member states and experts in agricultural commodities markets will be essential to developing a credible and acceptable policy option. This is likely to highlight both more challenges and potential solutions, and will be an important test of the rationale for action put forward in this paper.

The discussion around practicalities of implementation suggests that the costs associated with this proposal are highly dependent on the how the proposal is implemented. A poorly designed trigger could introduce unnecessary uncertainty into the biofuels market, with implications for investment and long run growth of the market in the same way that volatility in agricultural markets can also affect investment. A poorly designed method for introducing flexibility could make it harder for national governments to meet renewable energy objectives. Simple alternatives that avoid these problems are suggested in this paper, but need to be developed further.

For example, it would be worth exploring a trigger based purely on market prices because these represent an easily accessible aggregation of all available market information. Perhaps at given thresholds in an index of grain prices, mandates could be relaxed by 50%, 75% and 100% and reintroduced when the index falls.

It might also be worth exploring different "mechanisms" for introducing flexibility, perhaps developing Babcock's idea of allowing blenders to "bank" contributions to their obligation when grain is cheap, and "borrow" when grain prices spike.

## A fuller cost-benefit analysis of specific options

Throughout this paper we have argued that there are costs and benefits, winners and losers from this proposal. Examining the impacts of the proposal on agricultural prices is not enough to make a complete case for introducing flexibility into biofuels mandates: these benefits need to be weighed against costs to biofuels refineries.

A fuller cost-benefit analysis according to guidance set out in HM Treasury's Green Book (HMT 2003) involves attempting to put money values on all impacts of the proposal. Benefits may arise in agricultural markets from lower prices paid by grain consumers, whilst costs may arise from lower profits to biofuels refiners.

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# Annex A: Modelling the impact of flexibility in US biofuels mandates

**Author's note:** This annex was written as a stand-alone paper exploring the potential impacts of flexible biofuel mandates in the US. We were keen to explore the implications of introducing flexibility to both EU and US mandates simultaneously but our agricultural models could not solve with such substantial global policy changes, so the US was modelled independently.

Grant Davies

**Defra, June 2012**

## Introduction

1. Cross-Whitehall analytical work in relation to the 2007/8 price spike in agricultural markets concluded that a "fuller appraisal of the different types of biofuels policies and their impact on agricultural markets is required, in particular the impact of inflexible quantitative targets for biofuel consumption[14]".

2. However, it is important to note that available evidence does **not** suggest that biofuel demand has been a major driver in agricultural price spikes during 2007/8 and more recently in 2010/11.

3. Nevertheless, given the size of the US biofuel policy in particular, ensuring grain for biofuels is not unavailable to food markets in times of relative shortage could play a role in reducing the magnitude of price spikes in grain markets.

## Overview of US Biofuel Policy

4. The US biofuel policy consists of quantitative mandates for biofuel consumption (the Renewable Fuel Standard) requiring that by 2022, 36bn[15] gallons of renewable fuel be consumed annually and of this 15bn gallons come from maize-ethanol. Since the US is the only major maize-ethanol producer, this acts as an effective US production mandate. There is also a subsidy to ethanol blenders, the ethanol blenders' tax credit.

[14] HMG (2010). The 2007/8 Agricultural Price Spikes: Causes and Policy Implications.

[15] For reference, the US consumes around 140bn gallons of gasoline annually at present.

5. The Administrator of the Environmental Protection Agency (EPA) can waive the Renewable Fuel Standard mandates under certain circumstances; in particular, if "implementation of the requirements would severely harm the economy or environment of a state, a region, or the United States, or if EPA determines that there is inadequate domestic supply of [grain for] renewable fuel."[16] The request for a waiver can be made by US States, refiners and blenders. The EPA Administrator can also initiate the waiver without receiving a request. There are also provisions for "regular reviews of the impact of the mandates."[17]

## Economic Modelling

6. The OECD-FAO Aglink-Cosimo model was used to illustrate the potential for mandate waivers to mitigate price spikes as it allows us to run simplistic scenarios around the US biofuel mandate during price spikes. Results of these models should be interpreted with caution.

7. Firstly, a price spike in grain markets was simulated by reducing the US maize area harvested by 40% in 2011 – maize is the most important coarse grain globally – whilst maintaining the US biofuel mandate and ethanol blenders' subsidy. Secondly, various scenarios were simulated which waivered an increasing share of the US biofuel mandate but maintained the ethanol blenders' subsidy.

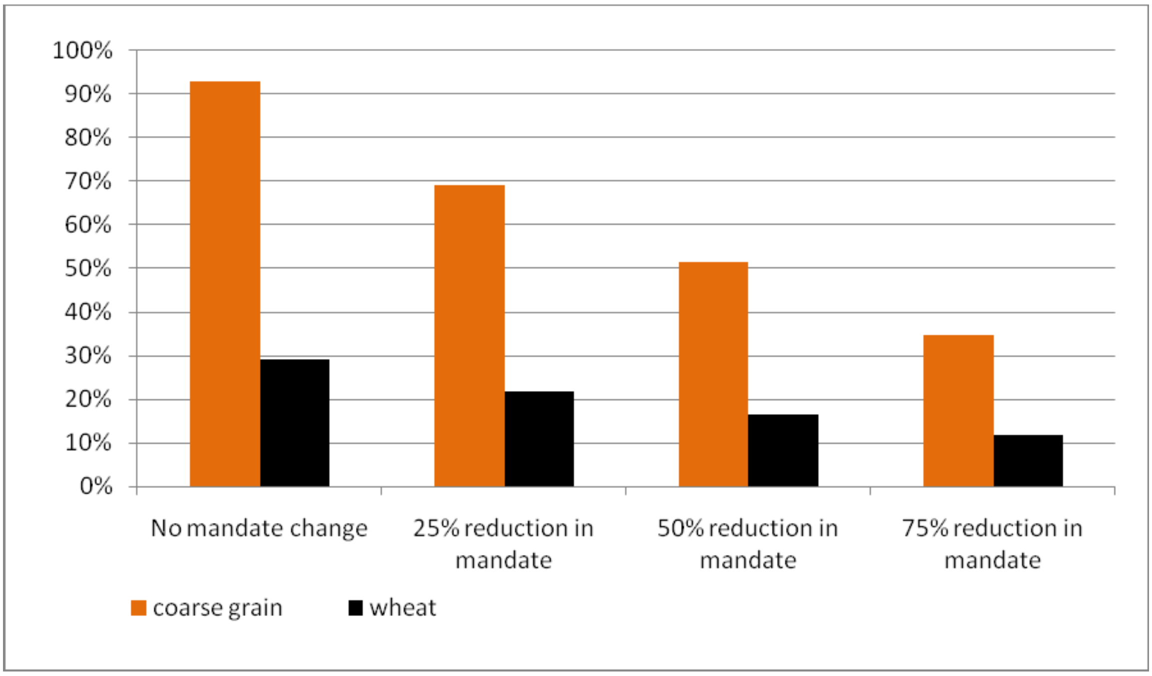
8. Consequently these illustrative scenarios show that a temporary reduction in the level of the mandate (a waiver) mitigates the hypothetical price spike significantly. This is because grain which was originally produced for ethanol manufacture moves into the food and feed market, increasing grain availability and dampening price increases.

9. Scenario outputs are given in Figure A1 below.

[16] Energy Independence and Security Act of 2007, or EISA (Public Law 110-140)

[17] Energy Independence and Security Act of 2007, or EISA (Public Law 110-140)

**Figure A1: Increase in world grain prices following 40% reduction in global maize area, under different biofuel mandate waivers**




10. In the scenario where the mandate is unchanged, the world coarse grain price is projected to rise by just over 90% in response to the reduction in maize area and production. On the other hand, if maize area is reduced but the mandate is waived by 75% then the price rise is projected to be 35%. Given that wheat and maize are substitutes for animal feed, wheat prices are also projected to rise in response to the reduction in global maize production. When the mandate is unchanged, wheat prices are projected to rise by around 30% in response to the fall in maize area. Alternatively, when the mandate is reduced by 75% wheat prices are projected to rise by 12% in response to the fall in maize area.

11. When the mandate is reduced, price increases are correspondingly mitigated and the larger the waiver, the greater the price mitigation, as more grain is free to move from ethanol to food and feed use. Furthermore, the effect of waiving the mandate is projected to be quite large. For example, *halving the mandate* reduces the projected price rise by over 40 percentage points; in other words, the impact on world coarse grain prices is also *roughly halved*.

12. These scenarios emphasise the importance of the **design** rather than the existence of biofuel policies. Waiving the mandate during temporary supply shortages in any given year and/or encouraging biofuel production through more flexible means such as incentives and subsidies (in place of mandates) could play an important role in mitigating the magnitude of price spikes in grain markets.

# Annex B: Simulating the change in biofuels policy in AGLINK-COSIMO 2010

This annex describes the detail of which parameters were changed in AGLINK-COSIMO to arrive at the results presented in the body of the paper and in Annex A. It is included to help experts who might wish to repeat the exercise, or comment on the approach we have taken.

AGLINK-COSIMO is a recursive-dynamic, partial-equilibrium, supply and demand model of world agriculture, developed and maintained jointly by the OECD and FAO. It covers annual supply, demand and prices for the principal agricultural commodities produced, consumed and traded in each of the countries represented in the model. The model contains advanced biofuel modules for both the US and the EU.

## Simulating a grain price shock in AGLINK-COSIMO

Grain prices in the model balance the European market for individual grains. For example, the European wheat price solves the following market balancing equation:

$$0 = \text{E27 wheat production}_t + \text{E27 wheat stocks}_{t-1} + \text{E27 wheat imports}_t - \text{E27 wheat consumption}_t - \text{E27 wheat stocks}_t - \text{E27 wheat exports}_t$$

Grain production in any given region or country in AGLINK-COSIMO is expressed as the product of area harvested and yield per hectare. For example, with respect to wheat:

$$\text{wheat production}_t = \text{wheat area harvested}_t * \text{wheat yield}_t$$

Area harvested itself depends on (lagged) gross revenues for the crop in question and for competing crops. Yields, when endogenous, are simple functions of prices and/or time trend variables which serve as proxies for technological change.

In order to simulate a supply shock to the EU grain market in a given year we therefore exogenised the relevant grain area equation and reduced the area by 25% as compared to the baseline value in that year alone. Such a shock significantly reduces grain production in one year.

# Removing/waiving biofuel support policies in AGLINK-COSIMO

## European Union

Biofuel support policies in the E27 are represented as blending obligations, tax incentives and tariffs on imported bioethanol and biodiesel. All are exogenous.

In order to remove blending obligations the following variables were set to zero in the model:

> ***E27_ET_QCS..OBL = 0*** *(ethanol blending obligation abolished)*
>
> ***E27_BD_QCS..OBL = 0*** *(biodiesel blending obligation abolished)*

In order to remove the tax incentives on biofuel consumption, taxes on ethanol and biodiesel were set equal to their fossil-fuel equivalents.

> ***E27_ET_TAX=E27_GAS_TAX*** *(equivalent taxes on ethanol and gasoline)*
>
> ***E27_BD_TAX=E27_DIE_TAX*** *(equivalent taxes on biodiesel and diesel)*

In order to remove tariffs on bioethanol and biodiesel, the following variables were set to zero in the model:

> ***E27_ET_TAS = 0*** *(ethanol import tariff set to zero)*
>
> ***E27_BD_TAV = 0*** *(biodiesel import tariff set to zero)*

## United States

Biofuel policy in the US is set out in the RFS legislation. In the model, US biofuel policy is represented as quantitative mandates on ethanol production, tax credits to ethanol blenders (increasing the margin on ethanol production) and tariffs on imported ethanol.

In the modelling exercise detailed in Annex A, only the quantitative mandates on ethanol production are altered. Both the tariff on imported ethanol and the tax credit to ethanol blenders are maintained[18].

US corn-ethanol output is calculated as a product of the corn-ethanol capacity in place and the utilisation rate of that capacity. US corn-ethanol capacities are modelled as a function of the quantitative mandate set by the RFS and also the economic returns to corn-ethanol production.

[18] It is noteworthy that both have now lapsed in US legislation.

***US corn-ethanol capacity $_t$ = f (corn-ethanol capacity $_{t-1}$ , RFS mandate $_t$ , margin on ethanol production from corn $_{t-1,2,3,4}$ )***

The US mandate for ethanol production (the "*RFS mandate $_t$*" term in the previous equation) is exogenous in the model and can be split into the amount of corn-ethanol supported by the RFS in any given year and the maximum amount of corn-ethanol permitted by the RFS. To get the results presented in Annex A, we ran scenarios in which the mandate was reduced by 25%, 50% and 75%. Accordingly, the following variables were reduced by 25%, 50% and 75% respectively:

***USA_RFS_CG*** *(amount of corn-ethanol supported by the RFS)*

***USA_RFS_CG..MAX*** *(maximum amount of corn-ethanol permitted under the RFS)*