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Impacts of the US dollar (USD) exchange rate on economic growth and the environment in the United States

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ABSTRACT

This paper investigates the impact of the USD exchange rate on economic growth and the environment in the United States by using a Structural Vector Autoregression (SVAR) model. The analysis is based on quarterly country-level data on the real trade weighted US dollar index, petroleum consumption, renewable energy consumption, net imports of pollution intensive products, real GDP and CO_2 emissions during the 1989–2015. The result shows that the USD exchange rate is positively related to petroleum consumption, net imports of the United States in pollution intensive industries with major U.S. trading partners, real GDP and CO_2 emissions. Moreover, petroleum consumption increases real GDP and domestic CO_2 emission levels, while net imports of pollution intensive products decrease real GDP and does not significantly affect CO_2 emissions.

1. Introduction

Greenhouse gases are one of the main causes of climate change. Burning of fossil fuels accounted for 62% of global greenhouse gas emissions in 2008 (C2ES, 2013). It is projected that by 2040 global fossil fuel demands will increase by 56% based on the demands in 2010 (EIA, 2013) and therefore greenhouse gas emissions will increase accordingly. According to a United States Environmental Protection Agency (EPA) 2013 report, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (F-gases) are the four primary greenhouse gases produced by human activities (United States Environmental Protection Agency, EPA, 2013a). Among these four primary greenhouse gases, carbon dioxide (CO_2), comprising 77% of total greenhouse gas emissions, is directly responsible for most climate change (IPCC, 2007).

Many countries have attempted to reduce CO_2 emissions by using a direct and an indirect method because CO_2 emission may lead to climate changes. Climate change negatively impacts economic growth. For example, one possible results of climate change is extremely hot or cold temperatures. Severe temperature can cause increased energy consumption, and frequent floods and droughts that can destroy industrial facilities and reduce crop production (United States Environmental Protection Agency, EPA, 2013b).

With the direct method, countries reduce greenhouse gas emissions by reducing domestic energy consumption. Some studies have investigated the impact of various energy factors on the environment. These energy factors include fossil fuel consumption, renewable energy consumption, and the proportion of renewable energy in total electricity generation or total energy consumption (Shabbir et al., 2014; Farhani and Rejeb, 2012; Amin et al., 2012; Maslyuk and Dharmaratna, 2013; Bozkurt and Akan, 2014). Primary economic models include the Auto Regressive Distributed Lag (ARDL) bound testing approach and the Vector Error Correction Model (VECM).

Using the indirect method, countries shift the domestic CO_2 emissions abatement burden to other countries through international trade. According to the pollution haven hypothesis (Cole and Elliott, 2003; Mongelli et al., 2006; Kellenberg, 2009), countries having relatively less strict environmental standards and policies represent a source of competitiveness in pollution intensive industries. These countries have a lower CO_2 emission abatement cost given that they face less pressure from the less stringent environmental regulations. Therefore, countries with weaker environmental regulations become net exporters, while

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countries with stricter environmental regulations become net importers of pollution intensive products. As a result, countries with environmental policies reduce CO_2 emission levels within their own countries' borders by either importing pollution intensive products from countries that have weaker environmental policies or relocating pollution-intensive firms to those countries with less carbon reduction pressure (carbon leakage).

The relationship between international trade and energy consumption on domestic environment and on economic growth has received little attention in the economic literature. Both economic growth and the environment have to be considered to achieve environmentally sustainable economic growth. If only one is pursued, the other might be sacrificed: emphasis only on economic growth can hurt the environment via unrestrained development, whereas emphasis only on the environment can hinder economic growth through overly-stringent environmental policies. To fill this knowledge gap in the literature, our study aims to investigate how the international trade and the energy sectors affect the environment (measured by CO_2 emissions) and economic growth (measured by real GDP) by using a structural vector autoregression (SVAR) model.

Specifically, we investigate how the direction and magnitude of pollution intensive industries' net import value (Import value − Export value) affects real GDP and domestic CO_2 emission levels. We focus on pollution intensive industries because they use more fossil fuels which results in higher CO2 emissions in the production process compared to other industries. In addition, net import measures the net impact of trade flow on economic growth and the environment by offsetting the effect of imports and domestic production for exports on real GDP and CO_2 emissions.

Our SVAR model included the currency exchange rate to show how it affects economic growth and the environment. Ćorić and Pugh (2010) and Mukherjee and Pozo (2011) have found that exchange rate volatility has a significant negative impact on trade volume. Fouquin et al. (2001) show the energy sector is among the sectors that are most sensitive to exchange rate volatility in the European manufacturing industry. In addition, Yu and Mallory (2014) find that the currency exchange rate affects the carbon credit price via European coal and natural gas markets. This implies that the exchange rate plays an important role in both international trade and the energy sector, as well as in economic growth and the environment.

This study focuses both on energy markets in the United States and trade in pollution intensive industries between the United States and their trade partners, because the United States have a profound influence on the global economy and the environment. As the largest economy in the world, the United States was the world's second largest CO_2 emitter (5.19 billion tonnes) in 2012 (British Petroleum Company, 2014; Olivier et al., 2013). In 2012, the United States ranked first or second in fossil fuel consumption: first for petroleum (817.0 million tonnes), second for coal (436.7 million tonnes oil equivalent), and first for natural gas consumption (657.3 million tonnes oil equivalent). In particular, U.S. bilateral international trade with major trade partners in pollution intensive industries which is categorized under the SITC code (Harris et al., 2002) accounts for 19.76% of total exports and 14.06% of total imports among major U.S. trade partners in 2012.[1]

The remainder of this paper is organized as follows: Section 2 describes the data; Section 3 introduces our econometric model; Section 4 estimates the SVAR model and reports the empirical results of impulse response functions (IRFs) and Variance Decomposition (VDs). Section 5 presents conclusions and considers policy implications.

[1] Calculated by the author using trade data from the United States International Trade Commission (USITC).

2. Methods

2.1. Data description

This study uses quarterly data from 1989 to 2015 (1989/Q1 ~ 2015/Q1) including 105 observations over 27 years. Many macroeconomic data series were collected at different frequencies, namely, monthly, quarterly or annually. We converted monthly data to quarterly data for this analysis to match the quarterly GDP data.

Monthly country-level data of carbon dioxide (CO_2) emissions represent the amount of CO_2 emissions from energy consumption in the United States. The data were obtained from the U.S. Energy Information Administration (EIA).

Real Gross Domestic Product (GDP) was generated by dividing nominal GDP by the consumer price index (CPI). The United States' nominal GDP and the CPI data were obtained from the Federal Reserve Bank (FRB) of St. Louis.

For the exchange rates, we employed a real trade-weighted U.S. dollar index (broad) that is a weighted average of the foreign exchange value of the U.S. dollar relative to the currencies of a group of major U.S. trading partners[2]: A high (low) value of the index indicates appreciation (depreciation) of the US dollar compared to the currencies of the trade partners. The source of the quarterly data of the real trade-weighted U.S. dollar index is from the FRB of St. Louis.

From the Unites States International Trade Commission (USITC), we obtained bilateral, monthly country-level export (Free Alongside Ship (FAS)) and import (general C.I.F) values of pollution intensive industries for the United States and its trade partners who have lower stringent scores of environmental regulations data. Countries with less stringency scores of environmental regulations than the United States were selected based on the stringency score at the World Economic Forum's report (World Economic Forum, 2013).[3] We focused on values representing trade between United States and countries who have less strict environmental regulations than the United States because this study attempts to investigate whether United States can decrease CO_2 emissions indirectly through trade with pollution intensive industries (pollution haven). Based on the SITC code, Harris et al. (2002) classified the following as pollution intensive industries: pulp and waste paper (SITC 251), petroleum products (SITC 334), residual petroleum products (SITC 335), organic chemicals (SITC 51), inorganic chemicals (SITC 52), fertilizers (SITC 562), chemical materials (SITC 59), veneers, plywood (SITC 634), wood manufactures (SITC 635), paper, paperboard (SITC 64), lime, cement, construction materials (SITC 661), iron and steel (SITC 67), non-ferrous metals (SITC 68) and metals manufacturing (SITC 69) industries. These values were also converted to real values by dividing by the CPI.

In addition, fossil fuels and renewable energy consumption were also included as endogenous variables. In this paper, petroleum consumption was used to represent non-renewable energy consumption since the consumption of petroleum comprised the largest share at 36% of total fossil fuel consumption in 2013. Petroleum consumption data was converted from a thousand barrels per day to trillions of BTU per month by multiplying by 0.0058 (conversion factor[4]) and 30 (days in a month).

Renewable energy consumption was measured by aggregating hydroelectric power, geothermal energy, solar/ photovoltaic (PV), and wind energy. We excluded bioenergies such as wood energy, waste

[2] Canada, Japan, Mexico, China, United Kingdom, Taiwan, Korea, Singapore, Hong Kong, Malaysia, Brazil, Switzerland, Thailand, Philippines, Australia, Indonesia, India, Israel, Saudi Arabia, Russia, Sweden, Argentina, Venezuela, Chile and Colombia., and eleven original member countries for Euro Area (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain).

[3] Canada, Mexico, China, Taiwan, Korea, Hong Kong, Malaysia, Brazil, Thailand, Philippines, Indonesia, India, Israel, Saudi Arabia, Russia, Argentina, Venezuela, Chile, Colombia, France, Italy, Portugal and Spain.

[4] 1 barrel = 5,800,000 (based on US consumption, 2013) from EIA (EIA, 2014).