Does Agricultural Growth lead to Methane Emissions?

By

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Introduction

- ❑ Increasing livestock production directly and indirectly leads to the emission of greenhouse gases (GHGs). Carbon dioxide is emitted as land for livestock feed production expands as non-agricultural land such as a forest is brought into production. Livestock directly increases the emission of methane through the digestion process.
- ❑ World meat production has increased across countries, especially in Asia, to meet the increased global meat demand (see Figure 1). Due to the increased meat production, methane, one of the major greenhouse gases from the livestock has increased globally.
- ❑ This paper investigates the causal relationship between agricultural growth meat exporting countries and methane emissions.
- ❑ We also examine the EKC hypothesis for methane production in the top 34 meat exporting countries.

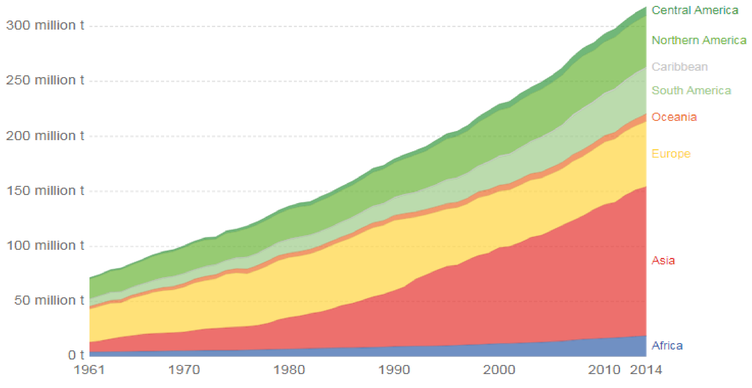

Figure 1. Meat Production by Regions (tonnes)

Source: The calculation of Richie and Roser (2018) from the data of UN Food and Agricultural Organization (FAO)

Data

- ❑ Countries: 34 main meat production countries
  - share a large portion of beef, pork, and broiler production in the world.
- ❑ The units of all variables: per capita
- ❑ Data Period: 1980 to 2012 (Yearly)
- ❑ Data Sources: World Development Indicators (WDI)

Methodology and Model

- ❑ Cross-Sectional Dependence Test: Frees (1995) and Pesaran (2007)
- ❑ Pesaran (2007) Panel Unit Root Test
- ❑ Pedroni (2004) Panel Cointegration Test
- ❑ Fully Modified OLS (FMOLS)

$$\hat{\theta} = \begin{bmatrix} \hat{\beta} \\ \hat{\gamma}_1 \end{bmatrix} = \left(\sum_{t=1}^{T} Z_{it} Z'_{it} \right)^{-1} \left(\sum_{t=1}^{T} Z_{it} y_{it}^{+} - T \begin{bmatrix} \hat{\lambda}_{12}^{+} \\ 0 \end{bmatrix} \right)$$

where

- Z_t: the stochastic regressors and the deterministic trend
- The long-run covariance matrix estimators are constructed for the FMOLS estimation.

- ❑ Model

$$ME_{it} = \alpha_{it} + \beta_{1i} AV_{it} + \beta_{2i} GDP_{it} + \beta_{3i} GDP_{it}^2 + \varepsilon_{it}$$

where

- *i*: country / *t*: time
- *ME*: Methane emissions per capita
- *AV*: Agricultural growth per capita
- *GDP*: GDP per capita

Results

Table 1. The Long-Run Coefficients Estimating Results

		Levels		First Differences	
		Im et al. (2003)	Pesaran (2007)	Im et al. (2003)	Pesaran (2007)
Ln(ME)	No Trend	1.085	-1.505	-13.491 ***	-3.640 ***
	Trend	0.626	-2.392	-12.137 ***	-4.103 ***
Ln(AG)	No Trend	4.362	-2.495 ***	-19.866 ***	-3.809 ***
	Trend	-4.350 ***	-2.431	-16.845 ***	-3.860 ***
Ln(GDP)	No Trend	2.786	-2.045	-8.109 ***	-2.305 **
	Trend	0.854	-1.961	-5.854 ***	-2.675 *
$Ln(GDP)^2$	No Trend	3.206	-2.001	-8.133 ***	-2.277 **
	Trend	0.808	-1.945	-5.851 ***	-2.659

Note: ***, **, * indicate 1%, 5%, and 10% significance level.

Table 2. Results of Pedroni Panel Cointegration Test

Test Statistics	Without Trend	With Trend
Within Dimension		
Panel *v*	0.496	1.680 *
Panel ρ	1.013	3.141 ***
Panel PP	-3.826 ***	-4.092 ***
Panel ADF	1.694 *	2.656 ***
Between Dimension		
Group ρ	3.518 ***	5.389 ***
Group PP	-3.683 ***	-3.576 ***
Group ADF	-0.386	-1.148

Note: ***, **, * indicate 1%, 5%, and 10% significance level.

Table 2. Test Results for Panel FMOLS Estimators

Test Statistics	Without Trend	With Trend
Within Dimension		
Panel *v*	0.496	1.680 *
Panel ρ	1.013	3.141 ***
Panel PP	-3.826 ***	-4.092 ***
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Note: ***, **, * indicate 1%, 5%, and 10% significance level.

Summary and Conclusions

- ❑ Our findings from the FMOLS estimation support a long-run relationship between methane emissions, GDP, and agricultural growth.
- ❑ The result indicates that a 1% increase in agricultural growth per capita leads to a 0.43% increase in methane emissions per capita in the long-run.
- ❑ We also find a non-linear relationship between GDP and methane emissions in the top 34 meat exporting countries, indicating the evidence of the EKC hypothesis on methane emissions
- ❑ **Two implications and contributions**:
  - **First**, this study fills a gap in the previous literature by taking into account methane emissions in the EKC framework in that methane emissions are impacted by livestock production.
  - **Second**, the existence of the EKC hypothesis incorporating methane will contribute to the discussion of reducing greenhouse gases.