Short communication: Effect of carbon emission trading on European Union butter prices

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ABSTRACT

Since its inception, the European Union (EU) carbon emission market has been vastly successful in reducing greenhouse gas emissions. Accordingly, the usage of environmentally friendly fuels (e.g., ethanol, biodiesel) has increased significantly over the last few years. Given that EU biodiesel is mainly produced from rapeseed oil and soybean oil, higher carbon taxes are likely to increase the demand of these important vegetable oils, which further affects the prices of its close substitute such as butter. Nevertheless, the association between the EU emission trading scheme and butter prices remains understudied. In this paper, we aim to fill this vacuum in the existing literature. Applying the autoregressive distributed lag bound testing procedure, we show that emission market seems to have a long-term effect on EU butter prices, implying that changes in the levels of carbon taxes will lead to changes in the price level of butter. These results are of vital importance to policymakers and investors.

Key words: carbon emissions, butter price, biodiesel, vegetable oil, European Union

Short Communication

Since its inception, the European Union (EU) emission trading scheme (ETS) has been remarkably efficient in the reduction of greenhouse gas (GHG) emissions. In 2015, for instance, GHG emissions in the EU-28 countries were down by 22% compared with 1990 levels, representing an absolute reduction of 1,265 million tonnes of CO₂-equivalents, putting the EU on track to surpass its 2020 target, which is to reduce GHG emissions by 20% by 2020 and by 40% by 2030 compared with 1990 (data from <https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1180.pdf>).

The success of the EU allowance (EUA) market has promoted the use of environmentally friendly fuels all

over the world. For instance, biodiesel has emerged as the leading biofuel used in the EU transport sector. A recent report published by the European Commission indicates that biodiesel production capacity has increased to about 26.3 billion liters, with an annual production of about 10.5 billion liters (8.3 million tonnes of oil equivalents) or 40% of total capacity. Such significant growths in biodiesel could be due to the concerns about energy security, GHG emissions, and oil market uncertainty (Chiu et al., 2016; Dutta, 2018).

In the EU, biodiesel is mainly produced from rapeseed oil and soybean oil. At present, rapeseed oil accounts for about 80% of the biodiesel feedstock. Given that vegetable oil is the main feedstock for producing biodiesel in the EU, it is likely that higher carbon permit prices would raise the demand for vegetable oil, which further affects the prices of a close substitute such as butter. Crago and Khanna (2014) also argue that as biofuel production competes for land with agricultural production, higher carbon tax could increase land rents, which would then raise feedstock prices. Nevertheless, investigation into the linkage between carbon emission and butter prices is understudied in the existing literature. This study aims to fill this void. As understanding the dynamics of butter prices plays a pivotal role in designing the EU dairy policy, our research could be of vital importance to policymakers and investors.

This paper uses monthly prices of the EU-ETS and butter covering the period from July 2009 to December 2017. The sample consists of 102 observations. The data were retrieved from Thomson Reuters DataStream (<https://eikon.thomsonreuters.com/index.html>). For the EU emission market, the data for 3 different periods are available. Phase I covers the period from January 2005 to December 2007, and phase II covers January 2008 to December 2012. At present, the EU-ETS is completing the third phase. The data for phase I are not included because the allowance prices were close to zero toward the end of phase I as a consequence of interphase EUA banking restrictions (Tian et al., 2016).

Table 1 reports the descriptive statistics for EUA and butter price indexes. These numbers suggest that food prices are more volatile than the emission market as

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Table 1. Main descriptive statistics (values in parentheses denote *P*-values) of the 2 indices under study¹

Index	Mean	SD	Skewness	Kurtosis	Jarque-Bera test
ΔEUA	-0.0530	1.0631	-0.4134	4.23	9.29 (0.00)**
$\Delta Butter$	1.4435	8.0547	-0.0361	3.48	1.01 (0.60)

¹ ΔEUA and $\Delta Butter$ = first-order differences in European Union allowance and butter prices, respectively. .

**Significant at the 1% level.

evidenced by the corresponding standard deviations. Moreover, both indexes are negatively skewed and kurtosis was >3 for each series, implying that the data follow leptokurtic distributions. The Jarque-Bera test suggests that the data are normally distributed only for the butter price index.

Table 2 shows the unit root test results for the indexes used. The results of both augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests indicate that although the data follow a nonstationary process at levels (i.e., raw data), the stationary condition is satisfied when first differences are considered. The ADF and PP tests are used to examine whether the data contain any trend. Nonstationary processes usually have trends, whereas stationary processes do not contain such trends.

Methodologically, we used the autoregressive distributed lag (ARDL) model to examine the long-term association between carbon emission trading and EU butter prices. The ARDL bound test has several attractive features. First, all the testing equations are allowed to have different lags. Second, it can be applied regardless of whether the underlying variables are stationary, that is, $I(0)$; integrated of order 1, that is $I(1)$; or fractionally integrated (Bouri et al., 2017). Finally, the test is free from the spurious regression problem. Note that this test has a prerequisite that the variables under study should not be integrated of order 2 or higher.

Now, we construct the following unrestricted ARDL regressions without any time trend component:

$$\Delta EUA_t = \omega_1 + \sum_{i=1}^n \alpha_{1,i} \Delta EUA_{t-i} + \sum_{i=1}^n \beta_{1,i} \Delta Butter_{t-i} \quad [1]$$

$$+ a_1 EUA_{t-1} + b_1 Butter_{t-1} + \varepsilon_{1t},$$

$$\Delta Butter_t = \omega_2 + \sum_{i=1}^n \alpha_{2,i} \Delta EUA_{t-i} + \sum_{i=1}^n \beta_{2,i} \Delta Butter_{t-i} \quad [2]$$

$$+ a_2 EUA_{t-1} + b_2 Butter_{t-1} + \varepsilon_{2t},$$

where Δ indicates the first difference operator: ΔEUA indicates the first-order difference for EUA prices, $\Delta Butter$ is the first-order difference for EU butter prices, α and β refer to the lag coefficients for ΔEUA and $\Delta Butter$, and ε_1 and ε_2 are error terms. To examine whether cointegrating relationship exists among the series under study, it is sufficient to test the null hypothesis $H_0: a = b = 0$, where a and b refer to the first-order lag coefficients for the EUA and butter prices. The general *F*-statistics are further calculated and compared with 2 different sets of critical values provided by Pesaran et al. (2001). One of these sets is used as the upper bound for purely $I(1)$ series, and the other is used as the lower bound for purely $I(0)$ series. Cointegration or a long-run relationship is said to be present only if the computed *F*-statistic surpasses the upper bound critical value.

Table 3 shows the results of the ARDL bound tests. These findings reveal that cointegration is present when butter prices act as the dependent variable. We do not find any significant linkage when emission market is the dependent variable. Such results indicate that causality runs from emission to butter price index, implying that changes in the price level of the EUA market cause significant changes in the butter price level.

In addition to the ARDL bound tests, we also employ the Toda-Yamamoto (TY) version of Granger causality test to investigate whether any short-term linkage exists between these 2 sectors. See Toda and Yamamoto (1995) for more details about the TY test. The results

Table 2. Results of unit root tests¹

Index	Augmented Dickey-Fuller test		Phillips-Perron test	
	Level	First difference	Level	First difference
EUA	-1.65 (0.45)	-12.29 (0.00)***	-1.55 (0.45)	-12.28 (0.00)**
Butter	-1.44 (0.56)	-12.63 (0.00)***	-1.31 (0.62)	-12.45 (0.00)**

¹EUA = European Union allowance. The values in parentheses denote *P*-values.

Significant at the **1% or ***0.1% level.

Table 3. Results of autoregressive distributed lag bound tests¹

Dependent variable	Test statistics	Decision
Δ EUA	1.70	No cointegration
Δ Butter	5.85*	Cointegration exists

¹The critical *F*-statistic at the 5% level for model with all I (1) series is 5.73. See Table CI(iii) with $k = 1$ (where k = number of explanatory variables) on page 300 of Pesaran et al. (2001). Δ EUA and Δ Butter = first-order differences in European Union allowance and butter prices, respectively.

*Significant at the 5% level.

of the TY test, displayed in Table 4, reveal that the EUA market and the butter industry do not move together in the short run.

Overall, these results suggest that the EUA market seems to have a long-term effect on the butter price index. Such findings are not surprising given that higher carbon taxes promote the production of biodiesel and hence the demand for vegetable oil, which is the main feedstock for the EU biodiesel industry, would increase considerably. Because butter and vegetable oil appear to be substitute commodities, the growing demand for vegetable oil leads to a significant rise in the butter price index. Thus, the carbon emission trading has an indirect, but prominent effect on EU butter prices.

The outcomes of this empirical research could be important for policymakers in formulating appropriate hedging strategies to avoid the contagious risk emanating from the EU emission trading scheme. In addition, the information on the EUA prices could be useful in predicting the price variations of the EU butter industry as we find a significant long-run linkage between these 2 markets. Moreover, in the near future, the production of biodiesel could undergo incredible

Table 4. Results of the Toda-Yamamoto test¹

Causality	Test statistics	<i>P</i> -value
EUA to butter	1.32	0.25
Butter to EUA	0.88	0.35

¹The lag used in the Toda-Yamamoto test is 1. The Akaike information criterion and Bayesian information criterion are used to determine the required number of lags. EUA = European Union allowance.

growth, which could, in turn, cause uncertainties in the butter industry. It is important therefore to develop and improve the futures market for butter to precisely measure the risk associated with this important food commodity. Such monitoring system could play a crucial role in planning EU food policy.

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