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Fuel Versus Food: An Empirical Scenario Analysis Based on Artificial Neural Networks

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Abstract

This paper deals with the highly discussed debate Fuel vs Food. Declining resources of fossil energy resources and technical progress lead to a revolution of biofuels. The possible issue of this development is that food crops are used for fuels and not for food, which could lead to undernutrition and hunger in the world. This paper investigates empirically, if this connection really exists and how the prices of food will develop in the future. In contrast to usual empirical studies, this study is performed with an artificial neural network, which can model non linear relationships.

Keywords: *Fuel vs Food, Biofuels, Hybrid Model, Artificial Neural Network, Vector Autoregressive Model*

1. Introduction

The above mentioned quotations of Barack Obama and Bill Gates reflect the essence of the Fuel vs Food discussion quite well. Declining crude oil resources and the unstoppable hunger for energy are leading to serious issues in the world. One approach to confrontate these problems are renewable energy sources, in case of fuels, the new alternative strategy are biofuels. But are these biofuels the panacea for the emerging problems of the world? Biofuels might be the solution for the energy problem, but they can cause other problems, for instance rising food prices. Suddenly, food crops are fill-

ing fuel tanks and not dinner plates, is the apprehension. So, will the prices of food crops increase and cause dramatical problems? Aim of this study is to investigate the relationship between Fuel vs Food and further the development of food prices in the future.

There is many literature about the Fuel vs Food debate. It is impossible to get an appropriate overview of recent literature about this topic. Nevertheless, in the following some conclusions of recent studies are shortly presented.

The most common opinion is that there is a positive relationship between biofuel production and food prices. A research paper from the World Bank, written from *Mitchell* (2008) comes to the result that the most important factor of the rising food prices is the large increase of biofuel production.¹ Further *Babcock* (2012) is convinced that it is "indisputable" that biofuels lead to higher agricultural commodity prices, not only because of increasing subsidies, also because of rising oil prices.² Also *Harrison et al.* (2009) agree that besides of rising food demand, rising demand in bioethanol made from corn, are the main factors of increasing food prices.³ *Abott et al.* (2009) note that besides the weak US Dollar, rising biofuel production is thightening the world grain and oilseed stocks and thus leads to increasing commodity food prices.⁴ However, there are also conclusions in the literature that biofuel should be supported or that the impact of biofuel on food prices is insignificantly low. A study from the United States Department of Agriculture (henceforth USDA) found out that there are many factors which are responsible for increasing food prices, as a decline in world stocks of grain and oilseeds, weather conditions, devaluation of US Dollar and rising demand of biofuel, but biofuels are not the main factor.⁵ *Armah et al.* (2011) come to the result that the main factors of rising food prices are not rising biofuel demand and supply, the main factors are rising energy costs in food production and thus rising oil prices.⁶ Another study, from *Cassmann et al.* (2007) assumed, rising biofuel production is not a problem because of technical progress and thus steadily higher crop yields.⁷ Thus, there are

¹D. Mitchell [n.d.](#), p.16.

²Babcock [2012](#), p.1.

³Harrison et al. [2009](#), p.500.

⁴Abbott et al. [2009](#), p.32.

⁵Trostle [2010](#), p.28.

⁶Armah et al. [2011](#), p.20.

⁷Cassman and Liska [2007](#), p.21.

many controversial results in recent literature. This study makes a further contribution to this debate. Innovative in this study is that the impact of biofuel on food prices is investigated with artificial neural networks. Artificial neural networks are used more and more to forecast time series, but also in relationship with usual linear models, so that in this study also a hybrid model will be used to predict the development of crop prices.⁸

At the beginning of this study a short overview of the Fuel vs Food debate is presented. At first some information about fuels is given and then about food crops. Further the world nutrition situation and problems with rising food prices are described. In Chapter 3 the choice of the data is explained and some additional descriptive statistics about exogenous and endogenous variables are shown. Chapter 4 includes the methodology of the investigation. At first, the non linear Model (or artificial neural network) is introduced and secondly the linear model (or vector autoregressive model), before the end of Chapter 4 explains, how these models are brought together and how the predicted time series for the food prices are done. After this, Chapter 5 presents the results, before Chapter 6 discusses them. Chapter 7 explains the limitations of this study and Chapter 8 concludes the results and findings of this study.

2. The Fuel vs Food Debate

As mentioned in Chapter 1 the Fuel vs Food debate is a very controversial discussed theme. Many influence factors should be considered, when handling this theme, thus some of them are explained in the following chapter to get the basic knowledge about this debate. Firstly, the sorts of fuel, which stay in the center of this discussion are introduced. Secondly, the affected food prices are explained. After this, the world nutrition situation is elucidated and it is explained why rising food prices can cause serious problems.

⁸G. P. Zhang 2003, p.160.

8. Conclusion

The aim of this study is to observe the impact of bioethanol and crude oil on food prices. Further, the prediction of the development of food prices are in the center of this investigation.

At the beginning of this study, information about crude oil, bioethanol and main food crops are presented, followed by an overview of the worlds nutrition situation. After that, the selected data is introduced and some descriptive statistics are given. Chapter 4 explains the methodology of this study and introduces the non linear model of the analysis (Faun) and the linear model (VAR) and how they are brought together. Chapter 5 reflects the results in detail. Firstly, the impact of bioethanol and crude oil on food prices and secondly, the price development of food prices. Chapter 6 discusses critical points in the data selection and methodology and in Chapter 7 the limitations of this study are reflected.

This study comes to the result that biofuels have an impact on food prices, but the impact is quite low. Further, the impact of crude oil is not clearly indentifiable, because it has a positive impact on US Wheat prices, but a negative impact on US Corn prices. Nevertheless, the scenario analysis for the price development of US Corn and US Wheat until 2040 includes three different scenarios. Because crude oil is important for all areas in every economy, three different crude oil forecasts are chosen as base for the scenario analysis. The results of the scenario analysis are that in every scenario the prices of US Corn and US Wheat will rise with progressing time. In the scenario where the price of crude oil rises sharply, the price increase of US Corn and US Wheat is not as high as in the scenario, where the crude oil price declines.

These results lead to interesting conclusions. Firstly, an impact of bioethanol on food prices exists, but is not as high as noted in recent literature (see Chapter 1). Secondly, rising crude oil can, but must not lead to higher food prices. Thirdly, nevertheless the prices of food will rise sharply in the future.

However, even small rises of food prices, can have significant impacts, because of rising production of biofuels. The predicted price development scenarios could lead to serious problems. Rising food prices and rising world population can cause hunger and undernutrition in many areas of the world and thus to unforeseen social issues. For this

reason, second- generation biofuels should be supported and incentives should be made that they can compete with first- generation biofuels. Second- generation biofuels can even counteract against rising food prices, because the producers can sell the "food" and the "non- food" part of the plant, which can lead to lower crop prices. Further, possible solutions are to increase the crop yield to produce more food. This can be reached by investments in agricultural research or in cultivation of non- crop land into crop land (but without causing ecological problems). Furthermore, a big share of food crops is used for meat production. Changes in food consumption could also lead to a reduce of rising food prices. Another part of the solution can be to reduce or abolish import and export duties for food crops so that the worlds market prices of food crops decline. Nevertheless, if the predicted scenarios will become true, the mankind has to face many problems and needs to find efficient solutions. It is not the proper way to confrontate nutrition problems by blaming only biofuels for rising food prices. A useful way would be a scientific and empirical based discussion without ideological influences, so the mankind could be prepared for upcoming issues in the world.

Referring to the quotations of Barack Obama and Bill Gates it can be concluded, that both statements were partially true. Biofuels can be a solution for upcoming problems which is why they should be supported so that they can establish on commercial markets. Nevertheless, it is important to be careful with supporting biofuels, because they can lead to rising food prices and thus to nutrition problems for poor people.