ENVIRONMENTAL REGULATIONS AND AGRICULTURAL PRODUCT TRADE

The Case of Thailand

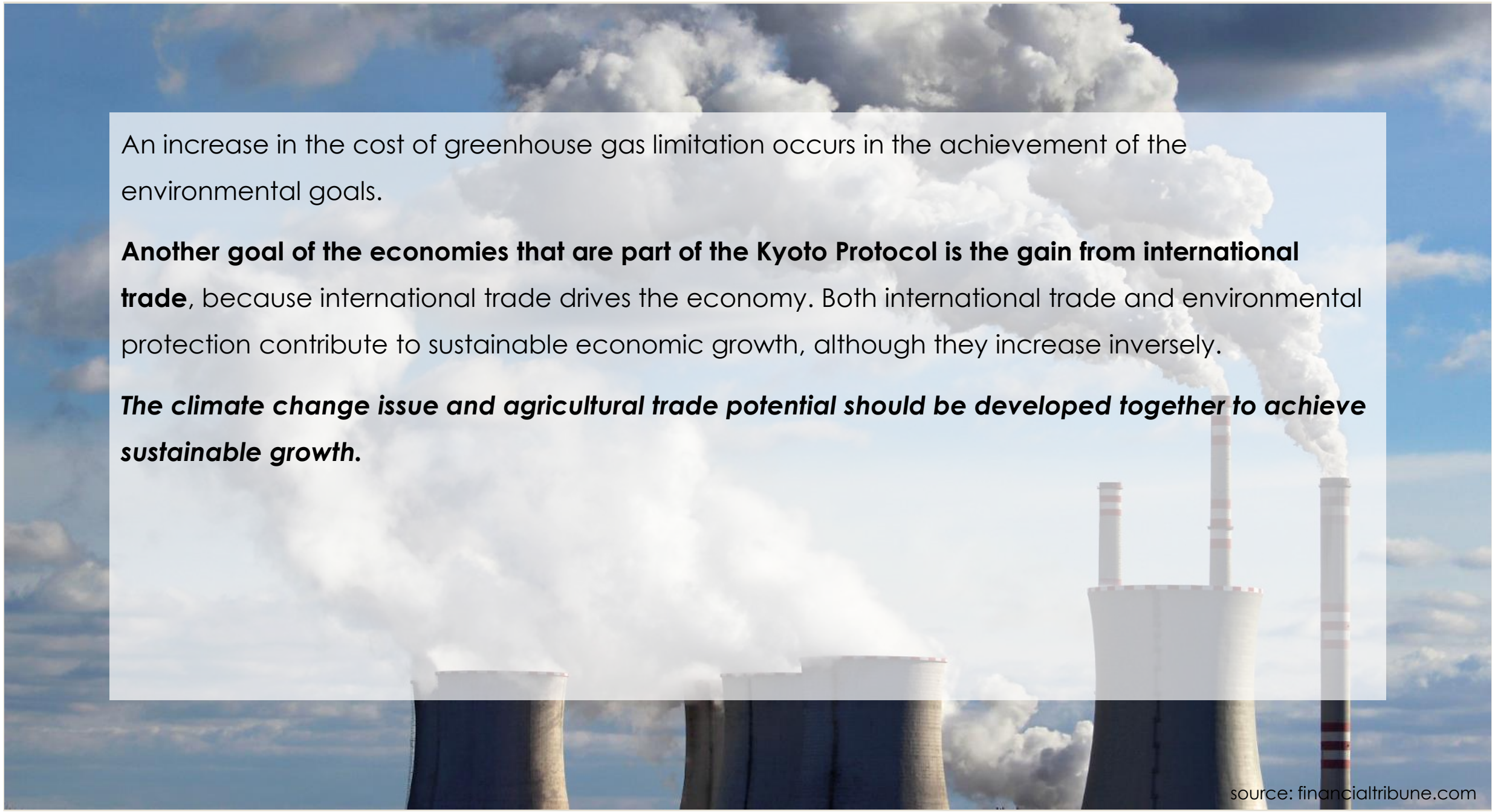
BACKGROUND

Kyoto Protocol

Climate change has become a worldwide serious problem because it affects humanity and ecosystems.

172 countries and the European Economic Community, which represent 61 percent of emissions, participated in the "Kyoto Protocol" under the United Nations Framework Convention on Climate Change (UNFCCC) .

- ***The Kyoto Protocol forces the members to limit and reduce greenhouse gas emissions***. The governments of the member countries provide the policy implementation to restrict the countries that do not address greenhouse gas emissions in their industry.

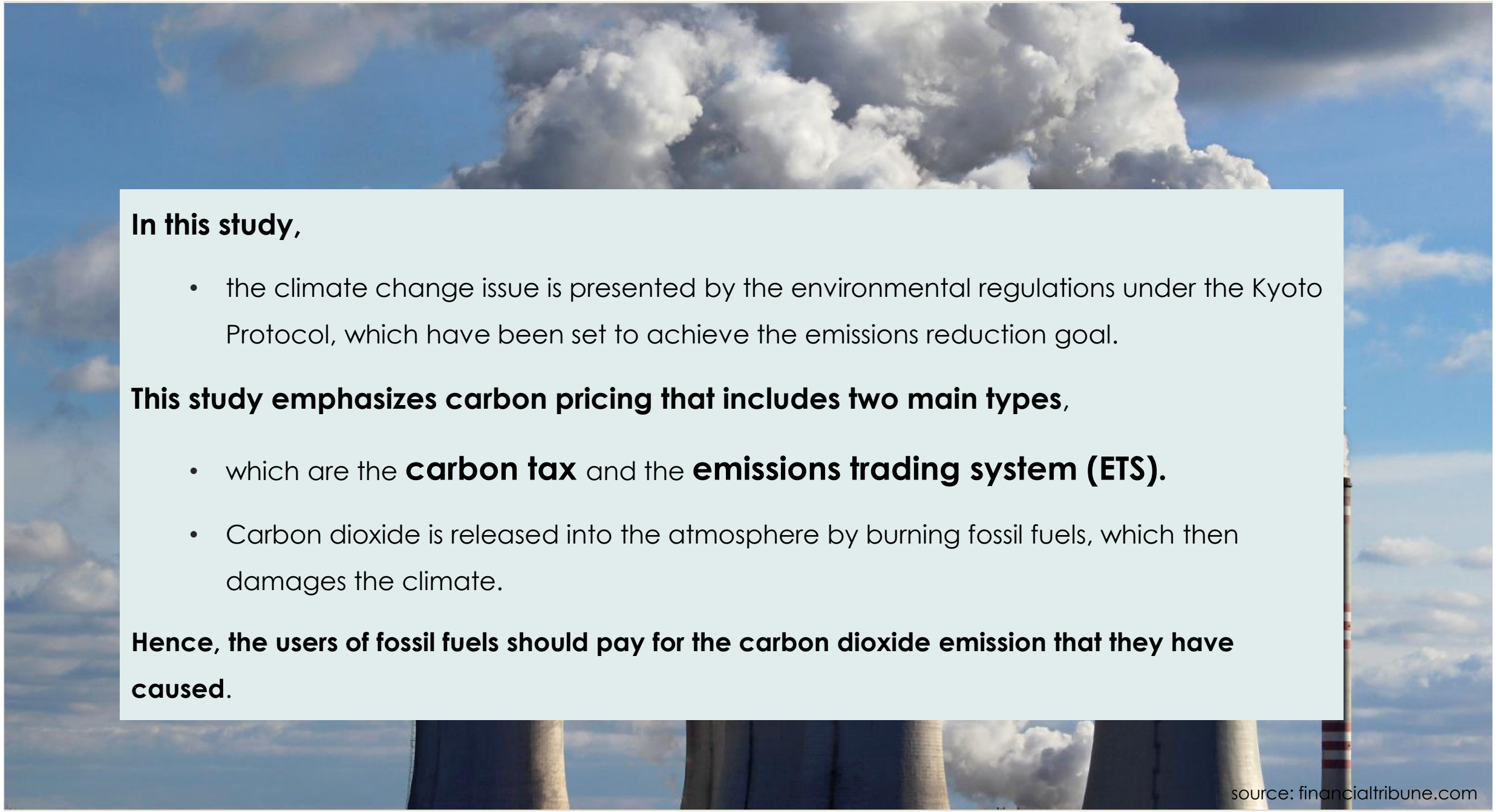


An increase in the cost of greenhouse gas limitation occurs in the achievement of the environmental goals.

Another goal of the economies that are part of the Kyoto Protocol is the gain from international trade, because international trade drives the economy. Both international trade and environmental protection contribute to sustainable economic growth, although they increase inversely.

The climate change issue and agricultural trade potential should be developed together to achieve sustainable growth.

source: financialtribune.com



In this study,

- the climate change issue is presented by the environmental regulations under the Kyoto Protocol, which have been set to achieve the emissions reduction goal.

This study emphasizes carbon pricing that includes two main types,

- which are the **carbon tax** and the **emissions trading system (ETS).**
- Carbon dioxide is released into the atmosphere by burning fossil fuels, which then damages the climate.

Hence, the users of fossil fuels should pay for the carbon dioxide emission that they have caused.

source: financialtribune.com

CARBON TAX

***Carbon tax* involves putting a price on carbon**. The carbon tax center states that "a carbon tax is the core policy for reducing and eliminating the use of fossil fuels (coal, oil, and natural gas) whose combustion is destabilizing and destroying our climate". **Carbon tax is defined as a tax rate on carbon dioxide emissions to achieve a cost-effective reduction in emissions**. If carbon tax is levied at a high enough rate, it will be the policy that will encourage the users of fossil fuels to switch to cleaner technology across their country. Then, the economy will move to non-carbon fuels and efficient energy use.

source: financialtribune.com

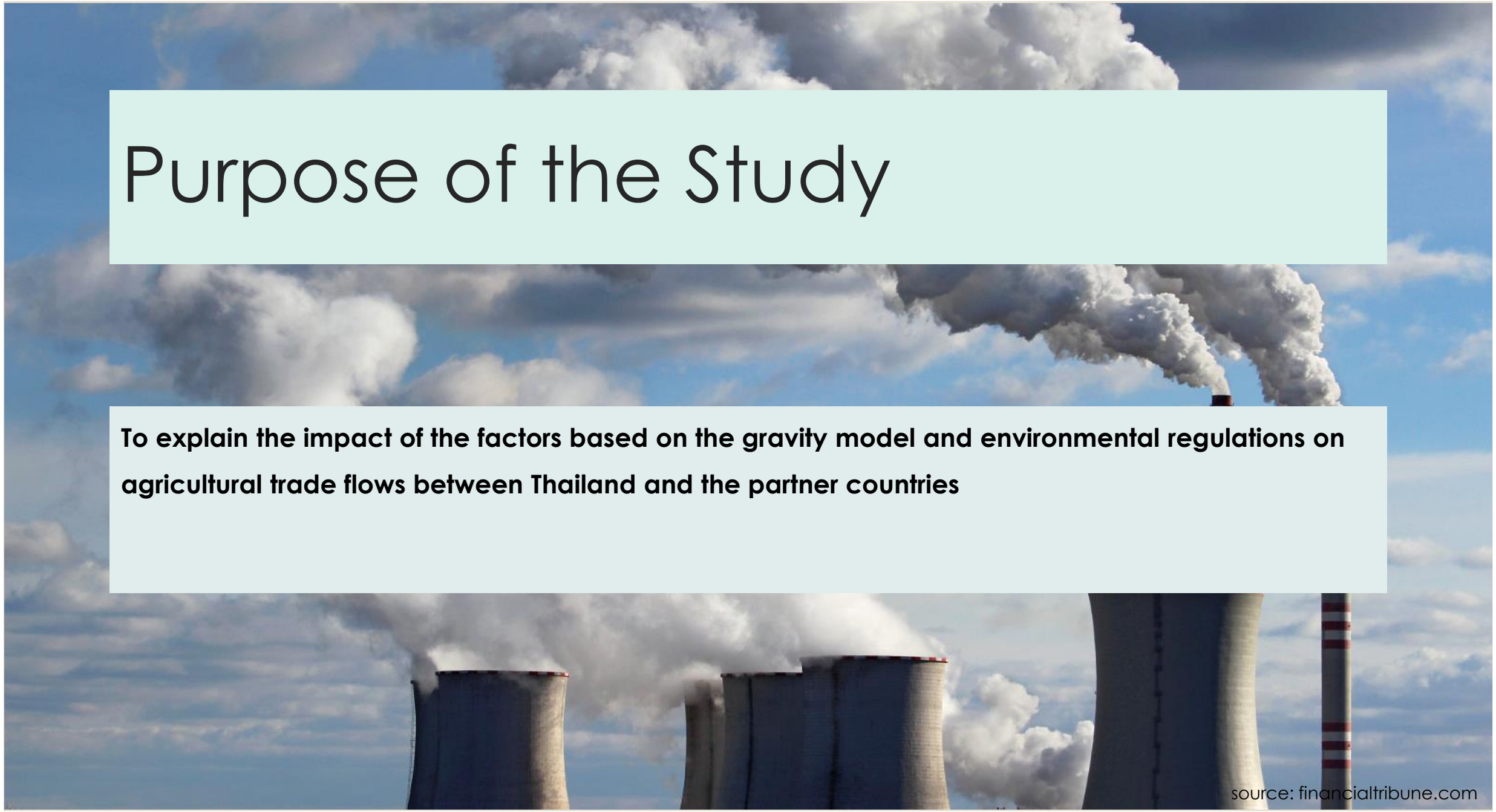
EMISSION TRADING SYSTEM

The *emission trading system* (ETS), or carbon cap-and-trade system, is another tool to put a price on carbon in order to alleviate climate change, and it is a key tool for reducing industrial greenhouse gas emissions cost-effectively. Member countries have a limit on the amount of greenhouse gas emissions**. If a country wants to emit more greenhouse gases, it can buy extra allowances from a country with low greenhouse gas emissions anywhere in the world**. The benefit of emission allowances is that one country can trade with another as it needs within their pre-allocated carbon budgets.

source: financialtribune.com

Purpose of the Study

To explain the impact of the factors based on the gravity model and environmental regulations on agricultural trade flows between Thailand and the partner countries



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METHODOLOGY

Scope of the Study

The yearly data sets were collected from the secondary macroeconomic databases of **China, Hong Kong, Indonesia, Japan, Korea, Malaysia, the United Kingdom, the United States and Thailand from 1996 to 2016.**

The export value of agricultural products to these countries was **60.89** percent of the total export value of Thailand's agricultural products in 2015. Thus, these countries are the partner countries, and Thailand is the home country.

Gravity Model

This study focuses on the impact of environmental regulations on agricultural trade flows between Thailand and its partner countries by using the gravity model. Nevertheless, there are factors in addition to environmental regulation that affect bilateral trade flows in the gravity approach. The main factors of the gravity approach are economic attractors and distance. The gravity model is widely used to determine the pattern of bilateral trade flows.

The gravity model specification is:

$$Agri_{ij,t} = \beta_0 + \beta_1 GDPPC_{i,t} + \beta_2 GDPPC_{j,t} + \beta_3 DIST_{ij} + \beta_4 CarbonTax_{i,t} + \beta_5 CarbonTax_{j,t} + \beta_6 ETS_{i,t} + \beta_7 ETS_{j,t} + \varepsilon_{ij,t} \quad (1)$$

where $Agri_{ij,t}$ is the growth of the value of bilateral agricultural product trade between Thailand (i) and a partner country (j) at time t, which is the sum of the value of agricultural product exports and the value of agricultural product imports.

$GDPPC_{i,t}$ and $GDPPC_{j,t}$ are the gross domestic product per capita growth of Thailand (i) and a partner country (j) at time t, respectively.

$DIST_{ij,t}$ is the distance between Thailand (i) and a partner country (j) at time t. Distance represents the cost of the transportation of agricultural products. Distances between the capitals of two countries is calculated from Google Maps. Annual average crude oil price (US dollars per barrel) is defined by the price of the OPEC Basket .

$CarbonTax_{i,t}$ and $CarbonTax_{j,t}$ are dummy variables for the country which imposes the tax on carbon emissions at time t.

$CarbonTax_{j,t}$ of Japan and the United Kingdom have a carbon tax, so of Japan and the United Kingdom is equal to 1, and $CarbonTax_{i,t}$ of Thailand and $CarbonTax_{j,t}$ of China, Hong Kong, Indonesia, Korea, Malaysia, and the United States is zero.

$ETS_{i,t}$ and $ETS_{j,t}$ are dummy variables for the countries in which the emissions trading system is implemented at time t. China, Japan, Korea, the United Kingdom, and the United States implement ETS, so their $ETS_{j,t}$ is 1. $ETS_{i,t}$ of Thailand and $ETS_{j,t}$ of Hong Kong, Indonesia, and Malaysia are zero.

Table 1: Where carbon is taxed

Country	Year Adopted	Overview	Tax Rate
Japan	2012	Japan's Tax for Climate Change Mitigation covers the use of all fossil fuels such as oil, natural gas, and coal, depending on their CO2 emissions. In particular, by using a CO2 emission factor for each sector, the tax rate per unit quantity is set so that each tax burden is equal to US$2/tCO2 (as of April 2014).	USD2 per tCO2e (2014)
United Kingdom	2013	The U.K.'s carbon price floor (CPF) is a tax on fossil fuels used to generate electricity. It came into effect in April 2013 and changed the previously existing Climate Change Levy (CCL) regime, by applying carbon price support (CPS) rates of CCL to gas, solid fuels, and liquefied petroleum gas (LPG) used in electricity generation.	USD15.75 per tCO2e (2014)

Source: World Bank

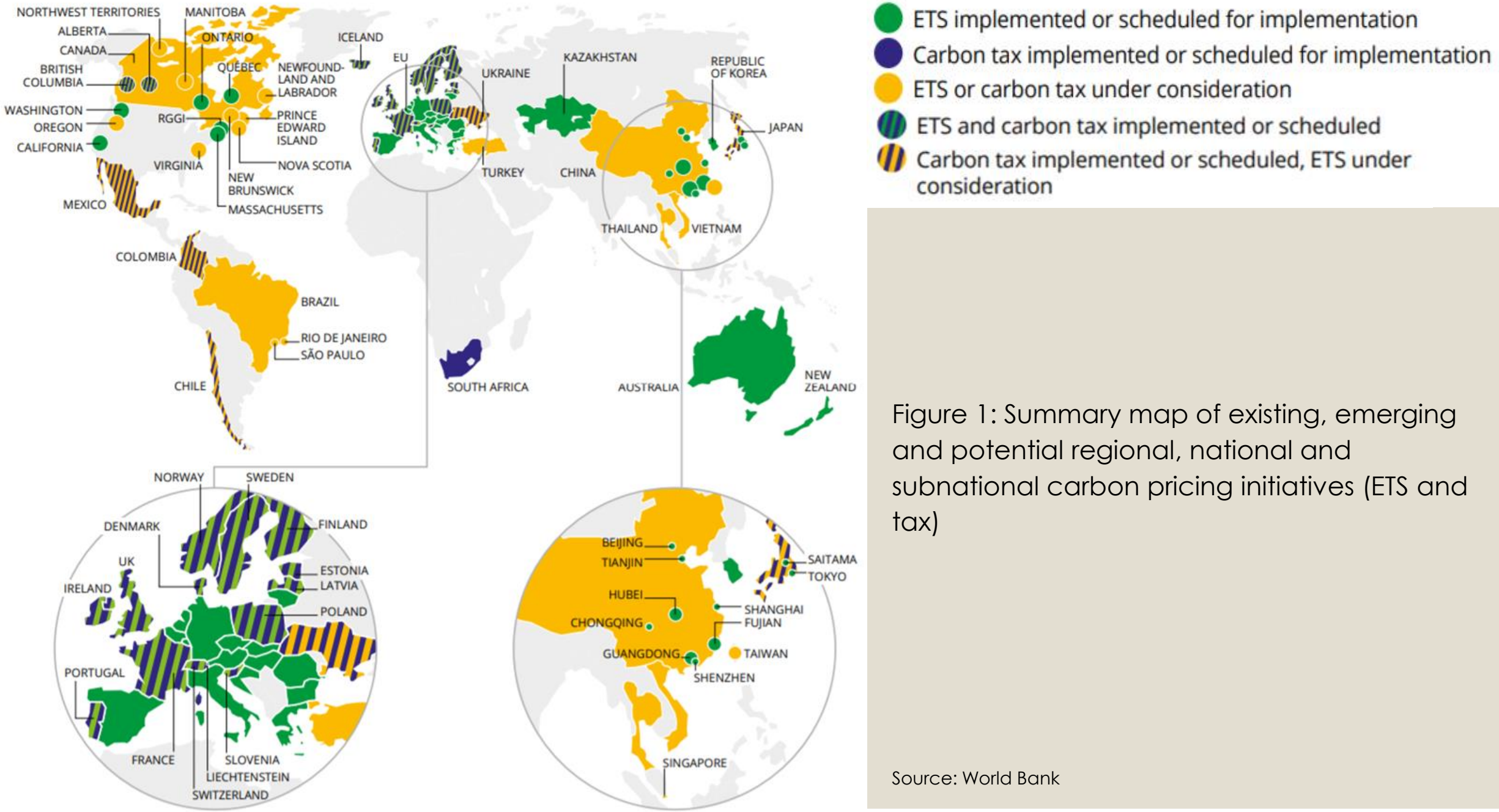


Figure 1: Summary map of existing, emerging and potential regional, national and subnational carbon pricing initiatives (ETS and tax)

Source: World Bank

MARSS Model

The gravity model of this study is evaluated by **multivariate autoregressive state-space (MARSS)** approach. Holmes, Ward, and Wills (2012) developed the MARSS model that is based on the maximum likelihood concept and uses a Kalman filter/smoother and Expectation-Maximization algorithm. The MARSS model is used to fit the linear MARSS model with Gaussian error to time series data. There are advantages of the MARSS model, such as it can contain the missing values, the different model structures and specified constraints.

The model specifications of the MARSS model include two processes, which are the state process and the observation process.

The state process:

$$\begin{bmatrix} GDPPC_{i,t} \\ GDPPC_{j,t} \\ DIST_{ij,t} \\ CarbonTax_{i,t} \\ CarbonTax_{j,t} \\ ETS_{i,t} \\ ETS_{j,t} \end{bmatrix}_{7\times1} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}_{7\times7} \begin{bmatrix} GDPPC_{i,t-p} \\ GDPPC_{j,t-p} \\ DIST_{ij,t-p} \\ CarbonTax_{i,t-p} \\ CarbonTax_{j,t-p} \\ ETS_{i,t-p} \\ ETS_{j,t-p} \end{bmatrix}_{7\times1} + \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \\ u_6 \\ u_7 \end{bmatrix}_{7\times1} + \begin{bmatrix} w_{1,t} \\ w_{2,t} \\ w_{3,t} \\ w_{4,t} \\ w_{5,t} \\ w_{6,t} \\ w_{7,t} \end{bmatrix}_{7\times1}, \qquad (2)$$

where $$\begin{bmatrix} w_{1,t} \\ w_{2,t} \\ w_{3,t} \\ w_{4,t} \\ w_{5,t} \\ w_{6,t} \\ w_{7,t} \end{bmatrix}_{7\times1} : \text{MVN}\left[0, \begin{pmatrix} q_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & q_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & q_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & q_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & q_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & q_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & q_{77} \end{pmatrix}_{7\times7}\right]$$

The observation process:

$$\left[Agri_{ij,t}\right]_{1\times1} = \left[\beta_1 \quad \beta_2 \quad \beta_3 \quad \beta_4 \quad \beta_5 \quad \beta_6 \quad \beta_7\right]_{1\times7} \begin{bmatrix} GDPPC_{i,t} \\ GDPPC_{j,t} \\ DIST_{ij,t} \\ CarbonTax_{i,t} \\ CarbonTax_{j,t} \\ ETS_{i,t} \\ ETS_{j,t} \end{bmatrix}_{7\times1} + \left[a_1\right]_{1\times1} + \left[v_{1,t}\right]_{1\times1}, \qquad (3)$$

where $\left[v_{1,t}\right]_{1\times1} : \mathrm{MVN}\left(0, \left[r_{11}\right]_{1\times1}\right).$

RESULTS

AND

DISCUSSION

Partner Country	β_1 ($Std.Err_1$)	β_2 ($Std.Err_2$)	β_3 ($Std.Err_3$)	β_4 ($Std.Err_4$)	β_5 ($Std.Err_5$)	β_6 ($Std.Err_6$)	β_7 ($Std.Err_7$)
China	0.0028 (0.0036)	-0.0002 (0.0036)	1.9898 (0.0014)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0293 (0.0166)
Hong Kong	0.0005 (0.0429)	-0.0025 (0.0070)	0.0027 (0.0029)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Indonesia	-1.97e-05 (0.0021)	2.12e-04 (0.0064)	7.24e-05 (0.0016)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Japan	0.0028 (0.0052)	-0.0005 (0.0052)	2.0632 (0.0059)	0.0000 (0.0000)	0.0438 (0.0281)	0.0000 (0.0000)	0.0729 (0.0284)
Korea	-0.0044 (0.0056)	0.0066 (0.0100)	0.0063 (0.0063)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.1064 (0.1160)
Malaysia	-0.0005 (0.0035)	0.0035 (0.0217)	0.0040 (0.0070)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
United Kingdom	-0.0002 (0.0080)	-0.0003 (0.0044)	0.0002 (0.0015)	0.0000 (0.0000)	0.0058 (0.0174)	0.0000 (0.0000)	0.0219 (0.1770)
United State	-6.12e-04 (0.0018)	-2.37e-05 (3.54e-04)	0.0032 (0.0024)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0383 (0.0082)

Environmental Regulations

- *Carbon tax*: in the partner countries that impose a carbon tax, the tax leads to additional agricultural product trade between Thailand and these countries.
- *Emissions Trading System (ETS)*: These countries participate in the emissions trading system, which causes the agricultural product trade between Thailand and these counties to increase.

Implementing environmental regulations leads to the reduction of the climate change problem. Based on the results, environmental regulations under the Kyoto Protocol, including carbon tax and emissions trading system, **boost agricultural product trade between Thailand and its partner countries as mentioned in the literature, even though they create additional costs in the production processes**. Moreover, the carbon tax and ETS are under consideration by various countries. Consequently, more environmental regulations will be provided in the majority of countries in order to achieve the least greenhouse gas emissions.

Gross Domestic Product Per Capita

- Thailand's trade of agricultural product with China, Hong Kong, and Japan rises when the gross domestic product per capita of Thailand increases.
- Thailand's trade of agricultural products with Indonesia, Korea, Malaysia, the United Kingdom, and the United States falls when the gross domestic product per capita of Thailand increases.

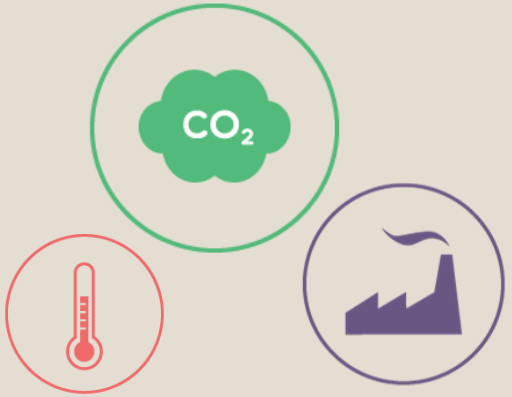
- Additional Thailand's trade of agricultural product with Indonesia, Korea, and Malaysia is affected by increases their gross domestic products per capita.
- Increases in their gross domestic products per capita lead to reducing their agricultural product trade of China, Hong Kong, Japan, the United Kingdom, and the United States with Thailand.

Distance

Additional transportation costs (US dollars per kilometer) leads to more agricultural product trade, which differs from various other works.

CONCLUSIONS

Environmental regulations under the Kyoto Protocol, including carbon tax and the emissions trading system, boost agricultural product trade between Thailand and its partner countries.



Based on the gravity model of Tinbergen (1962),

- **The gross domestic product per capita of Thailand has a *positive effect* on the agricultural product trade between Thailand and partner countries including China, Hong Kong, and Japan,** but it has **negative relation with agricultural product trade between Thailand and other partner countries including Indonesia, Korea, Malaysia, the United Kingdom, and the United States**. Moreover, the impact of the gross domestic products per capita of Indonesia, Korea, and Malaysia on their agricultural product trade with Thailand is positive, but the impact of the gross domestic products per capita of **China, Hong Kong, Japan, the United Kingdom, and the United States** on their agricultural product trade with **Thailand is negative.**
- **Distance has a positive impact on agricultural product trade** between Thailand and its agricultural trading partners.

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THANK YOU