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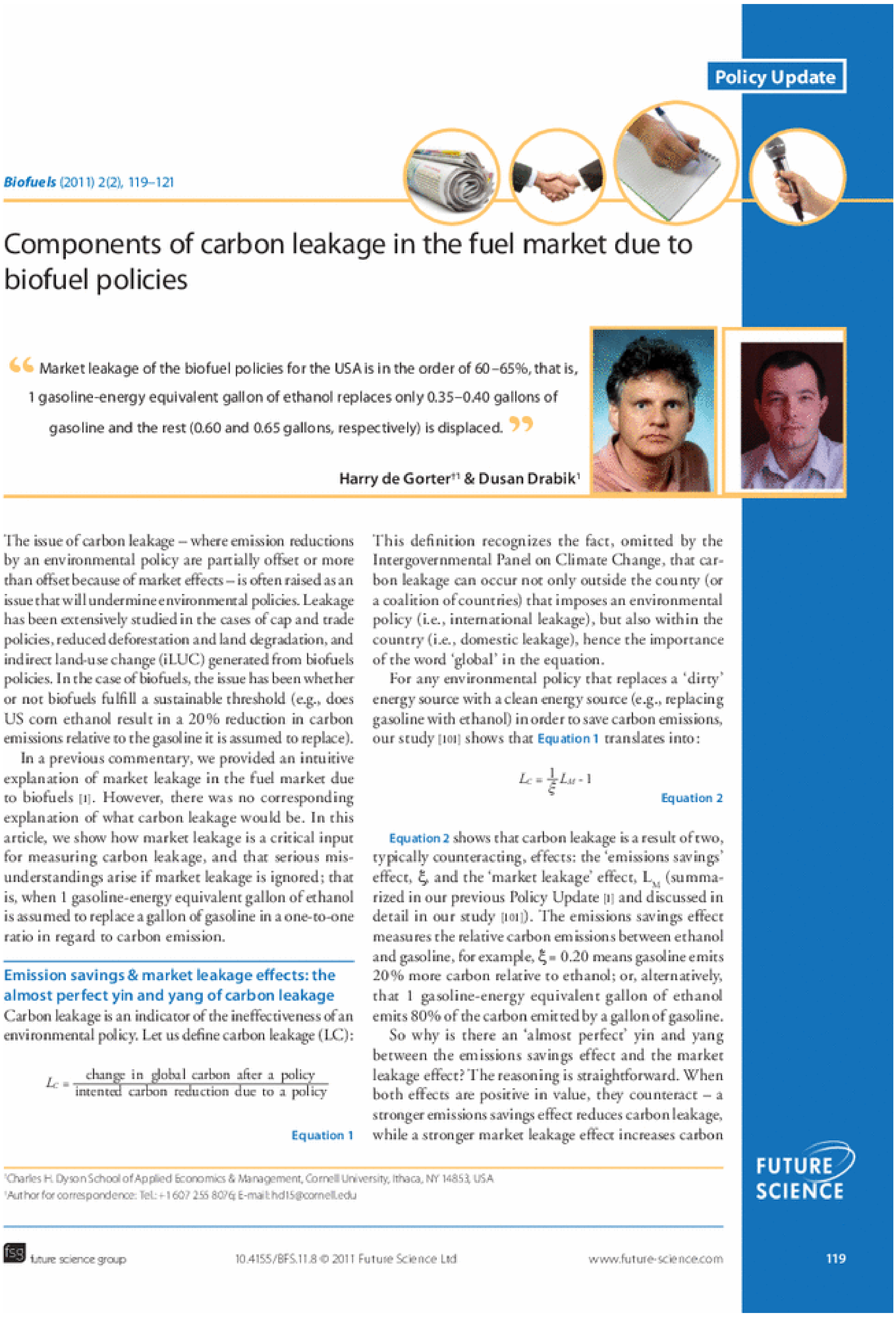

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Components of carbon leakage in the fuel market due to biofuel policies

"Market leakage of the biofuel policies for the USA is in the order of 60–65%, that is, 1 gasoline-energy equivalent gallon of ethanol replaces only 0.35–0.40 gallons of gasoline and the rest (0.60 and 0.65 gallons, respectively) is displaced."

Harry de Gorter[†1] & Dusan Drabik[1]

The issue of carbon leakage – where emission reductions by an environmental policy are partially offset or more than offset because of market effects – is often raised as an issue that will undermine environmental policies. Leakage has been extensively studied in the cases of cap and trade policies, reduced deforestation and land degradation, and indirect land-use change (iLUC) generated from biofuels policies. In the case of biofuels, the issue has been whether or not biofuels fulfill a sustainable threshold (e.g., does US corn ethanol result in a 20% reduction in carbon emissions relative to the gasoline it is assumed to replace).

In a previous commentary, we provided an intuitive explanation of market leakage in the fuel market due to biofuels [1]. However, there was no corresponding explanation of what carbon leakage would be. In this article, we show how market leakage is a critical input for measuring carbon leakage, and that serious misunderstandings arise if market leakage is ignored; that is, when 1 gasoline-energy equivalent gallon of ethanol is assumed to replace a gallon of gasoline in a one-to-one ratio in regard to carbon emission.

Emission savings & market leakage effects: the almost perfect yin and yang of carbon leakage

Carbon leakage is an indicator of the ineffectiveness of an environmental policy. Let us define carbon leakage (LC):

$$L_C = \frac{\text{change in global carbon after a policy}}{\text{intented carbon reduction due to a policy}}$$

Equation 1

This definition recognizes the fact, omitted by the Intergovernmental Panel on Climate Change, that carbon leakage can occur not only outside the county (or a coalition of countries) that imposes an environmental policy (i.e., international leakage), but also within the country (i.e., domestic leakage), hence the importance of the word 'global' in the equation.

For any environmental policy that replaces a 'dirty' energy source with a clean energy source (e.g., replacing gasoline with ethanol) in order to save carbon emissions, our study [101] shows that Equation 1 translates into:

$$L_C = \frac{1}{\xi} L_M - 1$$

Equation 2

Equation 2 shows that carbon leakage is a result of two, typically counteracting, effects: the 'emissions savings' effect, ξ, and the 'market leakage' effect, L_M (summarized in our previous Policy Update [1] and discussed in detail in our study [101]). The emissions savings effect measures the relative carbon emissions between ethanol and gasoline, for example, ξ = 0.20 means gasoline emits 20% more carbon relative to ethanol; or, alternatively, that 1 gasoline-energy equivalent gallon of ethanol emits 80% of the carbon emitted by a gallon of gasoline.

So why is there an 'almost perfect' yin and yang between the emissions savings effect and the market leakage effect? The reasoning is straightforward. When both effects are positive in value, they counteract – a stronger emissions savings effect reduces carbon leakage, while a stronger market leakage effect increases carbon

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