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Convergence of European wheat yields

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ABSTRACT

The paper makes several contributions to the study of wheat yield changes in Europe and the resulting economic consequences in the near to medium term future. In particular, it addresses the issue of the effects of yield changes on land use. The transition and growth of yields are estimated using a combination of convergence, time-series and dynamic panel models. Scenarios are then run using estimated yields as input into a computable general equilibrium (CGE) model. The CGE model provides a narrative framework through which the total economic impact of changes in yields can be analyzed. Together, the complementary approaches of econometrics and general equilibrium models allow a more complete economic analysis of the consequences of yield changes for this important biofuels crop to emerge. Although there is no evidence of a common rate of yield convergence across Europe, there is evidence of absolute convergence. Standard time series and panel forecasting methods indicate the potential for only very modest yearly yield increases across most of Europe given optimistic assumptions; although potential yearly increases in newer European states could, in some cases, be substantially higher. However, the total amount of land released as a result of potential yield increases in the wheat sector is only modest because of an increase in demand for land by sectors other than wheat. The overall question of whether significant yield increases will necessarily lead to large increases in land available to produce bio-energy crops is rejected. Land freed by wheat yield increases will go to the production of a wide range of agricultural products that value it as an input. The same reasoning which links yields and land use applies to all agricultural products when there are well functioning markets.

Contents

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1. Introduction

1.1. Issue

The paper addresses the effects of forecasted yield increases on land use in the European agricultural sector. The argument linking yields and land use is that technological advances which lead to increased yields will provide a means to circumvent the difficult trade-offs required to meet the various demands for biomass products [13,53,55]. The claim is that an increase in yields will mean that less land will have to be used to produce the same amount of crops, thereby avoiding or at least mitigating a part of the land use effects incurred when converting agricultural and non-agricultural lands into bio-energy crop production. Furthermore, given that a large component of the total costs of producing bio-energy products is the cost of the crop used, technological improvements that increase yields are expected to have positive economic consequences for bio-energy products in terms of prices and quantities produced [22]. This follows because crops are the principle cost of producing first generation biofuels; estimated biofuel share costs in Europe are approximately 70% for sugar beet, 75% for wheat, rye and maize, and 80% for rapeseed oil [37].

A review by de Wit et al. (2011) summarizes the findings of four reports that calculated the amount of additional land made available from yield increases [55]. The main argument in those reports is that yield increases will release land which is currently being used to grow crops to grow bio-energy crops and, particularly, crops to produce biofuels [14,16,17,19]. The calculated amount of land released for the production of biofuels in those studies is the hypothetical maximum in that each of the studies assumes that any land that is freed (in the case of the REFUEL study, 60 million hectares) will go to bio-energy production rather than the production of food, feed or fiber. Furthermore, it has been argued that a large potential source of production gains might come from expected yield increases in the newer states of Europe. Current yields for those countries are far below the European mean, suggesting that yields there are due for an increase. It follows that the question of whether yields in Central and Eastern Europe will converge to those in Western Europe will largely determine whether yields in Europe as a whole will increase.

It is self-evident that yield increases reduce the amount of land required to grow crops, all else equal, but *how* the freed land will be used depends on wider economic and social considerations. The argument underlying the conclusions of the studies mentioned rests on two assumptions. The first is that the land made available from increased yields will go to produce bio-energy crops rather than for some other use. Secondly, and more fundamentally, it assumes that there will be a demand, at a competitive price, for products which use bio-energy crops. Demand for such products is a necessary conditions, but by no means a sufficient condition for increasing the production of bio-energy crops. This paper addresses the first issue, in short, it asks what will be produced on freed land resulting from yield increases. The answer to the second issue, not addressed here, is largely dependent on government policies and the prices of petroleum and other bio-energy crop substitutes [49].

Land use has been an important consideration in assessing the economic viability and environmental impacts of biofuels and other biomass products since Searchinger et al.'s [44] paper first raised the issue. Searchinger et al.'s paper and many others which followed, have put land use on the political agenda as well, indeed, mitigating the negative effects of land used to produce biofuels is an important part of the European Biofuels Directive (2009/28/EC) [15]. While other researchers have used computable general equilibrium (CGE) models to address the issue of the effects of bio-energy crops on land use [25,26,41,33], our modeling framework differs to previous studies by introducing explicit econometric models to forecast yields as opposed to using standard yield assumptions of CGE models which are often difficult to reconstruct and reproduce. In addition, land use in MAGNET, the CGE model we use, has a sophisticated land supply module allowing us to better model the effects of yield changes on land use. It is the combination of econometric forecasting methods and the improved CGE framework which distinguishes our work and allows us to more fully address the research question.

The structure of the remainder of the paper follows directly from the main research question. In order to answer that question, we first need to determine the extent to which yields will increase in the future. We briefly discuss the data used in the analyses and then apply various techniques to understand the trajectory in which wheat yields have been following. We then build an econometric model in order to forecast yields. The forecasted yields are then used as input into MAGNET in order to assess their impact on land use.

2. Data and methodology

2.1. Data

2.1.1. FAO data

The study consists of two main parts. The first attempts to forecast European crop yields and the second calculates the economic consequences of those increases. All of the data used in the econometric analyses are publicly available and an effort has been made to be as explicit as is practicable about the techniques