Spillover effects of climate change on Gross Domestic Product: A spatial panel approach

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Plan

Literature reviews

- **LeSage andand Fischer (2008)**, used a Durbin spatial model, and find that the level of long-term stable regional income depends on the regions own and neighboring regional characteristics.

- **Baylis and al(2011)**, showed that climate change variables do not directly affect the agricultural production of the local country, but go through the production of the neighboring country and that indirect effect of climate variables appears to be greater than that recorded by the direct effect.

- **Zouabi and Peridy(2015)**, aims to examine the climate change on Agriculture production for Tunisia. The result shows the importance of spatial interactions in agricultural production and the significant role of climate in these spatial spillover effects. In fact, Tunisian agriculture is strongly dependent on the direct effects of temperature and precipitation for all the products considered at the regional level.

Main questions

1. How are climate change and Gross Domestic Product linked?
2. Can the spatial panel data model approach help to examine this relationship?
3. What are policy implications for policymakers and international organizations we can draw?

Data

A balanced panel sample of 80 developed and developing countries over the period 1980-2017, have been used in this study. The set of explanatory variables selection is based on data availability.

Annual data of the climate change expressed as Temperature and precipitation are available on Terrestrial Air Temperature and precipitation.

Annual GDP per capita, trade openness, inflation rate, Human capital, FDI inflow, domestic investment are obtained from World Development Indicators (WDI. 2020).

1.Spatial Durbin Panel Model (SDM)

Spatial Durbin Panel Model (SDM):

$$y_{i,t} = \delta(I_T \otimes W_N)y_{i,t} + (I_T \otimes W_N)X_{i,t}\,\gamma +$$

$$X_{i,t}\,\beta + (i_T \otimes I_N)\mu_t + \varepsilon_{i,t} \quad (1)$$

where δ represent a spatial autocorrelation which introduced in explanatory variable

The SDM Model can be used to determine the appropriate specification (Lesage and Pace (2009).

2.Spatial Autoregressive model(SAR):

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$$y_{i,t} = \delta(I_T \otimes W_N)y_{i,t}\, X_{i,t}\, \beta + (i_T \otimes I_N)\mu_t + \varepsilon_{i,t} \qquad (2)$$

where: δ : represent spatial autoregressive coefficient which measures the strength of contemporaneous spatial correlation between one countries and other geographically proximate countries,
$y_{i,t}$: is GDP per capita for country i at time t $(i = 1, ..., N)$
$X_{i,t}$: represent a set of the explanatory variables, which include climate change variable , trade openness, inflation rate ,human capital, FDI inflow and domestic investment

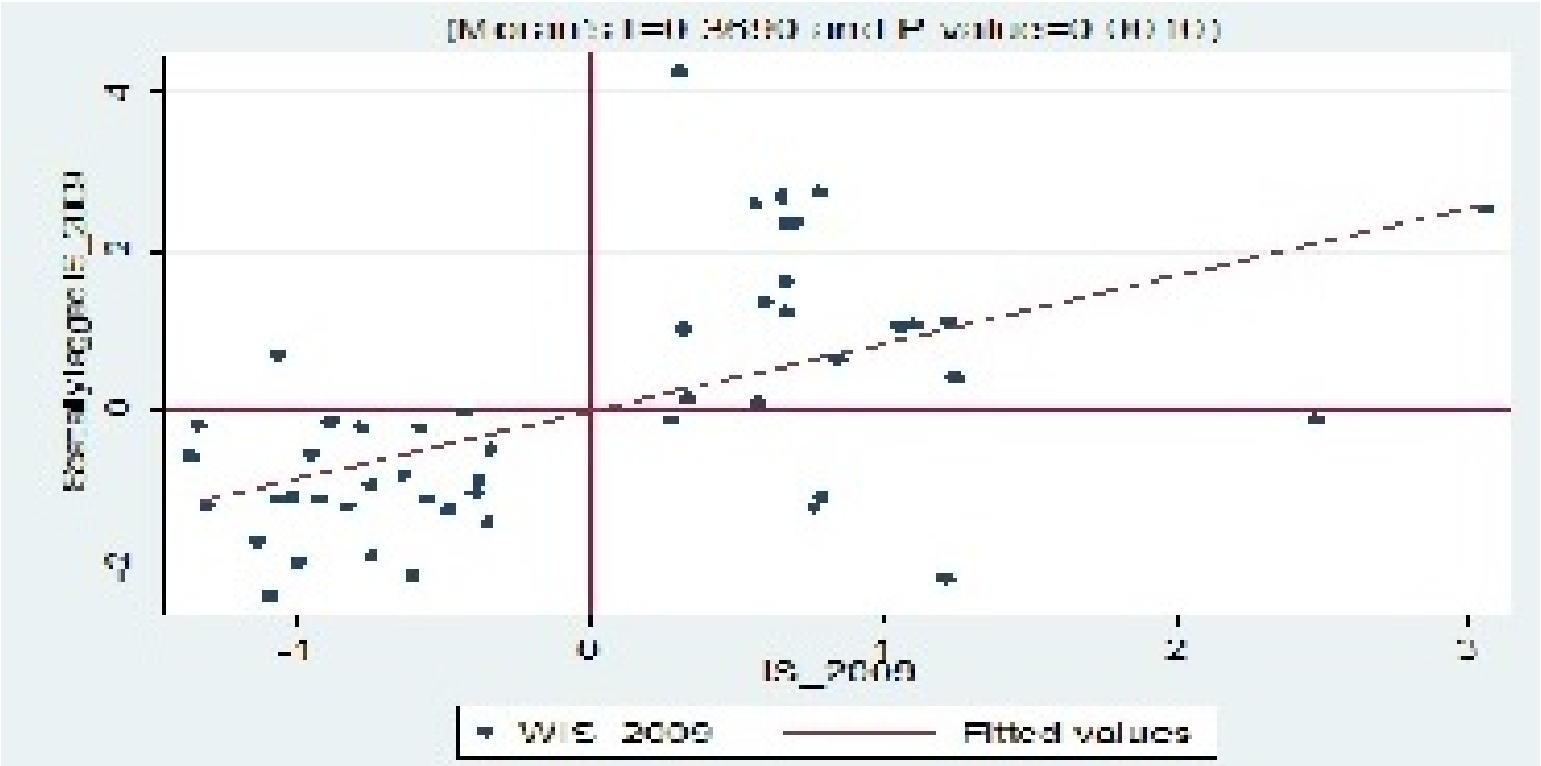
3.Spatial Error Panel Model (SEM):

Spatial Error Panel Model (SEM):

$$\begin{cases} y = X\beta + (i_T \otimes I_N)\mu + u \\ u = \rho(I_T \otimes W_N) + \varepsilon \end{cases} \quad (3)$$

whereρ :denotes the spatial autocorrelation which introduced only in the error term.

Figure: Moran Scatter Plot



The Moran's I index is consistently positive and are statistically significant at the 1% level. Thus that GDP per capita exhibits significant positive spatial autocorrelation.

The choice of the appropriate model

The first step is to select the appropriate model through LM tests (Anselin 2008, Elhorst (2003))

Table: LM and Hausman test result

/	Test	Prob.
LM spatial error	30.00	(0.00)
LM sptial lag test	26.65	(0.00)
Hausman Test	55.85	(0.00)

The result chows that the SDM model is the more appropriate

Tableau 2: Estimation results of SDM model

VARIABLES	Stat	Std error
INFLATION	-3.60e^{-05}	(0.00133)
TRADE OPENNESS	0.0103	(0.0170)
FDI	0.4453***	(0.0589)
INV	0.213***	(0.0647)
PRECI	-0.0844***	(0.0163)
PRECIT$_{s}q$	0.00444***	(0.0053)
TEMP	-1.291**	(0.504)
TEMP$_{S}quare$	0.03**	(0.0058)
W*INFLATION	-0.00394	(0.00943)
W* TREADEOPENNESS	-0.227**	(0.0951)
W*HUM	-1.360	(59.10)
W*FDI	0.603	(3.705)
W*INV	-0.145	(0.435)
W*OUV	-0.0596	(0.0741)
W*PRECIP	0.133***	(0.02819)
W*TEMP	-0.300**	(0.129)
W*PRECIP$_{S}QUARE$	-1.002	(1.15)
W*TEMP$_{S}QUARE$	0.200**	(0.005)
ρ	0.356**	(0.025)

Note: Standard errors are reported in parentheses below the coefficient estimates.
*, **, *** denote 1, 5 and 10% confidence levels, respectively.

Direct effect of climate change on GDP per capita

- δ is positive and statistically significant at 1% level, indicating the existence of spatial dependence presented in the data.
- An increase in GDP per capita of neighboring countries would cause the rising of GDP per capita in the host country.
- The temperature has a negative impact while the squared term carries a negative sign. The marginal effect of temperature calculated on the average is negative in the SDM model.
- The effect of precipitation is negative with a positive squared term. The marginal effect of precipitation calculated on the average is positive in the SDM model.

Indirect effect of climate change on GDP per capita

- For all the independent variables,the changes are tiny whether in term of significance or magnitude $\Rightarrow$
  confirms our main findings are robust with model specification

  These results highlight the importance of taking account of the spatial dependence to assess the determinants of GDP per capita.
- The temperature and precipitation influence GDP per capita not only directly but through the GDP per capita value of neighboring countries. The impact of the climate variables related to neighboring countries is not similar: the result shows that a rise in precipitation or a decrease in temperature in neighboring countries leads to a rise in the production in the host GDP countries.

- Economic growth is strongly dependent on the direct effects of temperature and precipitation.

- Temperature have generally a negative effect on GDP per capita and the impact of squared temperature is positive.

- The effect of precipitation is positive, but the direct impact of squared precipitation is negative and statistically significant.
- An Increase in the precipitation in a given country i makes it possible to increase the production of GDP per capita in this country but also its neighboring regions(spillover effect).
- An increase in the temperature in country i has a negative effect on the GDP per capita in this country but also its neighboring

Based on the empirical findings of this study, we can draw some important policy implications as follows:

- Spatial spillover effects of the dependent variable and independent variables have a significant effect on both of the local and surrounding countries. Therefore, policymakers and international organizations should not only focus on the profit of local country but also consider the influence on surrounding countries.

- Stronger international cooperation is crucial for energy conservation and emissions reduction.

THANK YOU FOR YOUR ATTENTION