The 2005 US energy act and the NAFTA region food prices: A non-linear approach.

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Abstract

Recent Energy Acts have raised the American consumption of biomass energy. Through land competition, this increase may have led to higher domestic and trade partners' food prices. We study the question for the U.S. and Canada using a non-linear VAR approach. Our very preliminary results suggests a non-zero impact of biomass consumption after 2005.

Keywords: Renewable Energy, Non-Linear VAR

1 Introduction

The objective of this proposal is to investigate the impact of the increased consumption of ethanol starting in 2005 on food prices in the NAFTA region (mainly the U.S. and Canada). We aim to do this using a variety of methods from this macroeconometrics course. The United States along with the other countries has been experiencing what can be qualified as an energy revolution. Environmental concerns and new energy opportunities have led to the enactment of a number of bills in the recent past. Two notables one are the Energy Act of 2005 and the Energy Independence Act of 2007. The bills differ somewhat on the particular points of implementation and categories but both aim to achieve an increased reliance on all forms of renewable energy in both the short and long term. There is all reason to believe that the accompanying effects of this policy are only gong to accentuate with time.

The ethanol consumption stands here doubly relevant because it is one of the oldest form of renewable energy used and recorded [1] but also because it is the central energy category in the above mentioned bills.

Our data show that real food prices had been decreasing in Canada and the U.S. up until 2005. Around that date, both series have experience a sizeable increase that lasted for many years. The economic literature is not without mention of a potential link between food prices and ethanol consumption. There are many reasons to believe that changes in ethanol production and consumption could lead to a trade-off for farmers. One explanation is that the main source of biomass is corn which is also an input for a number of food products (corn flakes, high fructose syrup...). Gilbert(2010) suggests that the diversion of these food crops to fuel purposes could result in an upward shift of the supply curve and higher food prices.

In this short proposal, we will explore this question using a non-linear VAR model. In addition, we will incorporate Canadian food data because of the trade partnership and the potential spill-over effect from these policy changes.

The remainder of this proposal is organized as follows. In the following section we will explore in more depth the origins of the data. Section III is a short overview of the relevant literature and the energy acts. Section IV presents a unit root testing procedure through a series Augmented Dickey-Fuller tests. We then present our empirical strategy and discuss our results.

2 Data Sources and Summary Statistics

Our data originate from two sources. We gather the biomass consumption data from the Energy Information Administration (EIA). They are monthly data provided in the standard energy unit (BTU [2]). We also acquire the total primary energy consumption measure and create a share of energy assumed by bioamass. In this proposal, we measure this share of primary consumption as the main measure of biomass consumption.

[1] This excludes hydro-power. Biomass data are available from the Energy Information Administration (EIA) back from the 1970s

[2] BTU is an acronym. It stands for British Thermal Unit. It's a form of measurement that measures energy. One BTU refers to the amount of energy that's required to increase the temperature of a pound of water by 1° F. https://www.bhiservice.com/

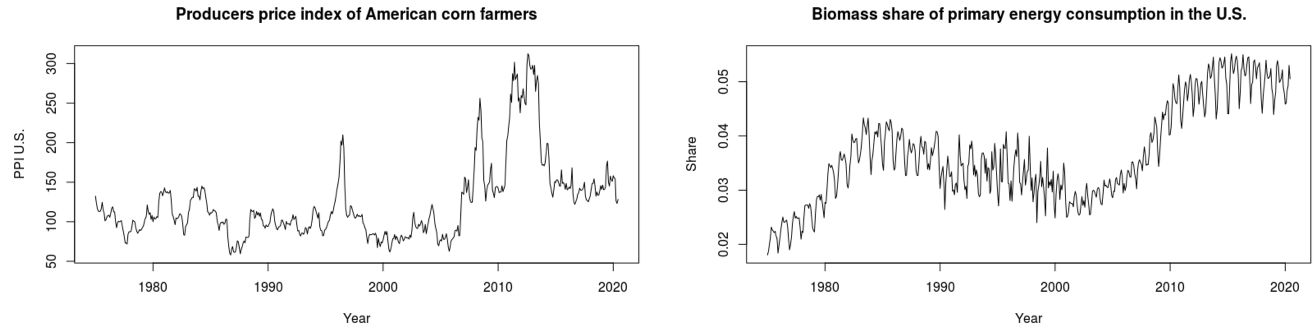

Figure 1: Corn PPI and biomass share of energy consumption.

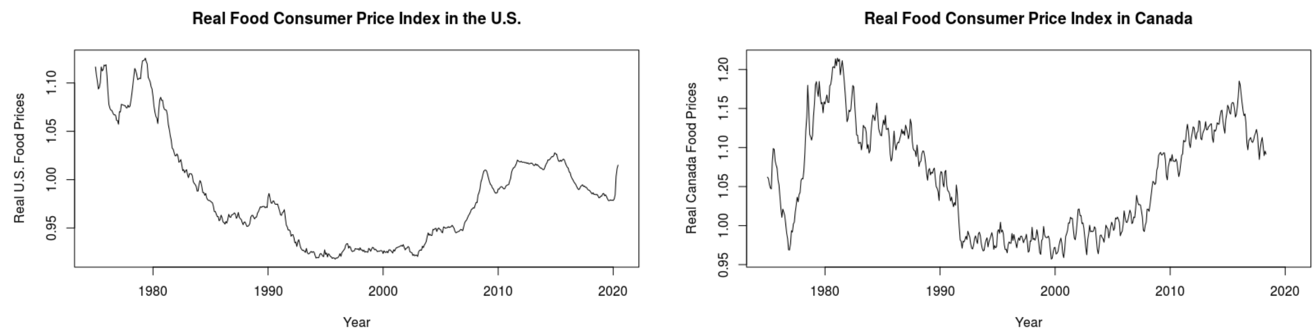

Figure 2: Real U.S. and Canada food prices indexes.

Next, we use the Federal Reserve Economic Data (FRED) for the U.S. and Canada food price indexes. We also acquire the corresponding consumer prices indexes without food and energy. We deflate both series to obtain the real U.S. and Canada food price indexes. We note that we do not incorporate Mexico's price series because they were only available at an annual frequency. Our analysis will thus be limited to only the U.S. and Canada.

Our series start in January 1975 and goes until June of 2020 as shown in Figure 2. After 2005 we can see a relatively clear increase of the biomass share in primary energy consumption. The producer price index of corn farmers also appear to increase at the same time.

3 Literature Overview and Background of the Energy Acts

There is a very prolific literature addressing the impact of energy consumption in general as well as the renewable subcategories. For the purpose of this short proposal we will only present an overview of the general consensus.

A seminal paper in the literature is Baumeister and Kilian (2004) which applied an SVAR model to examine how oil prices shocks affected food prices. They find no evidence that these shocks have been linked to more than negligible increase in food prices. They also report the increased food price since 2005.

Mostly two perspective exist in the literature. On the one hand, a number of paper provide evidence that renewable energy consumption increase do not cause higher food prices and on the other hand, some papers support the opposite.

Ajanovic(2010), among others, concludes that biofuels and food commodities can cohabitate but emphasizes that a complete shift to biofuels would be impossible because of land limitations. Likewise, Rathmann et al. (2010) provides evidence that a competitiveness exist in land uses with regard to biofuel crops and traditional food commodities. The paper also reports short run increases in food prices as a results of increased biofuels production. Zweibel et al. (2008) argue that the environmental consequences of carbon emissions and climate change have, in part, been responsible for the shift away from fossil fuels to alternative energy sources. These factors have led to US government policies and programs that provide incentives in the form of subsidies, tax credits, and rebates for choosing to produce renewable energy contributing to the pattern.

As previously mentionned, there are two main bills of relevance for this paper.

The first is the Energy Policy Act of 2005 which was signed into law by the president George Bush. Increased volatility in oil prices and concerns for U.S. dependence on foreign fossil fuels prompted prompted the bill. It involved many provision but the renewable fuels standard was the main one [3]. The Energy Independence of 2007 is the other bill which had for target a greater energy security to the U.S. and enhance the production and consumption of clean energy resources.

Together, the bills have led to the amount of corn going to fuel production to rise from 2.1 to 5.2 billion bushels. This happened between 2006 and 2014 in other words leading to a more than doubling of the category in less than a decade.The bills had a lot of other provision that we will refrain from discussing in detail for relevance sake.

[3]The gasoline sold in the United States had to contain an increasing amount of renewables in 2006 the like of biodiesel or ethanol. Motor fuels must contain at least 4 billions gallons of the renewables in 2006 with a target of 7.5 billions by 2012 under a yearly increment of 700 millions gallons.

4 Unit Root Testing

In this section, we carry the standard stationarity testing for all the relevant series of our study. As usual we will present the three versions of this test by placing one after the other some restrictions on α and β. Our augmented Dickey Fuller test takes the form:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + ... + \delta_{p-1} \Delta y_{t-p+1} + \epsilon_t \tag{1}$$

We present the three versions of this test for a more robust assessment. Failure to reject the null of existence of a unit root in any version of the test will results in the conclusion of a non stationary process. We will make the comparison against standard Dickey Fuller critical values at 5%.

Table 1: ADF test outputs

	Pure	Drift	Drift and Trend	Conclusion
Biomass share	-0.3704	-3.7492	-5.0845	non-stationary
Corn PPI	-1.0309	-2.854	-3.2671	non-stationary
Real U.S. food prices	-0.8512	-2.1464	-1.4656	non-stationary
Real Canada food prices	-0.036	-2.1627	-2.1544	non-stationary

Notes: The lag length optimization uses the Akaike Information Criteria (AIC). The 5% critical value for the **pure test is -1.95**; with trend =-2.87 then **drift and trend=-3.42**

We conclude that a unit root is present in the 4 series of our analysis. We will proceed accordingly in the following section of our proposal.

5 Transformation to stationary

As the series do not revert back to a constant mean and the ADF confirms that we cannot reject the existence of a unit root process, we will transform the series to stationarity. It is with these series that we will carry the remainder of the analysis.

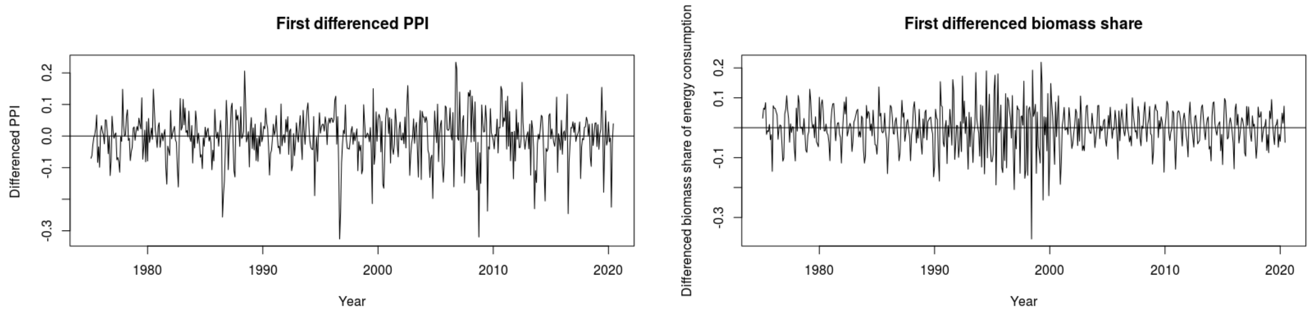

Figure 3: Differenced corn PPI and biomass share of energy consumption.

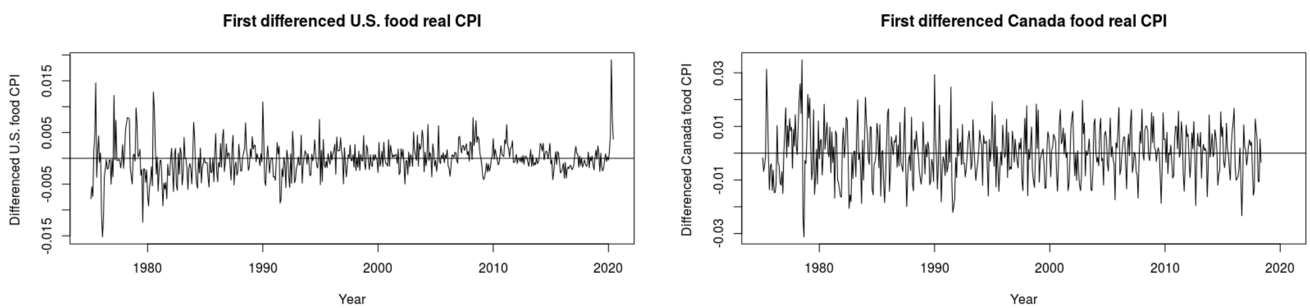

Figure 4: Differenced real U.S. and Canada food prices indexes.

6 Empirical Strategy

Our methodology will be as follows :

- **Linear SVAR**: Using an ordering assumption for identification, we will start from this model of food prices in USA, and Canada.
- **Non-Linear SVAR**: It is likely that a structural break happened in 2005, I will define a non linear VAR with a threshold in 2005. The literature has a consensus that around mid 2005 the relationship between biomass production and food prices may have changed. We will generate the IRFs in response to ethanol consumption increase for the two countries.

6.1 Structural VAR approach

We start from a reduced form VAR model to evaluate the impact of ethanol consumption shocks on food prices. We will therefore have the measures of food prices for each countries separately, each in its own VAR. Our approach will be a three variable VAR of ethanol consumption, corn production price index for US farmers and finally the food price index for either USA or Canada. We have the following model:

$$\begin{bmatrix} E_t \\ P_t \\ F_t \end{bmatrix} = \begin{bmatrix} a_0 \\ b_0 \\ d_0 \end{bmatrix} + \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ d_1 & d_2 & d_3 \end{bmatrix} \begin{bmatrix} E_t \\ P_t \\ F_t \end{bmatrix} + \begin{bmatrix} a_4 & a_5 & a_6 \\ b_4 & b_5 & b_6 \\ d_4 & d_5 & d_6 \end{bmatrix} \begin{bmatrix} E_{t-1} \\ P_{t-1} \\ F_{t-1} \end{bmatrix} + \begin{bmatrix} ee_t \\ ep_t \\ ef_t \end{bmatrix} \tag{2}$$

Where E_t is the measure of ethanol consumption, P_t and F_t are respectively the corn producers price index and the measure of food price for USA, Canada or Mexico.

Let ue_t, up_t, uf_t be the structural shocks to ethanol consumption, producer price index and food prices respectively. The residuals and structural shocks have the following relationship:

$$\begin{bmatrix} ee_t \\ ep_t \\ ef_t \end{bmatrix} = B_0^{-1} \begin{bmatrix} ue_t \\ up_t \\ uf_t \end{bmatrix} \tag{3}$$

where

$$B_0 = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \tag{4}$$

This ordering implies the following:

- The ethanol consumption responds to no other variables shocks contemporaneously.
- The corn producer price index only responds contemporaneously to ethanol consumption shocks but it takes at least a month for food prices to affect it.
- The food prices respond to all the other variables shocks contemporaneously.

6.2 The Non-Linear VAR approach

We now build on the previous step to the non-linear approach. My current hypothesis is that the relationship between NAFTA countries food prices, U.S. ethanol consumption and corn producer price indexes changed after 2005. This motivates my threshold VAR (non-linear) approach. The idea here is that the coefficients will change based on which regime we are in. I conceive of it as the following:

$$TVAR = \begin{cases} Y_t = A_1 Y_t + B_1 Y_{t-1} + U_t, & \text{t} \leq 2005\text{, regime 1} \\ Y_t = A_2 Y_t + B_2 Y_{t-1} + U_t, & \text{otherwise}, regime 2 \end{cases}$$

where

$$Y_t = \begin{bmatrix} E_t \\ P_t \\ F_t \end{bmatrix} \tag{5}$$

Here $A_1 Y_t$ and $A_2 Y_t$ are the contemporaneous terms and they differ because these dynamics could change across regimes. U_t are structural shocks. Here again our ordering suggest that food prices reacts to all the other variables contemporaneously, producer index only to itself and ethanol consumption and finally ethanol responds to none in the current period.

Using this arrangement, we will then produce the non linear IRFs as shown during class. After estimation we find that for the U.S. the parameters matrices show:

7 Results

In this section we will talk more about the difference between the two methods and which ones present a better representation of the dynamics in the NAFTA region following the U.S. energy Acts. I will use two main approaches in this section. First we will estimate the TVAR model in a similar fashion as we have done in class and generate the IRFs of a shock to ethanol consumption of the food prices indexes. The other approach coonsist in using two different SVARs.

7.1 Approach I

This approach follows the class example of a system that switches between regimes. With this IRF, I show how a shock to biomass +1: vs -1 and ppi of 0 and 0and finally Canadian food prices of 0 and 0.

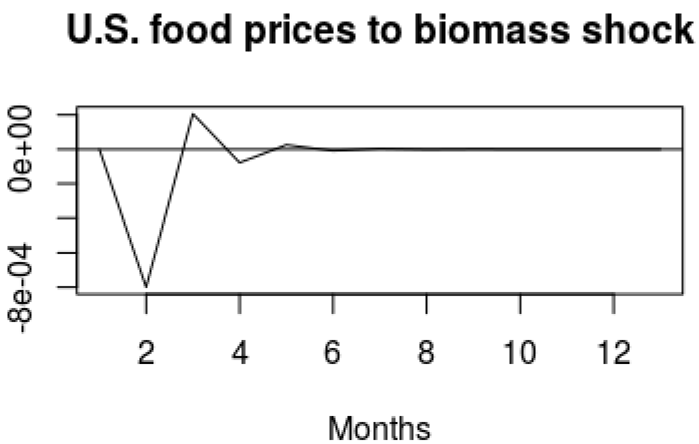

Figure 5: TVAR IRF for shock to biomass

We were not able to produce the IRF for Canada because the magnitudes were so small that the matrices were NA. This result for the U.S food prices suggests that a shock to biomass is followed by a short plunge then rise which dies out around 4 months after.

7.2 Approach II

In this approach, I will estimate a SVAR with the ordering assumption given above before 2005 and also after 2005 and produce the IRFs.

The first regime (before 2005) gives me for the U.S. only:

$$B_0 \begin{bmatrix} E_t \\ P_t \\ F_t \end{bmatrix} = B_0 \begin{bmatrix} a_0 \\ b_0 \\ d_0 \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} E_t \\ P_t \\ F_t \end{bmatrix} + B_0 \begin{bmatrix} -0.29 & 0.08 & -1.19 \\ -0.02 & 0.25 & -0.5 \\ -0.00 & -0.00 & 0.27 \end{bmatrix} \begin{bmatrix} E_{t-1} \\ P_{t-1} \\ F_{t-1} \end{bmatrix} + \begin{bmatrix} ue_t \\ up_t \\ uf_t \end{bmatrix} \tag{6}$$

The second regime for the U.S. (after 2005):

$$
B_0 \begin{bmatrix} E_t \\ P_t \\ F_t \end{bmatrix} = B_0 \begin{bmatrix} a_0 \\ b_0 \\ d_0 \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} E_t \\ P_t \\ F_t \end{bmatrix} + B_0 \begin{bmatrix} -0.13 & 0.01 & 1.20 \\ 0.02 & 0.16 & 0.48 \\ -0.00 & 0.00 & 0.47 \end{bmatrix} \begin{bmatrix} E_{t-1} \\ P_{t-1} \\ F_{t-1} \end{bmatrix} + \begin{bmatrix} ue_t \\ up_t \\ uf_t \end{bmatrix} \tag{7}
$$

I refrain from reporting the matrices for Canada because they may not bring more information. We observe that the coefficients of the first lag component are different. This does not necessarily imply statistical difference but they give us more perspective to look at the IRFs.

Mainly, these show that a shock to biomass does not affect American real food prices whether before of after 2005. On the other hand, Canada real food prices seems to increase in response to a shock after 2005 but never achieve positive significance.

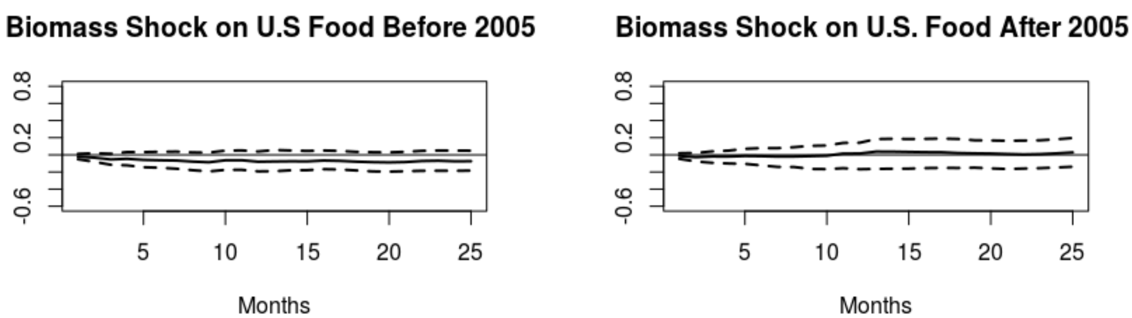

Figure 6: Impulse Response Function of a Shock to U.S. Biomass

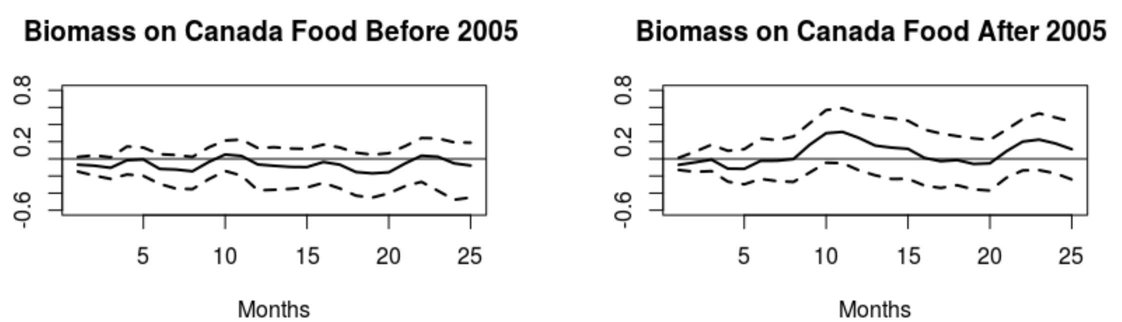

Figure 7: Impulse Response Function of a Shock to U.S. Biomass

8 Beyond the proposal: Local Projection Estimation.

This question could be a candidate for a method of estimation which has gained attention in the macroeconomic literature of recent years. Jorda(2005) offers an extensive treatment of the local projection approach which can be an alternative for non linear VAR estimation.

9 Conclusion

This short proposal was investigating the effect of recent renewable energy policy changes on food prices in the NAFTA region in particular the U.S. and Canada. We used a non-linear VAR approach to measure the impulse response function of a shock to the U.S. biomass consumption.

Our very preliminary outputs suggest that the relationship between ethanol and food prices in the NAFTA region may have changed after the 2005 Energy Act but not in a way that would lead to significant difference in the IRFs positive or significant nature.

References

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